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80 FUTURE 423

94 OF DATA 43

18 Golden demo's of COMMIT/ 495265

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# The big, bright future of data



Arnold Smeulders  
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Welcome to the world of Big Data. COMMIT/ is a public-private research community for the advancement of Information Technology in the Netherlands. The name COMMIT/ expresses the dedication to communicate advanced IT-solutions to you. As a public-private research community we are committed to pursue the latest Information Technology and to present it to the Dutch society. Running from 2010 – 2016, COMMIT/ is a precursor for the current wave of Big Data, from advanced infrastructure, to extensive content and web analysis, ad-hoc networks, data mining and to interaction.

We have collected fifty of our best results in demonstrators to make Information Technology visible for you. Each demonstrator will illustrate in what way it differs from the current state of the art.

Information Technology is *the* driver of economic innovation. Digital data have entered everyone's life, all professions, each business and all relations. It is hard to imagine any such driver in the past (or it must be electricity and the steam engine): the knowledge of Internet, the media of the digital channels, the instant social media, the transformation of the news, the organizational power of smart phones, the globalization enabled by the network, the ease of interaction, the support of apps which is starting to come and the statistics of professional live in Big Data. Under whatever name, Information Technology has transformed itself and the world around us overnight. Mobiles grew from zero to general acceptance in ten years, not only here but all around the globe. The same was true for smart phones, digital television and the Internet. The impact of Big Data will follow with the impact on economics, use and production.

The current fifty demo's collected in this booklet are a direct result from Dutch industry and have inspired IT-scientists of the Netherlands one-to-one at the work table. As a result, the prototypes you are about to see will be world-leading at least inside.

In science it is as important to be world-leading as it is in technology business. In science there is an additional need to make well-motivated and novel choices. In business there is an additional need to fit the uniqueness into a robust business model. It is the strive for uniqueness where science and technology business meet as the competitive edge endures longer for unique solutions. Though not always easy, we have put emphasis in our presentations to present the uniqueness of the demo. You are invited to ask the question: *Does Google already has this?*

Luckily, IT-science of the Netherlands is world-level, not just the network but also the Big Data tools we are proud to present. Whether they are local networks, information security, Twitter stream analysis, picture analysis, interaction, sensor data processing, compute platforms or web information management. You are invited to ask the question: *Who else does this world-wide?*

Information Technology has this strange and almost unique impact that it affects more than one, often completely different fields. For the demonstrators, we have selected one application to make it real, but almost always there is a second application hidden from a different field. You are invited to ask the question: *What else can you do with this?*

The fifty demo's are sorted by *type* and by *application*. As a result, the demo's are indicative of what can be done with the results for the purpose of inspiring you to other uses, maybe even your own use. We would be more than thrilled if you are inspired to a different use. The impact of Information Technology is phenomenal. Therefore, more than any other discipline, all modern societies should have a high-level of advanced Information Technology at hand. The impact is so big because its reach is immediate, instantaneous, and far-reaching. The impact is not limited to transporting bits from A to B, but expanding to understanding the content of the information. Mastering the network and the content leads to economic prosperity. IT is far too important to leave the technology to foreign companies only as they reach our doors and into our houses. Information Technology - and an active understanding thereof - is a matter of national quintessence as is implemented in all countries around us. A precursor to the *topsectors*, funding for COMMIT/ is for 45 percent from the government, 25 percent from universities and academia, and 25 percent from industry and non-profit for a total of 110 M€ over six years. We are grateful for the vision which underlies these choices.

On behalf of the COMMIT/ Board of Directors, you are invited to join in the world of Information Techies!

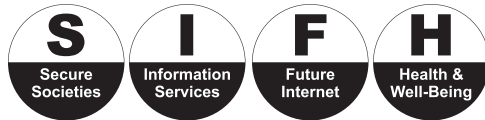


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Content	4	Content	5
	<b>Legend</b>		6
	<hr/>		
	<b>Volume &amp; Velocity</b>		
<b>Demo</b>	1. Tracking the use of data all the way		8
	2. To which music is the world listening?		10
	3. Monitoring reputation on Twitter		12
	4. Finding interesting information that you were not looking for		14
	5. Geographically exploring Twitter hot-spots		16
	6. Scavenger Hunt game helps in customer recommendations		18
	7. Smart search using common sense		20
	<hr/>		
	<b>Heterogeneity &amp; Quality</b>		
	8. Finding new drugs by visualizing the effect of their ingredients		22
	9. Rapidly finding variations between human genomes		24
	10. Scan and print yourself in 3D		26
	11. Exploration tool for investigative journalists		28
	12. Automatic photo tag recommendation for Flickr		30
	13. Finding the most interesting fragments in a tv-broadcast		32
	14. MediaMill Semantic Video Search Engine		34
	15. Visualization of topic evolution in news articles		36
	16. Automatic risk assessment of vessels in maritime areas		38
	17. Let an intelligent machine explain its decisions		40
	<hr/>		
	<b>Intelligent System Design</b>		
	18. A facelift for old software		42
	19. BTWorld: A Large-scale Experiment in Time-Based Analytics		44
	20. Monitoring group emotions		46
	21. Whiskers let your beloved ones feel your mood		48
	22. Early validation of software designs		50
	23. Emergency communication technology for crowd safety		52
	24. Intelligent lampposts warn crowds in emergency situations		54
	<hr/>		
	<b>Scalability</b>		
	25. Automatic testing improves software quality		56
	26. Rapidly visualizing Wikipedia page views		58
	27. Lost in your data? Let Blaeu give you a few tips		60
	28. Predicting the earth's climate with Graphics Processing Units		62
	29. Building the Internet of the future		64
		30. Telehomecare that protects people's privacy	66
		31. Trusted healthcare services	68
		32. Web-based tools for handling biomedical Big Data	70
		33. How to get more out of food research	72
		34. Wireless crowd monitoring in Arnhem	74
		35. Using smartphones for emergency messaging	76
		36. Measuring crowd densities for safety and efficiency	78
		<hr/>	
		<b>Physical User Interaction Styles</b>	
		37. Tikkertje 2.0	80
		38. Advising optimal step frequency for runners	82
		39. Run, talk and don't get injured	84
		40. Intelligently grouping amateur runners	86
		41. Learning with your body as interface	88
		42. Playing with emotions in the Moodroom	90
		43. Personalized interactive wall for elderly with dementia	92
		44. Send your loved one a gentle caress via a tactile sleeve	94
		45. An exercise game to reduce the risk of falling	96
		46. A serious game for training social skills of police officers	98
		47. Virtual learning helps people with language problems in societal participation	100
		<hr/>	
		<b>Human Computation</b>	
		48. Involving the end-user in the design process	102
		49. Socially adaptive apps	104
		50. Diabetes: Measuring Less to Feel More	106
		51. Monitoring moods of workers reduces sick leaves	108
		52. Coaching-app helps to find work-life balance	110
		53. Quantifying your life for a better well-being	112
		54. Molecular biobanks unravel the secrets of breast cancer	114
		55. Enriching use and experience of radio content	116
		56. Nichesourced annotation of cultural heritage collections	118
		57. One-click semantic enrichment of scientific data	120
		58. Evaluating the reliability of eHealth-data	122
		59. Privacy transparency tools give more trust in eHealth	124
		<hr/>	
		<b>COMMIT/ projects and project leaders</b>	126



The icon represents a **societal topic** that showcases the potential of each of the golden demos. Four societal topics are chosen in line with EU research programs:



Each golden demo comes with a short statement explaining the golden demo to one of the following personas:



**General Public:** explains what is in it for companies or society at large



**Product Developer:** describes to an entrepreneurial youngster the innovation potential and societal impact



**Innovation Manager:** provides arguments at the boardroom level for a trial project



**Scientist:** reveals to academics the ICT-science challenge underlying the golden demo

**Physical User Interaction Styles**

80

Physical User Interaction Styles

81

### 37. Tikkertje 2.0

Interactive playgrounds are installations that combine the benefits of traditional playgrounds for children with advances in technology. In our demo we show the Interactive Tag Playground (ITP), a modern, interactive version of the century-old game called 'Tagging' or 'Tikkertje' in Dutch. With the Interactive Tag Playground we actively steer the interaction between players. To this end, players are being tracked using Kinects and additional body-worn sensors. In its most basic version we project differently colored circles around each player to indicate the role of tagger or runner. When these circles collide, a 'tag' is detected and the roles of the players switch. We also add novel interactive elements such as power-ups and bonuses. Apart from entertainment, the Interactive Tag Playground is also a tool to study how children interact with each other and with the environment. Our final aim is to automatically steer the interactions in such a way that all players remain engaged and physically active.

**ICT science question**  
How can we best track the players and understand their interactive behavior? What kind of interactions are suitable at which moment during the play to maintain the engagement of players? How can players be motivated to adopt certain play styles such as cooperation or competition?

**Application**  
Our work can eventually be combined into playgrounds that allow for adapted play without any restrictions such as the need to wear certain sensors. We see great potential for these playgrounds in open spaces such as traditional playgrounds, shopping malls, sporting facilities and outdoor squares.

**Alternative Application**  
Interactive play is everywhere. Not only children can benefit or enjoy interactive play. Previously, we made an ambient interactive bar that was successful in entertaining adults. The techniques, both for sensing and interaction, are largely the same. One can also think about offering play to people who normally have limited play opportunities, such as heavily handicapped or demented people. Interactive play might help in socializing, entertaining, triggering physical activity or even branding.

**Nice to know**  
The behavior of adults and children while playing tag is largely the same. Except that children cheat more.  
In 2008, the UK Local Government Association promoted tag games stating that children are over-protected ("wrapped in cotton wool"). [Wikipedia]  
Variants of tag have fancy names such as "Cops and Robbers", "Kiss Chase" and "Ringolevio".

**Quotes from participating students:**  
"This looks so cool!! I want to play!"  
"I want to have this at home!"  
"This should be a new sport, Olympic!"  
"I think this would fit very well in gyms or fairs"

- An interactive whole-body game aimed at enhancing the player's fun, physical and social experience.
- An interactive game environment that senses players' behavior to facilitate a physically active, social and engaging experience with multiple other players without prior calibration.
- A novel game environment that mediates gameplay elements by sensing and tracking players to promote targeted behavior or improving the game experience.
- Tracking and analysis of human behavior to create engaging gameplay.

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This research was supported by the Dutch national program COMMIT7

These researchers are responsible for the golden demo

Each golden demo fits one of six **ICT-Science** clusters, clearly represented by a color

**Volume & Velocity** addresses those datasets that are huge but with the need to be processed in real-time using smart algorithms

**Heterogeneity & Quality** recognize that raw data originates from a variety of sources with different levels of quality and focus on finding patterns that are meaningful

**Intelligent System Design** centralizes around the question how to create systems and standards that will continue to work as the world evolves

**Scalability** closes the gap between computational complexity and available computing resources

**Physical User Interaction Styles** explore natural interaction models to interact with the physical world that is engulfed with data

**Human Computation** allows intuitive interaction with all sorts of data to bring contextual knowledge and trust into the process of understanding highly complex data

Partners that are involved with the golden demo

# 1. Tracking the use of data all the way

Data analysis and transformation are increasingly important activities in both scientific research (e.g. climatology) and other fields (e.g. open government data). Unfortunately it is hard to assess the trustworthiness and quality of the results without knowledge of what data the outcome was based on, and through what procedure the outcome was reached. This information about entities, activities and people involved in using data is called *data provenance*.

Our demo shows the integration of data provenance tracking and visualization in an existing, popular data science environment. The demo is an application of our work based on the PROV W3C standard, provenance visualization and tracking.

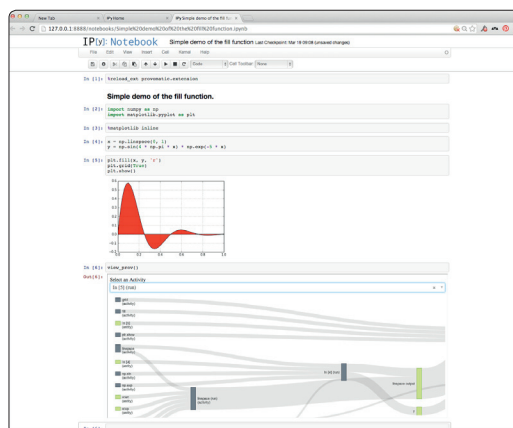
Our work allows for fine-grained tracing of conclusions in scientific papers to intermediate results, other publications, across applications and source data.

## ICT science question

Data are manipulated in a wide variety of tools. It is a grand scientific challenge to construct, reconstruct, communicate and connect data provenance traces. In solving this challenge we have to deal with a lack of standards and integration in tools. Another challenge is to integrate data provenance in environments that scientists already use, without forcing them to learn a new tool or adjust their way of working.

## Application

We apply our technology to support data scientists in creating a better argumentation for their research outcomes. We integrate the PROV W3C standard as part of an existing, widely used



open source data science environment (IPython Notebook) as well as version control systems and personal file storage solutions.

Currently provenance tracking has only been implemented in highly controlled, closed environments such as scientific workflow systems (WINGS, Taverna). Our innovative visualization tool PROV-O-Viz visualizes the flow of information through the provenance graph, giving users better insight in the important aspects of their workflow.

## Alternative Application

Provenance tracking has wide application areas outside scientific research. In the context of Big Data in industry and government, it becomes increasingly important to know the origin of individual datasets. This is not only because of reliability and trust issues, but also because of legal reasons such as license compatibility, copyright, intellectual property right and privacy.

## Nice to know

Without sufficient provenance information, scientific research cannot be reliably reproduced. Pharmaceutical company Bayer halts about two-thirds of drug target-validation projects, because experimental findings reported in literature cannot be reproduced.



Money well spent? Provenance is key in improving the efficiency, reproducibility, integrity and trustworthiness of research.



Anyone can publish dead data. But can you publish it in a way that others can find it, combine and reuse it?



Innovations should be seamlessly integrated in everyday practice, with a maximum effect on the quality and traceability of information exchange.



Suppose a reviewer walks up to you and says: "That number in Table 1, where does that come from?" Well, do you have an answer?



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Data2Semantics From Data to Semantics for Scientific Data Publishers

## 2. To which music is the world listening?

We have developed the web application Streamwatchr, that monitors Twitter to find out to which music people are listening. Streamwatchr offers real-time insights into music listening behaviour around the world.

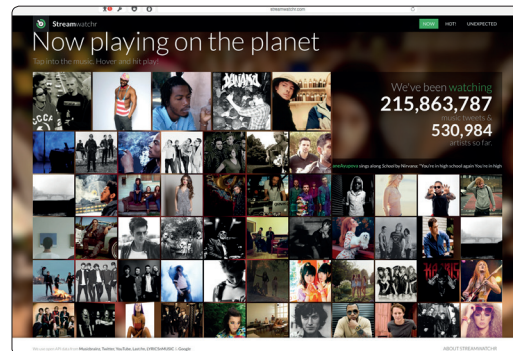
Using the button 'Now', we show the stream of plays coming in. It can be great to discover and listen to some unknown bands that others are listening to. Using the button 'Hot', we show a real-time chart, based on the current popularity of songs and artists. Finally, using the button 'Unexpected', we try to find songs and artists that could be booming soon. Streamwatchr's engine for interpreting music listening behaviour on Twitter uses YouTube, Musicbrainz, last.fm, lyricsNmusic for mapping and analyzing an incoming stream of tweets: six tweets per second, five hundred thousand tweets per day.

### ICT science question

The core scientific challenge that Streamwatchr addresses is how to interpret highly dynamic user-generated texts. Streamwatchr maps the content of text messages to a knowledge base in real-time.

### Application

*Streamwatchr* is a consumer-oriented web application based on tweets about music. The interface shows the music that is being played and listened to around the world in real-time via flipping tiles. By clicking a tile, users can play songs via Youtube and find related songs via *Streamwatchr*'s recommender system. Users can also see what people are singing along to now, or which parts of the lyrics are most popular for a song. *Streamwatchr*'s private partners are 904Labs and Eagerly Internet. Due to the highly competitive arena in consumer-oriented music discovery (e.g., iTunes, Spotify, Milk), *Streamwatchr* will use its backbone technology for developing business-to-busi-



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INFINITI Information retrieval for Information services

ness products different from the consumer-oriented web application. A non-profit partner can be Musicbrainz for using *Streamwatchr*'s song and artist popularity signals. A commercial partner can be Spotify, which can extend their signals with those from Twitter using *Streamwatchr*'s technology. For these applications, the core technology is in place but APIs for broadcasting the data are still to be developed.

### Alternative Application

Unstructured text analysis is broadly applicable. The technology behind Streamwatchr can be applied to analyze behavioural patterns around other consumer-oriented products, like movies, tv shows, food, or wish lists to name a few. Our technology allows for generating real-time popularity charts, detecting anomalies as early signals of the next music hit, and radio functionality via a recommender system that is updated in real-time with every single tweet.

### Nice to know

People around the globe report about their music listening behaviour, in half a million tweets. Every day. Streamwatchr encounters between two hundred and three hundred new bands per day. Every day. For its semantic interpretation engine, Streamwatchr fires two hundred million queries per month. Every month.



Streamwatchr's technology transforms the content from social media into meaningful signals. Streamwatchr has been selected as one of 12 projects that got funding for SXSW, the major event for music industry, and attracted very positive feedback.



The technology behind Streamwatchr adds a layer of intelligence in products that work on behavioral signals. Potential applications include online reputation management, discovery and predictive applications, and recommender systems.



Activities shared online is a powerful but hard-to-capture signal due to their high volume and their unstructured nature. Streamwatchr marks the first step beyond tedious manual annotation of these data by capturing their essence automatically.



To understand the world as it happens, our technology the mapping of unedited text to knowledge bases to see patterns in human behavior. Entity recognition and disambiguation is particularly challenging for songs and artists in the long-tail.

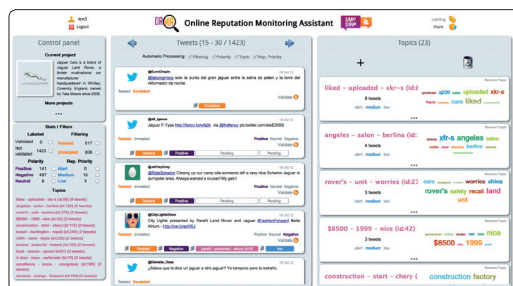


UNIVERSITY OF AMSTERDAM



# 3. Monitoring reputation on Twitter

In an online society reputation management is essential. Tweets can quickly make or break the reputation of brands, companies and organizations. We present a semi-automatic tool designed to monitor the reputation of companies, organizations and people on Twitter. The tool is called ORMA: Online Reputation Monitoring Assistant. ORMA automatically annotates tweets for relevance and reputation: Is the tweet about the entity? Has the tweet positive or negative implications for the reputation of the entity? The tool also groups tweets by topics and displays topics in decreasing order of relevance from a reputational perspective. ORMA helps the user to understand the contents being analyzed and to produce a manually annotated version of the data, using the output of the automatic annotation processes.



## ICT science question

How can the annotation process of unstructured texts be made more efficient? To solve this scientific challenge, we develop new techniques based on advanced semantic information retrieval and natural language processing.

## Application

Our reputation monitoring tool assists experts by suggesting automatic annotations that can be manually changed. Preliminary results suggest significant time saving compared with not using automatic annotations. We have developed the tool in collaboration with the leading Public Relations consultancy firm Llorente & Cuenca.

There are already reputation monitoring tools available on the market, for ex-ample Brandwatch, MYSYSPOT, Talkwalker and MetricPoint. However, ac-cording to a recent survey by Llorente &



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Cuenca, they do not satisfy the necessities of reputation experts due to a lack of relevant functionalities and poor performance.

## Alternative Application

Our research can be applied in other contexts involving consumer portals, opinions portals, news aggregators, marketing strategies, etc. New applications possibly require different visualization solutions, but the techniques we use for natural language processing and machine learning will be generally applicable.

## Nice to know

ORMA has already been used in a real annotation process in order to build a corpus of tweets for developing and testing Online Reputation Management algorithms at RepLab 2013. This is a competitive evaluation exercise for Online Reputation Management systems.

## Quote

"Using this tool the reputational experts will improve their efficiency aiming to analyze more data with the same time and improving the quality of their re-ports." – Analyst of consultancy firm



This tool can be effectively used by politicians to get powerful and comprehensive insights on their online reputation as distilled from relevant Twitter posts.



ORMA integrates a number of algorithms into a reputation monitoring solution that lies between full automation and manual analysis, combining automatically generated results and experts' feedback.



We propose a unique reputation monitoring tool able to learn from manual annotations of tweets to provide reputation insights in a more efficient and accurate way.



ORMA features advanced techniques for filtering, polarity classification of tweets, topic detection and their ranking by priority from a reputation management perspective.



This demo is part of the LiMoSiNe project in close cooperation with the COMMIT/ *demo to which music is the world listening?* (Nr. 2, also known as the StreamWatchr demo). The LiMoSiNe project runs within the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement nr 288024.

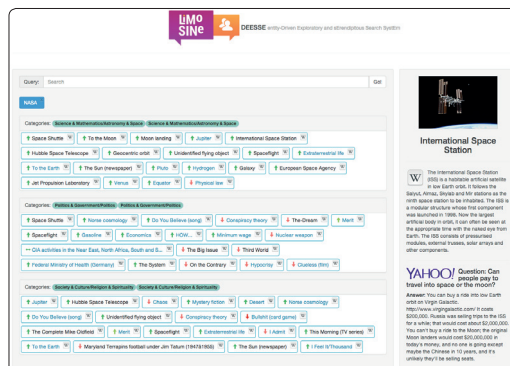


## 4. Finding interesting information that you were not looking for

When you use a search engine like Google or Yahoo, you are basically looking for an answer to a specific question. However, in everyday life you sometimes stumble upon interesting information that you were not looking for, for example when reading a newspaper or jumping from hyperlink to hyperlink on the web. This surprise effect is called serendipity. We are building a new type of search and exploration engine that promotes serendipity. Our serendipitous search engine, called DEESSE, provides results that are both relevant to the user's current interest, and interesting, to encourage the user to continue the exploration. DEESSE takes its data from both two major sources of user-generated content: Wikipedia, a collaboratively edited encyclopaedia, and Yahoo Answers, one of the most popular question-answering platforms where users freely exchange opinion and advice

### ICT science question

Serendipity and interestingness are subjective notions. Can we, despite this subjectivity, find a scientific approach to define, operationalize and evaluate what makes a search result serendipitous? No previous research or application has fully succeeded in this yet, although some attempts have been made to introduce serendipity into browsing social networks and portals. Additional challenges: How do we analyze data collections at a very large scale? How do we extract interesting and meaningful information from unstructured text?



### Application

We have built a fully functional prototype of a serendipitous search and exploration engine that uses multiple languages. Using Wikipedia and Yahoo Answers the engine extracts a network of related entities. Furthermore, it uses metadata about writing quality, topical category and sentiment (emotions evoked by the text: from very negative to very positive). Although recent research has focused on serendipitous search, few products have been developed that enable users to explore data using this paradigm. A tool like DEESSE is a direct competitor of existing search engines (Google, Bing, Yahoo) and other exploratory tools.

### Alternative Application

Search engines are a key technology. To make them function better has a wide impact.

### Nice to know

Do you know that the Yahoo Answers entity network is extracted from 67 million questions and 261 million answers?



Assisting users in unexpected but pleasant and meaningful discoveries when searching.



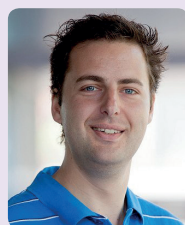
As user engagement is crucial for a successful product, we devise new ways of catching the curiosity of users by immersing them in a serendipitous search experience.



Using serendipitous search, we provide interesting and relevant facts that answer or complement the user's information need, that are otherwise buried in the information overload on social media nowadays.



Driving serendipitous discoveries in search by exploiting large scale entity networks from social media.



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## 5. Geographically exploring Twitter hot-spots

Geographical data are typically visualized using various information layers that are displayed over a map. Interactive exploration by zooming and panning actions needs real-time re-calculation. For layers containing aggregated information (such as counts and sums) derived from voluminous data sets, such real-time exploration is impossible using standard database technology. Calculations require too much time.

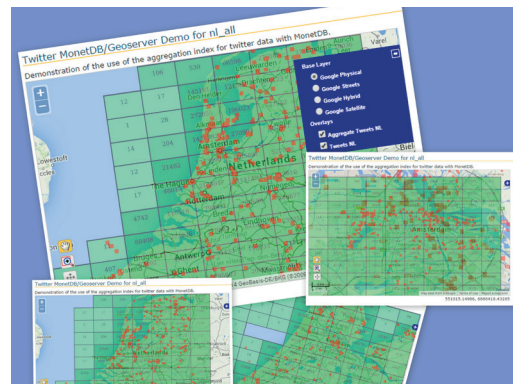
We have developed database technology that accurately aggregates data so that they can geographically be explored in real time. The technology is a plug-in to common open source technology. We demonstrate our technology by the exploration of tweeting hot-spots based on twenty to thirty million geo-tagged tweets from The Netherlands and the UK.

### ICT science question

A common operation in calculating with multidimensional data is the computation of aggregates. In order to obtain exact results with high performance from high data volumes, we face the challenge of finding clever ways of pre-calculating data as much as possible. An additional technical challenge is to develop technology that fits into standard open source database and GIS software.

### Application

In geo data visualization, the ability to quickly develop new information layers is important. Although many solutions exist, there is a niche: the combination of visualizing aggregation information, interactive data exploration in real-time, Big Data, calculating exact numbers instead of approximations, and doing so with common open source technology. Our technology for the first time integrates all these features.



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Our research partners are the companies Arcadis and Nspyre. They both have struggled with this combination of requirements in many of their projects.

### Alternative Application

Our database index technology is not specific to geographical data. It can be used with all types of multidimensional data. Visualization in business intelligence or eScience can also benefit from it.

### Nice to know

The DCMR Milieudienst Rijnmond has used our technology to investigate whether people send tweets about unpleasant odours as a possible signal of danger. This turns out not to be the case, probably because people think that nobody reads the tweets anyway. But if people have the idea that their complaining tweets are read, then tweets might be much more convenient than the reporting of unpleasant odours by telephone.



Interactively explore data on a map: showcase tweeting hot-spots.



Interactively explore data on a map: showcase tweeting hot-spots and the dialogue with the public through social media.



Interactively explore data on a map: supporting the dialogue with the public through social media using common open source technology only.



Database indexing of precise aggregations on all offsets and zoom levels necessary for interactive exploration of spatio-temporal and other multidimensional data.

UNIVERSITY OF TWENTE.



**NSPYRE** making technology matter

## 6. Scavenger Hunt game helps in customer recommendations

There are many web portals aiming to recommend businesses like shops, restaurants and cafes. They are interested to know how many people visit them. We help them by developing algorithms for determining actual visits based on GPS-traces from mobile phones and public data from the web only.

For proper scientific validation of the developed techniques, a large data set with GPS-traces is needed that is truthfully labelled with actual visits to points-of-interest. In our demo we show a means to obtain such data, namely a mobile Scavenger Hunt game ('Speurtocht'). The game has been used for the Kick-In events of the University of Twente in August 2013 and 2014.

### ICT science question

What is the best way to compute a visit to a point-of-interest based on GPS-traces from mobile phones?

Such actual visits can be computed from geographic data as an intersection of the GPS-trajectory with a polygon describing the circumference of the point-of-interest. Polygon-data are, however, not available. We have developed algorithms for estimating circumference polygons of point-of-interest-objects by analyzing more coarse-grained map data and data on other objects.

Our algorithms produce quite accurate results even when data of substandard quality is used. The latter is important, because it allows the application to use only publicly available data.

### Application

For the commercial recommendation of items, one needs indicators of suitability per target group



and other categorizations as expressed by points-of-interest (a shop, a restaurant, or a cafe). Our partner EuroCottage would like to recommend holiday homes taking into account neighbouring points-of-interest and indicators such as popularity. We automatically construct holiday home profiles with data on neighbouring points-of-interest. Factual data are harvested from the web. Popularity is derived from analyzing GPS-traces from mobile phones of previous vacationers.

### Alternative Application

Determining actual visits to places can provide important information in many different domains. Cars, planes and animals all produce trajectories. For example, automatically determining the feeding and nesting places of animals from sightings or GPS-tags helps to understand animal behaviour.

### Nice to know

Two applications have been created on this platform already: Kick-In Quest (2013) and Kick-In Scavenger Hunt (2014). They are available for download in the Play Market and the App Store.



Going beyond social media 'likes' while your phone keeps track which shops, restaurants and cafes you visit for the purpose of recommending holiday destinations.



In geographic information systems analysis, from your phone data it is determined which shops, restaurants and cafes you visit.



The system demonstrates the possibilities of intelligent social media supported maps.



Given trajectories and estimated polygons for points of interest, accurately determine true visits; and how to obtain truthfully labelled GPS-data for validation using a mobile game.



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<https://github.com/utwente-db>

COMMIT/ project  
TimeTrails Spatiotemporal Data Warehouses for Trajectory Exploitation

UNIVERSITY OF TWENTE.



## 7. Smart search using common sense

Searching information on a specific topic can be time consuming. Instead of using brute force searching that does not use any knowledge about the world, we develop smart methods that use background knowledge on specific domains. This background knowledge is formalized in an ontology: a network of concepts within a domain. An ontology in the food-domain might for example formalize that 'Jonagold' is a type of 'apple', which is related to 'orchard'.

We have developed two tools that enable smart search: the ROC+ tool and the SIEVE tool. ROC+ helps a domain expert to create his own ontology by making associations, using publicly available vocabularies. The SIEVE tool in turn uses this ontology to refine a collection of documents for example in a library, a company-specific corpus or the internet.

The ontology and the refined document set enable end users to efficiently find or organize specific and high quality information.

### ICT science question

Although domain-specific ontologies enable smart search, their construction is hard and time-consuming. Domain experts are generally required to distinguish relevant from irrelevant concepts. The scientific challenge is to minimize the effort by experts while maximising its usefulness.

### Application

The combination of our two tools minimize the effort needed from experts to build a specific document set and a dedicated ontology: the time needed can be reduced from weeks to hours.

On our FoodVoc-website we publish ontologies related to the food domain that can be used by these tools. One application is the Valerie project, which generates innovation advice for European



farmers based on results from EU-projects. The method has also been applied to assist in identifying innovation opportunities for small and medium food enterprises.

### Alternative Application

Our two tools can be used in any other domain than food, for example pharmaceuticals, chemistry, finance or automotive. With our experience in the food domain we can organize ontology creation sessions and assist in handling document repositories.

### Nice to know

Users have experienced our ROC+ tool also as a team building tool.

### Quote

"Your tools help us to retrieve relevant information tailored to our customers' needs" – Ivo van Ham, innovation manager of Syntens about sCore, a project that has used ROC+



Smart search tools to improve the innovation process.



Fun tools for smart search kick start our innovation process.



Smart search puts information at our employees' fingertips, so that assets previously wasted on ineffective search are put to good use elsewhere.



With smart search I find high-quality information for my research.



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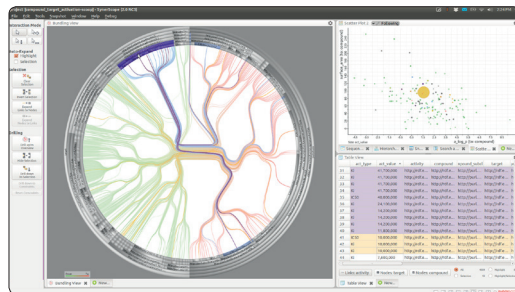
COMMIT/ project  
e-FOOD e-Foodlab



## 8. Finding new drugs by visualizing the effect of their ingredients

Finding new drugs to cure diseases is a hard task. This is because the chemicals in the drug interact in a very complex way with the cells and proteins in the human body. Visualizing this complex network of interactions is important to improve the development of new drugs.

Our demo shows how the interaction between the chemicals in a drug and the proteins in the body can be interactively explored in a rapid way. This rapid interaction makes it possible to get answers while you think, as opposed to waiting for answers, which breaks the train of thought.



### ICT science question

How to effectively visualize large graphs? This is a hard problem. Graphs that contain more than a thousand nodes tend to become cluttered using most visualization algorithms.

The implementation we show in this demo accelerates the visualization by using a graphical processing unit (GPU). This makes it possible to interact with large graphs (in the order of magnitude of one million nodes).

### Application

Our demo is an application of a well-known visual analytics tool (SynerScope) to the pharmaceutical data from the international Open PHACTS-project. Our visual tool combines a number of different visualization techniques to achieve highly scalable graph visualization while taking into account the interactions that help the user.

Natural competitors are visual analytics tool suites, like QlikView, Spotfire and Tableau, and open source tools like Gephi. However, they all miss scalable network visualization and rapid interaction response time.



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COMMIT/ project  
Data2Semantics From Data to Semantics for Scientific Data Publishers

### Alternative Application

The SynerScope visual analytics tools have been used in forensics, fraud detection, anti money laundering, risk-based pricing of insurance products, insurance claims process optimization, and e-mail communication analysis.

Future high potential markets are: smart grid monitoring, logistics optimization, cybersecurity, telecommunication network monitoring, high-performance cluster maintenance, auditing of supply chains.

### Nice to know

Usability studies have shown that SynerScope can be used effectively by high school students after a tutorial of only thirty minutes.

### Quote

"SynerScope, this is an amazing story, they are solving very complex issues by looking at billions of transactions, [...] They are saving the world of their share of the two hundred billion dollars that's lost to fraud annually." — Bill McDermott (CEO SAP)



Big data does not change the world, insight in big data changes the world. Large-scale visualization provides this insight.



Interactive exploration of network data reveals the hidden drivers behind trends. Knowing these drivers opens up new business opportunities.



Interactive visual analytics turns data analysis upside-down. We don't just answer questions, we also question answers.

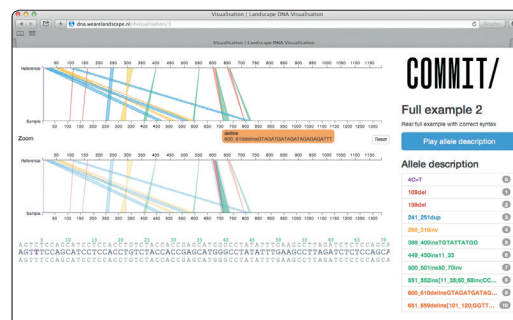


Explore your research data in completely new ways and discover patterns you didn't know existed.

## 9. Rapidly finding variations between human genomes

We have developed a software tool, called the Variant Description Extractor, that rapidly compares one human genome with another in order to find small but crucial genetic differences. Our tool generates a complete description for the human genome in about four hours.

The human genome contains twenty to twenty-five thousand genes distributed over a long molecule, called DNA. Genes can be described by long strings of the four letters A, C, G and T. Each of them stands for a simpler molecule in the DNA. On average, humans only differ 0,1% genetically from each other. However, especially for finding causes and solutions to diseases it is crucial to find and understand these small differences.



### ICT science question

The main scientific challenge is twofold. First, how to calculate short and unique descriptions from long strings of the letters that compose the genes? The genes can hold thousand to many millions of these four letters.

Second, how can this calculation be done within an acceptable and minimal amount of computational time?

### Application

Our Variation Description Extractor is integrated in the Mutalyzer suite. Mutalyzer is a very popular web-based software tool primarily designed to check descriptions of sequence variants according to the standard human sequence variant nomenclature of the Human Genome Sequence Variation Society. Mutalyzer aims to encourage the proper use of nomenclature in publications and reduce redundancy in gene variant databases. This greatly improves the findability of variants. Ultimately, these genetic variant descriptions are used in the diagnostics of hereditary diseases.



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COMMIT/ project

### Alternative Application

Although our software tool is now focused on comparing DNA-strings composed of four letters, it can easily be used on strings composed of other signs. The tool might for example be applied to describe the differences between two natural language texts. The fundamentals of the tool and the algorithm do not have to be changed. Certain operators that are now especially designed for DNA-comparison can easily be disabled.

### Nice to know

The Variant Description Extractor has already been downloaded 66 million times.



The Mutalyzer suite enables medical researchers to find all variants and combinations of variants in DNA sequences quickly. These variants can be used to effectively research complex diseases.



We use a state-of-the-art algorithm to quickly find variants in DNA sequences. The algorithm is supported by a Python suite of compatible tools adhering to the well-known HGVS standard.



The efficient extraction of variants on a individual level enables the targeting of diseases on a person-to-person basis. Making it a prerequisite for and a first step towards personalized medicine.



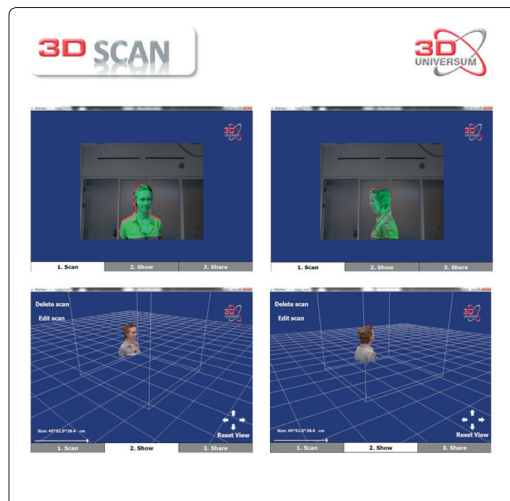
We propose an efficient algorithm for the extraction of biological meaningful descriptions of the variance between complete genome sequences with minimal length and computation time.



## 10. Scan and print yourself in 3D

The last few years have seen an enormous development in 3D-printing. Consumers can now buy their own printers for use at home. However, if you also want to do your own 3D-scanning of the object you want to print, present laser scanners are far too expensive. We have solved this problem by using a low resolution, low cost depth camera.

In our demo we show the 3D-scanning of objects and scenes, such as faces, bodies, furniture and rooms. To obtain a full 3D body scan, a person stands still on a platform. In less than half minute we perform a 360-degrees full body scan. As a take home gift, you will receive your own 3D scanned or printed body model.



### ICT science question

The main challenge is how to use a low resolution, low cost depth camera to perform real-time 3D-scanning in order to reliably print a 3D-model. The present high resolution 3D-laser scanners cost about twenty thousand euro. These scanners are not affordable by consumers and they are not user friendly. Moreover, the necessity of post-processing makes them less applicable for daily usage. An important sub-challenge is to develop new 3D-modeling solutions that can be used on the consumer market. Like with the scanners, the existing modeling solutions are often too expensive and too complex for consumers.

### Application

We provide a user-friendly and real-time 3D-object scanning solution at a very low cost: about ninety euro. As a consumer you only need our software, a standard computer and a depth sensor in order to scan real world scenes such as faces, bodies, furniture, rooms, cars, art, etcetera. Our solution will help to reduce the gap between 3D-modeling and 3D-printing.



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3duniversum.com

COMMIT/ project  
INFINITI Information retrieval for Information services

### Alternative Application

3D-printing is broadly applicable and 3D-scanning is an important technology to that purpose. 3D-scanning also offers new business opportunities for real estate agencies, for custom made clothing (eye wear, dresses...) and for the movie industry. 3D-Recording also allows applications in health monitoring and sports. Moreover, a large collection of 3D-scanned real world objects will help the field of artificial intelligence, in particular automatic image recognition.

### Nice to know

With our software you can create a 3D-selfie in less than a minute.



You do not have to invest thousands of euros on 3D scanners or you do not have to spend time to learn complicated 3D CAD systems. This demo provides you a low-cost and real-time 3D scanning solution.



Revolutionize the way you interact with objects such as bodies, rooms, and furniture. They are all in 3D now.



You can scan, visualize, interact and share real-world objects in 3D with a low-cost camera.



Real-time 3D reconstruction and recognition.



UNIVERSITY OF AMSTERDAM



# 11. Exploration tool for investigative journalists

Given a pile of documents, a journalist faces the task to dig deeply into the various layers that could yield a newsworthy story on political and other powers. Especially for investigative journalists we have developed the exploration tool FIDO (*Freedom of Information Document Overview*). FIDO supports the exploration, search and analysis of large collections of texts, such as the ones that journalists can get through Freedom of Information Act-requests (WOB in Dutch).

The journalists' starting point is the Documentcloud.org framework, where WOB-documents are stored, processed and annotated. FIDO extends this tool suite in order to support search for entities and context more intelligently. It also produces powerful visualizations of social networks, word clouds, maps and timelines.

## ICT science question

How can we discover in a large set of documents the key entities? How can we find the evidence central to these entities and the contextualization of mentions of the same entities in other sources? Specific technical challenges are the heterogeneity of resources to be integrated, the multi-lingual character inherent to the real-world setting and the noise resulting from optical character recognition (OCR - used to automatically generate a digital text by scanning an analog, printed text). Unique about FIDO is that it tackles these issues 'on-the-fly', instead of via a priori analysis.

## Application

Our demo shows how FIDO supports example scenarios handed in by journalists. One is inspired by an investigation of the Dutch-Swiss company Vitol, the largest independent energy trader in the world. Largely unknown to the public, Vitol emerges as a spider in the political-economic web in



FIDO. Compared to how the initial article on Vitol was written, FIDO offers a much more effective workflow.

## Alternative Application

The analysis of piles of documents is useful in many places.

The type of challenge faced by investigative journalists can be likened to other intelligence activities in which the starting condition is 'a pile of documents'. Therefore, alternative application areas are business intelligence, police investigation and academic research. We have plans to do usability studies with financial analysts responsible for reputation and trend analyses at a big investment management company. FIDO could increase the effectiveness of text analytics and show its relevance for generating financial forecasts.

## Nice to know

The development of the demo followed an interactive user-centric design process. Investigative and data journalists were and are being interviewed on their workflow and how FIDO should be shaped to fit this workflow.



Investigative journalists dig through more and more data to give the public what it wants: freedom of information.



Semantic search: integrating the most robust natural language and search technologies for unlocking information from text at superhuman scale and speed.



The only way to keep up with companies and governments producing increasing amounts of textual data, is to move to next-generation semantic search technologies.



Semanticizing and linking heterogeneous, multilingual sources with state-of-the-art natural language processing and information retrieval technologies.



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COMMIT/ project  
INFINITI Information retrieval for Information services





## 12. Automatic photo tag recommendation for Flickr

People from all over the world increasingly share their knowledge, experiences, opinions, photos and videos online. New kinds of language-based search technologies are needed to make this multi-media content effectively searchable.

In our demonstration, we offer a web interface which allows the user to annotate images taken at large scale social events: i.e. to describe in words some extra information about the image.

Annotation is done in order to make huge collections of photos better searchable by keywords.

We use social media data, as well as techniques from information retrieval and image processing, in order to automatically recommend photo tags. This makes the annotation process much easier. A photo sharing web service such as Flickr can benefit from our automatic photo tag recommendation.

### ICT science question

Automatically detecting objects and scenes from images is one of the biggest challenges in artificial intelligence. This is due to the fact that computers have no understanding of the world (the semantic gap).

Previous methods have used either the information of the pixels of the photos, or the tags added by the user in order to automatically annotate images. We offer a new solution which combines visual appearance, context and social media data in order to offer tag suggestions for photos.

### Application

Our demonstration applies to the process of annotating images uploaded online which are often annotated with less than four tags. Such a small amount of tags makes photo retrieval and recom-



mendation difficult. Our work could for example be applied in an image sharing website domain such as Flickr.

### Alternative Application

Annotation is broadly applied to build knowledge bases.

Our application is best suited for image annotation but could alternatively be applied to the annotation of any web object, such as videos, news articles, web documents etc.

### Nice to know

With the high velocity of social media, we are able to mine the 'wisdom of the crowd' to collect relevant tags describing images taken at large scale events as they happen.

### Quote

"Using the keyboard to tag images is slow and boring. This demo instead makes the whole process possible using only the mouse."



Make image tagging easy by using context and content recognition.



Exploit historical big data in order to compute on-the-fly tagging recommendations in a image sharing website scenario.



Offer an easy image tagging scenario to the user by exploiting big data.



Combine user tags, textual and visual features in order to suggest the best tags for a photo.



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ttagged.com/demo/

LiMoSiNe Project  
limosine-project.eu/



This demo is part of the LiMoSiNe project in close cooperation with the COMMIT/ *demo to which music is the world listening?* (Nr. 2, also known as the StreamWatchr demo). The LiMoSiNe project runs within the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement nr 288024.

# 13. Finding the most interesting fragments in a tv-broadcast

We have developed SocialZap, a multimedia search engine that finds the most interesting fragments ('zap points') in a television broadcast, based on microblog posts like tweets and socially tagged photos.

The main novelty of SocialZap is the fully-automatic transfer of the learned viewer's interest from textual posts to the visual channel. There is no need for any manual effort in the process.

Once SocialZap finds the zap points, users can easily browse through a television broadcast and directly watch the interesting fragments. Thus, SocialZap adds social experience to watching television.

## ICT science question

What happens where in digital video? The fundamental problem in video retrieval is that computers can – at present – only extract low-level features from a video signal, whereas humans interpret the data in a high-level conceptual way. It's a grand scientific challenge to bridge this so called 'semantic gap'. In particular we consider here the synchronization of audio and text signals when they refer to one and the same event.

## Application

The questions we pose here are highly relevant in a world in which visual communication is ever more important.

Existing web services like UitzendingGemist allow viewers to watch missed television broadcast on the web. However, a system that directly suggests the most interesting fragments to watch, based on social media, is non-existing. The particular challenge we face is the temporal mismatch between the moment that the user tweets about a concept and the moment at which it appears in the television broadcast. The tweet-time can radically differ from the appearance-time as viewers



either anticipate appearances or continue to tweet about topics that have previously appeared. In our SocialZap demo, we analyze data from social media to suggest interesting concepts (zap points) in television broadcast. SocialZap uses textual information from Twitter posts related to a television broadcast of interest, which provide a rich source of information of what viewers find interesting.

## Alternative Application

Video is everywhere and increasing, too much to watch all.

Our technology might be used in the digital humanities or by intelligence and security services.

## Nice to know

SocialZap provides the only service in the world that automatically links social multimedia noteworthiness to television content.

SocialZap has won the US-run NIST TRECVID video search engine benchmark in 2013 and 2014.



The things people say about TV are interesting and valuable: SocialZap allows that value to be exploited by the viewers of catch up TV, by linking micro-blog posts directly to interesting moments.



Both social media and TV are important sources of entertainment and information, but they live in separate worlds. SocialZap brings them together to enhance the appeal and usefulness of catch-up TV.



With catch-up TV we never miss anything on TV. SocialZap is the first to take it one step further, by offering users particularly noteworthy time points, reducing the time needed to catch up.



Computer vision has matured to the degree that it is useful in consumer applications. In SocialZap, new algorithms provide jump-in points to viewers by exploiting information from social media.



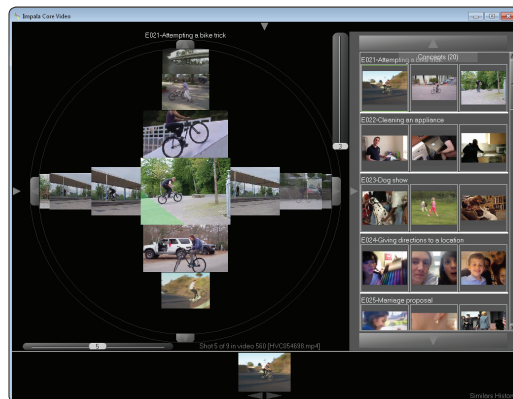
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COMMIT/ project  
SEALINCMedia Socially-enriched access to linked cultural media



# 14. MediaMill Semantic Video Search Engine

The demo shows the MediaMill semantic video search engine, a system facilitating access to the content of large collections of video streams. The system is based on a large lexicon of visual concept detectors, complex event detectors and an interactive video browser learned from example video material. MediaMill provides access to the content of videos without the need to label each and every video. The old way was to let someone tell you what is in the video, like is the common practice in YouTube. In order to make progress the power of the human eye to tell in words what is seen needs to be reproduced. MediaMill has found a way to do that by machine learned image recognition technology translating the pixels of an unknown video into a descriptive text.



## ICT science question

The world is full of digital videos and images. In this deluge of visual information, the grand challenge for computer vision is to unlock its content directly by understanding what is in the image.

## Application

Digital images containing 'busses', 'beaches' or 'babies', or any other concept for which a visual representation can be made like 'kitchen, even as abstract as 'wedding' are being identified. The latest addition to recognize video fragments on the basis of events like 'making a purchase', 'doing a magic trick', or 'rock climbing'. None of the recognition is perfect, and this will not be for some time to come, but the techniques are helpful in many interactive applications.



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COMMIT/ project  
SEALINCMedia Socially-enriched access to linked cultural media

## Alternative Application

As digital images are everywhere, access to the content of images is broadly needed. The MediaMill video search engine can be applied for automated moderation of social media, interactive search in forensics, home video handling, image sorting for real-estate brokers and other professionals, industry product maintenance, media publishers, and more where there are lots of digital images or videos.

## Nice to know

The software has been transferred to Euvision Technologies, a University of Amsterdam spin-off.

## Quote

The University of Amsterdam has landed in the top-three of the open-innovation TRECvid international competition run by the US-bureau for standards NIST on image and video search for 10 years in a row, amidst fierce competition from international universities and companies.

In addition, Cees Snoek receives Netherlands Prize for ICT Research 2012 NWO, 24 juli 2012 and Video search engine matures, NWO, September 2013.



The world is nowadays full of digital images - industry, video, web, professional, business or monitor. The computer will sort what is going on.



In the world-wide open-innovation competition of 50 image sort engines - with IBM, Oxford and CMU - this product has been in the top 3 for the last 10 years.



A camera plus automatic categorization learned from example images is efficient in many applications: social media, trend, monitoring, mobile, photo-memory.



The dominant human sensor, the eye, was weakly developed for computers. Naming things, actions, and states in the picture is a huge cognitive step.



UNIVERSITY OF AMSTERDAM



# 15. Visualization of topic evolution in news articles

**M**ore and more texts are available in digital form. Especially when these texts go back over many years (like with digitized newspapers and archives), it is interesting to understand how topics have evolved over time. How did a political situation change? How did a company start and evolve? Our demo shows an automatic visualization of the evolution of a topic over time. We take a different approach on traditional search result ranking methods as for example used by Google. We show a summary over time of the topic searched for. This summary can be used to quickly get an overview of the back-story of an entity in the text.



## ICT science question

How can we visualize the historical background of an entity appearing in a text in a concise way, without overloading the user with information? This is a hard problem, because of the need to summarize and visualize a large search result without having to cut off the information at a certain point (such as after the first page of Google search results).

## Application

Our main application lies in the visualization of the back-story of entities in news articles. Existing alternatives include word clouds, which ignore the dimension of time, or stream plots which focus on the trend comparison of a predefined set of categories, which ignores the open character of topics.

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COMMIT/ project  
METIS Dependable Cooperative Systems for Public Safety

## Alternative Application

Visualization of critical events is applicable in many situations. Our system will also be used to assist operators of the Metis System for Situation Understanding. This system will assist operators in maritime situations by highlighting vessels that the system deems worthy of attention. The operator then can investigate the back-story of a vessel using the methods presented above. Applying the demo to alternative domains would be as simple as finding and converting a suitable corpus of documents.



Allow a user to see in the definition of a topic over time at a glance.



The definition of a topic or an entity is important, especially how it changes over time. We provide a visualization of such a change at a glance.



How did a political situation change overtime?



Analyze large sets of textual information by leveraging the ability of the human brain to spot exceptions to patterns.



# 16. Automatic risk assessment of vessels in maritime areas

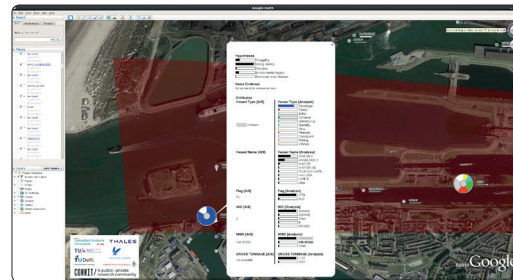
In the last decade marine traffic has grown greatly. At the same time terrorist and criminal activities have moved to the sea as well. The nations responsible for managing maritime areas therefore more and more face the problem of detecting suspicious vessels. Our demo shows how a human operator responsible for managing large complex maritime areas can be assisted by automatic risk assessment.

Our system takes inputs from reliable monitoring systems and combines this with information sources of unknown trustability (such as open source intelligence, public databases, websites and social media feeds). The system automatically presents suspicious vessels to the human operator. This automatic risk assessment can give a productivity boost to the coast guard, the police, the navy, the customs and to environmental protection agencies.

## ICT science question

How can systems collect and use information to develop a human-like understanding of complex dynamic situations? More specifically: How can systems automatically determine the intent of an action?

Current so-called 'situational awareness systems' are characterized by cleverly visualized and configurable operational pictures supporting the decisions of the human operator. If the human is taken out of the loop, the system becomes entirely ineffective. The unique approach of our demo is the integration of multiple artificial intelligence technologies into a seamlessly automatic operating solution providing the highest end-user value.



## Application

The main application is the monitoring of shipping activity and the prediction of the intent of shipping activities. How can we understand the intent of a vessel in a maritime area? The results can be used by the Thales company in decision support systems for the management of large maritime areas.

Current systems are fragmented, rely on experience of operators and do not scale well. Continuing cost pressures are driving the need for intelligent information and reasoning technology. Typical users can be the coast guard, the navy, the police, customs and environmental protection agencies. Competitors include for example: 3i:Mind, Greenline Systems and Saab Raytheon.

## Alternative Application

In addition to safety and security applications our technology is equally suited to providing the infrastructure needed for Condition Based Maintenance (CBM) systems. Such systems have many sensors or sources of information which can be used in combination with probabilistic reasoning models to predict the likelihood of essential maintenance being required in the future. Potential users are companies designing complex systems, for example ASML, Océ and Rijkswaterstaat. The hardest challenge is capturing the required domain knowledge.



Safety & security operators will be able to cope efficient with an overload of mission critical disparate data .. do more, effective, for less.



How to integrate various novel AI technologies into an effective innovative decision support system.



Innovative technologies for context-aware system architectures dealing with domains characterized by a certain level of uncertainty.



Using integrated high TRL level demonstrators as means to convince industry of the value and opportunities of my scientific innovation.



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COMMIT/ project  
METIS Dependable Cooperative Systems for Public Safety

**THALES**

Embedded Systems  
Innovation BY TNO

**VU** UNIVERSITY  
AMSTERDAM

Radboud University Nijmegen

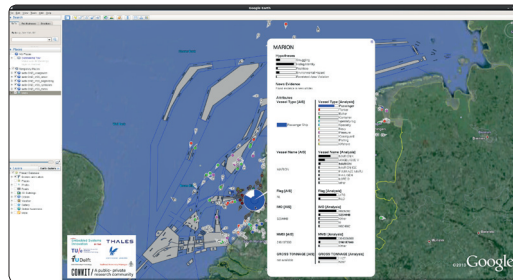
**TU Delft** Delft  
University of  
Technology

**TU/e** Technische Universiteit  
Eindhoven  
University of Technology

# 17. Let an intelligent machine explain its decisions

**M**ore and more decisions that traditionally were taken by humans, are taken by intelligent machines that perform complex reasoning. An automatic pilot can fly and even land an airplane. A medical expert system can propose diagnoses and treatments of patients based on their symptoms. In current systems, only the results of the automatic reasoning are shown to the user. This makes it hard for the user to understand and trust the results.

Our demo shows how a user of a safety and security system uses visualization to understand why and how an automatic reasoning system has reached its conclusions. This allows the user to gain both a better understanding of the situation and to improve trust in the reasoning system.



## ICT science question

How can we best visualize the reasons why an automatic reasoning system has come up with certain conclusions? The combination of the use of probabilistic reasoning and subsequent visualization of the reasons behind the decision is new and especially important in costly and safety critical situations.

## Application

Our current application area is the safety and security domain. No known products offer visualization of the reasons behind the decisions.



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COMMIT/ project

METIS Dependable Cooperative Systems for Public Safety

## Alternative Application

Any system employing automatic reasoning is a potential application. This is especially relevant in systems where automatic reasoning takes high impact decisions. For example: computer aided diagnosis systems are used to control the state of an aircraft. If the automated system indicates that an engine should be replaced, then a human would be expected to be able to carefully check the reasoning behind such a costly and safety critical decision.



Before one trusts complex high-tech critical decision support systems, they need to visualize their line-of-reasoning.



How to visualize the decision and reasoning rationale of complex decision support systems.



New insights in visualizing the internal line-of-machine-reasoning for complex decision support systems.



Visualization of the inner line-of-reasoning of a state-of-the-art reasoning technique.

# 18. A facelift for old software

**I**ndustrial software must continuously be maintained to stay in business. On the one hand this is caused by external constraints such as changes in hardware, the advice not to use the outdated Windows XP operating system anymore, or the Millennium Problem. On the other hand this is caused by technology changes within the company.

After several years of maintenance, a software redesign is needed to support further innovation. This is often postponed, because it is time consuming and it does not immediately create new product features.

Traditional software development is focused on documents, which quickly get outdated. Modern software development is focused on models that are used for code generation. We develop a facelift for old software, called 'model-based migration'. Model-based migration extracts models from the legacy software and transforms these models to a new model-based design.

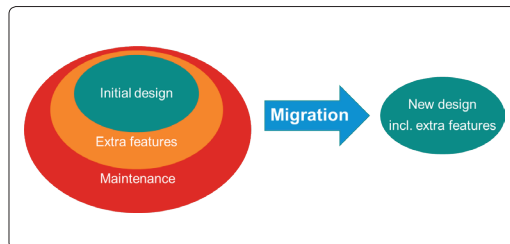
## ICT science question

The challenge is to obtain a cost effective solution for the huge industrial problem of maintaining legacy software. Starting from scratch is not acceptable; the domain knowledge must be maintained. As documentation is usually outdated, the legacy software itself becomes the primary information source. This information can be revealed by analyzing the source code and by learning from the observable behaviour.

## Application

We have applied model-based migration to the field service procedures for the interventional X-ray machines of Philips HealthCare. The legacy software has evolved over many years into a stack of in-house frameworks, that are difficult to maintain and extend. Our own experience indicates that an eighty percent productivity gain can be obtained using model-based migration.

The company SemanticDesigns also works on migration of legacy software, but their focus is on migrations from old programming languages to modern ones. In the applications we look at, the migration requires a more fundamental redesign.



## Alternative Application

In general, all companies that develop software for more than ten years have the same problem. More specifically, this work has led to the initiative for a follow-up project proposal on software rejuvenation in the European Ecsel program. Industrial partners from various countries have confirmed that they have similar problems with legacy software, and have expressed their interest to participate in such a project. This project also involves academic partners to further advance the technology.

## Nice to know

The amount of embedded software in high-tech systems is continuing to increase, currently being in the order of multiple millions of Lines of Code. As a rule of thumb, every fifty thousand Lines of Code requires one full-time software developer for maintenance only.



Boost innovation by renewing crucial software components.



Reuse existing domain knowledge without suffering from large and complex legacy software.



Large effort reduction for the maintenance and migration of legacy software.



Challenge is to automate the extraction of domain knowledge from legacy software as much as possible.



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COMMIT/ project

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# 19. BTWorld: A Large-scale Experiment in Time-Based Analytics

These days, large amounts of data are collected about the operation of many important systems, for instance, traffic systems and the financial system. Extracting meaningful information is very challenging: big data must be processed in time and without error.

At TU Delft, for the last four years, we have been collecting data about BitTorrent, a system used by hundreds of millions of people worldwide for sharing videos and other files. For example, musicians use it for the distribution of their work and software developers for the distribution of open source software.

Looking at the collected data from all the BitTorrent servers in the world, we can understand BitTorrent. To do so, we have created a workflow of big data queries that give answers to such questions as “How many videos are shared?” or “What is the location of the most used servers?” As our key innovation, we have designed an efficient iterative method to optimize big data workflows.

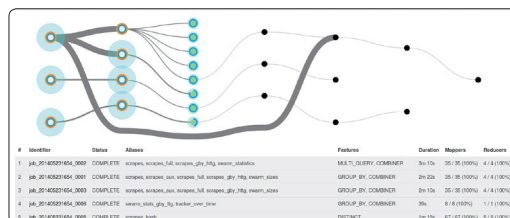
## ICT science question

Despite a large number of empirical and theoretical studies, observing the state of the global information networks remains a grand challenge. The main question we set out to answer was how to reliably analyze large scale time based datasets through different types of queries.

Other questions we address are: What are the programming models to be used? Only the MapReduce programming model or more? To what dataset sizes we can push our analysis? Whereas in 2013 we could only process 100 GB, we can now process 1.5 TB, and we are working on processing all of the 15 TB we collected. With that size, we are among the largest publicly reported Big Data experiments.

## Application

We apply our network analysis to the global BitTorrent network. We have a unique 15 TB dataset



obtained from monitoring BitTorrent, which we analyze in one of the largest publicly reported Big Data experiments. This leads to both the design of a workflow of queries with wide applicability, and an understanding of the monitored system. The dataset has been obtained by us by periodically contacting many so called BitTorrent servers worldwide over a period of more than four years.

## Alternative Application

Our design and experimentation with the BTWorld workflow is applicable to many other time-based datasets obtained from monitoring large scale distributed systems, e.g., financial systems, traffic systems and sensor networks.

## Quote

“This is a great example of a well-researched and well-engineered real use case of Big Data processing.” - Douglas Thain, chairman of the jury for the SCALE Challenge of the IEEE/ACM CCGrid 2014 conference in May 2014. We won this Challenge with BTWorld.



Productivity is increasingly associated with big data. Our innovation allows companies to pursue ambitious big data projects with complex workflows. E-governance processes may benefit to the same degree.



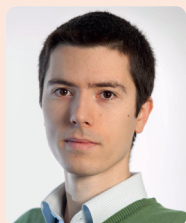
We enable SMEs and research labs with little technical expertise to process big data in innovative and creative workflows, helping to overcome the data deluge they face.



By 2020, companies will have access to over 40 ZB of data per year. It constitutes as much a business opportunity as it is a technical challenge. Our TRL 4 technology offers a critical advantage.



How to enable innovative but non-IT research labs and SMEs to process data with large volume, high velocity, and significant variety? We offer an efficient, iterative, flexible method.



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COMMIT/ project  
IV-e e-Infrastructure Virtualization for e-Science Applications



This research was supported by the Dutch national program COMMIT/



## 20. Monitoring group emotions

**W**e have developed the crowd emotion monitor SWEET (short for Sense & Tweet) that evaluates the emotion of a group of people based on photos.

SWEET automatically analyzes the emotional expressions on people's faces as they appear on images. The images can come from smartphone cameras or from cameras installed on fixed locations. Location tracking is done by using WiFi-sniffers to track the participants. Via a smartphone app the platform can share the resulted group emotion with stakeholders.

Our first objective is to enhance people's experiences during conferences. As a visitor of a conference SWEET can allow you to see the emotional states in various rooms. You can use this information to find out where the most interesting presentation is going on.

### ICT science question

How can we reliably track the location of people's smart phones in a crowd based on WiFi-sniffers? How can we automatically recognize emotional expressions on people's faces from images that come from smartphones or fixed cameras? How should we store and compute the data so to monitor group emotions in real time?

Our emotion monitor combines state-of-the-art sensing, event processing, reasoning and data communication technologies.

### Application

Crowd emotion monitor SWEET can be used at events like conferences to enhance people's experiences or for entertainment, like at dance parties. More generally, it can be used to guide people to locations where they can gain the best experience.

There are two ways to use SWEET in practice. First, the SWEET-smartphone app allows you to make photos of yourself and your fellow participants. The app analyzes facial expressions and



records the location and the surrounding sound. Subjective feedback is retrieved using an event-driven questionnaire tool about how the participants are feeling.

The second way is to sign up to the special SWEET Event Twitter Channel to receive messages related to the event. Tweets are broadcasted to inform people about special activities or wherever something nice or interesting is going on.

### Alternative Application

Alternatively, the crowd emotion monitor can also be used to increase safety at mass events. By monitoring the emotion of a crowd and seeing whether the group emotion gets heated up, possible incidents might be detected in an early stage. However, this alternative application requires the development of slightly different algorithms. Still another application is the use of SWEET as a tool to gain insight into group processes, which could be useful in various scientific research.

### Nice to know

The first version of SWEET has been demonstrated by SWELL partner Noldus on Dutch television (Editie NL, RTL4, 16 december 2013)



Local sensing and tweeting as an example of the internet of things.



Crowd Emotion Monitor to assess behaviour and emotion of people.



Use your Smartphone as platform for emotion detection.



Sense emotions locally, tweet worldwide.



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[www.commit-nl.nl/news/commitsweets-bij-editionl](http://www.commit-nl.nl/news/commitsweets-bij-editionl)

# 21. Whiskers let your beloved ones feel your mood

**A**lthough the Digital Age has made verbal communication over long distances extremely easy, non-verbal communication (like feelings as expressed by body language) has received much less attention. We develop new ways of non-verbal communication over long distances. Our demo consist of two 'whiskers', placed separate from each other. The demo looks like giant whiskers for humans that you can put in your home and that are connected via the internet to a whisker in the home of a beloved one.

By touching and moving a whisker in your place, the whisker in the home of your friend or relative starts to move in the same way. This is an innovative way to communicate your feelings in a subtle way without being physically together.



## ICT science question

What is a suitable medium for non-verbal communication using the internet? What is technically possible? What and how do people want to communicate non-verbally over long distances? Some existing products and concepts explore this idea, but generally use different modalities for the input and the output signal. For example, an input signal is translated into a blinking light as an output signal. Instead, in our prototype the input signal (giving a swing to one of the whiskers) and the output signal (the other whisker is swinging) are the same. This improves the feeling of being together.



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COMMIT/ project  
VIEWW Virtual worlds for well-being

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## Application

We develop Whiskers in the first place for elderly people who go through a transition in life. When an elderly retires, loses a dear one or suddenly has to cope with a physical disability, he or she might start to feel socially isolated. Whiskers create a new way of feeling socially connected.

## Alternative Application

As social connectedness benefits everybody, we want to create solutions for other target groups as well. In that way we also hope to avoid creating a stigmatizing device ("a device only for elderly"), but a pleasant experience that anyone wishes to have.

## Nice to know

Whiskers or vibrissae are specialized for tactile sensing (other types of hair operate as more crude tactile sensors). Vibrissae grow in various places on most mammals, including all primates except humans! (Wikipedia).

## Quote

"What a good idea to communicate through movements."

"Whiskers could be used to let others know all is fine without having to call them."



Loneliness increases the costs of healthcare. One step in solving this hidden problem is to increase social connectedness between people.



Movement as a mean to feel each other at a distance is new, and could help people to feel more connected to each other.



Loneliness is a huge social problem. Whiskers are a simple idea to make people feel more connected when they are separated from one another geographically.



Whiskers support a feeling of connectedness over a distance, without being explicit. It is like a virtual pat on the head.



waag society



Hogeschool van Amsterdam  
Amsterdam University of Applied Sciences

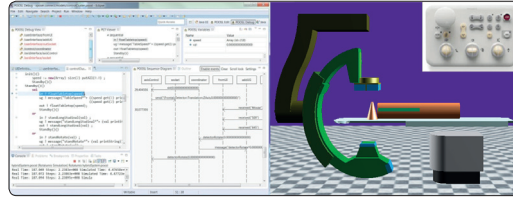
UNIVERSITY OF TWENTE.

## 22. Early validation of software designs

**M**any ICT-projects suffer from long delays because of an unpredictably long test and integration phase. The problem is that during this phase many bugs in the computer code have to be corrected.

Some bugs might lead to a costly redesign.

To detect faults much earlier during the development process, we propose a modelling approach based on the Parallel Object-Oriented Specification Language (POOSL). The new POOSL interface supports light-weight modelling and fast simulation. In addition, the new interface contains validation checks to detect modelling faults early. New designs can be validated by simulating POOSL-models in combination with a visualization of the user-perceived behaviour.



### ICT science question

The main challenge is to develop a system modelling environment which allows for fast and light-weight modelling early in the development process. In this early stage requirements might not yet be very clear and many decisions have to be taken about the structure of the system, the responsibilities and behaviour of the components, and their interaction.

The modelling environment should also allow industrially scalable simulations. On the other hand, the desire for model validation and analysis requires a proper formal semantics, i.e. a precise language to describe the model. Finally, support for model debugging and visualization of simulations results is required.

### Application

We have applied our method to parts of an interventional X-ray system of Philips Healthcare. The current way of working is rather document driven. Our proposed new method makes it possible to simulate and visualize the requirements and high-level designs very early in the development phase. The modelling tool that will be developed fills a gap between expensive commercial modelling tools



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(like Matlab and Rhapsody) that require detailed modelling, often close to the level of code, and drawing tools (such as Visio and UML drawing tools) that do not allow simulation.

### Alternative Application

Our approach can be used in all sectors of the high-tech industry, especially for systems where high-level supervisory control is important. Examples are the command and control systems of Thales and the lithography machines of ASML.

POOSL has been used already in cooperation with Thales, where performance aspects have been analyzed. At ASML, engineers are experimenting with a new interface of our modelling tool.

### Nice to know

If a problem in the requirements is found only after the product release, it would cost ten to hundred times more to fix than if it had already been found during the design phase.

### Quote

"Modelling the power control protocol of an interventional X-ray system in POOSL revealed a few design errors that could now be corrected early in the development process. Since POOSL models can be easily changed, they are very useful to explore the design space quickly. The simulation possibilities of the POOSL-tool also support the communication with internal stakeholders."



Increase the rate of innovation of the Dutch high-tech industry.



Fast product development by a shorter test and integration phase.



Avoid costly redesigns by detecting faults much earlier in the development process.



Develop industrially scalable modelling techniques that are maintainable and semantically consistent.

## 23. Emergency communication technology for crowd safety

**I**n emergency situations at crowded festivals and parades the 3G- and WiFi-networks often fail or become inefficient due to overload. We present a set of new and unique wireless sensor network technologies that help to solve this problem.

We demonstrate an efficient feature detection algorithm that is, for example, capable of learning the faces of suspects-on-the-run. We also show how to build a safe, privacy aware, emergency ad-hoc network by using the mobile phones of the visitors.

We show how unmanned aerial vehicles (UAVs) are used at parades or festivals to quickly deploy the infrastructure of an emergency communication network. Our final goal is to maintain communication when the standard infrastructure fails.

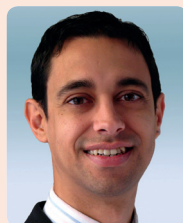


### ICT science question

How can we develop efficient algorithms for detecting important image features? How can we use the mobile phones of the crowd's participants to cope with the low bandwidth of current networks? How can UAVs be used to quickly deploy a network infrastructure for monitoring crowds?

### Application

We provide safe, reliable, and privacy-aware wireless sensor networking for crowd and city environment monitoring. Our technologies help festival organizers, crowd managers, urban environment monitoring agencies, and first responders (police, safety staff, and fire brigades) to obtain information in a faster and more reliable way.



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COMMIT/ project  
SENSAFETY Sensor Networks for Public Safety

### Alternative Application

Information networks are everywhere. Our technologies are also applicable for environmental hazards, military operations, and hard-to-deploy sensor networks. Also the monitoring of urban environmental conditions – especially in emergency situations such as explosions or contamination – can profit from a quickly deployable wireless sensor network. These features make us a potential partner for military units and environmental agencies.

### Nice to know

At festivals or parades, bad news – such as a fire or a fight - reaches Twitter or Facebook earlier than they reach first responders like police or fire brigade.



Better surveillance of public spaces and crowded events by autonomous drones and smart infrastructure.



Use drones and smart connectivity to set up or repair your large scale sensor network in minutes!



Drones and smart phones help bringing emergency news faster to first responders.



Improve your sensor network with flying base stations and smart phone connectivity.



## 24. Intelligent lampposts warn crowds in emergency situations

**I**t is difficult to inform crowds in emergency situations because communication is hard and slow, and because people are panicking. Still, the public should be informed. The intelligent lamppost (iLP) informs authorities and general public in an intuitive way in case of emergencies. The lamppost can change its light by color, intensity, pattern and direction. Thus it can show the place of an emergency to first responders or direct people to exits.

The intelligent lamppost is part of a larger ecosystem of autonomous emergency detection and communication. Our demo only shows part of this ecosystem, namely its lighting capabilities. Part of the demo is a model of a festival terrain with ten fully functional miniature lampposts demonstrating how they coordinate their actions.



### ICT science question

The scientific question is in the area of intelligent interfacing: how to apply intelligent lampposts in an intuitive way, such that people immediately understand what the lamppost is trying to 'tell' them. Some attempts have already been made to apply intelligent lighting (e.g. in Rotterdam and Groningen), but not as extended or smart as we propose.

### Application

At present there are only lamps available that can change intensity, but they are limited in function. Our intelligent lamppost goes a few steps further. We develop the intelligent lamppost for the emergency festival scenario, to inform the public during big events. This scenario shows the crucial features of sensor networks for public safety: not only lighting, but also communication and smart detection.

Our research partners are the Dutch police, Tendris, Strukton and the University of Twente. The



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COMMIT/ project  
SENSAFETY Sensor Networks for Public Safety

technical design and the interface of the lamps is ready but needs testing. Applications are in the conceptual phase.

### Alternative Application

The functions of our intelligent lampposts can be generalized to any kind of situation in which there is a wish to make people aware of their environment. The lamp can for example show the level of pollution or noise in a city. And a moving window of streetlights might turn blue to show that an ambulance is approaching.

### Nice to know

Intelligent lampposts not only enhance safety, but also save energy and produce less light pollution.

### Quote

"This looks very promising and we should test the lights on our campus."



The dynamic lighting conditions provided by intelligent lamp posts, give opportunities to improve safety and traffic control and are a first step towards the intelligent environment.



Sensing applications provide a flexible and ubiquitous means to influence the behaviour of people in outdoor environments.



Dynamic lighting offers a new means to implement strategies for public safety and traffic control.



Dynamic lighting conditions provide a new means to communicate with people.

## 25. Automatic testing improves software quality

**W**e develop modelling and testing tools that improve the quality of complex software. Underlying our tools is the so-called 'model-based' testing technique. This is a form of testing that is not ad-hoc, but based on validated scientific models. Thanks to this approach we can fully automatize the software testing process.

Our tools contribute to the development of better, more reliable and cheaper software. They check in a short time whether or not a software/hardware system conforms to its specifications. Furthermore, our tools make the software development process faster, smoother and more transparent. Finally, they reduce the time to market: the time between the conception of the product and its availability on the market.

### ICT science question

Testing complex software touches on many fundamental aspects of computer science: How to deal with the staggering amount of discrete states in which a computer can find itself while running software? How to deal with non-deterministic aspects, with timing of information flows and with data? How can we make our testing tools scalable to ever larger software systems? How can we improve the scientific models with which we describe software?

### Application

Our tools are used in a concrete product: the Axini TestManager, a tool that very thoroughly and in a short time models and tests complex systems.

Competitors: SmarTesting, Conformiq.



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### Alternative Application

Potential customers are all companies or governmental organizations that develop or use complex software/hardware systems, for example: ProRail, Philips Healthcare, Verkeer en Waterstaat, and financial companies like Achmea, ABN-AMRO, Rabobank.



Avoid software bugs that have a large impact on society.



Fast and extensive testing, based on early validated models of requirements.



Reduction of manual test effort and after-sales maintenance.



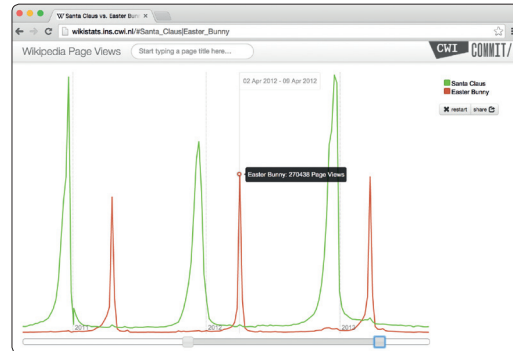
Improvement of model-based testing requires new techniques to deal with large state spaces and data.

## 26. Rapidly visualizing Wikipedia page views

**M**any sectors in our modern society are producing more and more data: science, medicine, finance, business, transportation, retail and telecommunication, to name a few. Visualization is an effective way to interpret the meaning of these data.

We develop techniques that greatly speed up the statistical processing of large amounts of data. We use these techniques to rapidly visualize the statistical results.

Our demo shows how the interest in a Wikipedia page changes over time. A user can select any set of pages to compare, and also find pages with similar interest over time. This can for example be used to judge interest in certain topics from society in general.



### ICT science question

How can we speed up the statistical processing of large amounts of data? What are the best visualization techniques for the statistical analysis of large data sets?

Complex statistics are usually limited by the amount of data, since statistical tools are not built to handle massive amounts of data. We embed a statistical processor into a high-performance relational database (MonetDB). This combination is unique, as the translation between the two systems is minimal and thus one hundred times faster than comparable systems. This system has the potential to deliver new insight into massive amounts of data.

### Application

Our application shows the interest in Wikipedia pages over time and is already available online: <http://wikistats.ins.cwi.nl>.



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Try your own Wikipedia page view visualizations on: <http://wikistats.ins.cwi.nl>

Watch a video about our work on: <http://vimeo.com/groups/amsterdamdatascience/videos/100491517>

COMMIT/ project

TimeTrails Spatiotemporal Data Warehouses for Trajectory Exploitation

Our database contains almost sixty million measurements from nine hundred thousand Wikipedia pages between January 2008 and July 2014. The data are taken from the Page view statistics for Wikimedia projects. (<http://dumps.wikimedia.org/other/pagecounts-raw/>)

### Alternative Application

Any company or research institute that analyzes large data sets through statistical processes is a potential customer. Applications range from health care over retail to government.

### Nice to know

According to our statistics, people visit the Wikipedia page about 'Love' four times more often than the one about 'Money'. There is some hope after all...

### Quote

"If you start analyzing big data with R + MonetDB, you will no longer have to wait around long enough to take a coffee break after running each analysis step." – Anthony Damico, Statistical Analyst at the Henry J. Kaiser Family Foundation



We produce statistical analysis results 100 times faster than before.



If the amount of data you have to handle for statistical analyses exceeds what your tools can handle, and you are already using R, we can help.



Our high-performance combination of R and MonetDB is published as Open Source software and can be used for your projects without licensing fees.



We study how the combination of statistical analysis tools and analytical data management systems can yield highly improved performance.

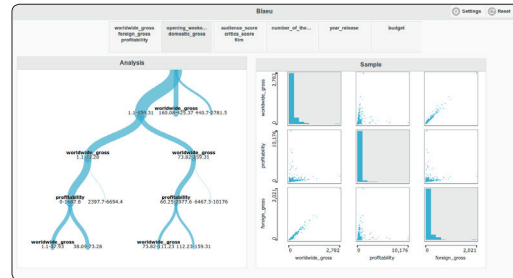


## 27. Lost in your data? Let Blaeu give you a few tips

Companies, governments, organizations and scientists have access to more and more data. But only a few of them have access to enough statisticians, enough visualization experts and enough processing power to explore the full richness of all these data.

To solve this problem, we have developed a data exploration tool called Blaeu. Our system is named after the famous 16th century Dutch cartographer Willen Blaeu. Our 21st century Blaeu is a digital 'data cartographer'.

Blaeu works as a graphical user interface which guides non-technical users through their data. Through a combination of cutting-edge database technology, smart machine learning algorithms and effective visualizations, Blaeu will change the way people explore their data.



### ICT science question

How can users who know close to nothing about databases become data scientists?

### Application

We have initially developed Blaeu to help astronomers to explore their databases. This domain is challenging, because we have to deal with huge volumes of data, and because we may not even know what we are looking for.



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COMMIT/ project  
TimeTrails Spatiotemporal Data Warehouses for Trajectory Exploitation

### Alternative Application

Our technology can help anyone with quantitative data. We love science, marketing, finance and the chemicals behind good wines.



Our technology makes data processing maths and algorithms easy to use. Therefore, more people can understand and monetize data.



Our system helps people write database queries with machine learning and visualizations. Instead of writing code, people select and zoom into maps.



Our prototype is an unprecedented attempt to make machine learning available to anyone with numerical data.



Our demo combines in-memory analytics, subspace clustering and hierarchical visualizations to enable fast database exploration.



## 28. Predicting the earth's climate with Graphics Processing Units

In order to predict the earth's climate, we need to understand the interaction between the atmosphere (air) and the oceans (water). Only at a resolution smaller than two kilometres essential physical phenomena such as ocean eddies are resolved in the ocean models. We develop ways in which climate modellers can use the enormous computing power that they need for high-resolution and long-running modelling. As high-resolution climate models require great computational power, we use Graphics Processing Units (GPUs) to perform the computations.

Our demo consists of two parts. The first part is a short movie that shows the results of our ICT-research: performance models for overlapping GPU-computations with CPU-GPU communication. The second part is an interactive visualization of the Parallel Ocean Program, a scientific research program to model the oceans. Our performance models have been applied in this research program.

### ICT science question

How to optimize data transfers between hosts and GPUs?

Real programs contain dozens of kernels, i.e. small computer programs that manage input-output requests. On GPUs, the computational time of these individual kernels can often be optimized and reduced to virtually zero. At that point the transfer times between all these GPU kernels become the next bottleneck. The problem is that there are many different mechanisms for these transfers and the best mechanism depends on details of the algorithm.

To solve this problem, we have developed a generic performance model that greatly helps in deciding which mechanism is optimal, thus avoiding the need to implement and measure all alternatives.

### Application

We apply the results of our ICT research in the Parallel Ocean Program (POP), a component of the coupled Climate Earth System Model, maintained by NCAR (Boulder, CO, USA). Our scientific partner in The Netherlands is prof. Henk Dijkstra from the University of Utrecht.



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COMMIT/ project  
IV-e e-Infrastructure Virtualization for e-Science Applications

### Alternative Application

The results of our research are being applied to a number of other domains, in particular in applications where CPU-GPU data transfers form a significant bottleneck.

One example is the problem of Radio Frequency Interference mitigation in Radio Astronomy. Another example is deep analysis of data obtained from crime scenes, in particular image and video data. In this latter domain of forensic analysis we have set up a collaboration with the Netherlands Forensics Institute (NFI).

### Nice to know

The GPU work was nominated for best paper at IEEE/ACM CCGrid'2014 (May 2014, Chicago, USA) from a total of 283 submissions. So, it belonged to the top one percent.

The work with Utrecht and several other international partners was winner of the Enlighten Your Research - Global 2014 Award (November 2013, Denver, CO, USA).



To understand the impact of climate change, researchers need high-resolution simulations, which require so much computational power that we use Graphics Processing Units to perform these computations.



This project presents a performance model that allows application developers to identify what implementation strategy to use when integrating Graphics Processing Units into applications.



The ability to efficiently use Graphics Processing Units will allow us to perform Climate simulations at extreme resolutions, where essential physical phenomena are fully resolved in the models.



Our work on performance models for overlapping CPU-GPU data transfers opens up several avenues for future work, while our work on climate models will lead to more insights in future climate.



# 29. Building the Internet of the future

Over the decades the number of computers and the data traffic has grown so enormously that the present Internet faces both problems of collapse and security. To cope with these problems we investigate a fundamentally new concept to organize the Internet: 'Internet Factories'. The idea is that with a push of a button one can manufacture a specialized internet. Essentially these internets can be used similar to the Internet as we know today. Yet our research allows groups of companies to manage the generated internet. Their specialist software gives the generated internets advanced properties.

Our research has resulted in prototype software that continuously defends a generated internet against cyber criminals. Our research enables an industry that takes care to provide all specialist networking properties our advanced Internet applications require. We will have more privacy, better bank safety and we will drive smart cars and use a smart electricity grid because each of these applications will use their own optimized internet.

## ICT science question

We envision distributed applications that are typically deployed over hundreds if not thousands of nodes using the services of tens of cloud providers spread having data centers at hundreds locations around the world. This leads to a number of scientific challenges: How can we manage the state of large distributed applications? What are the limits of their controllability?

## Application

Complex distributed applications are created by collaborating, multi-disciplinary groups. The interworking of the distributed application is enabled by well-known Internet technologies. Our contribution is a set of technologies that casts such a distributed application in a form that makes it manageable by control software that is also provided by us. The software controls all domain independent qualities of the distributed application. We demonstrate this with a distributed application from the Amsterdam Medical Center (AMC) that analyzes different types of brain scans.



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COMMIT/ project  
IV-e e-Infrastructure Virtualization for e-Science Applications

## Alternative Application

Our implementation is generic and suitable to create applications that control new, complex machines, geographical large scale infrastructures and distributed satellite systems. Currently we use our technology with KLM and Ciena Networks to create applications that can defend themselves against cyber attacks.

## Nice to know

Our view on the Internet of the future is that we should program the Internet as a whole. And programming the Internet as a whole is like programming an ant heap instead of individual ants.



Here we show how healthcare research and industry can profit from our ICT developments, and argue how these technology enhances the overall cyber security.



Our technology enables the creation of robust and secure application on more than a 1000 location over the world.



We demonstrate that our technology enables development of normal web-applications while independent development, using our software libraries, can optimize and add robustness to these applications.



Here we show the concept for next generation of Internet applications and engage in discussing future research internet applications and development.



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innovation  
for life

# 30. Telehomecare that protects people's privacy

Telehomecare involves the delivery of healthcare services to patients at home through the use of ICT. Based on centrally collected data through remote patient monitoring, specialized ICT-devices at the patient's home provide healthcare services such as suggestions on sports activities or medication. The utility of those suggestions is determined by the collected highly sensitive patient data, which causes major concerns about the privacy of the patients.

Our demo realizes telehomecare services while keeping all patient data confidential at all times. This increases patient trust into telehomecare and gives healthcare providers the technical means to comply with modern data privacy laws.

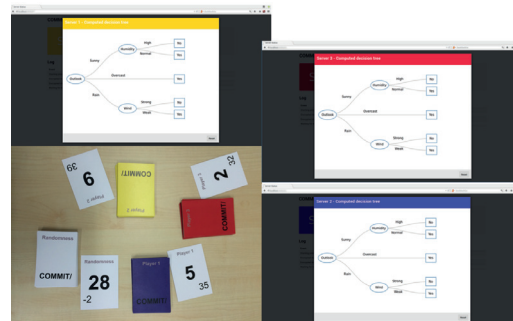
## ICT science question

How can we use cryptography to protect user privacy in data-mining tasks? In theory, the cryptographic technique of secure multiparty computation (SMC) allows multiple parties to jointly compute a given function on each party's input without any party learning the inputs of the other parties, thereby protecting the privacy of each party. In practice however, this general-purpose approach often turns out to be inefficient.

For the first time, we have constructed a highly efficient SMC-protocol tailored for the computation of an ID3-decision tree. This tree can then be securely evaluated to form specific predictions.

## Application

An ID3-decision tree is a commonly used data-mining algorithm used to provide medical advice to a patient based on sensitive data collected from other patients. With our partner, the rehabilitation



centre Roessingh, we use our privacy-preserving technology to realize the teletreatment of COPD-patients in a privacy-friendly way.

## Alternative Application

Our technology is also broadly applicable for computer vulnerability analysis and mitigation. Potential partners are small and medium enterprises that lack the financial means for IT-security experts helping to recover from cyber-attacks. On the basis of collected sensitive data on cyber-attack incidents and their mitigation, our technology can automatically provide advice on how to mitigate certain attacks without expensive experts. Except for specialized graphical user interfaces, no heavy technical development is needed to bring this into practice. In the Netherlands, this service could be offered by the National Cyber Security Centre (NCSC).

## Nice to know

To show practical feasibility, our prototype has been tested with real patient data from an automated telehomecare system of the Dutch rehabilitation center Roessingh.



New technology to keep sensitive data confidential in complex data mining tasks applied to the setting of telehomecare to protect the privacy of patients.



Mechanisms that reduce the rewards of cyberattacks and surveillance by keeping valuable data confidential/encrypted at all times.



Our high-performance combination of R and MonetDB is published as Open Source software and can be used for your projects without licensing fees.



Novel cryptographic approach to efficiently perform data mining tasks in the encrypted domain, thereby keeping all underlying data confidential.



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COMMIT/ project  
TheCS Trusted Healthcare Services



UNIVERSITY OF TWENTE.



# 31. Trusted healthcare services

Although there is a great demand for ICT-supported health care services, both patients and professionals are only reluctantly stepping in. A main obstacle is trust. We develop a web-portal that enables the delivery of healthcare services while incorporating and evaluating new trust technologies. Examples of these trust technologies are: data reliability evaluation to support decision-making, transparency tools to show how data is handled, and data leakage and secure multiparty computation for keeping patient data confidential. Our trusted healthcare services will be used and evaluated in the daily care setting of the Rehabilitation Centre with COPD and post-cancer patients – a living lab setting – so not just an academic platform.

## ICT science question

Which technologies can contribute to greater trust in the use of ICT-supported healthcare services? Can we demonstrate these technologies in a realistic setting? Can we develop a reliable trust measure for ICT-supported healthcare services?

## Application

Our trusted healthcare services include traditional modules like treatment planning and information, communication facilities and links to the Electronic Health Record (EPD). But they also incorporate state-of-the-art treatment modules like web-based exercising and an Personalised Activity Coach. This ambulant coach uses streaming sensor data and adaptive personalized feedback to achieve a physically active lifestyle.

The platform is developed in strong collaboration with Roessingh Rehabilitation Centre, Roessingh Research and Development and with the IT-companies VitalHealth and JC Groep, so it is solidly grounded in the real health world with stable ICT technology, advanced treatment modules and a firm scientific basis.



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COMMIT/ project  
TheCS Trusted Healthcare Services

## Alternative Application

By the way we develop and test the platform, we are creating an excellent starting point for successful valorization. We aim first at the Dutch rehabilitation market. A second market involves the care institutes.

## Nice to know

Roessingh Rehabilitation Centre is leading in the use of tele-rehabilitation services in the Netherlands and participates in several European projects to develop new services.

## Quote

“Based on the gained experiences, we will be able to develop quickly a patient portal for the rehabilitation centres in the Netherlands” - JC Groep



Only when e-health services are fully trusted by healthcare organizations and citizens, they will be massively used, resulting in reduction of health care costs and significant business opportunities.



We develop trusted health care services in a living lab environment, meaning that new modules can easily be integrated and tested the next moment by users, providing fast feedback on your product.



We deliver trusted healthcare services – co-designed by healthcare professionals and patients – with basic and advanced treatment modules, embedded in a living lab environment in daily rehabilitation care.



We offer a flexible platform to investigate new technologies that contribute to greater trust, and demonstrate and validate these technologies in a realistic living lab setting.





## 32. Web-based tools for handling biomedical Big Data

**B**iomedical research is facing Big Data challenges. At present however, researchers don't have user-friendly IT tools to handle these data. To solve this problem, Science Gateways are developed. Science Gateways are built as easy-to-use, web-based and scalable tools that manage and integrate data, methods and infrastructure for scientific research.

The AMC Science Gateways for biomedical research enable scientists to run large-scale data analysis easily and efficiently from web interfaces. From the gateway interface the scientist can start, monitor and inspect results of the analysis and collaborate with other researchers. The details of the underlying data and computing infrastructures are totally hidden from the researchers, so that they can focus on their research.

### ICT science question

How can Science Gateways deal with the perplexing amount and variety of system components? How can Science Gateways deal with the fact that the requirements from scientists are unknown or changing? Our research adopts principles of design science for information systems: we iteratively build science gateways, validate them in the field and generate methodologies and best practices for the construction of future gateways. Our approach is unique because our gateways are designed for, evaluated by, and adopted by researchers in daily practice. Furthermore, our methodology and technology enables fast construction of new gateways across scientific domains.

### Application

Our gateways will support the following domains and communities:

Neuroscience: AMC Brain Imaging Centre utilize our gateways to parallelize execution of computations for neuroimage data analysis and management.



Molecular docking: AMC Medical Biochemistry department uses our gateway to perform in vitro drug screening, which requires parallel execution of massive computations. DNA sequencing data management: the Bioinformatics Laboratory and the Department of Rheumatology and Clinical Immunology of the AMC will utilize our gateway to manage ImmunoGenomics data.

### Alternative Application

Various other groups have shown interest in Science Gateways because they simplify access to complex data and compute infrastructures. Also small research groups in other organizations from academia or industry could benefit from this approach.

Due to our methodology and technology, the customization to other applications is straightforward. For example, the Protein-docking Gateway was built in only three months by an intern reusing the Neuroscience Gateway components.

### Nice to know

During the past three years, our Science Gateways have been used by almost thirty researchers in the AMC. Together they computed approximately fifteen CPU-years and processed and generated three terabytes of data. They published so far five papers about the result of the data analysis that they have performed via the AMC Science Gateways.



Better, faster, cheaper biomedical research. Our Science Gateways enable researchers to handle their biomedical Big Data and harness the power of Big Computers without bothering about the IT-complexity inside.



Our Science Gateways are the new enterprise systems between researchers and Big Data and Computers. They integrate data, people and IT-infrastructure behind easy-to-use web and mobile interfaces.



Biomedical research needs tools to exploit Big Data and Computers more effectively. Our gateways provide web and mobile access to data and high-capacity infrastructure enhancing biomedical research.



Science Gateways facilitate dealing with Big Data and Computers, but they are difficult to build. We research methods to construct science gateways by iteratively building them and validating in the field.



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Watch our videos on YouTube: <https://www.youtube.com/user/ebioscience>

COMMIT/ project

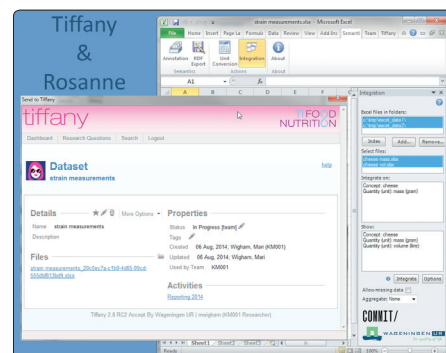


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# 33. How to get more out of food research

Effective food research requires that data and methods are shared. At present, careful data management is considered as a burden rather than a tool for good science. As a result, data can no longer be found or interpreted once time has passed. Furthermore, potential synergies slip through the net and costly duplications and mistakes occur. We have developed two tools for the easy management of food research data. The first tool, Tiffany, helps researchers to document their data in such a way that others can easily trace, understand and reproduce the research process. The researchers can use a second tool, Rosanne, to annotate their data in order to further improve search and reuse. Together, Tiffany and Rosanne increase the chances of successful valorisation of food research.



## ICT science question

Computers excel in data processing but do not understand the data. For example, they can find a scientific paper containing some given keywords, but they cannot tell where the conclusions in the paper came from. They can calculate the formulas in a spreadsheet but they cannot find related datasets and combine them.

To support the researcher in these tasks, the computer needs machine readable models of the real world. Challenges include: How can we develop a model that supports information exchange without restricting researchers? How can we embed this support in a user-friendly manner that fits in the everyday research practice?

## Application

We work together with the TI Food and Nutrition, a public/private partnership for long-term strategic research to enhance innovation in the food industry. We also cooperate with the member food



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Watch our video on: <http://youtu.be/cQIdHTwPL1Y>

COMMIT/ project  
e-FOOD e-Foodlab

companies of the institute in order to understand their needs. These companies include Unilever, Danone, Nestlé and DSM.

Data management is in its infancy in food research, limited to particular tasks, such as lab management systems, or to generic document systems. These systems have difficulty in exchanging data and don't allow the entire research workflow to be traced. Support for integrating datasets is non-existent.

## Alternative Application

Our work is easily extendable to research in other domains, both academic and industrial. Partners could be other research institutes and their industrial partners, research funding bodies or a commercial ICT partner to market the developed tools.

Our experience in developing semantic tools for research support is unique, due to the combination of theoretical research and the development of concrete practical tools. Further development would be required to improve the robustness and user-friendliness of our tools.

## Nice to know

Our tools Tiffany and Rosanne were nominated for the 2012 COMMIT/ Valorisation Awards. This is a national award given by the Dutch organisations ICT-Office, Stichting ICT-Milieu and the Centrum Wiskunde & Informatica (CWI).



Tiffany: better food research for the taxpayers money.



Semantic tools for sharing research data will revolutionise how we feed our society.



Taking time to invest in research data management makes the difference between research that looks nice on the shelf and research that changes people's lives.



Properly organising my research process gets the most out of my work.

## 34. Wireless crowd monitoring in Arnhem

Monitoring the movements of crowds in cities can lead to improved city planning, more efficient traffic flows and safer crowd management. As camera surveillance might lead to privacy violations, we use wireless sensor networks to measure who is close to whom. In particular, we use ordinary smartphones as sensors. We make sure that the data of individuals are anonymized.

Our demo shows a website acting as a dashboard for live streams from downtown Arnhem, where tens of WiFi-hotspots are tracking smartphones as they move. The trajectories of pedestrians are mapped onto the actual city plan of the downtown area. We don't know who the pedestrians are, nor can we find out: all smartphone identification is irreversibly transformed into a single cryptographic number before it enters our tracking system. Given such a number, it is impossible to say to which smartphone it belongs, let alone that we can identify its owner.

In our demo we will also show screen recordings of trajectories during the World Living Statues Festival on 27 September 2014, which is expected to attract some three hundred thousand people to Arnhem.

### ICT science question

How can we reliably detect mobile devices and realistically project their trajectories onto a city plan? One of the problems is that there are many false and missed detections, originating from very different sources. Identifying trajectories is difficult as there may be many alternatives paths between two subsequent detections of the same device at different locations.



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COMMIT/ project  
EWIDS Very large wireless sensor networks for well-being

### Application

Our main application is crowd monitoring in highly populated areas. Our partner Foundation Wireless Arnhem provides WiFi-hotspots for detection. Members of Arnhem City will use our application to obtain insight in crowd movements during the World Living Statues Festival.

Our live streaming of hotspot-based crowd detections is unique. Urban sensing as such is not unique, but the way we support crowd management has not yet been reported.

### Alternative Application

Our research can also be applied to identify different groups of people visiting a city, such as shoppers, tourists and commuters. It can provide much better insight in the long-term movements in a city, which can be used for city planning (traffic, parking spaces, bicycle trajectories). It can also be used to correlate shops and venues: e.g. if Alice goes to A, will she also visit B? Natural partners in our research are other cities, their shops and venue organizations.

Monitoring crowds is applicable to many things and not limited to humans.

### Nice to know

It is expected that in 2017 seventy percent of the world population will own a smartphone. Most of these will be WiFi-enabled.



We automatically measure the movement of crowds in urban spaces.



Our data will allow for the development of a to-do recommendation app.



With this system you will be able to optimize urban/pedestrian logistics.



We need new real-time and scalable mining techniques to deal with noisy data on proximity graphs.



## 35. Using smartphones for emergency messaging

Even in case that a GSM network is down (like during the Enschede fireworks disaster) or overloaded (like during recent festivals), it is important for public safety that smartphones can still be used for emergency text messaging. In this way the authorities can inform the public about the emergency. We have developed a way to realize this emergency communication.

Our protocol is called COCOON: Context-aware co-operative opportunistic network. COCOON can be used on any phone and is primarily being developed for the emergency festival scenario, to inform the public during big events. Apart from emergency scenarios, COCOON can also be used by normal users in a 'Twitter-style': to send and receive short messages in a peer-to-peer fashion.

### ICT science question

How can smartphones still be used for emergency messaging in the case that the GSM-network is down? What protocol do we need for this? How can we optimize its performance and the effectiveness? How do we make the protocol scalable from a small to a large network of smartphones? To solve these problems we use the WiFi (or Bluetooth) radio installed in almost every smartphone. Although this has been tried before, it could only be accomplished in phones that had been hacked in order to change the core software of the phone. Such efforts excluded the general public. Our protocol solves this problem as well.

### Application

COCOON can be used on any phone and is being developed to inform the public during emergencies at big events and festivals. The first and foremost partner in our research is the Dutch police. COCOON is under development and is being tested on a small-scale. We have plans to perform



medium- to large-scale tests in 2015. At present, the protocol code is stable, but further testing is needed for optimization.

There are some similar products available, but they all have limitations: OLSR (only hacked phones), Bluetooth communication (limited number of participants, needs previous pairing), WiFi Direct (needs previous pairing).

### Alternative Application

Our emergency text messaging protocol has many applications besides the emergency scenario, for example: Twitter-style messaging, advertising by shops or stands, public displays, city promotion and public transport.

We plan to make a public programming interface to COCOON, so it can be embedded in other applications as well, for example in apps used by festivals. COCOON can then also be used to give real-time information on any changes in the program, to let festival visitors give feedback and to give festival visitors the possibility to communicate with others in a Twitter-style.

### Nice to know

During Pinkpop it sometimes took more than an hour for an sms to reach its destination. At Pinkpop 2014 neighbors to the festival were asked to open their WiFi access point for visitors of the festival.



COCOON provides communication in emergencies when everything else fails.



The COCOON platform gives your app direct and free communication with other smartphones.



COCOON is a new way to communicate, available for any modern smartphone.



COCOON is an opportunistic delay-tolerant short message communication protocol for smartphones.



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COMMIT/ project  
SENSAFETY Sensor Networks for Public Safety



## 36. Measuring crowd densities for safety and efficiency

Events like concerts, festivals and sporting competitions often attract a crowd of people. The same can be the case for institutions like museums, hospitals and amusement parks. We have developed a real-time visualization of how the density of a crowd changes.

In our demo we will ask volunteers from the audience to wear our electronic badge. This badge will monitor the surrounding density of its user in real time. The measured densities will be made visible on one or more screens.

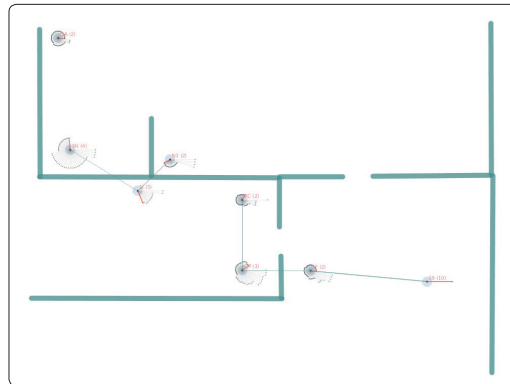
By giving instructions to the volunteers, we will also be able to show real-time changes in density measurements. All these measurements are done in the network, so that there is no offline, central server needed.

### ICT science question

The scientific challenge is how to reliably estimate the number of people that are in the neighbourhood of each person. Each person is a node in a constantly changing network. This estimation is a scientifically hard problem, because we consider mobile networks with high densities: each node has typically hundreds of neighbours. An additional challenge is that all nodes estimate the number of neighbours at the same time.

### Application

Tracking the density of crowds in real time can contribute to a safer and more efficient way to deal with crowds. Our estimator (called Estreme) can at the same time estimate the neighbourhoods of one hundred nodes with an error below ten percent. Competing solutions presently provide a



similar accuracy, but only on networks consisting of a few tens of nodes, where only a fraction of them estimates the number of neighbours at the same time.

### Alternative Application

Due to its simplicity, our algorithm can also be used in wristband devices. This makes it more practical and attractive for potential customers than using the badges, as in our demo.

### Nice to know

We have implemented our crowd density measurement tool in an open source operating system for the Internet of Things. We will soon use it at the Cobra museum in Amsterdam to monitor the flow of visitors and identify hot spots.



Events like concerts, festivals and sporting events often attract large crowds. Estreme provides a simple solution for real-time visualization of crowds, which is important for planning and safety.



Estreme is a low cost wristband that can be given to all attendees in an event. This wristband preserves the privacy of people but allows a real time monitoring of the crowd.



Estreme tracks crowds in real time, which makes an event safer and more pleasant. It can cope with higher densities than existing solutions (100's of neighbors) with the same low error (below 10%).



Estimating the density of crowds is a hard problem because it requires monitoring mobile networks with high densities. Estreme uses periodic but asynchronous radio signals to solve this problem.



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COMMIT/ project  
EWIDS Very large wireless sensor networks for well-being

## 37. Tikkertje 2.0

**I**nteractive playgrounds are installations that combine the benefits of traditional playgrounds for children with advances in technology. In our demo we show the Interactive Tag Playground (ITP), a modern, interactive version of the century-old game called 'Tagging' or 'Tikkertje' in Dutch. With the Interactive Tag Playground we actively steer the interaction between players. To this end, players are being tracked using Kinects and additional body-worn sensors. In its most basic version we project differently colored circles around each player to indicate the role of tagger or runner. When these circles collide, a 'tag' is detected and the roles of the players switch. We also add novel interactive elements such as power-ups and bonuses. Apart from entertainment, the Interactive Tag Playground is also a tool to study how children interact with each other and with the environment. Our final aim is to automatically steer the interactions in such a way that all players remain engaged and physically active.



### ICT science question

How can we best track the players and understand their interactive behavior? What kind of interactions are suitable at which moment during the play to maintain the engagement of players? How can players be motivated to adopt certain play styles such as cooperation or competition?

### Application

Our work can eventually be combined into playgrounds that allow for adapted play without any restrictions such as the need to wear certain sensors. We see great potential for these playgrounds in open spaces such as traditional playgrounds, shopping malls, sporting facilities and outdoor squares.



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COMMIT/ project  
IUALL Interaction for Universal Access

### Alternative Application

Interactive play is everywhere. Not only children can benefit or enjoy interactive play. Previously, we made an ambient interactive bar that was successful in entertaining adults. The techniques, both for sensing and interaction, are largely the same. One can also think about offering play to people who normally have limited play opportunities, such as heavily handicapped or demented people. Interactive play might help in socializing, entertaining, triggering physical activity or even branding.

### Nice to know

The behavior of adults and children while playing tag is largely the same. Except that children cheat more.

In 2008, the UK Local Government Association promoted tag games stating that children are over-protected ("wrapped in cotton wool"). [Wikipedia]

Variants of tag have fancy names such as "Cops and Robbers", "Kiss Chase" and "Ringolevio".

### Quotes from participating students:

"This looks so cool!! I want to play!"

"I want to have this at home!"

"This should be a new sport, Olympic"

"I think this would fit very well in gyms or fairs"



An interactive whole-body game aimed at enhancing the player's fun, physical and social experience.



An interactive game environment that senses players' behavior to facilitate a physically active, social and engaging experience with multiple other players without prior calibration.



A novel game environment that mediates gameplay elements by sensing and tracking players to promote targeted behavior or improving the game experience.



Tracking and analysis of human behavior to create engaging gameplay.

## 38. Advising optimal step frequency for runners

Every year about one-fifth of the 2,5 million Dutch amateur runners gets injured. Running with too large steps, and therefore mostly with a frequency that is too low, is known to increase the injury risk of a runner. The optimal step frequency of a runner depends on the heart rate and the running speed, and differs between individuals. Beginning runners are known to have step frequencies below their energetic optimum.



Using the smartphone as a sensing tool, a beginning runner can be guided to increase step frequency if necessary. From previous runs an optimal step frequency can be calculated. To this end, we develop a robust step frequency algorithm for unconstrained smartphones and calculate individual optimal step frequencies from training data.

### ICT science question

How can we use parameters measured of a variety of signals to optimize a desired response? Robust algorithms are needed to work beyond well-controlled environments of a laboratory. And another challenge is the time-variations in the signal.

### Application

The application centers around the question how to use parameters as heart rate, step frequency and speed to optimize the technique of an individual amateur runner? The optimal step frequency of a runner can change over time, due to training or injury. This requires an optimization process that combines group-based data with individual data of the runner. This has been done previously in laboratory research at slow running speeds, but finds its novelty in a broader range of speeds. As the optimal step frequency of a runner can change over time, due to training or injury. This requires an optimization process that combines group-based data with individual data of the runner. Individual amateur runners can use our application to help them finding their optimal step frequency.



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COMMIT/ project  
SENSEI Sensor based Engagement for Improved Health

cy. There is a growing market for running applications, like Endomundo, Runkeeper, MapMyRun, Zombies-Run and Nike+ Running. Also, sport watch brands like Garmin, Polar, Timex, TomTom, Suunto and MIO are competitors for this kind of applications. Although many of those applications give feedback on step frequency, none of the current brands have individualized feedback on individualized optimal step frequency.

### Alternative Application

Similar measurement approaches to ours are currently used in other sports, such as rowing and speed skating, and in medical applications, such as assessment of movement disorders in neurological patients and of fall risk in elderly. Our algorithm is innovative both in terms of real time use and in robustness, and can be of benefit in these fields as well. Similarly, combining accumulating individual data with group-based reference data is likely to be useful in many sports and medical applications and possibly in a much wider field.

### Nice to know

Because step frequency remains relatively consistent across different running event lengths, it is recommended to first optimize step frequency and later adjust step length to obtain the desired speed.



We provide feedback of current individual optimal stride frequency by changing (music) beats to the desired rhythm. In this way, the runner is stimulated to unconsciously run with an improved technique to prevent injuries.



We combine data sources, like heart rate, phone sensors and data from previous runs to provide the runner individualized feedback about their optimal stride frequency.



No expensive devices needed, you can run with your smartphone and still get accurate individualized feedback. Our application has a robust stride detection algorithm and uses previous runs to change music beats to your current optimal stride frequency.



Heart rate of previous runs is used to find an optimum stride frequency for different speeds for an individual. Higher stride frequencies lowers impact forces and therefore is expected to decrease injury. We developed a robust algorithm that detects strides for a broad range of periodic signals for unconstrained (phone) sensors.

## 39. Run, talk and don't get injured

We have developed a smartphone app that provides a novel, automated and unobtrusive way of assessing a runner's physical state based on speech. Beginning runners often have difficulty determining whether they are exercising at the right intensity. They often start with running too fast, and this increases the risk of exercise dropout and injuries.

One of the most widely used subjective ways to assess the level of exercise intensity is the 'talk test'. When you can still speak comfortably while running, you are running at the right intensity. Our smartphone app analyzes your voice and indicates whether or not you are exercising too hard.

### ICT science question

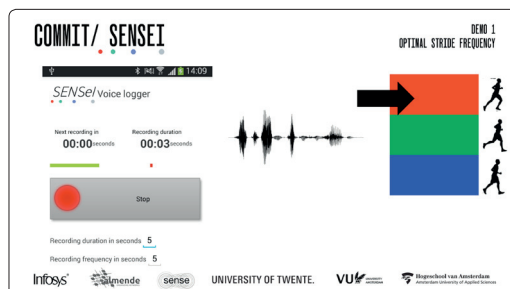
How does speech production change under influence of various conditions? How can we develop an algorithm that uses this knowledge for reliable automatic voice-based assessment?

To solve these challenges, we train classifiers to gauge two signals while they are being acquired each under individually varying circumstances.

### Application

The app measures the speech production during running exercises. Speech and heart rate data are collected from people talking while running at various intensity levels. To the best of our knowledge, we are the first to address these two challenges simultaneously.

Through automatic voice analysis, the 'talk test' can be made more objective but still in an individualized way. It works unobtrusively as a voice-based app on a smartphone that people often carry while running. Although there are many running apps available in the market, none of these have the features as presented in our demo.



### Alternative Application

The knowledge we gained about the human speech apparatus can also be applied in other areas, for example speech and language therapy. Some people have difficulty speaking due to breathing problems caused by diseases such as COPD. Having software programs that can help train people in their own time to control their speaking apparatus could be beneficial for these people. In addition, our software can be applied in other smartphone-based speech analysis tasks as well, such as emotion recognition.

### Nice to know

"It's very interesting. With the speech data obtained you not only learn a lot about how speech parameters change under physical stress, but you can also develop technology that classifies levels of physical stress. I would be very interested in using the speech data collected for classification challenges." – Anonymous



Assessing your exercise intensity by talking to your phone while running is a fun and cheap alternative to assessing it by measuring your heart rate through bands or expensive watches



Our voice app offers a fun and accessible way to assessing exercise intensity to help prevent beginning runners, who often run at a too high intensity, from risking injuries and program dropouts.



We will not only be innovative in our research, studies on speech under physical stress are still limited, but we will also utilize the knowledge to advance voice technology to detect physical states.



Research on changes in people's speech under the influence of physical activity is novel. It can be utilized for an app that detects exercise intensity through voice.



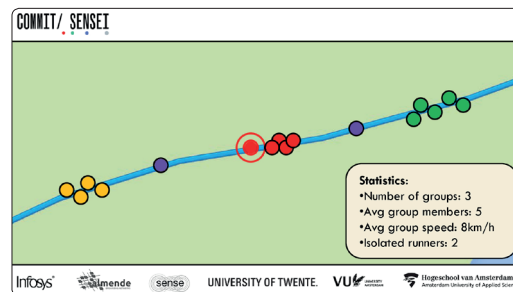
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COMMIT/ project  
SENSEI Sensor based Engagement for Improved Health



# 40. Intelligently grouping amateur runners

Currently, most amateur runners train alone, which may lead to decreased motivation over time. We have developed an app that intelligently groups runners with similar physical parameters in order to make the training more efficient and more fun. In our demo, we display interactively on a screen how a person running on a treadmill follows a track with other runners in a virtual environment. During the run, the app tries to match her with other groups of virtual runners that she passes by, based on the speed and fitness of the person. When a good group is found, the runners in the group are coloured in a certain way, to indicate our runner that she should train together with them.



## ICT science question

Can we make an app that clusters signals in groups that are similar? Can we develop a clustering algorithm that is fast, fault-tolerant and has low battery usage?

As a solution, we propose a novel peer-to-peer clustering algorithm. To our knowledge, this algorithm is the fastest of its kind and the attempt to cluster runners in real-time has never been made.

## Application

The context is to monitor runners in real-time based on their physical condition and social interests. Our clustering algorithm can use different types of criteria for matching, like physical parameters, interests, age etc. Depending on the chosen criteria, the app can be used to stimulate people to keep up with the others, thus improving performance or to encourage people to socialize. There are already other apps on the market that challenge people to run together (e.g. Endomondo), but ours is the first one that does this in real-time.



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## Alternative Application

The algorithm we propose can be applied to other domains as well.

For example, it can be used to help companies around the world to find potential business partners. If each company would expose its services in a standardized way, our system would be able to search among hundreds of thousands of companies in order to find meaningful partnerships (e.g. Apple with Nike). It could also be used to sell bundles of products that are related or to match people in social networks.

## Nice to know

The National Public Health Institute (RIVM) estimated that, in the Netherlands, 1,4 percent of expenditure on health is a consequence of too little exercise.

It has been estimated that in a big city like Rotterdam, sport benefits for nearly half a billion euro per year. Slightly more than half is the result of a healthier population, almost a quarter is due to less absenteeism at work, twelve percent to a greater quality of life and three percent to less school absenteeism.



Our app helps runners find people to run with that have the same interests and fitness, thus making running more fun and social.



We take an innovative approach to make running more social, by combining the latest mobile technologies in an app that helps runners make new friends while they run.



Bored of running alone? Our app helps you make new friends that are just as good runners as you, so you'll never have to run alone again.



We use a distributed clustering algorithm to group runners in real-time based on their physical parameters and social interests.



UNIVERSITY OF TWENTE.





# 41. Learning with your body as interface

**L**earning in the 21st century puts high value on cooperation, personal involvement and creativity on the one hand, and digital skills on the other hand. In most of these digital skills the human body hardly plays a role, apart from typing on a keyboard. However, it is well known that the body does play an important role in learning. The mind uses and grows out of such bodily capacities.

Especially for the use at schools, we have developed three balance objects (Rolling Stairs, Cylinder and Seesaw) that help teenagers to learn with their body as an interface. Each object has sensors and is connected to an audio box. Teenagers can stand on an object and try to reach a balance. Depending on their movements, they hear different musical sound as a feedback. The sounds motivates them to change their posture. The objects evoke body awareness and emphasize the natural functionality of our bodies, like standing up, climbing, stretching and balancing. All objects aim to be silenced by the user, as silence is taken as the ideal state-of-mind to focus on the embodied self.

## ICT science question

How to design interactive devices in which the body itself becomes the interface? What do we learn about the borders of the body while it interacts with these sensory devices? How easily does the body consider these objects as part of itself?

Comparing our prototype objects with other devices, using the body as interface like Wii Fit Plus, the feedback loop that we use is unique. The participant is not only focused outwards, towards the screen, but the objects constantly lead the focus back to the sensation of the moving body itself.

## Application

All our balance objects have a different purpose in an interactive game between the user and the object. The Cylinder is an empowerment tool focused on finding balance. The participant discovers



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the sensation of grounding the body while making different power poses like stretching up. Cylinder and Kinect camera are programmed to trigger loud noise when 'the performer' is not standing in the desired position on the object. When standing and moving in the right manner, it quiets down. The Rolling Stairs are a way to explore collaboration between two users. Interaction is focused on 'balancing' between different types of collaboration. The Stairs are programmed to trigger single notes or parts of melodies. Collaboration may lead to melodic lines, rhythms, musical compositions and finally silence as the ultimate composition. Our balance objects have great potential for use in special needs education (e.g. related to performance anxiety, ADHD and concentration problems), mental health care (anxiety and obsessive-compulsive disorder) and children's rehabilitation (cooperation, motivation, motor development, neuromotor impairments).

## Alternative Application

The found knowledge can be applicable in ICT and other domains, like rehabilitation, physical exercise, personal coaching, presentation, leadership training, etcetera.

## Nice to know

Our project was screened in the NTR TV education special '10x Beter': <http://waag.org/nl/nieuws/embodied-learning-op-tv>. Our project was nominated for the IPON Award 2014: <http://event.ipon.nl/genomineerden-ipon-awards-2014>



Cylinder, Rolling Stairs, and Seesaw are a series of balance objects, developed to enhance corporal literacy.



We aim at providing a feedback loop that stimulates focus on the moving body itself.



The concept of natural interaction with technology has a great potential for special needs education, mental health care and rehabilitation.



We promote natural interaction with technology through incorporating senses and the body.



waag society

Kennisnet

Marloeke van der Vlugt

## 42. Playing with emotions in the Moodroom

We have developed a Moodroom in which youngsters can express their emotions by moving their bodies. The Moodroom is an interactive installation that records bodily movements with a Kinect-sensor and translates them into colours, patterns, vibrations and sounds. The visual content is projected on three screens in front of the user. In the Moodroom youngsters can express and share their emotions without having to talk about them.



The Moodroom is based on the principles of embodied cognition. Embodied cognition is an upcoming subject in both social psychology and neuropsychology that recognizes the mutual influence between our body, senses and cognitive functions. One aspect of this is communicating about emotions through visual cues, like colors and patterns.

The goal of the Moodroom is to create a new way in which youngsters can get to know themselves and each other in an embodied learning environment.

### ICT science question

How can sensory experiences be translated and used in a playful way in an interactive environment? First, we focus on abstract visual representations to arrive at a new 'language' of movements in which participants can express and communicate their emotions better than in words.

We have the ambition to add other sensory experiences like sound and music.

### Application

Many youngsters experience difficulties in expressing emotions and showing empathy. By using a new 'language' based on sensory experiences and body movements, and with the use of visual and audio representations, youngsters can express themselves in an accessible and entertaining way without being hindered by the abstract character of language.

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We have partnered up with Bascule (a psychiatric institute for children and youngsters) to explore the possibilities to integrate the Moodroom in some of their therapies.

Competitors might be found in developers of Microsoft Kinect applications.

### Alternative Application

In other therapeutic situations, for example while rehabilitating after a stroke or injury, the Moodroom could function like a diary to record the recovery process in relation to the emotional health of the patient.

The installation could also have a place at festivals and other informal places where people can interact with each other. Visualization can have a more public function. The application can have a function both in communication and in empowerment.

### Quote

'NICE! I didn't know that you could show emotions with colours and shapes.' - Girl (15)

'The reactions of the youngsters were very positive. Nice to work with emotions in an interactive way.' - Therapist at the psychiatric institute Bascule



Visual communication of emotions in Moodroom is displaying embodied interaction, enabling youngsters to express and share their emotions without having to talk about them.



Moodroom is a physical space where visual communication of emotions can be displayed by embodied interaction domains.



Moodroom is a physical space for emotional communication, using a newly designed 'language' based on sensory experiences and body movements, which can be applied in a wide range of domains.



Moodroom is a physical interactive space where wordless and visual communication of emotions can be displayed, using a newly designed 'language' based on sensory experiences and body movements.



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Universiteit Utrecht

Bascule

## 43. Personalized interactive wall for elderly with dementia

People suffering from dementia often feel confused and depressed. Some of them also display wandering behaviour.

We build an interactive wall for people suffering from dementia. The wall uses computer vision to recognize the person in front of the wall and to recognize his or her behaviour and emotion. Based on the detected behaviour the wall then gives a personalized experience using video and music that the elderly like. Family members can upload content.



The interaction with the wall may diminish the behavioural problems of dementia such as agitation, aggression, fear, depression and apathy. The wall also gives those who display wandering behaviour a virtual place to go to.

### ICT science question

How to automatically recognize people, their behaviour and emotions? How to select appropriate audiovisual content automatically under demanding circumstances?

### Application

In the early stages of dementia people are aware of their situation, which leads to depression, while in later stages of dementia people become passive, they react to some triggers but do not show initiative by themselves.

The target audience of elderly suffering from dementia presents severe problems. Many of them cannot explicitly state their own preferences. Furthermore, their facial features and posture may change rapidly and their behaviour is sometimes unpredictable.

The interactive wall provides distraction from depressed feelings, activates people or calms them

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down and helps to retrieve memories. It provides a point of reference for people that display wandering behaviour.

The wall is developed together with care organizations AMSTA and Vivium Naarderheem. It has been tested at two different locations.

Competing products exist, but these do not use ICT to provide personalized content.

### Alternative Application

Computer interfacing supported by computer vision is broadly applicable.

The wall could also be used for people who suffer from mental disorders such as severe autism.

The computer vision technology can also be used for human pose recognition and for the classification of actions and interactions involving multiple individuals.

The content selection technology could be used to influence the mood of people in public spaces.

### Nice to know

Three students of the Hogeschool van Amsterdam (HvA) are exploring business opportunities for interactive technology for people with dementia through their startup company *iLLi-engineering*.

### Quote

"Ik zou wel willen dat dit geplaatst wordt in het verzorgingstehuis waar mijn moeder woont."



The Interactive wall improves the quality of life of people suffering from dementia by reducing wandering behaviour and providing a distraction from depressed feelings.



The interactive wall uses computer vision technology to give elderly suffering from dementia a personalized experience. This helps to retrieve pleasant memories and it reduces wandering behaviour.



The interactive wall reduces the wandering behaviour of elderly with dementia and provides a distraction from depressed feelings. And it allows the caregivers to spend more time on other patients.



Recognize people's movements and select personalized content to engage people with one another and with the interactive wall.



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Hogeschool van Amsterdam  
Amsterdam University of Applied Sciences



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CGI

## 44. Send your loved one a gentle caress via a tactile sleeve

We do not only use our sense of touch to explore the world around us, but also in social interaction. Social touch can help to reduce stress, communicate feelings and emotions, and is vitally important for the bonding between people. Unfortunately, our everyday digital communication via smart phones and computers completely lacks the sense of touch.

To overcome this disadvantage, we have developed a wearable, smart-textile sleeve, called TaSST (Tactile Sleeve for Social Touch). You can wear TaSST on your forearm and communicate through touch at a distance. The sleeve can register a gentle caress or a strong squeeze, and reproduce these touches as a vibrotactile pattern on a smart sleeve worn by somebody else. Our tactile sleeve helps to support physical closeness between people separated by distance.



### ICT science question

How can we use wearable haptic technology to communicate the important sense of touch?

### Application

We have designed our tactile sleeve as a research tool to study the communication of social touch. People separated by distance, such as family members working abroad, patients isolated in hospital wards, and people living in elderly homes can use the sleeve as an additional communication channel with loved ones. Deaf-blind people can benefit from it by allowing them to more easily communicate with their care-givers, and opening up their world to new experiences.

### Alternative Application

Tactile is one of the six human cognitive sensors.



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Alternatively, our tactile sleeve can be employed in the entertainment industry. For example, it can be an additional method of communication in online multi-player games. And while watching a movie with a distant friend, the smart sleeve can be used as a playful way to enhance the movie experience.

### Nice to know

Do Androids Dream of Electric Sheep? - Early versions of the TaSST used conductive wool (sheep's wool with metal fibres) to detect touches.

### Quote

"Pak de onderarm van je buurman eens vast. Pets er drie keer stevig op. Vraag dan: welke emotie probeer ik over te brengen? Wedden dat je buurman zegt: eeeuh, woede?" - NRC Next, 21-07-2012

"[...] de TaSST, een apparaat dat menselijke aanraking simuleert en deze over kan brengen naar een ander, waar dan ook ter wereld." - Scientias, 29-12-2012

"Nu communicatie via tekst, geluid en beeld goed op dreef is, is het tijd voor een extra zintuig: tast." - Voorpagina artikel, NRC Next, 22-03-2013



The TaSST uses custom designed fabric sensors, that can be reshaped and embedded in a host of different garments.



Health benefits of social touch are numerous, and mediated social touch could bring some of these benefits to people who may lack social touch in their treatment.



Mediated social touch is an understudied phenomenon and the TaSST offers researchers an open platform to study effects of mediated social touch.



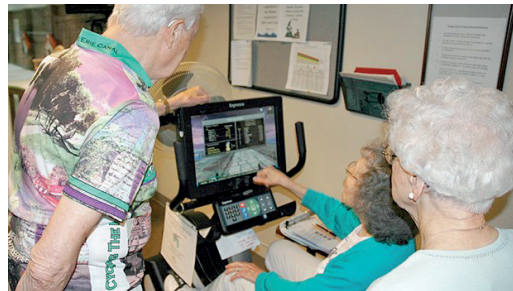
Mediated social touch can play an important part in helping people live independent lives, with intimate connections to their loved ones, for longer.



## 45. An exercise game to reduce the risk of falling

In many patients with neurological or orthopaedic disorders, but also in many healthy elderly, the ability to suddenly change the walking pattern is restricted. These people have a higher risk of falling, for example when trying to step over an obstacle. To reduce the falling risk, we have developed a fun and motivating exercise game.

During an assessment on a walking belt we measure the adaptivity of a patient's walking style. After defining a comfortable walking speed, we present a visual feedback of a target step length. The subject then needs to respond by taking smaller and larger steps respectively. The belt speed adjusts automatically to ensure a constant step frequency. We stimulate the patient to change his step frequency by controlled belt speed changes in combination with target step-lengths. Our assessment measures how well the patient performs adjustments in step lengths and step frequencies. The better the adjustment, the lower the risk of falling.



### ICT science question

How can we improve the adaptability to patterns in personal data?

### Application

Specifically, how can we reduce the risk of falling by data analysis?

Our fun and motivating exercise game helps to reduce the risk of falling. Patients are challenged to change their walking pattern constantly in response to their environment. In this way they will train their adaptive capacity and reduce the risk of falling.

To prevent falls in everyday life, people need to be able to adapt their walking pattern if necessary. We can change our walking pattern for example by taking a smaller or larger step or by taking a



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faster or slower step. These changes in walking patterns are required in situations like passing a doorstep or avoiding a puddle of water on the floor.

### Nice to know

Revalidation products based on extensive scientific research are becoming available for homecare, just in time for the move towards more practicing at home.



The system aims at accelerated rehabilitation by letting people do exercises at home as part of their daily routine.



The approach measures how well someone varies their walking pattern in response to environmental changes.



Sensors measure the degree of decreased adaptive capacity. It may predict the likelihood of a higher risk of falling.



How to measure walking patterns in response to the so-called deteriorating adaptive capacity of a person by use of sensor techniques.





## 46. A serious game for training social skills of police officers

We have developed a serious game called LOITER to train the social skills of police officers. Players of the game have to resolve a conflict with a group of loitering juveniles. Through playing this game, police trainees can improve their social awareness.

Players interact with virtual juveniles in a 3D-environment using a full-body immersive virtual reality system. The virtual juveniles use artificial intelligence to respond to the player according to theories from social psychology. Thus, the choices of the players in how to reason with the juveniles determine the outcome of the conflict.



### ICT science question

One of our main challenges is to model human behaviour and let virtual characters respond believably to human users. To create such a model, we analyzed interactions between police officers and civilians. We also implemented an interactive story structure that lets people experience the influence of their own behaviour on others. This results in different scenarios with different story endings.

Our approach is unique because of its combination of methodologies and the ability of the characters to explain the reasoning behind their actions.

### Application

We have developed LOITER in cooperation with the research centre for serious gaming T-Xchange, software developer re-lion, and the former national police services agency KLPD.

Existing products that focus on training of social skills for police officers are practically non-existent



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or offer only very limited interactivity. Using our implemented techniques, this training can be made more effective, because trainees can directly see the results of their actions and learn why the interaction played out as it did.

### Alternative Application

Serious gaming has a broad impact. Our approach can be used for similar serious games for other professions that would benefit from social skills training, such as social workers and health care professionals. Using our approach to serious games, the training programs for these professions can be made more effective. The technical framework underlying our game enables easy editing and creation of both scenarios and characters.

Other commercial partners could be companies specialized in assessment and human resource development.

### Nice to know

Currently, only a fraction of police trainees can practice their social skills with professional actors. Most of their knowledge is gained by accompanying more experienced officers.

The loitering juveniles in our serious game lend their names from the Dutch tv series "New Kids".



This serious game lets police officers improve their social awareness through training with intelligent virtual characters so that they are better at handling conflicts in a de-escalating way



This serious game uses a virtual reality setup to assist in social skills training by letting trainees gain first-hand experience in how their choices may affect others.



This serious game combines social and computer science to improve people's social awareness and paves the way for the creation of other scenarios for social skills training.



This serious game uses artificial intelligence informed by theories from social psychology to guide the behaviour of virtual characters so that players can improve their social awareness.

# 47. Virtual learning helps people with language problems in societal participation

We have designed a virtual learning environment that supports low-literates and immigrants with language problems to participate in the Dutch society.

In this virtual environment, users can select prototypical situations in which they need information and communication skills in both formal and informal social settings. We have developed four scenarios: online banking, grocery shopping, visiting a service desk and chatting at a bus stop.

The virtual environment uses virtual humanlike characters that graphically appear on a screen. The characters engage in a conversation, show gestures and have facial expressions like real humans. They either conduct conversations with the user or support him in doing participation exercises.

## ICT science question

What is the best way to design an effective virtual learning environment? In particular, the learning environment should be able to deal with large differences in the input.

The virtual learning environment should also adapt the offered content and the difficulty level over time.

## Application

The primary application of this system is in supporting the societal participation learning of low-literates and immigrants in the Netherlands. Therefore, the system should be able to support each individual user achieving their intended learning objectives taking into account large differences be-



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[commit-nl.nl/projects/wp-packages/social-conventions-learning-in-mixed-reality](https://commit-nl.nl/projects/wp-packages/social-conventions-learning-in-mixed-reality)

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tween individuals each with different cognitive, affective and social barriers to learning. Practicing in a virtual learning environment will provide users with requisite knowledge and skills, and increase the self-efficacy required to participate.

Currently, our vision is to distribute this system for instance in public libraries and classrooms, so users can use the system regardless of whether or not they own a personal computer.

## Alternative Application

Our virtual environment technology can also be used in many other application fields: language and culture learning, distance learning, learning on the job, and entertainment.

New tools can be included that could allow users to create their own content for use in this system. This would give the system the additional role of a lesson creation support tool for teachers, and a method of expression for students.

## Quote

“Het ontwikkelen van deze virtuele leeromgeving is volgens mij tamelijk origineel en innovatief.” – Wim Matthijsse, Stichting ABC



Virtual neighbourhood, software that learns how to help people of low literacy and non-native citizens to better take part in local daily life.



Virtual neighbourhood software modelling the social and physical environment to support people of low literacy and non-native citizens in engaging with public and private services in their neighbourhood.



A learning environment software package that employs state-of-the-art didactics, interaction and personalization to provide a lifelike virtual neighbourhood for social participation.



The system provides cognitive, affective, and social learning support using comprehensive user modelling and individualization to teach skills and to improve self-efficacy and motivation.

## 48. Involving the end-user in the design process

Good product design contributes to good business. Unfortunately, many people have difficulties with using everyday technological products. To solve this problem, the end-user should be more involved in the design process.

We have developed the Include Toolbox to support small and medium ICT-enterprises in applying 'inclusive design methods' in their product development. By involving the end-user in the design process, inclusive design tries to include as many users as possible.

The user of the Include Toolbox first chooses a method tailored to the specific design phase and envisioned user group. Next, the user receives step-by-step support from preparation and execution of the method to analysis of the results. Several toolbox methods have already been applied, which resulted in two apps. The first app supports children around the neighbourhood, for example, by keeping them safe and helping them make new friends. The second app supports elderly to organize adhoc help when needed.

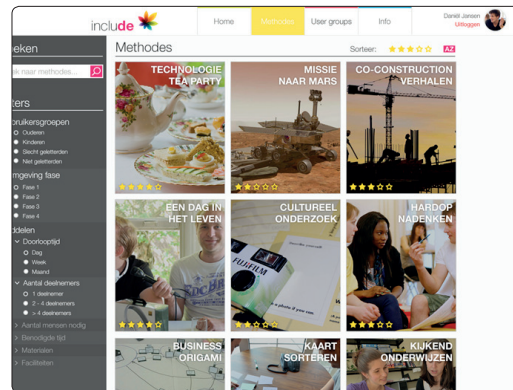
### ICT science question

How can we bridge the gap between theory and practice of inclusive design? The tool needs to be sufficiently detailed to address all end-user groups in a meaningful way. At the same time the tool needs to be comprehensible and accessible for both experienced and inexperienced users.

### Application

The tool is specifically aimed at small and medium ICT-enterprises. The Include Toolbox enables the application of scientific knowledge to business practice.

The Include Toolbox is a web-based toolbox where small and medium ICT-enterprises can find



guidance in involving end-users of their products throughout the entire development process, from recruiting participants to analyzing the results.

The toolbox does not educate bad designers to become good designers. It supports the small and medium enterprises with early discovery of possible product failures or exclusion of the user group of the developed ICT product or service.

Although a few digital inclusive design toolboxes already exist for research and designers, none of them is adapted to small and medium enterprises that develop ICT products and services.

### Alternative Application

Design is everywhere.

The toolbox can be extended with other end-user groups and methods, evaluation of methods, best practices, design guidelines and design patterns.

### Nice to know

The Include Toolbox itself is designed by including small and medium ICT-enterprises in the design process, with methods currently available in the toolbox, and will be evaluated by these end-users as well.



A toolbox supporting ICT design for specific user groups. End-user involvement lowers risks of new-product introduction and facilitates accessibility of ICT products and services for all civilians.



A toolbox that helps you design for your specific user group and various design phases by providing methods with step by step support. From preparation of the method to analysis of the results.



A toolbox that enables redesign of current products and design for new end users. Stimulating innovation that is really needed and used built on a solid scientific knowledge base.



A toolbox that presents existing theoretical knowledge on inclusive design methods in such a way that SMEs can apply it to designing their products, and provide practical suggestions for improvement.



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## 49. Socially adaptive apps

Although social applications such as Twitter, Foursquare, Life360 and Facebook help to connect people, they can conflict with important personal values like privacy, independence and freedom. For example, when parents use GPS-tracking to know where their children are 24/7, this may be beneficial for family security, but it negatively impacts children's privacy and independence.

We have developed two mobile apps for increasing social participation of people in the neighbourhood while at the same time supporting users' privacy, independence and freedom. The first app is designed for children between nine and twelve years old, to support them in their everyday activities (going to school, making new friends, etc.). The second app is designed for elderly people and their social network to make them feel safer and less dependent on others.



### ICT science question

Can the use of norms in social applications promote user values like independence better than the basic settings of existing applications like Facebook? How can social applications be designed to make them more usable to the special needs of vulnerable people such as children and elderly?

### Application

The application for children allows parents and children to 'check-in' at geographical locations they define and share these check-ins with selected family and friend groups. The app provides the ability to create customized agreements between users concerning the behaviour of the application, based on a normative model. Parents can for example agree with their children under which conditions check-ins are shared.

The application for elderly allows them to define the social network and to choose what information (e.g. location) will be shared and via which medium (e.g. SMS). The app also provides the possibility to set up a scenario. For instance, in case of emergency, the elderly can send out an alarm to

the social network that automatically alarms the relevant persons, depending on the rules that the elderly has defined.

### Alternative Application

The concepts of both our apps can be applied to other demanding target groups. For example, elderly citizens can use the app designed for children to organize events and find caregivers closest to their location. The concept of the social network alarm for elderly can be used by other target groups as well, e.g. people living on their own.

### Nice to know

The company LG is gearing up to launch a wristband that plots a child's every move via a built-in GPS sensor. The wristband is expected to launch this year in South Korea, and in Europe and the United States one year later. The British newspaper The Guardian says that this sort of technology will "edge us closer to a dystopian future".



Smart social applications for wellbeing of vulnerable people such as children and elderly.



Applications that can adapt to users' values, promoting, e.g., safety and social connectedness, without harming others such as privacy and independence.



Making mobile social platforms smarter through novel adaptive technology to better support people in their daily lives.



Socially adaptive context-aware applications to provide personalized support to people in their daily lives.



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[www.youtube.com/watch?v=xaAkU2MemQ4&feature=youtu.be](https://www.youtube.com/watch?v=xaAkU2MemQ4&feature=youtu.be)

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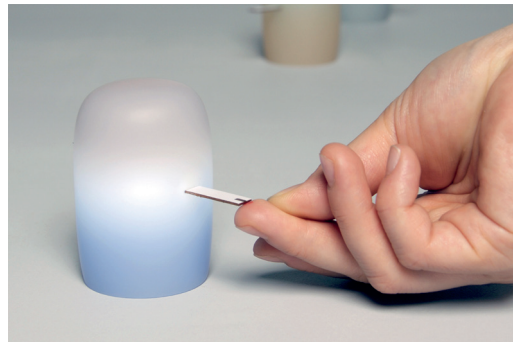
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## 50. Diabetes: Measuring Less to Feel More

At present there are about three hundred million patients with diabetes worldwide. Stress has a high impact on the successful management of diabetes. Field research has shown that diabetic people actually get additional stress by the device they use to check their blood sugar level. Stress releases more sugar into the bloodstream, thus creating a vicious circle. The current devices focus strictly on quantification, leaving no room for personal feeling.



We create a more intuitive interface to check the blood sugar level, so that the patient gains more tranquillity. Instead of numbers, we use the colour spectrum of a LED-light to express the blood sugar level. This more intuitive and sensitive language allows people to relate easier to their blood sugar level while staying in touch with their own sensation. We call our concept 'Measuring less to feel more'.

### ICT science question

How can we design pleasurable personal devices, which provide a clear feedback?

### Application

The artificial pancreas will be clinically tested in the beginning of 2015, for CE certification. The remaining question is: How to develop a glucose meter for taking blood-glucose measurements that is a more personal device than present alternatives? Important design requirements are that it should be pleasurable to use, should provide feedback relevant to the user and should diminish stress.

The 'Measuring Less to Feel More' concept is further developed in close collaboration with Inreda Diabetic BV. This is a Dutch company that develops an artificial pancreas. The artificial pancreas



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is a fully automated system that regulates a person's blood sugar level via infusions. The main advantage is that the quality of life can be improved considerably. Diabetic patients have full diet and exercise freedom. In addition, less finger pricks are necessary than with a regular treatment; only for the calibration of the sensors.

Waag Society is supporting Inreda Diabetic BV with the design of the device with a special focus on the interaction between the device and its user.

### Nice to know

It is possible to take a shower with the artificial pancreas. It is also possible to temporarily disconnect the system when taking a shower.

It is possible to swim with the artificial pancreas. The device is water resistant and will not break while swimming with it. However, the sensors cannot send their signals to the device while being under water.

### Quote

"If it works, I can feel almost Diabetes-free."



"The artificial pancreas INREDA Diabetic regulates blood sugar automatically. Diabetic patients feel they are being 'patient-off'." (Herman Wijffels Innovation Public Award 2013) The interaction design of the device is important.



For hundred millions of diabetes patients worldwide, the artificial pancreas could be an outcome. It is a fully automated system that regulates a person's blood sugar level via infusions. The quality of life can be improved considerably.



The combination of an artificial pancreas with an intuitive and user-friendly interface, which causes less stress in operating the device, will support diabetes patients to lead a life as normal as possible.



"Scientists worldwide worked for years on an artificial pancreas, but still without much success. We are the first to use glucagon besides insulin. Therefore our device resembles much more secure a real pancreas." (Robin Koops, founder Inreda Diabetics).



waag society

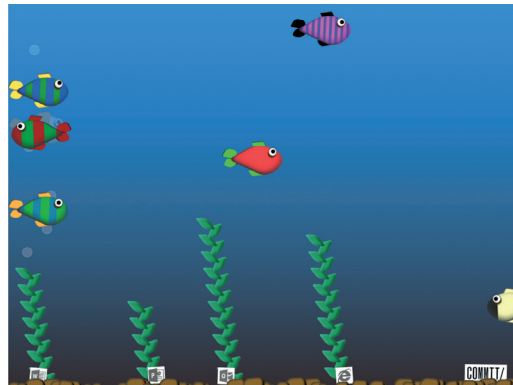
Inreda Diabetic BV



# 51. Monitoring moods of workers reduces sick leaves

In 2013 TNO-research indicated that one million people of the Dutch workforce show signs of burnout and that stress is the main reason for seven percent of all sick leaves. With the goal of reducing these numbers, we have developed the Fishualization monitoring system. Fishualization enables employees to gain insights into their working habits to reduce stress and increase productivity.

Fishualization is based on two components. First, by combining multiple sensor data we automatically measure the activity levels, the amount of focus and the mental energy of workers. Second, we show visualizations of the state or mood of an entire team of knowledge workers. Each employee is represented as an avatar in the form of a fish. At the bottom of the screen we show 'plants' that represent a group of tasks, for example: writing e-mail, editing a document, web browsing or preparing a presentation.



## ICT science question

How to analyze and interpret heterogeneous multi-scale sensor data? What is a reliable model to measure the state of an entire group of knowledge workers?

## Application

The Fishualization feedback system can help to reduce stress and increase productivity at work on the basis of an estimation of the workload and the mental and physical fitness of a worker. The initial model relies mostly on computer interaction, identification of tasks, and context switches. In the near future it will be combined with affect and physical aspects. We can also include the analysis of facial expressions or e-mail sentiments.



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At present there are no sensing based personal coaching products on the market that combine multiple sensors and look at both mental and physical fitness.

## Alternative Application

Sensor-based reasoning and decision-making can also be deployed in smart cities or other smart contexts. However, our Fishualization platform has the largest potential in other person-related monitoring and coaching situations, such as self-management of people with chronic diseases or e-learning systems.

## Nice to know

"Studies conclude that contemplation of fish in an aquarium seem to have a significant effect in reducing levels of stress and anxiety."

"In Feng Shui, moving water is considered beneficial in balancing chi, and a well maintained aquarium in the right location increases wealth and luck."



The goal of the Fishualization golden demo is to enable office workers to gain insights into their working habits in order to reduce stress levels, prevent burnout and increase productivity.



Fishualization is a reconfigurable intervention aimed at improving well-being at work. It is easily extended with new sensors, reasoning and mapping between data/information and visualized fish behaviour.



Fishualization raises awareness regarding workload and related stress by visualizing office worker activities as avatars on a centrally located display, which gives employees of an entire department feedback.



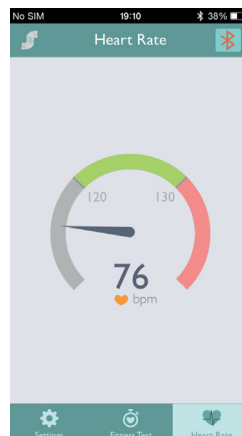
Fishualization is a unique social intervention that provides a group visualization of the estimated human computer activity and mental condition of a team of office co-workers using a combination of various unobtrusive low-level sensors.

## 52. Coaching-app helps to find work-life balance

We have developed the SWELL e-coaching app that helps knowledge workers in achieving personal goals related to their work-life balance. The app runs on a smartphone and can access a wide variety of sensors that recognize physical activity, work activity and working tasks.

Before using the e-coaching app the user is screened on physical fitness. Via a questionnaire and a condition test personal parameters and goals are evaluated. Subsequently, a user may enter a coaching program to improve sleep, physical fitness or mental fitness.

Depending on the goal, the app will measure parameters, compare with targets and provide feedback and suggestions. Key issue is that the app avoids unsuitable moments for feedback and that it adjusts the feedback according to the personality of the user.



### ICT science question

How to reason on the basis of uncertain information inputs that come from very different types of sensors? The sensors used are not proprietary developed sensors, but are off-the-shelf generic products. Currently, many users stop using feedback apps because they are not enough personalized and because the apps are too little aware of when to give feedback or not. We try to solve this problem by building a coaching app that predicts the suitable moments of feedback for each user.

### Application

Recent research (TNO, 2013) indicates that out of the Dutch workforce of 7.4 million people, one million workers show symptoms of burnout. The same research identifies stress and workload as the main reasons for at least seven percent of reported sick leaves. The total costs are estimated to be nine hundred million euro per year.

At present there are no personal coaching products on the market that combine multiple sensors and look at both mental and physical fitness.



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Our technology partners are Philips, Almende, Sense-OS. Competitors such as Fitbit have a single sensor approach and are only focused on the lifestyle market.

### Alternative Application

Sensor-based reasoning and decision making is important to modern life. It can also be deployed in smart cities or other smart contexts. The SWELL platform has the largest potential in other person related monitoring and coaching situations, such as self management of people with chronic diseases, or e-learning systems. Especially an adequate context aware intervention and messaging algorithm would have a wide field of application for apps providing coaching and personal messaging in any field.

### Nice to know

Sense-OS will build a commercial pilot along the lines of the SWELL e-coaching app for ASML to reduce and avoid burn-out with ASML employees.

### Quote

"We should do more with this!" – Reaction to SWELL presentation on context sensing; Well-being @ work conference, June 2014.



The goal of the e-coach is to do a holistic health related analysis of the work and life-style of office workers and to provide personalized activity recommendations in order to prevent burn-out and reduce the cost of sick leave.



With the e-coach we will develop a generic coaching engine that, for the first time, will adapt to personal needs and takes input from many (sensor) sources.



The proposed e-coaching app will decrease stress on the company workforce by having a unique personalized and integrated approach whilst securing privacy of employees.



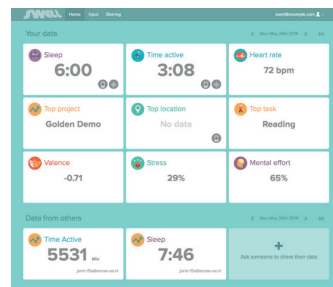
In the e-coach app, we try to combine knowledge of interaction between the physical and mental aspects of a person, as to how these factors contribute to an over-all sense of well-being or lack thereof.



## 53. Quantifying your life for a better well-being

Gathering objective data about every day life and work behaviour can help people to gain a better insight in both harmful and helpful patterns in their lives. With this aim we have developed the SWELL lifelog dashboard.

Using self-learning algorithms the SWELL lifelong dashboard combines data from various unobtrusive sensors, including workplace, smartphone and body worn sensors. All data are stored in a personal cloud store and can be downloaded or shared with others. Based on these measurements, the dashboard gives users insights into various physical, mental and work variables over a long period of time.



### ICT science question

How can we unobtrusively track physical and mental well-being, both at work and at home? Which algorithms are best suited for this task? In which way do we have to display the information so that people make optimal use of the dashboard?

Our approach is unique in its focus on individual users, its flexible set of different sensors, its novel algorithms.

### Application

Recent research (TNO, 2013) indicates that fourteen percent of the entire Dutch workforce shows symptoms of burnout and that stress related sick leaves account for an estimated cost of roughly nine hundred million euro per year. In an unique holistic combination of mental and physical states, by quantifying individual work and life, our SWELL lifelong dashboard can contribute to a better well-being.

Our technology partner Sense OS is currently commercializing different parts of the technology for several launching customers within her Sense Health daughter company.



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### Alternative Application

Sensor based reasoning and decision-making can also be applied in smart cities or smart contexts. However, the SWELL platform has the largest potential in other person related monitoring and coaching situations, such as self-management of chronic diseases, e-learning systems, serious games, mental healthcare, or personal security. Because of the modular architecture of our technology, applying parts of it in other contexts will be relatively easy.

### Nice to know

ASML Corporate Vitality Manager Maaikje Thijssen has won the Health Manager 2014 award based on her employee vitality program with the technology developed in the SWELL context. ASML is a launching customer for Sense's vitality solution.

Our technology partner Sense has won an EU eHealth award 2013 for a mental health application incorporating some of the SWELL technology.

### Quote

At the international well-being at work conference, SWELL was the only project in which data was sensed for personalized coaching. Many reactions were like: "We should do more with this!"



Improving creativity and productivity of knowledge workers through effortless tracking and feedback of mental and physical well-being.



Real-time self-learning algorithms combine data from 15 different unobtrusive sensors, (workplace, smartphone, wearables) to infer user-centric state information like sleep, activity, valence, stress, and work task.



Low cost user-centric solution for effortless monitoring of stress and burnout symptoms to help users prevent absenteeism and improve productivity of knowledge workers.



Validated algorithms for unobtrusive tracking and visualizing of both physical and mental well-being, and work context, without the need for proprietary hardware.

## 54. Molecular biobanks unravel the secrets of breast cancer

**M**odern medicine tries to understand diseases more and more by looking at the molecular fingerprint of a disease. This is done by molecular imaging of biological tissues. Molecular imaging can assist in the diagnosis and prognosis of diseases. It also enables the development of medicine specific for you and not just for everybody, a booming research field called 'personalized medicine'. Our demo presents a 3D-visualization of molecular imaging data generated by Mass Spectrometry Imaging (MSI). MSI is a technique for the simultaneous detection and visualization of a large variety of molecules based on their molecular masses. Using our interactive tool you can view and explore 3D-images of molecular breast cancer tissue.

### ICT science question

The main scientific challenge is to reduce, process, analyze and interpret huge datasets.

### Application

Molecular imaging with mass spectrometry easily generates large amounts of complex data. The embedding of molecular imaging in a clinical setting requires easy data visualization and extraction of relevant information.

In our demo you will experience the complexity of molecular imaging data. We expect that the information extracted from this data will assist medical doctors in clinical decision making in the future. It can then be used for example for diagnosis, prognosis and treatment response prediction.



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### Alternative Application

Alternative applications may lie in the field of different medical imaging modalities like MRI or microscopy. MRI or microscopy data can be correlated with molecular imaging from mass spectrometry.

A completely different possible application lies in the field of the molecular analysis of different layers of paint that compose for example a Van Gogh- or a Rembrandt-painting.

### Nice to know

One molecular image can contain more than one million spectra.



Visualization of molecular data for personalized, predictive, participatory and preventive medicine.



The development of software tools that can analyze complex molecular imaging data brings us closer to personalized medicine, the future of patient health care.



Innovative medical image generation, data processing and visualization (in cancer research).



Interactive 3D visualization and analysis of complex molecular imaging data.



## 55. Enriching use and experience of radio content

Until now radio content has been disconnected from other audiovisual and textual information. Our demo shows that radio can be much more than listening only. Radio can be made searchable to find a certain quote, person or topic. The experience of listening radio can be enhanced presenting related images from other information sources on a screen.

Reversely, radio content can also be linked to information on the web. A written news story might be enriched with a related radio interview.

We improve the use and experience of radio content by automatically processing audio files and combining the output with the latest audio search technology.

### ICT science question

How can information technology add value to media by enabling concepts that increase the use of audiovisual content?

The ICT-solution should look for a combination of speech technology and information extraction to decode the spoken words automatically and use these as labels for searching and linking functionalities.

### Application

How to enhance the experience of users engaging with the content? How do users evaluate these new functionalities and how can this feedback be used to fine-tune the technology?

We have developed a lab version of a platform for online radio, enhanced with automated content-based search, browsing and linking. We are also pleased to connect our technology to a potentially large user base via the Woord.nl platform: a collection of historical and recent radio stories.

Partners in our work are media industry representatives: content-owners (VPRO), archives (NIBG) and technology providers (Cross-Media Interaction).

Similar applications have the disadvantage that they require substantial manual resources to accomplish the same functionalities. Therefore they are limited in scope.



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### Alternative Application

The ICT science that we develop is applicable to any domain that uses audiovisual content. Alternative applications might therefore lie in the domain of meetings, presentations, talks, gaming etc.

### Nice to know

Our technology is implemented in a lab version of the woord.nl portal; it is used at the Netherlands Institute for Sound and Vision for searching audiovisual collections; and it is also adopted in a search application for researchers in the Digital Humanities interested in Oral History content (<http://zoeken.verteldverleden.nl>)



RadioPlus demonstrates audiovisual search to aid in the browsing of audio collections from diffuse sources. For industry, the technology enables education, journalism, research, and security.



For the holder of digital archives, better means are needed to exploit the content of the archives. RadioPlus connects audiovisual content with other content to create new engaging access tools for users.



RadioPlus provides a scenario for the impact of audiovisual search and linking technology for the use of multimedia content. The role of audiovisual media in every day life pleads for such technology.



The work behind RadioPlus aims to enhance search and exploration of large spoken word collections and to enable cross-media audio hyperlinking by spoken entities derived from the audio signal.



UNIVERSITY OF TWENTE.



## 56. Nichesourced annotation of cultural heritage collections

Cultural heritage institutions more and more provide their collections online. To make them accessible to a interested users, the collections need short descriptions (annotations). Creating such annotations requires knowledge and expertise that is not always possessed by the collection curators. The usage of crowdsourcing and nichesourcing techniques provides cultural heritage institutions with new tools to create high-quality annotations in an inexpensive and fast way. We demonstrate Accurator, a platform for the enhancement of the annotation process of cultural heritage institutions like museums and libraries. The enhancement is done with the domain-specific expertise of amateur enthusiasts and experts drawn from the crowd.

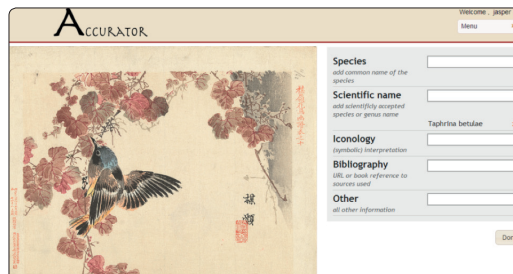
We show an demo of the Accurator platform that features innovative, easy-to-use content annotation applications, driven by domain-specific knowledge. These applications include a novel Web annotation interface; an expert finding module for social media and Q&A-forums; and an online dashboard for annotation campaigns monitoring and control.

### ICT science question

How to design efficient and effective crowdsourced content annotation is still an open research question. With our work we seek answers to the following research questions: How can large crowds and expert niches be activated to share their knowledge? How can expertise be identified on the Web? How can experts be discovered and engaged? How can linked data support and drive the content annotation process? How can semantically enriched knowledge repositories improve search and recommendation applications?

### Application

Our work is driven by the needs of public organizations such as the Rijksmuseum, the Naturalis Biodiversity Center, the National Library, and the Museum Het Prinsenhof in Delft. The Accurator



platform provides methods and tools to improve the quality of digital content annotation, and, ultimately, the performance of content exploration and retrieval tools.

We demonstrate the benefits of Accurator on the search interface of the Rijksmuseum Website, where high-quality crowdsourced annotation directly leads to improved search and exploration experience. In comparison with existing platforms for content annotation Accurator advances the state of the art by providing content curators with knowledge-driven tools for expert retrieval, evaluation, and engagement.

### Alternative Application

The Accurator platform can be easily transformed for usage in other domains. This is demonstrated by many on-going collaborations with companies such as IBM (knowledge creation and retrieval, software engineering) and Frontwise (event-centric search for audio-visual archive).

### Nice to know

Experiments have shown that the collective knowledge of the crowd matches at least one-third of the knowledge of domain experts.

Large amount of crowd workers can be easily engaged in cultural heritage content annotation tasks. For example, around one thousand workers were recruited in just a couple of days for the annotation of Rijksmuseum prints.



Support content curators in museums and similar professional organizations in their campaigns using annotations created by pro-amateurs.



Push the boundaries of crowdsourcing to efficiently valorize the passion, knowledge, and skills of crowds.



Enable customized expert annotations for next-generation multimedia content retrieval and fruition platforms.

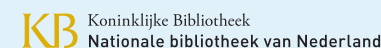


Exploit crowd sourced content annotations for professional high-quality annotation tasks.



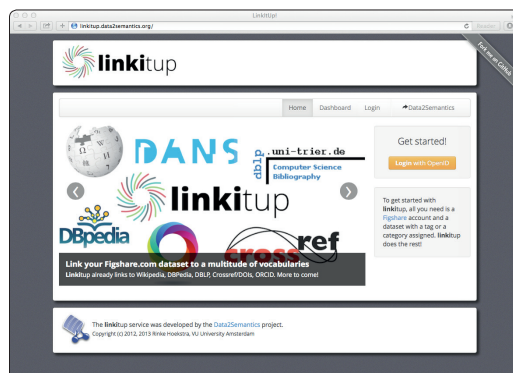
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COMMIT/ project  
SEALINCMedia Socially-enriched access to linked cultural media



# 57. One-click semantic enrichment of scientific data

Researchers, publishers, and funding agencies increasingly recognize the importance of publishing the original research data along with traditional journal articles. However, the threshold for publishing data in a way that enables reproducibility and reuse, is still too high for an unsophisticated scientist. To solve this problem, we have developed a web-based dashboard which incorporates a number of techniques for enrichment of research data with appropriate metadata, such as links to relevant external resources and identifiers. It also helps the user to upload the results to a popular research data repository where the data can be discovered, verified, and ultimately reused by other researchers.



## ICT science question

How can scientists publish their research data in such a way that their colleagues can easily reproduce or reuse them?

We approach this problem by automating metadata discovery and enabling the user to publish results as Linked Data following standards and best practices. For the convenience of the user we hide the details of the underlying semantic web technologies.

## Application

We apply the technology to support researchers who are not necessarily data management experts, but produce and publish original scientific data. A number of related efforts aiming at lowering the barriers for data publication and improving the quality of published data are underway. However, these efforts are platform-dependent and do not comply with emerging standards for

data publishing. Our approach relies on the latest semantic web standards for data publication and enables easy automatic processing of published results.

## Alternative Application

The exploration of texts is broadly needed. Rather than rely on researchers for enriching metadata and publishing Linked Data, repositories might use our technology in their user-facing applications, and for batch processing of existing deposits. We are collaborating with Mendeley (Elsevier's free reference manager and academic social network) and with Figshare (an online digital repository where researchers can preserve and share their research outputs) in order to bring parts of our technology to their products.

## Nice to know

Metadata is structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage an information resource. Metadata is often called data about data or information about information.



The value of scientific data is determined by reuse in academia and industry. Therefore every effort should be made to make all research data available and discoverable.



There is only one-way to ensure interoperability with future applications and services: follow the standards!



In the world where high quality scientific data is easy to find and verify innovation accelerates tremendously.



Data publication must provide enough context to be interpreted and allow citation. It's not that different from a journal publication, after all.



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COMMIT/ project  
Data2Semantics From Data to Semantics for Scientific Data Publishers



UNIVERSITY OF AMSTERDAM



## 58. Evaluating the reliability of eHealth-data

ICT-based home healthcare services are revolutionizing healthcare. The patient performs his own medical measurements and sends the results via the internet to the healthcare professional. The doctor has to trust and rely on the measurements to provide the correct medical advice. Unfortunately, people sometimes use a measurement device incorrectly, so that the reliability of the data becomes questionable.

Our demo assesses the overall quality of medical measurements by evaluating various quality aspects. We have developed a novel troubleshooting tool that can find possible causes of low data quality. For example, a patient's unstable measurement can be the result of incorrect sensor application, but it can also be the result of health deterioration.

Our technology provides the doctor with a unique interpretation of the patient's own medical measurements. For the acceptance of home healthcare services data reliability is crucial



### ICT science question

How to evaluate the overall quality of measurements? The evaluation should involve different quality aspects of a measurement, such as information stability, device application and data timeliness.

### Application

Our approach evaluates the measurement quality of medical measurements that people take at home by an activity monitoring system. Patients sometimes misuse the activity sensor and provide unstable measurements which complicates the interpretation by the doctor. In particular, patients might forget to apply the device or they place it incorrectly. Our application is able to detect such miscues.

With our partner, the Roessingh rehabilitation centre, we evaluate the activity measurement of COPD patients.

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### Alternative Application

Our approach can be applied to other domains that heavily rely on sensor data. Interesting alternative domains for application could be the automotive industry and smart energy grids, where multiple sensors are used and a unique interpretation is needed. Moreover, our approach can be used to investigate the causes of low data quality.



Reliable data contribute to fewer hospital visits, better diagnoses, lower costs; overall, a better healthcare.



Methods for evaluating data reliability can be integrated into healthcare services as plug and play components.



Methods enable doctors to trust and to rely on remotely measurements. Novel troubleshooting mechanisms are used to obtain the causes of low quality measurements. In this way patient compliance is improved.



The system includes methods to assess and to integrate various quality aspects of a measurement, such as information stability, measurement procedure and data timeliness.

## 59. Privacy transparency tools give more trust in eHealth

A growing number of users demand from service providers to offer transparency on how their data are handled. Data transparency is also more and more demanded by the law.

We have developed a toolkit with various privacy transparency tools that can be used in e-Health services, such as a hospital website. From our toolkit, service providers can choose specific tools that fit their user requirements and their service type the best. Our tools provide users with insight in how service providers claim to handle their sensitive data, how their sensitive data are actually handled, and with which third parties the data are shared.

The use of privacy transparency tools will lead to higher trust by users and hence a higher service acceptance. Ultimately this results in more available data and better medical care.

### ICT science question

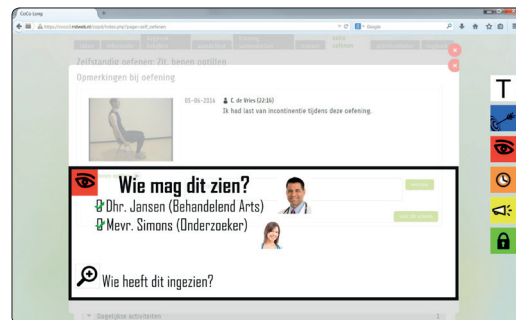
How can we best design tools that give users of information services insight in how their data are being handled? The tools should provide the right type and amount of information and in the right form, so not to overwhelm an average user.

The technical challenge is to provide complete information on what service providers actually do with data and why, not only what they claim to do (such as e.g. Google dashboard).

### Application

In the area of e-Health, our demonstration shows an implementation of privacy transparency tools for the case of the COPD portal of the Roessingh rehabilitation centre.

What makes our solution different from similar ones is that in the existing tools transparency is a side effect, and not a tool's main purpose. Existing tools have limited functionalities and are not



customized for different types of users and services. Also none of the tools has been validated on the effect.

### Alternative Application

Our solution is not only easily applicable to different types of eHealth services, but also to other service domains, for example e-Government, e-Commerce, e-Finance etc.

### Nice to know

Dutch law dictates parties who process personal data to actively inform their customers on the data processing they do. It is illegal to hide what you do with personal data or to only tell it when customers ask for it.

### Quote

"Transparency about personal data fits in with our principle of transparency about providing care in general."



Enhanced transparency increases end-user trust for organisations offering online services.



Transparency tackles the increasing societal concerns about personal data usage.



An organization's vision on honest handling of personal data is not a hollow promise: transparency tools make it concrete.



The transparency tools are an answer the question of which type of transparency information to present to the end-user, at which level of detail, and how to present it to maximize end-user.



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**INFINITI Information retrieval for Information services**  
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**IUALL Interaction for Universal Access**  
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**SENSEI Sensor based Engagement for Improved Health**  
[www.commit-nl.nl/projects/sensei-sensor-based-engagement-for-improved-health](http://www.commit-nl.nl/projects/sensei-sensor-based-engagement-for-improved-health)

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[www.commit-nl.nl/projects/virtual-worlds-for-well-being](http://www.commit-nl.nl/projects/virtual-worlds-for-well-being)

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**SEALINCMedia Socially-enriched access to linked cultural media**  
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**SENSAFETY Sensor Networks for Public Safety**  
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**EWIDS Very large wireless sensor networks for well-being**  
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**ALLEGIO Composable Embedded Systems for Healthcare**  
[www.commit-nl.nl/projects/composable-embedded-systems-for-health-care](http://www.commit-nl.nl/projects/composable-embedded-systems-for-health-care)

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**METIS Dependable Cooperative Systems for Public Safety**  
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**THeCS Trusted Healthcare Services**  
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**TimeTrails Spatiotemporal Data Warehouses for Trajectory Exploitation**  
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