# 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. 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.

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