Driftline biometrics

Introduction

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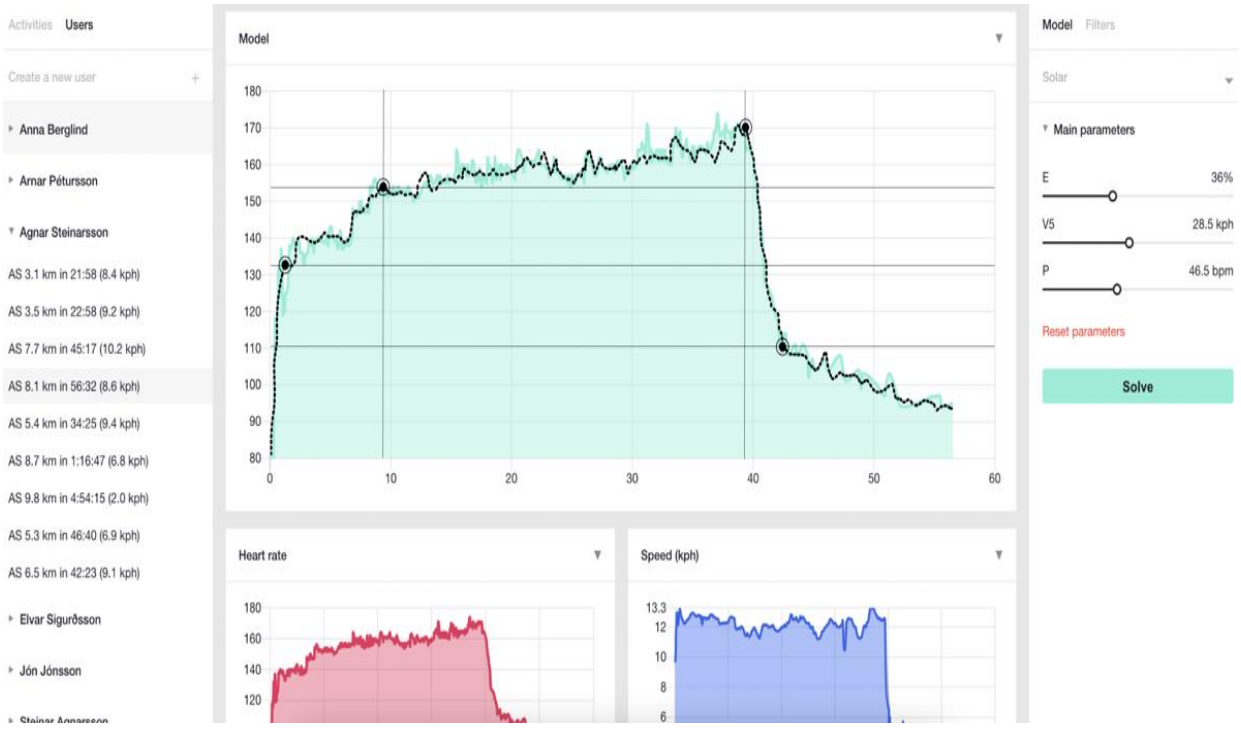
What does Driftline do?

Driftline is a fitness tech startup with a unique scientific foundation. We specialize in heart rate analysis from regular fitness trackers and smartwatches, and proudly claim to have **cracked the human heart rate code**. We have a patent-pending algorithm for heart rate analysis and we discovered **the first true measure of endurance**. We believe that Endurance is one of the most important health biometrics ever discovered. A key to tracking fitness and metabolism directly from heart rate. Our technology is easy and submaximal and set to shape the future of fitness analytics. Independent and on-going studies at the Reykjavik University (RU) have validated the Driftline methodology and suggested the Driftline approach as a new breakthrough in exercise physiology.

Heart rate analysis

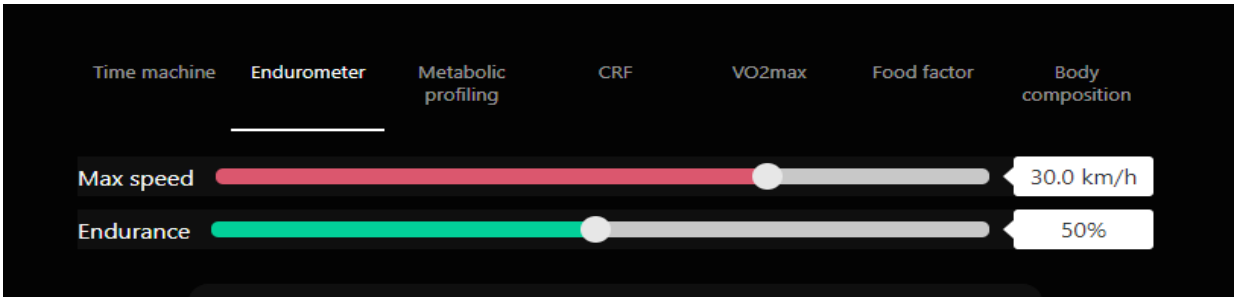
Below is an illustrative example to show how we **analyze heart rate data** from the activity- and recovery phases of a typical outdoor run.



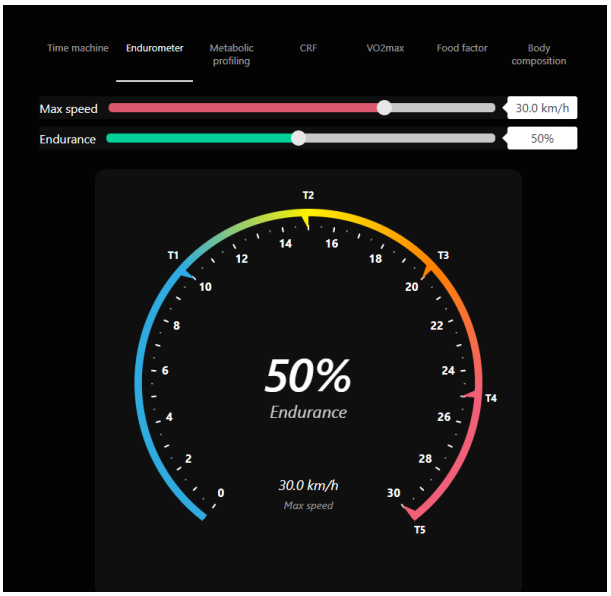
The **Driftline heart rate kinetic model** finds the best fit to the data and extracts many fitness-related parameters for the individual, such as maximum running speed, endurance, and maximum heart rate. For further information, please check out our website [Driftline - The future of fitness analytics.]

The biometric calculator

After discovering the concept of endurance, Driftline has also discovered that endurance, as defined and patented by Driftline, appears to be a key to calculating various important biometrics through the process of metabolic profiling. Driftline has subsequently developed a **biometric calculator**, controlled by max speed, endurance, and body weight. The screenshot below shows the biometric dashboard.



Endurometer and Time machine



The **Endurometer** is your personal running speedometer. It displays your vital fitness statistics, such as Endurance, max speed, exercise thresholds and performance zones.

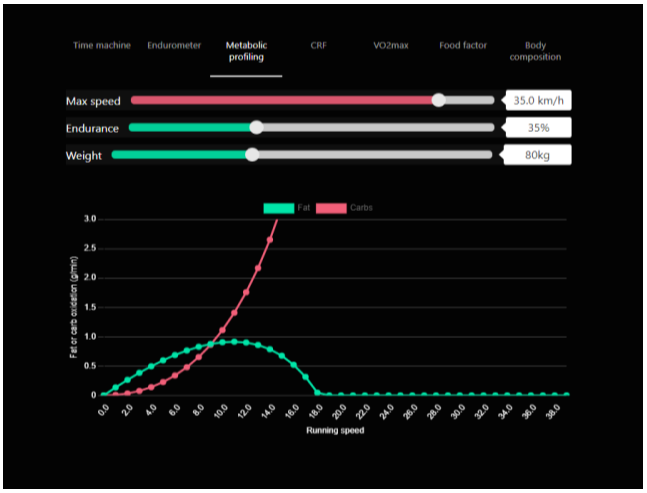
The Endurance parameter scales between 0 - 100% and reflects the proportion of slow, aerobic muscle fibers. A high-endurance runner will get good mileage from glucose stores and produce competitive race times over long distances. In a nutshell, **Endurance is fuel preservation through muscle efficiency**.

The Driftline **time machine** accurately predicts potential race times for everyone regardless of age, gender, or fitness level. This is done by adjusting only two parameters, the max speed, and the endurance.

The **Runscore** was developed by Driftline to facilitate a fair comparison of all runners, independent of age, gender, or runner type. A score is calculated for every race distance and the highest score equals the Runscore.

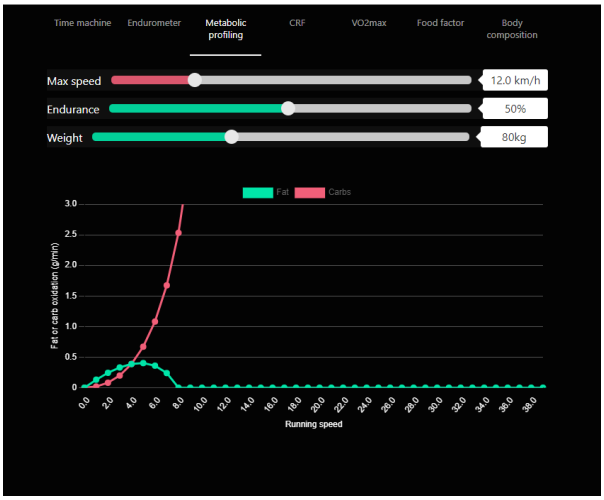
Metabolic profiling

Driftline has developed a new and innovative method of **metabolic profiling**, based on heart rate analysis and body weight. This type of profiling calculates the rates of **fuel oxidation** (fat and carbs) for different running or walking speeds. Below are screenshots from the Driftline biometric calculator, with the green curve showing the **fat oxidation** and the red curve showing the **carb oxidation**.



Endurance has a strong effect on the oxidation rates. The first screenshot above shows an example calculation for a marathon runner with 90% endurance, and the second screenshot shows a calculation for a sprinter with 35% endurance. The marathoner has a higher absolute **Fatmax** oxidation rate and a much higher fat oxidation capacity at higher speeds. This also leads to a strong glucose-sparing effect for the marathoner, especially at higher speeds. The difference in **glucose mileage** (g/min or g/km) is more than double for these two runners.

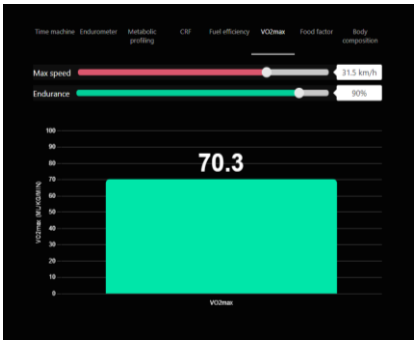
Ageing and obesity have been shown to be strongly related to both muscle typology and metabolic parameters. Ageing is typically associated with a loss of muscle mass (especially fast muscle fibers), whereas obesity has been strongly linked to a fast muscle typology and a low fat oxidation capacity.

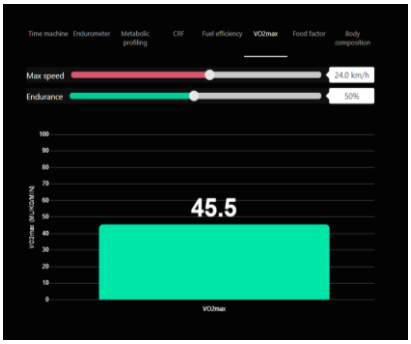


The screenshots above show suggested metabolic profiles associated with ageing (left) and obesity (right). In both cases, the **reduced fat oxidation capacity leads to a dramatic increase in carb oxidation**.

VO2max

The rate of maximum oxygen consumption (**VO2max**) is generally accepted as a **clinical measure of cardiorespiratory fitness** (CRF) and is commonly estimated indirectly through performance testing. Through metabolic profiling, Driftline is able to calculate VO2max directly from heart rate analysis. VO2max is in fact primarily a reflection of the individual's aerobic muscle mass. Driftline's endurance parameter may thus very well be the missing link to calculate VO2max directly from heart rate. The screenshots on the next page show some examples of calculated VO2max.

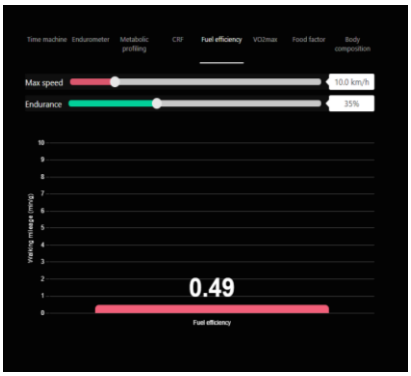




The first screenshot shows the VO2max of a top-class marathoner, while the second one may show the VO2max of a young untrained person. The last screenshot shows an example VO2max for an elderly person with low maximum speed and low endurance.

Fuel efficiency

Driftline's new Endurance parameter scales between 0 - 100% and reflects the proportion of slow, aerobic muscle fibers. A high-endurance runner will get good mileage from glucose stores and produce competitive race times over long distances. In a nutshell, Endurance is fuel preservation through muscle efficiency. As shown above, the oxidation of carbs and fat can be calculated through Driftline's metabolic profiling, but the pace must be standardized in order to compare fuel efficiency. We suggest a medium brisk 3.5 mph walking speed for convenient comparison of individuals over a wide range of fitness. We therefore define **fuel efficiency as carb oxidation efficiency at 3.5 mph walking speed** and present it in terms of "*walking mileage*" or "*minutes of walking per gram of glucose oxidized (min/g)*". The screenshots below show how the fuel efficiency is affected by endurance and body weight.



The first screenshot shows the fuel efficiency of a 65 kg top-class marathoner, while the second one may show the efficiency of a 65 kg untrained person. The last screenshot shows the calculated efficiency for a

100 kg individual with low maximum speed and low endurance. The efficiency values indicate that the marathoner will be able to walk for 9.39 minutes per gram glucose oxidized, while the overweight person will only be able to walk for 0.49 minutes per gram glucose oxidized (29 seconds).

Cardiorespiratory fitness

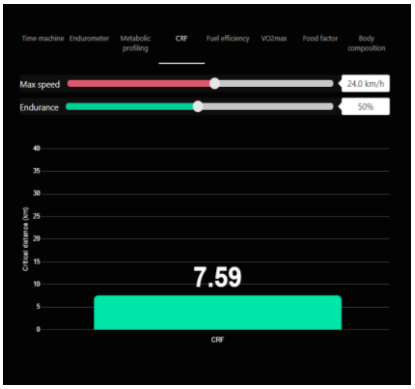
The age-related decline in cardiorespiratory fitness (CRF) is considered a major underlying cause of mortality and disease in the world´s aging population. The rate of maximum oxygen consumption (VO2max) is generally accepted as a clinical measure of CRF and is commonly estimated indirectly through performance testing.

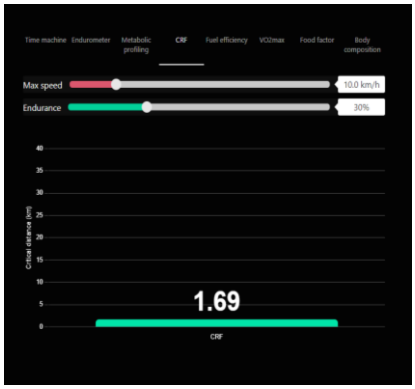
However, **VO2max may in fact not be the ideal measure of CRF**. It has to be measured through maximal exercise testing in the laboratory, and performance tests only show a moderate correlation with VO2max with a very large individual variation. Also, **VO2max does not have an efficiency component**, as can be seen by the fact that elite marathoners typically have a similar VO2max as average runners. The VO2max range is thus very narrow, with only about 4-5-fold difference between elderly citizens and elite marathon runners.

In view of the above, Driftline is suggesting a **new alternative measure of CRF**, based on Driftline's breakthrough discoveries in the field of exercise physiology. This is the **Critical distance (CD)**, or more specifically the *maximum distance that an individual could run or walk at Critical threshold pace* (lactate threshold pace). The CD can be indirectly estimated with a submaximal walking or running test. The CD is strongly endurance related and **has a much wider range than VO2max**, ranging from less than 1 km for the elderly or obese, to up to 42 km for world-class marathon runners. CD has a strong efficiency component (endurance) and therefore adds another dimension to VO2max as a measure of CRF.

For elderly citizens, CD can be estimated with the **Driftline submaximal walking test (DWT)**. The test may take longer than the 6-minute walking test (6MWT) but in return is much more diagnostic than the 6MWT. The DWT tests for various fitness- and metabolic biometrics, such as endurance, exercise thresholds, maximum heart rate, fuel efficiency, and fat oxidation. Being submaximal, the DWT may also be a good option for testing those who are not able to walk more than a few minutes.

The screenshots below show how the CRF (critical distance) is affected by endurance and max speed.





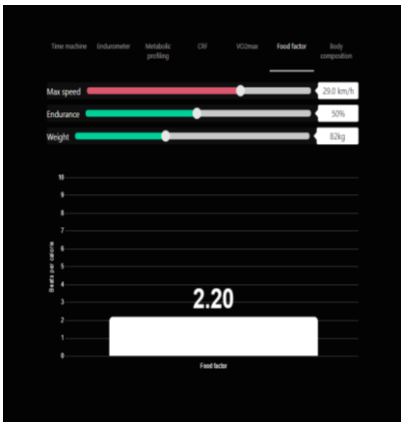
The first screenshot shows the CRF of a top-class marathoner, while the second one may show the CRF of a young untrained person. The last screenshot shows an example CRF for an elderly person with low maximum speed and low endurance. The indicated CRF values indicate that the marathoner would

maximally be able to run over 30 km at the critical threshold speed, while the elderly person would maximally be able to walk about 1.7 km at his or her critical threshold speed. Corresponding VO2max values would have been 70, 46, and 17 ml/kg/min for these three individuals. Clearly, the CRF value is a much more realistic measure of performance and cardiorespiratory fitness.

Food factor for calorie tracking

Driftline has for several years been developing new non-invasive methods to screen a person's energy metabolism, based on heart rate analysis. The ultimate goal is to be able to measure a person's **calorie expenditure and calorie intake from activity tracking and heart rate analysis**. It is well known that the **thermogenic effect of feeding** is reflected as elevated oxygen consumption and heart rate. Driftline has been developing methods to measure this thermogenic effect and a **pilot-scale calorie tracking study** provided support to this methodology.

Based on the results from the pilot study, Driftline defined a so called "**Food factor**" that equals the average number of *heart beats caused by the intake and digestion of 1 kcal of food energy* (food-beats per kcal). Driftline's metabolic profiling includes a calculation of the food-factor and shows how it is affected by max speed, endurance, and body weight (see below).

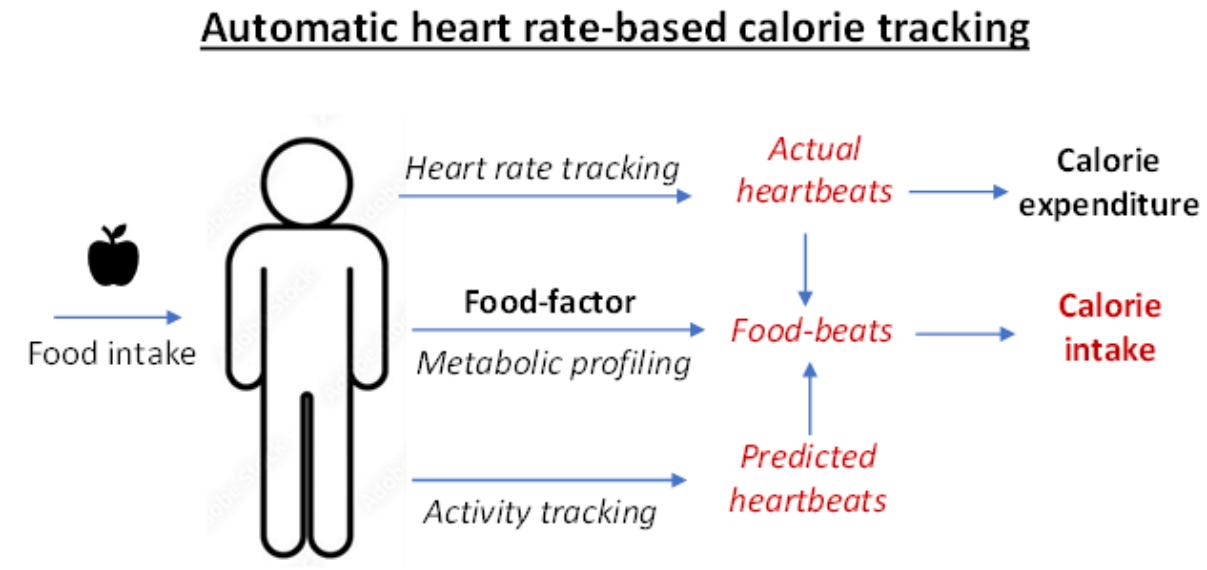


The screenshots above illustrate the large individual variability in the food factor. The **food factor is strongly affected by both endurance and max speed but also by the individual muscle mass**. The biometric calculator calculates muscle mass indirectly, based on heart rate analysis, for the calculation of the food factor. The large observed **gender difference in the food factor**, as seen in the results from the pilot study, is primarily caused by gender differences in muscle mass and body composition.

The first screenshot above shows a typical food factor for a fit male with medium endurance. The second screenshot shows a typical food factor for a fit female with medium endurance. The third screenshot shows a typical food factor for an overweight person with low endurance and max speed. This means that a standardized meal should cause a five times greater heart rate response in the overweight person, compared to the fit male. A 1000 kcal meal would be expected to cause 2.200, 5.180, and 11.390 extra heartbeats in these three individuals, respectively. It should be emphasized that these calculations have yet to be validated in an independent validation study.

Driftline is presently developing a **new and advanced approach of calorie tracking** that does not require the tracking of resting heart rate. This new approach analyses the individual food factor from heart rate

analysis and uses 24-hr activity tracking to calculate calorie intake based on the balance between predicted activity heart rate and actual observed heart rate. Driftline is joining forces in a Eurostars application with the Swiss microtechnology company CSEM, to develop a **prototype wrist-worn tracker for automatic calorie tracking**. Below is a simple diagram to explain the process of heart rate-based calorie tracking.



Body composition

Driftline is also developing a new methodology to measure **body composition** based on heart rate analysis and simple anthropogenic data (gender, height, and weight). The screenshots below show illustrative calculations in the biometric calculator.

The first screenshot shows the estimated body composition of a fit male with medium endurance. The second screenshot shows the estimated body composition of a fit female with medium endurance. The third screenshot shows the estimated body composition of an overweight female with low endurance and max speed. It should be emphasized here also that these calculations are only preliminary at this stage and have yet to be validated in an independent validation study.

White papers and patent applications

Driftline's PCT **patent application to the European Patent Office** (EPO) was approved last year and Driftline is now entering into the national phase with **regional patent applications in the EU and USA**. The invention was deemed by the EPO to be innovative, patentable, and applicable for industry.

Driftline is also planning to publish several **white papers** to introduce new and innovative theories to the scientific community. Below is a short-list with very preliminary titles:

- The new world of heart rate kinetics
- The new world of metabolic profiling
- The first true measure of aerobic endurance

Driftline is open to working with companies or universities on writing some of these or other related publications.