How to break new records in the 200 metres?

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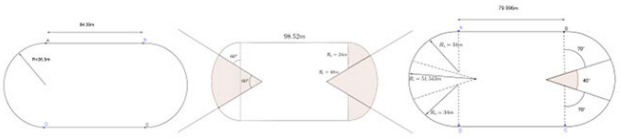
Usain Bolt's 200m record has not been beaten for ten years and Florence Griffith Joyner's for more than thirty years. And what if the secret behind beating records was to use mathematics? Thanks to a mathematical model, Amandine Aftalion, CNRS researcher at the Centre d'analyse et de mathématique sociales (CNRS/EHESS), and Emmanuel Trélat, a Sorbonne Université researcher at the Laboratoire Jacques-Louis Lions (CNRS/Sorbonne Université/ Université de Paris) have proved that the geometry of athletic tracks could be optimised to improve records. They recommend to build shorter straights and larger radii in the future. These findings are to be published in *Royal Society Open Science* on 25 March, 2020.

At present, there are three designs of tracks that can be certified by World Athletics: standard tracks (consisting of straights and semi-circles) and two types of double-bend track (where the double bend is made of three arcs of two different radii). It is usually admitted in the athletic community that the standard track is the quickest and that there is no chance of beating a record on a double-bend track. Double-bend tracks have actually been designed to accommodate a football or rugby stadium, and the main drawback is that the bends have a smaller radius of curvature. Therefore, the centrifugal force is greater and the double bend tracks are slower. Multi-sports arenas are therefore not adapted to athletic records and there is a major disadvantage to being on inner lanes.

The mathematical model developped by Amandine Aftalion and Emmanuel Trélat couples mechanics and energetics, in particular the maximal oxygen uptake (VO_2^{max}) and anaerobic energy, into a system of differential equations that combines velocity, acceleration, propulsive force, neural drive with cost and benefit parametres in order to determine the optimal strategy to run a race.

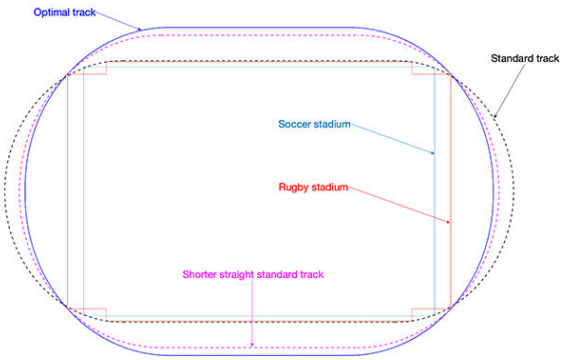


From left to right: standard track, consisting of two 84.3-metre straight lines; both types of basket handle-shaped track © Amandine Aftalion, Centre d'analyse et de mathématique sociales. Credit: CNRS/EHESS

Since this model optimises the effort to produce the best race, it makes it possible to compute the optimal geometry of a track and predict the discrepancy in records according to this geometry and the type of lane. For standard tracks, it shows that shorter straights and larger radii of curvature could improve the 200m record possibly by 4 hundredths of a second. The constraint to accommodate other sports can be met by opting for new tracks with shorter horizontal straights and

small vertical straights. The researchers' recommendation is to privilege such tracks in the future in order to improve runners' performance.

They are adapting their model to horse races with the support of the AMIES.



In blue: optimal track determined by this new model. In pink: the standard track with a shortened straight line. In black: the classic standard track © Amandine Aftalion, CNRS researcher at the Centre d'analyse et de mathématique sociales (CNRS/EHESS) and Emmanuel Trélat, Sorbonne Université researcher at the Laboratoire Jacques-Louis Lions. Credit: CNRS/Sorbonne Université/ Université de Paris

More information: Amandine Aftalion et al, How to build a new athletic track to break records, *Royal Society Open Science* (2020). DOI: 10.1098/rsos.200007

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