

# Optimising strategies for long-distance cycle races

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# Introduction

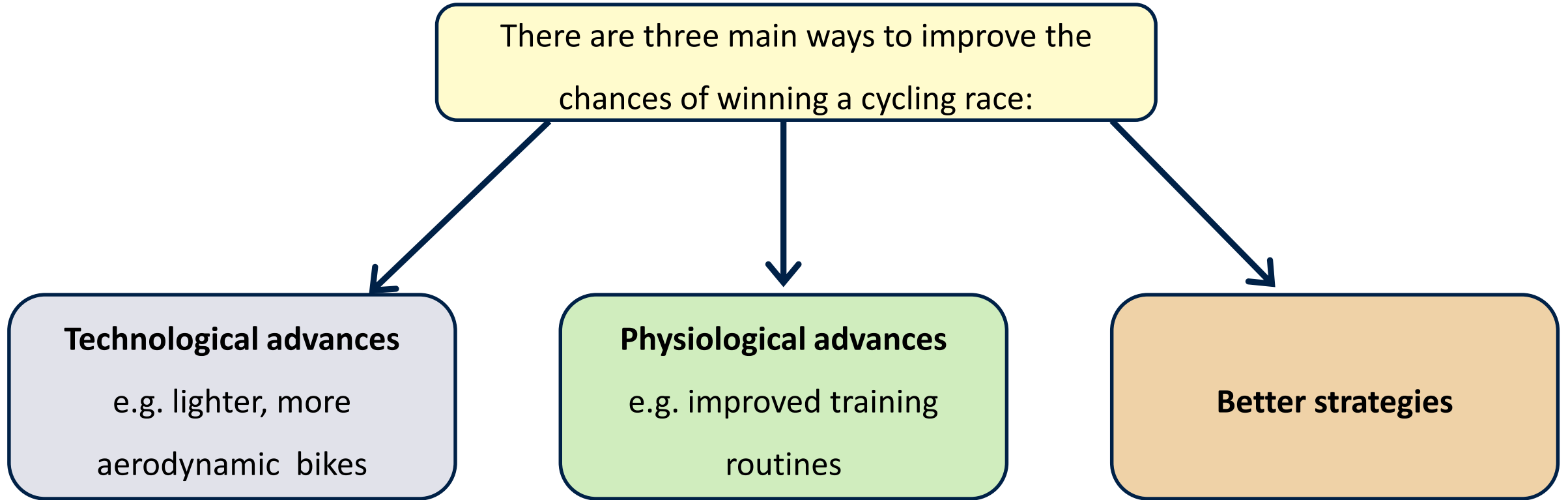
Cycle racing is a lucrative and competitive sport:

- In 2006, 2007, 2008, and 2020 Tour de France the winning margin was less than 1 minute for races taking approximately 90 hours.
- The winner of the 2023 Tour de France won at least €500 000.
- Similarly, the 2022 Men's London Marathon was won by 33 seconds with a prize of £55000.

Hence, there is a large incentive to find ways to improve your chances of winning long distance races.



# Introduction



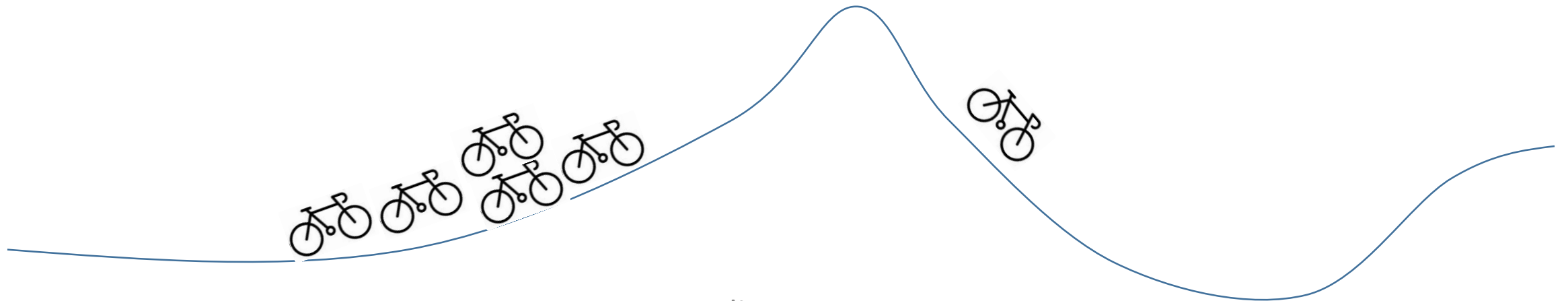
# Bike races

## Peloton

- A group of riders riding together.
- This reduces air resistance by 30%.
- Therefore energetically favourable to stay in peloton as long as possible

## Breakaway

- An individual rider (or small group) who rides out ahead of the peloton in an attempt to win.
- The extra speed and air resistance means the rider must exert a greater force.
- If the breakaway occurs too soon, then fatigue means the peloton may catch up.



Long distance races

# Causes of Fatigue/Exhaustion

Muscle fatigue can be caused by:

- Build-up of lactic acid
- Build up of Phosphate ions

Exercise also requires nutrients, so the total amount of work possible is limited by the energy supply in the body.

# Challenge

Develop a coupled mathematical model for:

1. The motion of cyclists over a long distance race course.
2. The effect of fatigue/ energy consumption on the cyclists.

Then use the model to predict the optimum breakaway point to win the race in the shortest possible time.

## Possible extensions:

- Complicated physiological modelling.
- How does the optimal strategy alter over a multi-stage race? Is one big breakaway better than several smaller ones? How should recovery between stages be modelled?
- Can the mathematical model be extended to find optimal pedalling/breaking/freewheeling strategies or be used to predict the fastest path through corners?
- How would the model need to be modified for ultramarathon running races?

- Course data for all stages of 2023 Tour de France

<https://www.cyclingstage.com/tour-de-france-2023-gpx/>