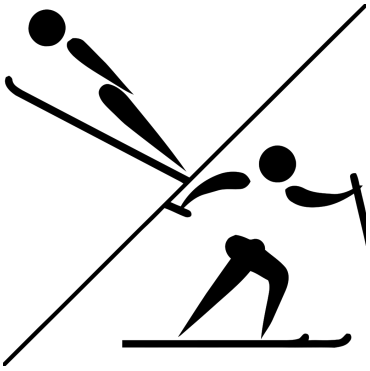
Nordic Combined



Motivation

Nordic combined is a winter sport in which athletes sequentially compete in two structurally different forms of sport: cross-country skiing and ski jumping. The result of the whole sport competition consists of the results of both single events which are combined using a predefined linear relation between (style plus width) points achieved in the ski jumping competition and time-difference from the cross-country competition. In order to win, an athlete needs to perform well in both competitions and achieve the highest combined score.

In the most common case, the whole event starts with the ski jumping competition. The winner of the ski jumping competition is the first to start the cross-country race. All other athletes follow delayed, whereas their time penalty depends on the difference between their own points achieved in the ski jumping compared to those of the leader. Finally, the first one finishing the cross-country race wins the whole competition.

The sport becomes particularly interesting as the skill level of athletes is not homogeneously spread on both competitions. Athletes who are more skilled in ski jumping usually need to achieve an advantage for cross country race, while athletes who are more skilled in racing need to avoid losing too much points on the ski jumping hill compared to the leader.

Research Target

There it always some time between the ski jumping and the cross-country competition. Apart from several other reasons (visitors need to change position, preparation of skies, television rights,...) athletes need to rest and warm-up for the upcoming structurally different sport type. This time-gap always leaves a lot of space for speculations: **How well is the achieved starting position of a specific athlete for the cross-country race? Who is most likely to win?**

Unfortunately this question is not as simple as it looks in the first place. Not only does it depend on the cross-country skill levels (average speed) of all athletes in the field, but also on potential athlete-clusters occurring on the track which benefit from each other making use of slipstream effects.

Tasks

Task 1

Develop and document a conceptional agent-based model wherein each agent represents one athlete in a Nordic combined cross-country race. Make sure that each agent has its own average racing speed for the specified distance (10km, 5km) and starts with the race with a certain time-delay. Develop a concept, how agents are able to utilise the slipstream effect in your model.

Task 2

Implement your model, at first, without slipstream effect, and run a couple of test scenarios to make sure your implementation works as intended. Document this verification process.

Task 3

Look for data which can be used to determine the average cross-country racing speed of each active World Cup athlete (e.g. official FIS race results). Write a program that processes the found data and determines the objected speed parameter for each athlete in a reproducible/extendable way. Document and justify, how your program determines the average speed. Make sure, your simulation model is able to use this information as parameter values.

Task 4

Find a way to quickly download and process ski jump results from Nordic combined competitions. Use this method to download the ski jumping result of the last World Championships and parametrise your implemented simulation model with it. Generate a fictional simulated race result.

Task 5

Implement a program that compares real, official race results with the ones generated/forecasted by your simulation. How well does your simulation perform for the last World Championships?

Task 6

Implement the slipstream effect as described in your conceptional model. Run a couple of test scenarios to make sure your implementation works as intended. Document this verification process. Does the slipstream extension improve the quality of your forecast for the last World Championships?

Task 7

Download at least 5 more official ski-jumping and race results and compare the simulated forecasts with the real results. Calibrate slipstream related parameter values to achieve the best possible fit of your simulations with the real race results.

Task 8

Implement at least one additional model-extension that make the model even more realistic (e.g. final sprint quality, shape of the trail, decreasing energy-level of athletes, ...) and prove that the chosen extension improves the validity of the simulation results.