Finding the Mathematical formula for winning the Winter Olympics

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1 - Introduction

I am an avid fan of watching sports and when watching the 2026 Winter Olympics in Italy I kept seeing these numerical values being used to represent a competitors performance that then saw them ranked against the other athletes. So I was wondering just perhaps if to get to this numerical result whether there is a mathematical formula that can be used to calculate their scores without a judges input. Therefore if this is that case then this formula should be able to be optimised to predict the score an athlete would require to win a gold medal at the Olympics. In this essay I am going to be using sport as a method to show how formulas can be derived and used to predict trends within maths.

I am using the Winter Olympics and specifically the women's snowboard big air competition to model my formula on as this was my favourite event at this year's Olympics. As well as this the jumps and judging criteria make logical sense to be modelled in this mathematical way.

2- How the competition works

In snowboard big air at the Olympics the riders get 3 runs and their best 2 are added up for their overall score. These 2 tricks must be in different spin directions and each trick is generally scored out of 100. They must spin in both frontside and backside directions which for a regular rider is counter clockwise and clockwise respectively. Using this we can build a reasonable predictive formula based on how the Judges score.

Judges usually score based on:

- Difficulty (D)
- Execution (E)
- Amplitude (A)
- Landing (L)
- Overall impression (I)

3- Deriving the Formula

$$R_i = Score\ of\ Run\ i$$

As only the best frontside and backside jumps count so I can model these as:

$$R_{Best\ F},\ R_{Best\ B}$$

Where $R_{Best\ F} = Best\ Frontside\ jump$ and $R_{Best\ B} = Best\ Backside\ Jump.$

I can model each run as:

$$R_i = w_D D_i + w_E E_i + w_A A_i + w_L L_i + w_I I_i$$

Where the letters D,E,A,L,I stand for the categories that the judges score based on.
The w stands for the weight of each element or the approximate judging emphasis put on each element as they are not all considered equally. Through research on scores and jumps of the past aided by commentators' outlook on jumps I have approximated the following weights for each element.

$$w_D = 0.30,\ w_E = 0.25,\ w_A = 0.15,\ w_L = 0.20,\ w_I = 0.10$$

This tells us that the Difficulty, Execution and Landing are the most important elements of the jumps to the judges as they have the highest weights.

In order to find a specific formula to win the Olympics these elements have to be combined and maximised for the best possible score of an athlete.

Where S stands for score

$$S_{Highest} = S_{Gold}$$

$$S_{Gold} = R_{Best\ F} + R_{Best\ B}$$

Then I can substitute my formula for each run into this:

$$S_{Gold} = \sum_{i=1}^{2} (0.20D_i + 0.25E_i + 0.15A_i + 0.20L_i + 0.10I_i)$$

I then had to adjust this to the data I collected from the previous Olympics. So following recent trends:

$$170 \leq S_{Gold} \leq 195$$

This is because all the gold medal winning scores fit into the above inequality. I then thought that the level of competition normally has a large impact on the performance of athletes as a higher level field pushes the athletes to compete better so to make this formula more accurate this should also be included.

I called the competition factor C

$$C = 1.00\ for\ an\ average\ field$$

$$C = 1.05\ for\ a\ very\ strong\ field\ (in\ olympic\ finals)$$

Therefore for this particular model I will use $C = 1.05$, therefore:

$$S_{Gold} = C(R_{Best\ F} + R_{Best\ B})$$

$$S_{Gold} = C\left(\sum_{i=1}^{2} (0.20D_i + 0.25E_i + 0.15A_i + 0.20L_i + 0.10I_i)\right)$$

We can simplify this model to make it more understandable which would look like:

$$S_{Gold} = 2 \times (0.30D + 0.25E + 0.20L + 0.15A + 0.10I) \times C$$

From this I can interpret that to win olympic gold in this sport you need:

- 2 runs between 86-97 each at a minimum - As shown in 2022 when Anner Gasser won gold with a 86.75 and a 95.50
- High difficulty tricks such as double / triple corks like Anna Gasser in 2022 who performed 2 double corks
- Near perfect landings
- Difficult rotations such as a 1080 or 1260

We have to remember this is just an approximation so we can't take into account judging bias,weather or breakthrough tricks that have never been seen before. However it does accurately capture the judging structure and matches historical evidence.

4- Prediction

I can then use this model and previous data to create a more predictive model that can show the consistent rise in the scores of gold medal winners in order to predict the score that is likely to be required in 2030 to win Olympic gold.

I will use 2018 as my data starting point (as this was the first year it was at the Olympics) and on average the gold winning score increases by 1.5-2.5 per year mainly due to trick progression but recently it has only been between 1-1.5 so I will use this more recent evidence of trick progression in my prediction.

$$t = Years\ from\ 2018$$

$$S_{Gold}(t) = 180 + 1.25t$$

For example in 2022 the score needed to win gold was 185.5 and using this model:

$$S_{Gold}(4) = 180 + 1.25(4) = 185$$

185 is only 0.5 lower than the actual score needed so this model is a reasonably accurate predictive model but still can't take into account judging bias and weather conditions so may always have a slight margin of error.

As a result:

$$C\left(\sum_{i=1}^{2}(0.20D_i + 0.25E_i + 0.15A_i + 0.20L_i + 0.10I_i)\right) = 180 + 1.25t$$

So at the next Olympics in 2030 I can predict that the score needed to win gold would be approximately:

$$180 + 1.25(12) = 195$$

Based on this I can substitute in my earlier equation to represent what this 195 should be made up of.

$$C\left(\sum_{i=1}^{2}(0.20D_i + 0.25E_i + 0.15A_i + 0.20L_i + 0.10I_i)\right) = 195$$

When we simplify this it becomes:

$$2 \times (0.30D + 0.25E + 0.20L + 0.15A + 0.10I) \times C = 195$$

5- Conclusion

Therefore using these models we have created we can predict that in the future you will need:

- At least 2 clean runs scoring between 92-98
- Tricks must show progression in the future such as a (1620 in 2030)
- Clean landings
- Significant amplitude as particularly in 2026 judges were particularly harsh on lower amplitude jumps

As a result 2 jumps that could win the 2030 Olympics could be a backside triple cork 1620 which pushed the ceiling on the 1440 today performed in competition and if perfectly executed would score between 95-98. As well as a cab triple cork 1440 which is difficult and if this is executed well could score 92-96 which overall would likely result in the gold medal.

I hope you enjoyed this ride through maths with me using prediction and deriving formulas from data. I also hope that through sport I was able to show how formulas and predictive models can be derived within mathematics. Perhaps a bit useless because we can never be 100% sure of a prediction but a bit of fun that I haven't been able to stop thinking about exploring for a while. I enjoyed being able to translate this wonderful sport into something I better understand and I hope you have enjoyed it too

but it has been wonderful to admire the sportsmanship and talent of these athletes whilst doing my research. It's rare that we get an opportunity to try something new and exciting particularly at A level so this was very fun to research and have a go at. Thank you very much for reading.