An Examination of Sport Climbing Competition Format and Scoring System

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Abstract

The purpose of this paper is to investigate the controversial competition format and scoring system of sport climbing, which is one of the sports making its debut on the Olympics stage at Tokyo 2020. Climbing Olympians will participate in three disciplines: speed climbing, bouldering, and lead climbing for a single set of medals, and a multiplied score of climbers' rankings in all three disciplines will be used to determine the overall standings. This work finds great evidence from historical data and simulations that speed climbing speed climbing should be separated from the combined format and have its own medals. Furthermore, it is shown that the product of ranks scoring system violates the independence of irrelevant alternatives property.

Keywords: sport climbing, rankings, 2020 Summer Olympics

1 Introduction

In 2016, the International Olympic Committee (IOC) announced the addition of five new sports to the 2020 Summer Olympics in Tokyo, Japan, which would then reschedule for 2021 due to the impact of the COVID-19 global pandemic. The five new events added to Tokyo 2020's competition program were baseball/softball, karate, skateboard, surfing, sports climbing (IOC 2016). One of the new sports, sport climbing, is particularly interesting because of its scoring system which uses the product of ranks across three disciplines to determine the medalists, with the lowest rank product declared the winner.

The three disciplines that comprise sport climbing at Tokyo 2020 are: speed climbing, bouldering, and lead climbing. Speed climbing takes place on a standardized course and competitors try to reach the top of the course as fast as possible. For Tokyo 2020, speed climbing is being contested in a head-to-head format with ranks determined by how far a competitor advances in the bracket. In bouldering, contestants have a fixed amount of time to complete as many courses as they can. Winners are determined based on who completes the most courses and ties are broken based on who had the fewest attempts. Ties are further broken by the competitor achieved the most "zone holds", which are holds approximately halfway through each course. Finally, in lead climbing, an athlete gets one point for each hold that they reach, so whoever reaches the highest point on the wall is the winner. Each lead climber only gets one attempt and when they fall their attempt is over.

The decision to combine the three climbing events and only award one set of medals for both men's and women's events in the Olympics has received a large amount of criticism from climbing athletes all over the world. In a series of interviews conducted by Climbing Magazine in 2016, a number of climbers shared their thoughts and concerns about the new Olympics climbing format. Climber Lynn Hill compared the idea of combining speed climbing, bouldering, and lead climbing to "asking a middle distance runner to compete in the sprint". She then added "Speed climbing is a sport within our sport". Other climbers also hold the same opinion as Hill regarding speed climbing, using words and phrases like "bogus", "a bummer", "less than ideal", "not in support", and "cheesy and unfair" to describe the new combined competition format. Courtney Woods stated "Speed climbers will have the biggest disadvantage because their realm isn't based on difficult movements".

Mike Doyle believed “Honestly, the people that will suffer the most are the ones that focus only on speed climbing. Those skills/abilities don’t transfer as well to the other disciplines”. Most climbers also expressed their hope for a change in the format in future tournaments, with some calling for each discipline to have its own set of medals. See Blanchard (2016) for more information on these interviews.

At the 2020 Summer Olympics, both sport climbing competitions for male and female at the begin with 20 climbers who has previously qualified for the Olympics from qualifying events held in 2019 and 2020. All 20 athletes compete in each of the three disciplines in the qualification round, and their performances in each concentration are ranked from 1 to 20. A competitor’s combined score is computed as the product of their ranks in the three events; specifically,

$$Score_i = R_i^S \times R_i^B \times R_i^L, \tag{1}$$

where R_i^S, R_i^B, and R_i^L are the ranks of the i-th competitor in speed climbing, bouldering, and lead climbing, respectively.

The 8 climbers with the lowest score (i.e. lowest product of ranks across the three disciplines) in the qualification round advance to the finals where they once again compete in all three disciplines. The final score for each person in the final stage is determined by multiplying their ranks in each discipline, similar to the qualification round, with the main difference being that there are only 8 competitors in the final as opposed to 20 in the qualification round. The climbers with the lowest, second lowest, and third lowest product of ranks in the final wins the gold, silver, and bronze medal, respectively. This type of scoring system heavily rewards high finishes and relatively ignores poor finishes. For instance, if climber A finished 1st, 20th, and 20th and climber B finished 10th, 10th, and 10th, climber B would have a score of 1000 whereas climber A would have a much better score of 400, despite finishing last in 2 out of 3 of the events.

To the best of our knowledge, we know of no sporting event, team or individual, that uses the product of ranks to determine an overall rankings. There are examples of team sports that use the sum of ranks to determine the winning team such as cross country, where the team with the lowest sum of ranks of the top five runners is determined to be the winner. For more detail on rank sum scoring, see Hammond (2007) and Boudreau et al.

(2018). In addition, some individual sports such as the decathlon and heptathlon rely on a sum of scores from the ten or seven events, however, these scores are not determined based on the ranks of the competitors. That is, a decathlete's score is entirely based upon their times, distances, and heights, and their overall score will be exactly the same if the times, distances, and heights remain the same regardless of the performance of other individuals. Full details of decathlon scoring can be found in Westera (2006).

The manuscript is outlined as follows. We first begin with some descriptions of the data and methods in Section 2. Our analyses and results are then presented in Sections 3 and 4. Finally, in Section 5, we summarize up our main findings and provide a discussion to close out the paper.

2 Data and Methods

Our first sets of data come from a simulation study that we conducted, with the purpose of examining the rankings and scoring for climbers in both qualification and final rounds. For each round, we performed 10000 simulations, and this was accomplished by randomly assigning the ranks of each event to every participant, with the assumption that the ranks are uniformly distributed. After the completion of the simulations, we calculated the total scores for every simulated round, as well as the final standings for the climbing athletes. The simulation results allow to answer questions about various topics, including the distributions of scores for qualifying and final rounds, and the probabilities of advancing to the finals or winning a medal, given certain conditions. First of all, Table 1 and Figure 1 are numerical and visual summaries of climbing total score obtained from our simulated data for the qualification and final rounds.

Table 1: Descriptive statistics of simulated scores for qualification and final rounds

round	min	Q1	median	Q3	max	mean	sd	n
Qualification	1	240	684	1638	8000	1158.84	1273.48	200000
Final	1	24	60	126	512	91.20	91.11	80000

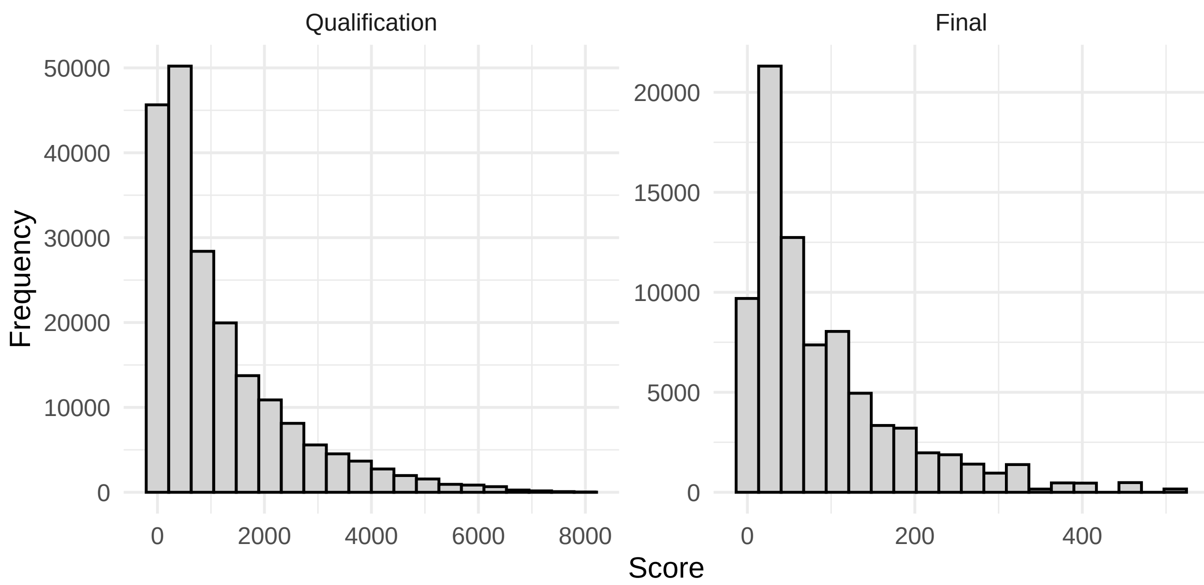

Figure 1: Histogram of simulated scores for qualification and final rounds

Additionally, we rely historical results from major climbing competitions in recent years. We collected data on climbing contests that took place between 2018 and 2020, where the combined format was used to determine the scores and ranks of climbers. The events include the 2020 Continental Championships of Europe, Africa, Oceania, Pan-America; 2019 and 2018 World Championships; 2018 Asian Games; and 2018 Youth Olympics. Data were obtained from various sources, including the event websites, Wikipedia, and the International Federation of Sport Climbing (IFSC). The main attributes of our datasets are the name and nationality of the climbers; bib number (for some competitions); the finishing place of climbers in speed climbing, bouldering, and lead climbing; the total score (which equals the product of event ranks); and the final rank. We utilize this data to compute the correlations between the event ranks and final table position, as well as to look at how often the final orderings change if one athlete is dropped and the ranks for each discipline are re-computed.

Paragraph on IIA/Social Choice

Suppose we have 3 people A, B, and C participating in a competition. If A finishes in the first place and C is later disqualified and removed, A should still win. If the original winner (A) loses the modified competition (with C removed), then the Independence of

Irrelevant Alternatives has been violated.

Economics, psychology, probability theory. Connect with cross country in previous section

First mentioned by Arrow (1951) `https://cowles.yale.edu/sites/default/files/files/pub/mon/m12-all.pdf`

Luce (1959) `http://www.scholarpedia.org/article/Luce%27s_choice_axiom`

and Luce (1977) `https://www.imbs.uci.edu/files/personnel/luce/pre1990/1977/Luce_JMP_1977a.pdf`

Ray (1973) `https://www.jstor.org/stable/1913820`

3 Simulations

3.1 Uniform Ranks

In this section, we discuss the results of our simulations described in Section 2. We first look at the chances of advancing to the final round for a qualifier, given that 1) they finish first in any of the three disciplines, and 2) they win the first event (which happens to be speed climbing in reality). Our simulation study shows that a climber is almost guaranteed to make the final round if they win at least one of the three climbing concentrations (99.51%, see Table) or if they win the opening event (99.48%, see Table). After winning the first event, a climber is also more likely to finish first overall (30%, see Table) than any other positions in the overall qualification rankings. Therefore, this product of ranks scoring format highly rewards climbers who can get off to a strong start, which is a major strategy climbing athletes should take note of.

In addition, the average score for qualification positions 1 to 8 are displayed in Table X. We notice that on average, the minimum score that one should aim for in order to move on to the final round is about 434 (for 8th rank).

Table 2: title

Win Any				Win First			
Rank	Count	Probability	Cumulative	Rank	Count	Probability	Cumulative
1	7890	0.2762	0.2762	1	2999	0.2999	0.2999
2	5943	0.2080	0.4842	2	1963	0.1963	0.4962
3	4644	0.1626	0.6467	3	1559	0.1559	0.6521
4	3651	0.1278	0.7745	4	1269	0.1269	0.7790
5	2766	0.0968	0.8714	5	957	0.0957	0.8747
6	1960	0.0686	0.9400	6	686	0.0686	0.9433
7	1118	0.0391	0.9791	7	363	0.0363	0.9796
8	448	0.0157	0.9948	8	155	0.0155	0.9951
9	127	0.0044	0.9992	9	42	0.0042	0.9993
10	19	0.0007	0.9999	10	6	0.0006	0.9999
11	3	0.0001	1.0000	11	1	0.0001	1.0000

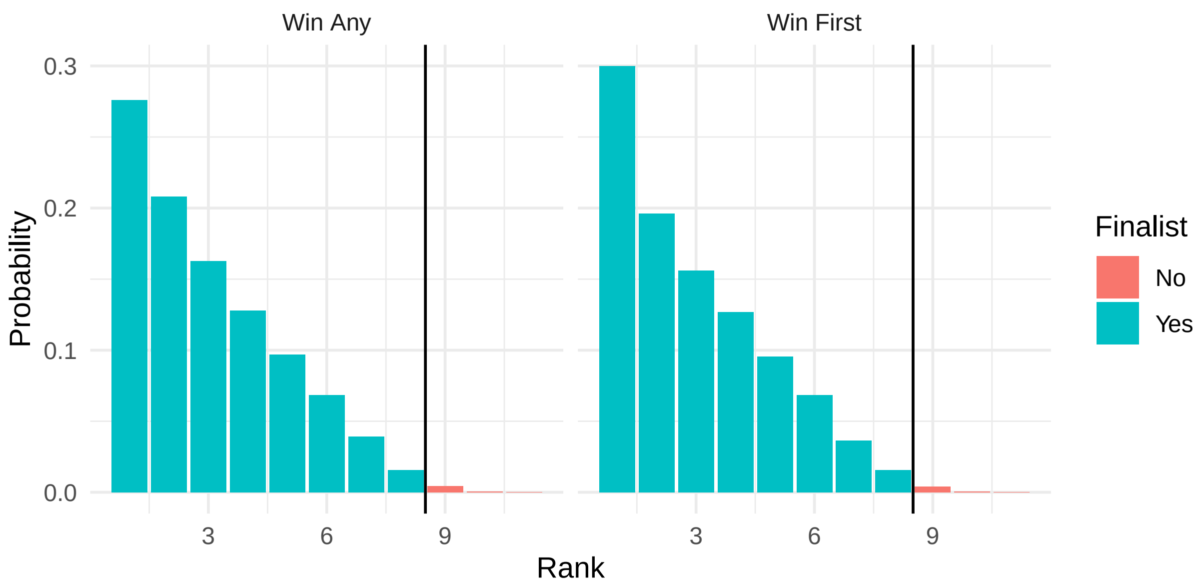

Figure 2: Probability of finishing at every rank given

Table 3: The average scores for the top 10 qualification ranks according to our simulations. A climber will secure a finalist spot if they finish in the top 8.

Rank	Average score
1	36.0187
2	73.6111
3	115.3954
4	162.2263
5	216.0041
6	278.1649
7	350.3272
8	434.5932
9	532.1383
10	642.3298

Regarding the finals, a climber is very likely to finish in the top 3 and hence earn a medal if they win the first event (83.03% chance) or any event (85.01% chance). Furthermore, according to our final simulations, in order to obtain a climbing medal, the average scores (rounded down) that put an athlete in position to receive gold, silver, and bronze medals are 9, 20, and 33, respectively (see Table 3).

Table 4: title

Win Any				Win First			
Rank	Count	Probability	Cumulative	Rank	Count	Probability	Cumulative
1	9277	0.3512	0.3512	1	4295	0.4295	0.4295
2	7409	0.2805	0.6317	2	2505	0.2505	0.6800
3	5257	0.1990	0.8308	3	1702	0.1702	0.8502
4	3078	0.1165	0.9473	4	1020	0.1020	0.9522
5	1187	0.0449	0.9922	5	393	0.0393	0.9915
6	198	0.0075	0.9997	6	83	0.0083	0.9998
7	7	0.0003	1.0000	7	2	0.0002	1.0000

3.2 Leave-one-climber-out

Another interesting question that we are interested in investigating is "What would happen to the rankings if a single climber is removed?". This is related to the concept of independence of irrelevant alternatives (IIA), as mentioned in Section 2.

We would expect that if a climber with a high combined ranking is removed from the list of competitors, the placement of lower-ranked climbers will shift. In the most trivial case, if we were to remove the 3rd place climber, we would see 4th place climber shift to 3rd, 5th place climber shift to 4th, etc. It is maybe less trivial that when a climber is removed from the list, the placement of their higher-ranking competitors may also shift. In other words, there is a non-zero probability of seeing a change in the placement - particularly of medalists - regardless of the fact that no changes occurred in the performance of the remaining climbers. Real examples are given in Section 4. In this section, we conduct

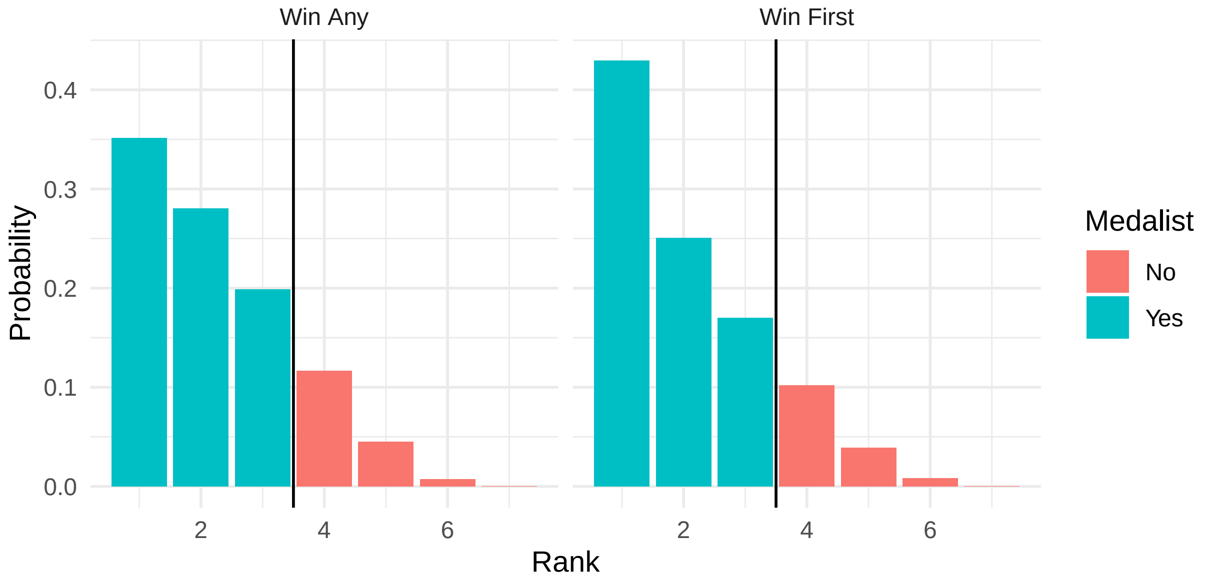

Figure 3: Probability of finishing at every rank given

Table 5: The average scores for all final ranks according to our simulations. Ranks 1, 2, and 3 are table positions that guarantee medalist status for climbers.

Rank	Average score
1	9.6687
2	20.1844
3	33.3658
4	50.5734
5	75.2499
6	110.7070
7	164.8258
8	265.0198

simulations to analyze the probability of seeing a reordering of medalists when one non-medalist is removed from the list of finalists.

3.2.1 Probability of Reordering in Higher Ranks

We first look at the rate at which the ranks above that of which is dropped are reordered.

Dropped Rank	Simulations	Avg. Probability	Median Probability	St. Deviation
4	100	0.25869	0.2590	0.0145433
5	100	0.34032	0.3405	0.0151263
6	100	0.38012	0.3820	0.0152430
7	100	0.40636	0.4060	0.0149582
8	100	0.39439	0.3930	0.0151023

3.2.2 Probability of Change in Finalists

A potential event of interest is the replacement of one finalist with another, taking the chance away from the original finalist to win a medal in the finals round. Here we compute the probability that a finalist will be replaced with a non-finalist after removing another non-finalist from the rankings. Below is a table summarizing the results.

Dropped Rank	Simulations	Avg. Probability	Median Probability	St. Deviation
9	100	0.0505	0.050	0.0217597
10	100	0.1538	0.150	0.0318386
11	100	0.1603	0.160	0.0343616
12	100	0.1416	0.140	0.0353259
13	100	0.1365	0.140	0.0336162
14	100	0.1217	0.120	0.0344965
15	100	0.1213	0.120	0.0308353
16	100	0.1159	0.120	0.0306197
17	100	0.1086	0.105	0.0314312
18	100	0.1026	0.100	0.0329867
19	100	0.0886	0.090	0.0291641
20	100	0.0700	0.070	0.0258590

as can be seen, the probability is relatively low when the 9th place competitor is removed. My hypothesis is that there is enough separation between the original finalists and the 10th+ ranking competitors in the individual events that there isn't a high chance that the total rankings of the finalists can be overtaken by 10+th place competitors. Note: it might be worth computing the probability of getting a low ranking in any of the individual events, given that a competitor is a finalist (ie: $P(r_1 > 8 \text{ or } r_2 > 8 \text{ or } r_3 > 8 \mid R_T \leq 8)$).

3.2.3 Probability that Medalists are Reordered or Changed

The second scenario of interest is if a medalist is displaced by another medalist, or even a non-medalist. Below are the results summarizing the probability of this scenario occurring under uniform random ranking conditions.

Dropped Rank	Simulations	Avg. Probability	Median Probability	St. Deviation
4	100	0.25872	0.2580	0.0137106
5	100	0.31988	0.3190	0.0161416
6	100	0.28741	0.2870	0.0127969
7	100	0.25631	0.2545	0.0145301
8	100	0.20631	0.2050	0.0120283

4 Data Analysis

4.1 Rank Correlation

For our analysis on the relationship between the rankings of the events and the final result, we used data from the 2018 Youth Olympics Women's Qualification. Figure 2 is a scatterplot and correlation matrix between the ranks of the individual events and the final standings, with Kendall's Tau (Kendall 1938) as our measure of ordinal association between the quantities. It is evidently clear that there exists a strong and positive correlation between the ranks of bouldering and lead climbing, and as a results, the standings of these two events are highly correlated with the final rankings. On the other hand, the correlation with the final rank is not as strong for speed climbing as the other two events. Thus, speed climbers are facing a huge disadvantage in this scoring system, compared to those that are specialized in the other two concentrations. This validates the concerns of climbers in the interview mentioned in Section 1. We also have evidence for these correlations from the qualification rounds of the 2018 Asian Games (Table 4), 2019 World Championship (Table 5), 2020 European Championship (Table 6), and 2020 Pan-American Championships (Table 7).

4.2 Leave-one-climber-out Analysis

Next, we perform analysis on the situations where a climber is dropped from the original standings. We once again make use of data from the 2018 Youth Olympics for this analysis, but this time we examine the final round of both men's and women's competitions.

Figure 3 shows the modified versions of the rankings after each ranked climber is excluded for both gender events. We have clear evidence from this plot that removing a single climber changes the rankings drastically, especially order of medalists. One particular interesting case is where an athlete's position change when someone who originally finished behind them drops out. This situation is illustrated by panel 5 of the women's competition, where the fifth-place climber, Krasovskaia, was excluded; and Meul, whose actual final rank was fourth, moved up to the second spot and claim the silver medal.

Likewise, dropping a higher-ranked athlete could also result in a major shake-up to the new orderings of players. This type of ranking change is demonstrated by panel 1 and 2 of the men's facet. After dropping the first ranked male contestant, Dohi; Schenk, who previously finished fourth and outside of the medalist group now has the lowest score and become the gold medal winner. A similar situation occurs in the case where the second best competitor (Tanaka) was removed, which results in a jump from fourth place to second place for Pan.

5 Conclusion and Discussion

Overall

Speed climbers

There is a great dependence on irrelevant party.

Figure 4: Kendall's rank correlations - 2018 World Championship, Men's and Women's Qualifications

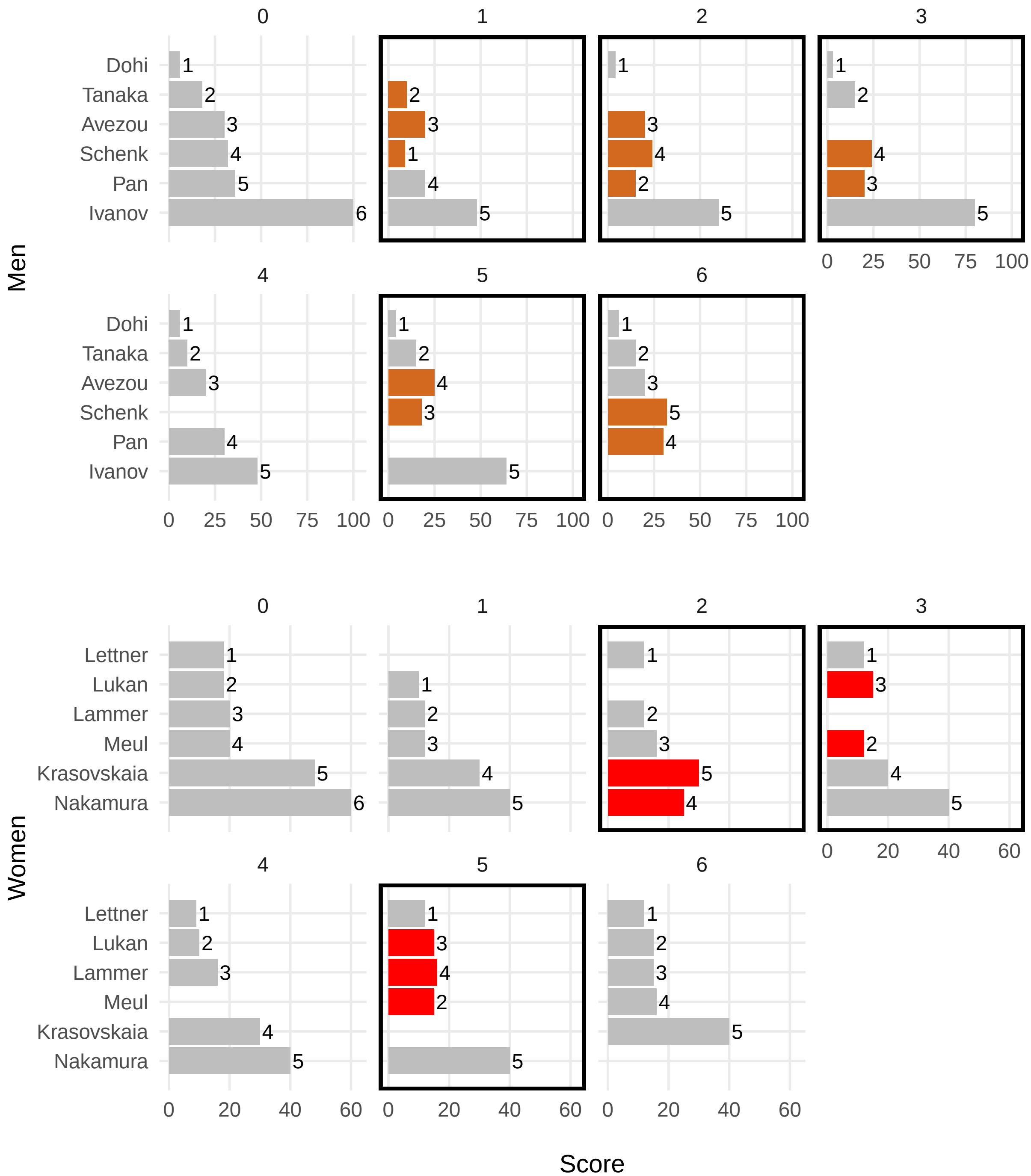

Figure 5: This figure illustrates the changes to the final rankings of the 2018 Youth Olympics Men's and Women's Finals when we leave out one climber. For each gender competition, each panel represents the rank of the drop-out athlete, with 0 being the original final results. Each case with a change in rank orderings is highlighted by a black panel border, and any player with a rank change is represented by a red-filled bar

Future work

Recommendations: climbers were right, need a change in format

Supplementary Material

All of the materials related to this manuscript are publicly available on GitHub at `https://github.com/qntkhvn/climbing`.

Table 6: This table shows Kendall's rank correlation coefficients between the overall and individual discipline ranks for men's and women's sport climbing qualifications at the 2018 Asian Games

	Men				Women			
	Overall	Speed	Bouldering	Lead	Overall	Speed	Bouldering	Lead
Overall	1.0000	0.5731	0.6760	0.6126	1.0000	0.5474	0.6878	0.7053
Speed	0.5731	1.0000	0.3022	0.2174	0.5474	1.0000	0.2540	0.2947
Bouldering	0.6760	0.3022	1.0000	0.6203	0.6878	0.2540	1.0000	0.6878
Lead	0.6126	0.2174	0.6203	1.0000	0.7053	0.2947	0.6878	1.0000

Table 7: This table shows Kendall's rank correlation coefficients between the overall and individual discipline ranks for men's and women's sport climbing qualifications at the 2019 World Championships

	Men				Women			
	Overall	Speed	Bouldering	Lead	Overall	Speed	Bouldering	Lead
Overall	1.0000	0.2632	0.3684	0.3474	1.0000	0.2316	0.5013	0.2526
Speed	0.2632	1.0000	-0.0947	-0.3263	0.2316	1.0000	0.0686	-0.4526
Bouldering	0.3684	-0.0947	1.0000	0.2000	0.5013	0.0686	1.0000	0.2902
Lead	0.3474	-0.3263	0.2000	1.0000	0.2526	-0.4526	0.2902	1.0000

Table 8: This table shows Kendall's rank correlation coefficients between the overall and individual discipline ranks for men's and women's sport climbing qualifications at the 2020 European Championship

	Men				Women			
	Overall	Speed	Bouldering	Lead	Overall	Speed	Bouldering	Lead
Overall	1.0000	0.0947	0.3810	0.2632	1.0000	0.1847	0.5358	0.5368
Speed	0.0947	1.0000	-0.1587	-0.4316	0.1847	1.0000	-0.1915	-0.0897
Bouldering	0.3810	-0.1587	1.0000	0.2751	0.5358	-0.1915	1.0000	0.5040
Lead	0.2632	-0.4316	0.2751	1.0000	0.5368	-0.0897	0.5040	1.0000

Table 9: This table shows Kendall's rank correlation coefficients between the overall and individual discipline ranks for men's and women's sport climbing qualifications at the 2020 Pan American Championship

	Men				Women			
	Overall	Speed	Bouldering	Lead	Overall	Speed	Bouldering	Lead
Overall	1.0000	0.5906	0.5556	0.6491	1.0000	0.5789	0.6140	0.5906
Speed	0.5906	1.0000	0.2164	0.4035	0.5789	1.0000	0.2632	0.3099
Bouldering	0.5556	0.2164	1.0000	0.2749	0.6140	0.2632	1.0000	0.3918
Lead	0.6491	0.4035	0.2749	1.0000	0.5906	0.3099	0.3918	1.0000

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