

# Final Project Writing Sample

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April 28 2022

## 1 Abstract

## 2 Introduction

This paper seeks to analyze figure skating competition data from the past Olympic cycle in order to predict the 2022 World Championship results and evaluate the significant factors that help identify champions. We also seek to evaluate potential judging bias and explore a potential correlation between individual judge rankings and the final placements.

### 2.1 The Structure of Figure Skating

There are four main disciplines in figure skating: men's singles, ladies' singles, pairs, and ice dance. Mens and Ladies disciplines are individual events whereas pairs and ice dance teams are partnered events, where each team consists of a man and a woman.

#### **Ladies & Men's Singles**

The Ladies and Mens disciplines of figure skating requires an individual to perform jumps, spins, and step sequences. Jumps comprise the majority of points in singles skating. Because of the higher element values of quadruple jumps, it is natural for men's scores to be higher than ladies.

#### **Pairs & Ice Dance**

The Pairs and Ice Dance disciplines of figure skating are partnered events. Pair teams perform technical elements such as side-by-side jumps, spins, throw twists, and pair lifts. Many elements of pair skating involve the man throwing or lifting the woman into the air. Unlike ice dance and similar to singles skating, pair skaters perform jumps. The Ice Dancing discipline is loosely based on ballroom dancing, and technical elements of an ice dance program focus on the precision and quality of step sequences.

#### **International Judging System (IJS)**

Each skater or team will compete a short program (SP) and a free program or free skate (FP, FS) set to music. Skaters usually perform the same programs throughout a skating season, occasionally opting to switch out elements for more challenging ones as the season progresses. The total score that determines final rankings is the sum of the short and free programs. The two segments of an ice dance competition are called the rhythm dance (RD) (formerly short dance) and the free dance (FD). Under the current IJS scoring system, each program is broken down into two segment scores: the Total Element Score, which represents the Grade of Execution (GOE) of each element performed, and the Total Program Component Score, which represents performance quality such as skating skills and interpretation of the music.

Rank	Name	NOC Code	Starting Number	Total Segment Score	Total Element Score	Total Program Component Score (factored)	Total Deductions
1	CHEN Nathan	USA	28	113.97	65.98	47.99	0.00

  

#	Executed Elements	Info	Base Value	GOE	J1	J2	J3	J4	J5	J6	J7	J8	J9	Ref.	Scores of Panel
1	4F		11.00	4.40	4	4	5	4	4	4	4	4	4		15.40
2	3A		8.00	2.29	3	3	3	3	4	2	2	2	4		10.29
3	CCSp4		3.20	1.05	4	4	3	4	3	3	3	3	3		4.25
4	4Lz+3T		17.27	x 3.94	4	4	4	3	4	2	2	3	4		21.21
5	StSq4		3.90	1.95	5	5	5	5	5	5	4	5	5		5.85
6	FSSp4		3.00	1.03	3	4	4	3	4	3	3	3	4		4.03
7	CCoSp4		3.50	1.45	4	4	4	5	4	4	4	5	4		4.95
			<b>49.87</b>												<b>65.98</b>
<b>Program Components</b>															
	Skating Skills			Factor	1.00	9.75	9.25	9.50	9.75	9.50	9.75	9.50	9.50		9.57
	Transitions			1.00	9.75	9.25	9.25	9.50	9.50	9.50	9.25	9.00	9.50		9.39
	Performance			1.00	10.00	9.50	9.75	10.00	9.50	9.75	9.50	9.50	10.00		9.71
	Composition			1.00	9.75	9.50	10.00	9.75	9.75	9.75	9.25	9.50	9.75		9.68
	Interpretation of the Music			1.00	10.00	9.75	10.00	9.75	9.50	9.50	9.50	9.50	9.50		9.64
	<b>Judges Total Program Component Score (factored)</b>														<b>47.99</b>
<b>Deductions:</b>															<b>0.00</b>

Figure 1: Nathan Chen’s Free Skate scoring breakdown from the 2022 Olympic Winter Games. The top half details the technical score, and the bottom half details the program components score.

Under the International Judging System, judges grade the quality of each element using a grade of execution score within a range of -5 to +5, which is added to or deducted from the base value. GOEs are proportional to the base value of each element. The highest and lowest scores for each element are omitted, and the remaining scores are averaged to determine the final GOE for each element. The GOE is then added to or subtracted from the base value for each element, and the sum of the scores for all elements forms the technical score.

The judges will award points on a scale from 0.25 to 10 for five program components to grade overall presentation. The highest and lowest scores for each component are removed, and the remaining scores are averaged. The components score is then multiplied by a factor to ensure that the technical and program components scores are balanced.

### The World Championships

The World Championships are the most important event in the regular skating season. They first took place in 1896, but it was not until 2005 that the current scoring system was introduced. The number of skaters allowed to compete from each country per discipline is determined by the results of the previous season’s World Championships. Each International Skating Union (ISU) member nation automatically receives at least one spot in each discipline, provided they have a skater/team who fulfills the technical minimum scores.

## 3 Methods

### 3.1 Data Collection

We scraped our data using the R package "rvest" from [skatingscores.com](https://www.skatingscores.com), a website that re-publishes scoring data from major international competitions made public by the ISU. We chose the top free skate scores from 15 distinct skaters at the past two senior world championships (2022 and 2021). Due to the volatile nature of the sport and short-lived seasons of skaters, we focus on skaters that performed well in the past two years.

## 3.2 Statistical Analysis

## 3.3 Predictive Models

### 3.3.1 Linear Regression Model

We can start by modeling a skater's score with a simple linear regression, using the skater's previous personal best total score as a predictor. We can also include the mean Grade of Execution (GOE) mark as an additional predictor because well-performed elements generally indicate a higher chance of placing well. We can break the total score into its two segments: the short program and free program.

Each segment is normally distributed based on the predictors, previous personal best ( $h_{short}$ ) and mean GOE ( $goe_i$ ).

$$short_i \sim N(\beta_{0,short} + \beta_{1,short} * h_{short} + \beta_2 * goe_i, \sigma_{short}^2)$$

$$long_i \sim N(\beta_{0,long} + \beta_{1,long} * h_{long} + \beta_2 * goe_i, \sigma_{long}^2)$$

### 3.3.2 Additional Models

### 3.3.3 Spearman Rank Correlation

The Spearman rank correlation will allow us to determine to what extent an individual judge's scores align with the final placement of a skater. A high correlation would indicate a "good" judge, whereas a low correlation would suggest a "biased" or "unusual" judge. Letting  $d_i$  be the difference between two ranks of each observation and  $n$  be the number of observations, the Spearman's rank correlation coefficient  $\rho$  can be expressed as follows:

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}$$

After calculating the correlation coefficients for each judge at the 2022 World Championships, we can construct a bootstrap distribution to reveal whether any of the coefficients are significantly low.

## 4 Results

## 5 Discussion

## 6 Conclusion

## References