

2021 IM²C

Problem: Who is the Greatest? Maradona or Pelé? Biles or Khorkina?

We read all the time in the sports pages about an athlete being called the **G.O.A.T.** - the *Greatest Of All Time*. What does that really mean and how can that truly be determined?

For the purpose of this IM²C problem, we consider two types of “**sports**” – and, we allow “sports” to be defined broadly.

1. Individual Sports. An individual person competes against one or more other players either “**one-on-one**” or against an **inanimate** standard (highest or lowest ranking or score or time measure). Competitors do not necessarily physically interact with each other (e.g. golf, marathon running, swimming, chess, and table tennis), but they could interact physically with their opponent (e.g. boxing, wrestling). Winners in these sports competitions are individuals and not teams.

2. Team Sports. A group of individuals competes against another group of individuals and the competition includes multiple interactions between any and all players physically, strategically, or through equipment. Examples of team sports include basketball, hockey, American football, International football (soccer), and water polo. Winners in team sports competitions are teams. Although team sports incorporate a variety of position players, individuals, like Michael Jordan in basketball, may stand out.

How is the *greatest* determined? Sometimes we judge sports figures based on an accumulation of records and results over several years such as Palmer or Nicholas in golf, Bonnie Blair in women’s speed skating, Ma Long in table tennis, or Tom Brady in American football. Sometimes we call them great because of one athletic feat such as Bob Beamon’s world record long jump in the 1968 Olympics or Nadia Comaneci’s perfect 10s in gymnastics during the 1976 Olympics. Some athletes come up at a time of rich competition or establish a famous rivalry like Evert and Navratilova in women’s tennis or Ali and Frasier in boxing.

Top Sport, a sports network, has hired your team to consider models to measure “greatness.” Your first assignment is to develop a model for individual sports and use your model to determine the “G.O.A.T.” of one individual sport.

Given that there may be different divisions in sports having restrictions for membership, such as separate competitions for men and women, or various weight classes in boxing, wrestling, and weight lifting, you should consider each of these divisions a single sport (e.g. women’s gymnastics, men’s gymnastics, featherweight boxing, lightweight boxing) each able to have its own G.O.A.T.

Requirements

1. Warm Up. Consider the individual sport of singles women's tennis over the period of one year in 2018. The best women's tennis players play in the four Grand Slam tournaments (Australian Open, French Open, Wimbledon, and US Open). We provide results of these tournaments on pages 4-6 ([2018 Grand Slam Results](#)). Who among these players was the greatest?

- Develop a mathematical model for determining the greatest woman tennis player in 2018 on the basis of Grand Slam tournament results. Discuss your choice of factors/variables and the development of your model.
- Use your model to choose the greatest woman tennis player of 2018. Analyze your result.

2. Finding the G.O.A.T. of any Individual Sport. Note that in #1 you only looked at one year of a particular individual sport. Now, consider determining the *Greatest Of All Time* (G.O.A.T.) of ANY individual sport.

- Choose one example of a individual sport (other than Women's Tennis), and develop a mathematical model (or models) from any factors and data you find significant, measurable, and obtainable for determining the G.O.A.T. in that sport. Analyze your result. Ensure you document any resources used in gathering data and information about your sport.
- Discuss any changes your G.O.A.T. model from #2.a. would require to determine the G.O.A.T. of any individual sport. You DO NOT need to develop a new model, but address and explain how models for other individual sports would differ.

3. Extending Your G.O.A.T Model from #2. Now think about team sports. Discuss any changes your G.O.A.T. models from #2 would require to determine the G.O.A.T. of a team sport. You DO NOT need to develop a new model, but address and explain how a model for team sports would differ from your models for individual sports.

4. Letter. Write a one-page letter to the Director of *Top Sport* describing your team's model and your example of the G.O.A.T. for your selected individual sport. The Director is an executive who understands little about math modeling and science, but is interested in general principles and your key findings.

Note that IM²C is aware of available resources and references that address and discuss this question. It is not sufficient to simply re-present any of these models or discussions, even if properly cited. Any successful paper MUST include development and analysis of your own team's model and clearly explaining the difference between your model and any referenced existing ranking system.

Your submission should consist of:

- One-page Summary Sheet
- Table of Contents
- One page letter to the Director of *Top Sport*.
- Your solution of no more than 20 pages (A4 or letter size), for a maximum of 23 pages with your summary, table of contents, and letter. Note that your font must be no smaller than 12-point type.

Note: Reference List and any appendices do not count toward the page limit and should appear after your completed solution. You should not make use of unauthorized images and materials whose use is restricted by copyright laws. Ensure you cite the sources for your ideas and the materials used in your report.

Glossary

G.O.A.T. – An abbreviation for *The Greatest of All Time* referring to the person considered the best ever to compete, perform, or participate in a specific sport or activity.

Inanimate – A description of something that is not alive.

One-on-One – Playing directly against a single opposing player.

Sport – An activity usually undertaken competitively, governed by a set of rules or customs, that involves particular skills or physical exertion.