MCM Director's Overview of the Mathematical Contest in Modeling: What Advisors Need to Know.

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Abstract

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The Mathematical Contest in Modeling (MCM) is an undergraduate level contest occurring annually in February. In 2020, students formed over 13,700 teams to address one of three open-ended problems (A-Continuous, B-Discrete, C-Data Insights) during the 100-hour weekend contest period. During the contest students build and analyze a model to address the problem, and then write a 25-page paper to showcase their work. We will discuss the MCM in general and will examine some sample problems to highlight characteristics of a competitive paper. We will also provide insights to advisors on how to put together a team, prepare for the contest, and be successful.

I. Overview of COMAP's *Mathematical Contest in Modeling*

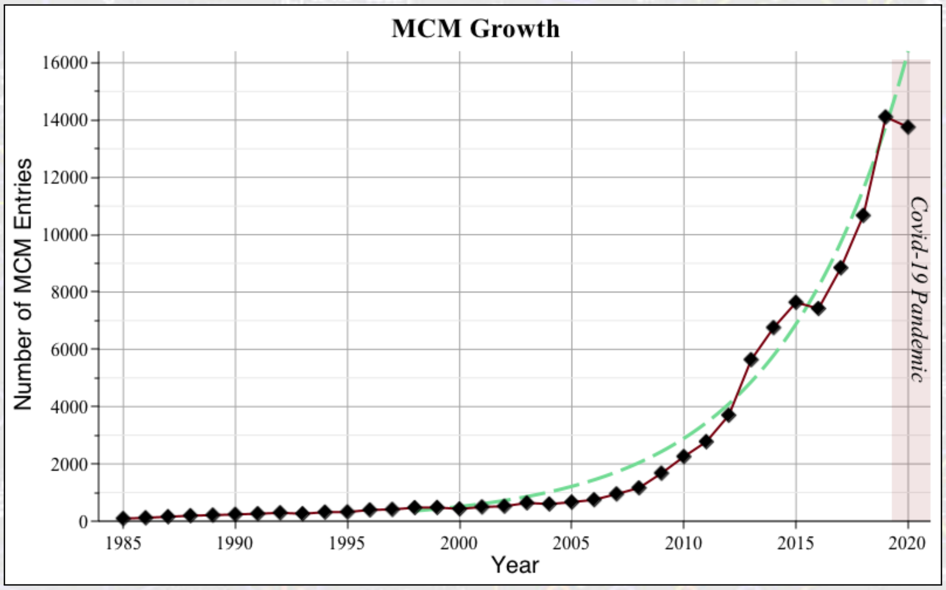
The Contest

From COMAP

"COMAP's Mathematical Contest in Modeling (MCM) is Real World Mathematical Modeling where research, analytics and applied intelligence reign along with less-quantifiable factors like timing and luck. Think you're up to it?"

"Mathematical Contest in Modeling (MCM), is an international contest for high school students and college undergraduates. It challenges teams of students to clarify, analyze, and propose solutions to open-ended problems. The contest attracts diverse students and faculty advisors from over 900 institutions around the world."

MCM Statistics



MCM Statistics

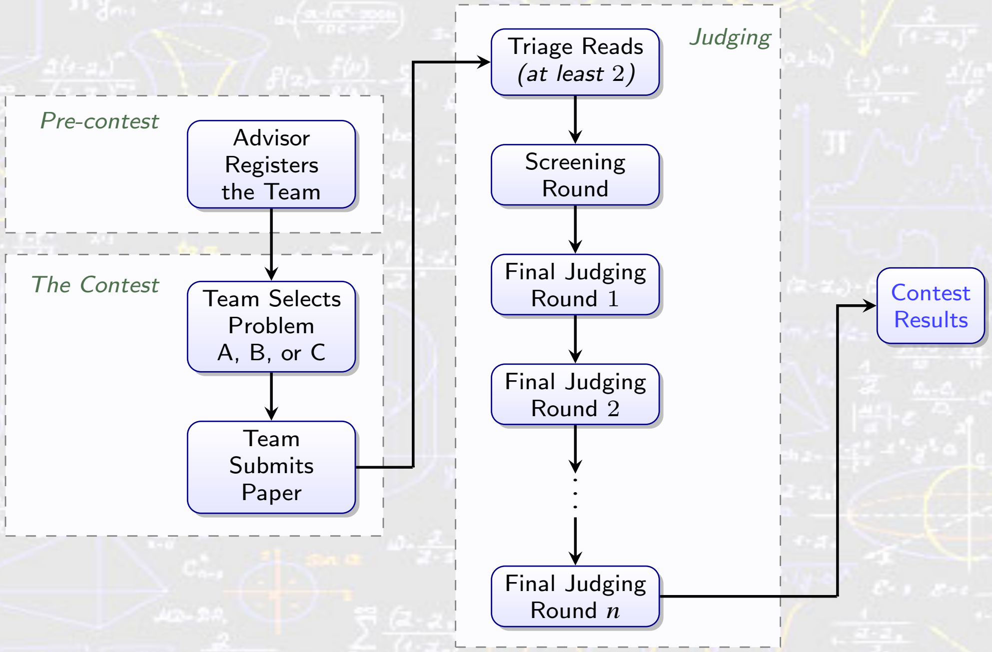
2020 MCM Statistics

- 13,753 teams entered
- 3,852 Problem A (28%)
- 2,455 Problem B (18%)
- 7,446 Problem C (54%)
- ~3% US Teams
- ~97% Foreign Teams[1]

- 19 Outstanding Winners
- 180 Finalist Winners (~1.3%)
- 839 Meritorious Winner (~2.9%)
- 3,525 Honorable Mention (~26%)
- 8,956 Successful Participant (~66%)
- 56 Unsuccessful Participant (<1%)
- 177 Disqualified (~1%)

[1] Australia, Canada, China, Finland, Hong Kong (SAR), India, Indonesia, Ireland, Macau (SAR), Mexico, Scotland, South Africa, South Korea, Spain, United Kingdom, and Vietnam, *and growing*. . .

The Path of a Team's Paper



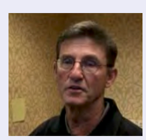
The Awards

MCM Awards

- Society Awards

  AMS, ASA, INFORMS, MAA, SIAM

- Special Named Awards

  Ben Fusaro Award, Frank R. Giordano Award

- COMAP and Two Sigma Investment Award

  "The International COMAP Scholarship Award will be awarded to the four(4) top MCM/ICM teams from any of the participating countries; $9,000 being split among the team members and $1,000 to the school represented."

The UMAP Journal publishes the results and selected Outstanding student papers.

II. Sample Problems and Insights

Sample Problems:

The A Problem — Continuous Mathematics

2015 Problem A: Eradicating Ebola

The world medical association has announced that their new medication could stop Ebola and cure patients whose disease is not advanced. Build a realistic, sensible, and useful model that considers not only the spread of the disease, the quantity of the medicine needed, possible feasible delivery systems (sending the medicine to where it is needed), (geographical) locations of delivery, speed of manufacturing of the vaccine or drug, but also any other critical factors your team considers necessary as part of the model to optimize the eradication of Ebola, or at least its current strain. In addition to your modeling approach for the contest, prepare a 1-2 page non-technical letter for the World Medical Association to use in their announcement.

Sample Problems: The B Problem — Discrete Mathematics

2005 Problem B: Tollbooths

Heavily-traveled toll roads such as the Garden State Parkway, Interstate 95, and so forth, are multi-lane divided highways that are interrupted at intervals by toll plazas. Because collecting tolls is usually unpopular, it is desirable to minimize motorist annoyance by limiting the amount of traffic disruption caused by the toll plazas. . . . Upon entering the toll plaza, the flow of vehicles fans out to the larger number of tollbooths, and when leaving the toll plaza, the flow of vehicles is required to squeeze back down to a number of travel lanes equal to the number of travel lanes before the toll plaza.

Make a model to help you determine the optimal number of tollbooths to deploy in a barrier-toll plaza. Explicitly consider the scenario where there is exactly one tollbooth per incoming travel lane. Under what conditions is this more or less effective than the current practice? Note that the definition of "optimal" is up to you to determine.

Sample Problems: The C Problem — Modeling with Data Insights (1-4)

2018 Problem C: Energy Production

Background: Energy production and usage are a major portion of any economy. In the United States, many aspects of energy policy are decentralized to the state level. Additionally, the varying geographies and industries of different states affect energy usage and production. In 1970, 12 western states in the U.S. formed the Western Interstate Energy Compact (WIEC), whose mission focused on fostering cooperation between these states for the development and management of nuclear energy technologies. An interstate compact is a contractual arrangement made between two or more states in which these states agree on a specific policy issue and either adopt a set of standards or cooperate with one another on a particular regional or national matter.

Sample Problems:
The C Problem — Modeling with Data Insights (2-4)

2018 Problem C: Energy Production

Problem: Along the U.S. border with Mexico, there are four states, California (CA), Arizona (AZ), New Mexico (NM), and Texas (TX), that wish to form a realistic new energy compact focused on increased usage of cleaner, renewable energy sources. Your team has been asked by the four governors of these states to perform data analysis and modeling to inform their development of a set of goals for their interstate energy compact. The attached data file "ProblemCData.xlsx" provides in the first worksheet ("seseds") 50 years of data in 605 variables on each of these four states' energy production and consumption, along with some demographic and economic information. The 605 variable names used in this dataset are defined in the second worksheet ("msncodes").

Sample Problems:
The C Problem — Modeling with Data Insights (3-4)

2018 Problem C: Energy Production

Part I.

A. Using the data provided, create an energy profile for the four states.

B. Develop a model to characterize how the energy profile of each of the four states has evolved from 1960 – 2009. Analyze and interpret the results of your model to address the four states' usage of cleaner, renewable energy sources in a way that is easily understood by the governors and helps them to understand the similarities and difference between the four states. Include in your discussion possible influential factors of the similarities and differences.

C. Determine which of the four states appeared to have the "best" profile for use of cleaner, renewable energy in 2009.

D. Based on the historical evolution of energy use in these states, predict the energy profile of each state, as you have defined it, for 2025 and 2050 in the absence of any policy changes by each governor's office.

Sample Problems:
The C Problem — Modeling with Data Insights (4-4)

2018 Problem C: Energy Production

Part II.

A. Based on your comparison between the four states, your criteria for "best" profile, and your predictions, determine renewable energy usage targets for 2025 and 2050 and state them as goals for this new four-state energy compact.

B. Identify and discuss at least three actions the four states might take to meet their energy compact goals.

Part III.

Prepare a one-page memo to the group of Governors summarizing the state profiles as of 2009, your predictions with regard to energy usage absent any policy changes, and your recommended goals for the energy compact to adopt.

Qualities of a Good Paper

From the "2018 MCM Problem A Triage Judging Guidelines"

"Key quality indicators in team papers include:

- proper applications of mathematics and science,
- depth of exploration,
- completeness of a recognized modeling process,
- proper reliance upon and documentation of supporting research,
- innovative and insightful modeling approaches, and
- clear and concise exposition,

among others."

Final Judging: The Final Judging Rubric

A Sample Final Judging Rubric

The panel of Final Judges creates a rubric to fit their particular problem adjusting categories and points as needed. A starting rubric appears below.

Document Number:						
Executive Summary	Assumptions & Justification	Model / Value Added	Sensitivity / Stren & Weak	Required Documents	Clarity of Writing	Total
10	15	40	15	10	10	100
Comments/Notes:						

How to Become a Judge

If you are interested in joining the adventure by becoming a Triage Judge, and can commit to scoring papers during a six week period (roughly averaging one hour per day) beginning early February, ...

then send an email to either

Prof. Kelly Black
A Problem Head Judge
(continuous)
University of Georgia
kjblack@gmail.com

Assoc. Dean Robert Burks
B Problem Head Judge
(discrete)
Naval Postgraduate School
reburks@nps.edu

Dean David Olwell
C Problem Head Judge
(data insights)
Saint Martin's University
dholwell@me.com

Thank You

MCM/ICM Website at COMAP
https://mcmcontest.com/

2021 MCM Announcement
- 5:00 pm EST Feb 4, 2021 to 8:00 pm EST Feb 8

https://www.comap.com/undergraduate/contests/mcm/flyer/2021_MCM-ICM_Flyer.pdf

These Slides
https://mathsci2.appstate.edu/~wmcb/JMM/2021/

Slides from Advisors Presentations
https://mathsci2.appstate.edu/~wmcb/JMM/2019/