THE CONSORTIUM FOR
MATHEMATICS AND
ITS APPLICATIONS

2019 MCM Problem A
Triage Judging Guidelines

Purpose and Background

The Mathematical Contest in Modeling (MCM) and ***The Interdisciplinary Contest in Modeling (ICM)*** both rely on a Triage Judging and Final Judging process to identify seven classes of participant performance – Disqualified, Unsuccessful Participant, Successful Participant, Honorable Mention, Meritorious, Finalist, and Outstanding – based on the technical reports submitted under the MCM/ICM contest rules (http://www.comap.com/undergraduate/contests/mcm/instructions.php).

Final Judging is the culminating process whose purpose is to identify the papers that will be designated as Finalist or Outstanding. Prior to this event, Triage Judging in the United States and China efficiently ranks and categorizes each MCM/ICM submission based on desirable characteristics and content established over years of MCM/ICM operations, and upon the peculiarities of each problem.

Overall, the MCM/ICM supports and advocates an iterative mathematical modeling process consisting of major elements that include:

- Problem Restatement,
- Assumptions & Justifications,
- Model Construction and Application,
- Model Testing and/or Sensitivity Analysis,
- Analysis of Strengths & Weaknesses.

Papers that contain major elements in sufficient detail to address the problem posed receive higher recognition from judges.

The triage process relies on the professional expertise, experience, and judgment of academic faculty and industry professionals supporting the administration of the MCM/ICM to read and recognize key quality indicators in team papers – 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. As noted frequently in UMAP Journal articles, elements such as these are universally valued among modelers, and are hallmark ingredients expected of top papers,.

While it is impossible to list all potential contributors to such quality, it is possible to note items that, if not present, will limit a paper's quality from the viewpoint of the MCM/ICM. While not claiming to be all-encompassing in its attempt to identify such limiting criteria, this memo will hopefully provide enough information to create a consistency in judgment despite extreme geographical and temporal separation of triage sites.

Triage Judging

In the Triage round we seek to cull out papers that do not have a chance at being Meritorious or Outstanding. In general we have percentage target levels we are planning to keep for final judging, but we always have to make some adjustments as we go through the process.

The judging of student team submissions uses seven paper classifications: Disqualified, Unsuccessful Participant, Successful Participant, Honorable Mention, Meritorious, Finalist, and Outstanding. The classification for each MCM/ICM paper is relative to the pool of papers received each year.

General guidelines and percentages for each category are as follows.

Disqualified (DQ) (% as warranted): the team's paper was found to be in violation of the contest rules. The rule violation should be noted in the comment column (e.g. "plagiarism," "same as paper xxx") and scored as 0. The MCM/ICM contest directors will review and verify all papers designated as disqualified (DQ).

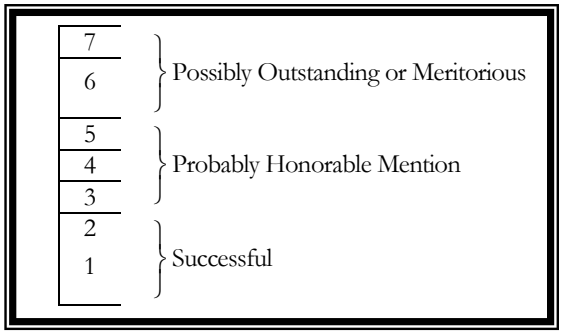
Unsuccessful Participant (UN) (% as warranted): the team's paper did not respond to any of the requirements of the contest problem, but did not violate any of the contest rules. A simple explanation of the failings should be noted in the comment column (e.g. "No modeling") and scored as 0. The MCM/ICM contest directors will review and verify all papers designated as unsuccessful (UN).

Successful Participant (P) (% as warranted): the team made an attempt at the problem and successfully submitted their paper. However, their overall paper is best described as fair to average, and possibly contains an incomplete modeling process or solution, and mathematical or logical errors. Scored as a 1 or 2.

Honorable Mention (HM) (% as warranted): the team submitted a complete, acceptable modeling approach and solution, but their solution contains at least one detractor, deficiency, or error that prevents it from being classified as Meritorious or Outstanding. Scored as 3, 4 or 5.

Meritorious (M) (10%): the team's paper represents an exemplary modeling approach, but their solution may contain minor errors or issues in logic, calculation, modeling, or assumptions. Scored as a 6 or 7.

Finalist (F)/Outstanding (O)(<1%): the team's paper represents an excellent modeling approach and a solid solution, including demonstrating an ability to clearly and concisely communicate their process, results, and conclusions. Scored as a 7.



Triage judging sessions are designed to accomplish a crude categorization of the papers. In the time allotted to each paper (no more than 15-20 minutes and 10-15 minutes on average), judges assess whether the required elements of the modeling process are addressed, and whether the teams have answered the questions posed in the problem statement. Judging during the triage sessions use a 7-point scale shown to the left to achieve the desired categorization. What makes this possible is the mindset of triage judges to primarily look for the very top papers and not try to fully evaluate every part of every paper. Don't be afraid to establish separations between quality levels with these numerical scores. Each paper is given 2 reads during the triage judging, so each judge is responsible for half the triage decision to have the paper forwarded to final judging or not.

The head judge culls approximately 60-80% of the papers after the triage round and take the remaining papers to final judging.

Triage Judging Notes

If you find a paper you are assigned to read is missing, damaged or incorrect, note the paper number and notify your head judge so that COMAP can check for the correct paper.

If you find that a team included any distinguishing information such as school name or student names, read the paper as normal and grade as normal, but add a note to the comment column (e.g. "includes school name on page xxx," "includes student name on page yyy").

If you find that a paper has gone over the assigned paged limit, read the paper as normal and grade as normal, but add a note to the comment column (e.g. "paper exceeded the assigned page limit").

Triage judges are encouraged, but not required, to include comments on their grading sheet. It could be as simple as a few words (e.g. "great assumptions"), or a sentence justifying the papers score (e.g. "fatal logic flaw on page zzz").

Problem Specific Guidance: Problem A (2019):

While it is always important for teams to provide a clear set of assumptions on MCM problems, it is even more critical this year on the A Problem. The teams are attempting to define the basic biology of fictitious dragons as well as the basic mechanics and behavior of the animals as described in the problem. Based on the assumptions that teams make, it is possible for teams to develop diverse modeling approaches, reach a wide range of conclusions, and produce results that differ dramatically from one paper to the next.

- Student teams should explicitly state their assumptions when developing their mathematical model for this problem, and they should make clear how these assumptions drive their modeling approach and limitations. Teams that do so should score higher than those who do not.
- A team that does not clearly state their assumptions and does not make it clear how their assumptions impact their modeling or its results should receive no higher than a 4 during triage.

The questions appearing in the problem can be divided into two parts. The first part focuses on developing a mathematical model to assess the biological needs and impacts of dragons. The second part extends the model to determine the impact of climate variability on a dragon. Teams are asked to explicitly address the second part in their two-page summary, although many will also integrate this into their main report as well. Part 1 questions must be answered in order to answer Part 2.

A team that does not address the Part 2 question concerning climate variation on dragons can receive a score no higher than 4 during triage.

Part 1: Modeling the biological needs and impacts of a dragon

The first part of the problem includes four broad questions. Each question is given below including notes about the expectations for each question.

Question One:

"First, what is the ecological impact and requirements of the dragons?"

- This question about the ecological impact is vague, and it may be distributed throughout a paper over different sections. Note that by answering the other questions they will implicitly answer this part of the problem. Be flexible in how you interpret the teams' response to this question.
- A team that does not address this question should not receive a score greater than 5 during triage.

Question Two:

"What are the energy expenditures of the dragons, and what are their caloric intake requirements?"

- This is a central question required for all of the other questions.
- Teams that fail to address and answer this question should receive a score no higher than 3 during triage.

Question Three:

"Also, how much area is required to support the three dragons?"

- This is an important question but has a lower priority than question two.
- The team does not have to provide specific land areas but should indicate the scale of land required for a dragon. The highest rated submissions should provide a discussion on how the land requirements change as a dragon grows.
- Teams that fail to address and answer this question should receive a score no higher than 4 during triage.

Question Four:

"How large a community is necessary to support a dragon for varying levels of assistance that can be provided to the dragons?"

- This question is the lowest priority of the four questions.
- The response to this question depends on a number of assumptions about the productivity of a community, and those assumptions should be made clear.
- Be flexible in how you rate a team's response to this question, and the answer does not necessarily require a great deal sophistication. Given the responses to the previous questions a team can provide a simple answer based on simple assumptions about the community in question.
- Teams that do not address this question concerning the area required or do not address the question about how large a community is necessary to support a dragon should receive a score no greater than 5.

Part 2: Extending the base model to determine the impact of climate variation

The second part of the problem requires each team to extend their model to account for wide variations in climate. The two page summary relies on the resulting analysis, and a team that does not adequately address this part of the problem should not receive a score greater than 5.

Aspect One:

"How important are the climate conditions to your analysis?"

- Like the questions in the first part of the problem, this question relies on a team's assumptions and should be consistent with their clearly stated assumptions.
- Teams that do not address this question concerning climate variation should receive a score no higher than 4 during triage.

Aspect Two:

"In particular, you should draft a two-page letter to the author of the original series, George R.R. Martin, to provide guidance about how to maintain the realistic ecological underpinning of the story especially with respect to the movement of dragons from arid regions to temperate regions and to arctic regions."

- This is a vital aspect of the problem. It requires students to supply a succinct and appropriate summary of their efforts.
- Teams that do not provide this required two-page summary should receive a score no higher than 4 during triage.

Aspect Three:

"Aside from the modeling activities themselves, describe and discuss a situation outside of the realm of fictional dragons that your modeling efforts help inform and provide insight."

- This question is different than the others. Teams can potentially answer this question in a host of ways, and you should give them a good amount of leeway as to how well they answered this.
- Teams that fail to address this question should be penalized 1 point from their triage total.

Finally, because the problem is dealing with a fictitious animal, it is possible that teams may be able to fall back on the presence of "magic" to explain some difficult modeling elements, behavior, or results. Given the context for the problem it may be acceptable to rely on this to a small extent.

- Teams are expected to strive to make the greatest use possible of real world limitations because the problem is casting fictional animals in a real world setting.
- Teams that use supernatural phenomena beyond simple measures should receive lower scores than those that work directly with real world phenomena.
- Teams that make use of a supernatural method for dragons to store and release energy should not be penalized during triage.
- Teams that make extended use of a supernatural method to obtain or create energy, though, should not be awarded a score greater than 4 during triage.

General Modeling Guidelines:

In addition to the scoring guidance above, some general guidelines associated with mathematical modeling and report writing should be followed. For example, students should make their assumptions clear as mentioned previously. They should also provide both citations and references to support their work.

- Papers without citations should be given a 1 point reduction in their score.
- Papers without references should be given a 1 point reduction in their score
- Papers that fail to clearly address their model's strengths and weaknesses should receive a 2 point reduction in their score.
- Papers that lack a discussion on sensitivity analysis should receive a 1 point reduction in score. This discussion can be a rudimentary discussion and exploration of sensitivity without a full analysis, but it should be present in at least a basic form.
- A paper in which many of the equations are given without description, development, or motivation should not receive a score greater than 2.
- A paper that displays a consistently poor use of grammar, misspellings, or incomplete sentences should receive a 2-point deduction from their score.
- A paper that includes figures that are poorly formatted, lack proper annotations, or lack captions should be given a 1-point reduction.
- A paper that includes figures without accompanying discussion or description within the narrative of the figures should be given a 1-point reduction.

The contest instructions say: "…a summary should clearly describe your approach to the problem and, most prominently, your most important conclusions. Summaries that are mere restatements of the contest problem or are a cut-and-paste boilerplate from the introduction are generally considered to be weak."

Besides the summary sheet as described each paper should contain the following mathematical modeling elements:

- Problem Restatement
- Assumptions & Justifications
- Model Construction and Application
- Model Testing and/or Sensitivity Analysis
- Model Revision
- An analysis of Strengths & Weaknesses.

These need not appear in stand-alone sections, but must be addressed somewhere in the paper for the team submission to be considered a complete modeling effort.

Papers that omit any of the five elements above can be scored no higher than a 4 during triage.

The Final Judging Sessions (for information only for triage graders)

The final judges develop a rubric for each problem and customize it to the problem being judged and the set of papers present. After the triage event, judges have a better idea of how the top papers they have read are addressing the problem and what elements are evolving to set papers apart from each other. This knowledge provides the basis for refining the rubric prior to the last judging session to pick the Outstanding papers. We usually have 4 or 5 rounds of final judging where approximately 50% of the papers are culled in each round.

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