**Solution Paper Template**

To give teams a running start, this outline for solution papers is provided as a potential way to organize your paper. It includes brief comments and advice for teams.

It is not required that teams use this template. It is provided only as a sample, for teams’ consideration of how you might organize your work.

This template is a Word doc for ease of use. If your team decides to use it, **remember to format and save your file as a PDF before uploading as your M3 submission**.

# Title of Your Choice - Summary

This is also known as the “Summary” or the “Executive Summary”

This is an important part of the paper. It lets the reader know what to expect and demonstrates your ability to communicate your methodology and modeling results concisely. As quoted from the M3 Challenge guidelines:

SUMMARY of results must be at the first page of your solution paper, clearly identified and not more than one page in length. It should be a concise, straightforward explanation of the main results and answer the questions posed, written with minimal use of technical language. Judges will not read past a poorly written summary.

The summary must briefly hit all the main points and ideas of your paper as well as describe the mathematics you used. If you did anything creative, include a brief description. Do not forget, the numerical results need to be included in the summary: “Our model predicts that by the year 2034, 98% of widgets will no longer be in use”.

The summary should be written last so that you know what you are writing about and have the bigger picture of the implications of your findings. The summary (and ideally the whole paper) should be written collaboratively, as a team.

Keep in mind that the summary is the first thing your reader will encounter, so you’ll want to put your best foot forward. Make sure you allocate time to proof-read it carefully.

Table of Contents (optional)

*Write a basic table of contents here. While not required, it often helps to have this page to organize the document both for the team and the judge. Note: if you are already close to the page limit (20 pages max), then a table of contents is not needed.*

Title of Your Choice

# Introduction

In the introduction, you want to restate the problem *as you interpret it.* Different teams may interpret certain aspects of the challenge question differently. Clearly explain your team’s notion of the problem statements. The introduction is also a place to give a little more background and motivation about the underlying real-world problem.

# For each of Questions 1, 2, and 3

The purpose of a mathematical model is to predict how some real world system will behave and to help to understand it. For *each question* in the challenge, there should be a section to describe the mathematical models. Most question write-ups can be broken down into three parts: the models, the solutions, and a discussion of the findings. Each of those may have subsections, depending on how you decide to organize things.

**The Model**

When describing the model, you need to state your assumptions, define your variables, state any parameters you are fixing to specific values, describe the mathematical relationships, processes, functions, or components that are the building blocks of your model. Make sure you explain why you made the modeling decisions you did, including how you decided which factors were most important and which ones you would leave out. You may choose to make those subsections as necessary. **Throughout, be sure to cite any sources you used to find information (refer to the References section below for more guidance)**.

**Solution(s)**

For each question, there must be a description of how the model was used to answer the driving question. Did your model determine a ranking system? Did you solve an equation using software? Did you write a computer program to serve as a simulation tool? Did you evaluate a function that you created over a specific set of scenarios?

Here, you will actually present the results, so you need to decide the best way to do that. Do you need separate sections that describe how your model works for different cases? Should you use a graph or a table? Point out the general trends and any exceptions to the rules.

**Discussion**

Here you need to explain the implications of your model. What did the model reveal about the underlying problem? What conclusions can be made using the model?

Identifying strengths and weaknesses of the model is a great way to go over the key things – explain the good and bad points of your approach. Your model will be viewed more favorably if *you* identify weaknesses; it shows that you have considered other aspects that you didn’t necessarily have time/computational tools to consider. A few words about other possible approaches may also be useful. What would you do if you could work on this problem for the next few months? Were there any algorithms that you thought would be great, but just could not implement on the computer? Time is very limiting, so this is a place to show that you can see the big picture.

**Sensitivity Analysis (Optional but encouraged when possible)**

If you have the time or opportunity to thoroughly explore the parameters of your models, you should demonstrate that and explain what was learned. How dependent are the results on the parameters you used? If you change your assumptions slightly, does it have a big impact on the results? This is a chance to show you have probed all aspects of your model as best you could.

# Conclusions

Summarize the main results, even though you just presented it in detail above. What are the main take-away messages of your investigation?

# References

Don’t forget to reference any resources that you use. You’re going to spend a lot of time digging through books and web pages looking for things that work. Every time you find something MAKE A NOTE! You’ll come up with some original ideas of your own of course, but most of what you’ll do is take existing ideas and adapt them to your particular problem.

* **At the end of your paper:** A list of all references used should be placed at the end of the paper in a bibliography or references page. No particular citation style is required so long as you are consistent.
* **Throughout your paper:** When a quote, figure, equation, statistic, paraphrased idea, insight, or any other information from a source is used/mentioned in your paper, it should be marked with an in-text citation, such as (Simmons 2002) or simply [17], referring to the full list of references at the end. This citation should indicate exactly what bibliography entry is being used, and it should be accompanied by a clear explanation or summarization of what information was used from the cited source. Any standard citation format is acceptable, just be consistent throughout the paper.

When you use someone’s idea without including a reference, that’s called PLAGIARISM! Even if you’re not stealing words, but just ideas, that’s still plagiarism, so don’t do it!

# Code Appendix (optional)

Writing code is not required for competing in the Challenge, but if you want to be eligible for the Technical Computing Scholarship Award (for coding other than spreadsheets), you must include your code as an appendix to your submission. Those appendix pages will NOT count towards your 20 page limit. Note: During your work time on Challenge weekend, if you write and include code, remember to **check the “Technical Computing” box on the upload page** to have your appended code considered for the extra credit Technical Computing Scholarship Award.

While code should be attached as an appendix, it must be clearly explained (at a “big picture” level) **in the main text of the report**. What is the purpose of the code written and how does it help answer the challenge question?

Considerations about the code itself:

* Variables should have meaningful names.
* Code should use consistent indentation for easy readability.
* Code should have comments included that describe how the code works.