M3C 2013 Guidelines and Modeling Problem

The 2013 contest problem is on page 2 of this document. Page 1 includes tips and guidelines for your successful submission.

Team identification numbers

To anonymize the judging process, each team will be identified by a number instead of teammate names. During Friday evening, Stefan Doboszczak will email each team with a number that **must** be included on the title page of submitted solutions. This number is the only identifying information that judges will be given.

Solution layout

M3C solutions should be written up as a complete, self-contained paper in the style of a journal article or research project. It is suggested that solutions contain the following sections: **title page**, **abstract**, **introduction** (including background info), **problem description**, **model specification**, **model assumptions**, **results**, **model analysis** (strengths and weaknesses), **conclusion**, **code appendix**, **works cited**.

- The title page should contain your paper title and team number. No names!
- Abstracts should we well-written and engaging. This might not make a large difference for the local competition, but it is a critical part of doing well in the international MCM.
- No model will be perfect, especially one made in the limited time available. Therefore, it is crucial that your writeup of model assumptions, strengths, and weaknesses be thorough, honest, and insightful.
- Include all code you wrote yourself in the code appendix. If you make use of publicly available software libraries, include links to them (but *not* their content) in the appendix as well.
- Works cited can be in any standard format, as long as it is consistent and includes all information. **Include proper in-text citations**.
- There are useful contest links on the M3C website (www.norbertwiener.umd.edu/Education/m3c.html).

Submitting solutions

The 2013 M3C ends at 10:00 AM on Monday morning. Please bring a single printed copy to Matt Guay's office (MTH 2121, near the central rotunda of the math building) **no later than 10 AM**. If you need access to a free printer, come to MTH 2121 after 9 AM but prior to 10 AM to print it from an electronic copy.

If printing in black-and-white, make sure that no important details from color figures are lost.

Contact information

During the course of the competition, competitors are not allowed to discuss their work with or seek help from people outside of their team. However, if you need any clarification on a problem or otherwise need to relay competition-related information, email Matt Guay at matt.d.guay@gmail.com.

MERS - Disease and Containment Modeling

From the CDC website: (http://www.cdc.gov/coronavirus/mers/)

> Middle East Respiratory Syndrome (MERS) is viral respiratory illness first reported in Saudi Arabia in 2012. It is caused by a coronavirus called MERS-CoV. Most people who have been confirmed to have MERS-CoV infection developed severe acute respiratory illness. They had fever, cough, and shortness of breath. About half of these people died.

This new virus, first reported in September 2012 in Saudi Arabia, has interesting properties which make modeling its global risk a challenge.

- The risk of person-to-person transmission is low but non-negligible. The Hajj pilgrimage to Mecca, Saudi Arabia draws enormous numbers of people annually from around the globe and places them close to outbreak centers. Umrah pilgrimages draw travelers year-round into the same area.
- The virus appears to have originated in bat populations in the Middle Eastern peninsula, which carry a genetically diverse coronavirus load. Further mutations could introduce more virulent strains to humans and pose severe epidemic threats in the future.

Fortunately, modern epidemic containment measures have evidently helped to keep new infections from spreading too widely. But, how lethal would this virus be without them?

Modeling challenges:

Solutions are expected to address Questions 1, 2, and 3. The (a) and (b) subproblems are elaborations which can be attempted for an added challenge (and better ranking!), but it is not required to address them all.

1. Model the global spread of MERS, assuming no prophylactic measures are taken (face masks, increased hand washing, quarantine, etc.). Pay special attention to the effects of the Hajj and Umrah pilgrimages on your infection model. Without epidemic prevention strategies, is the transmission risk low enough to avoid a pandemic?

   (a) Do regional differences in geography or lifestyle (culture, socioeconomics, etc.) put certain parts of the world at an elevated risk for disease spread?

   (b) Global social networks exhibit complicated network topologies. Does your model attempt to approximate this structure in a systematic way? How so?

2. How can your model from Question 1 be modified to account for modern epidemic prevention measures? Run your model with these changes and explain how the results compare with observed infection data from the past year. What is the effect of realistic levels of noncompliance?

   (a) Can your model account for regional differences in disease response protocol? For differences in compliance rates? Which regions are at an elevated risk for infection despite prophylaxis?

3. Suppose a mutation created a coronavirus with a similar disease profile to MERS but higher rates of person-to-person transmission. What do your models (both non-prophylactic and prophylactic) predict would happen in case of a "small" increase in transmissibility? Justify your definition of a "small" increase.