Brown Mathematical Contest for Modeling
Solution due Sunday, November 9th at 10am

Choose one of the two problems proposed below. Submit your model report and anything else that the problem might ask for in a zip file to bmcm@brown.edu by **Sunday, November 9th at 10 am**. Reports received after this time will not be considered.

Your report should start with a cover sheet page that includes the following information: names of your team members, title of your report, and which problem you chose to solve. The rest of the pages in your report **should not include your team members' names**. Remember to reference your sources at the end of the report.

Problem 1: Short-term Refugee Camps

The conflict in Syria has displaced half its population from their homes. Millions are living in refugee camps in Syria, while hundreds of thousands of others have flooded the borders of other nations. Coupled with refugees from other countries in unrest, this situation has been termed a global refugee crisis.

This weekend, you have the opportunity to provide insight into this crisis. In this problem, you are asked to design a set of temporary refugee camps while balancing the logistical upsides of a large central camp with the safety, security, and sanitation benefits of smaller decentralized camps.

Whenever people are displaced from their homes, the United Nations High Commission for Refugees (UNHCR) plays a leading role in designing, building, staffing, and maintaining refugee camps. In your role at the UNHCR, you have been asked to develop a proposal for a set of camps to house 100,000 refugees who are expected to arrive in less than a week; therefore you must submit your plan to your boss at UNHCR in 41 hours. Your proposal should consider a variety of factors, such as:

- Size of camps and number of camps;
- Layout of the camps;
- Distribution of the camps;
- Security of the camps from external threats;
- Safety of refugees, especially women and children;
- Delivery of food and water to refugees;
- The number and role of staffers needed to run the operation.

You must report the total cost of your proposal for the initial set-up of the camps and the ongoing cost to keep the camps operational for the next 6 months. Another team at UNHCR will be responsible for procuring the land you need, so you do not need to consider the cost of land procurement in your proposal. In addition to having relevance in the current refugee crisis, your work has the potential to be broadly applicable; it could be used in the future when setting up camps for those displaced by natural disasters.

Besides your model report, you must present to your boss at UNHCR a half-page non-technical summary of your proposal to be released to the press.

Problem 2: The Hanta Virus

The Hanta virus killed several people in the Four Corner regions of the United States in 1993. You are a World Health Organization (WHO) worker going to combat a new outbreak in a different region of the world and must determine the medical requirements for your unit. In particular, you want to come up with a scheme to help your team determine:

- When patients became infected, and
- How quickly they need to be treated,

based on when they started experiencing symptoms.

You know a few facts about the Hanta virus. If just one copy of the virus enters a human body, it can start reproducing very rapidly. In fact, the virus can double its numbers in one hour! The human immune system can be quite effective, but this virus hides in normal cells. As a result, the immune response doesn't begin until the virus has one million copies floating around in the body.

One of the first actions of the immune response is to raise the body temperature, which lowers the virus replication rate to merely 150% per hour. The fever and flu-like symptoms are usually the first indication of illness. Some people with the virus assume that they just have the flu or a bad cold, so they do not report the symptoms until late. This assumption leads to deadly consequences, since the immune response alone is not enough to combat the virus. At maximum reaction, the immune system can only kill 200,000 copies of the virus per hour.

To fully combat the illness, the infected person must receive an injection and hourly doses of a special antibiotic. The antibiotics do not affect the replication rate of the virus (the fever keeps it at 150%), but the immune system and the antibiotics together can kill 500,000,000 copies of the virus per hour. If these antibiotics are not started before the number of copies of the virus in the body reaches one billion, the virus cannot be stopped. When the virus reaches one trillion copies, the person will die.

In your role at the World Health Organization, you have been asked to model the different time phases of the illness. Your supervisor expects you to construct and analyze your model in 41 hours. In your report, you must describe how long it will take for the immune response to begin, and how much time a person has to get help from medical authorities. You must include assumptions, strengths and weaknesses and should comment on how reliable your results are. Your report should describe how your team can make use of your model when approached by more than one patient at a time.

Besides your model report, you must present to your supervisor and your team a half-page non-technical summary of your plan to be released to the press.