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SCUDEM 2017 Problem A - Going Viral

Advertisers strive to reach the greatest number of people using the least amount of resources. The prevalence of social media and easy access to digital media has resulted in the development of strategies to create advertisements that go "viral." Advertisers want a large number of people to share their message in ways that the number of people seeing the message grows rapidly in a short time.

This has been done in a variety of ways. One way is to target specific groups of people who are known to have broad audiences that can spread a message quickly. Another way is to make an advertisement available to a great number of social media outlets in a short time span. The hope is that the advertisement will be shared by enough people that the sharing itself will gain momentum and increase rapidly.

A good deal of research has been conducted to model the way information spreads. Many of these models focus on the structure and size of the network of people. In practice the networks of people are already established and can be vast and quite complicated. Is it possible to construct a simpler model that can describe the way the number of people are exposed to an idea and predict viral growth?

In particular, an advertising company would like to know the minimal amount of resources that can be spent and result in a rapid expansion of the number of people exposed to a message. For example, is there some minimal number of people who must be exposed to their message in a short time to cause the message to go viral? If an advertisement does not go viral quickly after release how likely is it that it will never go viral, or is it possible to add resources in a way that can promote an advertisement so that it does go viral if at first it does not appear to be successful?

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Supplemental Issue for Problem A - Going Viral

An organization is considering using your model but wants a change. They want to also have a prediction as to how long it will take for the information they want to spread to hit the peak transfer rate. They want the model adapted so that if the methods in use will not result in a quick dissemination they can make changes to the approach to insure that the information is spread more rapidly. Determine what should be monitored, and how that additional information can be used to make changes to the recommendations.

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SCUDEM 2017 Problem B - Drug Interactions

Patients undergoing medical treatment may be given a combination of drug therapies, and the information about the interaction between drugs can be limited[1]. One commonly prescribed class of drugs is diuretics which promote kidney function as a way of removing water and sodium from the circulatory system. The way that a diuretic can interact with other drugs can be quite complicated and depends on the type of diuretic.

We ask that you examine the simpler issues of the reduction or removal of a compound from within a patient's system. A drug can be reduced within a patient's system in several different ways. For example, it can be metabolized and broken down within the liver, and a patient's kidneys can directly remove it from the bloodstream.

You are asked to provide an analysis that will give direct guidance for the administration of a drug. The patient will be given a diuretic to relieve symptoms associated with heart disease. At the same time a patient will be given another drug to help treat other symptoms. The goal is to maintain a consistent level of both drugs within a patient's circulatory system.

The issue is that the diuretic will promote a more rapid removal of both drugs from the patient's system, but at the same time the other drug must be maintained at levels that are effective and safe. The medical staff would like to know how to balance the administration of the two drugs. They need to know what schedule and what dosages are appropriate for a given situation.

Egger, S. S., J. Drewe, and R. G. Schlienger. 2003. *Eur. J. Clin. Pharmacol*. 58: 773-778. doi:10.1007/s00228-002-0557-z.

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SCUDEM Supplemental Issue for Problem B - Drug Interactions

As part of the treatment a patient may be given additional fluids to counteract the loss of fluids due to the diuretic. Some patients will be given the additional fluids using an intravenous fluid therapy, and the fluids will be introduced at a relatively constant rate. Other patients will be asked to drink large amounts of water at regular time intervals. Adapt your model to be able to predict what will happen when the concentrations of the drugs can change due to different rates of water intake.

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SCUDEM Problem C - Game Play

A new game is proposed for a hand-held device. The game needs to be relatively simple and the computational resources required must be kept small. The proposed game is a network based game, so two players can play at the same time on their separate devices.

The concept is that there is an animated ping pong ball that moves through an obstacle course and its motion is controlled in turn by the two players. The first player moves a paddle to hit the ball into the obstacle courses. When the ball reaches the other end of the obstacle course the second player must move a paddle to return the ball to the first player who then maneuvers the ping pong ball back to the second player on the other end of the obstacle course. The process repeats until a player is unable to return the ball, thus giving the player who misses one point. Much like table tennis when a player reaches 21 points and the margin in points is 2 or more the player with the higher points loses and a winner is declared. Service alternates and either player can score on service.

The ping pong ball must move in two dimensions, left- right and forward- backward. The ball is exposed to friction so it will slow down if no other forces act on it. The players can provide a boost by pushing the ball with a force that can be forward or backward and a force that can be left or right. The player must use the forces to move the ball through the obstacle course as quickly as possible while avoiding any obstacles.

You are asked to develop the system of equations that describe the motion of the ping pong ball. You should also provide recommendations to the software developers. They need to know the levels of force necessary to make the game interesting, yet still playable. They also need to know what limitations should be put in place so that the game will be challenging, but not too easy. For example, there should be a limit on the amount of propellant available to apply force to the ping pong ball. The developers want players to develop a strategy on how to use the limited propellant allowed. Since these decisions depend on the number and size of the obstacles you should also provide recommendations about the obstacle course and overall game play that will make the experience as enjoyable as possible.

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SCUDEM Supplemental Issue for Problem C - Game Play

Provide an analysis of which of the possible factors of the game result in the biggest changes for small changes. For example, does a small change in the number of obstacles have a large impact on the game? Does a small change to the amount of propellant make a big difference? Use your analysis to augment your report to indicate which factors will require the most testing and review.