SIMULATION ASSIGNMENT

20 points; due Tuesday, April 16

This assignment guides you through an exploration of various aspects of simulating complex systems using computers. Type your answers to the numbered questions in a word processing document, which you will submit for a grade.

Part I: Elevator simulation (queuing system)

Load the elevator simulation at:

http://euclid.huntington.edu/cs111/elevator.php

1. Let the simulation run for one minute with the default parameters. What is the average waiting time? How many people did the elevator serve? What was the maximum elevator load?
2. What is the average waiting time if the building has only 5 floors? (Keep all other parameters the same.)
3. Set the simulation to the following parameters: people arrive at *medium* speed, elevator speed is *very fast*, elevator services floors at *medium* speed, and elevator capacity is 10. How many floors can the elevator service if the maximum acceptable waiting time is 8 seconds?
4. Suppose the building has 10 floors, people arrive *very fast*, elevator moves *very fast*, and elevator services floors at *medium* speed. What minimum capacity should the elevator have so that it never (or hardly ever) gets full?
5. Suppose the building has 12 floors, elevator capacity is 10, people arrive *very fast*, the elevator moves *fast*, and the elevator services floors at *medium* speed. What happens as the simulation runs for one minute? Is this elevator adequate for this building? If the elevator is not adequate, what would you recommend to improve the situation?
6. Is this elevator simulation a continuous simulation or a discrete-event simulation? Why?
7. This simulation is designed to be fairly realistic, but all simulations have limitations. What are *three* ways in which this simulation is not realistic?

Part II: Graphics rendering

One common way of rendering computer graphics is known as *ray tracing*. Go to the Wikipedia page on ray tracing:

http://en.wikipedia.org/wiki/Ray_tracing_(graphics)

Read the first few sections of the page and look at the sample images. Then answer the following questions:

8. Give a brief summary, in your own words, of how ray tracing works.
9. What are some challenges involved in creating photo-realistic computer renderings?

Part III: Animation/Finite element analysis

Watch each of the following short videos:

- water pouring: http://youtu.be/jdnpy0FFqxU
- cloth folding: http://youtu.be/1olBMubVvMA
- materials shattering: http://youtu.be/k4tbOW5bIfw
- bullet striking aluminum plate: http://youtu.be/MI_hu7stdQM

If you are interested, you may watch more videos of similar physical simulations. Then answer the following questions:

10. What do you find realistic about such videos? What do you find unrealistic?
11. Videos such as these are often produced by a process called *finite element analysis*, in which objects are partitioned into a large (but finite) number of tiny pieces. The computer then uses mathematics to simulate how each tiny piece interacts with other pieces. Why do you think this would be challenging?
12. Why is it useful to use computer simulations of physical interactions?

Part IV: Supercomputers

Simulation of complex systems requires *very* powerful computers. Some institutions build supercomputers consisting of many thousands of processors to do tasks such as simulation. The web site www.top500.org maintains a list, updated twice per year, of the most powerful supercomputers in the world.

Go to www.top500.org and answer the following questions:

13. When was the list last updated? *Hint*: Click on *Lists*.
14. What is the world's fastest supercomputer? Where is it? How many processing "cores" does it have?

Now read the following article:

http://tinyurl.com/b25k2bq

15. How many operations can Titan process each second?
16. Titan is primarily used for what types of research?
17. A fast desktop computer today can process about 10 billion operations per second. How many times faster is Titan than a fast desktop computer?

Make sure you have answered all the questions, and then submit your answers via the Moodle site for this course.