Modeling and Simulation -- Overview

CSE 100

People have always made models of the physical world, both to better understand it and to aid in project planning. Computers can enable very complex systems to be modeled accurately.

FIT 100 Modeling The Physical World

- A computer model represents characteristics of some physical, social, or economic phenomenon, and attempts to reproduce or approximate its behavior and/or outputs in response to inputs
  - Trivial example -- the Mac's Audio CD Player, discussed as the "perfect GUI," attempts to replicate a physical CD player to aid users in understanding its operation
  - Complex example -- Boeing's 777 was designed on-line; certain parts such as the wing used sophisticated techniques computational fluid dynamics to create an "optimal" design

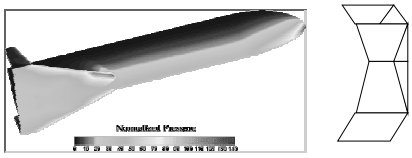
The examples have dramatically different purposes

FIT 100 Computer Modeling ...

- Physical world models are used in all areas of science and engineering, they are common in finance, production, marketing and most of business
- Modeling has the advantage that …
  - An artifact need not be created to be studied -- design
  - Complicated phenomena, too fast (explosive reactions), too tiny (molecular structure), too dangerous, or too distant (Jupiter) to observe, can be studied
  - Explanations for phenomena can be checked out before constructing an experiment or going on a field trip -- exploration
- Modeling's main disadvantage: It's only as good as the model

FIT 100 Constructing A Computer Model

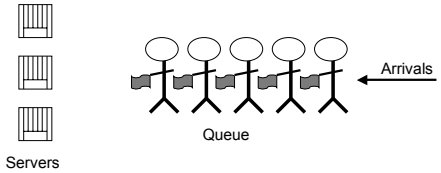
- In a model all phenomena are represented as data (mostly numbers) and all changes are realized by computations on the numbers
  - To model the atmospheric pressure of an aircraft's surface as it returns from space flight, the geometry of the plane must be represented in a computer: polygons



  - The Navier-Stokes equations for air flow must be applied

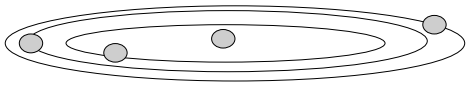
FIT 100 Simulation: Making A Model Behave

- An essential tool of computer modeling is simulation
- A bank can be modeled using simulated tellers and depositors and mathematics called "queuing theory"
- Select a random arrival rate (frequency of new customers, and service rate -- teller speed)



FIT 100 Representation

- A key issue in a simulation is the representation of the physical phenomena
- It is not necessary to give form to all aspects of the phenomena, only those features necessary for the computation



To model the orbits of the planets of the solar system, it is only necessary to know their positions in space (x,y,z) and their mass

FIT 100 Modeling And Simulation Accuracy

- A computer model is only as good as the mathematics and programming on which it is founded
- All computer models ignore features of the physical system and all make simplifying assumptions
- A computer model's predictive ability is directly related to the features ignored and the assumptions made … so, do not automatically accept a computer model any more than you would automatically accept a legal contract … Check the fine print!

FIT 100 Modeling And Simulation: Key Ideas

- Simulations will usually have some representation of time and space
  - Example: in the Game of Life, a 2-D rectangular grid of cells for space, and a step count for time
- Models are abstractions of the real world – we can't represent everything, so we pick with care the attributes of interest to represent