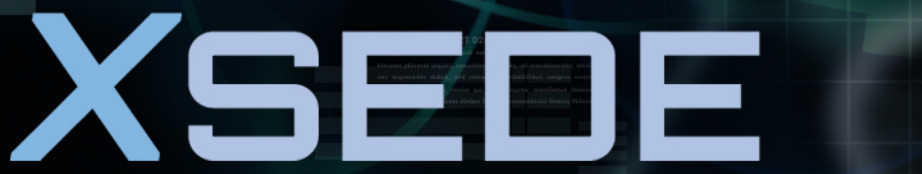
August 6, 2014

RMACC Symposium

Computational Thinking and the Curriculum



Extreme Science and Engineering Discovery Environment

Install The Software Linked Here

- https://www.osc.edu/~sgordon/RMACC

Why Computational Science?

- How science and engineering is done while emerging efforts in social sciences and humanities
  - Models allow insights when systems are too large, too small, or too complex to fully understand through experimentation
  - Reduces time to solution for many types of research and design
  - Can explore virtual environments of past and present
  - Allows exploration of wide variety of digital media
  - Facilitates research that could not be done in any other way

Computational Science Skills

- Computational science provides skills needed in the present and future workforce
  - Understanding of modeling techniques that are used in research and business
  - Analytical skills
  - Teamwork skills
  - Communications skills
- Inquiry-based education approach engages students in learning

Benefits to Students

- Inquiry-based learning is more effective than traditional lecture oriented instruction
  - Students are actively engaged in the learning process
  - Students gain deeper insights and have higher retention rates for the information
  - Facilitates the integration of information across academic disciplines – math, science, engineering, computer science

Goals for the Sessions Today

- Demonstrate the pedagogy for computational science education
- Introduce materials and models that can be incorporated for classroom use
- Introduce simple tools that can be used to build and demonstrate modeling techniques
- Discuss approaches to incorporating computational science in the curriculum

Outline for Session 1

- Using existing models to introduce modeling and science concepts
- Collections of models for educational use
- Introducing modeling tools
  - Excel
  - Vensim

Getting Started

- Point your browser here and bookmark:

- https://www.osc.edu/~sgordon
  - Choose Workshop Materials
  - Then Links to other materials
  - https://www.osc.edu/~sgordon/workshop/materials

Outline for Session 2

- More on building systems models with Vensim
- Agent based modeling
  - Overview and examples
  - Using AgentSheets
- Combining introductory programming with modeling

Building a Simple Model

- Let's now build a simple model of a rabbit population
- From the Start Menu, choose Vensim
  - Choose **File New** from the menu, **30** for final timestep, **0.125** as the increment, **Year** for time units
- We are going to add items to the sketch that represent different components of the a simple population model

Some Sketch Tools

Auxiliary Variable (constant)

Box Variable (Level)

Arrow (connects cause and effect)

Rate

Add to Your Sketch

- Box variable – label as Rabbit Population
  - Click on the tool, drag it to the open area and drop it
- Rate variable
  - Click on tool; click 2 inches to the left of Rabbit Population then click inside of the Box; name it Births
  - Click in the box and then 2 inches to the left – name it deaths
- Note that the diagram represents adding to the population with births and decreasing the population with deaths

More to Add

- Auxiliary variable
  - birth rate (under births)
  - Average lifetime (under deaths)
- Connect the components with the arrow tool
  - Birth rate to births
  - Average lifetime to deaths
  - Population to births
  - Population to deaths
- Make pull on the circle in the last two to get a curved arrow – just for aesthetics
- Save it

The Sketch and the Model

- The logic of the model is in the sketch
  - What does it show?
  - What is left out?
- Now must enter the equations
  - Click on the equations tool (second from right)
  - Unidentified items turn black
- Click on Births
  - Fill in by clicking on the variables and operators
    - Births*Rabbit Population
    - Units – type in rabbits/year

More Model

- Rabbit Population
  - Births – deaths (unit rabbits)
  - Initial value 1000
- Rest
  - Average lifetime = 8 (years)
  - Birth rate = 0.125 (fraction/year)
- Check the model
  - **Model Check Model**
  - **Model Check Units**
- **Deaths**
  - Rabbits/Average Lifetime (rabbits/year)

Run the Model

- Create the label for the run – equilibrium
- Hit enter or click on the first runner
- To see outcomes
  - Click on a variable then a tool on the side
  - Try it with the graph for Rabbit Population
  - Why did it come out as a constant?
- Change the model
  - Title to Exponential Growth
  - Click on SyntheSim (second runner)
  - Drag birth rate to 0.2
  - Click stop
  - Look at graph

Other Alternatives

- Change the constant from the sketch view
- Create an interface to play with the parameters
- Save your model

Agent Based Modeling

- Telling a story
  - The actors or agents are nouns
  - Their actions are verbs
  - Conditions are adjectives
- Simple Sick Model
- Building a model with AgentSheets

Large Scale Agent Models

- A few open source tools
  - Repast
  - Link to primer
- Very large scale models use custom programming

Other Options

- Modeling and simulation course using a high level language
  - Matlab modeling course example

Outline for Part 3

- XSEDE Resources for Education and Training
- Developing a computational science curriculum
- Other education related opportunities


Our reach will forever
exceed our grasp, but,
in stretching our horizon,
we forever improve our world.
XSEDE
Extreme Science and Engineering
Discovery Environment