# CSC 446/546 Operations Research: Simulation / Operations Research II

Dr. Sudhakar Ganti sganti@uvic.ca

# Course details

- Lectures: Tuesday, Wednesday and Friday 12:30 to 13:20PM, COR A120
- Office hours: TWF 10:30-11:30AM
- My office: **ECS 628**
- Text Book:
  - □ Discrete-Event System Simulation, Fifth Edition
     Jerry Banks, John S.Carson, Barry L.Nelson, David
     M.Nicol, Prentice Hall, 2005, ISBN: 0-13-144679-7

### **Course Website**

- Class material (Slides, Assignments etc) will be available through connex system (<u>https://connex.csc.uvic.ca</u>) for all the registered students
- Let me know of any problems you may encounter
- I will post the class slides and other material in the pdf format

# **Plagiarism**

"The action or practice of taking someone else's work, idea, etc., and passing it off as one's own; literary theft. (Oxford English Dictionary online, 2006)"

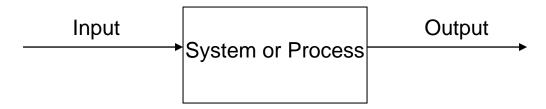
- Give credit when you use other people's content in your academic work.
- Your assignments, exams and projects must be your own original work, not someone else's.

# What the course is about?

- It is not definitely about
  - □ Flight simulations!!
  - □ or other game simulations
  - □ or Virtual reality simulations
  - □ These all are concerned with graphical emulations of some real-world or imaginary problems
    - Issues are how well you can perform graphical modeling
    - Need faster graphical processors, better I/O, cool rendering algorithms
  - Useful for training and entertainment scenarios

# What the course is about?

- It is about
  - Discrete Event Simulations
    - Will define soon what this is!!
  - Used to simulate systems or processes in order to study a particular design, it's behavior and performance characterization
  - □ The trick here is how well you capture the behavior (model) of the intended design



# Interdisciplinary

### Involves

- ☐ Statistics (Probability Theory)
  - Used to model various inputs, outputs and system behavior
  - Analyze the observed behavior
- Queueing Theory
  - Many real-life systems can be modeled as queues or network of queues
  - Analyze various Queueing systems and study their behavior
- Programming
  - Modeling the whole system using either general purpose languages (C, C++, Java) or special purpose languages.

# **Course Outline**

- Introduction to Discrete-Event Simulations
- Elementary Probability and Queueing Theory
- Basic techniques of discrete event simulation
- Generating Random Numbers and Random Variates
- Input and output modeling
- Simulation Programming using general purpose languages and also special purpose simulation tools
- Analysis of Simulation results

# **Grading**

- 4 Assignments (4@10%) = 40%
- 2 Mid-term Examination = 30%
  - □ Papers are different for CSC 446 and 546
- Final Project and Report = 30%
  - Projects will involve using a simulation tool
  - □ Topics will be listed in first week of October or you can choose your topics.
  - Expect grad students to take more challenging problems here.

# What is expected

- Note that the course intention is to teach simulation concepts and methodology, but not any specific packages
- Therefore, students are expected to learn the usage of the simulation tools on their own, slowly but steadily!!
- We will use a simulation tool called OMNeT++ (<a href="http://www.omnetpp.org">http://www.omnetpp.org</a>)
  - □ Mainly meant for Queueing network simulations
- It is installed on all Windows lab (ECS 250, 258, 266) machines
  - Documentation is available on the OMNeT webpage as well as on the course website.
- There is also another simulation tool available from SSFNET (<u>www.ssfnet.org</u>) written in Java.

# **Questions??**



# Poll

# Poll

- Why are you taking this course?
- Anyone with Probability Theory background?
- Anyone with Queueing Theory background?
- Anyone with simulation tool experience?

# What is Operations Research (OR) ??

# What is Operations Research (OR)?

In a nutshell:

Operations research is the discipline of applying advanced analytical methods to help make better decisions and improve performance.

# What is Operations Research (OR)?

- By using techniques such as mathematical modeling to analyze complex situations:
  - Operations research gives the *power to make* more effective decisions and build more productive systems based on:
    - More complete data
    - Consideration of all available options
    - Careful predictions of outcomes and estimates of risk
    - The latest decision tools and techniques

# OR: The secret of better decision making

- Executives and Researchers in every kind of organization – large and small, private and public, for-profit and not-for-profit – are using operations research (O.R.)
  - □ to unlock the value in their data,
  - □ model complex systems,
  - performance characterization of systems
    - Bottleneck Analysis (Where the problem is ...)
    - Performance Analysis (How well the system works ..)
    - Risk Analysis (How reliable a given system is ..)
  - □ and make better decisions with less risk.

# OR (continued ..)

- The performance of a given process (or system) depends upon:
  - □ What kind of "resources" it has and how many
    - Type, Dimensionality, Risk
  - Who is "contending (or accessing)" for these resources
    - Resource request and usage
    - Causes bottleneck if too much demand
  - □ How well these resources are "allocated"
    - Optimal Resource Allocation

# OR: The secret of better decision making

- Whether O.R. is used to inform high-level strategy or to improve day-to-day operations, the results speak for themselves:
  - ☐ Insight into difficult problems.
  - □ Improved processes, productivity, and performance.
  - Millions in cost savings and increased revenues.
  - More (and better) options.
  - □ Accurate predictions, plans, and forecasts.
  - More profitable pricing. Greater market share. Higher quality. Superior ROI (Return Of Investment).
  - □ Better asset utilization....

# OR (continued ..)

- To achieve these results, O.R. professionals draw upon the latest analytical technologies, including:
  - □ Simulations Giving you the ability to try out approaches and test ideas for improvement.
  - □ Optimization Narrowing your choices to the very best when there are virtually innumerable feasible options and comparing them is difficult.
  - Probability and statistics Helping you measure risk, mine data to find valuable connections and insights, test conclusions, and make reliable forecasts.

# **OR Value Proposition**

- Business insight Providing quantitative and business insight into complex problems
- Business performance Improving business performance by embedding model-driven intelligence into an organization's information systems to improve decision making
- Cost reduction Finding new opportunities to decrease cost or investment
- Decision making Assessing the likely outcomes of decision alternatives and uncovering better alternatives
- Forecasting Providing a better basis for more accurate forecasting and planning

# OR Value Proposition (continued ..)

- Improved scheduling Efficiently scheduling staff, equipment, events, and more
- Planning Applying quantitative techniques to support operations, tactical planning, and strategic planning
- Pricing Dynamically pricing products and services
- Productivity Helping organizations find ways to make processes and people more productive
- Profits Increasing revenue or return on investment; increasing market share
- Quality Improving quality as well as quantifying and balancing qualitative considerations

# **OR Value Proposition (continued ..)**

- Recovery Gaining greater control and achieving turnaround
- Resources Gaining greater utilization from limited equipment, facilities, money, and personnel
- Risk Measuring risk quantitatively and uncovering factors critical to managing and reducing risk
- Throughput Increasing speed or throughput and decreasing delays

# 5 Signs one can benefit from OR



- Facing Complex Decisions
- Having Problems with Processes
- Troubled by Risk
- Organization not making use of its data
- Want to Beat the Competition

# OR (continued ..)

- OR I: deals with Optimization Techniques
- OR II: deals with Simulations and Analysis

# Time for OR Executive Guide