Program
2013 Governor's Institute in Mathematical Sciences
June 16 - 21, 2013

Descriptions of the class sessions for this year's Institute:

Revealing Patterns of Movement, Information, and Emotion with Large-Scale Data

Online interactions have recently enabled computational social scientists to ask very interesting questions. For example, how do the connections in your social network influence your behavior? How can mobile phone data be used to improve our understanding of the spread of disease? How does our happiness vary as a function of time, geographical location, or age? In this set of talks, we will explore how mathematics is being used to describe, model, and even understand human behavior. This course is taught by Chris Danforth of the UVM Department of Mathematics.

A Mathematical Marriage

This course will sample many different topics, including: modular arithmetic, Latin squares, and planning round-robin tournaments, cardinality of sets, and different types of infinity. On the last day, we'll discuss the Stable Marriage Theorem, namely, how *n* men and *n* women be "married" in such a way that no unmarried couple would be happier together than with their current spouse. There is an algorithm that solves this problem and we will demonstrate the workings of that algorithm, and in doing so we will prove the theorem. This algorithm is currently in use on "match day" when all of the medical students around the country get matched with a medical residency program. This class will be taught by Jeff Dinitz, of the UVM Department of Mathematics and Statistics.

All Generalizations are false, including this one – How Statistics can come to the Rescue

Nothing is certain. So how can you make any conclusions in the face of this uncertainty? In this course, we will learn the best way to gather data, and how to use probability to make the appropriate conclusions from it. This class will be taught by Sheila Weaver of the UVM Department of Mathematics and Statistics.

Lattice polygons and Pick's theorem

A lattice polygon is a polygon whose vertices have integer coordinates. Pick's theorem is an amazingly simple relationship between the area of a polygon and the number of interior and boundary lattice points. The theorem is a wonderful example of mathematics at work and is incredibly useful to compute areas when you're short on time! The class will be taught by John Voight, of the University of Vermont Department of Mathematics and Statistics.

Juggling Probabilities

From the right perspective, everything is mathematical - even juggling. I'll describe how juggling relates to traditional mathematical fields such as graph theory and look at what happens when a person starts juggling randomly. In doing so, I'll illustrate how these mathematical underpinnings can be useful even to accomplished jugglers. There will be numerous live demonstrations. This class is taught by Greg Warrington of the UVM Mathematics Department.

Slip Sliding Away – When Slide Rules Ruled

What does the Empire State Building, the Golden Gate Bridge, and the Apollo Moon Landing all have in common? Their designers all used slide rules for their mathematical calculations. Up until 1970, Slide rules, not hand held calculators or

computers, were the workhorses of mathematicians, engineers, physicists and economists. Learn what amazing feats these remarkable devices could do, and make and use a simple slide rule in class. This class is taught by Bill Gottesman.

Evolutionary Robotics

Building a robot is hard work: it requires an understanding of physics, biology, math, mechanical and electrical engineering, and computer science. So rather than build a robot by hand, could we get a computer to build a robot for us? In this course we explore how we can use computer programs known as `evolutionary algorithms' to create and compete virtual robots against one another, much like in Will Wright's 'Spore' computer game. Along the way, we'll learn much about biological evolution, computer simulation, and robotics. This class is taught by Josh Bongard of the UVM Computer Science Department.

Applied Mathematics and Human Intelligence

Just what is it that makes humans intelligent? Some have suggested pattern recognition -- the ability to see order in a chaotic environment -- is not only necessary for life, but is a skill at which we excel. This talk will explore artificial neural networks, in particular pattern recognition algorithms. This class will be taught by Donna Rizzo of UVM's School of Engineering.

The Role of Mathematical Modeling in the Woburn Trial

Mathematical modeling is often used to predict behavior; but sometimes, as in the case of the Woburn trial that forms the foundation for the book and movie Civil Action, it can be used to reconstruct the past. Such was the case when it was necessary to determine what the concentration of chemicals in contaminated wells was at a time when no measurements were being taken. This information was needed to assess whether chemicals from these wells caused the cancer that resulted in the death of children in Woburn. This class will be taught by George Pinder, professor of the UVM School of Engineering.

Number Pattern Challenges

How can you predict the value of a secret number based on its location on some "magical" cards? How can you advise a game show host as to how to best award prizes from one dollar up to one thousand dollars using only dollar bills filling a mere ten envelopes? How could you use an amazing forty pound broken rock to measure various weights at the farm from one pound up to forty pounds? These challenges and more reveal fascinating patterns of numbers, and strategies for solving problems. This class will be taught by George Ashline of St. Michael’s College Department of Mathematics.

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Problem Solving Strategies

This session is taught by Felix Wu, Junior at Harvard, and GIV Math Alumnus.