**Spring 2013 Individual Comps Presentations**

On Thursday, May 16, there will be six independent comps presentations from 3:00-5:20 pm in CMC 206.

**Distribution Theory**  
(3:00-3:20 pm)  
Lorenzo Najt

The successes of the derivative are undermined by its inability to capture the underlying physical intuition in a number of frequently occurring scenarios. To remedy this, one may leave behind the model of a function considered in real analysis for the more abstract setting of distributions. In the distributional setting, a locally integrable function $f$ is described by the behavior of an associated functional $\varphi \to \int_{-\infty}^{\infty} f \varphi$ acting on compactly supported, infinitely differentiable test functions $\varphi$, rather than by a set of ordered pairs of real numbers. A distributional derivative inspired by integration by parts can then be defined that preserves the usual derivative in most cases and that otherwise establishes a meaningful derivative of every order for every locally integrable function. Among the distributional derivatives that do not correspond to a locally integrable function is the Dirac Delta function, and an exploration of its properties and other salient features of the distributional perspective point towards the construction a larger but more easily understood space in which the functionals $\varphi \to \int_{-\infty}^{\infty} f \varphi$ and their distributional derivatives can be densely embedded. Though this embedding will introduce functionals which are neither analogs of locally integrable functions nor their distributional derivatives, the structure of this larger space revealed by a generalization of convolution demonstrates the natural elegance of its application to distributions, originally due to Laurent Schwartz.

**Random Walks and Electric Networks**  
(3:30-3:50 pm)  
Evan MacAyeal

Random walks represent an important stochastic process, utilizing probability to touch on many different disciplines such as physics, chemistry, ecology, and biology. Random walks help answer questions about the time progression of a system between its different states by projecting it onto a graph with vertices connected by edges. Similar to graphs, simple electric circuits consist of nodes connected by conducting wires with resistors through which charged particles flow. Elements of a random walk can be related to measurable, physical properties of these electric circuits including resistance, electric current, voltage, and energy of a circuit. This talk will first build the foundation of probability, stochastic processes, and electric circuit theory on which this material is based to establish the strong connection between random walks on graphs and electric networks and then utilize this relationship to explore some surprising results about random walks on both finite and infinite graphs.

**Self-Avoiding Random Walks**  
(4:00-4:20 pm)  
Milan Cvitkovic

In addition to being interesting mathematical entities in their own right, random walks are used ubiquitously as models in fields from economics to biology to physics. In this talk we will
explore self-avoiding random walks: one of the longest studied yet least well understood varieties of random walk. In particular we will focus on the techniques mathematicians and scientists have used to try to understand this conceptually simple yet hard-to-analyze process.

Non-parametric Density Estimation
(4:30-4:50 pm)
Iris Wang

The probability density function (PDF) is a core concept in statistics. For any random variable $X$ that has PDF $f$, the function $f$ gives a natural description of the distribution of $X$ and allows us to calculate the probabilities associated with $X$. Since the PDF of a given set of data is often unknown, statisticians have developed various approaches, parametric and non-parametric, to estimate a density function. A nonparametric method can be defined as a method that is valid independently of the distribution of the sampled data. My talk will focus on the non-parametric methods for density estimation, with an emphasis on the kernel method.

Simulated Annealing
(5:00-5:20 pm)
Jerry Yang

Simulated annealing (SA) is a general optimization technique for solving combinatorial optimization problems, that is, finding the global optimum of a given function through local search. In my presentation, I will start with the concept of a combinatorial optimization problem and then proceed to the introduction and comparison of threshold algorithms, a class of local search algorithms to which SA belongs. Also, I will justify the SA algorithm by investigating its asymptotic convergence results, through homogeneous and inhomogeneous models. After some theoretical understanding of SA, I will present some “real world” applications and remaining issues.

Congratulations to Daoji Huang and Ben Strasser, recipients of the Math Department’s Steven Galovich Prize!

The Steven P. Galovich Prize is an endowed fund intended to support the graduating mathematics major or majors who best reflect Professor Galovich’s enthusiasm for and love of mathematics, zestful joy in life, sense of humor and compassion for others. The recipients are selected by the math department faculty.

Meet a Major: Justin Troyka

This week’s Gazette introduces Justin Troyka, a senior mathematics major from Carol Streams, Illinois.

GG: Why are you a math major?
JT: Cuz I like math. That’s actually the only reason.
GG: What are your plans for after graduation?
JT: I am going to graduate school at Dartmouth. Probably for combinatorics.
GG: And what are your post grad-school plans?
JT: Being a professor somewhere, I guess.
GG: I’m sure a lot of people have gotten help from you in the Math Skills Center. Why do you like working there?

JT: That’s a good question. I think it’s interesting… In order to help lots of people with the same problem you have lots of different ways of thinking about that problem and a way of thinking that works for each person. The job has a lot of variety.

GG: Besides being a huge Beatles fan, what else do you want to tell the world?

JT: I love mint chocolate chip ice cream and I think that anyone who doesn’t like it is a chump.

GG: Really?

JT: No.

**Fulbright Scholar: Milan Cvitkovic**

Milan Cvitkovic, a double major in math and chemistry, is heading to Singapore next year to study theoretical chemistry on a Fulbright fellowship. Milan will be working at the University of Singapore with Professor Ryan Betten to develop a quantum-mechanical, many-molecule model of water based on Betten’s theoretical methods. Congrats, Milan!

**PROBLEMS OF THE WEEK**

1. The small prairie town of Wohascum Center is laid out in no-nonsense fashion as a rectangle subdivided by a square grid, with equally spaced north-south streets and east-west avenues forming blocks that are perfect squares. A long-time resident has found that there are exactly 792 ways to bicycle from the extreme northwest corner of town (where she lives at the corner of First Street and First Avenue) to the intersection at the extreme southeast corner (where she works) efficiently, that is, by heading either east or south to begin with and also at each subsequent intersection. However, now that the frost is finally out of the ground, all four sides of the central block of the town are under construction, and so she now avoids bicycling along any side of that block (although she is willing to pass through an intersection at a corner of the block). With this new constraint, how many ways to bicycle to work efficiently does she have left?

2. Suppose you start with the number 1 and go through a series of steps, where at each step you add, to the number you have, a (positive integer) divisor of that number, to get a new number. For instance, the first step is forced; you have to take 1 + 1, so the new number is 2. Now you have two choices; the next number could be 2 + 1 = 3 or 2 + 2 = 4. If you choose 4, the next step after that could take you to 5, 6, or 8. Find the least number of steps needed to get from your starting number 1 to the number 2013 (and show why your answer is correct).

The good news is that solutions for all problems from the past two weeks have arrived from John Snyder in Oconomowoc. The bad news is 1) that there don’t seem to be any solutions coming in from the rest of you and 2) that the time crunch continues unabated, so that I haven’t had a chance to post any of my own solutions. Might 1) and 2) be related, perhaps? Anyway, good luck on the new problems!

-Mark Krusemeyer