REU Talks

Friday, August 10, 2012

Kairui Wang: *What is Persistent Homology?*

Persistent homology is a relatively new area of study that has applications to computer vision. Visual information is sampled from an object by a sensor and we wish to design a program that can infer what the original object is based on this sample. To do so, the program must have some way to decide the relative importance of features in the sample and have a way to identify errors in the sample. Persistent homology offers a way to answer these questions. In this talk, we will attempt to define one form of persistent homology and see how it provides a numerical summary of the questions we posed above.

Salman Siddiqi: *Geometric Stability Theory: A Dichotomy Theorem*

Geometric stability theory is a field of logic that grew from questions of categoricity and classification theory. One of the central results in its development was the dichotomy theorem, which was first proved by Buechler in (I believe) the early 1980s. This showed that there was a kind of trade-off between complexity in the model theoretic sense, and complexity in the geometric sense. I will go through as few definitions as I possibly can in order to state the theorem properly and make it seem interesting.

Anirudh Sankar: *Monads as a Way to Describe Algebraic Theories*

In this talk we look at a certain construction in category theory called a monad, which provide a framework for discussing certain algebraic theories. This can be illustrated in simple cases when we look at what is called an algebra over the monad (for example, the algebra over the monoid monad in the category of small sets gives us monoids there). However, such an observation is slightly mysterious until we consider the relation between monads and adjunctions. Although monads only make reference to one category in its definition, they are in fact intimately related to adjunctions between this category and other categories. We can talk about a certain category of adjunctions that “give rise” to a monad, and the Kleisli and Eilenberg-Moore constructions that give canonical initial and terminal objects in this category can be seen to illuminate more strongly the link between monads and algebraic theories.

Aaron Krahn: *Quantum Computation and Quantum Algorithms*

This talk provides an introduction to the world of quantum computing by starting with the fundamentals of quantum mechanics, including the state vector, time evolution, and measurement of quantum systems. A comparison to classical computation then gives a useful transition for discussing the building blocks of quantum computers: qubits, quantum gates, and quantum circuits. Finally, we discuss one of the most famous quantum algorithms, Grover's Searching Algorithm, which provides a quadratic speedup (compared to its best classical counterpart) when searching an unsorted database.

Nina Kuklišová: *A Talk For Tired Mathematicians (Markov Chains and Their Basic Properties)*

Markov Chains are stochastic processes in which the next step is only determined by the previous step. With this assumption, many real-world problems can be modeled as Markov Chains. Once knowing their convergence properties, we can easily predict the evolution of the process. The key property in this analysis is the stationary distribution, we will see when and how we can find them and how much can we learn from them.