# Math Honours Presentations
## April 7, 2015

## Coarse Geometry of the Firefighter Problem
Brandon Thorne

**Abstract.** A fire breaks out on a finite set of vertices of graph $G$. Then fire fighters protect $f$ vertices not on fire. At each subsequent integral time, the fire spreads to all adjacent unprotected vertices and the fire fighter protects $f$ unburned vertices. We say that $G$ has the $f$-containment property if for every finite initial fire, there is an strategy to contain the fire protecting $f$ vertices at each turn.

Two graphs have the same coarse geometry if they are quasi-isometric. Our main result is that for a fixed maximum degree, having the fire containment property is preserved by quasi-isometry. Then, any semi-regular tiling of the Euclidean plane has the fire containment property, no semi-regular tiling of the $n$-dimensional Euclidean space has the containment property if $n > 2$, no semi-regular tiling of $n$-dimensional hyperbolic space has the containment property if $n > 2$.

Supervised by Dr. Danny Dyer and Dr. Eduardo Martinez-Pedroza.

## Acceleration Techniques for Mesh Generation via Domain Decomposition Methods
Devin Grant

**Abstract.** When solving time and space dependent partial differential equations, adaptive mesh techniques are often employed to concentrate mesh points where the error is expected to be highest. This distribution of this adaptive mesh may be determined by the equidistribution principle. We will discuss parallel approaches to determining this equidistributed mesh, specifically examining the classical Schwarz method with Dirichlet boundary conditions, for both De Boor's Algorithm and the differential equation formulation of the equidistribution principle in one spatial dimension, and the effect that parallelization has on convergence. Further, we will examine the effect of coarsening strategies on the convergence rates of parallel Schwarz algorithms, in order to counter the deceleration introduced by the parallel algorithm. This includes both standard discrete coarsening strategies, and a new coarsening strategy on the continuous level, for which convergence will be proven and discussed. We will compare the efficiency of various coarsening strategies through numerical results.

Supervised by Dr. Ron Haynes.

# Adaptive Mesh Methods and a Smoothed Schwarz Algorithm Implementation

Andrew Rose

**Abstract.** Employing an adaptive mesh for the purpose of solving PDEs is an effective, though complicated, method for improving analysis. We will discuss the implementation of a classic Schwarz algorithm for a given, simple monitoring function in an effort to generate these meshes. This will initially be done on a single subdomain as a proof of concept before moving on to examine the behaviour and convergence of domain decomposition. This is done for the purposes of parallelization with multi-core processing machines. Next, we will modify the original monitoring function to a "smoothed" version for the Schwarz algorithm. Comparisons of the standard and "smoothed" techniques will provide motivation through complex monitoring functions. Numerical results are provided to demonstrate that domain decomposition techniques can be used to generate smoothed adaptive meshes via the Schwarz algorithm.

Supervised by Dr. Ron Haynes.