Mathematical Fire Fighting: Combating Fire with Delaunay Triangulation and Longitudinal-Reversible Cellular Automata

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The purpose of this second-year project furthered the previous findings of mathematical modeling of wildfires. The first goal was to optimize the Cellular Automata model created last year in order to enable reversible cell states and longer experimental periods. The second was to construct an algorithm for a 3-D Delaunay Triangulation Model (DTM) to model edge-based fire dynamics. Both models incorporated realistic environmental factors. After the models were optimized, simulations were run and total acreage burnt was compared to data collected by the National Interagency Fire Center for 2004-2014. The US Risk Ranking (USRR) was created and each state was ranked based on risk of environmental and economic damage from wildfires after inclusion of demographic factors. Major wildfires were recreated with FARSITE and acreage burned vs time was compared to both models. The Longitudinal-Reversible Cellular Automata (LRCAM) enhanced the CA model and its linear progression. Cells were updated to have reversible states and subsets to increased accuracy of modeling. A new update function developed incorporated more heterogeneous environmental conditions and was applied to all cells. The DTM was made using special triangulation of longitude/latitude points and envelope fire front propagation calculations. Simulations for the entire US were run. The LRCAM had 3% error and the DTM had 10% error when compared to the NIFC data. Historical major wildfires were created with FARSITE and compared to both models. The LRCAM was 2.3 times more time efficient than FARSITE. The USRR provided valuable insight regarding the dangers wildfires pose to the country. These models can be used either as a risk analysis tool to predict future outbreaks or as a real time crisis resource manager.

Awards Won:

American Mathematical Society: First Award of $1,000