Fireline Construction in a Heterogeneous Forest Landscape

Xu Yang and Emanuel Melachrinoudis
Department of Mechanical and Industrial Engineering

Abstract
In our research, a case study for the Montague Plain Wildlife management Area (MPWMA) is used to demonstrate the methodology due to the availability of detailed fire modeling data.

Approach
Optimal Fireline Generation using Modified Dijkstra’s Algorithm
- We represent the landscape as a partition of homogeneous Voronoi polygons.

Data Layers
- Fuels
- Topography (slope, aspect and elevation)

Randomness: Weather Conditions
- Temperature, Moisture, Wind speed and direction

The Delaunay Triangulation $G(V, E)$ forms the fire propagation network.
- We introduce a fireline construction network $G'(V', E')$ whose node set $V'$ consists of points on the polygon edges $E$, and edge set $E'$ consists of line segments connecting nodes from $V'$ belonging to each polygon.
- Each node of $V'$ has as attribute the fire arrival time generated by the fire spread model.
- A methodology is developed that uses modified Dijkstra’s shortest path algorithm to find the fastest yet safe paths for two firefighting crews who work simultaneously in opposite directions. The two crews start at one point (anchor point) and stop until they meet and thus encircle and contain the fire.

Data Tessellation
- Voronoi polygons with homogeneous attributes in each cell

Delaunay Triangulations
- Fire spread network $G(V, E)$
- Compute fire spread rate along each edge
- Compute fire arrival time to specific points of interest

Selected References