A Markov Model for Lost Person Navigation
Agenda

• Rescue Planning
• Descriptive Navigation Model
• Analysis of Environment Factors
• Environment Model
• Generating Transition Probabilities
• Simulation
• Validation
Rescue Planning:
Initial Estimates of Victim’s Location

- Theoretical Method
- Statistical Method
- Subjective Method
- Mattson Method

Rescue Planning: Initial Estimates of Victim’s Location
Rescue Planning:
Initial Estimates of Victim’s Location
Descriptive Model:
How would you get around?

- Most wilderness users start on some course.
- When a person realize he is lost, he generally continues in some direction with the hope of discovering a familiar landmark.
- He will most likely continue on that course until he is forced to make a decision.
- Instead of turning around and losing ground, he will likely use his new location as a base point for further exploration.
- He will likely give precedence to routes that favor travel and offer a notion of direction.

Descriptive Model:
How would you get around?

- Individuals lost in the wilderness tend to be found near *linear environmental features*.

Factor Analysis
What matters?

• Explicit modeling of relevant factors
  ◦ Victim factors
    • Age and experience
    • Circumstances leading to the incident
    • Last known location and direction of travel
    • Intended destination
    • Elapsed time
  ◦ Environment factors
    • Terrain
    • Vegetation density
    • Possible routes
    • Barriers
Factor Analysis
What matters?

- Initial Analysis
  - Terrain
  - Trails
Factor Analysis
What matters?

- Initial Analysis
  - Terrain
  - Trails
- Kolmogorov-Smirnov two sample test:
  - $p = 7.9297 \times 10^{-263}$
Environment Model

Where in the world...?

• The search area is *partitioned*.
• Each region is a state.
• The victim’s location at any time is the state of the Markov process.
• Urban areas are made absorbing states.
• Complexity is reduced by considering a smaller set of possible locations.
Environment Model
Where in the world…?

• Possible partitions:
  ◦ Regular tessellations
  ◦ Region similarity
  ◦ Path-priority
Generating Transition Probabilities

Why do people go where they go?

• Using the path-priority partition, we include as variables:
  ◦ Elevation difference
  ◦ Region type
  ◦ Region identity
Generating Transition Probabilities

Why do people go where they go?
Simulation
Where might he be now?
Validation
How good is the model?

• How well does it agree with known behavior?
  ◦ Compare with historical data on net distance traveled.
  ◦ Compare with estimates from experienced rescuers.

• What additional information is given?
  ◦ Test accuracy in real search situations.
Validation

How good is the model?
Validation
How good is the model?
Future Work

• Improve transition probabilities with region classification and expanded state.
• Formal evaluation by experts and comparison with traditional methods.
• Integrate with search planning and coverage mapping applications.