MapScore: A Portal for Scoring Probability Maps

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Abstract

Wilderness searches consume thousands of man-hours and millions of dollars per year. Timeliness is critical. After 24 hours, survivability drops by about 20%. Good probability maps could greatly speed intensive searches.

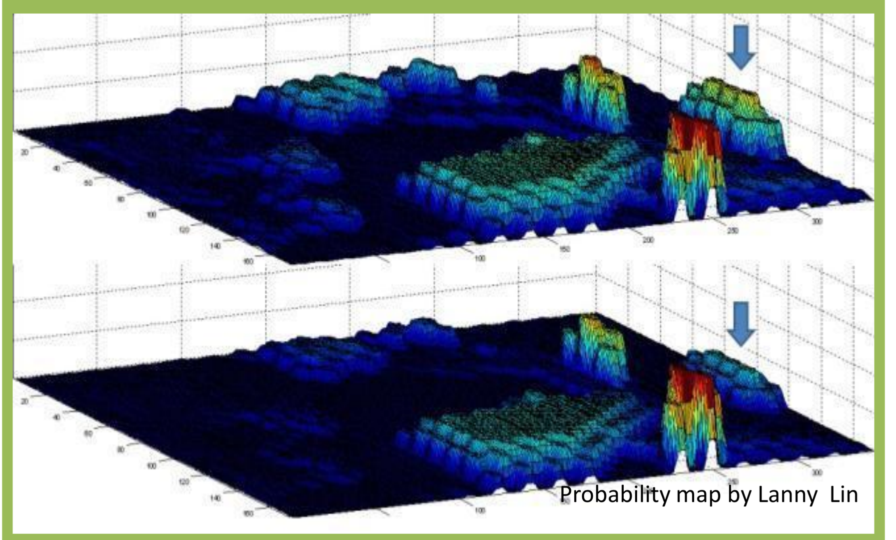
MapScore (mapscore.sarbayes.org) provides a web-based portal for scoring, comparing, and improving models of lost person behavior – or any 2D probability map where ground truth is known.

Researchers receive case data and upload maps which are then scored according to the actual find location.

Cases come from the International Search & Rescue Incident Database (ISRID). MapScore now uses 100 of the thousands of available ISRID cases.

Wilderness Search and Rescue (WiSAR) is decades behind maritime search, and there are no theoretically sound tactical decision aids, in part because it lacks good probability maps. MapScore aims to change that.

Right now three universities are testing and refining their models. We describe the system and present preliminary results

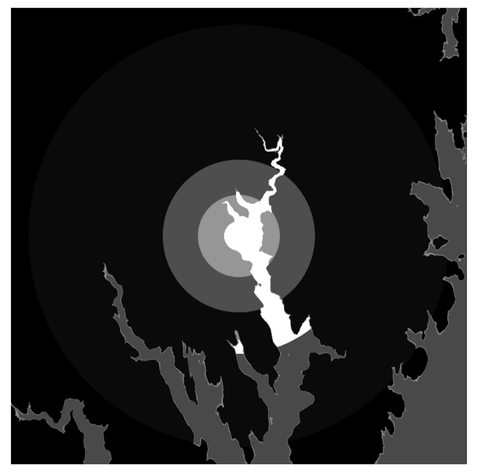


Poster presented at MORSS'80 (June 2012). Dr. Charles Twardy ctwardy@gmu.edu. Funded by an NSF REU award in collaboration with Brigham Young University on their NSF #0812653.

† Undergraduates funded by the REU.

Static Models of Lost Person Behavior

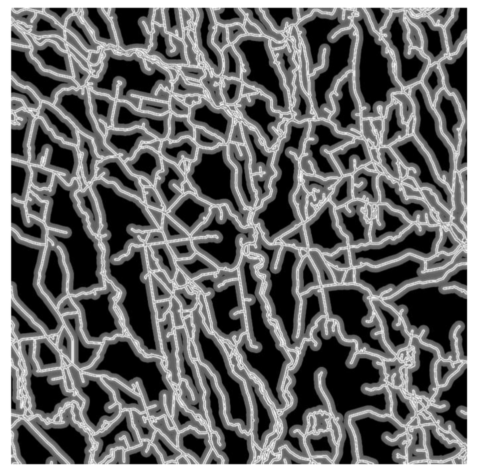
We can generate probability maps directly from Koester's (2008) statistical summary of the International Search and Rescue Incident Database. These statistical models are based on actual find location and assume that the lost person is **stationary** during the search. Sarow (2011) created ArcGIS models for Yosemite National Park. We modified them for MapScore.



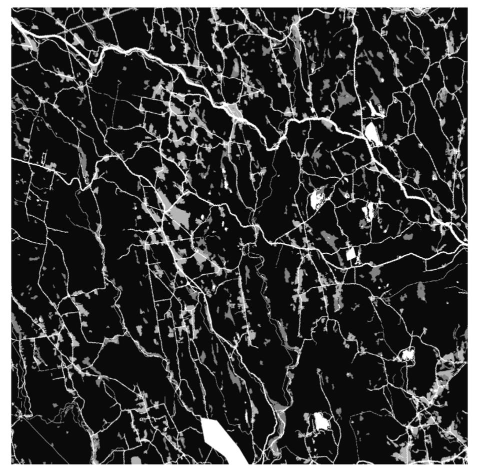
From the New York 108 Case

The image on the left combines two basic models: the Distance from Initial Planning Point (IPP) and the Elevation Change from (IPP). The Distance from IPP model depicts the 25%, 50%, 75%, and 95% distance rings from the IPP. In all the images , higher probabilities are brighter. The Elevation Change assigns different probabilities to cells based on both distance from IPP and whether the cell is uphill, downhill, or at the same elevation as the last known point.

The Linear Features/Track Offset model creates distance buffers around the combined linear features in the search area – currently roads and rivers. Cells closer to the linear feature have a greater probability per cell than cells farther away from the feature.



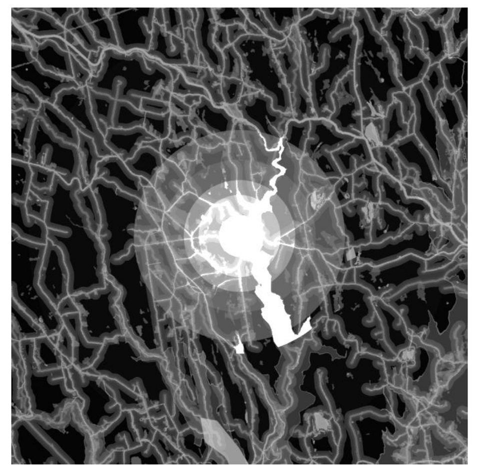
From the New York 108 Case



From the New York 108 Case

The Find Location model assigns different probabilities to different land types (forests, meadows, brush, water, etc.). ISRID reports terrain and vegetation for find locations. Sarow's models support buildings, campgrounds, ranger stations, and trails if available. So far we have not used these features.

Lastly, an equally weighted average is calculated , and reported as the DELL model (for Distance, Elevation, Landover, and Linear features.)

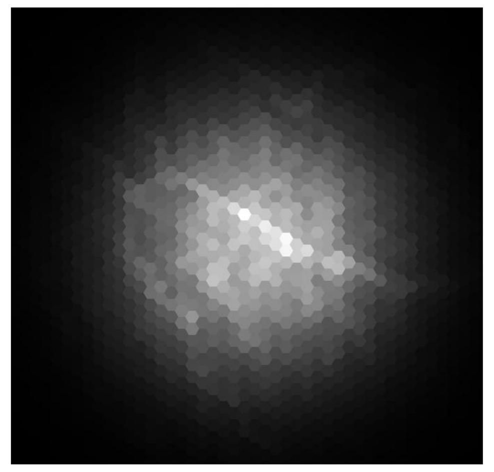


From the New York 108 Case

BYU Motion Model

One can also generate probability maps with Monte Carlo simulations of wandering behavior – a motion model. Potentially much more informative, these models have many hidden parameters for which there is no data – lost people usually don't have track logs and can't be trusted to recall their path.

Colleagues at BYU estimated separate transition probabilities for terrain, vegetation, and elevation changes, and created a motion model assuming these transitions are independent, and run the simulation on a large hexagonal grid. The resulting probabilities maps diffuse over time, according to land features.



From the New York 108 Case

Subjective Maps

From a tabletop exercise.

The usual method for land search has been to generate a probability map by drawing large search regions and averaging the subjective estimates of experienced search managers. We used this method in tabletop exercises at three SAR conferences: despite the low resolution, it scored well.

MapScore Rating System

The MapScore website lets researchers compare various WiSAR models on actual incidents from ISRID. This version has 100 U.S. cases (mostly AZ and NY). Users are presented with a lost person scenario including last known position, elapsed time, and the characteristics of the lost individual. Based on this information, users create a probability map *by whatever means they* like, and upload a grayscale raster image (PNG format) . Images must match our bounding box (25 x 25 km centered on the IPP, with each pixel representing 5 x 5 m). These maps uploaded to the portal and automatically scored using the actual find location.

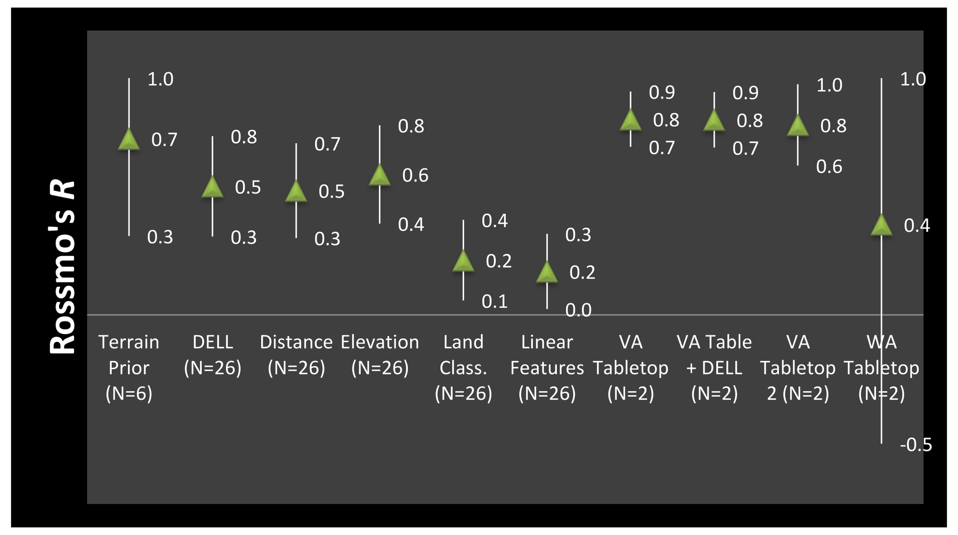
Metric

Our probability maps are scored using Rossmo's *R*, which ranges from -1 (bad) to 1 (good). Roughly, *r* is the proportion of pixels with probability > that of the find location, and *R* rescales it to [-1,1] with a random map receiving a score of 0. A slight tweak ensures that uniform maps also receive a score of 0. Formally:

$$r = \frac{n}{N} + \frac{m}{2}, \text{ and } R = \frac{.5 - r}{.5}$$

Preliminary Results

Only the static models have enough cases for reliable measurements. Of these, the Distance, Elevation, and DELL perform similarly, while Land Classification and Linear Features lagging.



Detailed Results for Static Models

Case	Elevation	DELL	DistIPP	Linear Features	Land Class.
Arizona07	0.91	0.86	0.95	-0.04	-0.21
Arizona09	0.98	0.97	0.95	0.83	-0.05
Arizona13	0.87	0.80	-0.17	-0.01	0.87
Arizona14	0.90	0.68	-0.17	0.90	-0.17
Arizona19	-0.09	-0.31	-0.17	-0.08	-0.11
Arizona22	0.98	-0.92	-0.16	-0.04	0.51
Arizona25	-0.23	-0.40	-0.17	-0.10	-0.51
Arizona28	0.93	0.98	0.99	-0.17	0.42
Arizona31	0.96	0.82	0.78	-0.06	0.85
Arizona95	0.99	-0.50	0.92	-0.05	0.94
Arizona01	-0.20	-0.17	-0.04	0.95	0.80
Arizona03	0.95	0.88	0.97	-0.08	0.99
Arizona35	*0.99*	*0.99*	*0.95*	*0.87*	*-0.09*
NY108	0.99	0.98	-0.08	-0.16	0.98
Avg Hiker	**0.71**	**0.40**	**0.40**	**0.20**	**0.37**

References

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