UCF DEPARTMENT OF COMPUTER SCIENCE

CECS Distinguished Speaker Series

EVACUATION ROUTE PLANNING: NOVEL SPATIO-TEMPORAL NETWORK MODELS AND ALGORITHMS

FRIDAY, APRIL 22, 2016

9:00 AM – HPA1 125

Efficient tools are needed to identify routes and schedules to evacuate affected populations to safety in face of natural disasters or terrorist attacks. Challenges arise due to violation of key assumptions (e.g. stationary ranking of alternative routes, Wardrop equilibrium) behind popular shortest path algorithms (e.g. Dijktra's, A*) and microscopic traffic simulators (e.g. DYNASMART). Time-expanded graphs (TEG) based mathematical programming paradigm does not scale up to large urban scenarios due to excessive duplication of transportation network across time-points. We present a new approach, namely Capacity Constrained Route Planner (CCRP), advancing ideas such as Time-Aggregated Graph (TAG) and an ATST function to provide earliest-Arrival-Time given any Start-Time. Laboratory experiments and field use in Twincities for DHS scenarios (e.g. Nuclear power plant, terrorism) show that CCRP is much faster than the state of the art. A key Transportation Science insight suggests that walking the first mile, when appropriate, may speed-up evacuation by a factor of 2 to 3 for many scenarios. Geographic Information Science (e.g. Time Geography) contributions include a novel representation (e.g. TAG) for spatio-temporal networks. Computer Science contributions include graph theory limitations (e.g. non-stationary ranking of routes, non-FIFO behavior) and scalable algorithms for traditional routing problems in time-varying networks, as well as new problems such as identifying the best start-time (for a given arrival-time deadline) to minimize travel-time.

Experiments with real and synthetic transportation networks show that the proposed approach scales up to much larger networks, where software based on linear programming method crashes. Evaluation of our methods for evacuation planning for a disaster at the Monticello nuclear power plant near Minneapolis/St. Paul Twin Cities metropolitan area shows that the new methods lowered evacuation time relative to existing plans by identifying and removing bottlenecks, by providing higher capacities near the destination and by choosing shorter routes. In 2005, CCRP was used for evacuation planning (transportation component) for the Minneapolis-St. Paul twin-cities metropolitan area. It facilitated explorations of scenarios (e.g. alternative locations and times) as well as options (e.g. alternative transportation modes of pedestrian and vehicle). It also led to an interesting discovery that *walking able-bodied evacuees (instead of letting them drive) reduces evacuation time significantly for small area (e.g. 1-mile radius) evacuations.*

In future work, we plan to formally characterize the quality of solutions identified by the CCRP approach. We will explore new ideas, e.g. phased evacuations and contra-flow, to further reduce evacuation times. In addition, we would like to improve modeling of other transportation modes such as public transportation.

SHASHI SHEKHAR

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Shashi Shekhar is a Mcknight Distinguished University Professor at the University of Minnesota (Computer Science faculty). For contributions to geographic information systems (GIS), spatial databases, and spatial data mining, he was elected an IEEE Fellow as well as an AAAS Fellow and received the IEEE-CS Technical Achievement Award, and the UCGIS Education Award. He was also named a key difference-maker for the field of GIS by the most popular GIS textbook . He has a distinguished academic record that includes 300+ refereed papers, a popular textbook on Spatial Databases (Prentice Hall, 2003) and an authoritative Encyclopedia of GIS (Springer, 2008).

Shashi is serving as a co-Editor-in-Chief of Geo-Informatica : An International Journal on Advances in Computer Sciences for GIS (Springer), and a series editor for the Springer-Briefs on GIS. Earlier, he served on the Computing Community Consortium Council (2012-15), and multiple National Academies' committees including Models of the World for USDOD-NGA (2015), Geo-targeted Disaster Alerts and Warning (2013), Future Workforce for Geospatial Intelligence (2011), Mapping Sciences (2004-2009) and Priorities for GEOINT Research (2004-2005). He also served as a general or program co-chair for the Intl. Conference on Geographic Information Science (2012), the Intl. Symposium on Spatial and Temporal Databases (2011) and ACM Intl. Conf. on Geographic Information Systems (1996). He also served on the Board of Directors of University Consortium on GIS (2003-4), as well as the editorial boards of IEEE Transactions on Knowledge and Data Eng. and IEEE-CS Computer Sc. & Eng. Practice Board.

In early 1990s, Shashi's research developed core technologies behind in-vehicle navigation devices as well as web-based routing services, which revolutionized outdoor navigation in urban environment in the last decade. His recent research results played a critical role in evacuation route planning for homeland security and received multiple recognitions including the CTS Partnership Award for significant impact on transportation. He pioneered the research area of spatial data mining via pattern families (e.g. collocation, mixed-drove co-occurrence, cascade), keynote speeches, survey papers and workshop organization.

Shashi received a Ph.D. degree in Computer Science from the University of California (Berkeley, CA). More details are available from http://www.cs.umn.edu/~shekhar.