NIKOLA MARKOVIĆ, PH.D.

Postdoctoral Research Associate
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Education

University of Maryland, College Park, USA

Ph.D., Civil & Environmental Engineering, 2013
"*Evasive Flow Capture*"
Focus: facility location, stochastic optimization, logistics
Advisor: Paul Schonfeld

M.S., Civil & Environmental Engineering, 2010
"*Scheduling Under Uncertainty for a Single-Hub Intermodal Freight System*"
Focus: probabilistic analysis, metaheuristics, logistics
Advisor: Paul Schonfeld

University of Belgrade, Belgrade, Serbia

Dipl.-Ing., Transport & Traffic Engineering, 2009
"*A Petri Net Simulation Model of the Batajnica Railway Station*"
Focus: simulation modeling, regression analysis, railway systems
Academic Advisor: Dušan Teodorović

Employment

University of Maryland, College Park, USA

Postdoctoral Research Associate — January 2014 – August 2015

Graduate Research Assistant — August 2009 – December 2013

Research Proposals

Evasive Flow Capturing Problem: Optimal Allocation of Weigh-in-Motion Stations, Tollbooths, and Security Checkpoints. 2013-2015

$220,000 award from the NSF (#1335416), PI Paul Schonfeld. I co-wrote the project proposal based on preliminary results from my dissertation and, as a Postdoctoral Research Associate, I have been working on this project as the lead researcher.

Research Interests

I am interested in the development and application of operations research techniques in analyses of transportation systems. In my dissertation I developed models for the optimal location of violator-intercepting facilities in large-scale transportation networks. My further work on this topic is supported by NSF Grant #1335416.

My other research projects include freight logistics, vehicle routing and scheduling for passengers and freight, applications of machine learning, and public transit. For more information about these projects, see the full list of my publications and some of the software implementations.

Articles in Refereed Journals

1. Marković, N., Nair, R., Schonfeld, P., Miller-Hooks, E., & Mohebbi, M. (2014). Optimizing dial-a-ride services in Maryland: benefits of computerized routing and scheduling. Conditionally accepted subject to minor changes in *Transportation Research Part C: Emerging Technologies*.
2. Marković, N., Ryzhov, I.O. & Schonfeld, P. (2014). Evasive flow capture: optimal location of weigh-in-motion systems, tollbooths, and safety checkpoints. *Networks*. DOI: 10.1002/net.21581
3. Marković, N., Drobnjak, Ž., & Schonfeld, P. (2014). Dispatching trucks for drayage operations. *Transportation Research Part E: Logistics and Transportation Review*, Vol. 70, 99-111.
4. Marković, N., Milinković, S., Schonfeld, P., & Drobnjak, Ž. (2013). Planning dial-a-ride services: statistical and metamodeling approach. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2352, Num. 1, 120-127.
5. Marković, N. & Schonfeld, P. (2011). Scheduling under uncertainty for a single-hub intermodal freight system. *Transportation Research Record: Journal of the Transportation Research Board,* Vol. 2238, Num. 1, 24-31.
6. Marković, N., & Schonfeld, P. (2013). Scheduling for a single-terminal intermodal system recovery with Poisson arrivals. *Strojniški vestnik-Journal of Mechanical Engineering*, Vol. 59, Num. 9, 564-572.

Articles in Refereed Journals (Under Review)

7. Marković, N., Milinković, S., Hajnal, M.A., Tikhonov, K.S., & Schonfeld, P. (2014). Predicting train arrival delays based on route and train information. Submitted to *Transportation Research Part C: Emerging Technologies*.
8. Marković, N., Park, H. & Schonfeld, P. (2014). Machine learning models for optimal design of dial-a-ride systems. Submitted to *Transportation Research Record: Journal of the Transportation Research Board*.

Refereed Conference Proceedings

1. Marković, N., Nair, R., Schonfeld, P., Miller-Hooks, E., & Mohebbi, M. (2014). Optimizing dial-a-ride services in Maryland. Transportation Research Board 93rd Annual Meeting.
2. Marković, N., Milinković, S., Schonfeld, P., & Drobnjak, Z. (2013). Planning dial-a-ride services: statistical and metamodeling approach. Transportation Research Board 92nd Annual Meeting.
3. Bešinović, N., Marković, N., & Schonfeld, P. (2013). Optimal allocation of truck inspection stations based on *k*-shortest paths. Transportation Research Board 92nd Annual Meeting.

4. Perovanović, J., Jaiswal, J., Marković, N., & Hoffman, E. (2013). Nuclear envelope laminopathies: evidence for developmentally inappropriate chromatin-nuclear envelope interactions. *Epigenetics & Chromatin*, *6*(Suppl 1), P65.
5. Marković, N., Drobnjak, Z., & Schonfeld, P. (2012). Nonstationary Markov chain framework for optimizing dedicated check-In. Transportation Research Board 91st Annual Meeting.
6. Marković, N., Bešinović, N., & Schonfeld, P. (2012). Simulation-based optimization of recovery for multi-terminal freight transportation system. Transportation Research Board 91st Annual Meeting.
7. Bešinović, N., Marković, N., & Schonfeld, P. (2012). Location of truck inspection stations based on stochastic flows. Transportation Research Board 91st Annual Meeting.
8. Marković, N. & Schonfeld, P. (2011). Scheduling under uncertainty for a single-hub intermodal freight system. Transportation Research Board 90th Annual Meeting.

Software

Optimizing Dial-a-Ride Services

I worked for 7 months on the development of commercial software for routing and scheduling vehicles in dial-a-ride operations (i.e., transportation of elderly and disabled passengers). My role was to adapt an efficient insertion heuristic from the literature to meet the requirements of several dial-a-ride operators. My implementations of static and dynamic dial-a-ride heuristics were deployed by companies in Maryland, Virginia, and Arizona. The company marketing the software is IT Curves (http://www.itcurves.net/). (Journal paper #1.)

Dial-a-Ride System Design

I developed statistical and machine learning tools to predict the required fleet size of a dial-a-ride system, given the information about the service area and operator's constraints. The tools included linear regression, generalized linear model, artificial neural networks, and support vector regression. The generalized linear model was built into an online system (http://www.planning-dial-a-ride-services.com/) which can provide practitioners with the free decision-support in designing capacities of dial-a-ride systems. (Journal papers #4 and #8.)

Optimizing Delivery Routes

I developed routing and scheduling software for vehicles delivering packages. The software includes classic vehicle routing problem (VRP) heuristics (i.e., Gillet-Miller and 2-opt) whose implementations are widely available online. The main challenges were development of an interface, web scraping travel times, and visualization of results. The software is being implemented in a small company in Serbia. This project was carried out pro-bono to establish contacts with the industry that could lead to 1) obtaining real-world data for research and 2) commercialization of the software.

Teaching Experience

I was a three-time guest speaker in two graduate-level courses offered by my advisor Paul Schonfeld and University of Maryland Business School professor Ilya Ryzhov. The two courses are entitled “Urban Transit Planning and Rail Transportation Engineering” (ENCE 674) and “Stochastic Optimization” (BMGT 808E). I presented my work on optimizing dial-a-ride services and locating facilities to intercept violators.

Research Projects

Facility Location

Evasive Flow Capturing Problem: Optimal Allocation of Weigh-in-Motion Stations, Tollbooths, and Security Checkpoints. Sponsor: National Science Foundation. Period: 2013-2015.

We addressed the problem of locating facilities in order to intercept non-cooperative flows of cars. The main objective was to exploit the structural properties of the problem and make it solvable for large-scale transportation networks. For example, I showed that: (1) some random parameters can be replaced with their means; (2) some integer variables can be linearly relaxed; (3) the scenario-based variables and constraints can be formulated recursively. This significantly reduced complexity of the problem (without altering it), and enabled us to solve our stochastic facility location problem on real-world road networks of Nevada and Vermont. (Journal paper #2)

Vehicle Routing and Scheduling

Smart Algorithms for Managing Ridesharing Services. Sponsors: the Maryland Industrial Partnerships Program and one private firm. Period: 2011-2012.

We developed a software solution to manage operations of a company providing transportation services for elderly and disabled. I extended existing insertion heuristics to account for several practical requirements of the potential user of the software. My implementations of the static and dynamic vehicle routing heuristics were included into the final product and deployed by companies in three states: Maryland, Virginia, and Arizona. The comparison of heuristic-based routes with those manually designed by the dispatchers showed operational savings of about 17%. (Journal paper #1)

Logistics

Urban Goods Deliveries. Sponsor: the U.S. Department of Transportation. Period: 2012-2013.

We observed a truck-rail intermodal system and developed a novel model to optimize truck dispatching decisions for drayage operations. We accounted for several sources of uncertainty (i.e., random trip durations and connection times) and developed a model to minimize expected costs given various operational constraints. The challenging part was to derive several mathematical expectations which were included in the objective function and constraints. A simple preprocessing procedure was employed to efficiently optimize a problem including hundreds of multi-dimensional integrals in the objective function and constraints. (Journal paper #3)

Transfer Coordination in Intermodal Freight Systems. Sponsor: the U.S. Department of Transportation. Period: 2009-2011

We looked at the problem of coordinating transfers in a single-hub intermodal system. The objective was to scheduling departures on the outbound routes, given the information about the stochastic arrival times of connecting vehicles on the inbound routes. We derived several expectations and built them into the objective function and

constraints. The resulting nonlinear nonconvex model was solved with metaheuristics. (Journal papers #5 and #6)

Freight Transportation Efficiency and Reliability. Sponsor: the U.S. Department of Transportation. Period: 2013-2014

We analyzed the effect of travel time variability and slack times provided in schedules on the reliability of connections at transfer terminals and deliveries to customers.

Research Projects (Pro Bono)

Machine Learning Applications

Predicting Dial-a-Ride System Capacity

We sought to establish a functional relation between the required system capacity and various characteristics of the service area and operator's constraints (e.g., demand density and its temporal distribution, size of the area, time windows, maximum route duration). We accounted for new influencing factors and showed that the generalized linear model outperformed linear regression, artificial neural network, and support vector regression. The generalized linear model was consequently implemented into an online system to provide free decision support to practitioners. (Journal papers #4 and #8)

Predicting Passenger Train Arrival Delays

We propose models that establish a functional relation between train delays and various characteristics of a railway system. Such models can be used to evaluate effects of different infrastructural projects on train delays, and thereby help managers design an investment plan to reduce delays in the most economical way. We identify new influencing factors. We present the first application of the support vector regression to the problem of predicting train delays, and show it provides competitive results with the neural network, which was applied successfully to similar problems in the literature. (Journal paper #7)

Professional Activities

Transportation Research Board (TRB) member

Institute for Operations Research and the Management Sciences (INFORMS) member

Reviewer for:

- Transportation Research Record, 2013 (3 papers).
- Transportation Research Record, 2014 (3 papers).
- Omega, The International Journal of Management Science, 2014 (1 paper).
- Winter Simulation Conference, 2014 (1 paper).

Programming/Software

MATLAB, GAMS, LaTeX, basic knowledge in C++ and VB

Languages

Serbian, English, German (~ZMP), Spanish (DELE Intermedio), French (basic)

Ski Instructor Licenses

- Landeslehrer 1, Carinthia, Austria, 2005
- Kinderlehrer, Carinthia, Austria, 2004