

WILLIAM BARBOUR

Research Scientist
Institute for Software Integrated Systems
Vanderbilt University
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EDUCATION

Vanderbilt University, Nashville, TN (VU) Doctor of Philosophy Civil and Environmental Engineering	<i>January 2018 - May 2020</i> GPA: 4.0
University of Illinois at Urbana-Champaign (UIUC) Master of Science, Civil and Environmental Engineering	<i>June 2015 - December 2017</i> GPA: 3.66
University of Tennessee, Knoxville (UTK) Bachelor of Science, Biosystems Engineering	<i>August 2011 - May 2015</i> GPA: 3.98

RESEARCH INTERESTS

- **Emerging technology in transportation:** Applying and understanding connectivity, automation, and data to improve efficiency, sustainability, and accessibility of transportation systems. This interest spans transportation modes to include rail freight transportation, shared micromobility, pedestrians and cyclists, and connected and automated vehicles.
- **Cyberphysical systems:** Bringing together computational tools, sensors, and the built environment to unlock new possibilities in our cities and infrastructure.
- **Societal applications of data science:** Designing new methods and using data in new ways to understand how people make decisions and how we can improve quality of life.

HONORS

Top Doctoral Fellow, Dwight D. Eisenhower Transportation Fellowship	<i>2020</i>
Dwight D. Eisenhower Transportation Fellowship, United States Department of Transportation	<i>2017, 2018, 2019, 2020</i>
2019 NSF Travel Grant for IEEE Pervasive Computing and Communications Conference	<i>2019</i>
Eno Leadership Development Fellow, Eno Center for Transportation	<i>2018</i>
Tennessee Sustainable Transportation Award, Tennessee Department of Transportation	<i>2018</i>
Student of the Year Award, Roadway Safety Institute	<i>2016</i>
Invited Participant at ThinkChicago: Chicago Ideas Week	<i>2016</i>

Civil and Environmental Engineering Graduate Fellowship, University of Illinois	2015 - 2016
College of Agricultural Sciences and Natural Resources Outstanding Senior Award	2015
Department of Biosystems Engineering and Soil Science Outstanding Senior Award	2015
William Harris III Undergraduate Research Award	2014
Research award in College Agricultural Sciences and Natural Resources	2013
University of Tennessee Chancellors Honors Program	2011 - 2015
University of Tennessee Haslam Scholar (one of 15 students annually)	2011 - 2015

PUBLICATIONS

Journal articles

- **W. Barbour**, S. Kuppa, D. B. Work. “Optimization-based evaluation of empirical dispatching results of freight trains.” *Transportation Research Part B: Methodological*, 2020 (submission pending).
- **W. Barbour**, M. Wilbur, R. Sandoval, C. Van Geffen, B. Hall, A. Dubey, and D. Work. “Data driven methods for effective micromobility parking.” *Transportation Research Part A: Policy and Practice*, 2020 (submission pending).
- D. Goudemans, **W. Barbour**, Z. Wang, C. T. Dick, D. B. Work. “Multi-label machine learning classification of simultaneous mechanical faults in electric motors.” *Journal of Rail and Rapid Transit* 2020 (under review).
- C. Janssen, **W. Barbour**, E. Hafkenschiel, M. Abkowitz, C. Philip, D. B. Work. “A City-to-City and Temporal Assessment of Peer City Scooter Policy.” *Transportation Research Record*, 2020 (in press).
- **W. Barbour**, S. Kuppa, D. B. Work. “Enhanced data reconciliation of freight rail dispatch data.” *Journal of Rail Transport Planning & Management*, 2020.
- G. Gunter, C. Janssen, **W. Barbour**, R. E. Stern, and D. B. Work. “Model based string stability of adaptive cruise control systems using field data.” *IEEE Transactions on Intelligent Vehicles*, 2019.
- **W. Barbour**, J. C. Martinez Mori, S. Kuppa, and D. B. Work. “Estimating Arrival Times for US Freight Rail Traffic.” *Transportation Research Part C: Emerging Technologies*, 2018.
- **W. Barbour** and P. Ayers. “Multi-Pass Rut Volume and Applied Power Study.” *Pursuit Journal of Undergraduate Research*, Volume 5: Issue 1, Article 5, 2014.

Conference proceedings

- **W. Barbour**, M. Wilbur, R. Sandoval, A. Dubey, and D. Work. “Streaming computation algorithms for spatiotemporal micromobility service availability.” In *Proceedings of the International Workshop on Design Automation for CPS and IoT*, Sydney, Australia, 2020.
- **W. Barbour**, M. Wilbur, R. Sandoval, C. Van Geffen, B. Hall, A. Dubey, and D. Work. “Data driven methods for effective micromobility parking.” In *Proceedings of the Transportation Research Board Annual Meeting*, Washington, D.C., 2020.
- C. Janssen, **W. Barbour**, E. Hafkenschiel, M. Abkowitz, C. Philip, and D. Work. “Comparative review of peer city scooter policy: city-to-city and temporal assessment.” In *Proceedings of the Transportation Research Board Annual Meeting*, Washington, D.C., 2020.

- M. Abkowitz, E. Kopstain, C. Philip, L. Shoup, **W. Barbour**, A. George, E. Hafkenschiel, A. Majewski. “Complete Campus: Vanderbilts Integrated Transportation Demand Management and Enhanced Mobility Program.” *Proceedings of the World Conference on Transportation Research*, Mumbai, India, 2019.
- **W. Barbour**, S. Kuppa, D. B. Work. “Data reconciliation of freight rail dispatch data.” In *Proceedings of the 9th International Conference on Rail Operations Modeling and Analysis*, Norrköping, Sweden, 2019.
- **W. Barbour**, A. Majewski, L. Shoup, E. Kopstain, C. Philip, D. Work. “Data-driven methods for dockless bike infrastructure planning.” In *Proceedings of the IEEE Pervasive Computing and Communications Conference*, Kyoto, Japan, 2019.
- **W. Barbour**, C. Samal, S. Kuppa, A. Dubey, D. Work. “On the Data-Driven Prediction of Arrival Times for Freight Trains on U.S. Railroads.” In *Proceedings of the IEEE Intelligent Transportation Systems Conference*, Maui, Hawaii, 2018.
- J. C. Martinez Mori, **W. Barbour**, S. Kuppa, D. Work. “Predicting Delay Occurrence at Freight Rail Sidings.” In *Proceedings of Transportation Research Board Annual Meeting*, Washington, D.C., 2017.
- **W. Barbour**, S. Kuppa, D. Work. “Supporting automated operations with improved arrival time predictions on US freight railroads.” In *Proceedings of the IRTL Conference on Integrated Transportation*, Stockholm, Sweden, 2016.

Other publications

- **W. Barbour**, E. Hafkenschiel, C. Philip, L. Shoup, D. Work. “Scooters are here to stay in Nashville. We have to make it work. – Opinion.” *Tennessean*, 24 June 2019.
- D. B. Work, **W. Barbour**, and R. Wang. “Improving Railroad Grade Crossing Safety: Accurate Prediction of Train Arrival Times for Emergency Response Management and Driver Decision Support.” Center for Transportation Studies, 2019.
- C. T. Dick, D. B. Work, **W. Barbour**, D. Gloudemans, Z. Wang. “Machine learning detection and classification of electric motor failure modes.” Final report to CRRC Corporation, 2019.
- K. Cagney, C. Catlett, P. Beckman, K. Galvin, M. Papka, M. Potosnak, D. Work, D. Pancoast, **W. Barbour**, J. Dunn, N. Ferrier, V. Forgione, D. Gloudemans, R. Kotamarthi, R. Sankaran, V. Welch. “Array of Things User Workshop.” Report to National Science Foundation, 2018.

WORK EXPERIENCE

Institute for Software Integrated Systems, Vanderbilt University Apr 2020 - Present
Research Scientist

- Manage and work on a variety projects in the domain of transportation systems; these include freight railroad operation, urban mobility, and highway traffic.
- Contribute to multiple aspects of project on real-world traffic control using autonomous vehicles. Experimentation will occur on the I-24 autonomous vehicle testbed, which is being planned, built, and developed in parallel.

Institute for Software Integrated Systems, Vanderbilt University Jan 2018 - Mar 2020
Graduate Research Assistant

- Project lead on data-driven methodologies for freight rail systems; collaboration with CSX transportation.

- Contributing to development of the I-24 autonomous vehicle testbed.

Vanderbilt Center for Transportation and Operational Resilience Jan 2018 - Mar 2020
Graduate Research Assistant

- Technical and strategic contribution to the MoveVU, the Vanderbilt campus mobility strategy.
- Project lead on the implementation of Array of Things sensors and video analytics for mobility applications.
- Leading multiple efforts on the management of micromobility devices at Vanderbilt and in the city of Nashville.

CSX Transportation Summer 2016
Network Modeling and Analytics Intern

- Led integration of GIS referencing with network simulation tools. Investigated the delay and predictability of freight train arrivals into terminals.

University of Illinois at Urbana-Champaign Jun 2015 - Dec 2017
Graduate Research Assistant

- Developed machine learning models for prediction of estimated time of arrival (ETA) of freight trains, using historical data mining and real-time network traffic state information.
- Implementing machine learning techniques to detect electric motor failure modes.

Oak Ridge National Laboratory Summer 2014
Utilities Engineering Intern

- Conducted engineering studies on fiber optic communication, water, and electric utility infrastructure to support sustainable capital expansion of Oak Ridge National Laboratory.

Biosystems Engineering Lab, University of Tennessee Oct 2011 - May 2015
Undergraduate Research Assistant

- Designed and built specialized multi-sensor platforms for underwater and river-bank video mapping based on canoes, kayaks and snorkels. Developed techniques for spatial referencing and cataloging of rich sensor data.
- Conducted terrain impact studies of wheeled vehicles in cooperation with the US Army Corps of Engineers.

Hawaii Department of Land and Natural Resources Apr 2014 - May 2014
Consultant

- Utilized aquatic multi-sensor platforms and geospatial data analytics for assessment of urban waterways.

TEACHING EXPERIENCE

Undergraduate student mentorship

List of students, accomplishments, and future placement

- Juan Carlos Martinez Mori: Worked on machine learning for freight rail forecasting, which was published as a conference paper at the TRB Annual Meeting, 2017. Carlos went on to study as a Ph.D. student in systems engineering at Cornell University.

- Bochen Xu: Performed advanced visualization for rail dispatching data, which continues to aid in freight rail projects and publications. Bochen graduated and began studying as a M.S. student in computer science at the University of Massachusetts, Amherst.
- Derek Gloudemans: Applied multi-label machine learning algorithms and signal processing techniques for the classification of electric motor failure modes. This work was prepared as a journal article and is pending submission. Derek stayed at Vanderbilt as a Ph.D. student in computer science.
- Caroline Janssen: Contributes to the Array of Things project at Vanderbilt, as well as multiple efforts related to micromobility and campus transportation. Her work on micromobility was accepted as a conference paper at the TRB Annual Meeting, 2020, and is in review with *Transportation Research Record*.
- Ricardo Sandoval: Continues to work on big data analysis and machine learning applications for micromobility infrastructure and equity. He has contributed to two accepted conference proceedings – IEEE PerCom, 2019, and TRB Annual Meeting, 2020 – and two pending journal submissions.
- Caleb Van Geffen: Continues to work on data-driven micromobility parking management, which was accepted as a conference paper at the TRB Annual Meeting, 2020, and is pending as a journal submission.
- Brandon Hall: Worked during summer 2019 on data-driven micromobility parking management, which was accepted as a conference paper at the TRB Annual Meeting, 2020, and is pending as a journal submission.
- Matthew Neuendorf: Continues to contribute on systems engineering analysis report for I-24 autonomous vehicle testbed and parking localization of micromobility devices using radio frequency identification.
- Crystal Chen: Works on parking localization of micromobility devices using radio frequency identification.

School for Science and Math at Vanderbilt (SSMV)

November 2019 - present

Project Mentor

- Served as project mentor to a group of three high-school students working on a multi-sensor data dashboard for the Array of Things project at Vanderbilt.

Vanderbilt Summer Academy (VSA), Peabody College

January 2019 - August 2019

Course Designer and Instructor, “Sensors and Big Data Analysis”

- Designed and instructed summer course for 30 gifted high school students participating in residential summer education program at Vanderbilt University Peabody School of Education.
- Course focused on societal applications of sensors and data, electrical engineering of sensor prototypes, and analysis of large datasets in Python.

Weekend Academy at Vanderbilt (WAVU), Peabody College

October 2019

Course Designer and Instructor, “Sensors and Big Data Analysis”

- Designed and instructed one-day course for 15 high school students, focusing on assembling electrical circuits, interfacing with sensors to collect data, and using data analysis to answer a research question.

CE 5890: Sustainable Infrastructure Systems

Fall 2018

Graduate Teaching Assistant

- Led introduction of students to Python programming language and translated course materials into Python.
- Conducted project help sessions for students, regarding programming and course content.

Mentoring Undergraduate Students in Engineering (UIUC)

2016 - 2017

Graduate Mentor

- Mentored undergraduate engineering students in semester-long research projects. Taught skills such as database management, data visualization, and basic machine learning techniques.

UNHO 102: Humanity and the Environment (UTK)

Spring 2013

Instructor

- Designed and led 1-hour seminar course taken by freshman honors students, focused on anthropogenic environmental impacts and sustainable energy.

BSE 451: Electronic Systems (UTK)

Spring 2015

Teaching Assistant

- Prepared lab materials and exercises and assisted students with completion.
- Delivered abbreviated lectures to supplement laboratory exercises.

HSP 195: Leadership Program (UTK)

Summer 2013, Spring 2015

Teaching Assistant

- Assisted in program planning for entering freshman Haslam Scholars.
- Presented on general undergraduate research at the University of Tennessee. Led kayaking lesson, relating to personal stream mapping research with kayak sensor platform.

PRESENTATIONS AND LECTURES

Academic presentations

- “Data-driven micromobility management.” Eisenhower Fellowship Doctoral Research Showcase, Transportation Research Board Annual Meeting, 2020.
- “Data-driven methods for effective micromobility parking.” Transportation Research Board Annual Meeting, 2020.
- “Data reconciliation of freight rail dispatching data.” International Conference on Rail Operations Modeling and Analysis (RailNorrkping), 2019.
- “Data-driven calibration for optimal dispatching.” International Conference on Rail Operations Modeling and Analysis (RailNorrkping), 2019.
- “Data-driven methods for dockless bike infrastructure planning.” Workshop on Technologies and Solutions for Urban Mobility at the IEEE Pervasive Computing and Communications Conference, 2019.
- “Data-driven methods for smart rail transportation.” IEEE Intelligent Transportation Systems Conference, Smart Rail Workshop, 2018.
- “On the Data-Driven Prediction of Arrival Times for Freight Trains on U.S. Railroads.” IEEE Intelligent Transportation Systems Conference, 2018.
- “Data-driven methods for dockless bike infrastructure planning.” Tennessee Sustainable Transportation Forum and Expo, 2018.

- “Prediction of arrival times of freight traffic on US railroads using support vector regression.” INFORMS Annual Meeting, Houston, TX, 2017.
- “Prediction of arrival times of freight traffic on US railroads using machine learning regression.” Rail Infrastructure and Vehicle Inspection Technology Conference 2017, University of Illinois at Urbana-Champaign.
- “Prediction of arrival times of freight traffic on US railroads using machine learning regression.” Presentation at National University Rail Center, University of Illinois at Urbana-Champaign, 2017.
- “Supporting automated operations with improved arrival time predictions on US freight railroads.” IRTL Conference on Integrated Transportation, 2016.
- “A machine learning framework for predicting arrival times of freight traffic on US railroads.” Workshop on Data Quality in an Era of Big Data, University of Indiana, 2016.
- “Design of a Mobile Shade and Cooling Structure for Grazing Dairy Herds.” Exhibition of Undergraduate Research and Creative Achievement, 2015 (with J. McMillan and E. Moore).
- “Integration of Continual Water Parameter Measurement with Existing Aquatic Habitat and Streambank Mapping Systems.” Honors Undergraduate Research Symposium, 2015.
- “Design of an Underwater Video and GPS Mapping System for the Exploration of Streambed Aquatic Populations.” Exhibition of Undergraduate Research and Creative Achievement, 2013.
- “Multi-Pass Rut Volume and Applied Power Study.” Honors Undergraduate Research Symposium, 2013.

Outreach presentations

- “Keeping tech enabled mobility systems from making mobility worse.” Governing Wicked Problems seminar, Vanderbilt Law School, 2019.
- “Mobility analytics and management.” Presentation to Kansas City Chamber of Commerce, 2019.
- “Vanderbilt University mobility initiatives.” Presentation to BCycle, 2019.
- “Autonomous vehicles: the end of traffic?” Vanderbilt University Family Weekend, 2019.
- “Urban planning and transportation engineering.” STEM day with Metro Nashville Public Schools at Vanderbilt University, 2019.
- “Data-driven infrastructure and mobility.” Invited presentation, Hawkins Partners, 2018.
- “Urban planning and transportation.” STEM day with Montgomery Bell Academy and Harpeth Hall School, 2018.
- “Rail transportation engineering and logistics.” Guest Lecture, CE 3501: Transportation Systems Engineering, 2018.
- “Data analytics and insight.” Presentation to Chancellor and executive leadership of Vanderbilt University, 2018.
- “Undergraduate research at the University of Tennessee.” New faculty orientation at the University of Tennessee, 2014.

Other presentations

- “Insights from machine learning techniques on data-driven prediction of train arrival times.” Presentation to CSX Transportation Operations Research, Network Modeling, and Analytics, 2016 (with D. Work).

PROJECTS

Freight rail analytics and modeling

- Development of next generation data-driven modeling for freight rail networks using machine learning and large-scale optimization.
- Automated data feasibility correction and missing data imputation of rail trajectory/dispatching data.
- Relies on fusion of multiple high-volume data streams and geospatial data.

Micromobility analytics and planning

- Performing data-driven planning for urban micromobility, focused on improving safety and adapting the built environment to new forms of personal transportation.
- Dockless bike share route assessment to determine locations in need of bike infrastructure improvements and the associated rider impact potential of each.
- Optimal locations for micromobility parking facilities using dataset of 1.5M dockless e-scooter trips.
- High resolution parking localization using radio frequency identification (RFID) technology.

Smart cities sensing

- Leading the deployment of Array of Things sensors on the campus of Vanderbilt University for collecting air quality and environmental data.
- Deployment of continuous computer vision processing for anonymized mobility data.

Highway traffic sensing and autonomous vehicle technology evaluation

- Developing sensing system for highway traffic using a dense deployment of high-resolution cameras to extract precise vehicle trajectories.
- Collection of vehicle telemetry data during controlled field experiments of low-level autonomy functions. Data is used to model the real-world traffic stability of platoons of vehicles employing these technologies.

COURSEWORK

Computer science	Artificial intelligence, Reinforcement learning, Data mining, Analysis of network data
Mathematics	COURSE NUMBERS
	Introduction to optimization, Statistics of big data and clustering, Control system theory and design
Cyberphysical systems	Cyberphysical systems, Data science methods for smart city applications
Transportation	Traffic capacity analysis, Logistics systems analysis, Public transportation systems

SERVICE

Organizations

- Programming committee, International Conference on Rail Operations Modelling and Analysis, 2019.
- Senior design project mentor, Civil and Environmental Engineering, Vanderbilt University, 2018-2019.
- Organizer, FutureVU Mobility Expo, Vanderbilt University, 2018.
- Project team member and leadership team member, MoveVU initiative, Vanderbilt University, 2018.

- Parliamentarian, American Society of Agricultural and Biological Engineers, Southeastern Region, 2014.
- President (2013), Treasurer (2014), American Society of Agricultural and Biological Engineers, University of Tennessee chapter.
- Chair, Haslam Scholars Program Recruitment Committee, 2013-2014.
- Study abroad ambassador, College of Agricultural Sciences and Natural Resources, 2013-2015
- Selection committee for Director of Chancellors Honors and Haslam Scholars Program, Spring 2012
- Tau Beta Pi Engineering Honor Society, 2011-present

Publishing

- Reviewer, IEEE Transactions on Intelligent Transportation Systems, 2018-2019.
- Reviewer, IEEE Transactions on Intelligent Vehicles, 2018-2019.
- Reviewer, IEEE Intelligent Transportation Systems Conference, 2018.
- Reviewer, Transportation Research Board Annual Meeting, 2016-2020.

Volunteering

- Founding member and Vice President of Finance and Fundraising of Net Impact, University of Tennessee chapter.
- Trip leader, Alternative Spring Break program on environmental conservation, Spring 2014.
- Volunteer, Knoxville Botanical Gardens and Arboretum, 2012-2015
- Volunteer, Ijams Nature Center (Knoxville, TN), 2014-2015
- Volunteer, Ronald McDonald House (Knoxville, TN), 2013-2015

TECHNICAL SKILLS

Programming	Python (level 4/5), MATLAB (level 3/5), Java (level 2/5), R (level 2/5)
Machine learning	Scikit-learn, Tensorflow, Keras
Databases	PostgreSQL, MySQL, Oracle
Mathematical programming	AMPL, CPLEX, optimization in Python
Embedded systems	Arduino, CircuitPython
GIS	QGIS, ArcMap, PostGIS
Software & Tools	MS Office, LaTeX
Engineering design and fabrication	AutoCAD, Autodesk Inventor, woodworking, welding, basic metal machining