

# KRISHNA MURTHY GURUMURTHY

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## EDUCATION

### The University of Texas at Austin, USA

Doctor of Philosophy in Civil Engineering (*Transportation Engineering*)

**expected August 2020**

GPA: 3.88 / 4.00

*Dissertation* Shared Autonomous Vehicle System Designs for Major Metro Areas: An Examination of Geofencing, Road-Pricing, Drivetrain, Dynamic Ride-Sharing, and Stop-Location Decisions

*Current Courses* 'Consulting Seminar' and 'Maximum Likelihood Statistics'

### The University of Texas at Austin, USA

Master of Science in Statistics and Data Sciences

**expected May 2020**

GPA: 3.95 / 4.00

*Courses* 'Graduate Research in Statistics', 'Design and Analysis of Experiments', 'Mathematical Statistics – II', 'Mathematical Statistics – I', 'Bayesian Statistical Methods', 'Dynamic Traffic Assignment' and 'Public Transportation'

### The University of Texas at Austin, USA

Master of Science in Civil Engineering (*Transportation Engineering*)

**December 2017**

GPA: 3.81 / 4.00

*Thesis* [Perceptions and Preferences of Autonomous and Shared Autonomous Vehicles: A Focus on Dynamic Ride-Sharing](#)

*Courses* 'Statistical Modeling I', 'Advanced Theory of Traffic Flow', 'Optimization I', 'Design and Evaluation of Ground-based Transportation Systems', 'Sensors and Signal Interpretation', 'Transportation Network Analysis', 'Urban Transportation Planning' and 'Linear Regression and Discrete Choice Methods'

### National Institute of Technology Karnataka (NITK), India

Bachelor of Technology in Civil Engineering

**May 2016**

GPA: 8.92 / 10.00

*Project Report* Framework for Various Traffic Models under Mixed Traffic Conditions

*Courses* 'Highway and Traffic Engineering', 'Railways, Tunnels, Harbors and Airports' and 'Traffic Engineering and Management'.

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## RESEARCH EXPERIENCE

### Graduate Research Assistant

**Fall 2016 – Present**

*Supervisor: Dr. Kara Kockelman*

*UT Austin*

- Worked on two projects sponsored by the Texas Department of Transportation (0-6847 & 0-6838) from 2016-18, both focusing on autonomous and shared autonomous vehicles (S/AVs).
  - Deliverables included (1) creating and disseminating a U.S. survey on AV & SAV preferences, model estimations, and reporting, (2) an agent-based simulation of Austin, Texas using MATSim to capture travel behavior and future mode forecasts, that lead to two pricing-related journal papers, and (3) an AirSage-data supported simulation to estimate dynamic ride-sharing potential, that also lead to a journal paper.
- Mentored an MS student on an NSF-funded SRN project to simulate and forecast travel behavior for the Minneapolis-St Paul region using MATSim.
- Currently charged with an ANL project focusing on transportation planning/forecasting for SAVs
  - Completed deliverables include successful SAV integration within POLARIS, along with a heuristic-based dynamic ride-sharing algorithm.
  - On-going deliverables include incorporation of a shared electric AV module in POLARIS that keeps track of charging stations and available charge, and a road-pricing module integrated into the available router.
  - The impact of ride-sourcing vehicles at the O'Hare airport will also be investigated.

### Research Aide – Technical

**Summer 2018**

*Supervisor: Dr. Joshua Auld*

*Argonne National Laboratory*

- Tasked with developing algorithms for the control of shared-automated vehicle fleets and implementing the control & optimization algorithms in ANL's POLARIS
  - This 3-month internship involved understanding POLARIS, refreshing C++ syntax, developing an SAV module that integrates into the existing simulator to preserve feedback, and verifying SAV behavior through both code logic and visual tracing.

### Project Research Intern

**Spring 2016 – Summer 2016**

*Supervisors: Drs. Tom V Mathew & Gowri Asaithambi*

*Indian Institute of Technology Bombay*

- Implemented a bi-directional traffic flow heuristic and mid-block pedestrian crossing models into a simulator developed in MATLAB. Tested robustness and ensured both components worked well together, and reported brief simulator results to confirm functionality.

#### Summer Research Intern

Summer 2015

Supervisor: Dr. Tom V Mathew

Indian Institute of Technology Bombay

- An innovative traffic flow model, the spring-mass-damper, was implemented in MATLAB to test the impact and sensitivities of model parameters, and was consequently presented at TRB.

### TEACHING EXPERIENCE

#### Teaching Assistant

Course Instructor: Dr. Kara Kockelman

Spring '19

CE392E: Acquisition and Analysis of Transport Data (Graduate Course)

UT Austin

- Responsible for students' performance in designing, implementing, collecting and modeling survey data focused on transportation engineering and policy.
- Created an assignment to educate students on data scraping opportunities using APIs to enhance the value of survey-collected data.
- Introduced Bayesian-approaches to data analysis by modifying existing assignments to encourage learning non-traditional approaches.
- Held office hours to improve students' understanding of STATA so that they can apply it on class projects.

#### Teaching Assistant

Course Instructor: Dr. Kara Kockelman & Ms. Heidi Ross\* Spring '17, '18\* & '19

CE367G: Design & Evaluation of Ground-Based Transportation Systems (Undergraduate Course)

UT Austin

- Responsible for students' understanding of highway-design terminology and curve design.
- Introduced the use of Excel for benefit-cost analysis, rule-of-half to include induced demand, and the solver for basic optimization.
- Helped students navigate the use of MicroStation and GEOPAK for highway design on their final design-project for this capstone course in transportation engineering.

### BOOK CHAPTERS

- Gurumurthy, K.M.**, Kockelman, K.M., and Loeb, B.J. 2019. Sharing Vehicles & Sharing Rides in Real Time: Opportunities for Self-Driving Fleets. Forthcoming chapter in *Advances in Transport Policy and Planning: The Sharing Economy and the Relevance for Transport* (Ed. Elliot Fishman).
- Co-author of Chapter 18 in *Smart Transport for Cities & Nations: The Rise of Self-Driving & Connected Vehicles*. 2018. Kara Kockelman and Stephen Boyles (Eds). Published by CreateSpace on Amazon.com, August 2018. ISBN-10:0692121501, ISBN-13: 978-0692121504.

### PUBLICATIONS

- Gurumurthy, K.M.**, Kockelman, K. and Simoni, M.D. 2018. Benefits & Costs of Ride-Sharing in Shared Automated Vehicles across Austin, Texas: Opportunities for Congestion Pricing. *Transportation Research Record* 2673 (6): 548-556.
- Simoni, Michele D., Kockelman, K., **Gurumurthy, K.M.** and Bischoff, J. 2018. Congestion Pricing in a World of Self-Driving Vehicles: An Analysis of Different Strategies in Alternative Future Scenarios. *Transportation Research Part C: Emerging Technologies* 98: 167-185.
- Gurumurthy, K.M.** and Kockelman, K. 2018. Analyzing the Dynamic Ride-Sharing Potential for Shared Autonomous Vehicle Fleets using Cellphone Data from Orlando, Florida. *Computers, Environment and Urban Systems* 71: 177-185.

### CONFERENCE PAPERS

- Mahmoud, J., Auld, J., and **Gurumurthy, K.M.** 2018. Intra-Household Fully Automated Vehicles Assignment Problem: Model Development and Case Study. Presented at the 98th Annual Meeting of the Transportation Research Board.
- Gurumurthy, K.M.** and Kockelman, K. 2018. Modeling Americans' Autonomous Vehicle Preferences: A Focus on Dynamic Ride-Sharing, Privacy & Long-Distance Mode Choices. Presented at the 98<sup>th</sup> Annual Meeting of the Transportation Research Board and under review for publication in *Technological Forecasting and Social Change*.

- Kotagi, P., Asaithambi, G. and **Gurumurthy, K.M.** 2018. Development of Microscopic Simulation Model for Bidirectional Mixed Traffic on Urban Roads. Presented at the 97<sup>th</sup> Annual Meeting of the Transportation Research Board in Washington, D.C.
- **Gurumurthy, K.M.**, Munigety, C.R., Peeta, S., Mathew, T.V. and Asaithambi, G. 2017. An Integrated Pedestrian Crossing Behavioural Model Using Spring-mass-damper Dynamics. Presented at the 96<sup>th</sup> Annual Meeting of the Transportation Research Board in Washington, D.C.
- **Gurumurthy, K.M.**, Singh, V. and Asaithambi, G. 2016. Microscopic Analysis of Lateral and Longitudinal Gaps in Mixed Traffic Conditions with Weak Lane Discipline. Presented at the 12th International Conference on Transportation Planning and Implementation Methodologies for Developing Countries in Mumbai, India.
- Munigety, C.R., Gupta, P.A., **Gurumurthy, K.M.**, Peeta, S. and Mathew, T.V. 2016. Vehicle-type Dependent Car following Model Using Spring-mass-damper Dynamics for Heterogeneous Traffic. Presented at the 95<sup>th</sup> Annual Meeting of the Transportation Research Board in Washington, D.C.

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## PRESENTATIONS

- Invited Speaker, at the SESYNC Pursuit: People, Land, Water and Fish - Integrating Social and Environmental Models in the Chesapeake Watershed held in Annapolis, Maryland, presentation titled "Modeling Emerging Modes and Advanced Policies in MATSim", 21-22 February 2019.
- Selected Speaker, at the TRB Workshop on Doctoral Research in Transportation Modeling and Travel Behavior held in Washington, D.C., presentation titled "A System of Shared Autonomous Vehicles for Chicago: Anticipating Impacts at Multiple Stages of Adoption", 13 January, 2019.
- Invited Speaker, at the Machine Intelligence in Autonomous Vehicles Summit held in San Francisco, presentation titled "Anticipating a World of Shared Fully-Automated Vehicles" on behalf of Dr. Kara Kockelman, 23-24 March, 2017.

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## PAPERS UNDER REVIEW

- **Gurumurthy, K.M.**, de Souza, F., Enam, A., and Auld, J. Large-Scale Simulation of Shared Autonomous Vehicles: Integrating the Supply and Demand Perspectives. Under review for presentation at the 99<sup>th</sup> Annual Meeting of the Transportation Research Board, Washington, D.C.
- **Gurumurthy, K.M.**, and Kockelman, K.M. Impacts of Shared Automated Vehicles on Airport Access & Operations, With Opportunities for Revenue Recovery: Case Study of Austin, Texas. Under review for presentation at the 99<sup>th</sup> Annual Meeting of the Transportation Research Board, Washington, D.C.
- **Gurumurthy, K.M.**, Auld, J., and Kockelman, K.M. A System of Shared Autonomous Vehicles for Chicago: Understanding the Effect of Geofencing the Service. Under review for presentation at the 99<sup>th</sup> Annual Meeting of the Transportation Research Board, Washington, D.C.
- **Gurumurthy, K.M.**, Kockelman, K.M., and Zuniga-Garcia, N. First-Mile-Last-Mile Collector-Distributor System using Shared Autonomous Mobility. Under review for presentation at the 99<sup>th</sup> Annual Meeting of the Transportation Research Board, Washington, D.C.
- Yan, H., Kockelman, K.M., and **Gurumurthy, K.M.** Agent-based Simulation for Shared Autonomous Vehicle Use across the Minneapolis-Saint Paul Region. Under review for presentation at the 99<sup>th</sup> Annual Meeting of the Transportation Research Board, Washington, D.C.
- Becker, H., Becker, F., Abe, R., Bekhor, S., Belgiawan, P.F., Compostella, J., Frazzoli, E., Fulton, L.M., Garrick, N., Bicuda, D.G., **Gurumurthy, K.M.**, Hensher, D.A., Joubert, J.W., Kockelman, K.M., Kroger, L., Kuhnimhof, T., Vine, S.L., Malik, J., Marczuk, K., Nasution, R.A., Rich, J., Carrone, A.P., Shen, D., Shiftan, Y., Tirachini, A., Verdis, D., Wong, Y.Z., Zhang, M., Bosch, P.M. and Axhausen, K.W. 2018. Impact of Vehicle Automation and Electric Propulsion on Production Costs for Mobility Services Worldwide. Under review for presentation at the 99<sup>th</sup> Annual Meeting of the Transportation Research Board, Washington, D.C., and for publication in *Transportation Research Part A: Policy and Practice*.

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## TECHNICAL REPORTS

- Kockelman, K., Boyles, S., Sturgeon, P., Claudel, C., ... **Gurumurthy, K.M.**, He, D., ... and Yarmohammadisatri, S. "Phase 2 - Bringing Smart Transport to Texans: Ensuring the Benefits of a Connected and Autonomous Transport System in Texas - Final Report". Technical Report FHWA/TX-18/0-6838-3, TxDOT, CTR, UT Austin, TX, July 2018.
- Kockelman, K., Loftus-Otway, L., Stewart, D., Nichols, A., Wagner, W., Boyles, S., Levin, M., Liu, J., Perrine, K., Kilgore, S., and **Gurumurthy, K.M.** "Best Practices for Modifying Transportation Design, Planning, and Project Evaluation in Texas." Report 0-6847-P1, TxDOT, CTR, UT Austin, TX, March 2017.

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## PEER REVIEWER – JOURNALS

*Transportation Research – Part A, Part B, Part C, Part D • Computers, Environment and Urban Systems • Transport Policy • Transportation • Transportation Research Record: Journal of the Transportation Research Board*

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## PROGRAMMING LANGUAGES

C++ • MATLAB • Java • R • Python • C#

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## SOFTWARE SKILLS

TransCAD • Microsoft Office • ArcGIS, QGIS • STATA, SPSS, SAS • Mathematica • MicroStation, GEOPAK

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## RESEARCH PROJECTS

### **Implementing Shared Autonomous Vehicles in POLARIS and Assessing the Impact of Dynamic Ride-Sharing in Chicago** **Fall 2018 – Present**

*Supervisor: Dr. Kara Kockelman (Sponsored by Argonne National Laboratory)*

*UT Austin*

POLARIS, an agent-based discrete event simulator developed by the Argonne National Laboratory, is being enhanced to simulate shared autonomous vehicles with dynamic ride-sharing capabilities. Policies such as geofencing the service, pre-determined pick-up and drop-off spots, and congestion pricing are being analyzed to understand the future of mobility.

### **First-Mile-Last-Mile Collector-Distributor System Using Shared Autonomous Mobility** **Fall 2018**

*Supervisor: Dr. Randy Machemehl (In a graduate course: CE 392M)*

*UT Austin*

An agent-based simulator, MATSim, was used to analyze an SAV fleet serving as a first-mile-last-mile collector-distributor system. The outcome of the analysis revealed that parameters like SAV fares, transit fares and SAV service characteristics were integral to SAVs complementing and supplementing transit. Without proper regulation, transit shares were found to drop across many scenarios.

### **Agent-Based Microsimulations of Shared Autonomous Vehicles in Austin using Dynamic Ride-Sharing on MATSim** **Fall 2016 – Summer 2018**

*Supervisor: Dr. Kara Kockelman (Sponsored by TxDOT)*

*UT Austin*

Multi-Agent Transport Simulation (MATSim), an agent-based simulation model was used to simulate shared autonomous vehicle simulations. Tolling and AVs were incorporated into an existing SAV module. Several scenarios were run based on different congestion-pricing and fare policies with dynamic ride-sharing being an integral part of the analysis. Studies showed that thoughtful tolls and policies may be integral to moderating added congestion.

### **Nationwide Survey on the Implications of Autonomous Vehicles in the United States** **Spring 2017 – Spring 2018**

*Supervisor: Dr. Kara Kockelman (Sponsored by TxDOT)*

*UT Austin*

A survey with around 70 questions was created to address various issues regarding autonomous vehicles (AVs). The main topics targeted in this survey were privacy, security and ethics and questions regarding dynamic ride-sharing. 2,588 respondents were acquired using a panel of Americans by Survey Sampling International. Key questions on dynamic ride-sharing, privacy and long-distance travel were modeled using different statistical models. Model elasticities revealed that privacy may not be a concern in the future, willingness to pay to share rides would increase and shared AVs would dominate shorter long-distance trip shares.

### **Analyzing the Dynamic Ride-Sharing Potential for Shared Autonomous Vehicle Fleets Using Cellphone Data from Orlando, Florida** **Spring 2017 – Spring 2018**

*Supervisor: Dr. Kara Kockelman (Sponsored by TxDOT)*

*UT Austin*

Cellphone data obtained for Orlando was spatially and temporally disaggregated to have a resolution of one minute and intersection-level detail. Disaggregated data was used to assess the dynamic ride-sharing potential for the region by comparing origin-destination versus en route dynamic ride-sharing. A simulation of a fleet of autonomous vehicles was used to estimate optimal fleet sizes for the region.

### **Estimating a Car-Following Model Based on Spring-Mass-Damper Dynamics using NGSIM Data** **Fall 2017**

*Supervisor: Dr. Christian Claudel (In a graduate course: CE 391F)*

*UT Austin*

An open-source dataset for vehicle trajectories by NGSIM was used to develop a microscopic car-following model. Model formulation was carried out based on an existing spring-mass-damper-based dynamics with certain alterations. Then, data

fitting was carried out using non-linear optimization in MATLAB. Lag reaction times were estimated using an auto-correlation chart. Model was found infeasible when incorporating lag.

### **Evaluating Traffic Characteristics by Mining IMU Data: An Exploratory Study**

**Spring 2017**

*Supervisor: Dr. Christian Claudel (In a graduate course: CE 397)*

*UT Austin*

An inertial measurement unit (IMU) fitted with a GPS device was used to collect 3-4 hours' worth of data over a period of 7 days. Data was cleaned and processed to ensure segmented continuity, and an unsupervised machine-learning model was applied. The predictive power of certain pitch and acceleration variables from the IMU was high. The project concluded that better data collection efforts and data tagging can ensure high prediction of traffic characteristics using an IMU.

### **Travel Demand Modeling using TransCAD**

**Fall 2016**

*Supervisor: Dr. Kara Kockelman (In a graduate course: CE 391H)*

*UT Austin*

Austin's MPO (CAMPO) data was used to carry out travel demand modeling in the 6-county region of Austin. Various scenarios were developed and their individual feasibilities were tested. Increasing parking costs in the central business district showed most promise to mitigate congestions.

### **A Path-Based Incentive Approach to Achieving System Optimum**

**Fall 2016**

*Supervisor: Dr. Stephen Boyles (In a graduate course: CE 392C)*

*UT Austin*

A mathematical model with equilibrium constraints was developed to achieve system optimum. Budgeted allocation of path-based incentives was analyzed. Significant reductions in travel times relied primarily on appropriate use of funds.

### **Framework for Various Traffic Models under Mixed Traffic Conditions**

**Fall 2015 – Spring 2016**

*Supervisors: Dr. Gowri Asaithambi & Dr. Tom V Mathew*

*NITK & IIT Bombay*

Previous simulation models under mixed traffic conditions were studied to identify important parameters affecting similar conditions. Models for pedestrian crossing, uncontrolled intersections were formulated and executed.

### **Quantitative Determination of Vehicle Influence in Mixed Traffic Conditions**

**Fall 2015**

*Supervisor: Dr. Gowri Asaithambi*

*NITK*

Open access mixed traffic trajectory data collected in Chennai, India was used in this project. Vehicle type dependency and factors affecting the influence was analyzed. Sensitivity analysis was conducted to check the effect of influential parameters.

### **Modeling Mid-Block Sections under Mixed Traffic Conditions**

**Summer 2015**

*Supervisor: Dr. Tom V Mathew*

*IIT Bombay*

The traffic model was theorized based on spring-mass-damper dynamics for integrated movement. Microscopic model for a single vehicle was implemented in Excel and then extrapolated as a simulator for many vehicles using MATLAB. Extensive test cases were conducted to verify the robustness of the model. Quick turnover in internship requirements led to a conference paper immediately.

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## **CO-CURRICULARS & VOLUNTEERING**

<b>Friend</b> , TRB's AHB30 Standing Committee on Vehicle-Highway Automation	2019 – Present
<b>Friend</b> , TRB's ABJ40 Standing Committee on Travel Survey Methods	2018 – Present
<b>Friend</b> , TRB's ABE50 Standing Committee on Transportation Demand Management	2018 – Present
<b>Friend</b> , TRB's ADB40 Standing Committee on Transportation Demand Forecasting	2017 – Present
<b>Friend</b> , TRB's ADE90 Standing Committee on Transportation in the Developing Countries	2017 – Present
<b>Eno Fellow</b> , Eno Center for Transportation	Class of 2019
<b>Core Team Member</b> , UT Austin Traffic Bowl Team	2017 & 2019
<b>Marketing Coordinator</b> , UT Apartment's Tenant Advisory Board	Spring 2019 - Present
<b>Selection Committee</b> , UT Graduate Student Assembly's Travel Awards	Spring 2019
<b>Volunteer</b> , Clean-up drive organized by Capital Area Section – ITE	Spring 2017, Spring 2018
<b>Volunteer</b> , Women's Transportation Seminars – Heart of Texas' Annual Gala	Spring 2018
<b>Member &amp; Ex-Officer</b> , Women's Transportation Seminars, UT Austin Student Chapter	Fall 2017 – Present
<b>Member &amp; Past President</b> , Institute of Transportation Engineers, UT Austin Student Chapter	Fall 2016 – Present
<b>Member &amp; Ex-Officer</b> , Intelligent Transportation Society of America, UT Austin Student Chapter	Fall 2016 – Present
<b>Mentor</b> , Graduates Linked with Undergraduates in Engineering ( <u>GLUE</u> )	Fall 2017
<b>Lead Event Organizer</b> , Texas Student Leadership Summit	Fall 2017
<b>Member</b> , ASCE UT Austin Chapter	Spring 2017 – Fall 2017
<b>Executive Member</b> , ASCE NITK Students' Chapter	Spring 2014 – Spring 2016

## **AWARDS & ACHIEVEMENTS**

- Received the Conference of Minority Transportation Officials (COMTO) scholarship to attend the 2019 Eno Future Leaders Development Conference in Washington, D.C.
  - Awarded the Graduate Research Award by the Airport Cooperative Research Program for the period 2018-19.
  - Received the Outstanding Student Award at TexITE Spring Meeting in 2018.
  - Awarded the CAS-ITE (2017), ITS Texas (2017, 2018) scholarships, and Texas district ITE fellowship award (2017).
  - Part of the UT Austin Traffic Bowl Team that won the Texas district championship in Spring 2017 and came second in the International championships in Summer 2017
  - Won the “Best Paper Award” at a student-run symposium called “AAKAAR” at IIT Bombay for presenting a paper titled “Quantitative Determination of Vehicle Influence in Mixed Traffic Conditions”.
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## **MENTEES**

Haonan Yan (MS) • Hyungseung (Jeffrey) Hahm (UG) • Evelyn Reyes (GLUE)

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## BIOGRAPHY

Krishna Murthy Gurumurthy is a doctoral student in transportation engineering at The University of Texas at Austin, pursuing his research under Dr Kara Kockelman. He received his master's in civil engineering from UT Austin in December 2017, and a bachelor's from the National Institute of Technology Karnataka, India in May 2016. He is expected to graduate with a Ph.D. in summer of 2020, along with a master's in statistics.

His research focuses on travel demand modeling & forecasting, especially through the utilization of largescale agent-based simulation tools. He is particularly interested in capturing the impacts of shared and automated vehicles (S/AVs) on travel patterns and congestion and measuring the resulting effects of various policies.

Murthy, as he's often called, is an Eno Fellow from the 2019 class, actively participates in events organized by transportation organizations like ITE, ITS and WTS, and has previously served in leadership roles in their respective student chapters at UT. In addition to several scholarships, he is also the recipient of the 'Outstanding Student' award by Texas ITE. In his free time, he enjoys playing basketball and racquetball, and is interested in photography.

