Rafał Kucharski *born October 17, 1986*

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Summary

Assistant Professor, Jagiellonian University, Krakow, Poland

I research complex social systems: urban mobility. Congested, urban multimodal networks used by millions of agents to reach their destinations and leaving huge sets of mobility traces ready to be applied for modelling, optimization, understanding and control.

From 2023 I will run the *ERC Starting Grant* which will simulate *COeXISTENCE* between AI and humans in future cities. I will merge transport modelling with deep reinforcement learning with a group of 3 PhDs and a PostDoc.

Currently, as an Assistant Professor in the Faculty of Mathematics and Computer Science of Jagiellonian University in Krakow (Poland) I am part of the Group of Machine Learning Research GMUM. I run the NCN Opus Grant on Shared Mobility in the pandemic times and run a team to research complex social systems of urban mobility within the DigiWorld scheme. We are now a team of two PhDs and two PostDocs.

Before, I worked (2019-2021) with Oded Cats at TU Delft in his ERC Starting Grant Critical MaaS. I model two-sided mobility platforms, specifcally focusing on ride-pooling (making people share their Uber with co-travellers). I did PhD with Guido Gentile in non-equilibrium dynamic traffic assignment. I worked with the Department of Transport planning of prof. Andrzej Szarata at Cracow University of Technology from 2010-2019.

Education

Cracow University of Technology — Kraków, Poland
PhD — *2011 – 2015*
Simulation of rerouting phenomena in Dynamic Traffic Assignment with the Information Comply Model, co-supervised by prof. Guido Gentile, La Sapienza Roma

Cracow University of Technology — Kraków, Poland
MSc — *2005 – 2010*
Transportation Engineering, master thesis written at KIT Karlsruhe (Erasmus)

Jagiellonian University — Kraków, Poland
no degree — *2006 – 2008*
Philosophy, undergraduate studies

Professional Experience

Jagiellonian University — Princial Investigator
assistant professor — *2023 – now*
PI in the ERC Starting Grant grant *COeXISTENCE*, leader of the interdisciplinary group with 3PhD and PD.

Jagiellonian University — Post Doc
assistant professor — *2021 – now*
PI in the NCN Opus grant, leader of the group with 2PhD and 2PD. Recipient of the DigiWorld IDUB award at Group of Machine Learning, Faculty of Mathematics and Computer Science.

TU Delft — Post Doc

postdoctoral researcher *2019 – 2021*
PostDoc in the ERC Starting Grant of prof. Oded Cats, Critical MaaS. Modelling demand, operations and behaviour of shared-mobility. Developer of Agent Based Model to simulate shared mobility on demand. Running joint research with Uber, ViaVan, Amsterdam Gemeente.

North Gravity — DATA SCIENTIST
big-data r&d software developer *2017 – 2019*
Software architect and algorithm designer for AWS-based complex solution for data-science. Implementing Python based solutions for clustering (`scikit-learn`), forecasting (`keras`) , data-mining (`pandas`), cloud computing (`SageMaker`), etc.

PTV SISTeMA — R&D DEVELOPER
real-time DTA models *2012 – 2015*
Developing algorithms for real-time, large scale dynamic traffic assignment. Implementing novel gradient based implicit paths assignment model (published in *TR:B*). Developer of new modules and functionalities (VMS, fixed-path rerouting, Rolling-horizon model).

i2 intelligent infrasturcture — FOUNDER, DEVELOPER
IT solutions for transportation engineering, software add-ons, consulting, modelling *2010 – 2015*

Department of Transportation Systems, Cracow Univeristy of Technology — MODELLER, PROJECT MANAGER
Strategic transport models *2010 – 2015*
Head of modelling team for demand models of Standard Regional Model (2016), Warsaw Agglomeration (2015), Warsaw Region (2014), Krakow Agglomeration (2013), Krakow Region (2012). Member and/or team-leader in national level research grants.

Publications

Journal papers

1. **Kucharski**, R. & Cats, O. Exact matching of attractive shared rides (ExMAS) for system-wide strategic evaluations. *Transportation Research Part B: Methodological* **139,** 285–310. **IF:0191-2615** (2020).
IF:**4.79**, MNiSW:**200**pkt.
2. **Kucharski**, R., Fielbaum, A., Alonso-Mora, J. & Cats, O. If you are late, everyone is late: late passenger arrival and ride-pooling systems' performance. *Transportmetrica A: Transport Science,* 1–24 (2020).
IF:**3.49**, MNiSW:**100**pkt.
3. Drabicki, A., **Kucharski**, R., Cats, O. & Szarata, A. Modelling the effects of real-time crowding information in urban public transport systems. *Transportmetrica A: Transport Science* **17,** 1–39 (2020).
IF:**2.60**, MNiSW:**100**pkt.
4. Niedzielski, M. A. & **Kucharski**, R. Impact of commuting, time budgets, and activity durations on modal disparity in accessibility to supermarkets. *Transportation Research Part D: Transport and Environment* **75,** 106–120. **IF:1361-9209** (2019).
IF:**4.57**, MNiSW:**140**pkt.
5. **Kucharski**, R. & Gentile, G. Simulation of rerouting phenomena in Dynamic Traffic Assignment with the Information Comply Model. *Transportation Research Part B: Methodological* **126,** 414–441 (2019).
IF:**4.79**, MNiSW:**200**pkt.
6. Cantelmo, G., **Kucharski**, R. & Antoniou, C. Low-Dimensional Model for Bike-Sharing Demand Forecasting that Explicitly Accounts for Weather Data. *Transportation Research Record* **2674,** 132–144 (2020).
IF:**1.56**, MNiSW:**40**pkt.
7. **Kucharski**, R., Drabicki, A., Paszkowski, J. & Szarata, A. Lewis–Mogridge Points: A Nonarbitrary Method to Include Induced Traffic in Cost-Benefit Analyses. *Journal of Advanced Transportation* **2020,** 3096260 (2020).
IF:**2.42**, MNiSW:**70**pkt.
8. **Kucharski**, R., Drabicki, A., Żyłka, K. & Szarata, A. Multichannel queueing behaviour in urban bicycle traffic. *European Journal of Transport and Infrastructure Research* **19** (2019).
IF:**1.70**, MNiSW:**70**pkt.
9. **Kucharski**, R. & Drabicki, A. Estimating Macroscopic Volume Delay Functions with the Traffic Density Derived from Measured Speeds and Flows. *Journal of Advanced Transportation* **2017** (2017).
IF:**1.67**, MNiSW:**70**pkt.
10. Fielbaum, A., **Kucharski**, R., Cats, O. & Alonso-Mora, J. How to split the costs and charge the travellers sharing a ride? Aligning system's optimum with users' equilibrium. *European Journal of Operational Research* (2021).
IF:**5.34**, MNiSW:**140**pkt.

11. **Kucharski**, R., Cats, O. & Sienkiewicz, J. Modelling virus spreading in ride-pooling networks. *Scientific Reports* **11,** 1–11 (2021).
IF:**4.38**, MNiSW:**140**pkt.

12. Banet, K., Naumov, V. & **Kucharski**, R. Using city-bike stopovers to reveal spatial patterns of urban attractiveness. *Current Issues in Tourism*, 1–18 (2022).
IF:**7.43**, MNiSW:**140**pkt.

13. Cats, O., **Kucharski**, R., Danda, S. R. & Yap, M. Beyond the dichotomy: How ride-hailing competes with and complements public transport. *Plos one* **17,** e0262496 (2022).
IF:**3.24**, MNiSW:**100**pkt.

14. De Ruijter, A., Cats, O., **Kucharski**, R. & van Lint, H. Evolution of labour supply in ridesourcing. *Transportmetrica B: Transport Dynamics* **10,** 1–28 (2022).
IF:**3.03**, MNiSW:**100**pkt.

15. Drabicki, A., **Kucharski**, R. & Cats, O. Mitigating bus bunching with real-time crowding information. *Transportation*, 1–28 (2022).
IF:**5.19**, MNiSW:**100**pkt.

16. **Kucharski**, R. & Cats, O. Simulating two-sided mobility platforms with MaaSSim. *PLOS One* (2022).
IF:**3.247**, MNiSW:**100**pkt.

17. Soza-Parra, J., **Kucharski**, R. & Cats, O. The shareability potential of ride-pooling under alternative spatial demand patterns. *Transportmetrica A: Transport Science* **0,** 1–23. eprint: https://doi.org/10.1080/23249935.2022.2140022. https://doi.org/10.1080/23249935.2022.2140022 (2022).
IF:**2.60**, MNiSW:**100**pkt.

Scopus papers

18. Drabicki, A., Kucharski, R. & Szarata, A. Modelling the public transport capacity constraints' impact on passenger path choices in transit assignment models. *Archives of Transport* **43,** 7–28. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85030464283&doi=10.5604%2f01.3001.0010.4224&partnerID=40&md5=f572bc416aa27040814cfa5929f1e6d7 (2017).

19. Kucharski, R. & Gentile, G. Modeling information spread processes in dynamic traffic networks. *Communications in Computer and Information Science* **640,** 317–328. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85000783894&doi=10.1007%2f978-3-319-49646-7_27&partnerID=40&md5=9ee08d8050efe1f665b421a6a5650f51 (2016).

20. Kucharski, R. & Gentile, G. Observing rerouting phenomena in dynamic traffic networks. *2015 International Conference on Models and Technologies for Intelligent Transportation Systems, MT-ITS 2015*, 140–147. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84951012887&doi=10.1109%2fMTITS.2015.7223249&partnerID=40&md5=bd72c3744164d1bc08f09b907b9ed5b4 (2015).

21. Kucharski, R. & Gentile, G. Indirect observation of rerouting phenomena in traffic networks - Case study of warsaw bridges. *Archives of Transport* **32,** 29–41. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84962821882&doi=10.5604%2f08669546.1146996&partnerID=40&md5=2f3e9e445d7ec7f838f550ed8fa6c8e5 (2014).

22. Kucharski, R. & Gentile, G. Direct observation of rerouting phenomena in traffic networks. *Archives of Transport* **30,** 57–66. https://www.scopus.com/inward/record.uri?eid=2-s2.0-84962703465&doi=10.5604%2f08669546.1146977&partnerID=40&md5=458ff9bb3614603fae3d62f98082b444 (2014).

23. Kucharski, R., Kulpa, T., Mielczarek, J. & Drabicki, A. Method to decompose regional travel demand model -case study of kraków region. *Lecture Notes in Networks and Systems* **51,** 114–124. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85063202825&doi=10.1007%2f978-3-319-98615-9_10&partnerID=40&md5=4bcfbd33f14c7b15043acee85536381e (2019).

24. Kucharski, R., Kostic, B. & Gentile, G. Real-time traffic forecasting with recent DTA methods. *5th IEEE International Conference on Models and Technologies for Intelligent Transportation Systems, MT-ITS 2017 - Proceedings*, 474–479. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85030230016&doi=10.1109%2fMTITS.2017.8005719&partnerID=40&md5=aba078260bc367d8c55cf598a5d78850 (2017).

25. Drabicki, A., Kucharski, R., Cats, O. & Fonzone, A. Simulating the effects of real-time crowding information in public transport networks. *5th IEEE International Conference on Models and Technologies for Intelligent Transportation Systems, MT-ITS 2017 - Proceedings*, 675–680. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85030264951&doi=10.1109%2fMTITS.2017.8005598&partnerID=40&md5=a9777cf439ec9371b59fd654f5f82b63 (2017).

26. Drabicki, A., Szarata, A. & Kucharski, R. Suppressing the effects of induced traffic in urban road systems: Impact assessment with macrosimulation tools-results from the city of Krakow (Poland). *Transportation Research Procedia* **47,** 131–138. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85084657012&doi=10.1016%2fj.trpro.2020.03.085&partnerID=40&md5=8bf53489f0194e93065da22ae6c09d99 (2020).

Other peer-reviewed papers

28. Kulpa, T., Kucharski, R. & Szarata, A. Budowa regionalnych modeli transportowych-założenia i dylematy. *Prace Naukowe Politechniki Warszawskiej. Transport* (2016).
29. Kucharski, R., Drabicki, A. & Szarata, A. Modelowanie oporu skrzyżowań w modelach makroskopowych. *Transport Miejski i Regionalny* (2016).
30. Kucharski, R., Kulpa, T. & Szarata, A. Model wyboru środka transportu w dojazdach do i z pracy w Warszawie. *Transport Miejski i Regionalny,* 20–25 (2016).
31. Drabicki, A., Kucharski, R. & Szarata, A. Zastosowanie ograniczeń przepustowości sieci transportu publicznego w makroskopowym modelu rozkładu ruchu. *Transport Miejski i Regionalny* (2016).
32. Kucharski, R. Optymalizacja kształtu monocentrycznej sieci komunikacyjnej z zastosowaniem optymalizacji wielokryterialnej. *Przegląd Komunikacyjny* (2011).
33. Kucharski, R. Gromadzenie danych do budowy modeli ruchu-przegląd możliwości. *Transport Miejski i Regionalny,* 22–26 (2013).
34. Drabicki, A., Szarata, A. & Kucharski, R. Analiza symulacyjna etapowej realizacji zachodnich odcinków III obwodnicy Krakowa i ich oddziaływania na układ transportowy. *Przegląd Komunikacyjny = Transportation Overview,* 10–17 (2018).
35. Gągorowska, M., Kojałowicz, P. J. & Kucharski, R. Macierz kosztów uwzględniająca czasy podróży różnymi środkami transportu. *Transport Miejski i Regionalny,* 33–36 (2016).
36. Kucharski, R., Szarata, A., Mielczarek, J. & Drabicki, A. Trip volume seasonal variations at regional level – case study of Małopolska GSM OD matrices. *Archives of Transport System Telematics,* 40–45 (2018).
37. Drabicki, A., Szarata, A. & Kucharski, R. Modelowanie skutków zjawiska wzbudzenia (tłumienia) ruchu w analizach efektywności miejskich inwestycji drogowych. *Planowanie ruchu a wyzwania globalne* (ed Krych, A.) 183–196 (2019).
38. Kucharski, R., Mielczarek, J., Drabicki, A. & Szarata, A. Metoda aktualizacji modelu podróży z wykorzystaniem macierzy przemieszczeń telefonów komórkowych. *Transport Miejski i Regionalny* (2018).
39. Drabicki, A., Szarata, A. & Kucharski, R. Analiza symulacyjna postulowanych zmian w ciągu III oraz II obwodnicy Krakowa i ich oddziaływania na układ drogowy miasta pod kątem potencjalnego zjawiska ruchu wzbudzonego. *Transport Miejski i Regionalny* (2018).
40. Drabicki, A., Kucharski, R. & Szarata, A. Zjawisko bus bunching w transporcie zbiorowym i jego odwzorowanie symulacyjne. *Polskie inwestycje transportowe : doświadczenia, badania i przyszłość* (ed Krych, A.) 253–268 (2017).
41. Paszkowski, J. & Kucharski, R. Paradoksy przepustowości miejskiej sieci drogowej i sposoby ich odwzorowania w modelu czterostadiowym. *Transport miejski i regionalny* (2017).

Please refer to my researchgate and google scholar for a more complete and up to date list.

Editor

1. 6th MT-ITS2019 proceedings in IEEE Xplore. Collection of 91 papers indexed in Scopus.
2. SI in Algorithms journal editor.

Selected talks

2022 Uniwersytet Jagielloński, Wydział Fizyki, Astronomiii Fizyki Stosowanej, Mark Kac Seminar "Enigmas of Chance"

2021 University of Warsaw, "What constituted transportation engineering as a Science"

2021 Hungarian Academy of Sciences, "Virus spreading in ride-pooling networks"

2021 Vrije Universiteit Amsterdam, "Exact matching of attractive shared rides"

2018 EPFL Lausanne, "Rerouting phenomena in Dynamic Traffic Assignment"

2017 PTV Karlsruhe, "Modelling rerouting phenomena in Dynamic Traffic Assignment"

Open-source scientific software

- ExMAS Exact Matching of Attractive Shared rides for system-wide strategic evaluations (`pip install ExMAS`)
- MaaSSim Agent-based simulator for two sided urban mobility markets (`pip install MaaSSim`)

External funding

1. **ERC Starting Grant 2022** 101075838 - COeXISTENCE – Playing urban mobility games with intelligent machines. Framework to discover and mitigate human-machine conflicts. (2023-2028)
2. **NCN OPus 19** 2020/37/B/HS4/01847 - Mobilność współdzielona w czasach pandemii. Modelowanie i kontrola rozprzestrzeniania się wirusów w sieciach mobilności przejazdów wspólnych (2021-2024)
3. **DOCTUS Małopolski program stypendialny** ZS 4112-55/11 Modelowanie wpływu zachowań kierowców w sytuacjach incydentów ruchowych, na stan miejskiej sieci transportowej (2011-2014)

Reviewer

• Journal of Intelligent Transportation Systems: Technology, Planning, and Operations (ISSN: 1547-2450) • Journal of Advanced Transportation (ISSN: 0197-6729) • IET Intelligent Transport Systems (ISSN: 1751-9578) • Transportation Research Record (ISSN: 0361-1981) • **IEEE ITS Transactions** (ISSN: 1558-0016) • European Journal of Transport and Infrastructure Research (ISSN: 1567-7141) • **Transportation Research Part C: Emerging Technologies** (ISSN: 0968-090X) • **Transportation Research Part C: Emerging Technologies** (ISSN: 0968-090X) • **Scientific Reports** (ISSN: 2045-2322) • **Physica A: Statistical Mechanics and its Applications** (ISSN: 3784-371) • **IEEE Access** ISSN: 2169-3536 • Energies (ISSN: 1996-1073) • Algorithms (ISSN: 1999-4893) • Electronics (ISSN: 1751-9578) • Computers (ISSN: 2073-431X) • Computation (ISSN: 2079-3197) • Sustainability (ISSN: 2079-3197) • Sensors (ISSN: 1424-8220) • Frontiers In Future Transportation (ISSN: 2673-5210) • Priomet - Traffic&Transportation (ISSN: 1848-4069) • Models and Technologies for ITS 2015, 2017, 2019, 2021 • hEART 2017, 2018, 2019, 2020, 2022 • Transportation Research Board 98th, 99th , 100th, 101th • Transportation Research Arena 2019 • International Symposium on Transport Network Reliability 2020, 2021 • The 12th International Conference on Ambient Systems, Networks and Technologies, 2021

Teaching Experience

teaching materials and script

Courses taught: Microsimulation • Transport Network Planning • Forecasting • Effectiveness of Transport Systems • Vulnerability of Transport Networks • Transport Strategies and Policies • Introduction to Transportation Planning (in english) • Transport Demand Modelling

PhD cosupervision

1. mgr inż. Arkadiusz Drabicki (2015-) - supervisor prof. Andrzej Szarata, co-supervisors prof. Achille Fonzone (Napier University), prof. Oded Cats (TU Delft).
2. mgr Michał Bujak (2021-) - supervisor prof. Adam Roman, prof. UJ.
3. mgr Farnoud Ghasemi (2021-) - supervisor prof. Jacek Tabor, prof. UJ.

Master and bachelor theses

1. Skuteczne uczenie ze wzmocnieniem dla pojazdów autonomicznych w ruchu mieszanym, Kamil Górski, Uniwersytet Jagielloński.
2. Ride acceptance behaviour investigation of ride-sourcing drivers through agent-based model, Farnoud Ghasemi, La Sapienza Roma.
3. Drivers' repositioning algorithm and their efficiency with MaaSSim, Daan Knobbe, TU Delft.
4. Spatial distribution of ride-pooling efficiency - case of Amsterdam, Marko Maricic, TU Delft.

5. Study of the accessibility of Lesser Poland voivodeship communes to Cracow by PT, Katarzyna Sliwinska
6. Vulnerability analysis of road network - Bielsko-Biala sase study, Katarzyna Kubica
7. Optimization of Transit network of tourist town, Zakopane case study, Mateusz Pietruch
8. Filling analysis of selected separated car parks in the city of Wrocław, Alexander Pawlowski.
9. Methods to analyze and visualize travel data: Lesser Poland Voivodeship case study, Krzysztof Skrzypek
10. Reproducing Lewis-Mogridge Position with the Four Stage Demand Model, Jan Paszkowski
11. Analysis of travel behavior of BlaBlaCar users in Warsaw-Cracow corridor, Athina Jurkowska
12. Impact analysis of the intensity and parking type on travel time in urban setting - comparison of parallel, perpendicular and angled parking, Jakub Romanczuk
13. Utility analysis of planned expressways for regional and local traffic based on the example of the S19 road in provinces Lubelskie and Podkarpackie, Jan Bielecki
14. AADT change from 2010 to 2015 - case study of Warsaw Agglomeration, Joanna Wieczorek
15. Bus Rapid Lines Scheme Optimization - Case Study of Aleje Korridor in Krakow, Mateusz Kargulewicz
16. Cyclists Travel Time Analysis at Mogilska Rd in Krakow, Maciej Konarzewski
17. Long-term cross analysis of traffic volumes on Warsaw road network, Natalia Boruta
18. Observing Cyclists Queuing Behavior at Signalized Intersections, Klaudia Zylka.

R&D funding (selected)

1. 2022, CoreLogic, AGH, Trafficar - CarSharing Repositioning
2. 2016-2020, National Roads Agency and National R&D Agency: INMOP3 Intermodal transport models at three levels (900k eur)
3. 2015, Warsaw Municipality, MTAW 2015 Greater Warsaw Transport Model (500k eur)
4. 2018, GosPoStrateg, Databasing for Transport Analyses (200k eur)
5. 2018, DPK. Mobility data driven transit timetable optimization (100k EUR).

Conference host

MaaS@AMS - event organised by TU Delft and AMS Institute. Cooridinator of four interactive workshops
MT-ITS 2019 Kraków - 6th International Conference on Models and Technologies for ITS.
Modelling 2018, 2016, 2014 polish benchmark modelling conference.
KoKoNaT 2016, 2015, 2014 polish benchmark student transport engineering conference.

Technical skills

• python • pytorch • tensorflow • slurm • .NET • AWS • SageMaker • ANN • BusMezzo • SQL • noSQL • qGIS • pandas • scikit • matlab • sciPy • BIOGEME • R • MatSIM • plotly • basic Java • basic `C++` • JIRA • SVN, git. • PTV Visum • PTV Optima

Languages skills

Polish (*mother tongue*) • English (*full professional proficiency*) • Italian, Russian, German (*restaurant/tourist level*),

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Interests

Non-exhaustive and in random order: history, maths, science and science history, gardening, popular science, geography, visualisation, OpenTTD, maps, airports, boxing, volleyball, alpine superG, geopolitics, philosophy, quantum world, travelling with my better-half and smaller-halves

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