3iA Côte d'Azur
Interdisciplinary Institute for Artificial Intelligence

Postdoctoral research topic

- Title of the proposed topic: Advanced data-driven modelling for traffic flow accounting for emerging technologies
- Research axis of the 3IA: AI for intelligent and secure territories
- **Supervisor (name, affiliation, email): Paola Goatin, Inria, paola.goatin@inria.fr**
- Potential co-supervisor (name, affiliation):
- The laboratory and/or research group: Inria Sophia Antipolis, EPI ACUMES

Apply by sending an email directly to the supervisor.
The application will include:

- Letter of recommendation of the supervisor indicated above
- Curriculum vitæ including the list of the scientific publications
- Motivation letter
- Letter of recommendation of the thesis supervisor

- Description of the topic:

At a macroscopic scale, traffic is usually represented as a fluid flowing on the road network. In order to characterize the evolution of the system, we define aggregated quantities such as the flow or density of vehicles. The challenge is to be able to understand, reproduce and anticipate the evolution of density and flux in space and time, relying both on this mathematical modeling and on traffic data.

This project aims at contributing to intelligent mobility management practices through data driven mathematical models accounting for new opportunities offered by the latest technologies. In particular, we tackle modeling issues raised by the introduction of vehicle-to-vehicle and vehicle-to-infrastructure communication to govern vehicular traffic on road networks, such as routing applications and autonomous vehicles. These devices can deeply change traffic dynamics, and can be used as additional control actuators to improve road network efficiency.
We aim at developing new advanced macroscopic models coupled with statistical techniques leveraging the information recovered by real data, to ensure realistic simulations and predictions of multi-commodity network dynamics

ACUMES Project-Team (https://team.inria.fr/acumes/) has an established experience in (macroscopic) traffic flow models, and disposes of a large set of data coming from loop

detectors. More data can be found on publicly available data repositories, such as Mn-DOT (http://data.dot.state.mn.us/datatools/) and UTD19 (https://utd19.ethz.ch/)
Further actions to recover suitable data will be conducted during the project.

References:

- F.A. Chiarello and P. Goatin, Non-local multi-class traffic flow models, Netw. Heterog. Media, 14(2) (2019), 371-387.
- A. Festa and P. Goatin, Modeling the impact of on-line navigation devices in traffic flows, 2019 IEEE 58th Conference on Decision and Control (CDC), Nice, France (2019), 323-328.
- M. Garavello, P. Goatin, T. Liard and B. Piccoli, A multiscale model for traffic regulation via autonomous vehicles, J. Differential Equations, 269(7) (2020), 6088-6124.
- G. Piacentini, P. Goatin and A. Ferrara, Traffic control via moving bottleneck of coordinated vehicles, IFAC PapersOnLine, 51(9) (2018), 13-18. Proceedings of the 15th IFAC Symposium on Control in Transportation Systems.
- G. Piacentini, P. Goatin and A. Ferrara, Traffic control via platoons of intelligent vehicles for saving fuel consumption in freeway systems, IEEE Control Systems Letters, 5(2) (2020), 593-598.
- G. Piacentini, P. Goatin and A. Ferrara, A macroscopic model for platooning in highway traffic, SIAM J. Appl. Math., 80(1) (2020), 639-656.
- S. Samaranayake, J. Reilly, W. Krichene, M.L. Delle Monache, P. Goatin and A. Bayen, Discrete-time system optimal dynamic traffic assignment (SO-DTA) with partial control for horizontal queuing networks, Transport. Sci., 52(4) (2018), 982-1001.

Keywords: macroscopic traffic flow models; multi-scale models; hyperbolic PDEs; micro-macro limits; finite volume schemes; calibration and validation; optimization; learning; routing; autonomous vehicles.

Scientific profile requested:

- PhD in Mathematics or Engineering
- Background in hyperbolic Partial Differential Equations (PDE) analysis and numerical approximation, computer simulations.
- Knowledge of hyperbolic systems of conservation laws and finite volume schemes, statistics, data analysis as well as experience in mathematical modeling and/or optimization techniques are considered an additional plus.

Skills:

- Technical: experienced knowledge of Matlab / Python, R, Latex (bibtex, tikz, beamer)
- Languages: English level B2
- Relational: good communication and presentation skills, proactive attitude, teamwork