Offre n°2024-07115

PhD Position F/M PhD thesis Proposal - Modelling and Estimation for Large Scale Multimodal Mobility Networks 2024-2027

Le descriptif de l’offre ci-dessous est en Anglais

Type de contrat : CDD

Niveau de diplôme exigé : Bac + 5 ou équivalent

Fonction : Doctorant

A propos du centre ou de la direction fonctionnelle

The Centre Inria de l’Université de Grenoble groups together almost 600 people in 22 research teams and 7 research support departments.

Staff is present on three campuses in Grenoble, in close collaboration with other research and higher education institutions (Université Grenoble Alpes, CNRS, CEA, INRAE, …), but also with key economic players in the area.

The Centre Inria de l’Université Grenoble Alpe is active in the fields of high-performance computing, verification and embedded systems, modeling of the environment at multiple levels, and data science and artificial intelligence. The center is a top-level scientific institute with an extensive network of international collaborations in Europe and the rest of the world.

Contexte et atouts du poste

Motivation of PhD
Our society is more and more conscious of the contribution of current mobility modes to the climate crisis. This is why innovative low-carbon mobility solutions are being promoted by decision-makers and increasingly adopted by citizens. It is, for instance, expected that Electric Vehicles (EVs) will account for 70% of sold vehicles by 2030. The EU Commission, with its Fit 55 plan, even envisions a ban on the sale of new petrol and diesel cars as early as 2035. Meanwhile, adoption of micromobility modes is increasing significantly. Micromobility is an umbrella term used to describe the category of transportation using non-conventional battery-powered vehicles aimed at shrinking the physical and environmental footprint required for quickly moving people over relatively short distances. With micromobility, urban transportation modes have diversified very quickly. The challenge for cities encompasses organization and planning of public space and promotion of active mobility for health purpose given the passivity of some micromobility modes (e-scooters in particular). The co-existence of these modes in shared spaces cause various kinds of inconvenience for other users (people in wheelchairs, walking with a baby in a stroller, or elderly people) and alters the perception of safety which can lead vulnerable people to be more sedentary. Beyond the perception, it is attested that the number of accidents due to e-scooters is constantly increasing. It is therefore crucial to monitor the use of these micromobility modes by collecting information in a dynamic and non-intrusive way and then make recommendations for safer shared spaces and physical activity.

Principales activités

Proposed work during PhD
Three main tasks are envisioned for this thesis:

a)- City-wide mobility model: This task aims at developing a dynamic network model for multimodal mobility over a city. For this purpose, our starting point will be the recent works by the team which developed a large-scale mobility model to characterize the daily movement of people in an urban network. This model is based on the modeling of people’s mobility between their place of residence and 5 categories of destinations (work, schools, etc.). It generates a graph with nodes (origins and destinations) and also their interconnections through the origin-destination matrix that characterizes: directions, weights and temporal profile of the connections between nodes. The model simulates the movement of people at an aggregate level (no distinction of individuals, no information on the routes connecting origin and destination), Pratap et al. 2022. It has been used to control epidemics propagation while preserving the territory productivity, Niazi et al. 2021.

For monitoring multi-modal mobility, we will divide the city in cells. Each cell will define a node of the mobility networks. Each node will have several states representing the number of users for each mobility mode. Transition can be done from one mode to another. Therefore, there will be a dynamic for mobility...
mode in each node. Each node will interact with its neighbors. Two nodes will be adjacent if there is at
least one mode from which people can jump from one node to another. The graph is expected to be large
and dense with weights related to mobility between nodes. The originality of this task rests in the finer
grain of the proposed description and the accurate distinction between the possible transportation
modes, including cars, public transportation and micromobility.

b)- From discrete to continuous: Here we will develop a dynamic continuous counterpart to the discrete
city-wide network of the previous task by using graphons (Ruiz et al, 2021) and/or continuation (Nikitin
et al. 2021). The city-wide network from the previous task is equipped with dynamics for the evolution of
the shares of the mobility modes. We expect that these dynamics will feature diffusion and transport
terms: therefore, the dynamics belong to a class that we are able to treat by continuation and graphon
methods (or a combination of both). While the apparent geographical interpretation is conducive to
continuation methods, public transportation (such as tramways in the Grenoble case study) effectively
introduces long-range connections and counters the inherent sparsity of the micromobility diffusion.

c)- Network estimation: The aim is to develop techniques for state estimation for providing a
cartography of transportation modes usage. The estimation problem here consists in: (i) the estimation
of connection weights (probabilities) in the context of dynamic network models; (ii) estimate the states
of the nodes or aggregated states in order to provide a cartography of co-existence of transportation
modes. Connection weights will be treated as functional data. The question here is therefore to estimate
the tensor of weights (or connection probabilities; tensor here means multiway array from partial
measurements provided by people using mobility modes detectors (Taia-Alaoui et al. 2022) or other
sensors like loop detectors for vehicles and bicycles (the latter are available in the city of Grenoble and
our team has acquired experience with dealing with similar data in building the GTL and GTL-Ville
platforms). This task will include methods for dynamic network completion using graphon
approximation, which will be acutely needed to cope with partial observations. These methods will be
based on related methods proposed for collaborative filtering, such as (Shah and Lee, 2018).
Furthermore, we will develop techniques to detect (despite noisy and possibly patchy data) potential
conflict zones, where conflict and safety issues originate from high rates of penetration of micromobility
modes such as e-scooter (Dozza et al. 2022).

Dozza, M., Violin, A., and Rasch, A. A data-driven framework for the safe integration of micro-mobility into
the transport system: Comparing bicycles and e-scooters in field trials, Journal of Safety Research, Vol. 81,
2022, Pages 67-77.

mobility for epidemic mitigation”, 60th IEEE Conference on Decision and Control (CDC), Austin, TX USA.

Niazi, M.U.B, C. Canudas-de-Wit, C., and A. Kibangou. Average state estimation in large-scale clustered

Nikitin, D., Canudas-de-Wit, C., and Frasca, P. A continuation method for large-scale modeling and
control: from ODEs to PDE, a round trip. IEEE Trans. on Automatic Control, 67 (10): 5118–5133, 2021

urban networks: the Grenoble saga”, submitted to Transportation Research Part C: Emerging
Technologies.

Ruiz, L., Chamon, L.F., and Ribeiro, A. Graphon signal processing. IEEE Trans. on Signal Processing,
69:4961–4976, 2021


Sosoe, K. “Modeling of multimodal transportation systems of large networks”, PhD thesis. Univ. Paris Est,
2017.

transport networks’” 16th IFAC symposium on Control in Transportation Systems (CTS 2021), Lille, France

Taia Alaoui, F., Fourati,H., Kibangou, A., Robu, B., and Vuillerme, N. Urban transportation mode detection

Compétences
The candidate should have a solid background in estimation theory or signal processing and good
computer skills in Matlab and/or Python.

Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours)
  + possibility of exceptional leave (sick children, moving home, etc.)
Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
Professional equipment available (videoconferencing, loan of computer equipment, etc.)
Social, cultural and sports events and activities
Access to vocational training
Social security coverage

Rémunération

- 2100 euros gross salary (1st & 2nd year)
- 2190 euros gross salary (3rd year)

Informations générales

- Thème/Domaine : Optimisation et contrôle de systèmes dynamiques
- Ville : Campus de Saint-Martin d'Hères
- Centre Inria : Centre Inria de l'Université Grenoble Alpes
- Date de prise de fonction souhaitée : 2024-05-01
- Durée de contrat : 3 ans
- Date limite pour postuler : 2024-03-22

Contacts

- Équipe Inria : DANCE
- Directeur de thèse : Kibangou Alain / alain.kibangou@inria.fr

A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 215 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

L'essentiel pour réussir

How to apply:
Applications should be declared as soon as possible. The position may be closed as soon as a competent candidate has applied. Please include the CV, and marks.

Contact: Alain Kibangou, alain.kibangou@gipsa-lab.fr (Supervisor)
Hassen Fourati, hassen.fourati@gipsa-lab.fr (Co-supervisor)

Attention: Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

Consignes pour postuler

Sécurité défense :
Ce poste est susceptible d'être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L'autorisation d'accès à une zone est délivrée par le chef d'établissement, après avis ministériel favorable, tel que défini dans l'arrêté du 03 juillet 2012, relatif à la PPST. Un avis ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

Politique de recrutement :
Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.