2-year Post-doc position in Robotics/Simulation/Artifical Intelligence
at INSA Rouen Normandy, France:

Connected and Autonomous Vehicle virtualization framework for Transfer Learning applications

Context

Connected and Autonomous Vehicles (CAVs) take advantage of the advancement of communication and sensing technologies to offer a potential sustainable alternative to current mobility services. Many ongoing projects are studying the effects of CAVs on the network, at the same time trying to identify the best strategies to develop in order to design new and dedicated traffic control strategies. The challenge here is to solve the medium-term situation where both conventional and automated traffic will share the road network.

Very first real-world deployments have been carried out experimentally and tend to confirm the expected benefits of cooperation between AVs (Stern et al., 2018), that have been previously identified in simulation (Guériau et al., 2016). However, the high cost of running such full scale tests (with relatively small amount of vehicles) is one of the reason CAV technologies deployment takes more time than expected. Indeed, **autonomous driving algorithms**, especially when built using Artificial Intelligence techniques and **learning-based approaches**, **require** substantial quantities of **data and experience that cannot be solely provided by actual field-tests**.

The **deep-learning** community is being more and more aware that machine learning models are "costly to train and develop, both financially, due to the cost of hardware and electricity or cloud compute time, and environmentally, due to the carbon footprint required to fuel modern tensorprocessing hardware"[1]. This is led to the emergence of an interesting and novel research effort, called ***Green AI*** in the litterature (Schwartz et al.,2019), that aims at reducing the amount of data required for deep-learning based approaches to converge. One the the strategies "which has been recently gaining importance to drastically reduce computational time and energy consumed is **to exploit the availability of** different information sources"[1], or **different models, environments.**

Simulation and robotic models (such as in Hyldmar et al., 2019) appear to be the fastest way to first develop, train and then test autonomous driving tasks, allowing the system designer to investigate the behaviour of embedded navigation systems in a wide range of situations and/or conditions and across different environments (including for instance adverse weather conditions that affect vision-based perception, Blin et al. 2020). This process however faces several challenges: **reality gap**, when a simulation/model fails to capture all the particularities of a real system, and **domain adaptation**, when a model is developped/trained in a particular context and has to adapt to a different one.

In this context, techniques akin to **transfer learning** (TL) have been developed to enable knowledge acquired by one or multiple (Taylor et al., 2019) learner (source) agents to be transferred to another or the same (target) system, helping the latter to learn a similar but different task or to adapt an existing algorithm to a similar domain. Recently, TL was shown to be particularly efficient when transferring autonomous driving tasks, between different domains (Sharma et al., 2019) and **from simulation to a real system** (Balaji et al., 2019).

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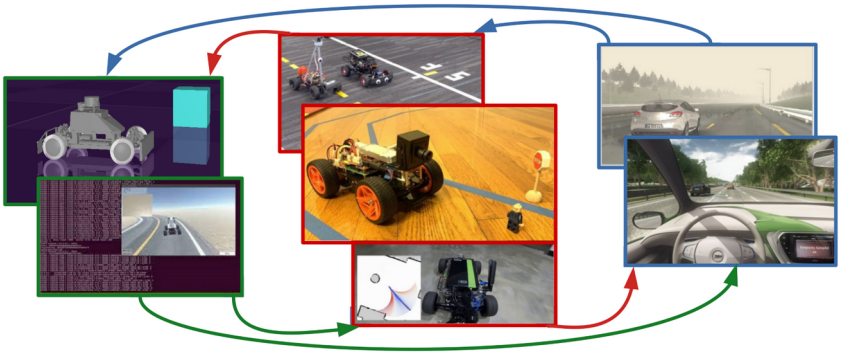
1 https://news.mit.edu/2020/artificial-intelligence-ai-carbon-footprint-0423



The work intended within this Post-doc position is part of a research project named MultiTrans, that focuses on exploring novel TL approaches for autonomous vehicles scene semantic segmentation and detection accross **3 different environments** (as depicted in the Figure above: **simulation**, a **robotic** platform and a **real-world** autonomous shuttle test-bed). This position is funded by the Agence Nationale de la Recherche (ANR) under grant reference ANR-21-CE23-0032.

Objectives

The main objective is **to build a novel autonomous vehicle virtualization framework (digital twin) enabling to investigate and propose new algorithms that rely on transfer learning techniques.**
More specifically, the work is expected to contribute to the following objectives within MultiTrans project:

- Identification of critical applications requiring multi-domain transfer (extracted from real-world domains);
- Scripting of base use cases, small variations (taking advantage of computer power in simulation), major variations (that require realistic alterations of sensing capabilities) and corner cases (that could be modelled and tested in the robotic testbed);
- Development of a virtualization framework allowing simulation environments and real environments to benefit from each other.

Expected contributions and research outreach

The work undertaken by the successful candidate **should contribute** and is not limited **to**:

- a **better understanding** of issues **related to** implementing **autonomous driving across different domains**: reality gap, overfitting, few-shots learning, experimental biases, etc;
- **insights on the use of simulation and robotics environments to foster and accelerate the development and deployment** of connected and autonomous driving technologies.
- **novel approaches to transfering and acquiring knowledge** from simulation to real-world and from real-world to simulation;

Given that part of the research will be led jointly using a robotic environment and the newly developped digital twin, it is expected that the framework developped will allow for reproducible **experiments** that **could be used as demonstrators for research/teaching** but **also for disseminating** material (such as video recordings) to the public.

References

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Keywords

Simulation, robotics, transfer learning, autonomous driving, computer vision, deep (reinforcement) learning.

Qualification and skills

The successful candidate would:

- have completed a PhD. in Computer Science or Robotics with a specialization/interest in Robotics, Simulation, AI- and/or machine learning-based techniques;
- have demonstrated research experience and relevant publication records;
- have strong English and/or French writing and oral communication skills.

Knowledge and/or experience with the following fields would be greatly appreciated:

- robotics environments (ROS, etc.) and/or vehicular simulation (CARLA, SUMO, etc.);
- intelligent transportation systems, connected and automated vehicles;
- AI techniques such as deep learning, reinforcement learning, transfer learning, multi-agent systems.

Supervision

Maxime Guériau (Assistant Professor) and Samia Ainouz (Professor), both member of the Intelligent Transportation Systems team (STI) at LITIS lab (*Laboratoire d'Informatique, de Traitement de l'Information et des Systèmes*), INSA Rouen Normandy, France.

About LITIS lab and the STI team

The research conducted at LITIS lab covers 3 major fields: information access, bio-medical information processing and ambient intelligence with applications in health, automotive and

smart territories. The expertise of LITIS members is recognized internationally and includes: machine learning, multi-agent systems, intelligent vehicles. The STI team (the successful candidate will be joining) is specialized in advanded driving assistance systems, computer vision, distributed and autonomous systems.

The LITIS is a laboratory (EA 4108) of University of Rouen Normandy, University of Havre Normandy and INSA Rouen Normandy. It is a member of the doctoral school MIIS and of the normand network «Digital Normandy». LITIS is a partner of the Normastic CNRS Research Federation.
Address: 685 Avenue de l'Université, 76800 Saint-Étienne-du-Rouvray.

The candidate will be allowed to access to different experimental platforms to carry out the work:

- a robotic platform featuring different robot cars equipped with state-of-the-art perception sensors;
- an autonomous shuttle test-bed with equipped infrastructure;
- an intensive computing center (CRIANN: Centre Régional Informatique et d'Applications Numériques de Normandie).

Salary, starting date, travel and support

This 2-year (24-month) Post-doc position is funded by the Agence Nationale de la Recherche (ANR) under grant reference ANR-21-CE23-0032.

Salary: 2300€ net/month

Expected starting date: around Sept. 2022.

The successful candidate will receive support for occasional international travel (participation to conferences). Occasional national travel (mainly to Nice and Paris) will be organised, enabling the candidate to visit the partners of MultiTrans project.

Dissemination and visibility of the work will be ensured by advertising it on MultiTrans website and sharing resources, open-source algorithms, framework and findings (on a Git repository).

Application process

Candidates applications should include:

- a full resume, including a comprehensive list of publications, and;
- a cover letter, and;
- contact details of up to 2 references;

And be sent to:

maxime.gueriau@insa-rouen.fr,
samia.ainouz@insa-rouen.fr,

By no later than May 27th 2022.