

# Position Description

## 1. General Information

<b>Name of the position</b>	<b>Optimization of roadside management based on artificial intelligence</b>
<b>Foreseen date of enrolment</b>	1 October 2023
<b>Position is funded by</b>	<ul style="list-style-type: none"> <li>• COFUND, Marie Skłodowska-Curie Actions (MSCA), Horizon Europe, European Union</li> <li>• Université de Lorraine (UL)</li> <li>• University of Technology Sydney (UTS)</li> </ul>
<b>Research Host</b>	Université de Lorraine
<b>PhD awarding institutions</b>	Université de Lorraine & University of Technology Sydney
<b>Locations</b>	Primary: Nancy, France Secondary: Sydney, Australia
<b>Supervisors</b>	Mauricio CAMARGO and Brunelle MARCHE (UL) Adriana Simona MIHAITA (UTS)
<b>Group of discipline</b>	Industrial engineering, system engineering, computer science

## 2. Research topics (only one of these projects will be funded)

### Project 1: *Multi-objective optimizations for roadside management*

The relationship between road infrastructure and economic development is widely studied, as 25 million kilometres of new roads will be built by 2050. The vegetated strips of land located near roads that separate them from the surrounding landscape, called roadside or road verges, are affected by this growth in road infrastructure. Recent studies have shown that the roadside plays an important role in mitigating road impact on the territory and its ecosystems. A sustainable management approach of these green spaces can provide different ecosystem services that can improve the citizen's life conditions. Indeed, the maintenance of roadsides integrates several issues with various aspects: (i) economic (e.g. continuous investment in the maintenance equipment, the attractiveness of the territories linked to the quality of the maintained landscape), (ii) technological (e.g. the biomass valorisation, the reduction of the carbon footprint), (iii) social (e.g. road safety, flood and fire prevention) and (iv) environmental (e.g. the preservation of the biodiversity, the water improvement, the air and soil quality, etc.).

Optimal road mowing is a significant challenge for territories, which requires a large budget and detailed annual maintenance in terms of staff and mowing devices; making informed decisions regarding the staff requires a minimum distance that needs to be delivered in a limited amount of time to represent crucial factors that need a data-driven



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decision-making modelling approach. This thesis subject addresses the problem of planning optimal trajectories of roadside maintenance machines (mainly mowing machines) in order to minimize economic and environmental costs and impacts on the territory. In this project, territories will be able to serve as territories of experimentation.

The project comprises of three major phases:

- 1) Investigating and collecting all data related to the road side maintenance from several regions in France
- 2) Building a multi-objective optimisation algorithm that will find the minimal route that needs to be undertaken in order to service all road types in a dedicated area, by their own dedicated technical centre
- 3) Construct several scenarios of optimisation approaches based on time and human constraints that would lead to a reduction in fuel consumption and allocated time throughout the year.

**Supervisors:** Mauricio CAMARGO (UL), Brunelle MARCHE (UL), Adriana Simona MIHAITA (UTS) and Christophe BACHMANN (ACTIBAC group)

**Research Fields:** multi-objective optimization, optimal routing, territory management

### Project 2: *Data management for road-side maintenance planning tools*

The relationship between road infrastructure and economic development is widely studied as 25 million kilometres of new roads will be built by 2050. The vegetated strips of land located near roads that separate them from the surrounding landscape called roadside or road verges are affected by this growth in road infrastructure. Recent studies have shown that roadside plays an important role to mitigate roads impacts on the territory and its ecosystems. A sustainable management of these green spaces can provide different ecosystem services that can improve the citizen's life conditions. Indeed, the maintenance of roadsides integrates several issues with various aspects: (i) economic (e.g. continuous investment in the maintenance equipment, the attractiveness of the territories linked to the quality of the maintained landscape), (ii) technological (e.g. the biomass valorisation, the reduction of the carbon footprint), (iii) social (e.g. road safety, flood and fire prevention) and (iv) environmental (e.g. the preservation of the biodiversity, the water improvement, the air and soil quality, etc.).

Open data can play an important role in the management of the territory, contributing to the improvement of its operation: maintenance, development. Currently, there are many public databases that can participate in a better understanding and characterization of this territory, and in particular the roadsides This thesis focuses on the integration of open data in the management of roadsides to improve and optimize their maintenance. One of the aspects studied will be how to integrate this data sets into optimization algorithms to help authorities in their maintenance planning. In this project, territories will be able to serve as territories of experimentation.

**Supervisors:** Mauricio CAMARGO (UL), Brunelle MARCHE (UL), Adriana Simona MIHAITA (UTS) and Christophe BACHMANN (ACTIBAC group)

**Research Fields:** open data, smart territory, territory management, optimization

### Project 3: *Artificial intelligence for roadside management*

The relationship between road infrastructure and economic development is widely studied as 25 million kilometres of new roads will be built by 2050. The vegetated strips of land located near roads that separate them from the surrounding landscape called roadside or road verges are affected by this growth in road infrastructure. Recent studies have shown that roadside plays an important role to mitigate roads impacts on the territory and its ecosystems. A sustainable management of these green spaces can provide different ecosystem services that can improve the citizen's life conditions. Indeed, the maintenance of roadsides integrates several issues with various aspects: (i) economic (e.g. continuous investment in the maintenance equipment, the attractiveness of the territories linked to the quality of the maintained landscape), (ii) technological (e.g. the biomass valorisation, the reduction of the carbon footprint), (iii) social



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(e.g. road safety, flood and fire prevention) and (iv) environmental (e.g. the preservation of the biodiversity, the water improvement, the air and soil quality, etc.).

Roadside maintenance is complex because it depends on many factors (economic, environmental, climatological, organizational), which can make the optimization of work sites difficult. Artificial intelligence (AI) techniques offer alternative computational approaches to learn from data and optimize routing processes. AI has proven effective in tackling bad-defined problems, learning from past experiences, and managing uncertainty and incomplete data. This subject is interested in identifying the optimal route through AI-based algorithms considering traffic circulation, the territory's characteristics (risks areas, intersections, the presence of ditches, a ligneous vegetation), the machine speed or multiple destinations for example. In this project, territories will be able to serve as areas of experimentation.

**Supervisors:** Mauricio CAMARGO (UL), Brunelle MARCHE (UL), Adriana Simona MIHAITA (UTS) and Christophe BACHMANN (ACTIBAC group)

**Research Fields:** Optimization, Artificial intelligence, smart territory, territory management

### 3. Employment Benefits and Conditions

Université de Lorraine offers a 36-months full-time work contract (with the option to extend up to a maximum of 42 months). The researcher has a trial period of two months. The working time is fixed at 7 hours per day, 35 hours per week.

The remuneration, in line with the European Commission rules for Marie Skłodowska-Curie grant holders, will consist of a gross annual salary of 30,000 EUR. Of this amount, the estimated net salary to be perceived by the Researcher is 1,975 EUR per month. However, the definite amount to be received by the Researcher is subject to national tax legislation.

#### Benefits include

- The candidate will have access to the facilities and premises of the ERPI laboratory, Université de Lorraine and UTS.
- Tuition fees exemption at both PhD awarding institutions.
- Yearly travel allowance to cover flights and accommodation for participating in AUFRANDE events.
- 10,000 EUR allowance to cover flights and living expenses for 12 months in Australia (which may be taken in several blocks over the period of the employment term as best suits the needs of the researcher). In support of researchers with family obligations, this funding may also be used to support any travel of the researcher's immediate family that may need to relocate with him/her.
- The doctoral candidate has 25 days of paid leave according to the university calendar. Maternity leave is 112 days (if any) and paternity leave (if any) is 28 days. In case of illness, a medical certificate must be provided and a receipt must be produced for any absence. The candidate must immediately, and at the latest within 48 hours of the beginning of the absence, inform his/her supervisor, specifying the reason and the probable duration of the absence. Sick days will be paid at 100% the first month by the employer and at 50% the second month, there is a one day waiting period on each absence.
- The candidate will have social security coverage for illness and work-related accidents/occupational diseases as part of his/her contract.



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## 4. PhD enrolment

Successful candidates for this position will be enrolled by the following institutions and must comply with their specific entry requirements, in addition to AUFRANDE's conditions.

### Université de Lorraine (UL)

Applicants must hold a national Master's degree or another qualification conferring the status of Master (5 years of higher education).

More information: <http://doctorat.univ-lorraine.fr/en/apply-phd/apply-enroll>

### University of Technology Sydney (UTS)

Applicants must have completed a UTS recognised master's by research or bachelor honours degree with first class or second class / division 1 honours, or an equivalent or higher qualification, or submitted other evidence of general and professional qualifications that demonstrates potential to pursue graduate research studies.

The English proficiency requirement for international students or local applicants with international qualifications is: Academic IELTS: 7.0 overall with a writing score of 7.0; or TOEFL: internet based: 94-101 overall with a writing score of 27; or AE6: Pass; or PTE: 65-72 overall with a writing score of 65; or C1A/C2P: 185-190 overall with a writing score of 185.

More information: <https://www.uts.edu.au/research-and-teaching/graduate-research/future-research-students/application-essentials>



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