Funded by the European Union

Marie Skłodowska-Curie Actions

Green Field Data

Exceptional
36-months Double Degree PhD Scholarship
Position-N
Phd in Computer Science

Optimization-simulation coupling for the GHG emission-based supervision and planification of a fleet of autonomous agricultural robots

EU Recruiting institutions	TSCF, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement (INRAE), Clermont Ferrand, France (18 Months) Aarhus Universitet, Electrical and Computer Engineering (ECE), Aarhus, Denmark (18 Months)
Keywords	Data Science, ML & AI, Digital Agriculture, Remote Sensing (IoT and IoRT), Data warehouses and analytics,

Exceptional benefits at a glance

- ***International PhD training excellence (here)***
- ***Renowned supervisors & top-tier labs***
- ***Interdisciplinary & multi sectoral research***
- ***Competitive MSCA salary & allowances***
- ***Global academic & industrial network***
- ***Non-academic secondments***

	Living Allowance	Mobility Allowance*	Family Allowance**
Gross salary	**EUR 4736**	**EUR 710**	**EUR 660**

Long Term leave allowance (if applicable)

Special needs allowance (if applicable)

*private mobility-related costs (e.g. travel and accommodation costs), not their professional costs under the action

**doctoral candidate has or acquires family obligations during the action duration, i.e. persons linked to him/her by (i) marriage, or (ii) a relationship with equivalent status to a marriage recognised by the legislation of the country or region where this relationship was formalised; or (iii) dependent children who are actually being maintained by the researcher, the family allowance must be paid to him/her as well

GreenFieldData Project at glance

GreenFieldData: "IoRT Data management and analysis for Sustainable Agriculture" is a project funded under the action HORIZON Marie Sklodowska-Curie Action (MSCA) Joint Doctoral Network. **GreenFieldData** will train a new generation of researchers able to tackle digital and green transition challenges using a human-centric approach to ensure the robustness and relevance of the solutions responding to the specific needs of the EU market in a context of climate change and increasing socio-economic constraints. At a policy level, **GreenFieldData** outcomes will feed in directly to the aims of the HE Strategic Plan 2025-2027, EU Partnership Agriculture of Data and Digital EU Program. **GreenFieldData**

proposes a high-level interdisciplinary, inter-sectoral and international (triple 'i') research project and training network on new IoRT (Internet of Robotic Things) based solutions for sustainable agriculture. **GreenFieldData** will mobilize 14 Doctoral Candidates (DCs) enrolled in Double Degree Doctorate programmes with 12 academic main beneficiary partners, across 7 EU countries. Moreover, 21 non-academic associated partners, and 3 academic associated partners will provide support to the DCs. The partners form a high quality network, where Academic partners have previous research collaborations as outlined in a common vision paper. The ambitious project will provide the DCs with a unique toolbox of cutting-edge knowledge, tools and strategies which will boost their employability and benefit the next generation operational workforce (researchers, Digital Technologies (DTs) and agricultural stakeholders). The project results will also benefit EU innovation as the human-centric IoT devices & robotics, and data-based solutions tailored to EU context will enable the agricultural sector to assess and mitigate the impacts of climate change, and define new sustainable low input practices, thus increasing resilience and competitiveness.

PhD Position N – Optimization-simulation coupling for the GHG emission-based supervision and planning of a fleet of autonomous agricultural robots

Context: Optimization-simulation coupling is a cutting-edge technology that has revolutionized the supervision of robotic fleets for precision farming. By integrating optimization algorithms with simulation models, farmers can efficiently manage and control their robotic fleet to maximize productivity and minimize costs. This innovative approach allows farmers to dynamically adjust their fleet operations based on real-time data, resulting in improved decision-making and higher yields. With optimization-simulation coupling, farmers can achieve greater precision, efficiency, and sustainability in their farming practices, leading to a more profitable and environmentally friendly operation.

The optimization-simulation coupling generally makes it possible to obtain realistic planning where optimization alone would provide solutions that are far too theoretical and not robust in terms of dynamically occurring events. However, the associated calculation times are often incompatible with real-time supervision. Our proposal consists of designing a new form of coupling, in particular from a generic approach which makes it possible to combine the power of resolution of certain optimization algorithms (essential for a readjustment in time of a schedule) with the fine representation of a simulation model (essential to obtain realistic schedules). The results of this approach will then be submitted to a human decision-maker for (1) validation if a case emerges, and (2) a choice between several cases if no choice emerges or the problem resolution time is estimated to be too long.

Objectives: This thesis is part of the development of a fleet of autonomous robots for arable farming. Work is underway to enable the management and supervision of a fleet at the scale of a site (i.e. a farm). This thesis proposes to set up a sharing of robots in an agricultural equipment-sharing cooperative. It will then be a question of managing a fleet of robots which will be maintained (maintenance, repairs...), configured (installation, change, of tools for agricultural tasks), and stored in a warehouse, before being deployed to work on several sites. The deployment will then consist of transporting the robots to a site where the local supervisor will take control of the robot. The central supervisor must be informed of the progress of the robots in their task, and of any hazard, or additional request from a site, which would call into question the provisional planning of resources. During the thesis, it will therefore be a question of proposing optimization and simulation models to respond to the problems raised, and of studying different coupling approaches integrating a human to allow realistic decision-making in real-time. The success of the different coupling approaches will be measured by considering metrics like planning efficiency, decision-making speed, and adaptability to unforeseen events, etc. Objectives are:

1) Propose coupled optimization and simulation models for robotic fleet deployment in a cooperative farm using intercropping of legumes and mechanized agricultural practices, with new coupling methods for these models supported by assessment of GHG emission; **2)** Make real-time decisions for robot deployment considering scheduling and managing robot maintenance, configuration, storage, and deployment across multiple farms and adapting to unexpected events (breakdowns, delays, weather) during robot operations. This objective will benefit of the previous and ongoing work of INRAE that has been developing an architecture for robots data storage using a data lake approach; **3)** Provide a visual interface for ergonomic end-users' real-time interactions; **4)** Provide prescriptive methods for rescheduling actions based on historical data. This objective will benefit of the previous and ongoing work of INRAE that has been developing a simple visual interface for robots data alerts.

Work plan and task scheduling:

1. Development of targeted optimization and simulation models for robot deployment including assessment of GHG emission that accurately represents the dynamics of the robotic fleet and the farming environment. [Duration: month 1-14]
2. Readjust and adapt the algorithms for real-time planning, taking into account unforeseen delays and breakdowns, but also new demands. [Duration: month 17-22]
3. Calibration and validation of optimization-simulation coupling model by testing it in various scenarios and settings. This step helps ensure the system is robust and reliable under different conditions in cropping systems employing a fleet of robots. The calibration will be done first for the main planner, and then for the adjusted real-time planner, hence two steps. [Duration: month 15-16 and 23-24]
4. The development of a human centric tool enabling the definition of a plan for the deployment of the robotic fleet. [Duration: month 25-30]
5. Deploy the optimization-simulation coupling in the field, and monitor the robot(s)' performance over time. Collect data on the efficiency and effectiveness of the robotic fleet in precision farming operations and use this data to further improve the system. This will be done in parallel of the development of the human-centric tool, allowing for the integration of users' needs and better feedback. [Duration: month 25-32]

Expected Results **1)** Development of optimization and simulation models for robot deployment in a cooperative farm with new coupling methods for these models that include human decision-making supported by performance including assessment of GHG emission; **2)** A human-centric tool enabling the definition of a deployment plan of robots based on needs expressed by farmers; **3)** Readjustment of the algorithm for real-time planning in the event of unforeseen hazards or new demands; **4)** Calibration and validation of the developed optimization-simulation coupling model with a fleet of robots.

References

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- Sandro Bimonte, Hassan Badir, Pietro Battistoni, Houssam Bazza, Amina Belhassena, Christophe Cariou, Gérard Chalhoub, Juan Carlos Corrales, Adrian Couvent, Jean Laneurit, Rim Moussa, Julián Eduardo Plazas, Monica Sebillo, Nicolas Tricot: Data-centric UML profile for agroecology applications: Agricultural autonomous robots monitoring case study. Comput. Sci. Inf. Syst. 20(1): 459-489 (2023).

- Bruno Bachelet & Loïc Yon. Model Enhancement: Improving Theoretical Optimization with Simulation. Simulation Modelling Practice and Theory (15-6), pp. 703-715 (2007).

- Sørensen, C.G. (eds) (2024). Smart Farms – Improving data-driven decision making in agriculture. Burleigh Dodds Series in Agricultural Science Number 147.
- Mateus Vilela Souza, Bruno Bachelet, Thiago Noronha, Loïc Yon, Christophe Duhamel. A Model for Scheduling a Fleet of Autonomous Electric Agricultural Robots. LIV Brazilian Symposium of Operational Research (SBPO), Nov 2022, Juiz de Fora, Brazil (2022).
- Mahdi Vahdanjoo, Claus Grøn Sørensen, Michael Nørremark 2025. Digital transformation of the agri-food system. Current Opinion in Food Science, Available online 24 February 2025, 101287, https://doi.org/10.1016/j.cofs.2025.101287.

PRACTICAL INFORMATION

Recruiting and host institutions	• TSCF, Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement (INRAE), Clermont Ferrand, France (18 Months) (Recruiting institution). Location : 9 Avenue Blaise Pascal, 63178 Aubiere France • Aarhus Universitet, Electrical and Computer Engineering (ECE), Aarhus, Denmark (18 Months) Location:Finlandsgade 22, 8200 Aarhus N, Denmark
Doctoral schools	• SPI @ University Clermont Auvergne, Clermont-Ferrand, France • GSTS @ Aarhus University, Aarhus, Denmark
Supervisors	• Dr. Sandro BIMONTE (TSCF, INRAE, Clermont-Ferrand, France) • Pr. Claus Sorensen (Aarhus University, Aarhus, Denmark)
Non-academic mentors	• Dr. Tom Simonsen (Conpleks Inc., Tom Simonsen, Denmark) • Dr. Nicolas Chollet (Sherpa, France)
Secondments (1 to 6 hosting months)	• Conpleks Inc., Struer , Denmark; month 12-15. Work and train the challenges related to the deployment of a robotic system based on extensive experiences from the practical deployment of robotic systems in agriculture, (e.g. FieldSurveyor robot) • Sherpa, Clermont-Ferrand, France month 24-25. Business process and data engineering. Comprehensive guidance and advisory support will be provided throughout the PhD program on AI, Robotics and Embedded system technologies
Contact information	• sandro.bimonte@inrae.fr • claus.soerensen@ece.au.dk

RECRUITMENT CRITERIA

General criteria

- MSCA Mobility Rule: researchers must not have resided or carried out their main activity (work, studies, etc.) in **France** for more than 12 months in the 36 months immediately before their date of recruitment
- All researchers recruited in a DN must be doctoral candidates (i.e. not already in possession of a doctoral degree at the date of the recruitment)
- An applicant must have received the equivalent of 300 ECTS with a major in computer science or applied mathematics, from which at least 120 ECTS corresponds to a master degree. The master degree must be granted by a university recognized by the International Association of Universities.
- Scientific excellence to fit the PhD project
- Fluent (oral and written) English skills as the project operates in English language
- Knowledge of the language of the host country may be considered a merit
- Team-mindedness

Required skills

- Advanced databases and programming skills
- Advanced operations research skills (optimization, graph theory, logistic models)
- Interdisciplinary work
- Master degree in Computer Science

APPLICATION

How to apply?

- **All information are provided here**

Deadline: **15th April 2026**

Other information

INRAE and TSCF research unit

INRAE. The French National Research Institute for Agriculture, Food and Environment (INRAE) is a public research institution bringing together a working community of 12,000 people, with 272 research, service, and experimental units located in 18 centers throughout France.

INRAE ranks among the world's leading institutions in agricultural and food sciences, and in plant and animal sciences. Its research aims to build solutions for multi-performing agriculture, quality food, and the sustainable management of resources and ecosystems.

TSCF. The 'Technologies and Information Systems for Agrosystems - Clermont-Ferrand' (TSCF) research unit employs 60 staff and is based at 2 sites: the Pôle Scientifique et Universitaire des Cézeaux in Aubière (63) and the Site de Recherche et d'Expérimentation in Montoldre (03). Its activities come under INRAE's MathNum and AgroEcoSystem departments.

Within the framework of agroecology, the research laboratory mobilises engineering sciences and information and communication sciences and technologies to conduct research into methods and tools for agro-environmental systems engineering.

It also conducts research, expert appraisal and testing activities in the field of safety and performance of agricultural equipment to help improve safety in agriculture and reduce pollution of agricultural origin.

The TSCF direction team consists of Roland Lenain (Director - Les Cézeaux site), François Pinet (Deputy Director - Les Cézeaux site), Frédéric Chabot (Deputy Director - Montoldre site).

The laboratory is structured around 5 research themes:
- Environmental analysis and modelling, led by François Pinet and Raphaël Rouveure
- Equipment autonomy and automation, led by Jean Laneurit
- IoT for sober observation, led by Laure Moiroux-Arvis
- Integration and adoption of new technologies, led by Nicolas Tricot
- Innovative methods and tools for the agro-ecological transition, led by Marilys Pradel

Various working groups deal with subjects that cut across the unit:
- Thematic forum (leader: Roland Lenain)
- Unit communication (leader: Johann Laconte)
- Infrastructures (leader: Frédéric Chabot)
- Steering tools (leader: Géraldine André)
- Transition supervision (leader: Guillaume Jeanneau)

Your Quality of Life at INRAE

By joining INRAE, you benefit from (depending on the type and duration of your contract):

- Up to **30 days of paid leave** + **15 RTT** days per year (for a full-time position);
- **Parental support**: **CESU** for childcare, benefits for leisure activities;
- **Skill development schemes**: training, professional orientation counselling;
- **Social support**: advice and listening, social aid and loans;
- **Holiday and leisure benefits**: *chèque-vacances* (holiday vouchers), accommodation at preferential rates;
- **Sports and cultural activities**;
- **Collective catering** (cafeteria/canteen).

The Cézeaux site is served by Tram Line A, and is also equipped with parking and services dedicated to cycling.

Notes on terms:

- **INRAE**: The French National Research Institute for Agriculture, Food and Environment.
- **RTT** (*Réduction du Temps de Travail*): Days off granted in compensation for working slightly more than the official legal working hours (a mechanism for reducing working time in France).
- **CESU** (*Chèque Emploi Service Universel*): A payment voucher/scheme in France used to pay for personal services, often including childcare. **CESU for childcare** refers to a specific pre-financed voucher for childcare expenses (usually for children aged 0-6).
- ***Chèque-vacances***: Government-subsidized holiday vouchers in France used to pay for travel, accommodation, and leisure activities during holidays.

Aarhus University

Aarhus University is a dynamic, modern and highly international university. Since its founding in 1928, it has grown to become a leading public university with international impact and reach across the entire research

spectrum. Aarhus is a great place to study and a great place to work. Here are some of the top reasons to come work or study with us.

We are a Top 100 University: AU is consistently ranked as one of the world's top universities. It was ranked number 85 in the latest Shanghai ranking and is among the world's 100 best universities in 17 out of 48 subjects in the latest QS World University Rankings by Subject.

Denmark is a great place to live.

Safe, secure and equal: Denmark is widely cited as one of the world's most liveable places for a variety of reasons. It has the world's highest level of income equality, according to the OECD. Furthermore, Denmark is widely cited as one of the world's most liveable places. And based on the Corruption Transparency Index, Denmark is the least corrupt country in the world. Levels of public trust are high and crime is low.

We're always here for you: AU offers all the practical support and guidance you need to feel at home here. For students, the International Centre offers a full induction and introduction programme as well as professional, friendly support and guidance throughout your time at AU.

For researchers and PhD students, Aarhus University offers a full range of services to make your transition to the university as smooth as possible. IAS (International Academic Staff) assists researchers and PhD students from abroad with all practical matters, including visa, residence and work permits, housing services, child care, etc.

Top reasons to study in Aarhus

Our teachers are world-class lecturers: At AU, classes are taught by active researchers in an informal, stimulating atmosphere. All degree programmes are deeply rooted in the latest research and are subject to a rigorous quality assurance programme to ensure they meet the highest global quality standards.

English is our second language: AU offers more than 50 full degree programmes in English at Bachelor's and Master's level. All PhD programmes are in English. And Danes were recently ranked as among the best non-native English speakers in the world on the on the annual English Proficiency Index (EPI), so it's easy for international students to feel at home in Denmark from day 1.

Our student body is diverse and highly international: Around 12 per cent of AU's 36,000 students are internationals – from over 120 countries.

Denmark offers an attractive green card scheme: The green card residence permit granted to international university students in Denmark is valid for an additional six months after completion of the degree, which gives graduates time to look for work in Denmark.

Top reasons to work at AU

We have state-of-the-art research facilities: Aarhus University offers world-class research facilities and laboratories in a wide range of subjects. We have a strong tradition of multidisciplinary research for instance in one of our 42 major research centres.

We offer attractive working conditions: When asked about what they appreciate most about AU, our international staff at AU emphasise favorable working conditions as an important motivation for working at Aarhus University. These include an attractive salary, a generous pension scheme and parental leave benefits. What's more, international academic staff members are eligible for tax breaks in many cases.

We are world champions in work-life balance: Danish workplace culture stresses the importance of work-life balance, and AU is no exception. Researchers enjoy flexible working conditions and a high level of autonomy and self-determination. What's more, the municipality offers a range of high-quality social services that enhance the quality of life for internationals, including free healthcare and subsidised childcare and international schools.