lab recherche environnement
VINCI | PARISTECH

CALL FOR EXPRESSIONS OF INTEREST: ARTIFICIAL INTELLIGENCE AND BLOCKCHAINS

The lab recherche environnement aims to develop knowledge and tools to help local stakeholders better take environmental aspects into account in decisions concerning urban projects and regional planning.

The research teams from the three partner schools – l'Ecole des Mines Paris - PSL, l'école nationale des ponts et chaussées and AgroParisTech - contribute to the work carried out by the lab in the fields of transport, biodiversity, urban agriculture, buildings and energy. Recent advances concern the application of artificial intelligence to ecodesign. Indeed, large quantities of data relating to the built environment, geolocation, the behaviour of different actors, etc., are now available thanks to computer applications on the Internet or other databases. Artificial intelligence methods make it possible to process this data. They could provide indications to reduce complexity, fill in missing data, or discover new structures (data mining) useful for the ecodesign of infrastructures, buildings, and territories.

The purpose of this call for expressions of interest is to encourage collaborations between lab researchers and specialists in artificial intelligence and big data, in order to study the possibilities of taking advantage of these technologies to improve ecodesign tools and practices.

A budget of around €200k over 3 years is available for all projects. Two or three teams will be selected during a seminar where each team will present its approach and suggest applications. The terms of the collaboration will be studied according to the proposed projects, which can last from 6 months to 3 years: full funding by the chair or co-funding provided by the candidates. The publications resulting from these projects must mention the support of the lab. Regular exchanges with the lab researchers are expected. At a minimum, a kick-off meeting, a mid-term meeting and a restitution meeting must be organised. In addition, it is possible to contact the lab researchers in advance with a view to co-constructing the research actions:

- Transport and mobility: Nicolas Coulombel -nicolas.coulombel@enpc.fr
- Building, district, energy: Charlotte Roux -charlotte.roux@minesparis.psl.eu
- Biodiversity and urban agriculture: Patrick Stella and Erwan Personne:patrick.stella@agroparistech.fr and erwan.personnel@agroparistech.fr

Responses (short presentation of the research team and interest in the topic – 1 to 2 pages) must be received before March 31, 2025, by the chair secretary Marie-Astrid Krames: marie-astrid.krames@minesparis.psl.eu as well as to the chair coordinator: Charlotte Roux: charlotte.roux@minesparis.psl.eu

The themes considered are as follows:

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a) Transport: What contribution does artificial intelligence make to the eco-design of mobility?

Transport is particularly concerned with the development of digital technology, the diversification of the information produced (geolocation, customised information, real-time traffic status, intermediation between service providers and customers of transport service, etc.), their availability in all places by various media and now in particular everyone's smartphone. Despite this explosion in the volume of digital traces linked to mobility in recent years, the information provided by these traces is often difficult to exploit directly due to its fragmentary nature. Some elements necessary for the analysis of mobility are not always characterised precisely, or not at all, such as the mode of transport, the exact destination (depending on the spatial precision of the data source), or the reason for travel.

Artificial intelligence methods provide answers to a number of these limitations by enriching digital traces (via mode, pattern prediction, etc.) to better analyse mobility behaviours. In some cases, the methodology used can even aim to modify individuals' behaviours by suggesting more environmentally virtuous alternatives for their travel while being assessed as relevant for the user, given their preferences, habits, and the travel considered. This is, for example, the approach taken by MIT's work on Future Mobility Sensing, which makes it possible to investigate individuals' mobility based on the collection of digital traces enriched via artificial intelligence methods and also to suggest alternative mobility solutions where appropriate. Finally, we are witnessing the emergence of artificial intelligence methods in mobility modelling, whether for calibrating models (4-step, multi-agent, etc.) as a substitute or complement to traditional econometric estimation methods or in direct application to predict modal choice behaviours, for example.

Proposals may focus on applications of artificial intelligence for the analysis and eco-design of personal mobility (freight transport will be the subject of a later call). This includes applications related to the enrichment of digital traces, mobility analysis (behaviour prediction, model calibration, etc.), or optimisation / eco-design (intelligent recommendations, solving mobility optimisation problems such as dial-a-ride problems, etc.). Ideally, the response will include a short state-of-the-art on the intended application case, and proposals in synergy with the lab's research work on the eco-design of mobility will be valued.

b) Buildings, districts and energy

Ecodesign tools make it possible to assess the environmental impacts of urban projects through digital simulation. Some input parameters, particularly concerning uses and behaviours, are difficult to assess, and the uncertainty about these parameters leads to uncertainty about the results of the assessments. There are national statistics such as the INSEE time use survey, but the collection of local and/or more targeted data would be helpful in the following aspects, for example:

- presence of occupants (number of people, times, occupation of different rooms in a home, offices, shops, etc.);
- temperatures in spaces (heating, air conditioning);
- ventilation (flow rates) and window opening (duration);
- use of artificial lighting (power and duration);
- consumption of domestic hot water and cold water (volumes);
- specific electricity consumption (household appliances, office automation, etc.);
- use of sun protection (duration);
- comfort felt by the occupants.

In addition, energy consumption data (heating, air conditioning, domestic hot water, lighting, ventilation) would be useful in comparing model outputs with statistics by building type and region. The devices for measuring, transmitting and collecting data on these different elements allow for an enrichment of the simulation; in addition, the relationship between the precision of the measurements and their possible uses could be studied.

A simulation model is useful for carrying out the energy diagnosis of an existing building during the current operating phase or after construction or renovation work for verification purposes. This process is sometimes called retro-commissioning. It consists of using model identification or calibration methods to estimate the physical characteristics of the building and the Heating, Ventilation, and Air Conditioning (HVAC) systems from in situ measurements.

In an occupied site, users significantly disrupt this process (presence, changes to instructions, opening windows, etc.). Therefore, it is interesting to identify uses and behaviours from measurements to improve the identification of parameters related to the building and HVAC systems.
To model usage and behaviour in occupied buildings, several data sources can be used: sensors in the building (temperature, humidity, noise, CO_2, electricity consumption, home automation interface, etc.), contextual data (e.g. weather data, geographic/urban context, sociological data, etc.), or even users' smartphones. To do this, machine learning methods, supervised or not, can be used.
To optimise the management of HVAC systems, it is useful to make progress on short-term forecasting (30 min to 48 hours) of uses and behaviours.

The goal is to heat, cool, or ventilate where and when necessary. It would be useful to identify habits, patterns announcing events (such as a departure, a return, a window opening, etc.), or even anomalies. The data sources and models mentioned above can be used for this purpose.

c) Biodiversity and urban agriculture

ICT (Information and Communication Technologies) are now widespread among the civilian population, thanks to consumer electronics: beyond the telephone and the computer, almost everyone has internet access and uses interactive applications, in particular, to participate in groups; everyone also has digital cameras. The smartphone ensures the convergence between photography, telephony and all kinds of digital interactions. In the field, any motivated individual with a smartphone can take a photo of one or more representatives of a natural species, of a view of an ecosystem, in order to geolocate it in real-time and then transmit it or send it to a group via a website. Alongside this democratisation of the possibilities of observing nature, professional sensors are spreading with ever-increasing functional capacities and at an ever-lower price: cameras to record scenes, including night vision, RFID tags to associate with mobile entities, etc.

The Ecoconception Chair invites contributions to inventory the technical possibilities of nature observation and to make an international state-of-the-art of existing applications, including websites intended for the collation of observations and the development of diagnoses. Particular interest will be given to the comparison between France and, in particular, Austria, Germany, the United States, and Japan. Two observation themes will be favoured: on the one hand, the local state of biodiversity and, on the other hand, the observation of invasions of species, animals and plants.

d) Reliability, robustness and potential biases of artificial intelligence tools

The family of algorithms included in the definition of artificial intelligence is very varied but have in common the difficulty of precisely identifying how the result is generated and, therefore, the potential associated biases. Some risks, such as over-learning, are well known. Still, it is necessary for researchers using these new techniques, but not experts, to better understand the potential performance of the different algorithms and the associated biases and risks of errors. They can then develop validation protocols for new tools and models based on AI, adapted to their use and operation.

e) Blockchain Technologies

Five years ago, the environmental research lab initiated a prospective exploration of the opportunities related to artificial intelligence. This theme is now an integral part of the roadmap of our research program. In the same way, it may be interesting to explore the opportunities related to the interfaces between blockchain technologies and our work such as:

- Accurate monitoring of a project's environmental impacts through blockchain LCA (Blockchain-based LCA, Zhang et al., 2020). This monitoring can take place in real-time or certify a project's performance over time.
- The use of smart contracts for energy performance guarantees or for real-time evaluation of energy savings in building or mobility infrastructure projects.
- The monetisation of negative externalities (for example, through tokenisation) or positive ones (for example, with renewable energies for proof of work blockchains).

These examples are not exhaustive. The proposed approaches will have to put into perspective their environmental costs and benefits.