Intership positions

HERawS: Highlights on Europe Raw materials Sustainability

HERawS is a multidisciplinary consortium aiming to decipher the question of raw materials for Green and Digital transition by providing an open and interactive platform to assess the impact of new technologies. We are looking for highly motivated students with different background (Material Science, Geosciences, IT, Energy Science etc…) ready to join an ambitious and innovative project. Three internship positions are currently open:

1) **Materials impact of batteries**

Raise of public awareness of the Climate emergency has led to a significant increase in the number of electric cars. A vehicle fleet made up of electric cars powered by renewable energy would be a clear step forward. However, the battery, a major constituent of the electric vehicles (EV), requires tens or even hundreds of kilos of metals such as Nickel, Cobalt, Aluminum, Iron etc... This new demand for these materials will certainly lead to economic and logistical upheavals. Before the mass production of the EVs takes place, it is important to compare battery technologies to evaluate the material impact of them. The objective is to suggest the most sustainable solutions, beyond the simple cost-performance paradigm.

Supervisors: Agnes Samper – Alexandre Nominé – Univ Lorraine

2) **Environmental impact of Nickel and Cobalt extraction**

The Cobalt and Nickel supply chain is the backbone of the electrification of the vehicle fleet currently at work. This supply chain includes the extraction of the ore, its transformation into metal, its purification, its transport etc... These stages are not neutral either in terms of greenhouse gas emissions nor in terms of energy... The recruited trainee will be in charge of establishing the overall CO2 and energy impact of the extraction of these metals.

Supervisors: Agnes Samper – Michel Cathelineau – Univ Lorraine

3) **Batteries for a cleaner computing: proposal for a holistic decision-making approach.**

The digital world must provide services without interruption and regardless of the level of carbon emitted to produce the electricity to power the underlying IT architectures. One solution to maintain the service offer while reducing pollution is the installation of batteries that can store clean energy. It will then be necessary to play (1) on batteries integrated in mobile devices (laptops, telephones, tablets, etc.), on external batteries normally used as backup in the event of a power cut and (2) on intelligent algorithms allowing to charge and discharge the batteries in an optimal way, that is to say with the aim of reducing greenhouse gas emissions. These algorithms concern the use phase, but it is necessary in an ecological approach to integrate the entire life cycle of the computer architecture. Also, the development of this architecture associating batteries will have to be studied in a holistic way. The purpose of the Master's subject will therefore consist in developing a decision-making tool on the most suitable batteries for our application context by considering the resources to be extracted from the Earth, its manufacture, geopolitical choices, its performance, its durability, its recyclability… This work will be done in collaboration with specialists in these fields.

Supervisors: Eric Rondeau, S. Kubler – Univ Lorraine (CRAN) /Univ. Luxembourg

Applications :

Applicants must send their CV and Cover letter to Dr. Agnes Samper (agnes.samper@univ-lorraine.fr); Alexandre Nominé (alexandre.nomine@univ-lorraine.fr) and Pr. Eric Rondeau (eric.rondeau@univ-lorraine.fr) **The application deadline is February 15th.** The expected starting date is April 1st and the internship duration is between 4 and 5 months.

Te@chLab project

1) Scanning Electron Microscopy

Mines Nancy recently acquired a tabletop Scanning Electron Microscopy[1] dedicated to both classical teaching and students' projects. The intern will be trained in the use of a scanning electron microscope and will have to be quickly autonomous in the use of this tool. The intern will be proactive in proposing ideas for educational activities for students and will oversee the design of an outreach demonstration toolkit. Therefore, the intern must demonstrate a sense of scientific communication.

Applicants must be currently in a Master course in Materials Science (or equivalent). Practical experience in electron microscopy is not mandatory, however, basic knowledge of materials characterization is required. Practical experience in metallography would be a plus.

Supervisors: Sebastien Allain – Alexandre Nominé – Univ Lorraine

[1] *Link to the scanning electron microscope description here*

Applications :

Applicants interested to join Te@chLab project must send their CV and Cover letter to Dr. Alexandre Nominé (alexandre.nomine@univ-lorraine.fr) and Pr. Sebastien Allain (sebastien.allain@univ-lorraine.fr). **The application deadline is February 15th**. The expected starting date is April 1st and the internship duration is between 4 and 5 months.

AI for Science

1. AI for High Entropy Materials

High Entropy Materials are a new and exciting family of Materials. They have shown impressive mechanical and catalytic properties. Even if the IJL team revealed a promising potential in the field of non-linear optics, the theoretical description of HEM and particularly in sight of their optical properties remain unsatisfactory. Therefore IJL and LORIA develop a joint AI-based approach to discover new optically active HEM. The first step of the internship consists in data engineering on existing, open-access data (1000+ alloys). The second step consists in feature engineering, that is, the translation of scientific hypotheses (eg network distortion effect) into mathematical parameters that can be integrated into algorithms. The third step is the development of an AI approach for the prediction of new HEM. The challenges of the AI algorithms rely in the fact that they will be developed with a limited number of data, that they will have to account for the experimental uncertainties and that their predictions must be explainable and interpretable by the HEM community.

2. Knowledge graphs for Culture diffusion in Yakutia from XV till XIXth century

Culture diffusion in Siberia in from the XVth century is a complex process involving different ethnies (Russians, Yakut, Tungunz etc...) throughout more than 3 centuries. During the contact with Europeans, the diffusion of new cultural models (evolution of clothing, funeral rites, etc.) could have followed several paths: (i) those of "influencers": notables chosen (chiefs) by the Russian newcomers and named Duke of Russia by the tsar and identifiable thanks to their signet rings of Russian design ; but these "influencers" could also be clans, regions, kinships, etc. (ii) by a mechanism of transmission known as vertical involving the lineages or kinship (followed via genealogies) of these influencers At the time of contact with Europeans, conservative phenomena could have played a role via a phenomenon of group pressure (generalized) linked to (i) marriages at a distance (several hundred kilometers) (ii) the resistance of traditional clan chiefs who had signet rings made to imitate Russian signet rings in order to preserve their powers. The recruited intern will join a multidisciplinary team (AMIS Lab - Univ Toulouse: Genomics & Archeology ; IJL: Material Science; LORIA: AI) that have acquired multiple (genomic, metallurgical, isotopic, tobacco etc...), diverse (210 individuals spread over almost one million km² and 300 years), and heterogeneous (digital, semantic, concepts) data. Moreover, the archaeological context implies a low volume of data, a relative uncertainty on specific data, and missing data. The selected intern will be in charge of the elaboration of multi-relational graphs where the nodes represent individuals and the arcs the relations between them, which can be various (filiation, meetings, the similarity of rings, etc...). The objective is to identify the individual influencers and the 'first followers' and the places that have been crucial to cultural exchange few centuries ago in Eastern Siberia...

3. Edge computing in Artificial Intelligence

The education sector has seen extensive integration of technology to stimulate and facilitate learning. Today, the objective of guaranteeing ethics and respect for the privacy of the technologies implemented is facilitated by the use of edge computing. It's about processing data at the edge of the network, closer to the source of the data. This approach makes it possible in particular to use computing resources that are not permanently connected to a network and to transmit only the necessary data, thus allowing security as close as possible to the data source. In this context, Federated Learning (FL) is a new paradigm increasingly used to apply AI at the edge. In this approach, a predictive model is learned simultaneously across multiple sites holding sensitive data, while ensuring that no data, and only very little information overall, leaves each site.

The main objective of this internship is to develop machine learning algorithms, suitable for use in federation, to predict the dropout of students following an online learning, using different connection devices such as the tablet, phone and PC. The data generated by each student is stored locally on their devices. The main tasks of the internship are:

- Design and implement federated machine learning algorithms to predict dropouts and compare them using different quality metrics.
- The work has already been carried out using the same data set in centralized mode. A comparison in terms of performance and accuracy will be made between the federated approach and the centralized approach.
- Machine learning algorithms should be adapted for future use on IoT devices. Thus, a complexity study and an encapsulation are necessary for a future embedded implementation.
- Use of TensorFlow and TensorFlow Federated to implement the algorithms.

4. Session-based Recommender Systems using Knowledge Graphs

The recommender systems are tools that are widespread in our daily lives and influence our choices in many types of situations, from choosing a movie to watch to purchasing a gift or even finding a loving partner. They are used in many industrial applications (e.g., e-commerce, video on demand, social networks, news portals, etc.) as well as in academic scenarios (e.g., MOOCS, Learning games, University portals, etc.). To be effective a recommender system needs at least two kinds of information, the items to be recommended and the interaction of the user with those items.

One of the drawbacks of such systems is their need for a considerable amount of information to work properly, however, in some scenarios such as the recommendations in news portals or websites where the user is not logged in, the only information available is a cookie to characterize the user.

How to use such little information to provide good recommendations is the challenge treated in this stage. The literature shows that one of the ways to have better recommendations is by using knowledge graphs to model user-item interactions and use such information with a deep-learning algorithm.

The expected tasks for this internship are:

- User sessions data exploration.
- Looking for session-based recommender systems that can use knowledge graphs.
- Implementation of such algorithms.
- Evaluation of system accuracy.

Applications :
Applicants interested to join AI for Science project must send their CV and Cover letter to Dr. Guilherme Medeiros Machado (guilherme.medeiros-machado@loria.fr) and Pr. Anne Boyer (anne.boyer@univ-lorraine.fr). **The application deadline is February 15th**. The expected starting date is April 1st and the internship duration is between 4 and 5 months.