Post doc Advisors:

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Context of the study:

There are many cases where graph structures are used, and where severe uncertainties are associated to the characteristics of these graphs. Examples include finding paths (in a vehicular or connection network) when the efficiency (modelled by weights) of the links are uncertain (due to weather conditions, uncertainty about the state of the channel, …), or predicting complex structures (vectors of relevant labels of an image, ranking between items in recommendation systems). Such problems concern mostly the fields of machine learning (to learn the characteristics of the graph) and of operations research (to find optimal solutions in the graph).

Our goal in this post-doc is to explore such optimization problems when uncertainty over the graph is defined by imprecise probability structures. Such uncertainty models are very general models that encompass as special cases sets (i.e., robust optimisation) and probabilities (i.e., stochastic optimisation).

A particular problem we wish to explore is what data or what expert opinion should be collected to reduce the number of potentially optimal decisions, therefore defining optimal collecting strategies, to be used, e.g., in predictive maintenance or active learning. Recent advances from multi-criteria and multi-objective optimization literature suggest that such optimal and computationally efficient protocols are reachable (see references).

This topic is mainly connected to axis 1 and 3 of the Labex, as it involves optimization problems for uncertain combinatorial structures. It will allow a new collaboration within Heudiasyc, and concerns very generic problems, meaning that the found solution will then be applicable to a lot of different issues.

Post doc description:

The post-doctoral candidate will be set in the Heudiasyc laboratory, and will be part of on-going collaborations between the fields of combinatorial optimization (David Savourey) and uncertainty reasoning (Sébastien Destercke). The candidate will then explore some problems connected to the handling of graphs characterized by severe uncertainties. Examples of problems we want to deal with are the following:

- Make cautious inferences (i.e., in the form of sets of predicted graphs) when the presence/absence of edges in the graph is ill-known and when the set of graphs to consider belongs to specific sub-families (trees, bi-partite or multi-partite, acyclic). Such problems are typically found in many machine learning problems, such as multi-label (bi-partite), clustering (sets of cliques) or label ranking (acyclic) problems.

- Solving classical combinatorial optimization problems such as shortest path finding, or finding the minimum spanning tree, when the knowledge of edge characteristics is modelled by imprecise probabilistic models.

Both cases include interesting questions, such as how to determine and characterize, in an exact or approximate way, the set of possibly optimal graphs (a notion close to the Pareto front of solutions), or what data to collect or questions to ask in order to reduce, as much as possible, this set of possible graphs, and hence converge as quickly as possible to a small set of solutions (from which the final user could then pick easily).

The goal of the post-doc is to develop generic algorithmic solutions to solve such issues, and to possibly explore the theoretical complexity of solving such problems. It should however be noted that the considered problems (minimal spanning trees, shortest path, label ranking, multi-label problems) have every-day applications in network design, health diagnosis, recommendation systems, intelligent transport, etc.

Candidate's profile:

The candidate will ideally have a strong background in combinatorial optimization and severe uncertainty handling, with an interest in imprecise probabilistic and robust approaches. We expect strong skills in at least one of these fields or a closely connected one, backed up by a strong publication record.

Documents required to apply:
Send to sebastien.destercke@utc.fr and david.savourey@utc.fr
- Curriculum vitae
- Motivation letter
- At least two references and/or recommendation letters
- A statement of research experience and interests

Location:
Laboratory Heudiasyc UMR CNRS-UTC 7253
Université de Technologie de Compiègne (UTC)

References:

- Nawal Benabbou, Patrice Perny: Incremental Weight Elicitation for Multiobjective State Space Search. AAAI 2015: 1093-1099
- Sébastien Destercke: Multilabel predictions with sets of probabilities: The Hamming and ranking loss cases. Pattern Recognition 48(11): 3757-3765 (2015)