European Institute of
Innovation & Technology
Foundation

EIT FOUNDATION – INTERNSHIP PROPOSAL

Internship title: <u>Multi-stage stochastic programming (MSSP) under uncertainty</u> Company offering the internship position: **Alcatel-Lucent Bell**

1/Project description (including the objectives):

In multi-stage stochastic programming (MSSP), the uncertainty in parameters, e.g. demands, yields, defining a decision problem are represented by probability distributions. The term multistage refers to the ability to make decisions at multiple stages, and thus reflecting the dynamic nature of the problem. The interactions between the stochastic and decisions processes are modelled so that the decision-maker can take corrective decisions (recourse) and actions as uncertainty is revealed sequentially over multiple stages (time periods).

Compared to exogenous uncertainty where decisions cannot influence the stochastic process, in case of endogenous uncertainty, the stochastic process depends on the decisions that can alter it by either changing the probability distribution or resolving the uncertainty partially (or even fully). Recently, the problem of finding optimal decisions with gradual reduction of uncertainty in the yields has been formulated as a decision-dependent MSSP where action (e.g. investment) plans reduce uncertainty and time-varying distributions describe uncertainty.

Objectives:

Assume that individual entities composing a distributed system are modelled as agents performing a joint task, e.g., serve external time-varying uncertain demands. Each agent performs at each time period its multi-modal capacity allocation decision (note: capacities remain finite) together with its routing decision following various coordination/consensus processes that reduce the randomness in agents predictions and decisions; the objectives are to design, develop and evaluate:

- Decomposition methods for stochastic programs (applicable to distributed routing under uncertainty);
- Distributed decomposition methods for stochastic programs (applicable to distributed routing under uncertainty);
- Investigate performance trade-offs under different state visibility mode (full state visibility, partial state visibility).

2/Tasks to be performed by the intern and expected deliverables:

The tasks to be performed are directly linked to the objectives listed here above and include:

- Formulate the corresponding multistage stochastic programming model and demonstrate its properties;
- Extend the multistage stochastic programs to multi-agent/distributed routing decision processes with uncertain demands; for this purpose, decomposition methods are considered as method of choice in order to enable combining both decision processes;
- Application (numerical execution) for information routing under various uncertainty assumptions (endogeneous uncertainty, exogeneous uncertainty, mixture).

Deliverables:
- Technical report (publishable in international journal);
- Intermediate report(s) will be proposed in order to ensure follow-up on progress and facilitate publication of the final report.

3/Key learning points:
- Explore new stochastic program formulation and resolution techniques
- Application to real-world operational problems in context of stochastic information networks
- Cross-disciplinary investigation linking stochastic programming, multi-agent optimization, and dynamic consensus processes

4/Intern's profile, desired skills and competences:
- Experience in stochastic programming and optimization (including decomposition techniques)
- Experience in stochastic programming solvers and modelling tools

5/Project timing: starting date and duration:
Starting date: earliest 1 September, 2014; latest 1 January 2015
Duration: 1 year

6/Location, country and city:
Alcatel-Lucent Bell NV
Copernicuslaan 50
2018 Antwerpen, Belgium

7/Confidentiality level: Low – **Medium** – High

8/Non-Disclosure Agreement needed: Yes / **No**

9/Compensation level[1]:
Approximately 1100 €

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[1] *The company hosting the intern will provide a standard compensation according to its internal rules. The compensation should cover the local costs of living and housing costs. The compensation SHOULD NOT be considered as a salary.*