06-AL-BellTrans-BE

EIT FOUNDATION – INTERNSHIP PROPOSAL

Internship title: Non-standard diffusive transport (applied to complex information systems)

Company offering the internship position: **Alcatel-Lucent Bell**

1/Project description (including the objectives):

Reaction–diffusion equation for non-standard diffusive transport with non-exponentially distributed waiting time translates the non-trivial coupling between the reaction and transport processes. Experimental evidences show for instance the occurrence of long-tailed waiting time probability density functions (PDFs) in a variety of natural and technological systems. However, little is known concerning information spreading when similar conditions are met. As the memory effects in the non-standard transport process (which differs from the Brownian motion or standard diffusion), results in a nontrivial combination of reactions and spatial dispersion; hence, understanding, the memory effects on pattern formation and front propagation in complex information systems becomes an interesting subject of investigation.

For this purpose, two modelling approaches are considered:

- Non-markovian reaction-diffusions equations with non-exponentially distributed waiting time (e.g., sub-diffusive transport) where memory effects in the diffusive transport process causes a nontrivial coupling/non-separable combination between diffusion and reaction in the equations governing the evolution of the densities; for instance, by formalizing the description of the epidemic/information/knowledge spread under non-Markovian transport processes governed by continuous-time random walks (CTRW) with non-exponential waiting time distributions, the goal is to adapt the mesoscopic modelling of a reaction-transport system performing a CTRW in order to incorporate non-linear kinetic terms corresponding to the transmission of the infection/ information/knowledge.
- Kinetic equations, in particular, the Vlasov-Fokker-Planck (VFP) equation with fractional noise term, and the Vlasov-McKean equation, and their hydrodynamic limit; the goal is to extend this powerful modelling technique with mesoscopic and macroscopic indicators (e.g., mean fields) to model and measure the progress/increase of information organization (e.g., negentropy which measures the distance to normality) in the overall system.

Objectives:

- How different information sources in complex systems contend and compete each other and which strategy/control policy to adopt when different sources of information are considered.
- Formalize the behavioural/structural properties governing/influencing information spreading in such system, whether they can be predicted and possibly tuned (with external control/supervision)
- Determine the conditions for appearance and persistence of Turing instability.

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:

- Model information spreading in complex information systems by means of the formalism describing non-standard diffusion processes
- Translate the corresponding process into exchange and information handling procedures
- Determine up to which extend this process is controllable and derive corresponding control theoretic formalism

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 kinetic modelling and theory of reaction-diffusion equations
- Experience in numerical resolution and simulation tools (MatLab, R)

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 €

[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.*