

Master Internship

Software Engineering and Artificial Intelligence for Mechanistic Modeling in Epidemiology

Hosting team, supervision

- Hosting team: Dynamo team, UMR1300 BIOEPAR (INRAE, Oniris), Chantrerie, route de Gachet, Nantes
- Supervisors: Sébastien Picault (INRAE – Dynamo team), Massimo Tisi (IMT Atlantique – NaoMod team)
- Contacts: sebastien.picault@inra.fr, massimo.tisi@imt-atlantique.fr
- Keywords: domain-specific language (DSL), mechanistic modeling, software engineering, knowledge representation, AI, epidemiology
- Duration: 5-6 months

Context

Mechanistic modeling in epidemiology allows scientists to better understand and predict the transmission of endemic diseases, and to assess the effectiveness of the management actions to employ. Recently, artificial intelligence methods have been employed to produce a generic software framework for the design of these models.

These models have to integrate knowledge coming from non-modeling scientists, in a readable form, allowing them to easily validate or revise the underlying hypotheses.

The development of a DSL (Domain-Specific Language) allows users to describe all the components of an epidemiologic model in an explicit form that is automatically manipulated by a simulation engine. A first proof-of-concept has been produced at BIOEPAR in the open-source software EMULSION (DOI : 10.1371/journal.pcbi.1007342 - <https://sourcesup.renater.fr/www/emulsion-public>).

To be autonomously usable by modelers in epidemiology or in veterinary medicine, the DSL has now to facilitate the representation of knowledge, their verification (especially of coherence) and the automatic code-generation for simulation and exploitation of results. To achieve this, we need to rely on software engineering and metamodeling methods (MDE, Model-Driven Engineering), like the ones developed in the Naomod team, at IMT Atlantique.

Objectives and means

The objective of this internship is identifying and testing the most suitable software-engineering and metamodeling methods, in order to answer to these problems. The expected work combines research in epidemiology (mechanistic modeling), in artificial intelligence (multi-agent multi-level simulation engine, knowledge representation) and in software engineering (DSL, metamodeling). The first two areas are represented by Oniris (BIOEPAR). The third one by IMT Atlantique (Naomod).

The internship student will be hosted within the modeling team DYNAMO of BIOEPAR, with meetings and visits to IMT Atlantique.

Main steps:

- Learn the modeling language used in EMULSION to get familiarity with the components of a mechanistic model in epidemiology.
- Identify the most suitable software-engineering/metamodeling approaches for the definition and the management of the DSL (e.g., parser vs. projectional editor)
- Translate to this formalism the syntactical and semantic elements of the metamodel
- Elaborate a proof-of-concept of an editor responding to the needs of modelers, and generating a usable model for EMULSION
- Redaction of the report and preparation of the dissertation

Acquired competences during the internship

- Metamodeling methods, DSL design, model transformation, code generation
- Introduction to multi-agent simulation (multi-scale architecture)
- Introduction to epidemiological modeling and animal epidemiology
- Ability of integrating with scientists from different disciplines and cultures

Required competences

- Master student in computer science or equivalent
- Solid preparation in software engineering (e.g. *Model-Driven Engineering*) and notions of artificial intelligence, in order to be proactive in the design choices
- Competences in redaction and interest on modeling and life sciences will be necessary, in order to facilitate the dialog between modelers and epidemiologists, integrate their domain knowledge in the metamodels and documenting the choices of employed methods.

Internship Remuneration: YES

To apply:

Send CV + motivation letter to:

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