Project proposal
Master Informatique

Verification of transformations of infinite graphs

Scientific Context

Within the projects Climt[1] and Dynres[2], we are working on graph transformations, and in particular the verification of graph transformations.

Graph transformations have wide-spread applications, such as pointer-manipulating programs and model transformations in languages such as UML. They are also interesting for graph databases, such as those represented with RDF schemas, and the link structure of the World-Wide Web. This is the kind of application that we are aiming at in this project. Indeed, huge databases or the WWW are so large that they can be considered as infinite: it is not possible to inspect the whole graph at once, and to apply classical algorithms like Floyd-Warshall to compute transitive closures.

One rather has to turn to stream-processing frameworks that only have limited capacities for storing intermediate results. For example, it seems impossible to extract from an infinite graph representing persons all the cliques of persons knowing one another, at least if not disposing of an infinite amount of storage.

Planned work

The work proposed here aims at obtaining a better understanding of the kind of transformations that can be carried out on graphs when imposing limitations on the structure of graphs and on the capacities of the computing devices. The project is strongly research-oriented and consists to a large extent of an in-depth study of literature about:

- Automata models for infinite structures (Büchi automata) and logics for infinite strings and trees (LTL, CTL).
- Modal and Description logics for reasoning about finite graphs and their transformation.
- Functional programming techniques for infinite streams (such as in the Haskell language).
- Tools and results from finite model theory, such as the Ehrenfeucht-Fraïssé games and Gaifman's theorem.

[1] http://www.irit.fr/~Martin.Strecker/CLIMT/
[2] http://anr-dynres.loria.fr/

- Graph decompositions, notions of tree width and clique width.

On this basis, we will make a selection of the most promising techniques. The project can then evolve in several directions:

- Extension of an imperative graph transformation language currently developed in the Climt project to a transducer of infinite graphs; adaptation of the existing logic for reasoning about these programs.
- Development of a functional transformation model, in the spirit of the Haskell language, but adapted to dealing with infinite graphs.
- Extensions of games used in finite model theory to infinite games.

This project is mostly a theoretical study; however, the implementation of experimental prototypes is highly appreciated.

Prerequisites and interests

The project is aimed at students having a solid background in theoretical computer science, logic and mathematics. We do not expect in-depth knowledge of any of the concepts mentioned above, and we will help in selecting appropriate introductory texts and recent literature. Still, a high degree of autonomy and motivation is required.

Administrative Context

Interested? Then please contact

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- Ralph Matthes[4]
- Martin Strecker[5]

for further inquiries and for applying for the project. Funding will be provided for the duration of the project. The project is an ideal starting point for a PhD thesis.

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