Probabilistic Functional Programs: Termination and Verification

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Title. Probabilistic Functional Programs: Termination and Verification

Topic. Theoretical Computer Science, Probabilistic Lambda-Calculus, Type Systems, Termination Analysis, Verification

City and country. Aix-Marseille, France.

Team or project in the lab. Team LIRICA: https://www.lis-lab.fr/lirica/

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General presentation of the topic. Functional programming is a successful paradigm originating in $\lambda$-calculus. It has led to the development of programming languages such as OCaml and Haskell.

On the other hand, probabilistic computation is more and more used nowadays, in cryptography, robotics or for machine learning-related approaches.

Both approaches have been combined in languages such as Church [2] or Anglican [5]. We propose to study termination and verification problems for probabilistic $\lambda$-calculi, which mix functional programming with probabilistic programming.

Objective of the internship. The purpose of this internship is to work on the analysis of probabilistic $\lambda$-calculi. In recent work, Dal Lago and Grellois [4] defined a type system which ensures that a typable probabilistic $\lambda$-term terminates with probability 1: divergence is improbable. A first possible objective of the internship would be to work on type inference for this type system: how to
compute a typing derivation for a typable term? For the deterministic case, a type inference procedure already exists [1].

Another objective would be to devise a type system in the spirit of [4], but aiming to do probabilistic verification of the probabilistic λ-term of interest. This would combine intersection types, in the spirit of Kobayashi [3], with the distribution types introduced by Dal Lago and Grellois in [4]. A typable term would satisfy a property of interest with probability 1: failure would be improbable.

For more information and discussion on these matters, please contact me at charles.grellois@univ-amu.fr

**Expected ability of the student.** The student should have a strong interest in theoretical computer science. A prior knowledge of the basics of λ-calculus and of type systems would be very helpful.

**References**


