2019-01491 - Post-Doctoral Research Visit
F/M Dependence-based program intermediate representations and formally verified SSA-based optimizing compilers.

Type de contrat : CDD de la fonction publique
Niveau de diplôme exigé : Thèse ou équivalent
Fonction : Post-Doctorant

A propos du centre ou de la direction fonctionnelle
Inria, the French national research institute for the digital sciences, promotes excellence in research and technology transfer to maximise its impact. It employs 2,400 people. Its 200 agile project teams, generally with academic partners, involve more than 3,000 scientists in meeting the challenges of computer science and mathematics, often at the interface of other disciplines.

Inria works with many companies and has assisted in the creation of over 160 startups. It strives to meet the challenges of the digital transformation of science, society and the economy.

Mission confiée

The Celtique team develops mechanised semantics for full-fledged programming languages focusing on the source C language and JavaScript. In addition, the Celtique team conducts mechanization efforts related to the implementation of source languages. This includes the formal study of intermediate representations used in optimizing compilation chains, or runtime environment components.

A particular effort is dedicated to the semantic modeling and analysis of intermediate representations such as those found in modern optimizing compilers, e.g. SSA and variants thereof. We build on the CompCert C compiler [1], which is mainly developed by X. Leroy from the ÉPI Gallium. CompCert is an industrial-strength C compiler which is both programmed and proved correct inside the Coq proof assistant. This is a flagship of formal verification which is the cornerstone of national (ANR Verasco) and international research projects (NSF DeepSpec).

The actual CompCert C compiler does not use SSA-based optimization techniques. In the Celtique team, we study this particular technique through the CompCertSSA middle-end [2], that we started to develop in the team several years ago now. CompCertSSA extends Compert with an optimizing middle-end based on the SSA (Static Single Assignment) form. Currently, the compiler has satisfying performance in terms of compile-time and running-time of generated code, but there are a couple of remaining open problems we would like to explore.

In particular, we would like to improve it with techniques relying on the explicit representation of data and control-dependencies of programs. It improves on the initial SSA form, which was initially seen as a simple control-flow-graph. Examples of such techniques include the Program Dependence Graph, Sea-of-Nodes [3], of Monadic Gated SSA [4].

The challenge here is to shift from an operational setting where an abstract machine is running instructions one after another, to a more equational view of program behaviours, where data and control dependencies are what drive the program execution. Additionally, we will need to design adequate reasoning and proof techniques that scale to large mechanized developments such as realistic verified compilers. We have started to work in this direction on SSA variants such as the Sea-of-Nodes [5], and we would like to start working on the monadic gated SSA form [4].

A short-to-middle term objective is the formal definition of an equational semantics for SSA, perhaps reusing ideas from the synchronous languages community where programs are seen as value streams generators. In the context of verified compilation, one of the main challenges is to be able to relate such an equational semantics back to its operational version, which is essentially what is actually implemented by the compiler backend. The long-term goal is to make this semantic approach a foundation of verified program optimizers, or verified translation validators, embedded in optimizing verified compilers.

References

Informations générales
- Thème/Domaine : Preuves et vérification
- Ville : Rennes
- Centre Inria : CRI Rennes - Bretagne Atlantique
- Date de prise de fonction souhaitée : 2019-09-01
- Durée de contrat : 1 an, 4 mois
- Date limite pour postuler : 2019-04-30

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A propos d'Inria
Inria, l'Institut national de recherche dédié aux sciences du numérique, promeut l'excellence scientifique et le transfert, pour avoir le plus grand impact. Il emploie 2 400 personnes. Ses 200 équipes-projets agiles, en général composées avec des partenaires académiques, imploquent plus de 3 000 scientifiques pour relever les défis des sciences informatiques et mathématiques, souvent à l'interface d'autres disciplines. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 160 start-up. L'institut s'efforce ainsi de répondre aux enjeux de la transformation numérique de la science, de la société et de l'économie.

L'essentiel pour réussir

Applicants must have a PhD in Computer Science. We seek candidates with a strong background in Computer Science with an interest in at least one of the following topics: formal semantics, programming languages, compiler implementation, interactive theorem provers. Applicants should have a strong theoretical background, but also some experience with software development.

The position is for 18 months minimum and the starting date is flexible to some extent. The working language is English, knowledge of French is not required. The successful candidate will join the Celtique team at Inria Rennes: https://team.inria.fr/celtique/

Consignes pour postuler

Please submit online : your resume, cover letter and letters of recommendation eventually

Sécurité défense :

Ce poste est susceptible d’être affecté dans une zone à régime restrictif (ZRR), telle que définie dans le décret n°2011-1425 relatif à la protection du potentiel scientifique et technique de la nation (PPST). L’autorisation d’accès à une zone est délivrée par le chef d’établissement, après avis ministériel favorable, tel que défini dans l’arrêté du 03 juillet 2012, relatif à la PPST. Un avis


**Principales activités**

- Design and implement efficient validation techniques for SSA-based optimizations
- Semantic characterization of the validation process, proof of correctness
- Contribute to the state-of-the-art of compilers formal verification
- Disseminate new contributions in international conferences or journals

**Compétences**

- PhD in Computer Science
- Background in optimizing compilers techniques
- Background in SSA-based optimization techniques
- Background in formal verification in interactive proof assistants
- Fluent in English
- Autonomy
- Ability to work in team

**Avantages**

- Subsidized meals
- Partial reimbursement of public transport costs

**Rémunération**

Monthly gross salary amounting to 2 653 euros