



Offre n°2024-07962

## Post-Doctoral Research Visit F/M Source-to-Source Optimization of OCaml Programs

*Le descriptif de l'offre ci-dessous est en Anglais*

Type de contrat : CDD

Niveau de diplôme exigé : Thèse ou équivalent

Fonction : Post-Doctorant

### Contexte et atouts du poste

The work is conducted as part of the ANR OptiTrust project.

### Mission confiée

The OCaml programming language encourages development with a high degree of modularity and abstraction. It therefore leads to higher productivity, higher code reuse, and fewer bugs. Moreover, thanks to its simple semantics, OCaml code lends itself better to formal verification.

The downside of programming at a high level of modularity and abstraction is that these aspects generally hinder code optimization. The OCaml compiler extension called "F-lambda" performs a number of inlining steps in order to facilitate further optimizations. Yet, it is guided by heuristics, and falls short of performing advanced optimizations. Besides, the C++ approach of using templates for static code specialization is associated with numerous limitations, such as complexity in the source code, blow-up in the size of the generated code and its compilation time, and issues with understandability of error messages.

We would like to devise an approach that allows programmer to explicitly guide the application of series of advanced optimizations. This approach would allow refining high-level code down to high-performance code. Concretely, each optimization would take the form of a source-to-source transformation. At each step, the programmer would get feedback in the form of human-readable code.

This approach of user-guided source-to-source transformations is already implemented as part of the OptiTrust framework, which currently applies only to C code, but internally relies on an imperative lambda-calculus very close to OCaml. For certain optimizations, their correctness is verified by means of lightweight Separation Logic assertions, which accompany the code.

The aim of this project is to generalize the OptiTrust framework to operate on OCaml code, and to extend the framework with transformations relevant for ML-style programs. A possible extension to the project consists of developing refinements from OCaml functions down to optimized C implementations of these functions.

### Principales activités

The concrete plan for the postdoc is as follows.

1. Extend OptiTrust to input and output OCaml syntax.
2. Implement source-to-source transformations relevant for optimizing OCaml programs, such as inlining, specialization, simplification of pattern matching, elimination of avoidable allocations, removing of indirections on records, refinement of data constructors e.g. to generalize from unary

to n-ary list cells.

3. Apply the approach to case studies, such as optimization of the buckets of a hashtable, compilation of higher-order iterators into tight loop nests, specialization of the 'Sek' sequence data structure.
4. Demonstrate the possibility to refine allocation-free OCaml functions down to C code, with generation of C-bindings. Demonstrate the possibility of producing high-performance vectorized C code, e.g. for loops processing numeric data. An interesting case study would be the compilation of code from the Catala DSL, via OCaml, down to optimized C code.

## Compétences

The candidate must:

- be fluent in OCaml programming;
- be familiar with the notions of AST, and of semantics;
- be familiar with programs logics, in particular logical invariants;
- have knowledge of C programming.

## Avantages

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

## Rémunération

2788 € gross/month

## Informations générales

- **Thème/Domaine** : Architecture, langages et compilation  
Ingénierie logicielle (BAP E)
- **Ville** : Strasbourg
- **Centre Inria** : [Centre Inria de l'Université de Lorraine](#)
- **Date de prise de fonction souhaitée** : 2024-10-01
- **Durée de contrat** : 1 an
- **Date limite pour postuler** : 2024-08-10

## Contacts

- **Équipe Inria** : [CAMUS](#)
- **Recruteur** :  
Charguéraud Arthur / [Arthur.Chargueraud@inria.fr](mailto:Arthur.Chargueraud@inria.fr)

## A propos d'Inria

Inria est l'institut national de recherche dédié aux sciences et technologies du numérique. Il emploie 2600 personnes. Ses 215 équipes-projets agiles, en général communes avec des partenaires académiques, impliquent plus de 3900 scientifiques pour relever les défis du numérique, souvent à l'interface d'autres disciplines. L'institut fait appel à de nombreux talents dans plus d'une quarantaine de métiers différents. 900 personnels d'appui à la recherche et à l'innovation contribuent à faire émerger et grandir des projets scientifiques ou entrepreneuriaux qui impactent le monde. Inria travaille avec de nombreuses entreprises et a accompagné la création de plus de 200 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

There you can provide a "broad outline" of the collaborator you are looking for what you consider to be necessary and sufficient, and which may combine :

- tastes and appetencies,
- area of excellence,
- personality or character traits,
- cross-disciplinary knowledge and expertise...

This section enables the more formal list of skills to be completed and 'lightened' (reduced) :

- "Essential qualities in order to fulfil this assignment are feeling at ease in an environment of scientific dynamics and wanting to learn and listen."
- " Passionate about innovation, with expertise in Ruby on Rails development and strong influencing skills. A thesis in the field of \*\*\*\* is a real asset."

Concretely, the candidate will contribute to the OptiTrust code base, which is implemented in OCaml. The work should lead to the writing and presentation of research papers on the work produced.

**Attention:** Les candidatures doivent être déposées en ligne sur le site Inria. Le traitement des candidatures adressées par d'autres canaux n'est pas garanti.

## Consignes pour postuler

### 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 ministériel défavorable pour un poste affecté dans une ZRR aurait pour conséquence l'annulation du recrutement.

### Politique de recrutement :

Dans le cadre de sa politique diversité, tous les postes Inria sont accessibles aux personnes en situation de handicap.