The addressed algebraic optimizing transformations are based on the counting of integer points inside parametric polyhedra. The main underlying mathematical theory is related to Ehrhart polynomials.

Ehrhart polynomials are integer-valued polynomials that express the exact number of integer points contained by a finite polyhedron, i.e., a polytope, which depends linearly on integer parameters. If we consider a d-dimensional polytope depending linearly on parameters $p_1, p_2, ..., p_m$, then its Ehrhart polynomial is a polynomial of degree $d$ whose variables are $p_1, p_2, ..., p_m$, and whose coefficients are periodic numbers. However, every coefficient is constant whether every vertex of the polytope has integer coordinates. Ehrhart polynomials can be computed automatically by using software implementations as the one in library barvinok.

Among interesting properties of loop nests, the order, or rank, of an iteration is given by an Ehrhart polynomial: given a tuple of possible values of the loop indices, the rank of the associated iteration is the number of iterations that are executed before a given condition is met.
This number is the number of tuples in the iteration domain which are lexicographically less than the addressed tuple. Thus, a ranking Ehrhart polynomial associates to each tuple characterizing an iteration, a unique integer value between 1, which is the rank of the very first iteration, and the total iteration count of the loop nest. Conversely, one unique tuple of the iteration domain is associated to an integer value in the interval. Thus, a ranking polynomial defines a bijection, and can then be inverted.

We have developed a technique to invert such ranking polynomials that has been implemented in a dedicated software. The mathematical expressions that resulting are called Trahrhe expressions. They are algebraic expressions of complex numbers, including radicals, and from which are extracted their real and integer parts.

The first goals of the PhD work are to consolidate the existing developments:
- Improving the efficiency of non-rectangular loop collapsing and algebraic tiling;
- Improving and extending the software implementation for computing and applying Trahrhe expressions.

Then, the work should be oriented toward theoretical and practical extensions:
- Extending algebraic tiling to stencil computations requiring loop skewing;
- Developing new algebraic optimizations (e.g. algebraic scheduling);
- Generalizing algebraic transformations;
- Implementing an automatic chain of algebraic optimizations, for example as passes of the compiler Clang/LLVM.

**Compétences**

**Required qualifications**

MSc in computer science, good knowledge in compiler optimizations and parallel programming, good mathematical skills.

**Language**

Fluent English.

**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**


Monthly salary after taxes: around 1596,05€ for 1st and 2nd year. 1678,99€ for 3rd year.

for Bachelor and Master (or the last 5 years).

Master thesis (or equivalent) if it is already completed and publications if any (it is not expected that you have any). Only the web links to these documents are preferable, if possible.

In addition, one recommendation letter from the person who supervises(d) your Master thesis (or research project or internship) should be sent directly by his/her author to philippe.clauss@inria.fr.

Applications are to be sent as soon as possible.

**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°2011-429 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.

**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.