Offer #2025-09003

PhD Position F/M Compilation of a DSL based on vectorial circuit to SIMD optimized code

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

Level of experience : Recently graduated

About the research centre or Inria department

The Inria University of Lille centre, created in 2008, employs 360 people including 305 scientists in 15 research teams. Recognised for its strong involvement in the socio-economic development of the Hauts-De-France region, the Inria University of Lille centre pursues a close relationship with large companies and SMEs. By promoting synergies between researchers and industrialists, Inria participates in the transfer of skills and expertise in digital technologies and provides access to the best European and international research for the benefit of innovation and companies, particularly in the region.

For more than 10 years, the Inria University of Lille centre has been located at the heart of Lille's university and scientific ecosystem, as well as at the heart of Frenchtech, with a technology showroom based on Avenue de Bretagne in Lille, on the EuraTechnologies site of economic excellence dedicated to information and communication technologies (ICT).

Context

Within the framework of a partnership public with LCIS within the scope of ANR SxC.

Streaming data processing is a crucial approach that focuses on traversing data to extract pertinent
information. Applications ranges from network packet manipulation to analysing DNA. Modern data-
processing tools heavily depend on efficient implementations that harness hardware acceleration to
achieve high performance. This acceleration can sometimes be achieved through automatic compilation,
but frequently demands expert developers to craft optimizations by hand.
One critical facet of this optimization process involves SIMD optimization, where data is packed into
chunks and processed with minimal branching in the code, often using bit vector operations. These
optimizations are at the core of numerous well-known software applications, such as regular expression
matching in tools like ripgrep, JSON parsing in libraries like SimdJSON, and even fundamental operations
like string encoding and decoding (Unicode parsing). Developing these optimizations requires a broad
skill set and is a testament to the expertise of programmers worldwide.

Assignment

Designing VIR: an intermediate representation of vectorial programs.
During this PhD, we will explore the design and implementation of VIR, an intermediate representation
of vectorial programs heavily influenced by synchronous programming, high-performance compilation
of array languages and vectorial circuits.
The end goal is to have a machine and optimization friendly formal representation of computation
relying heavily on SIMD accelerations.
Some cases studies have already been performed in the context of various experiences, coming from
early-stages internships in which the premises of complete toolchain to evaluate simd solutions has been
designed; or a complete project, vizitig, which proposes simd implementations of programs analyzing
DNA strings.

Main activities

The core of our specialized language will benefit from these experiences.
In the context of this PhD, the student will:
• make an extensive bibliography of existing approaches for compiling programs into vectorial
code, focusing on intermediate representations to represent parallelism at different abstraction
levels;
• study the specificities of different vectorial targets, especially from the circuit complexity point
of view;
• make different propositions as VIR as intermediaire representation;
• contribute to the compilation stack inside the project, focusing on back-ends.

Benefits package

- 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 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

General Information

- **Theme/Domain :** Algorithmics, Computer Algebra and Cryptology
  Scientific computing (BAP E)
- **Town/city :** Villeneuve d'Ascq
- **Inria Center :** Centre Inria de l'Université de Lille
- **Starting date :** 2025-09-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2025-07-16

Contacts

- **Inria Team :** LINKS
- **PhD Supervisor :**
  Paperman Charles / charles.paperman@inria.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

The keys to success

The candidate should ideally be familiar with formal approaches in programming language design,
notably type systems, semantics, and logic. From the practical point of view, a basic experience in
software programming and usage of collaborative tools such than git. This PhD strongly relies on
the fact that practical implementation should have strong theoretical foundations and that further
refinements of the theory should get inspiration from the practical side. We expect the candidate to
agree with this philosophy.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

Instruction to apply

Please send your CV and cover letter

Defence Security :
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :
As part of its diversity policy, all Inria positions are accessible to people with disabilities.