Context and motivation

Geometric problems are central in many areas of science and engineering. Computational geometry, the study of combinatorial and algorithmic problems in a geometric setting, has tremendous practical applications. Traditionally, the scope of computational geometry has been limited to algorithms on data in the Euclidean space.

However, some results in computer science used combinatorial hyperbolic structures (SSTDL). Also, hyperbolic surfaces are natural and appear in various fields in physics and material sciences. For instance, the triple periodic minimal surfaces of Euclidean space have hardly been studied.

We have already obtained results about the computation of Delaunay triangulations in hyperbolic spaces (BDT) and on very specific hyperbolic surfaces (IT). The need of a very geometric toolbox for hyperbolic surfaces has become critical to tackle more general hyperbolic surfaces. Some combinatorial constructions on such surfaces have been proposed from a mathematical point of view (Bus), however the algorithmic and practical properties have hardly been studied.

Mission confiée

Objectives

The purpose of this PhD is to explore the geometry of hyperbolic surfaces and provide such a geometric toolbox.

Two main discrete structures have been proposed to describe hyperbolic surfaces: Fenchel-Nielsen coordinates and fundamental polygon with side gluings. These representations are not unique, which leads to research questions like: how to compute a good pants decomposition? or how to compute a fundamental domain that is a Voronoi cell? Also, elementary queries associated to the underlying surface? These representations are not unique, which leads to research questions like: how to compute a good pants decomposition? or how to compute a fundamental domain that is a Voronoi cell? Also, elementary queries associated to the underlying surface?

Many other interesting questions may be considered, so, the candidate will have the opportunity to choose between different possible directions. In each case, the goal will be to present an algorithm, analyze it, and implement it. Considering the potential applications and targeted users, SageMath seems to be a good option for implementations.

Compétences

Prerequisites

This PhD thesis involves knowledge from both

- mathematics (in particular: low-dimensional topology and geometry)
- and computer science (in particular: algorithms, graph theory, and C++/Python).

Candidates should have a strong expertise in one of those fields and a real interest for the other one.

Languages

French is no compulsory. English is required.
### 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. (medical insurance included).