From epistemic approach to topology for distributed computability

Encadrants: Emmanuel Godard (prenom.nom@lis-lab.fr)
Laboratoire: LIS – équipe DALGO

Context

Distributed Computability of a task is the study and characterization of the conditions on the environment for this task to admit a distributed solution. Depending upon the type of uncertainty appearing in the environment, there exists different approaches. When uncertainty is about space, algebraic approaches are used, when uncertainty is about time, discrete topology approaches are used [HKR13].

Subject

We consider the Consensus problem. Given different initial values, process should decide a common output value from those initial values. This problem is a central problem in distributed computing.

The general approach for distributed computablity is to use discrete topology since[HS99], and it is now realized that the first impossibility proof techniques for consensus, the so-called bivalency techniques[FLP85], are actually related to connexity, a central concept in topology.

Recently, an a general characterization of consensus computability has been proposed in[NSW19] by mixing epistemic consideration to the topological approach. This is intriguing since the epistemic approach was not successful in the 90's to solve the $k-$set agreement problem, a generalization of consensus. It was actually solved using a topological approach (and topological theorems from the 30's).

The main goal of the internship is to investigate whether the used epistemic ingredients can be made into a more self-contained topological approach. Reflecting on what was missing from the epistemic approach to succeed could also be under consideration.

Requirements

No deep knowledge of epistemic logic or topology required, only a curious mind about seemingly unrelated part of mathematics.

Conditions:
Standard allowance for research internship + Great team environment

References

[FLP85] Michael J. Fischer, Nancy A. Lynch, and Michael S. Paterson. Impossibility of distributed consensus with one faulty process. 32(2):374–382, 1985.

[HKR13] Maurice Herlihy, Dmitry N. Kozlov, and Sergio Rajsbaum. *Distributed Computing Through Combinatorial Topology*. Morgan Kaufmann, 1 edition edition, 2013.

[HS99] Maurice Herlihy and Nir Shavit. The topological structure of asynchronous computability. *Journal of the ACM*, 46(6):858–923, 1999. see also http://people.csail.mit.edu/idish/sigactNews/DC-col47-Sep12.pdf.

[NSW19] Thomas Nowak, Ulrich Schmid, and Kyrill Winkler. Topological characterization of consensus under general message adversaries. In *PODC*, pages 218–227. ACM, 2019.

Scientific Environment

Laboratoire d'Informatique et Systèmes

The Laboratoire d'Informatique et Systèmes (LIS) is a joint research unit of CNRS – Université Aix-Marseille UM7020. LIS has about 190 tenure researchers and professors, about 125 doctoral students and 40 post-docs and 20 technical staff.

LIS is made of four thematic departments. The DALGO team belongs to

"Computing" department theoretical computer science, logic, algorithmic and complexity, quantum computing, geometry and topology, artificial intelligence

Overall, the themes of research of these teams cover a significant part of modern computer science. The members of this department share the same demanding approach to research, be it theoretical or more application-oriented: they aim at producing results that may actually contribute to computer science, viewed as a whole scientific field on its own.

DALGO Team

The Distributed Algorithms (DALGO) team is part of the CNRS laboratory LIS. It is located on the Luminy Campus, south of Marseille. The DALGO team is concerned with the study of distributed and decentralized systems with a focus on the algorithmic aspects. In particular we are interested in the computational power of various models for distributed computing and the communication complexity of distributed solutions to fundamental problems in these models. Members of our team work on the following themes of research:

- Design and Analysis of Distributed Algorithms
- Distributed Computing with Mobile Agents or Mobile Robots
- Dynamic Network Models
- Embedded Systems and Synchronous Programming Languages

The team head is *Jérémie Chalopin*.

See website at https://www.lis-lab.fr/en/dalgo-2/