

EPIT 2017 Program

Speakers

- Petr Kuznetsov, INFRES, Telecom ParisTech, France
Lower Bounds Techniques for Distributed Computing
- Pierre Fraigniaud, IRIF, CNRS and Univeristé Paris Diderot, France
Local Distributed Computing
- Cyril Gavoille, LaBRI, Université de Bordeaux, France
Compact and Distributed Data Structures
- Amos Korman, IRIF, CNRS and Université Paris Diderot, France
How can a Distributed Algorithmic Perspective Contribute to the Study of Biological Systems?
- Paul Gastin, LSV, ENS Cachan, France
Formal Methods for the Verification of Distributed Algorithms
- Boaz Patt-Shamir, Tel Aviv University, Israël
Network Algorithms
- Michel Raynal, IRISA, Université de Rennes 1, France
Distributed Universal Constructions: a Guided Tour
- Sebastien Tixeuil, LIP6, Université Pierre et Marie Curie, France
Distributed Algorithms for Mobile Networks
- Cyril Gavoille, LaBRI, Université de Bordeaux, France
Locality beyond Classical Models

Program at a glance

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Detailed program

Sunday, May 14

19h15 **Dinner**

Monday, May 15

9h00 - 12h30 **Distributed Universal Constructions: a Guided Tour**

Michel Raynal

Abstract: The notion of a universal construction is central in computing science: the wheel has not to be reinvented for each new problem. In the context of n -process asynchronous distributed systems, a universal construction is an algorithm that is able to build any object defined by a sequential specification despite the occurrence of up to $(n-1)$ process crash failures. The aim of this tutorial is to present a guided tour of such universal constructions. Its spirit is not to be a catalog of the numerous constructions proposed so far, but a (as simple as possible) presentation of the basic concepts and mechanisms that constitute the basis these constructions rest on.

Document: Distributed Universal Constructions: a Guided Tour, Slides

12h30 **Lunch**

14h00 - 17h30 **Lower Bounds Techniques for Distributed Computing**

Petr Kuznetsov

Abstract: Models for distributed systems come in many flavors: processes may communicate through shared memory or by message passing, they may be synchronous or asynchronous, susceptible to failures or not, and so on. The different models require different lower bound results. Nevertheless, many of these proof rely on common techniques, having to do with information transfer and the difficulty of dealing with indistinguishable scenarios. This lecture will explore and explain some of these techniques, together with their applications.

Slides

19h30 **Dinner**

Tuesday, May 16

9h00 - 12h30 **Network Algorithms** *Boaz Patt-Shamir*

Abstract: We shall talk about three types of problems and algorithms for networks of processors communicating by short messages:

- problems such as computing maximal matching, that can be solved essentially locally,
- problems dealing with distances such as computing approximate all-pairs shortest paths, and
- problems dealing with bandwidth such as computing max-flow. We shall see some classical as well as state-of-the-art results in all topics.

Slides

12h30 **Lunch**

14h00 - 17h30 **Local Distributed Computing** *Pierre Fraigniaud*

Abstract: The lecture will address locality in distributed network computing. The objective is to study how to solve complex tasks in a network where nodes are bounded to interact locally, that is, where nodes can only exchange information with nodes in their vicinity, i.e., at constant distance, or at distance bounded by a function negligible compared to the diameter of the network. The lecture will present the main techniques to derive lower bounds, as well as several deterministic or randomized algorithms for solving non trivial symmetry breaking tasks in networks. In addition, the lecture will survey the most recent results in the context of local computing, and the main open problem in this field.

Slides

19h30 **Dinner**

Wednesday, May 17

9h00 - 12h30 **Distributed Algorithms for Mobile Networks** *Sébastien Tixeuil*

Abstract: Current distributed systems frequently include some kind of mobility (e.g. passively mobile sensors can be embedded on animals or vehicles whose movements must be coped with by the sensors, while actively mobile devices such as autonomous robots can use mobility to solve complex distributed problems). This talk will present key results and models for designing distributed algorithms run by mobile entities. Recent research results and ongoing projects will also be discussed.

Slides

12h30 **Lunch**

13h45 - 15h15 **Exercises**

Abstract: Participants will be proposed various exercises on the different topics covered so far in the school in order to help them better comprehend the notions and techniques presented in the different lectures.

Exercises Solutions

15h15 **Social event**

19h30 **Dinner**

Thursday, May 18

9h00 - 12h30 **Compact and Distributed Data Structures** *Cyril Gavoille*

Abstract: A fundamental question in Distributed Computing is to understand how localized and how much information are required to solve a task on a network. Typically, if the distance between any pair x,y of nodes in a network is asked, we would like to know which minimal information about x and y in the network are needed. The goal in labeling schemes is precisely to understand how much information must be attached to the nodes (formalized as labels) to solve a graph problem assuming the answer can be determined solely on the basis of the labels of the nodes invoked in the query. In this lecture, we will present the main tools and techniques to solve such labeling problems, including distance labeling schemes, nearest common ancestor labeling schemes, and label-based compact routing schemes.

Slides

12h30 **Lunch**

14h00 - 15h30 **How can a Distributed Algorithmic Perspective Contribute to the Study of Biological Systems?** *Amos Korman*

Abstract: I will speak about different directions that I take in order to study computational aspects that are fundamental to biological systems while employing a distributed algorithmic perspective. I will mostly focus on the study of ensembles such as ants or birds, and elaborate on modeling their computational challenges with respect to basic tasks such as searching (i.e., foraging for food) and stochastic dissemination of information (i.e., recruitment or alarming processes).

16h00 - 17h30 **Formal Methods for the Verification of Distributed Algorithms** *Paul Gastin*

Abstract: We introduce an automata-theoretic method for the verification of distributed algorithms running on ring networks. In a distributed algorithm, an arbitrary number of processes cooperate to achieve a common goal (e.g., elect a leader, sort an array). Processes have unique identifiers (pids) from an infinite, totally ordered domain. An algorithm proceeds in synchronous rounds, each round allowing a process to perform a bounded sequence of actions such as send or receive a pid, store it in some register, and compare register contents wrt. the associated total order. An algorithm is supposed to be correct independently of the number of processes. To specify correctness properties, we introduce a logic that can reason about processes and pids. Referring to leader election, it may say that, at the end of an execution, each process stores the maximum pid in some dedicated register.

We show that the verification problem of distributed algorithms can be reduced to satisfiability of a formula from propositional dynamic logic with loop and converse (LCPDL), interpreted over cylinders over a finite alphabet. This translation is independent of any restriction imposed on the algorithm. However, since the verification problem (and satisfiability for LCPDL) is undecidable, we propose an underapproximation technique, which bounds the number of rounds. This is an appealing approach, as the number of rounds needed by a distributed algorithm

to conclude is often exponentially smaller than the number of processes. Using our reduction to LCPDL, we provide an automata-theoretic solution, reducing model checking to emptiness for alternating two-way automata on words. Overall, we show that round-bounded verification of distributed algorithms over rings is PSPACE-complete, provided the number of rounds is given in unary.

Slides

19h30 **Dinner**

Friday, May 19

9h00 - 10h15 **Locality Beyond Classical Models** *Cyril Gavaille*

Abstract: The objective of this lecture is to understand the impact of quantum resources on the efficiency of distributed algorithms. We will present the basic concepts of quantum information, and how to use them to extend the LOCAL model and to solve problems such as coloring or its variants.

Slides

11h00 - 12h15 **Discussion**

12h15 **Lunch**

13h15 **Boat to Tour Fondue**, to be confirmed

End of the school