CS-455  
Topics in theoretical computer science

<table>
<thead>
<tr>
<th>Cursus</th>
<th>Sem.</th>
<th>Type</th>
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<tbody>
<tr>
<td>Data Science</td>
<td>MA1, MA3</td>
<td>Opt.</td>
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<tr>
<td>Informatique</td>
<td>MA1, MA3</td>
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<td>Mineur en Informatique</td>
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<td>SC master EPFL</td>
<td>MA1, MA3</td>
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Language  
English

Credits  
4

Session  
Winter

Semester  
Fall

Exam  
During the semester

Workload  
120h

Weeks  
14

Hours  
4 weekly

Lecture  
3 weekly

Exercises  
1 weekly

Number of positions  
1

Remarque  
pas donné en 2018-19

Summary  
The students gain an in-depth knowledge of several current and emerging areas of theoretical computer science. The course familiarizes them with advanced techniques, and develop an understanding of fundamental questions that underlie some of the key problems of modern computer science.

Content  
• Examples of topics to be covered include:
  
  • Streaming: given a large dataset as a stream, how can we approximate its basic properties using a very small memory footprint? Examples that we will cover include statistical problems such as estimating the number of distinct elements in a stream of data items, finding heavy hitters, frequency moments, as well as graphs problems;
  
  • Sketching and sampling: what can we learn about the input from a few carefully designed measurements (i.e. a ‘sketch’) of the input, or just a few samples of the input? We will cover results in sparse recovery and property testing that answer this question for several fundamental problems;
  
  • Sublinear runtime: which problems admit solutions that run faster than it takes to read the entire input? Examples include sublinear time algorithms for graph processing problems, nearest neighbor search and Sparse FFT;
  
  • Communication: how can we design algorithms for modern distributed computation models (e.g. MapReduce) that have low communication requirements? We will discuss graph sketching, a recently developed approach for designing low communication algorithms for processing dynamically changing graphs.

Keywords  
streaming, sketching, sparse recovery, sublinear algorithms

Learning Prerequisites  
Required courses  
Bachelor courses on algorithms, complexity theory, and discrete mathematics.

Learning Outcomes  
By the end of the course, the student must be able to:
• Design efficient algorithms for variations of problems discussed in class;
• Analyze formally space/time/communication complexity of randomized algorithms
• Prove space/time/communication lower bounds for variations of problems discussed in class;
• Select appropriately algorithmic tool for big data analysis problem at hand

Teaching methods
Ex cathedra, homeworks, reading

Expected student activities
Attendance at lectures, completing exercises, reading written material

Assessment methods
• Continuous control

Supervision
Office hours
Assistants
Others
Yes
Yes
Electronique forum : Yes

Resources
Bibliography

There is no textbook for the course. Notes will be posted on the course website.

Ressources en bibliothèque
• Randomized Algorithms / Motwani