M1 Course - Performance Evaluation in Networks

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Performance Evaluation?

Studying the performances of computer/communication systems/networks (but not only, e.g. transport networks, supply chains), with three complementary features:

- observation
- prediction
- control/optimisation
Systems / Performances

**Systems:**
- architectures / hardware (micro-processors, PC clusters, supercomputers)
- code / software (runtime, compilation)
- communication networks (internet, telecom, embedded) / distributed systems
- logistics, industrial processes, transport networks, ...

**Performances:**
- “metrics”: speed, power, bandwidth, delay, load, losses ...
- worst case, on average (under probabilistic hyp.), equity ...
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Studying the performances of a system

Investigation tools:
- mathematical/numerical analysis of abstract models
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- simulation (math model, scale model)
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Investigation tools:
- mathematical/numerical analysis of abstract models
- simulation (math model, scale model)
- experiments/measures on real system
- data analysis (statistics)
Reminder: the scientific method

Hypotheses / model

Validation

Observations

Predictions

Experiments
Course Objectives

Objectives:
- designing and analysing mathematical models, in particular with probabilistic assumptions
- reinforcing knowledge about probabilistic/statistical tools
- reinforcing knowledge about communication networks
- practising simulation with a simulation software
- practising statistics with a statistics software

Pre-requisite:
- basics in Probability
- knowledge about networks is good, but not essential
Why so many probabilities?

- **Intrinsic randomness**: real systems / math models where randomness is desired or suffered
- **The art of reasoning “à la louche” / “gross estimation”**: quantifying frequent vs rare, rich bestiary of inequalities, probability in statistics.
- **Probabilistic/stochastic models**: good in practice
Cloud of $n$ experimental measures

Execution time of a task with regard to its size

- Which information can be retrieved?
- Should we carry out more measures?
Trajectories of \( n \) simulation runs

- What can be deduced about the transitory/asymptotic behavior of the system?
- Should we make the simulations last longer?
Analyzing a network of queues

- Does the system risk overload?
- How long will I wait before being served?
Course topics

- Probability basics \(\times 1 \text{ or } 2\)
- Random generation & Simulation \(\times 1 \text{ or } 2\)
- Queuing theory \(\times 4 \text{ or } 5\)
- Statistics \(\times 3 \text{ or } 4\)
- Measures in networks \(\times 0 \text{ or } 1\)
Evaluation:

- 3 hours exam in January (coeff = 1/2)
- continuous assessment including a 2 hours mid-term exam and a couple of homeworks (coeff = 1/2)

⚠️ attending courses & TD/TP = good for performances

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Web sites / Softwares

Web sites:
- The Probability Web: [http://probweb.berkeley.edu/](http://probweb.berkeley.edu/)

Softwares for the course:
- NS2 / NS3: [https://www.nsnam.org/](https://www.nsnam.org/)
- R: [https://www.r-project.org/](https://www.r-project.org/)