

# Communication Networks, Algorithms & Probability Theory

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## Communication Networks

- ▶ **Philippe Robert**  
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- ▶ **Research Area:**  
Stochastic Modeling of Communication  
Networks.

### Examples

- ▶ Telephone.
- ▶ Internet.
- ▶ Sensors
- ▶ mobile, Wifi, ...

## Problems

### Dimensioning.

### Design of algorithms

- ▶ Admission. Congestion Control.
- ▶ Resource Allocation.
- ▶ Bandwidth Sharing.  
Quality of service.
- ▶ Web search Internet. Page Ranking.

## Two main ingredients

### Algorithms

- ▶ Algorithmic Framework.
- ▶ General classes of algorithms.

### Probability

- ▶ Statistical nature of traffic.  
⇒ Impact on design.
- ▶ Randomness used by algorithms.

## Analysis of the evolution of the network

- ▶ Stability properties.
- ▶ Congestion, loss phenomena.
- ▶ Estimation of delays.
- ▶ Global use of the network. (Efficiency).

## Mathematical tools

Markov property.

Poisson Processes.

Stability of Markov Processes.

**Advanced mathematical tools are mandatory.**

## General goals of these lectures

- ▶ Fundamental results of **discrete probabilistic** modeling.
- ▶ **Algorithms**: design and analysis.
- ▶ Impact on the **evolution** of networks.

## Plan

- ▶ Markov Processes and Chains.
- ▶ Poisson processes.  
**Models for requests arrivals.**
- ▶ Markovian models of networks.
- ▶ Product Form networks.  
**Application to circuit switching networks**

## Plan (II)

- ▶ Study of access protocols :  
**ALOHA, Ethernet, tree algorithms.**
- ▶ Analysis of **TCP** protocol.
- ▶ Mathematical models of **Internet**.

### Internship subjects

- ▶ Mobile Networks.
- ▶ Network traffic in wireless networks.
- ▶ Web search.
- ▶ Neural networks.

## Research Labs

- ▶ Orange Labs.
- ▶ Microsoft, Google.
- ▶ US: Columbia (NYC), Brown, ...
- ▶ INRS (Montreal), Waterloo.
- ▶ Eurandom (Eindhoven), CWI (Amsterdam).
- ▶ EPFL (Lausanne)