

# Covering trees: alea and application

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**Timetable:** 24 hours. First lecture on June 5, 2017, 11:00 (dates already fixed see calendar), Torre Archimede, Room 2BC/30.

**Course requirements:** The course assumes the knowledge of basic probability, including the elementary theory of Markov Chains. If necessary, 1-2 introductory lectures will be given before the course.

**Examination and grading:** Oral exam.

**SSD:** MAT/06 Probability and Mathematical Statistics

## **Aim:**

Covering trees of connected graphs are basic tools in operation research and communication protocols. As they are seen as random object, they reveal a number of connections between seemingly distant areas of mathematics. Starting with Kirchoff work, they have been use to build connections between the theory of electrical networks, algebra and combinatorics: one could for instance obtain the intensity of the electrical current in a network through the computation of determinants related to the counting of covering trees for the network. They have the become key tools in the study of the so-called *determinantal processes*, whose properties can be expressed in terms of the random walk on the underlying graph. The resulting formulas are also useful for the spectral analysis of graphs, and for solving models in Statistical Mechanics.

## **Course contents:**

The course will begin with a detailed analysis of the connections mentioned above, in the case of finite graphs. We will then make extensions to random graphs and infinite graphs, working either directly in the infinite graphs or by considering limit of sequences of finite graphs. We will see connections with the associated random walks, some recent results and open problems. The last part of the course will be devoted to applications to multiscale analysis of graphs and markov processes, and to problems emerging in signal processing.