4th Stochastic Geometry Days, August 24 - 28 2015
LMA, Université de Poitiers

Lectures, August 24-26 2015

LECTURES ON STOCHASTIC METHODS FOR IMAGE ANALYSIS

Agnès DESOLNEUX
CNRS and CMLA, ENS Cachan, France

Abstract. These lectures about stochastic methods for image analysis will be divided in four parts, corresponding to the four lectures.

1. *Visual perception and the non-accidentalness principle.* In this first lecture, I will first introduce the Gestalt theory that is a psychophysiological theory of human visual perception. Then, I will show how it can be translated in a mathematical framework thanks to a perception principle called the non-accidentalness principle, that roughly says that "we immediately perceive in an image what has a low probability of coming from an accidental arrangement".

2. *A contrario method for the detection of geometric structures in images.* The a contrario method is a generic method, based on the non-accidentalness principle, to detect meaningful geometric structures in images. I will first show in detail how it works in the case of the detection of straight segments in an image. Then, I will show some other detection problems. At the end of the lecture, I will also explain how the a contrario detection method can be, using a maximum entropy principle, turned into a method able to generate new images having the same visual content as an original given image.

3. *Stochastic geometry for the detection of vanishing points in images.* Vanishing points are small regions in the image domain that are intersected by a high number of (previously detected) lines in the image. I will show how one can detect these vanishing points using the a contrario framework. To do this, I will introduce some elementary results of stochastic geometry, mainly about questions like: what is the probability that a random line meets a given region ?

4. *Stochastic models of images : the problem of modeling and synthesizing texture images.* In this last lecture, I will give an overview of some methods of texture synthesis. I will also discuss two models of texture images: shot noise random fields (also sometimes called lumpy background) and stationary Gaussian random fields. I will end showing several applications of these models for image analysis.

LECTURES ON AN INTRODUCTION TO RANDOM TOPOLOGY

Robert ADLER
Technion-Israel Institute of Technology, Haifa, ISRAEL

Topology, as a mathematical discipline, has both its differential and algebraic aspects. While different, these are inherently connected, and both are concerned with providing qualitative and, when possible, quantitative approaches to the elusive notion of "shape".

In the study of Probability and Stochastic Processes, there is a similar dichotomy, into the worlds of the continuous and the discrete. The world of continuous stochastic processes itself further separates into the world of the smooth and the rough, the archetypical example of which is Brownian motion.

To introduce the notions of Random Topology, the first three lectures will concentrate on the Differential Topology of smooth random functions, describing both some of the beautiful theoretical advances of the last decade as well as some of the applications. They will start from basics, with an introduction to Gaussian processes, and then proceed at a leisurely pace through the topology (and some geometry) assuming no previous exposure to this material from the participants.

The last lecture will look at the discrete world, and explain why we need to look towards Simplicial Topology as a natural tool for this setting. This lecture will explain the connection of topics such as Homology, which is generally outside the probabilists' collection of tricks, to the of study random networks, and how it even adds to our understanding of the behaviour of Poisson and other point processes.