**Headline:** Constrained Deep Learning for Big Data

**Background:**

Deep learning is currently an extremely active research area in machine learning and pattern recognition. Deep learning algorithms attempt to learn multiple levels of representation of increasing complexity/abstraction. As the data keeps getting bigger, deep learning is coming to play a key role in providing big data predictive analytics solutions [1]. While the potential of Big Data is undoubtedly significant, fully achieving this potential requires new ways of thinking and novel algorithms.

This PhD thesis aims to propose a novel classification algorithm which recognizes learned patterns in a huge volume of unstructured data. This algorithm should satisfy two main requirements. First, the proposed pattern detection/classification algorithm should have reliable statistical performance in regards to the random aspect of Big Data. Taking into account the veracity dimension of data is now essential for all Big Data algorithms. Second, the algorithm should be easily parallelized. In other words, it should be adapted to the famous Hadoop MapReduce/Apache Spark framework.

Multimedia is the biggest Big Data as the most important and valuable source for insights and information. In the area of image and video processing, many challenges exist all around the world to evaluate algorithms for object recognition and image classification at large scale [2, 3, 4]. Hence, this PhD thesis will especially focus on images and videos to illustrate the performance of the proposed constrained deep learning classification algorithm. The PhD student will do his/her PhD thesis in Sophia Antipolis which is the largest technology park in Europe.

**Objectives:**

Deep learning attempts to model high-level abstractions in data by using model architectures composed of multiple non-linear transformations. It is essentially based on learning representations of data. One of the promises of deep learning is replacing handcrafted features with automatic hierarchical feature extraction. A large number of data (such as images under varying geometric transformations) are thought of as constituting highly nonlinear (i.e., non-flat) manifolds in a high-dimensional observation space. Visualization and exploration of high-dimensional data are the focus of much current machine learning research. However, most recognition systems using conventional methods [5] are bound to ignore subtleties of manifolds (such as the curvature). This is a bottleneck for achieving highly accurate recognition. This PhD proposal aims to design a manifold recognition algorithm based on the deep learning principle.

The main objective of this PhD proposal is to define an almost optimal classifier to identify the true manifold (corresponding to the analyzed data) among a finite set of possible manifolds [6]. Each manifold corresponds to a data explicative model. These manifolds are derived from a large-scale learning database. The main awaited novelty consists in developing an algorithm which identifies the manifold by using a hierarchical set of features. This set of features will be derived from the structure of the manifolds. By this way, the deep learning based classifier will be constrained by the structure of the manifolds.

Finally, a major issue of this research is to propose a simple and very quick recognition algorithm which will be able to process large-scale databases. A typical large-scale image database contains more than one million of images. As an indication, a processing time of 1 second per image (which is rather optimistic for pattern recognition) requires approximately 12 days for processing such a database. It is crucially important to design a low complexity algorithm. The proposed method will be tested on a large-scale image database [3]. It could also be tested on other kinds of data since the developed results will concern Big Data processing in general.

**Summary:**

- To study the existing pattern recognition methods with a special focus on deep learning;
- To design a classifier for manifold recognition based on deep learning;
- To study the accuracy of the proposed classifier;
- To verify numerically (with Matlab and/or C++) the performance of the proposed classifier.

**Expected skills:** Mathematics, probability, image processing and programming (Matlab or C++)

**Laboratory:** I3S laboratory, SiS team, MediaCoding project, Sophia Antipolis (06).
Contact (please send your CV + grades + motivation letter):
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Website to apply before Sunday, May 24th 2015: http://edstic.unice.fr/edsticTheses2015/

Duration: 36 months (starting date: October 2015).

References: