Deep learning for sequential tracking

Team LARSEN, Inria Nancy, France

Team: https://team.inria.fr/larsen/

Supervisors: Francis Colas and Emmanuel Vincent

Starting date: Spring 2016

Duration: 4 to 6 months

To apply: send a CV, a letter of motivation, and your MSc transcript to francis.colas@inria.fr and emmanuel.vincent@inria.fr

The problem of sequential tracking arises in many fields, such as computer vision, radar, financial modelling, brain imagery... The goal is to estimate the posterior distribution of a vector variable (called state) over time from a series of measurements using a state model and a sensor model.

Sequential Monte Carlo techniques [1], also known as particle filtering, are asymptotically optimal but computationally intensive. Other methods such as extended Kalman filtering (EKF) [2] and unscented Kalman filtering (UKF) [3] are computationally cheaper, but they rely on some approximation of the nonlinearities in the state model and the sensor model which are often inaccurate. Moreover, all these methods rely on the assumptions of Markovian independence of the state sequence and independence of the measurements given the states, which are also often inaccurate.

This internship aims to study a new approach to sequential tracking based on deep learning. The idea is to exploit data in order to correct these inaccuracies by training a deep neural network (DNN) in a supervised fashion to predict the state distribution given the measurements. The replacement of UKF by DNN has recently led to a great improvement for the propagation of the posterior distribution at a given time step in the field of speech processing [4,5]. The recruited candidate will extend this achievement to multiple time steps and apply it to the field of robotics.

The results will be evaluated for the task of tracking the pose of a mobile robot over time given odometry measurements. Experiments will be performed in the smart room facility of Inria Nancy using a Turtlebot and existing software for the measurement of the ground truth pose using a Qualisys motion tracking system.

Seeked profile:
MSc in robotics, machine learning, or computer science. Programming experience in Python/SciPy. Experience with Theano and ROS is a plus.

[1] A. Doucet, N. de Freitas, N. Gordon (eds), *Sequential Monte Carlo Methods in Practice*, Springer, 2001.

[2] B. Anderson, J.B. Moore, *Optimal Filtering*, Prentice-Hall, 1979.

[3] S.J. Julier, J.K. Uhlmann, "Unscented filtering and nonlinear estimation", *Proceedings of the IEEE*, 92(3):401-422, 2004.

[4] D.T. Tran, E. Vincent, D. Jouvet, "Nonparametric uncertainty estimation and propagation for noise robust ASR", *IEEE/ACM Transactions on Audio, Speech and Language Processing*, 23(11):1835-1846, 2015.

[5] D.T. Tran, *Uncertainty learning for noise robust ASR*, PhD thesis, University of Lorraine, 2015.