

Universidade de Pernambuco
Programa de Pós-Graduação em Engenharia da
Computação (PPGEC)

Proposta de Dissertação de Mestrado

Área: Computação Inteligente

Título: Investigations of Reservoir Computing Techniques with Application to Dynamic Gesture Recognition

Orientador – Bruno José Torres Fernandes (bjtf@ecomp.poli.br)

Co-orientador – Doreen Jirak (jirak@informatik.uni-hamburg.de)

Description – A major challenge in artificial intelligence (AI) is the processing of (spatio-) temporal patterns or sequences like speech, facial expressions, and gestures. However, the recognition of these modalities is important to create natural and intuitive interfaces in e.g. cognitive robotic scenarios. Computational models like the Hidden Markov Model (HMM) or Recurrent Neural Networks (RNN) were state-of-the-art methods for sequential processing and recognition applications but come along with high computational complexity and convergence problems **1**.

This project aims at joining the recognition of so called “dynamic gestures” from visual sensors with the “Reservoir Computing” paradigm **2**, which introduced a novel concept for fast and robust RNN training. We focus on a specific network implementation, Echo State Networks (ESN) **3**, to investigate the network behavior when driven with gesture input in terms of stability **4**, timescales **5**, memory **6**, and the influence of the parameters as well as their interplay on the network performance (classification). An intermediate study within the project could provide performance comparisons between different sequence models, e.g. contrasting HMMs and ESN, or summarizing significant findings for future reference in a subsequent Master thesis. Depending on the project progress, it is also possible to link ESN with deep learning techniques for development of new neural architectures **7, 8**.

The candidate for this project should have a mathematical background and the curiosity to learn about dynamical systems, respectively, neural networks and their evaluation. Data and pointers to existing software for a start are available.

Referências Bibliográficas

1. Bengio Y., Simard P., Frasconi P. Learning long-term dependencies with gradient descent is difficult IEEE Transactions on Neural Networks, 1994, 5, 157-166
2. Lukosevicus M. and Jaeger H. Reservoir Computing approaches to recurrent neural network training, Computer Science Review, Elsevier Science Publishers BV, 2009, 3, 127-149
3. Jaeger H., Tutorial on training recurrent neural networks, covering BPTT, RTRL, EKF and the echo state network approach, German National Research Center for Information Technology, 2002, 48 pp.
4. Yildiz I., Jaeger H., Kiebel S.J. Re-visiting the echo state property, Neural Networks, 2012, 35, 1-9
5. Gallicchio C. and Micheli A. Architectural and Markovian factors of echo state networks, Neural Networks, 2011, 24, 440-456
6. Jaeger H. Short Term Memory in echo state networks, German National Institute for Computer Science, GMD, 2001
7. Jirak D., Barros PVAd, Wermter S. Dynamic Gesture Recognition using Echo State Networks, in Proceedings of the 23rd European Symposium of Artificial Neural Networks and Machine Learning, 2015, pp.475-480
8. Gallicchio G. and Micheli A. Deep Reservoir Computing – A critical analysis, in Proceedings of the 24th European Symposium on Artificial Neural Networks and Machine Learning, 2016, pp. 497-502