Final Presentation and Project Topics

Computational Neuroscience (CNS)

Topics for Final Presentations (I)

- Hebbian and Competitive Learning
  1. Modelling Hebbian learning in spiking neurons
  2. A review of synaptic plasticity mechanisms from the point of view of time-duration of the synaptic modification
  3. Modelling a competitive learning mechanism inspired by the repetition-suppression effect in the visual cortex
- Associative Memory
  4. Sensor fusion in human-robot applications by ART models
  5. Self-supervised learning in ARTMAP
  6. A Hopfield neural network model for storing and recalling long term memories with mean-field analysis of the stable states

Topics for Final Presentations (II)

- Representation and Deep Learning
  7. Convolutional Neural Networks – In-depth into the model and/or a review of modern architectures
  8. The HMAX model – A computational model for hyper columns and visual processing in the cortex
  9. Deep network of stacked denoising autoencoders that can learn feature filters from natural images
  10. Foundations and motivations of the dropout technique
  11. Learning hierarchical visual representations by convolutional Deep Belief Networks

Topics for Final Presentations (III)

- Representation and Deep Learning
  12. Deep Learning for detecting robotic grasps
  13. A Deep Restricted Boltzmann Machine model with an attentional mechanism to learn to direct gaze on interesting/informative parts of an image
  14. A deep associative memory for sequences using complex-valued vectors to increment storage capabilities
  15. Deep models of affect and emotion from physiological signals
  16. CNN for biomedical data

Topics for Final Projects

- Implementation from scratch of simple models of competitive, representation and deep learning
  - Hopfield networks with continuous-valued neurons
  - Deep RBM
  - Simple Deep Belief Networks (DBN)
  - Validation on small-medium dataset (e.g. MNIST)
- Implementation of advanced models and learning algorithms with support from available software libraries
  - Convolutional NN, stacked autoencoders, advanced DBN and DeepRBM
  - Challenging applications and datasets: image understanding, face recognition, music generation, brain decoding, …
  - Can choose preferred language: Matlab, Python, C++, …
  - Can start from available tutorials but report must show that you have experimented with different model configurations (n. layers, activation/pooling functions, …)

If interested in these presentation or project topics contact the instructor of the second module to receive more information and reading materials

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