

# Projects

9.520

2011

- 1 HyperBF: review and formulate Bayesian equivalent formulation; also greedy optimization for HyperBF
- 2 Delete random patches of connections from S2 to C2 (pooling stage): how much does position tolerance decrease?
- 3 Project fly and Bayes
- 4 Class specific computations for object recognition imply a non-trivial architecture for the ventral stream
- 5 Project Panda
- 6 Psychophysics: ask people what they see in images flashed for 20msec (without mask)
- 7 How can the different dependency of receptive field size on eccentricity in different visual areas be explained by HMAX-type models?
- 8 Silencing by motion is accounted for by the ventral/dorsal hmax model (see Suchow and Alvarez, 2010)

- 1 The puzzle of the normalization operation in cortex: relations to Bayesian inference? Example of attention, Bayesian model: Chikkerur et al 2010
- 2 Describe classical mechanics in 2 different ways (and discuss whether Bayes is the only theoretical language to describe intelligence):
  - in the language of Bayes inference and Langevin equations (and MCMC?)
  - in the language of constrained optimization (Hamiltonian formulation?)
- 3 Can a learning algorithm be devised to replace NSF review panels?
- 4 A society of cancer cells?

# Wikipedia-like projects 2011

- 1 Computational learning theory: to be redone or new entry in Generalization Bounds
- 2 RKHS is ok but could be improved on the learning side
- 3 Stability in Learning Theory – as seen in the class – is missing
- 4 Radial basis function network should be rewritten or edited
- 5 VC theory exists in a minimalistic form, should be expanded
- 6 Regularization networks/theory IS TERRIBLE...EASY TO IMPROVE
- 7 Statistical learning theory is a mess

- 1 Parameter tuning for dimensionality reduction in terms of bias-variance trade-off. Papers?. [L]
- 2 Find a way to formalize and exploit dependence among related learning tasks (multiple kernel, statistical techniques). [L]
- 3 Why Reproducing Kernel Hilbert Spaces are a natural set of hypothesis spaces for supervised learning? Draw ideas from embedding theorems, extension to Banach spaces having in mind sparsity based regularization.[TP, L]
- 4 Option pricing: using modern techniques and more recent data improve on the approach of Hutchinson, J.M., A. Lo and T. Poggio. A Nonparametric Approach to Pricing and Hedging Derivative Securities Via Learning Networks, Journal of Finance, Vol. XLIX, No. 3, 851-889, 1994.

# Review-type projects 2010

- 1 Review: Random Projections.
- 2 Review: Unbalanced training set.
- 3 Review: Learning from non i.i.d. data.
- 4 Review: Regularization parameter choice.
- 5 Review: Variable selection.
- 6 Review: Learning Invariances.
- 7 Write/edit (create account first) entries for Wikipedia (eg Regularization Networks, Radial Bases Functions, Learning Theory, RKHS, Generalization Bounds, Stability in Learning)

# iPhone machine learning applications!

# Computational Neuroscience and Biology projects

- 1 Inference on regulatory networks.
- 2 Various projects on the visual cortex model are available. These projects will typically require more time but may also lead to some paper.
- 3 Experiments with derived kernels. Developing existing code. Use CNS (GPU-based).