

Kernel Methods

**First Meeting: 12th October 2009, 5pm,
Seminarroom Inffeldgasse 16c, ground floor**

Instructor: Franz Pernkopf, Gernot Kubin (?)

Regular Meeting: **Wednesday, 16.30 – 18.30, Seminar room CGV (Inffeldgasse 16c, 2nd floor)**

Kernel methods enjoy great popularity throughout science and engineering. In this seminar, we want to introduce the fundamentals of Kernels and its applications in various methods, e.g., SVM, RVM Kernel Fisher Discriminant Analysis, Kernel PCA, Kernel LMS/RLS, Kernel Regression, Single-Class Classification, Gaussian Processes.

We would like to discuss the following topics:

Introduction: **(Christina Leitner, 11.November)**

Kernels: Kernel Trick, RKHS, etc. (*Ch2 of "Learning with Kernels", Section 2 of "Kernel Methods in Machine Learning"*).

Support Vector Machine (SVM) **(B. Lesser, 11.November)**

Relevance Vector Machine (RVM) **(T. Buchgraber and M. Bergmann, 13. Januray)**

PCA - Kernel PCA **(T. Quaritsch and M. Unger, 18. November)**

LDA - Kernel Fisher Discriminant Analysis **(S. Schulter and C. Zechner, 25. November)**

Support Vector Regression (1 Person)

ICA - Kernel ICA **(Pfeifenberger, 2. December)**

LMS/RLS - Kernel LMS/RLS **(M. Fröhle and M. Forrer, 9. December)**

Singe-Class Problems (Clustering) (1 Person)

Gaussian Processes **(S. Shahzad and M. Soudan , 16. December)**

To each group of 1-2 students one topic is assigned. They should give an in-depth presentation of this topic and the referenced work therein (for about 1.5-2hours). Then we would like to discuss the article – presentation. Therefore, it is necessary that each participant reads this article.

Since there are many demos around (Matlab, Java applets) it would be nice to present them for the particular methods.

Grading: Grades are given based on the presentation and the participation in discussions (50% - 50%). The presentation slides have to be sent to pernkopf@tugraz.at.

Literature: (see: www.kernel-machines.org)

Books:

Bernhard Schölkopf and Alex Smola. Learning with Kernels. MIT Press, Cambridge, MA, 2002.

Christopher M. Bishop. Pattern Recognition and Machine Learning. Springer, 2006

Tutorials and Papers

Hofmann, T, Schölkopf, B, and Smola, AJ (2008) Kernel Methods in Machine Learning, Annals of Statistics, 36:1171-1220.

Burges, CJ (1998) A Tutorial on Support Vector Machines for Pattern Recognition, Knowledge Discovery and Data Mining, 2(2).

Schölkopf, B (2000) Statistical Learning and Kernel Methods, Microsoft Research, MSR-TR(2000-23).

Müller, K, Mika, S, Rätsch, G, Tsuda, K, and Schölkopf, B (2001) An Introduction to Kernel-based Learning Algorithms, IEEE Neural Networks, 12(2):181–201.

M.E. Tipping, "Sparse Bayesian Learning and the Relevance Vector Machine", JMLR, 2001.

B. Schölkopf, A. Smola, K.R. Müller, "Nonlinear Component Analysis as a Kernel Eigenvalue Problem", Neural Computation 10, 1998.

F. Bach and M.I. Jordan, "Kernel Independent Component Analysis", JMLR, 2002.

Pokharel, P.P.; Weifeng Liu; Principe, J.C., "Kernel LMS", ICASSP 2007.

Van Vaerenbergh, S.; Via, J.; Santamana, I., "A Sliding-Window Kernel RLS Algorithm and Its Application to Nonlinear Channel Identification", ICASSP 2006.

Seeger, M (2004) Gaussian Processes for Machine Learning, International Journal of Neural Systems, 14(2):1–38.

MacKay, D (1997) Introduction to Gaussian Processes, Miscellaneous publication.