Library overview

- A general open-source kernel library

  - Kernels
    - Standard kernels: linear, polynomial, Gaussian and sigmoid
    - Sequence kernels: \( n \)-gram, gappy \( n \)-gram, mismatch and arbitrary rational kernels

  - Learning kernel tools
    - one-stage and two-stage methods

  - Implementation
    - works with LIBSVM
    - uses the OpenFst library (http://www.openfst.org)
Rational Kernels

A sequence kernel $K$ is a rational kernel if there exists a transducer $U$ over the real semiring s.t.

$$K(x, y) = U(x, y)$$

- If $U = T \circ T^{-1}$, then $K$ is positive definite symmetric (PDS).
- Commonly used sequence kernels are rational

**Example**: $n$-gram kernel

$$K_n(x, y) = \sum_{|z| = n} c_x(z) c_y(z)$$

$$T_n(x, z) = c_x(z) \quad \text{and} \quad K_n(x, y) = (T_n \circ T_n^{-1})(x, y)$$

with $c_x(z)$ is the number of occurrences of $z$ in $x$
Learning Kernel Tools

- Tools for using training data to automatically combine multiple kernels

  - One-stage algorithms
    - L1-regularized linear combinations [Lanckriet et al., 2004]
    - L2-regularized linear combinations [Cortes et al., UAI 2009]
    - L2-regularized quadratic combinations [Cortes et al., NIPS 2009]

  - Two-stage algorithms
    - Alignment-based methods [Cortes et al., ICML 2010]
      - Simple alignments
      - More general alignments by solving a QP (next release)
Future plans

- New algorithms
  - Kernel PCA
  - Structured prediction
  - Online algorithms
- Other efficient solvers
  - To benefit from new optimization techniques
- Automata-based solution
  - Useful for sequence kernels [Allauzen et al., CIAA 2010]
- Low rank approximation
  - Nyström method [Williams and Seeger, NIPS 2000; Drineas and Mahoney, JMLR 2005]
  - Ensemble Nyström [Kumar et al., NIPS 2009]