Sample Course Outline, ELEC / COMP 602
Artificial Neural Networks and Information Theory II.
Approximately 13 x 3 = 39 hours, 3 credits

Notation: CF k/m = *Colin Fyfe text, volume k, chapter m.*
EM: <list> = *compiled by Erzsébet Merényi from works in <list>*

1. **Introduction, orientation**
2. **Review part of ELEC/COMP 502, ANNs & Information Theory I.**
   2.1. Review of Unsupervised Learning, Hebbian Learning, Self-Organizing Maps, LVQ
   2.2. The Basic Kohonen SOM
3. **Kohonen Maps (SOMs) and Their Interpretation** (EM: Kohonen, Kaski, Van Hulle, Ritter, …)
   3.1. Visualization of SOM knowledge – basics: U-matrix and variations, density map
   3.2. Visualization of SOM knowledge – advanced: Connectivity Matrix and graph representation
   3.3. Finding clusters: interpretation of the visualized knowledge, and cluster extraction
   3.4. Data compression, and coding aspects
4. **Variants of Self-Organizing Maps** (EM: Haykin, Van Hulle, Ritter, Paisley group, Villmann)
   4.1. Original Kohonen, Conscience algorithm, neighborhood functions and metrics
   4.2. Issues of faithful topographic mapping, criteria; Measures of topology violation in SOM, monitoring of topology violations, fixes
   4.3. Neural Gas, Growing Self-Organizing Maps
   4.4. Magnification in SOMs
   4.5. Distortion based and information based Self-Organizing Maps, density matching
5. **Self-Organizing Maps for High-Dimensional and Complex Data** (EM)
   5.1. Issues related to high dimensionality and complexity of data spaces
   5.2. Why and how some favorite traditional methods fail for complicated, high-dimensional data
   5.3. How do SOMs deal with high-dimensional data; Applications, case studies
6. **Unsupervised Learning as Support for Supervised Classification** (EM)
   6.1. Hybrid ANN architectures containing unsupervised and supervised learning components
   6.2. Classification versus prediction of continuous parameters (underlying causes)
   6.3. The use of unlabeled samples to boost performance
7. **Evaluation of Clustering Quality, and Classification Accuracy**
   7.1. Cluster validity indices
   7.2. Evaluation of classification accuracy: sampling requirements, k-fold cross-validation, ROC curves, Kappa statistics, Wilcoxon signed ranks
   7.3. Case studies
8. **Dimension Assessment and Non-linear Dimension Reduction** (EM: Hammer, Villmann
   8.1. Generalized Relevance Learning Vector Quantization and (GRLVQ and GRLVQI)
   8.2. Matrix GRLVQ
9. **Metrics for Learning, and Learning of Metrics**
   9.1. Feature spaces: homogeneous and inhomogeneous feature vectors
   9.2. Feature representation: homogeneous and inhomogeneous representations
   9.3. Domain specificity in metric construction

10. BSS and ICA (EM, ICA book, Hyvärinen/Karhunen/Oja; Haroult and Jutten; Bell & Sejnowski; Földiák, Fyfe & Girolami)

10.1. Independent Component Analysis with neural approaches
10.2. Independent Component Analysis with SOMs

11. Unsupervised Learning Using Kernel Methods (CF 2/9)
Time permitting; this section to be expanded

Prerequisites: ELEC / COMP 502 (Artificial Neural Networks and Information Theory I.) or equivalent, or instructor's permission

** Colin Fyfe text: developed by Prof. C. Fyfe for his classes at the Department of Computing and Information Systems, University of the West of Scotland, Paisley, Scotland.*

Course related notes:

This course is a specialized seminar/lecture course, emphasizing active student participation and research.
Since most classes will consist of presentation and critical discussions of papers and book chapters by students, homework will be in the form of reading assignments and writing reviews of the assigned papers. The emphasis is on deep understanding of the chosen topics, and therefore on the presentation quality and critical discussion of papers.

Simulations and exercises can be based on C/Matlab programming, on NeuralWare software, and/or on my group's research software environment.