

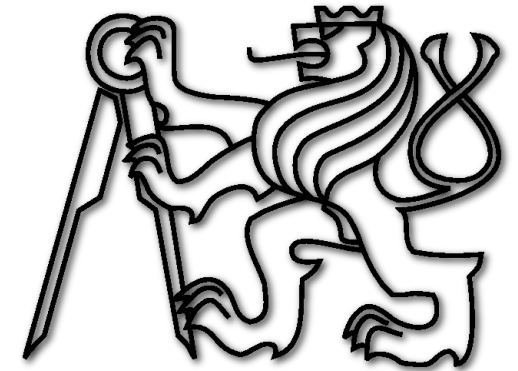
Artificial Neural Networks

Examples



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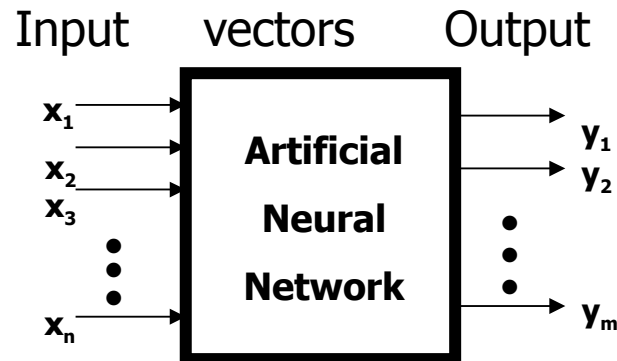
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Faculty of Electrical Engineering
Czech Technical University in Prague*

Outline

- Learning artificial neural networks (ANNs).
- Task to solve with ANNs.
- ANN applications.
- Assignment overview.

ANN, Learning & Recall

- ANN is a black box performing transformation.

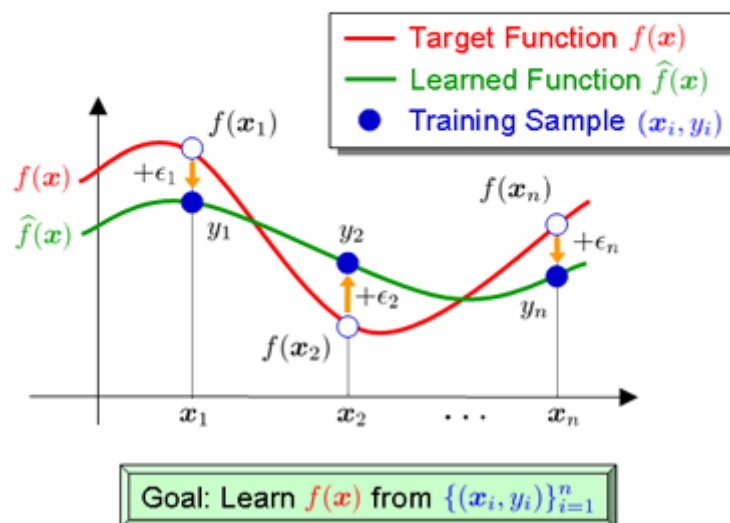


- ANNs work most frequently in two phases:
 - **Learning phase** – adaptation of ANN's internal parameters.
 - **Evaluation phase (recall)** – use what was learned.

Supervised learning

- Learning by examples:
 - given a set of example pairs $P_i=(x_i, y_i)$,
 - find transformation \mathbf{f} which approximates $y_i=\mathbf{f}(x_i)$ for all i .

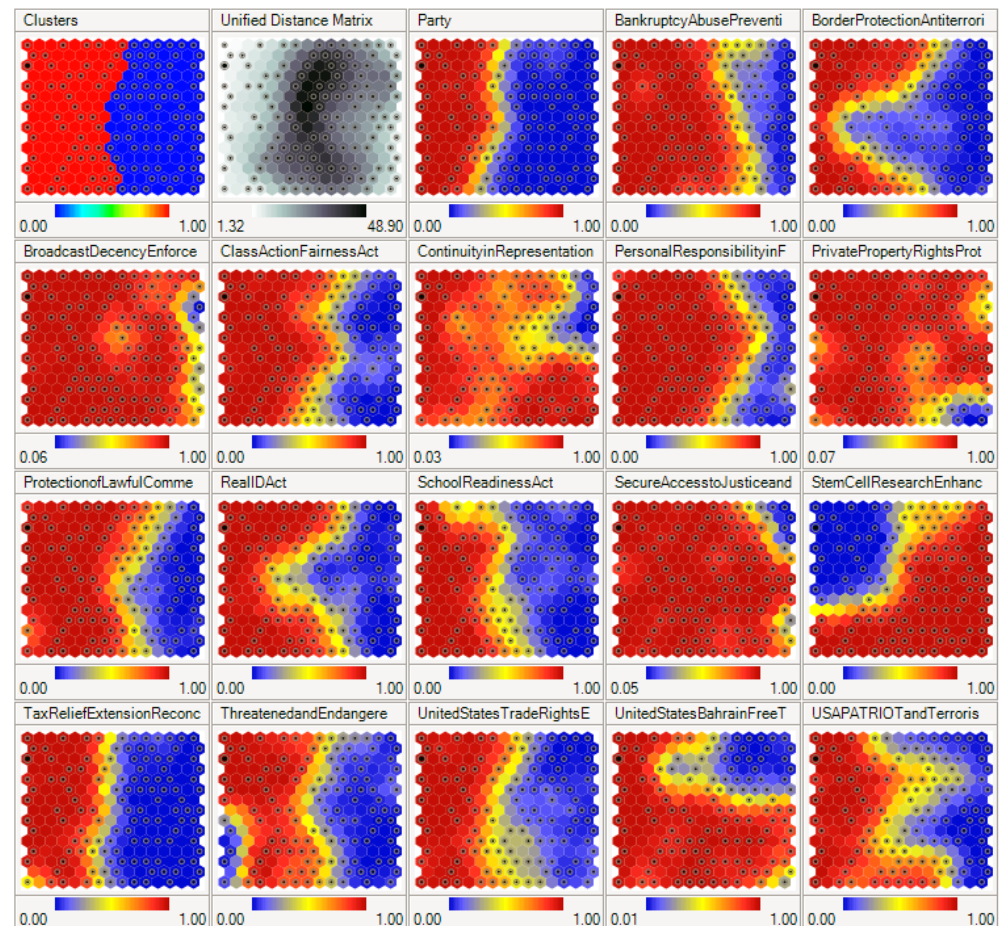
Supervised Learning as Function Approximation



<http://sugiyama-www.cs.titech.ac.jp/~sugi/figs/supervised-learning.png>

Unsupervised learning

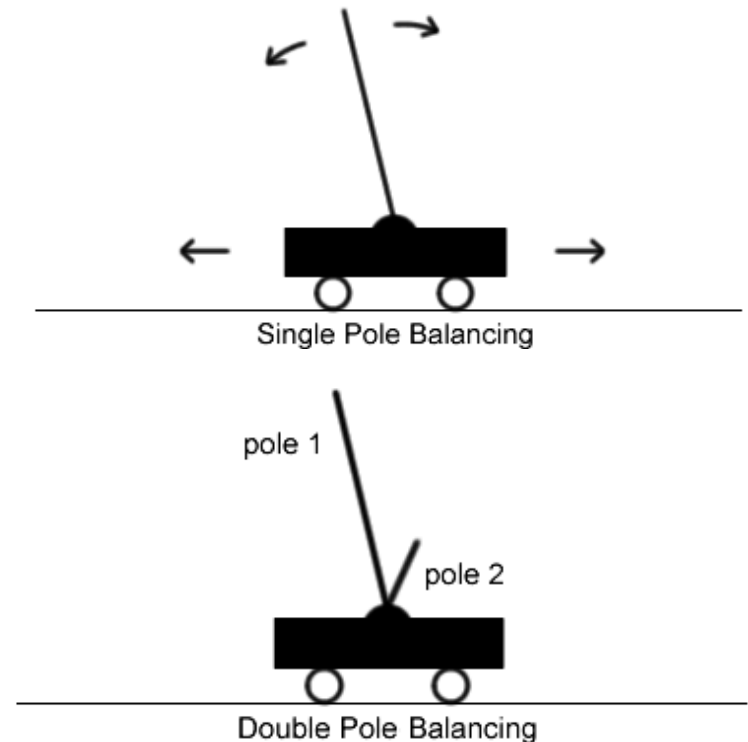
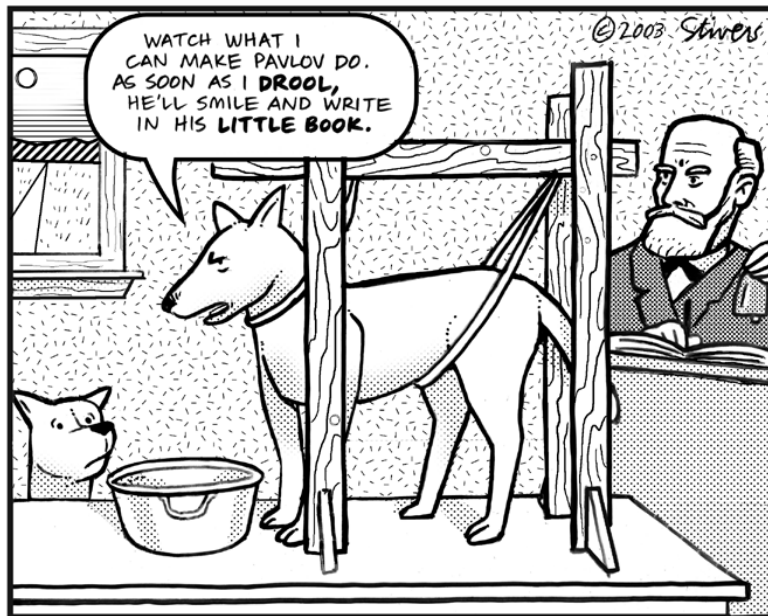
- Self-organization, no teacher.
- SOM, ART...



http://en.wikipedia.org/wiki/Self-organizing_map

Reinforcement learning

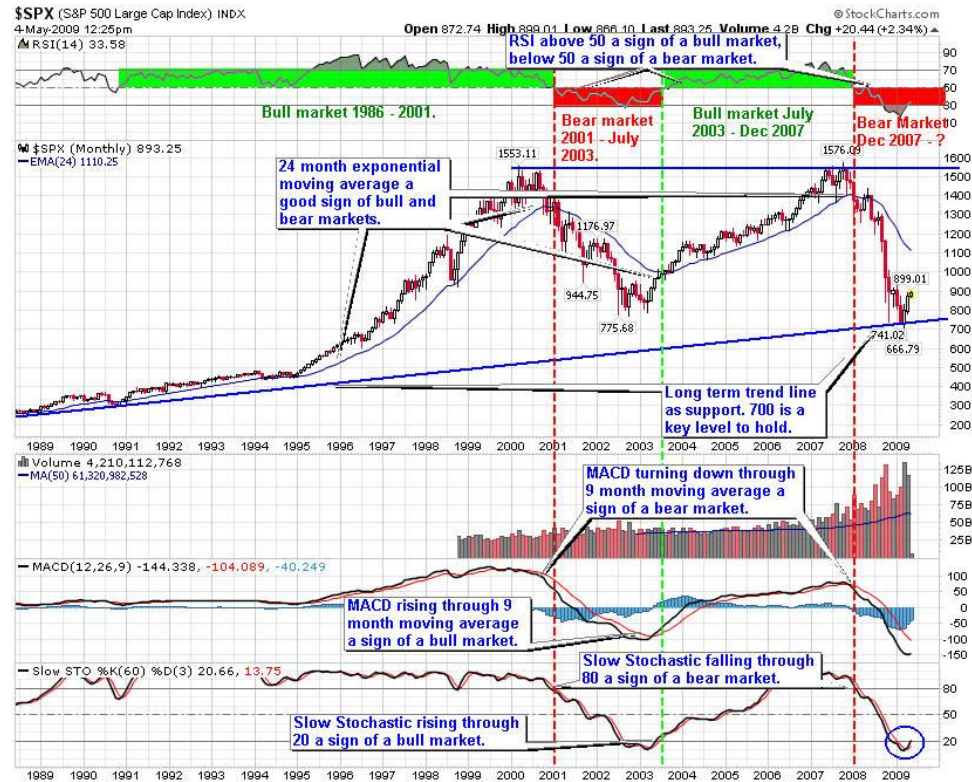
- Teaching examples not available → they are generated by interactions with the environment (mostly control tasks).



<http://anji.sourceforge.net/polebalance.htm>

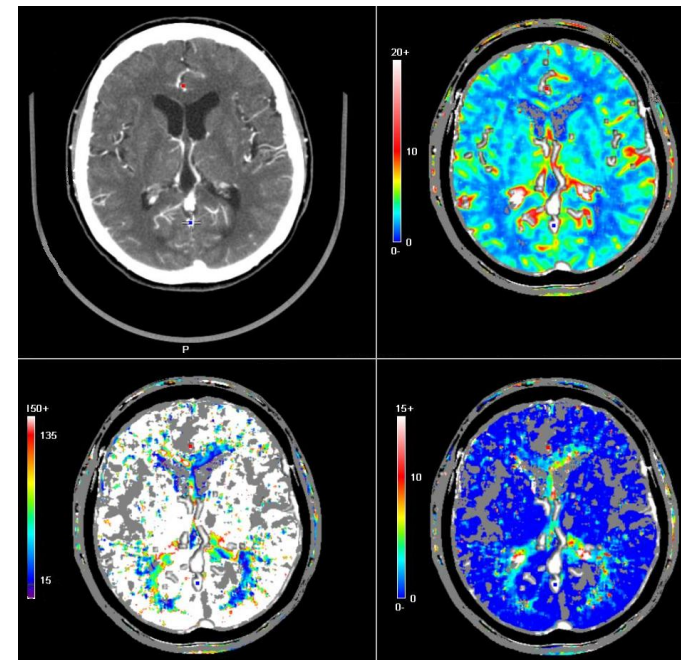
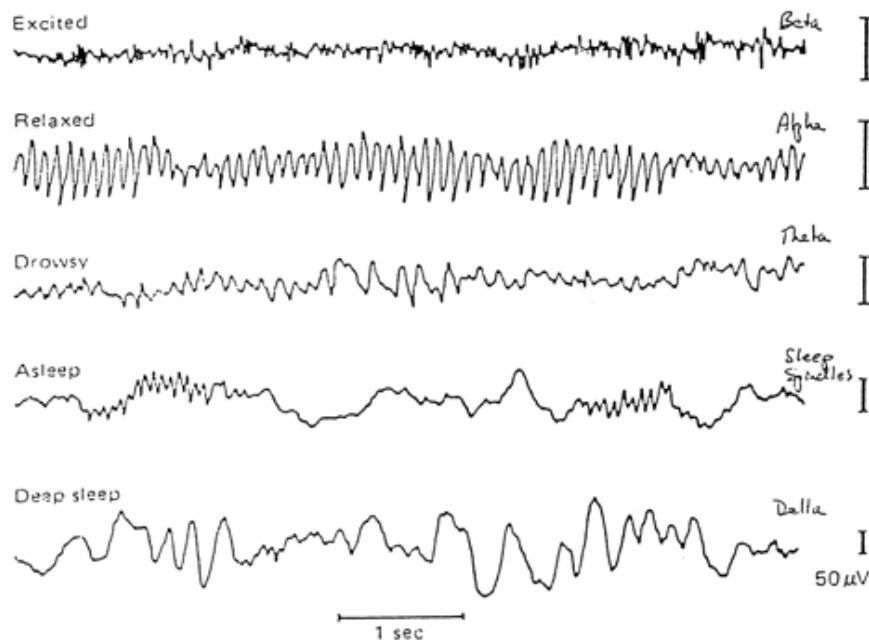
Financial Applications

- Stock market time series forecasting.
- Buy/sell timing detection and stock portfolio selection.

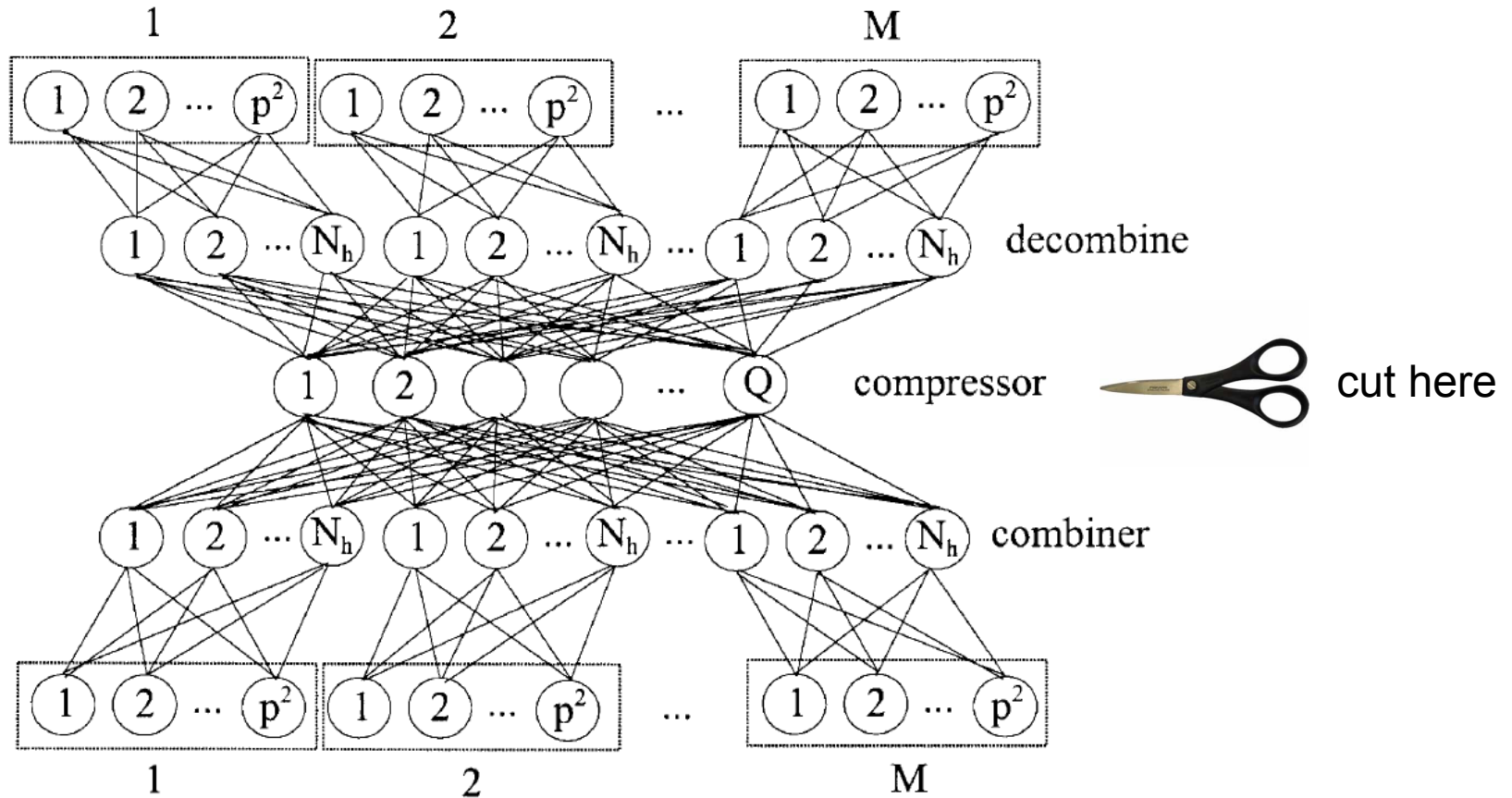


Medical

- EEG/ECG processing – e.g. sleep disorder
- Survival analysis – e.g. breast cancer
- Pattern/Image recognition – MR, CT



Compression by ANNs

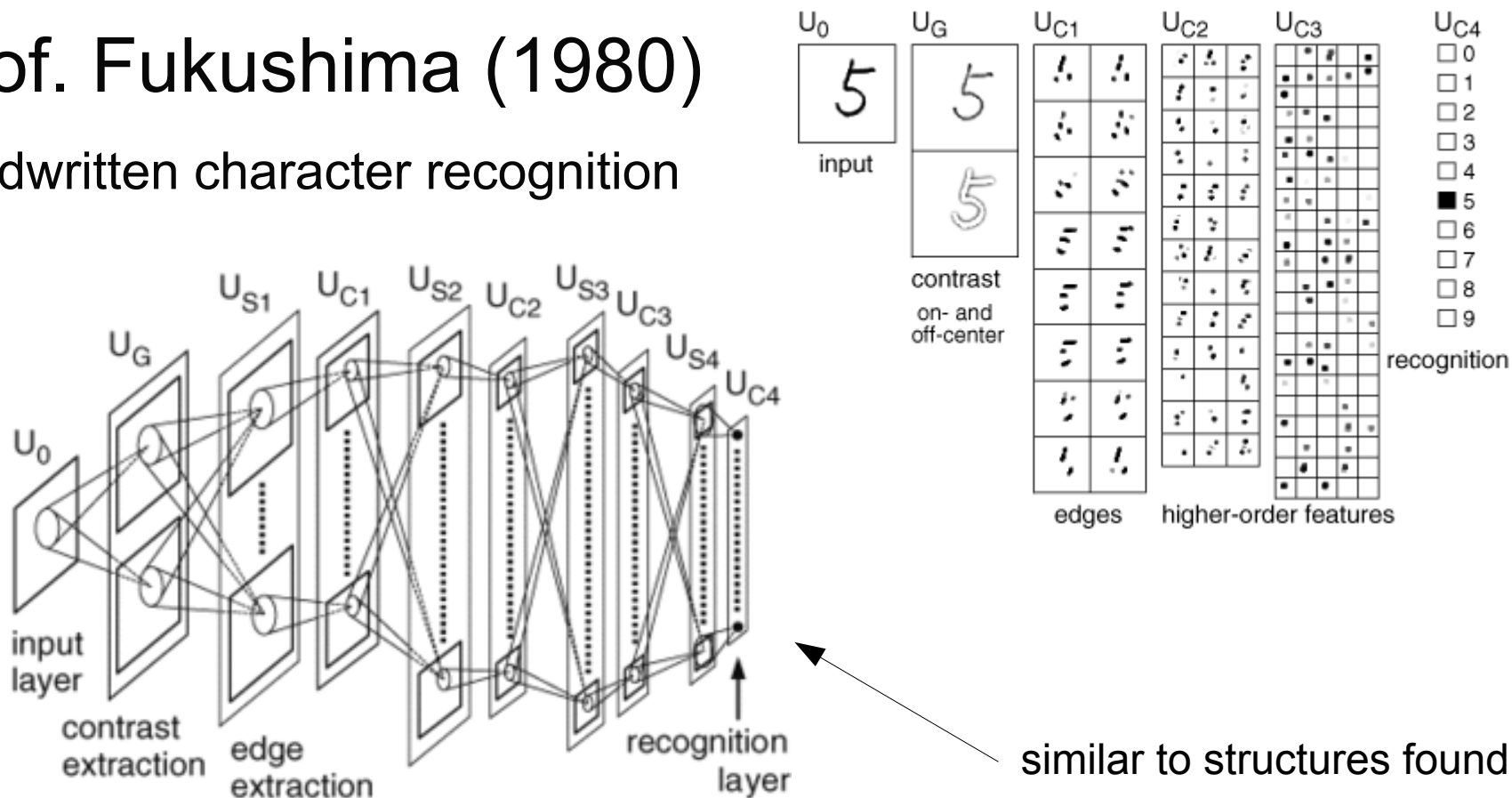


<http://www.cse.unr.edu/~looney/cs773b/NNimage-compress.pdf>

Neocognitron

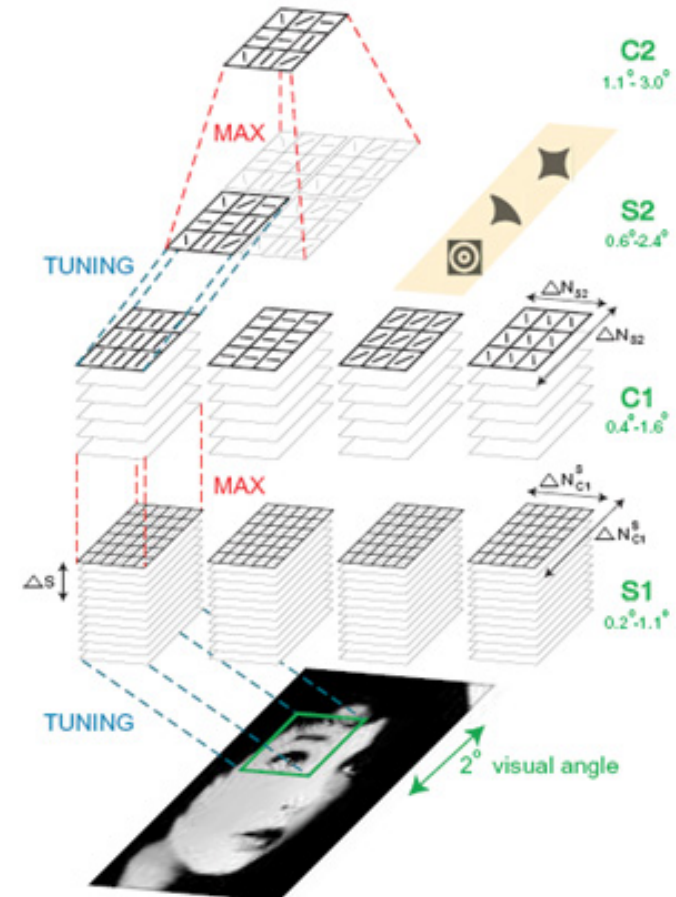
Prof. Fukushima (1980)

handwritten character recognition



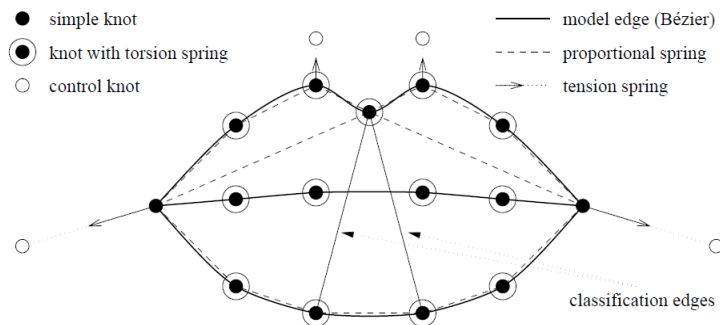
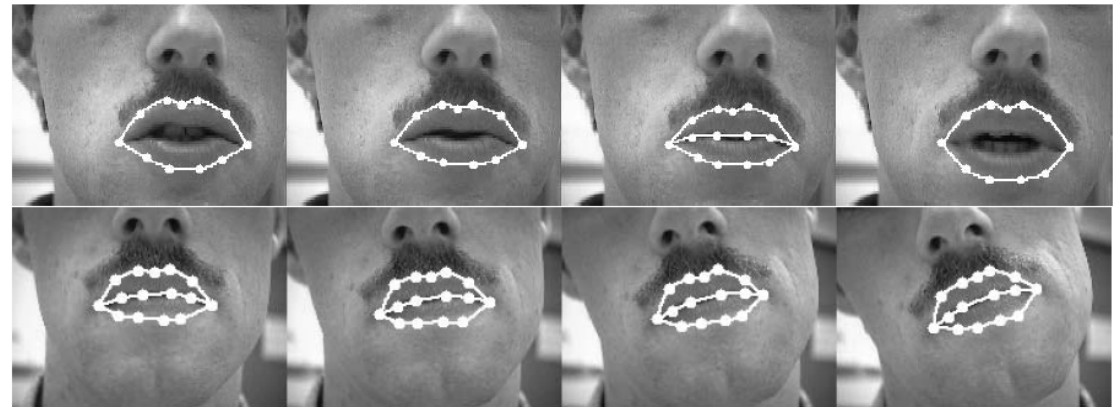
Feedforward NN for Rapid Vision

- Serre, Thomas (2007)
- Similar to the Neocognitron



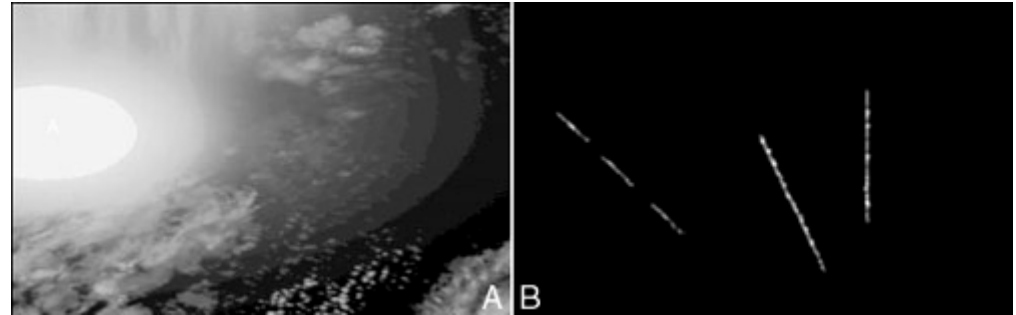
Speechreading (Lipreading)

- Günter Mamier, Marco Sommerau & Michael Vogt, Universität Stuttgart.
- A neural classifier detects visibility of teeth edges and other attributes.



Detection and Tracking of Moving Targets (ICBMs)

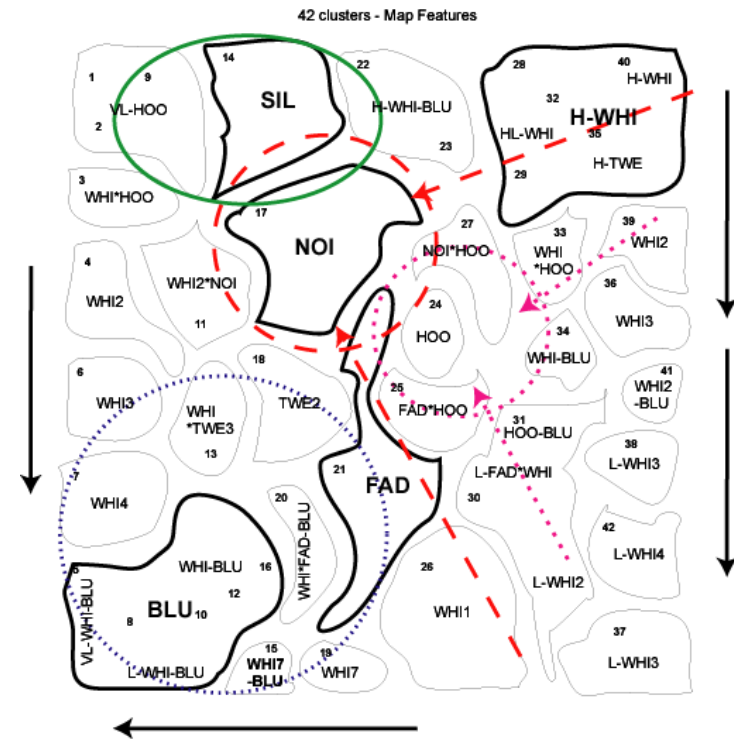
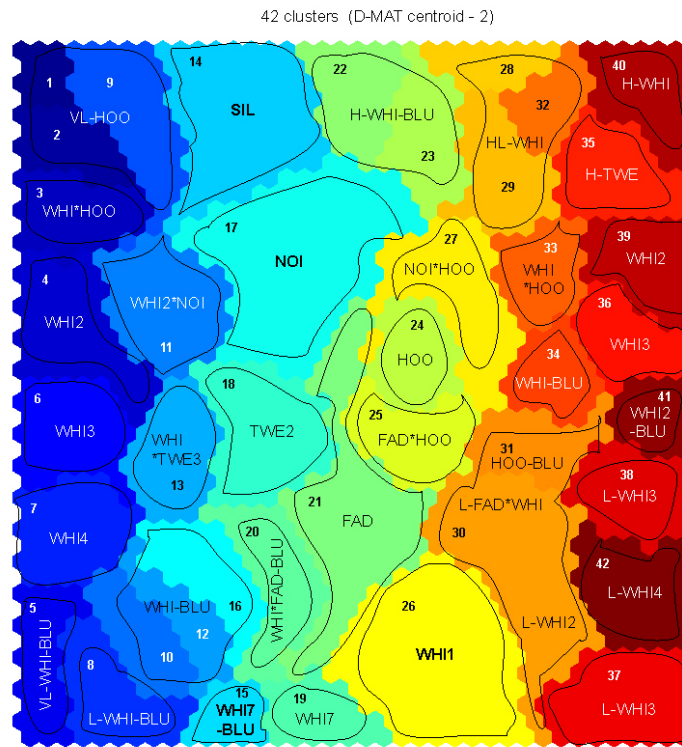
- The moving target detection and track methods here are "track before detect" methods.
- They correlate sensor data versus time and location, based on the nature of actual tracks.
- The track statistics are "learned" based on artificial neural network (ANN) training with prior real or simulated data.
- Reduce false alarm rates by up to a factor of 1000 based on simulated SBIRS data for very weak ICBM targets against cloud and nuclear backgrounds.



[http://tralvex.com/pub/nap/#Detection and Tracking of Moving Targets](http://tralvex.com/pub/nap/#Detection%20and%20Tracking%20of%20Moving%20Targets)

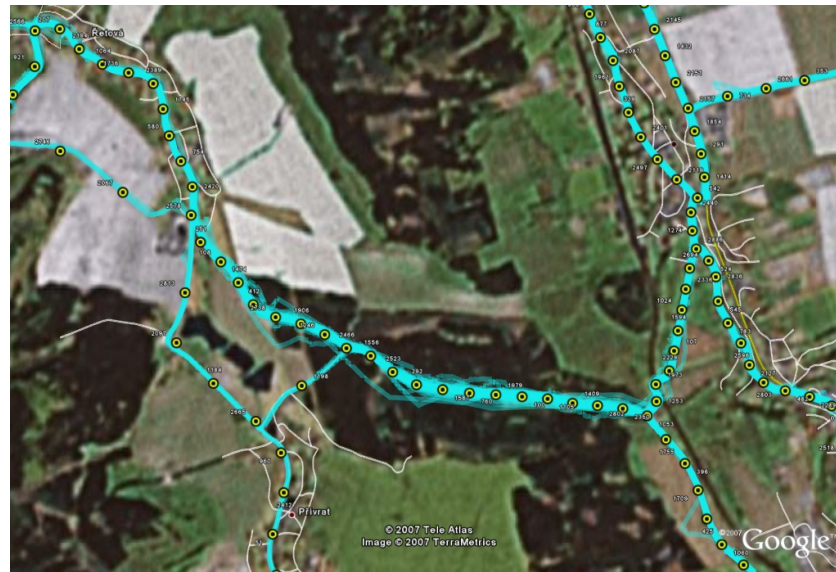
Parrot Speech (FEE CTU)

- Classification of parrot sounds → parrot speech consists of 41 “words”. Self Organization Map (SOM).



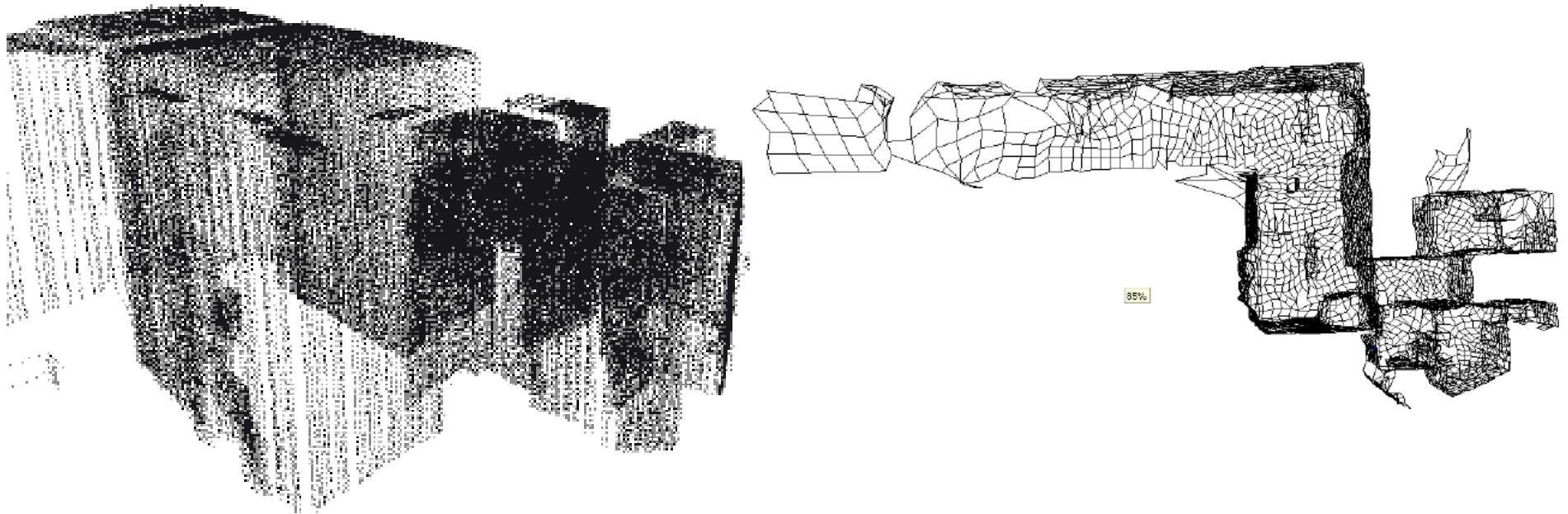
Colabroute (FEE CTU)

- GPS Data Mining - THSOM.
- Automatic detection of crossroads.
- Detection of interesting places (gas stations, dangerous crossroads,...)



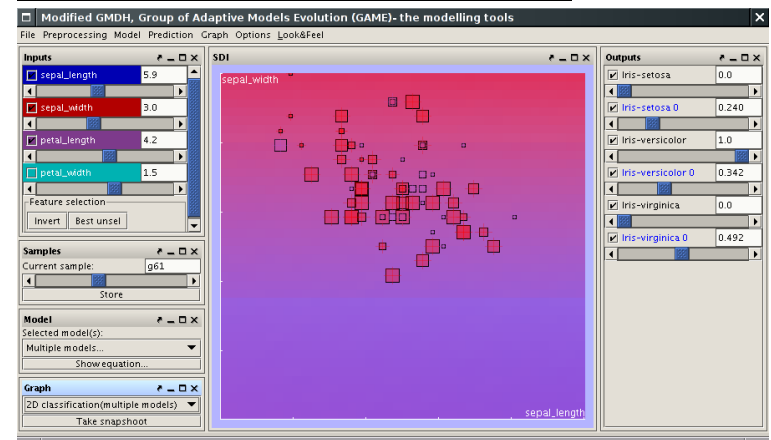
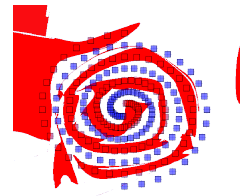
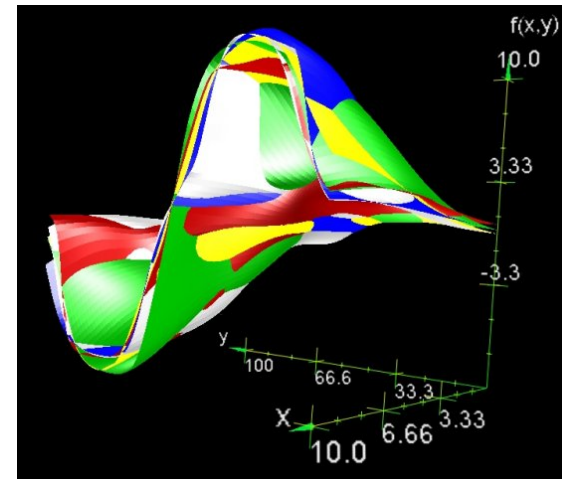
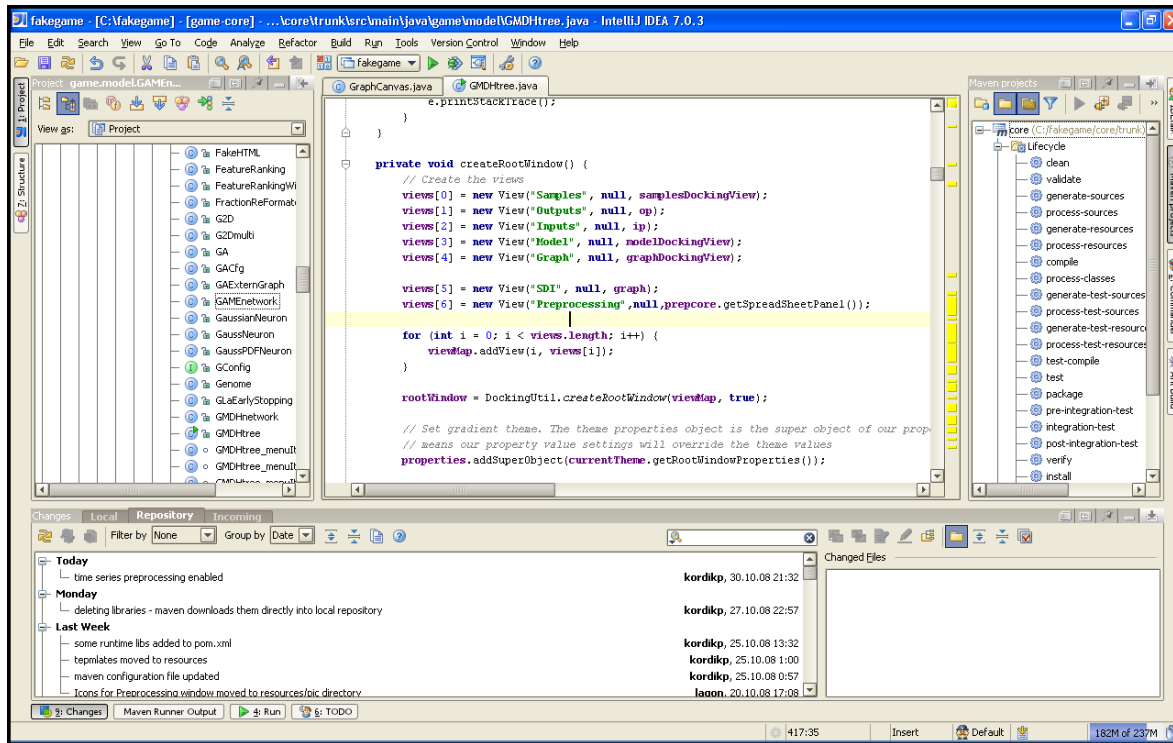
ShapeSOM (FEE CTU)

- Reconstruction of a room model out of unordered clusters of points.



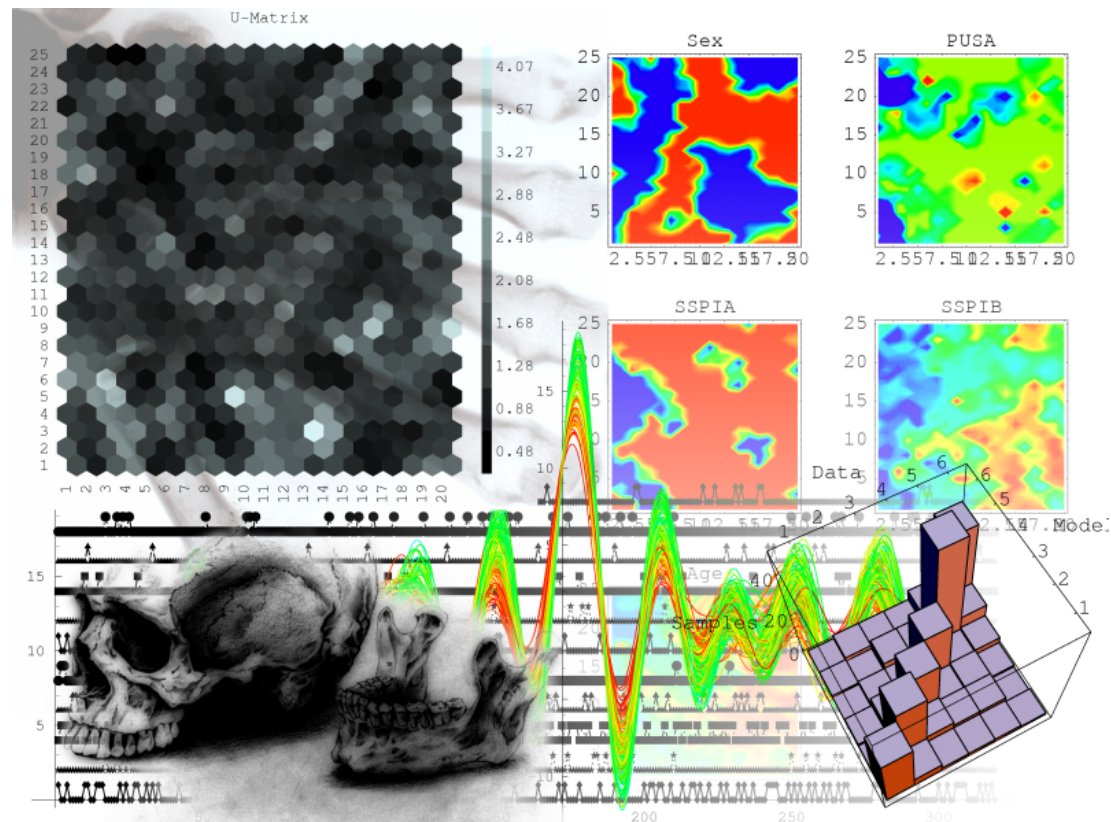
GAME & FAKE GAME

- FAKE (Fully Automated Knowledge Extraction)
- by GAME (Group of Adaptive Models Evolution)



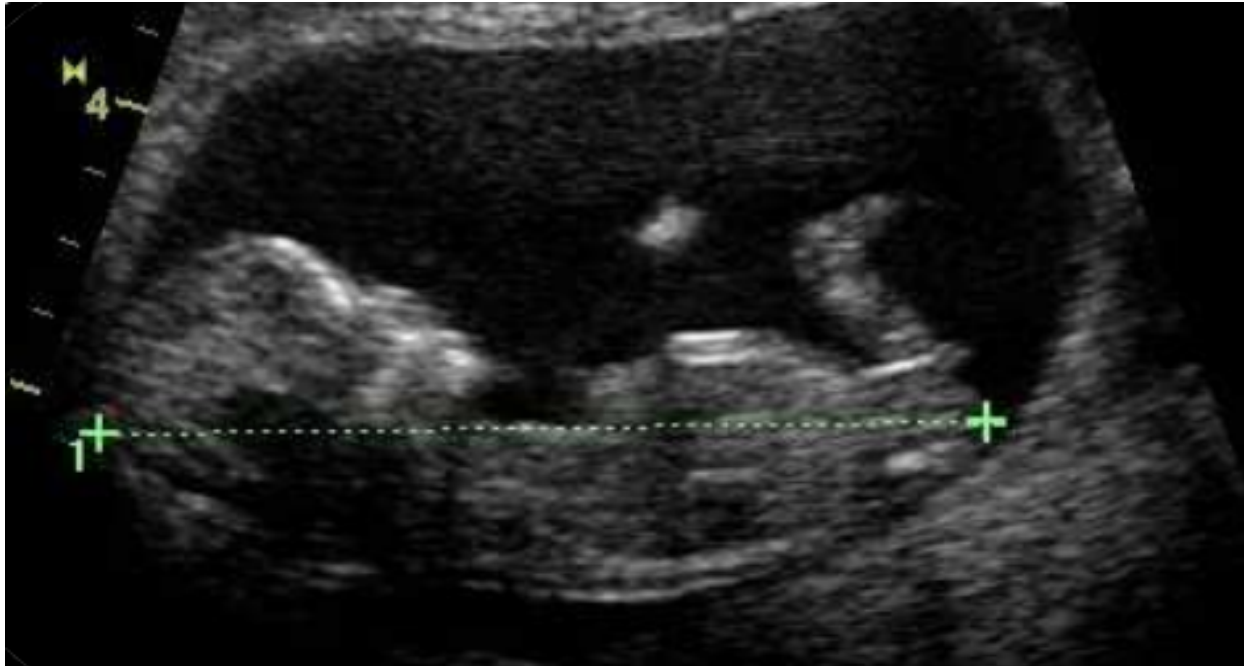
Bone Age Modelling (FEE CTU)

- Modelling of age based on bone measurements.



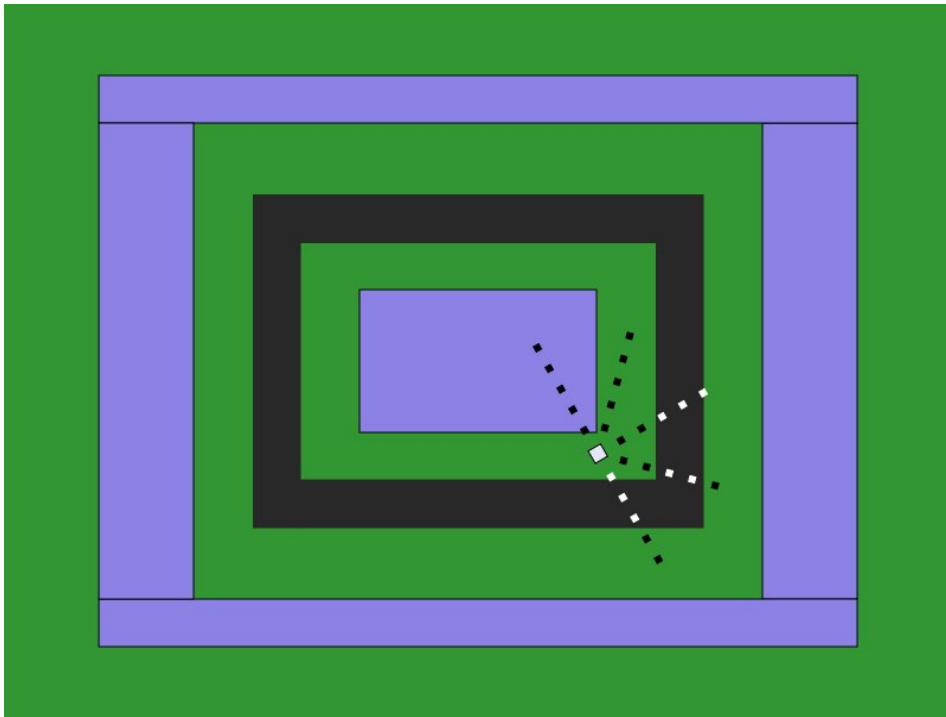
Fetal Weight Prediction (FEE CTU)

- $EFW = 0,0504AC^2 * 16,427AC + 38,867FL + 284,074$



RoboNEAT (FEE CTU)

- Neuroevolution of robotic controllers.
- HyperNEAT – large-scale ANNs.



What is Dataset?

- Dataset: table of data.
- Rows: instances.
- Columns: attributes (features):
 - input
 - output.
- We model mapping of input attributes to output attributes.

Classification data set example: Iris

- Classification → single output attribute “**the class**”
- See http://en.wikipedia.org/wiki/Iris_flower_data_set

Regression data set: Boston Housing

- One to many **continuous** output attributes.
 - 1. CRIM: per capita crime rate by town
 - 2. ZN: proportion of residential land zoned for lots over 25,000 sq.ft.
 - 3. INDUS: proportion of non-retail business acres per town
 - 4. CHAS: Charles River dummy variable (= 1 if tract bounds river; 0 otherwise)
 - 5. NOX: nitric oxides concentration (parts per 10 million)
 - 6. RM: average number of rooms per dwelling
 - 7. AGE: proportion of owner-occupied units built prior to 1940
 - 8. DIS: weighted distances to five Boston employment centres
 - 9. RAD: index of accessibility to radial highways
 - 10. TAX: full-value property-tax rate per \$10,000
 - 11. PTRATIO: pupil-teacher ratio by town
 - 12. B: $1000(B_k - 0.63)^2$ where B_k is the proportion of blacks by town
 - 13. LSTAT: % lower status of the population
 - 14. **MEDV: Median value of owner-occupied homes in \$1000's**

<http://archive.ics.uci.edu/ml/datasets/Housing>

Info on your Assignment

- UCI Machine Learning repository: <http://archive.ics.uci.edu/ml/>
- We suggest these datasets:
 - <http://archive.ics.uci.edu/ml/datasets/Adult>
 - [http://archive.ics.uci.edu/ml/datasets/Breast+Cancer+Wisconsin+\(Original\)](http://archive.ics.uci.edu/ml/datasets/Breast+Cancer+Wisconsin+(Original))
 - <http://archive.ics.uci.edu/ml/datasets/Census+Income>
 - <http://archive.ics.uci.edu/ml/datasets/Ecoli>
 - <http://archive.ics.uci.edu/ml/datasets/Forest+Fires>
 - <http://archive.ics.uci.edu/ml/datasets/Glass+Identification>
 - <http://archive.ics.uci.edu/ml/datasets/Heart+Disease>
 - <http://archive.ics.uci.edu/ml/datasets/Wine>
 - <http://archive.ics.uci.edu/ml/datasets/Wine+Quality>
- Or use your own data!

Info on your Assignment II

- Experiment with ANNs preferably in Matlab or Wolfram Mathematica.
- Test different ANN architectures/learning algorithms.
- If you are decided to use your own data then:
 - Do not choose data with missing values.
 - Do not choose too large or too small data sets
 - # of attributes (say > 100)
 - # of instances (< 50 is not enough, you have to reduce for several thousands...).

Info on your Assignment III

- You will NOT be penalised for inability to model chosen dataset with low error → some of the datasets are very noisy...
- Use template:
<https://cw.felk.cvut.cz/doku.php/courses/a4m33bia/hodnoceni>

Other Possible Assignments

- Neuroevolutionary robotic control.
- <http://www.flightgear.org/>
- <http://torcs.sourceforge.net/>



Other Possible Assignments II

- Agent Crowd Control.

