# Artificial Neural Networks Examples

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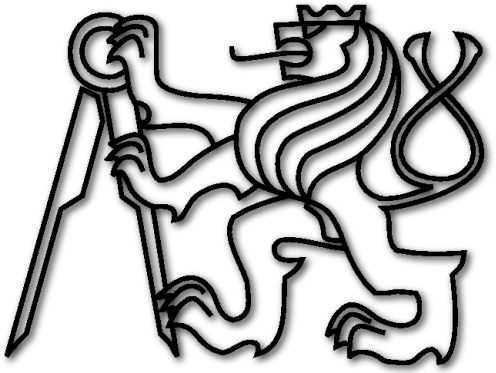

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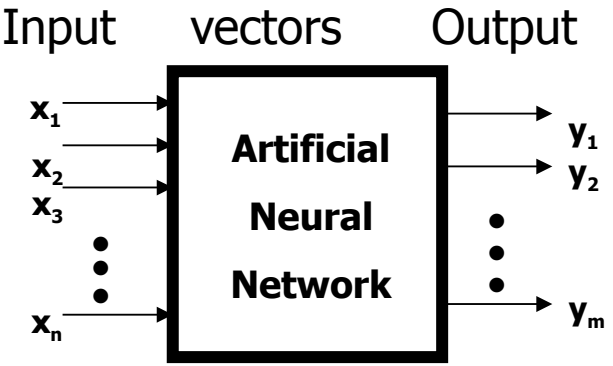
*Faculty of Electrical Engineering*
*Czech Technical University in Prague*

# Outline

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

# ANN, Learning & Recall

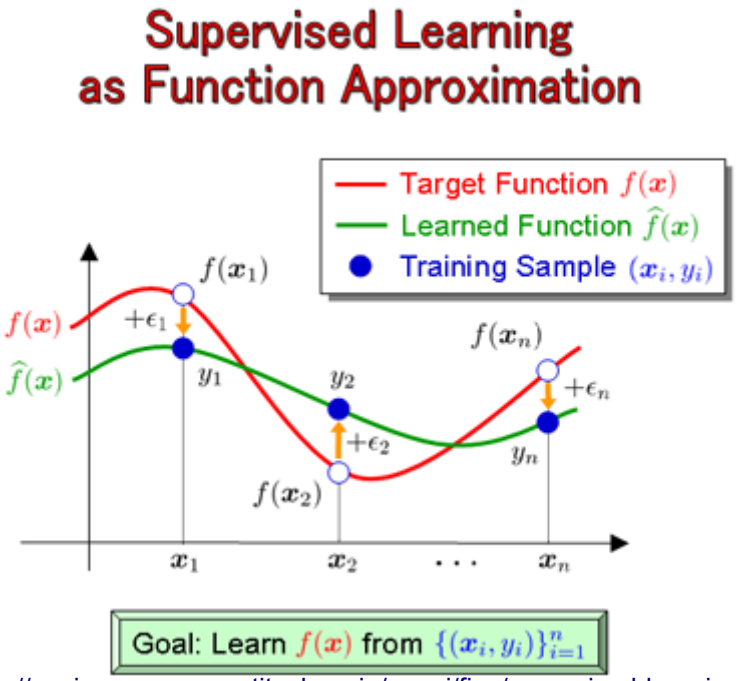
- ANN is a black box performing transformation.




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

# Supervised learning

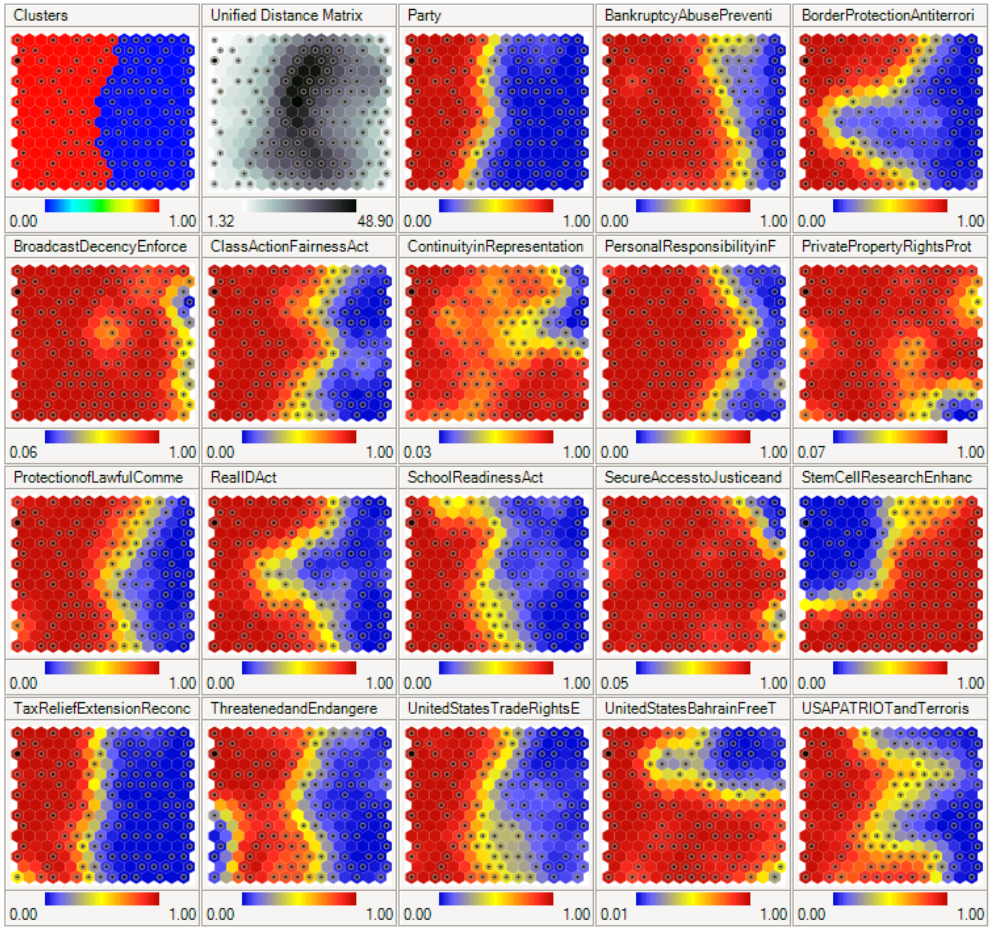
- Learning by examples:
  - given a set of example pairs $P_i=(x_i,y_i)$,
  - find transformation **f** which approximates $y_i=\mathbf{f}(x_i)$ for all *i*.




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

# Unsupervised learning

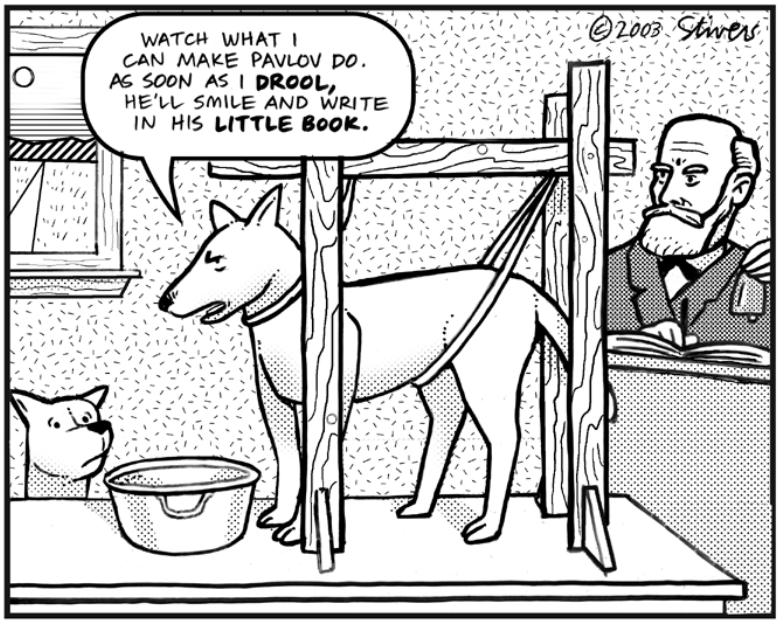
- Self-organization, no teacher.
- SOM, ART...

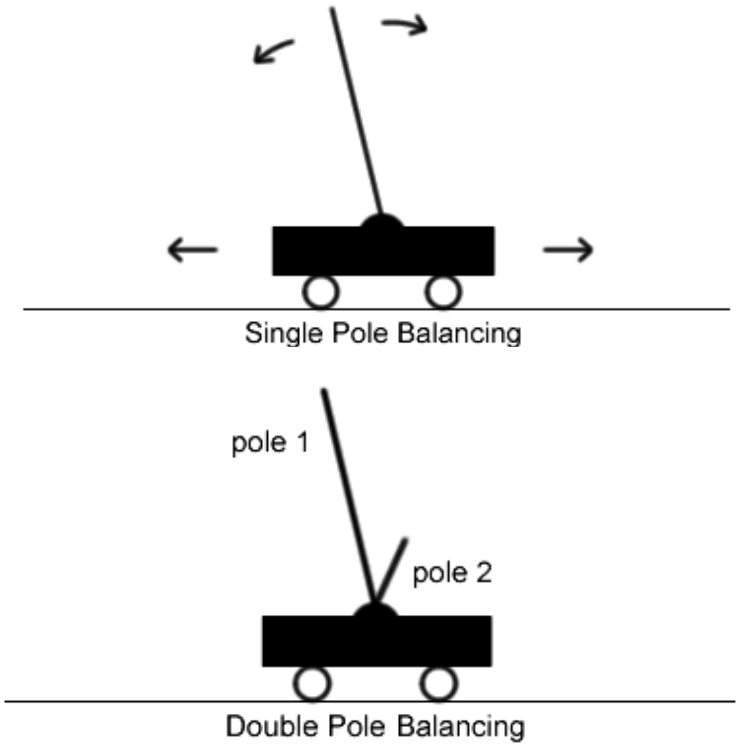



http://en.wikipedia.org/wiki/Self-organizing_map

# Reinforcement learning

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

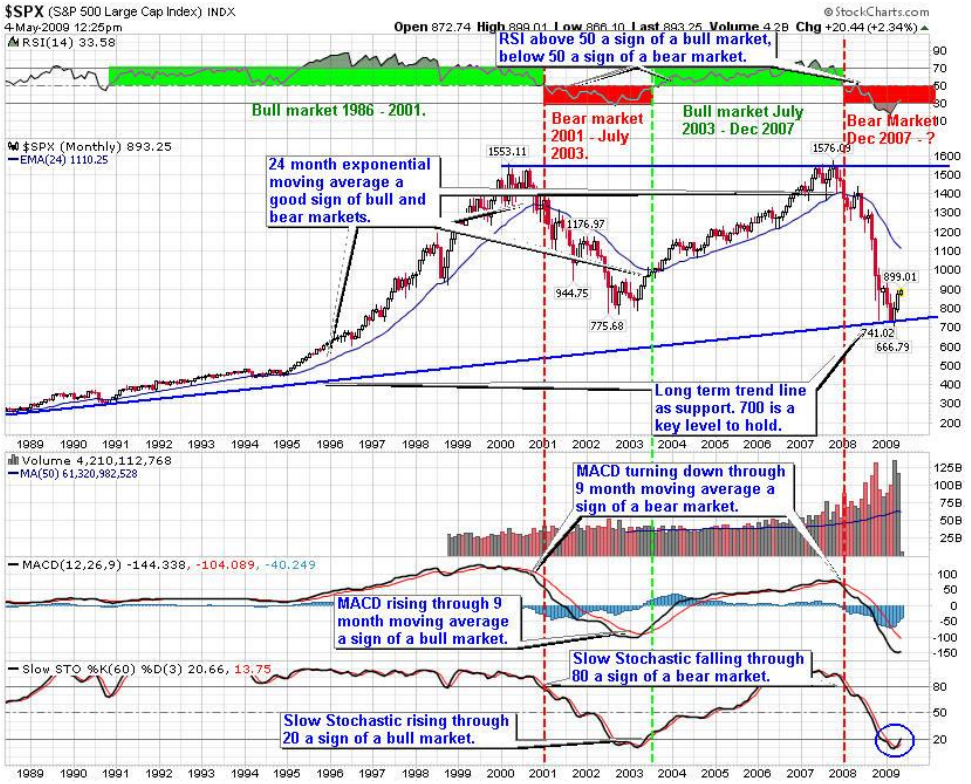



http://anji.sourceforge.net/polebalance.htm

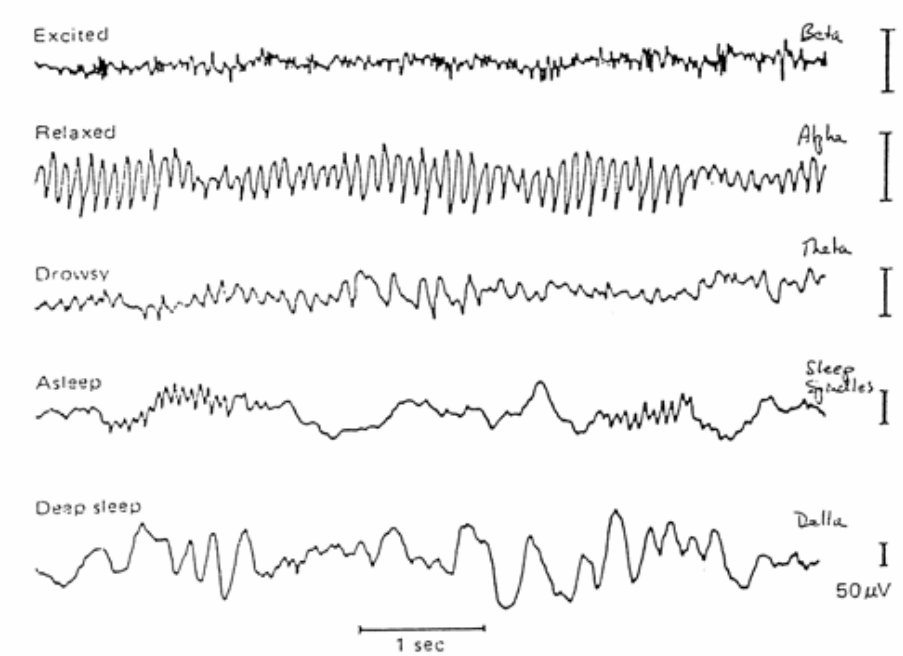
# Financial Applications

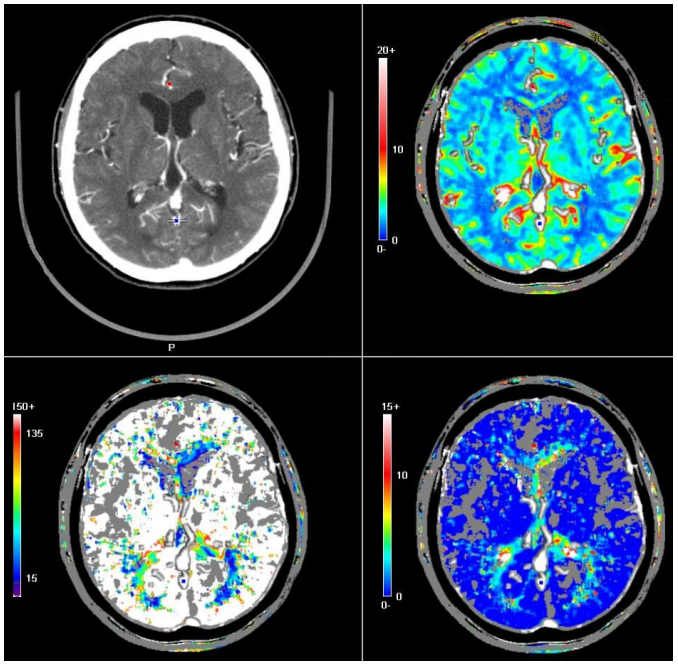
- Stock market time series forecasting.
- Buy/sell timing detection and stock portfolio selection.

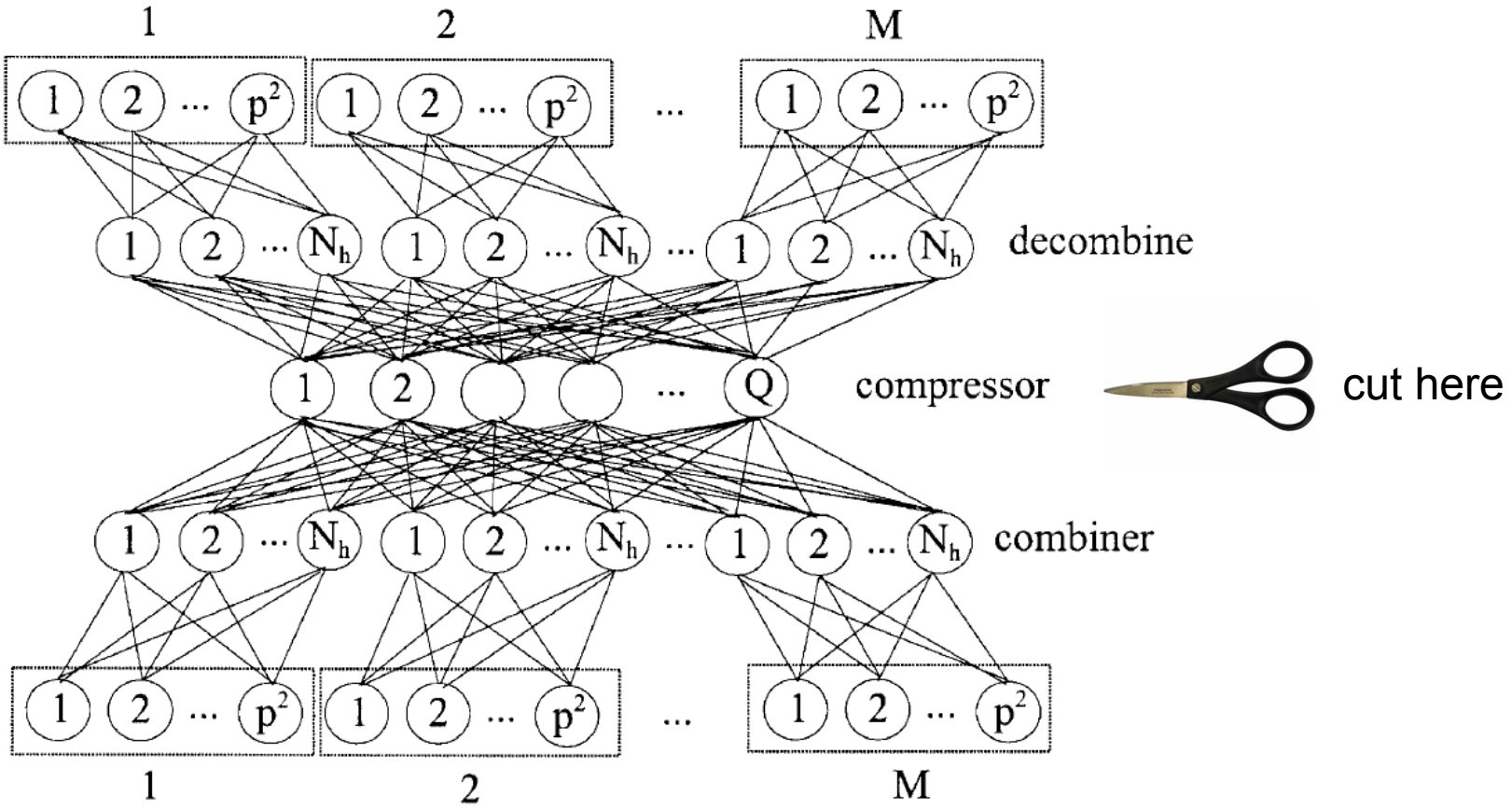
# Medical

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



# Compression by ANNs

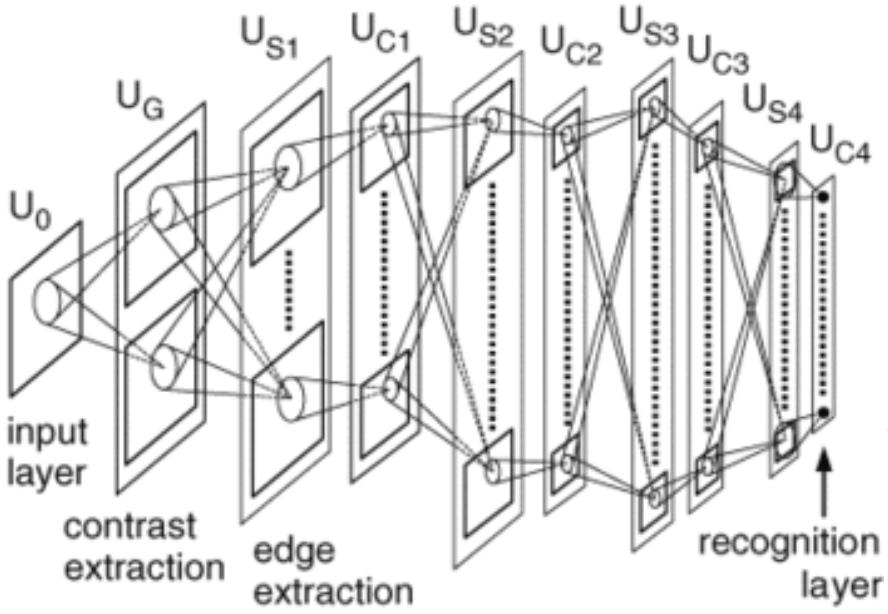


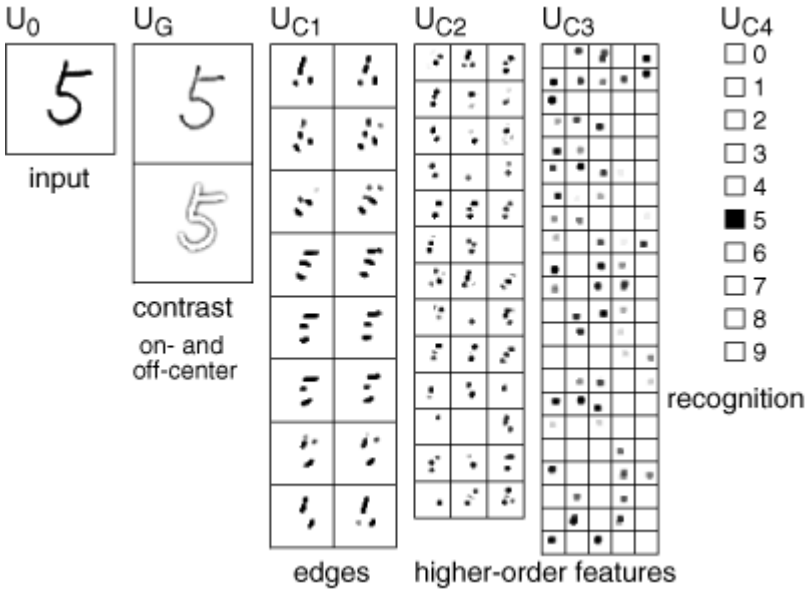

http://www.cse.unr.edu/~looney/cs773b/NNimage-compress.pdf

# Neocognitron

## Prof. Fukushima (1980)

handwritten character recognition

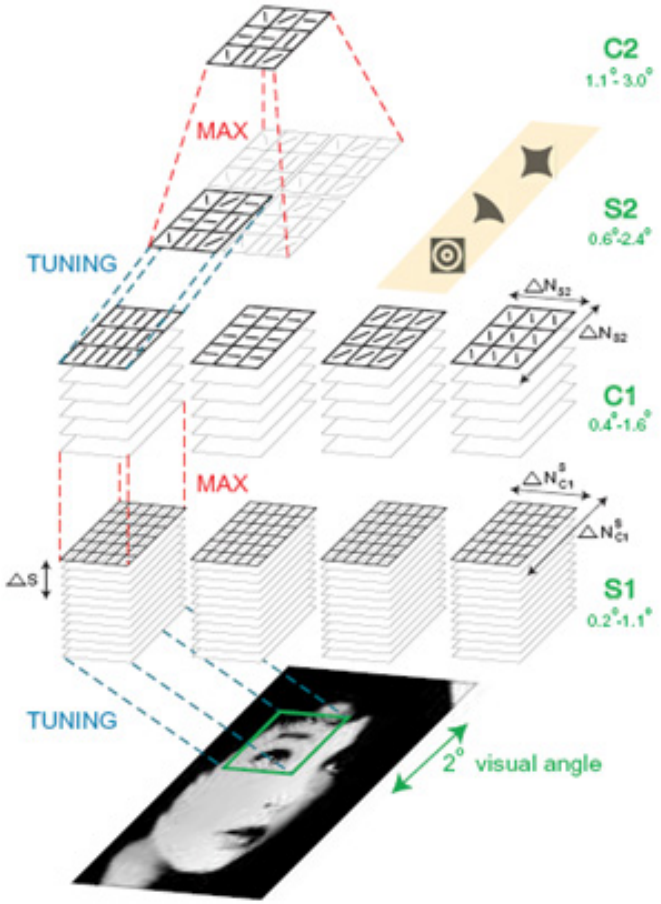



similar to structures found in retina

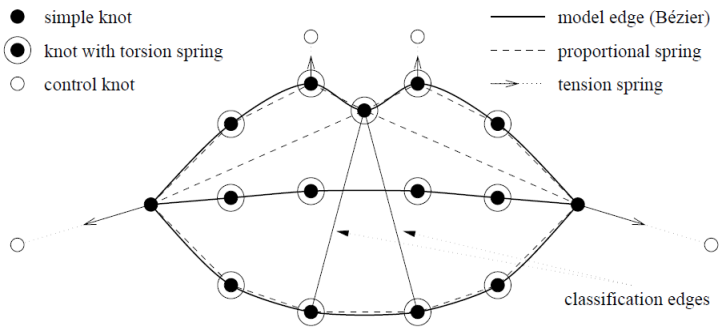
# Feedforward NN for Rapid Vision

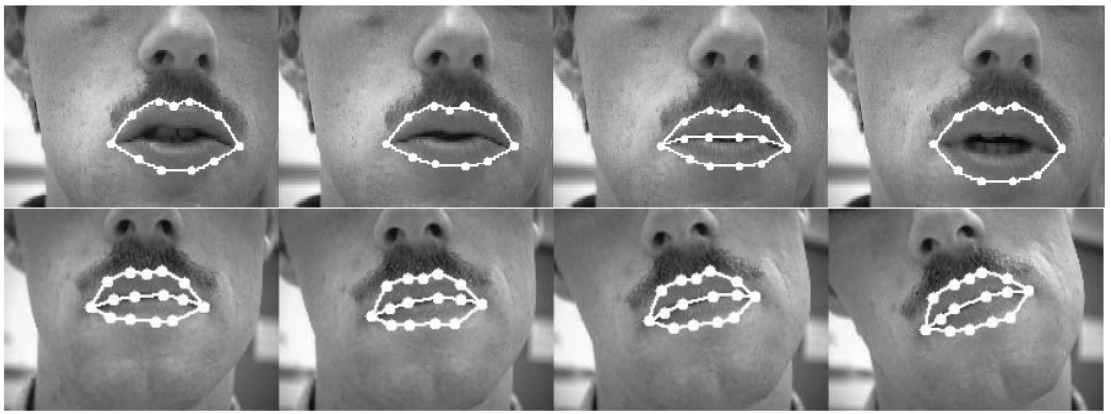
- Serre, Thomas (2007)
- Similar to the Neocognitron



# Speechreading (Lipreading)

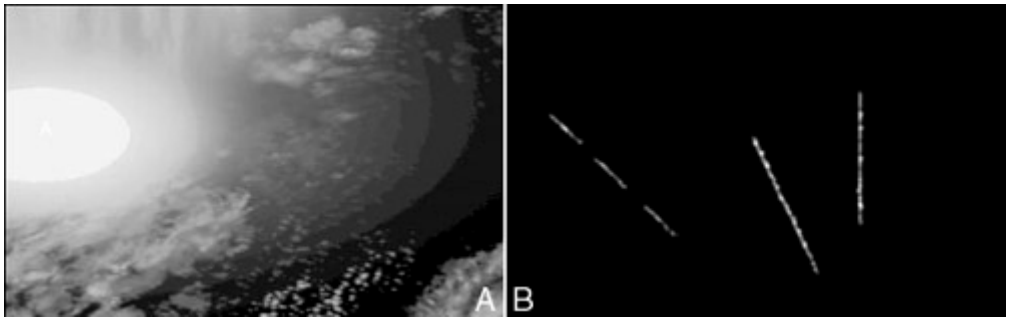
- Günter Mamier, Marco Sommerau & Michael Vogt, Universität Stuttgart.
- A neural classifier detects visibility of teeth edges and other attributes.



# Detection and Tracking of Moving Targets (ICBMs)

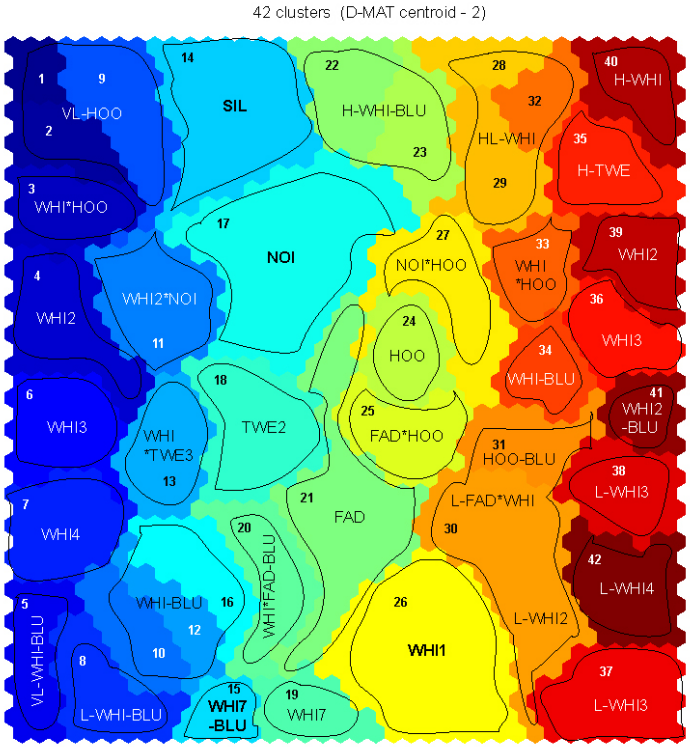
- The moving target detection and track methods here are "track before detect" methods.
- They correlate sensor data versus time and location, based on the nature of actual tracks.
- The track statistics are "learned" based on artificial neural network (ANN) training with prior real or simulated data.
- 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.

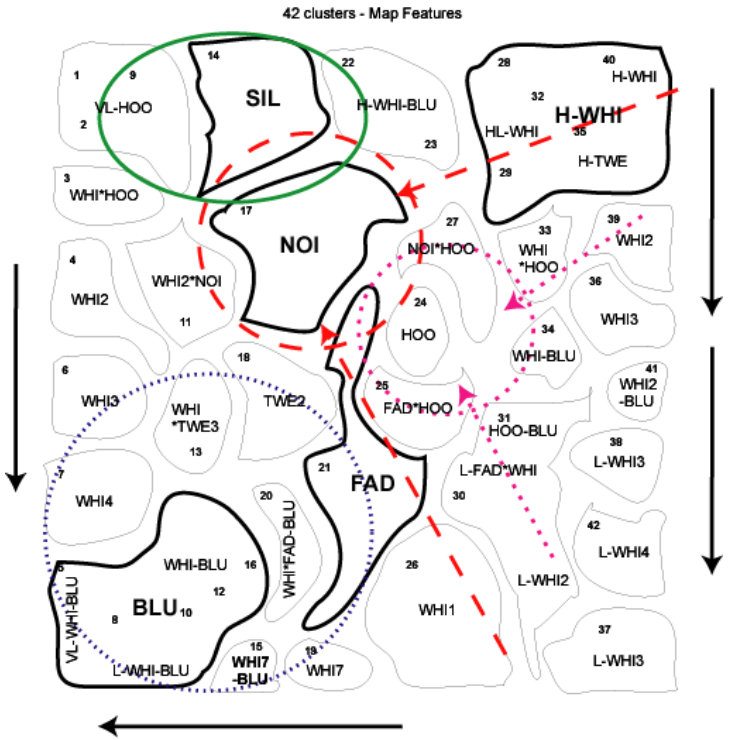



http://tralvex.com/pub/nap/#Detection and Tracking of Moving Targets

# Parrot Speech (FEE CTU)

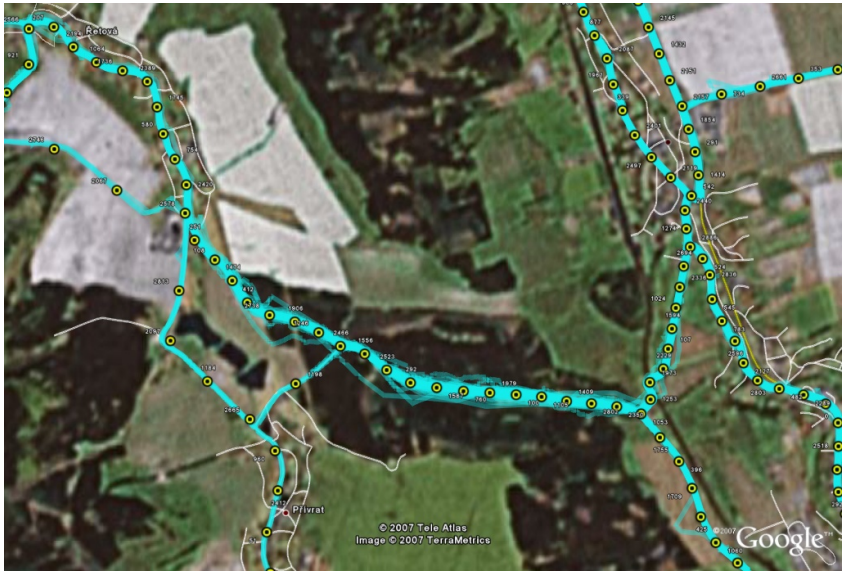
- Classification of parrot sounds → parrot speech consists of 41 “words”. Self Organization Map (SOM).



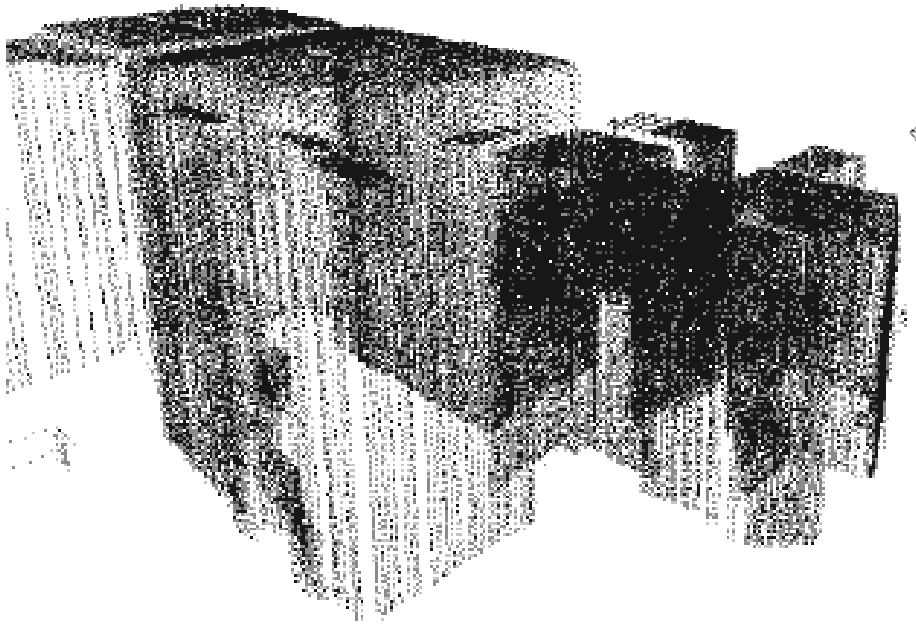
# Colabroute (FEE CTU)

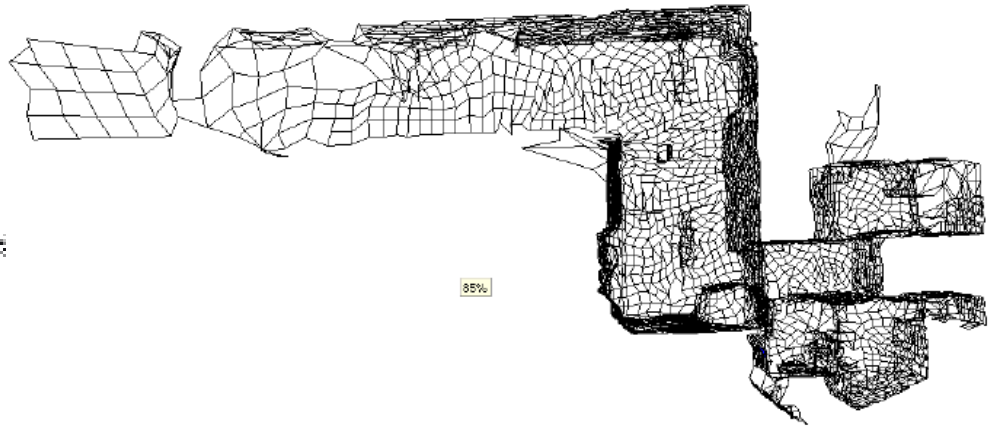
- GPS Data Mining - THSOM.
- Automatic detection of crossroads.
- Detection of interesting places (gas stations, dangerous crossroads,...)




# ShapeSOM (FEE CTU)

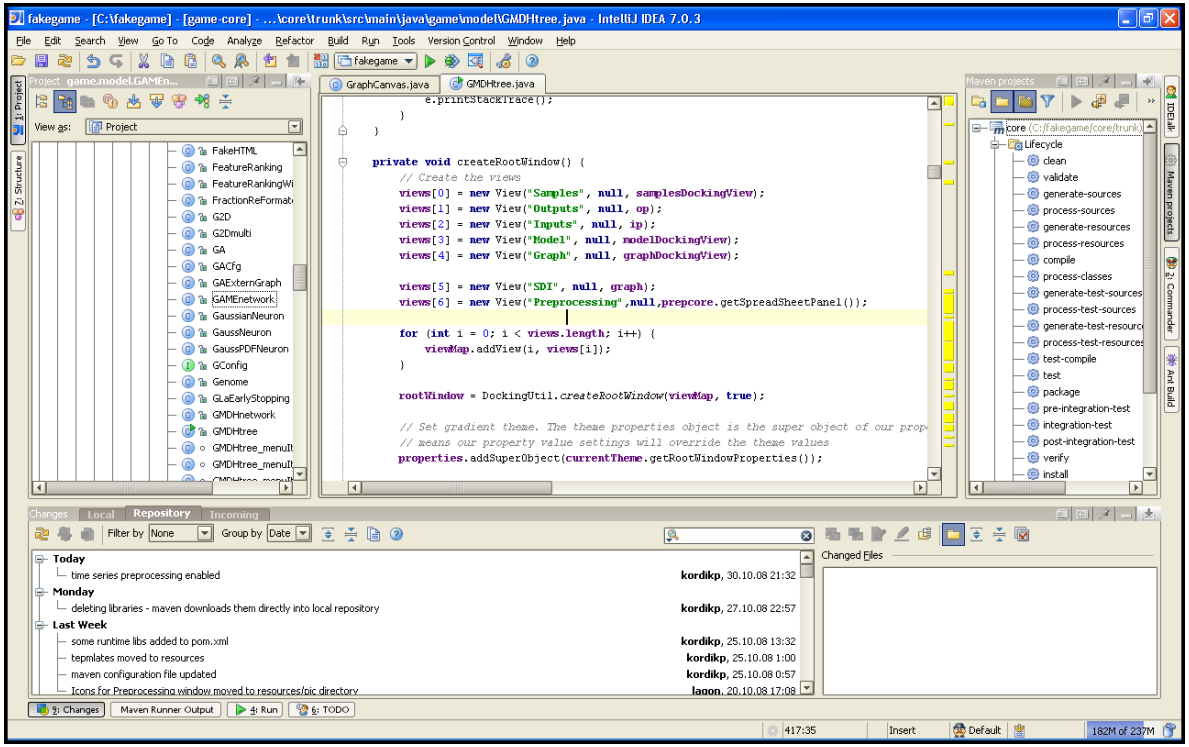
- Reconstruction of a room model out of unordered clusters of points.

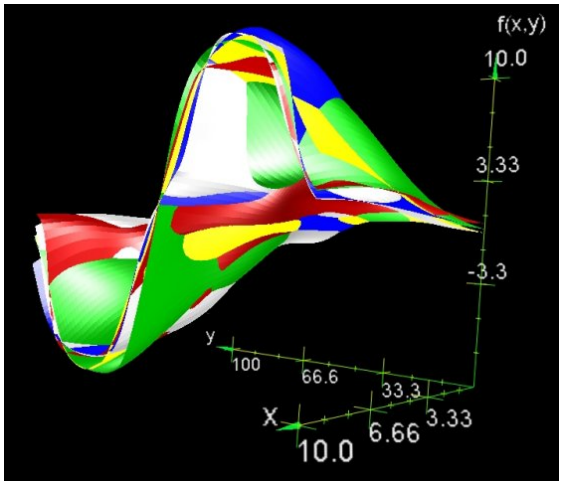


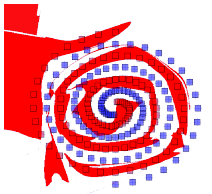


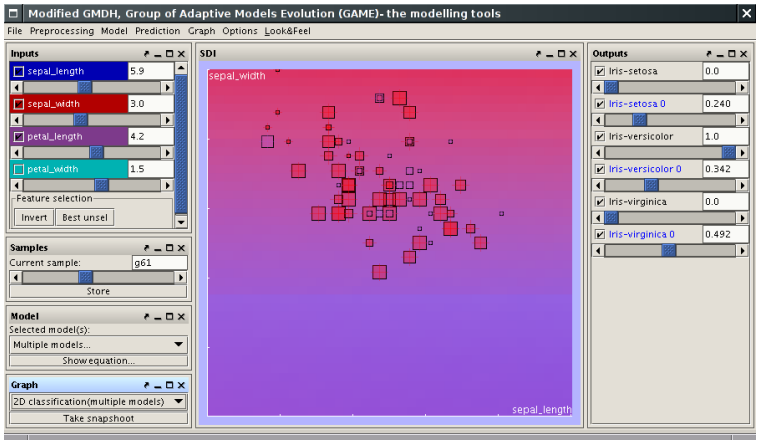
# GAME & FAKE GAME

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



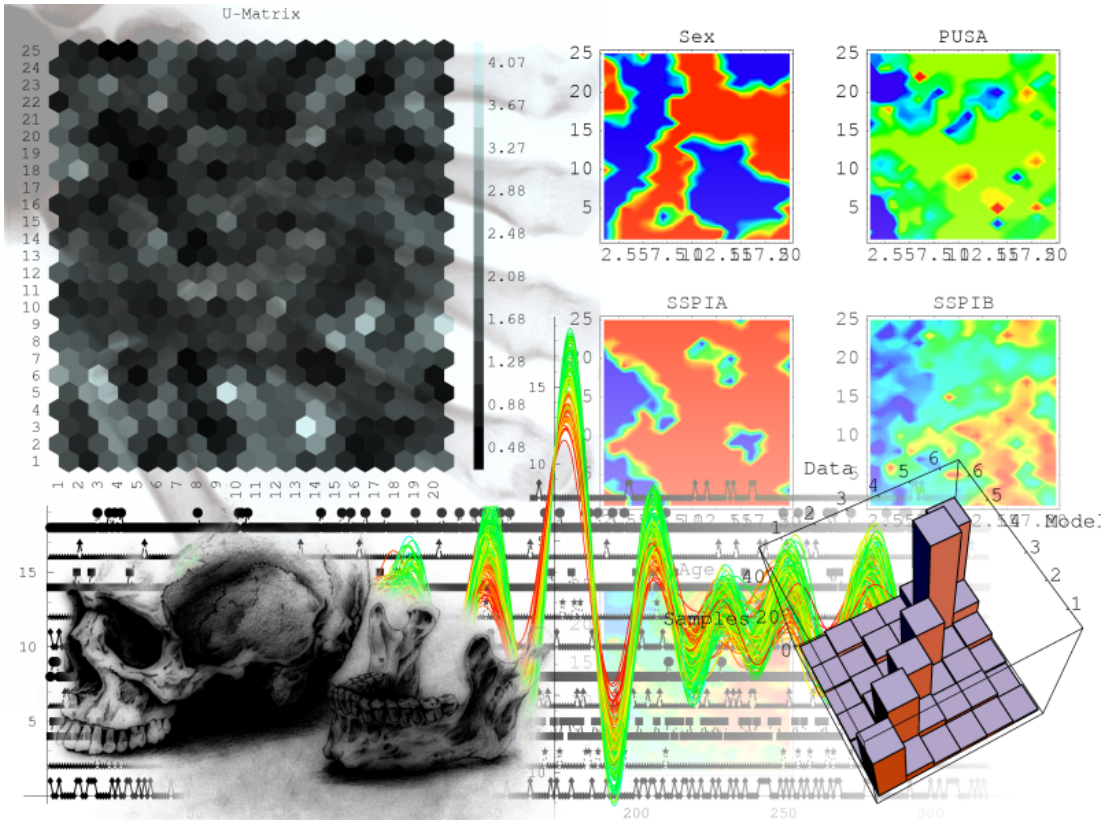





# Bone Age Modelling (FEE CTU)

- Modelling of age based on bone measurements.

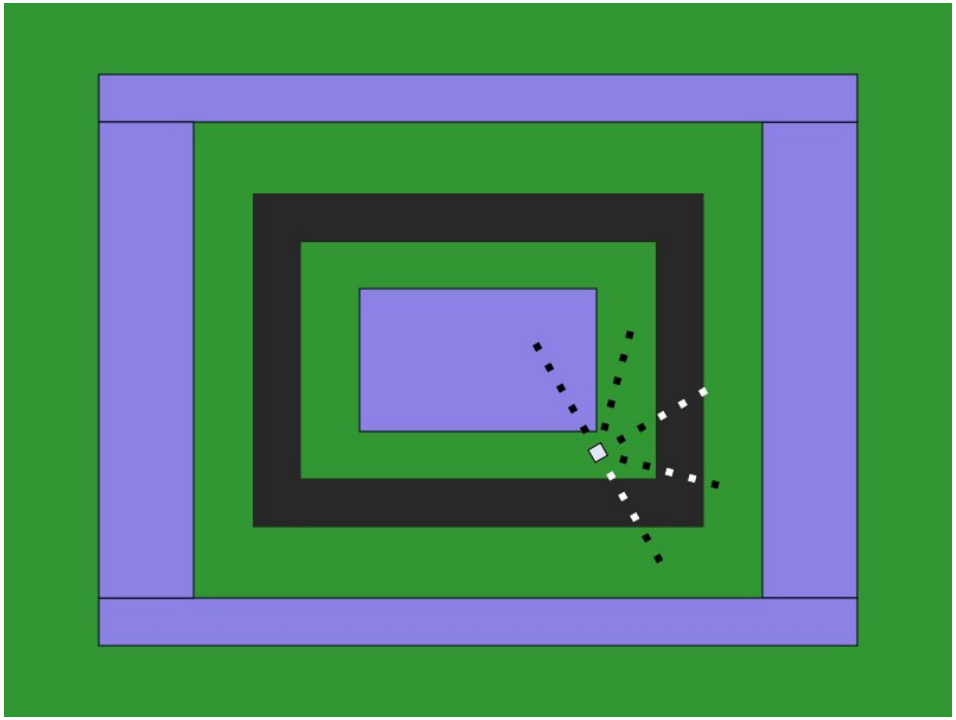


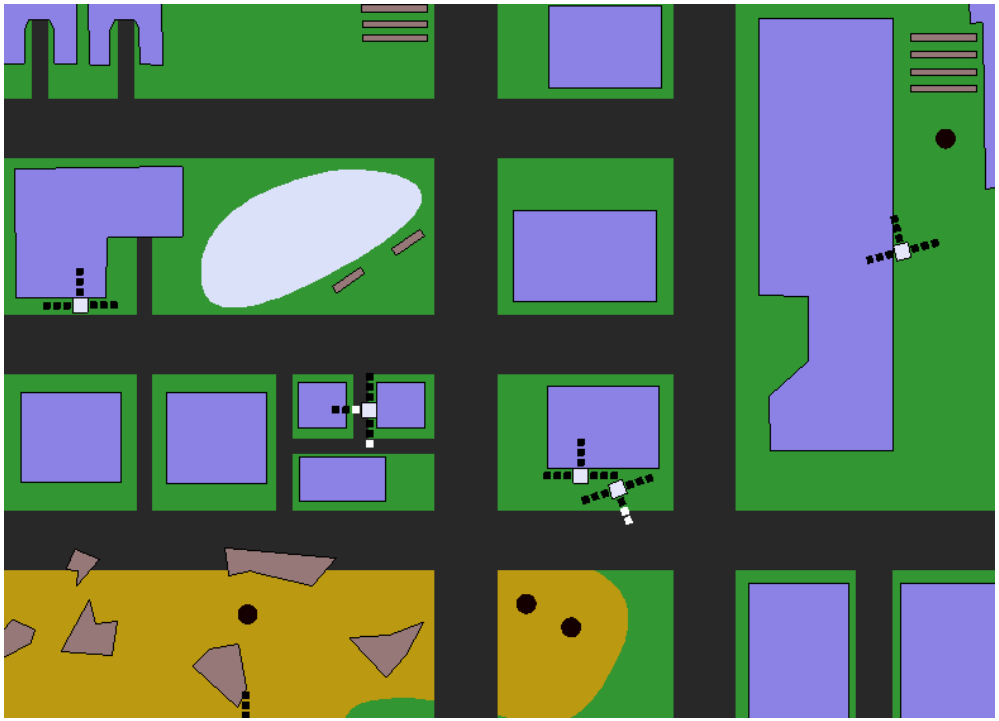
# Fetal Weight Prediction (FEE CTU)

- EFW = 0,0504AC2*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(Bk - 0.63)^2 where Bk 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/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 in JavaNNS (other tools not supported, but you can use them at your own risk).
- 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://simbad.sourceforge.net/
- http://www.flightgear.org/
- http://torcs.sourceforge.net/