

Artificial Neural Networks

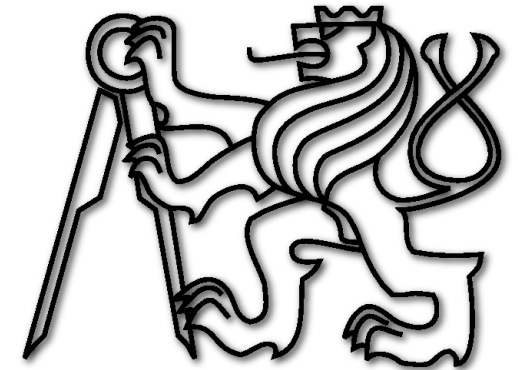
Examples



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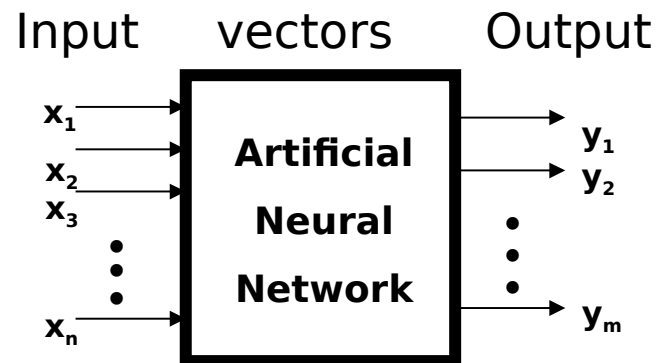


Outline

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

ANN, Learning & Recall

- ANN is a black box performing transformation.

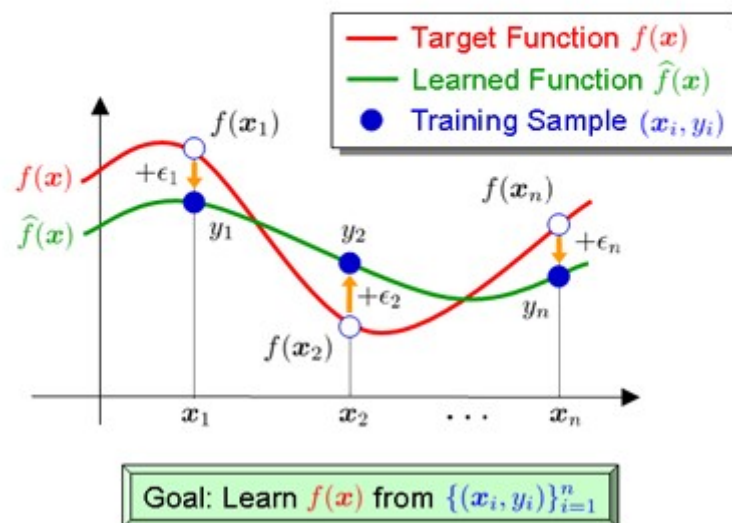


- ANNs work most frequently in two phases:
 - **Learning phase** – adaptation of ANN's internal parameters.
 - **Evaluation phase (recall)** – use what was learned.

Supervised learning

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

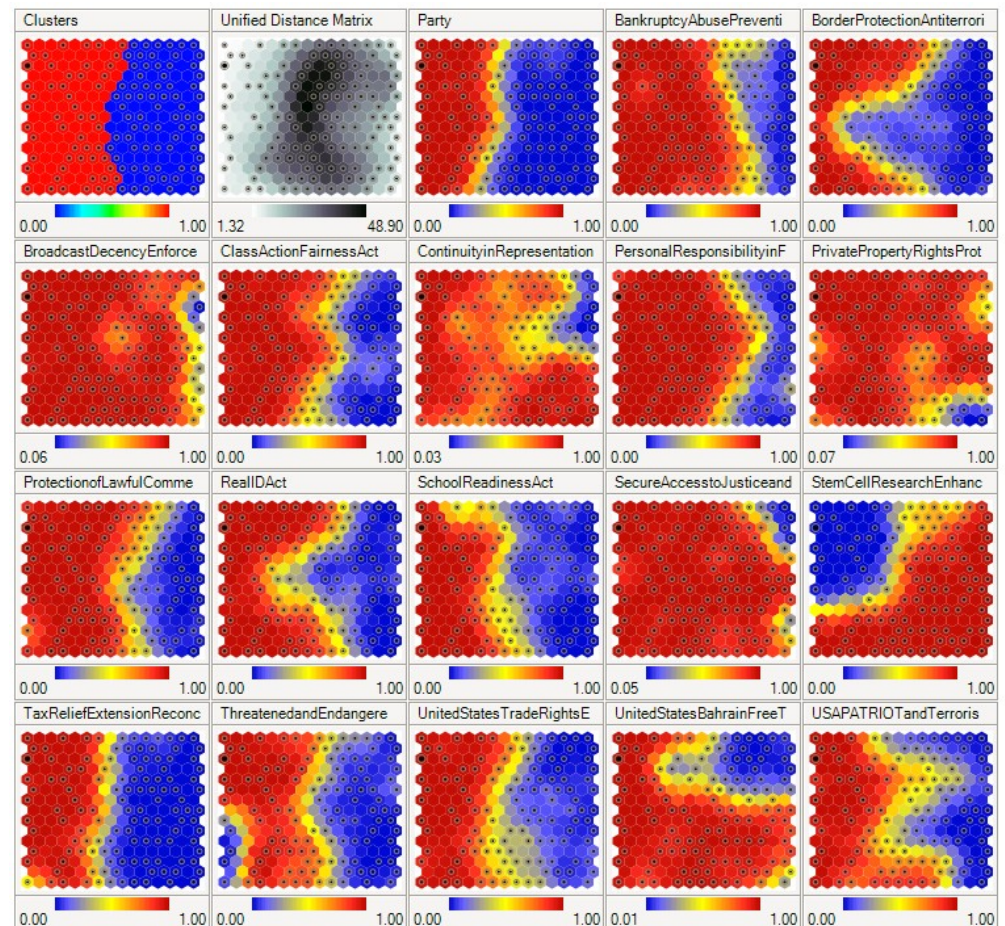
Supervised Learning as Function Approximation



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

Unsupervised learning

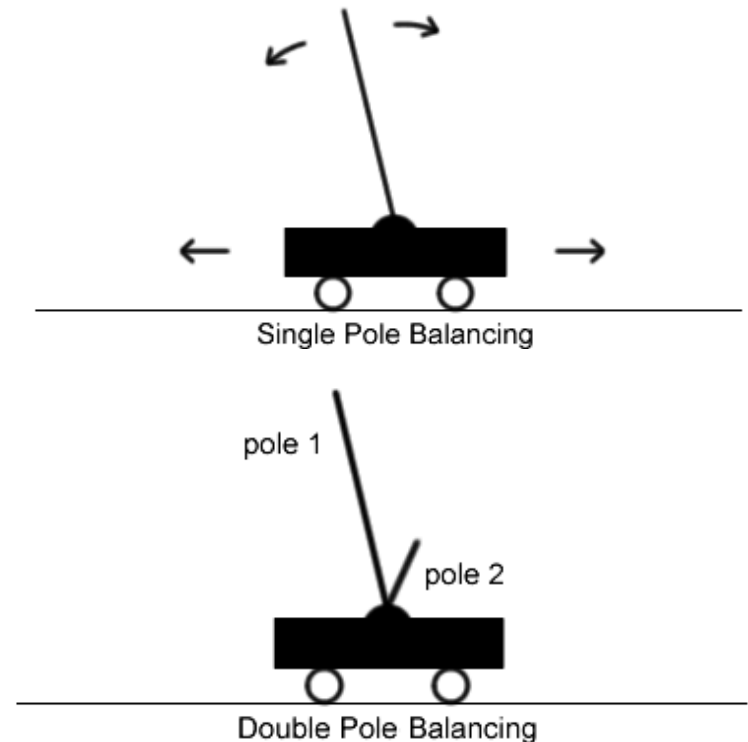
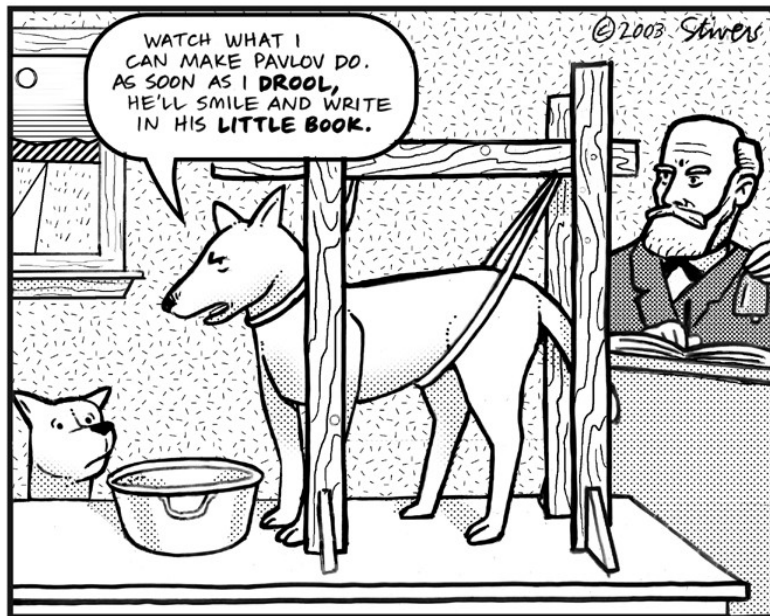
- Self-organization, no teacher.
- SOM, ART...



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).



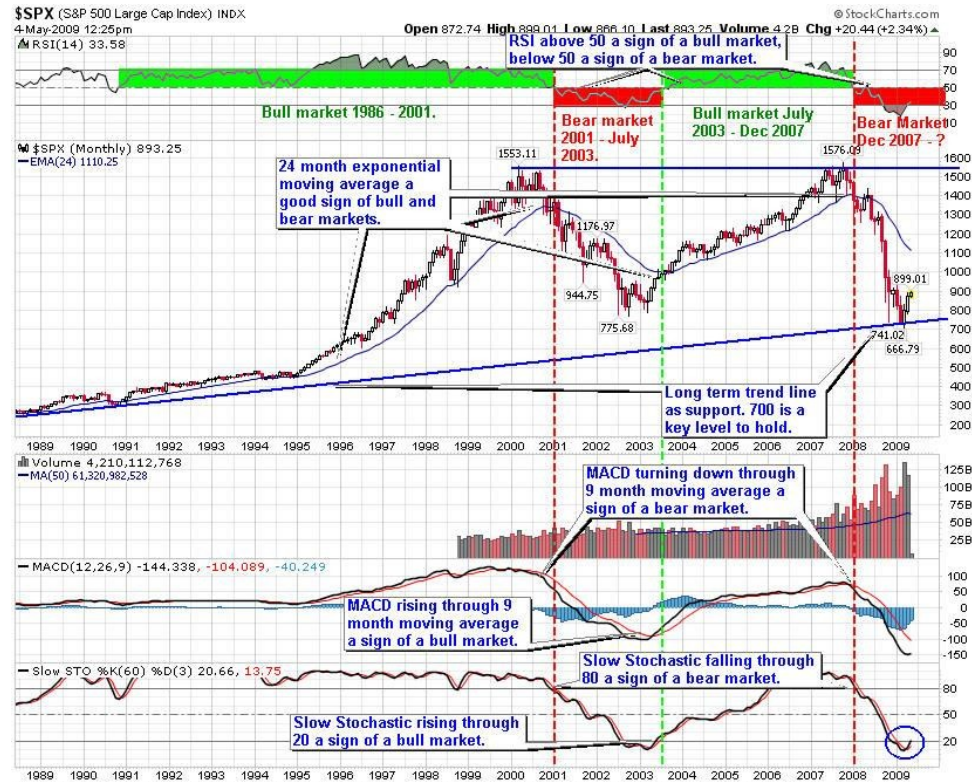
<http://anji.sourceforge.net/polebalance.htm>

Reinforcement Learning Demonstration

- 1994, Karl Sim's: Evolving Virtual Creatures video.
- Evolves both creature bodies (including sensors) and controlling networks...
- You can play with <http://www.framsticks.com/>

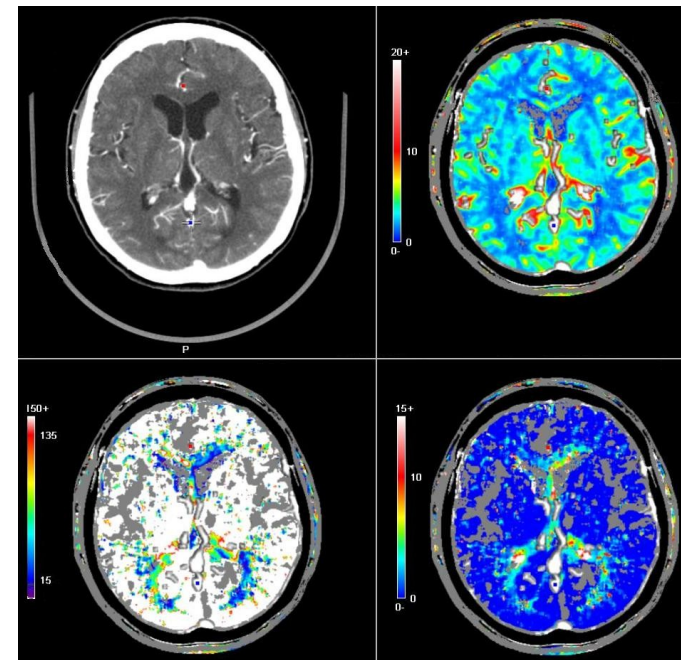
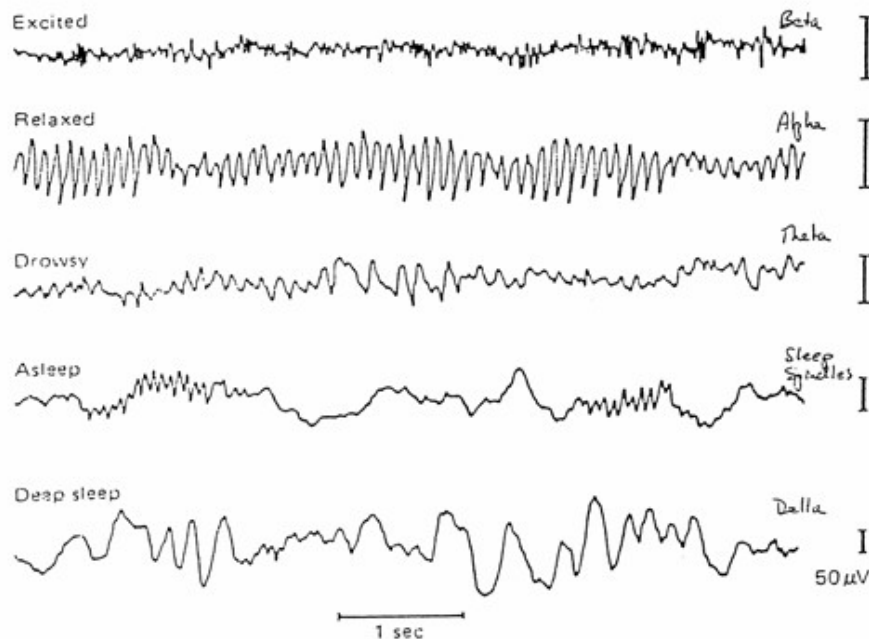
Financial Applications

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

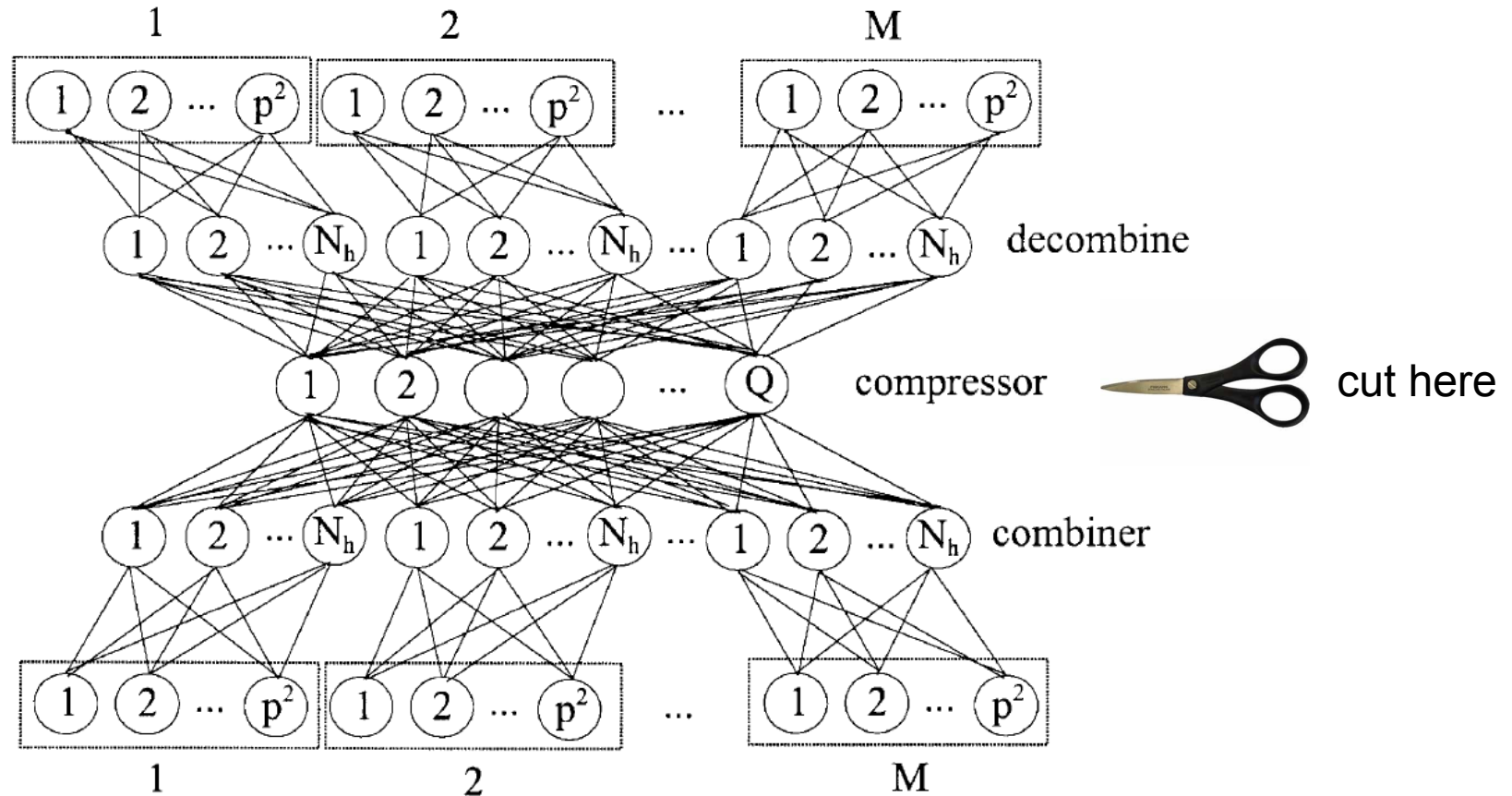


Medical

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



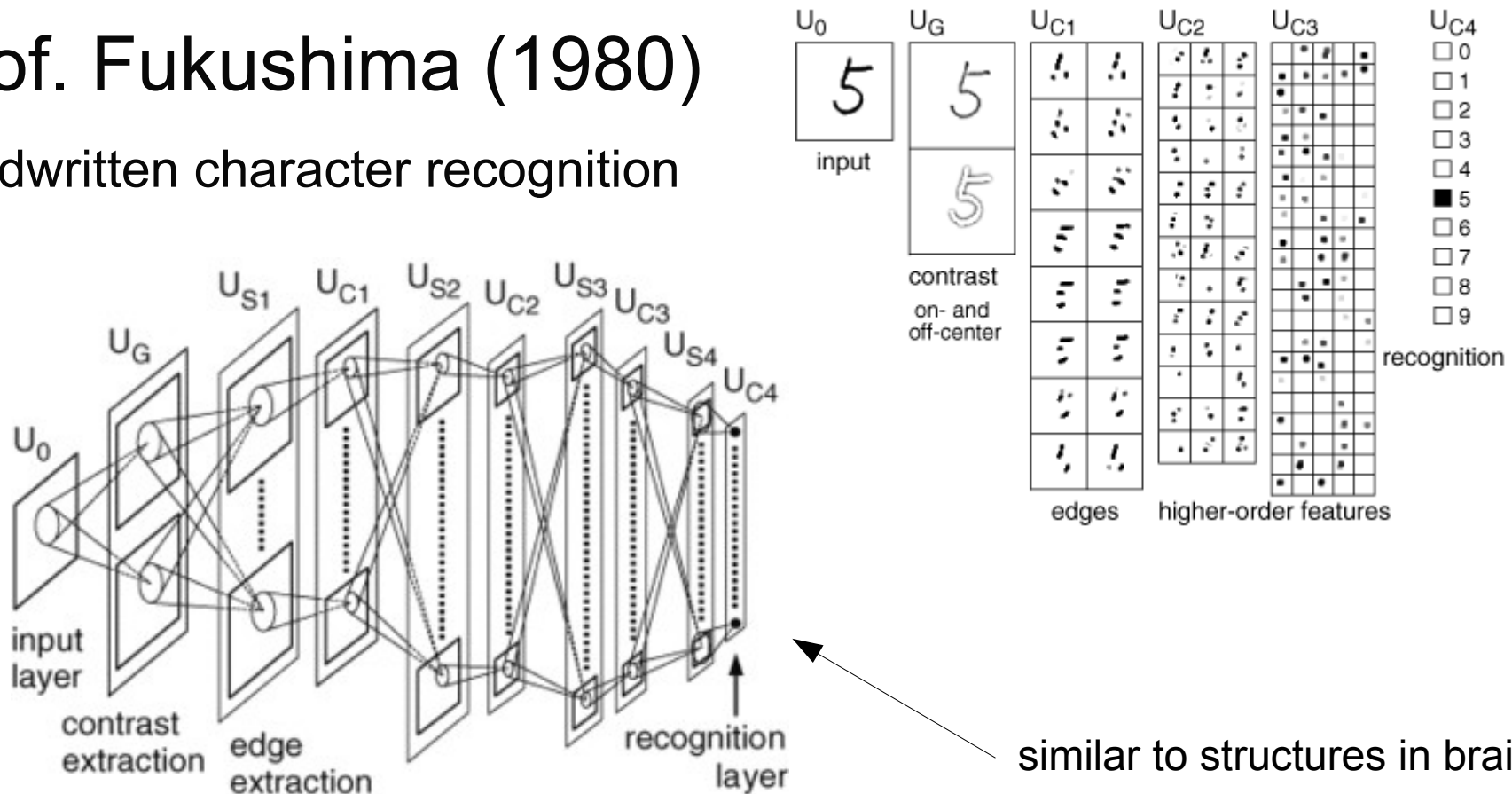
Compression by ANNs



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

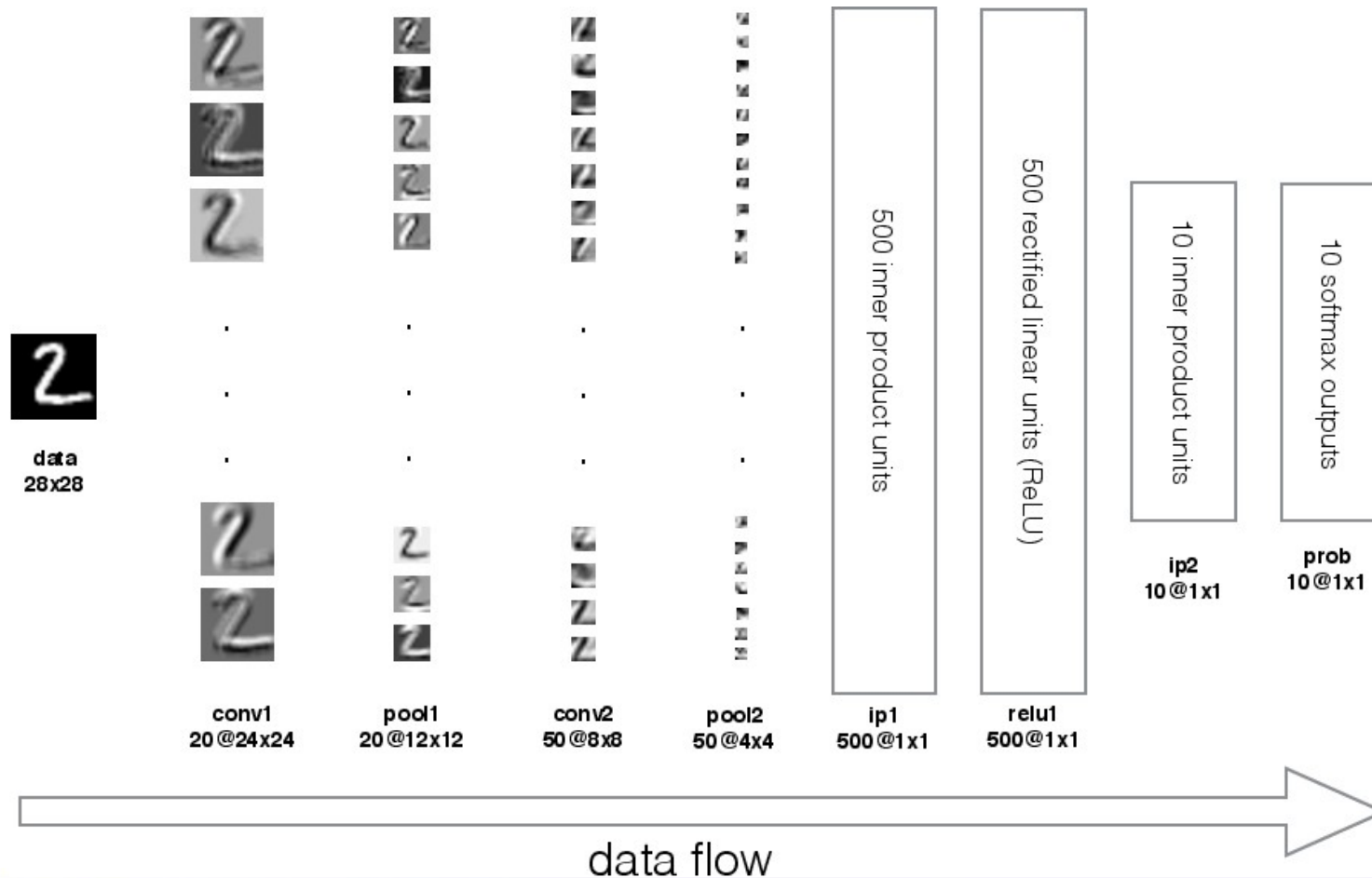
Neocognitron

Prof. Fukushima (1980)
handwritten character recognition

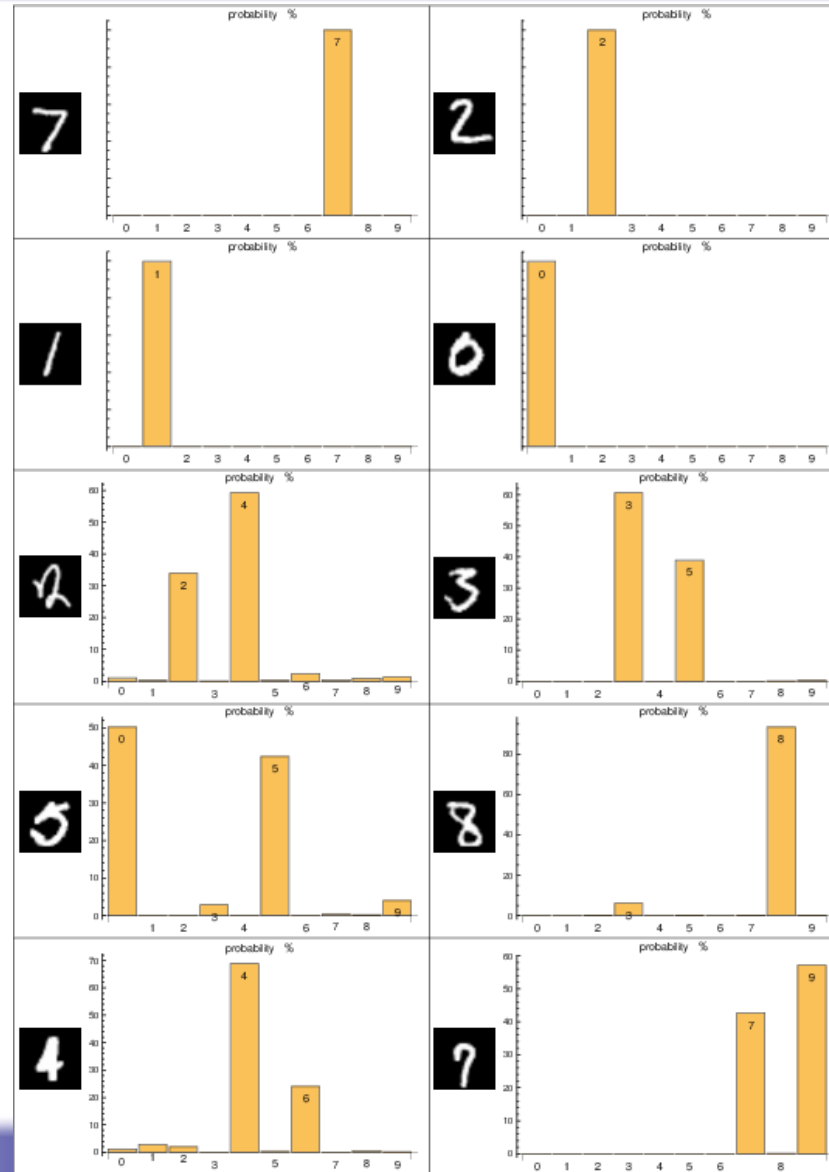


Convolutional Neural Networks: LeNet

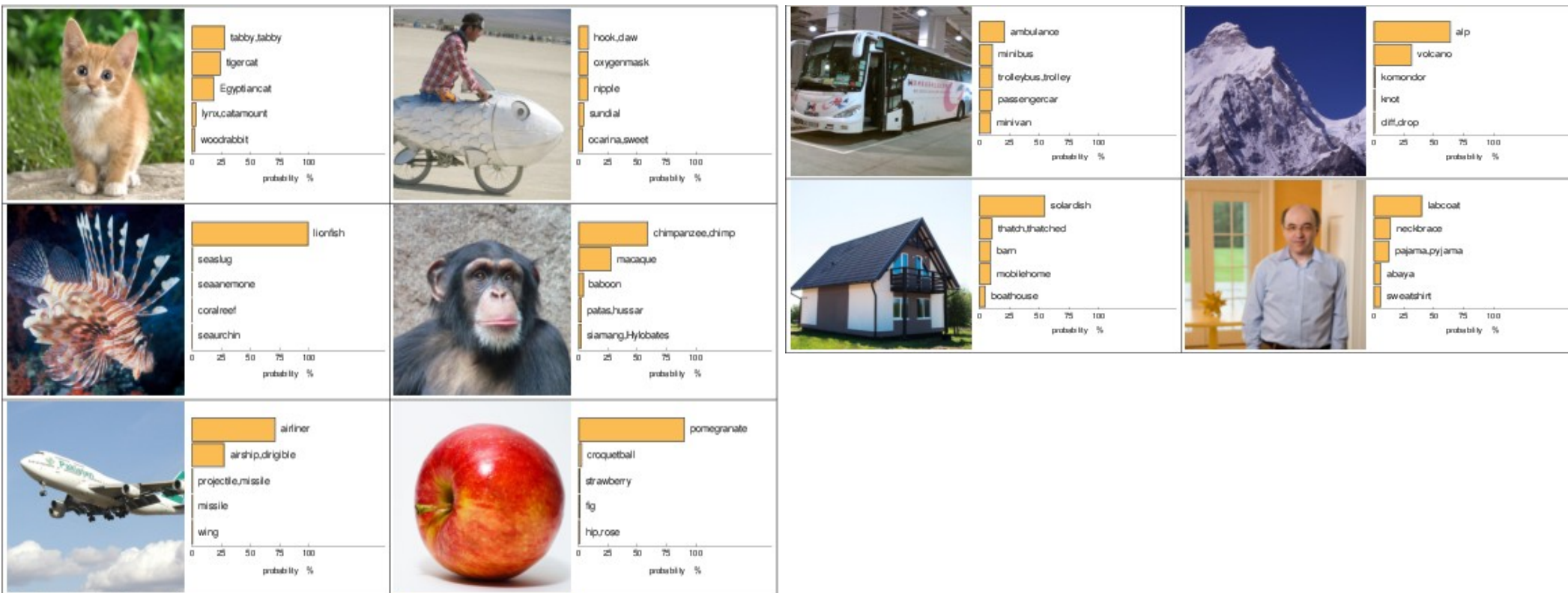
- Yann LeCun



CNNs: MNIST

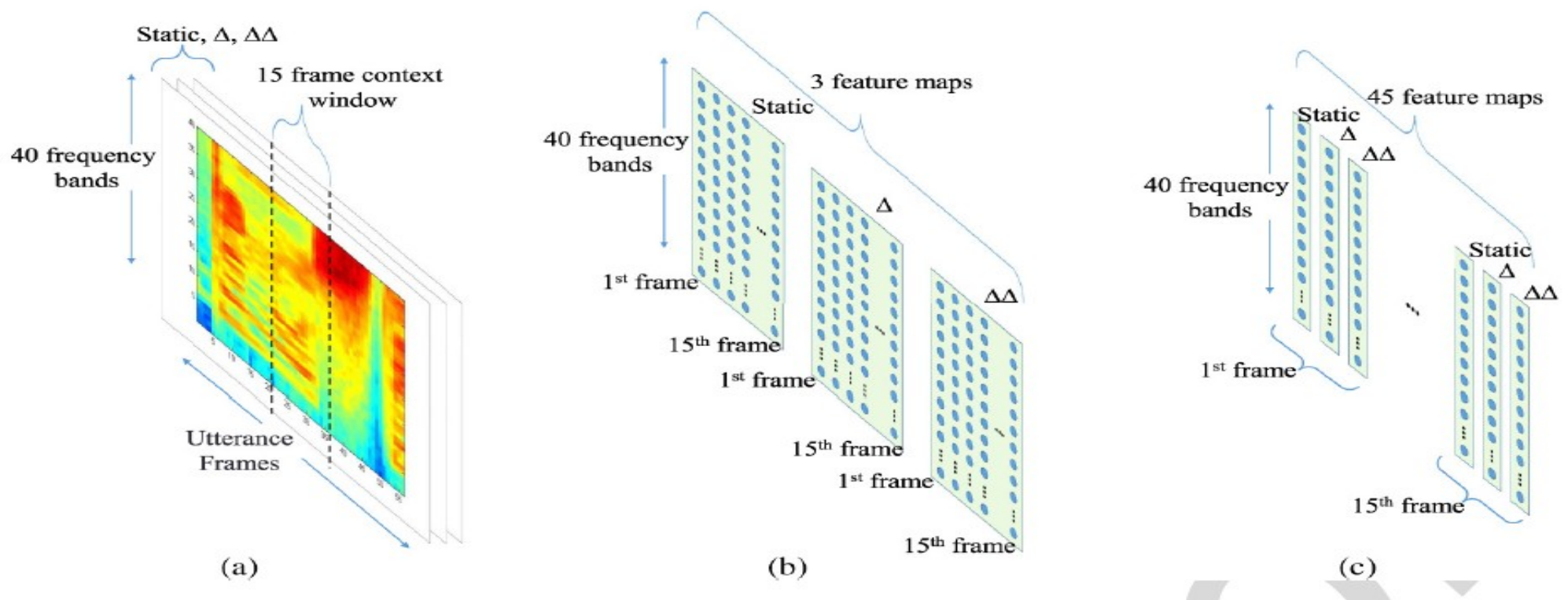


CNNs: ImageNet



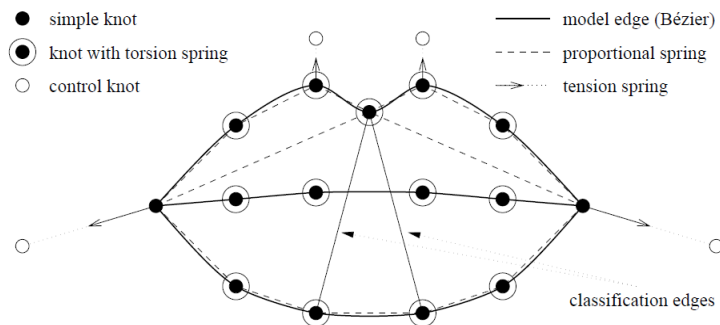
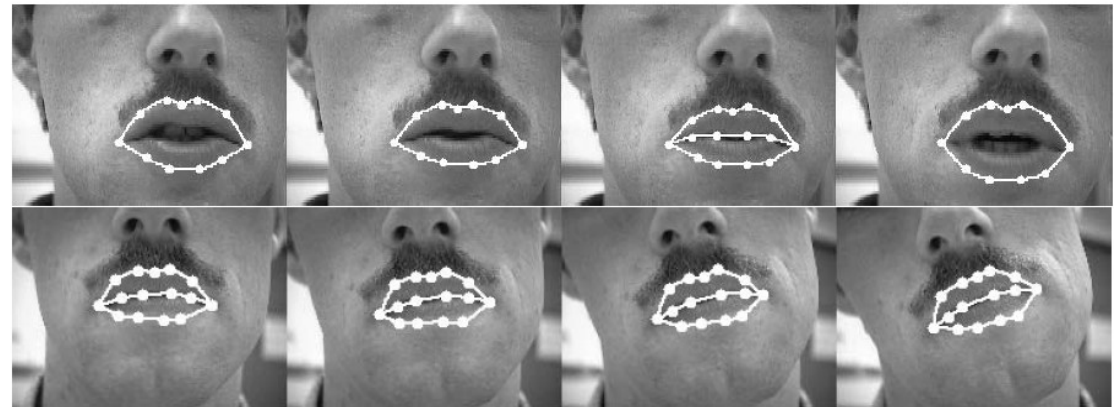
CNN for Speech Recognition

- Abdel-Hamid et al. (2014)



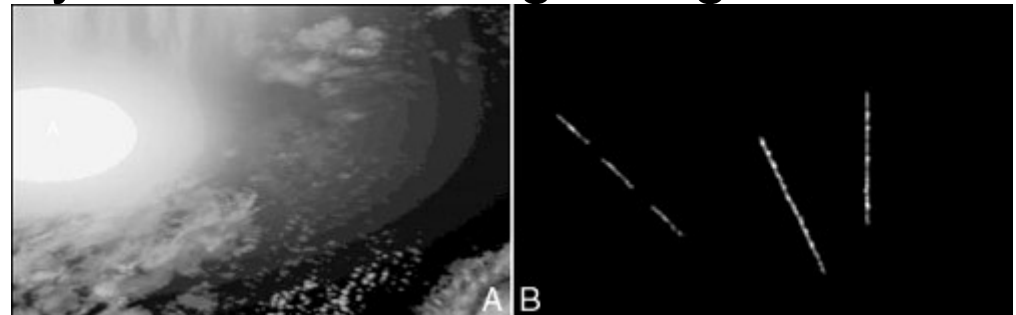
Speechreading (Lipreading)

- 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.



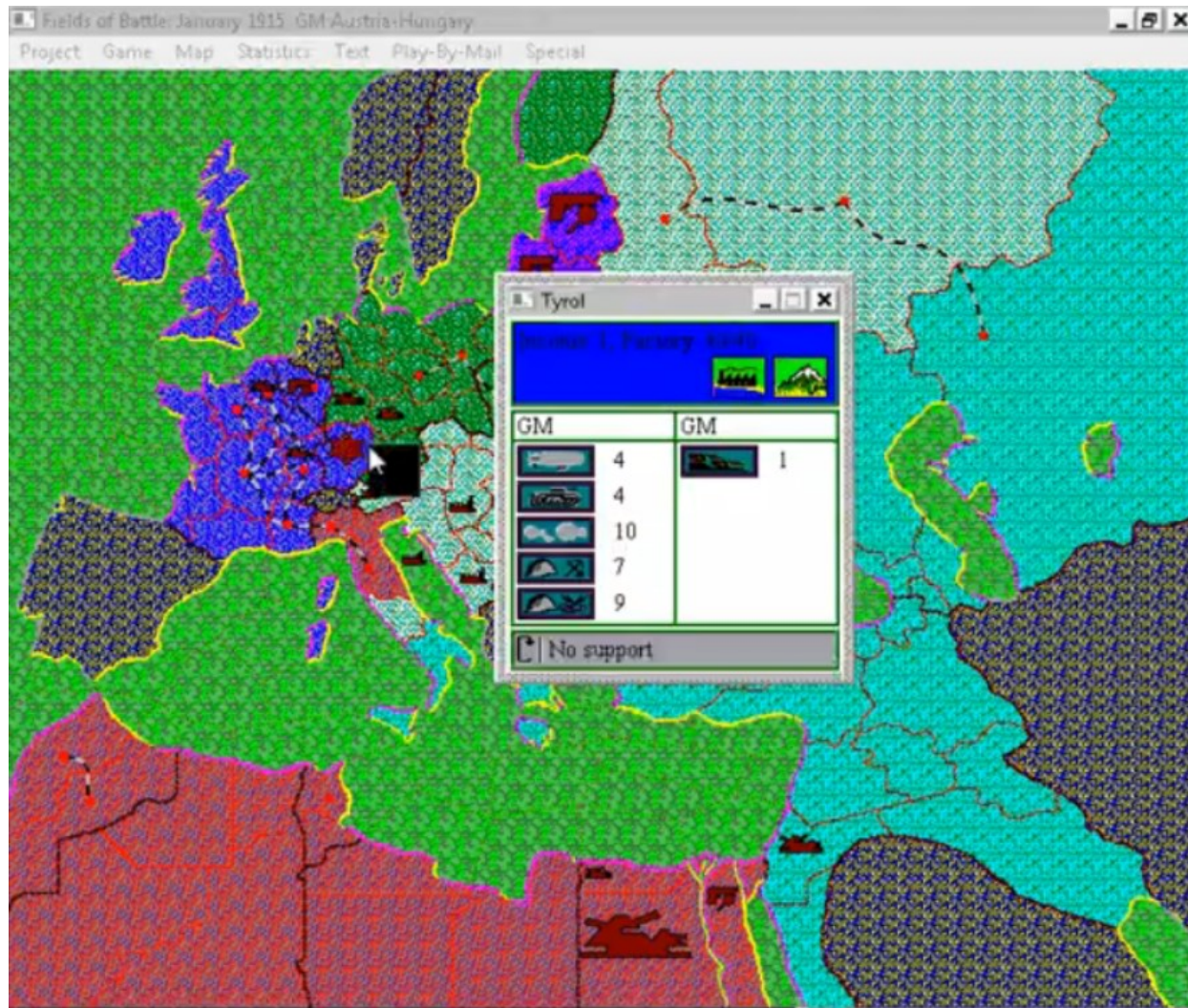
[http://tralvex.com/pub/nap/#Detection and Tracking of Moving Targets](http://tralvex.com/pub/nap/#Detection%20and%20Tracking%20of%20Moving%20Targets)
<https://web.archive.org/web/20011204214308/http://www.ca.defgrp.com/detect.html>

ANNs and Game AI

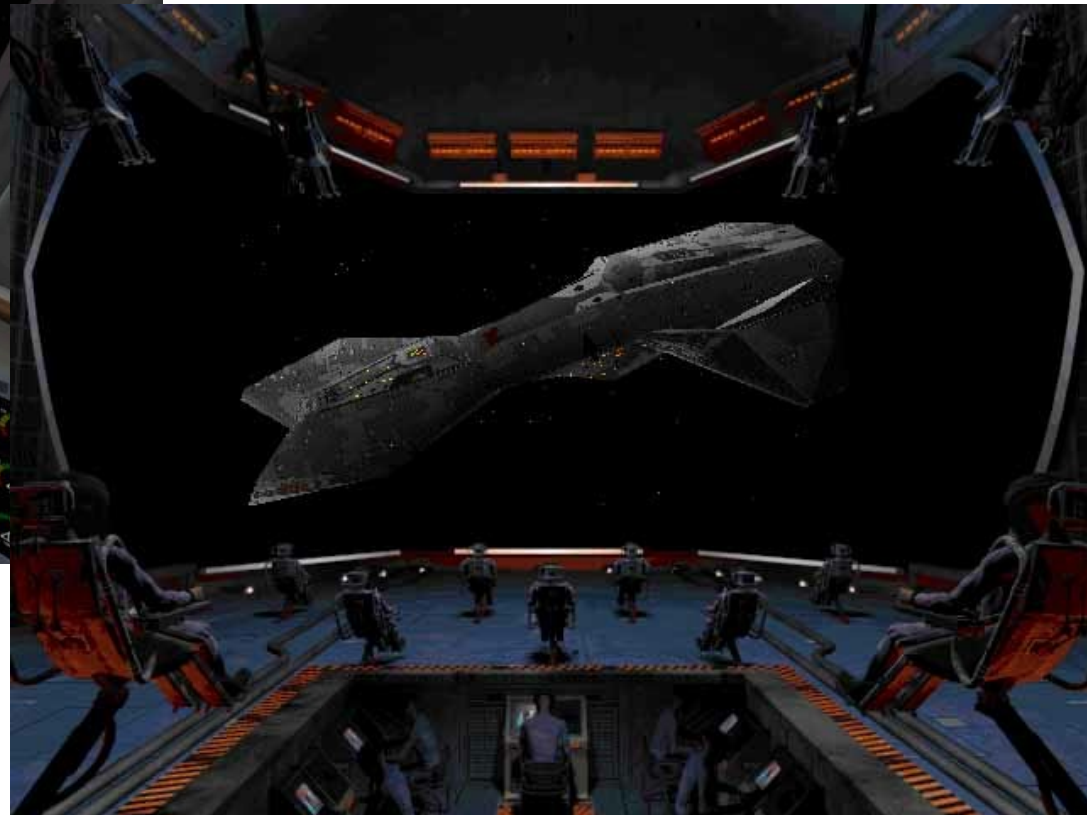
- AI opponents.
- Modeling player behaviour.
- Strategy estimation.
- Realistic motion.
- Cheat detection.



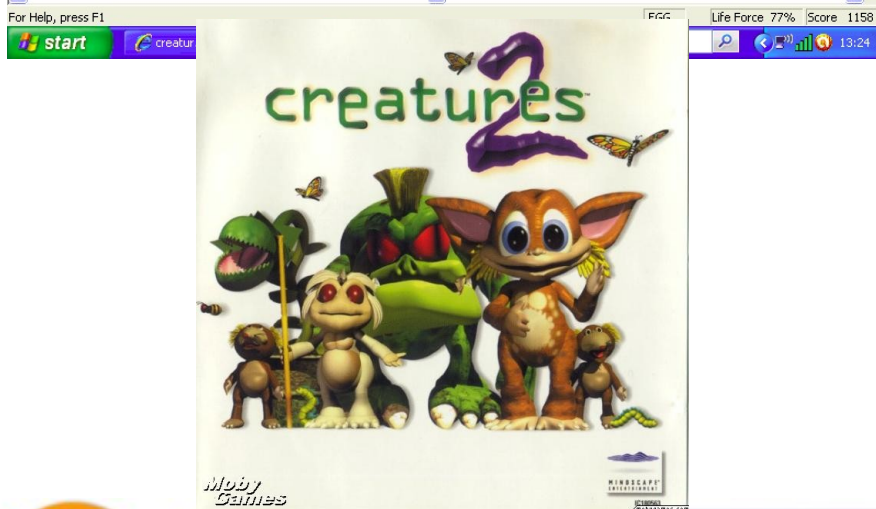
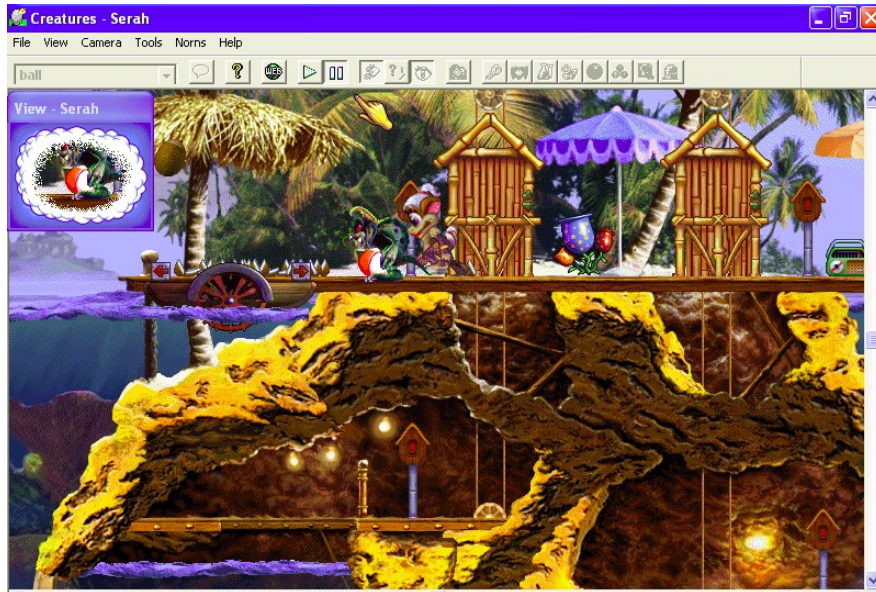
Fields of Battle (1995)



Battlecruiser 3000AD (1996)

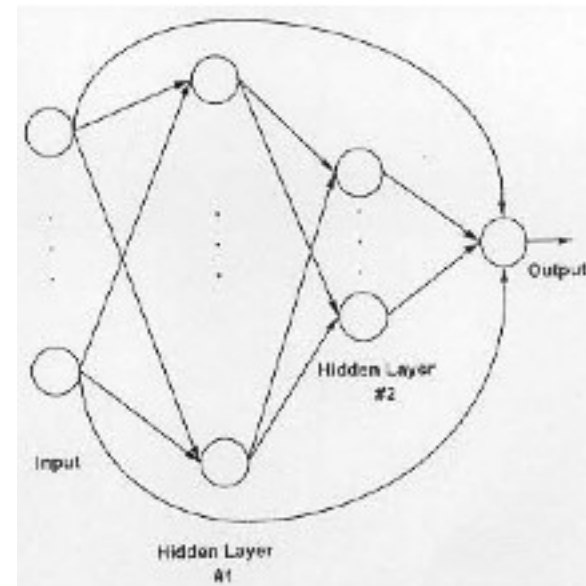
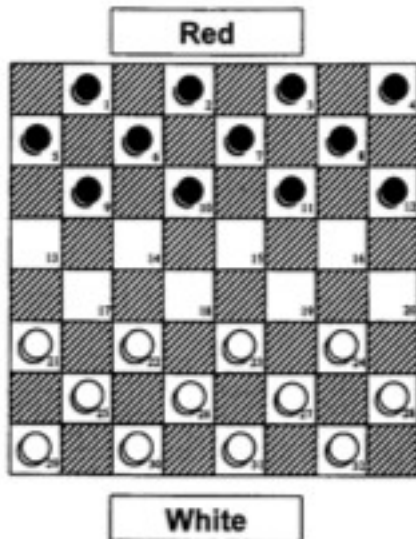


Creatures (1996-)



Blondie 24 Chess (1999)

- David B. Fogel.
- Combination of minmax. & neuroevolution.
- Coevolution.
- Defeated 99.61% of 165 online players (including masters).



Colin McRae Rally 2.0 (2001)



- Opponents AI.
- MLPs, RPROP learning.
- ANN driving model follows optimal track.
- Different models for different cars and road conditions
- Different networks for steering and speed control.

<http://www.ai-junkie.com/misc/hannan/hannan.html>

Black & White (2001)



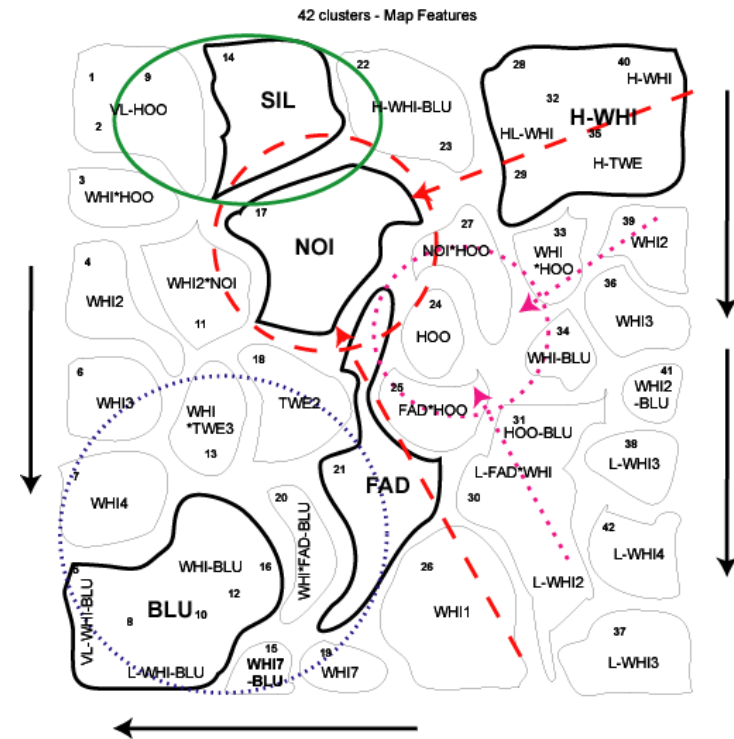
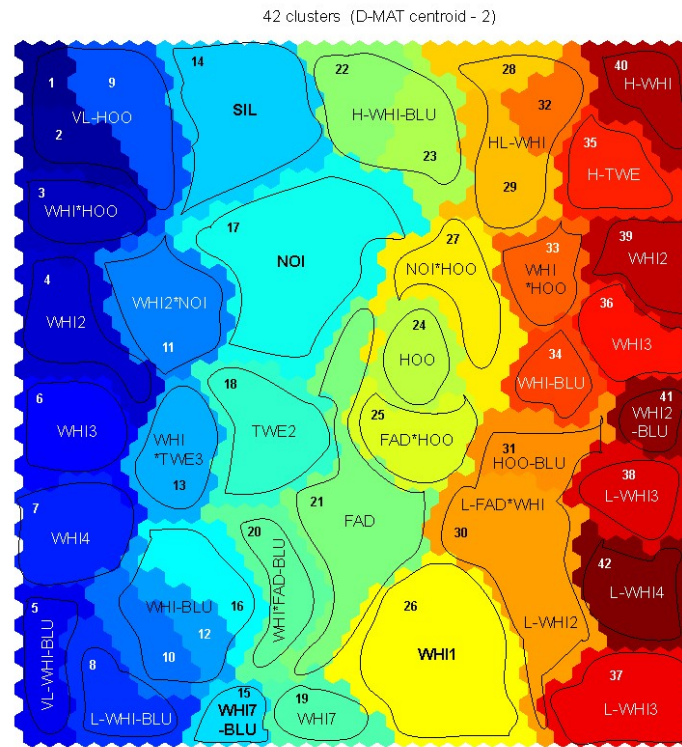
Forza Motorsport 2 (2007)

- Opponent AI.



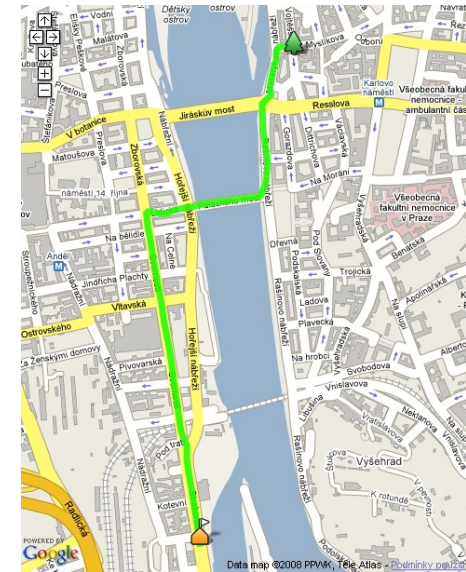
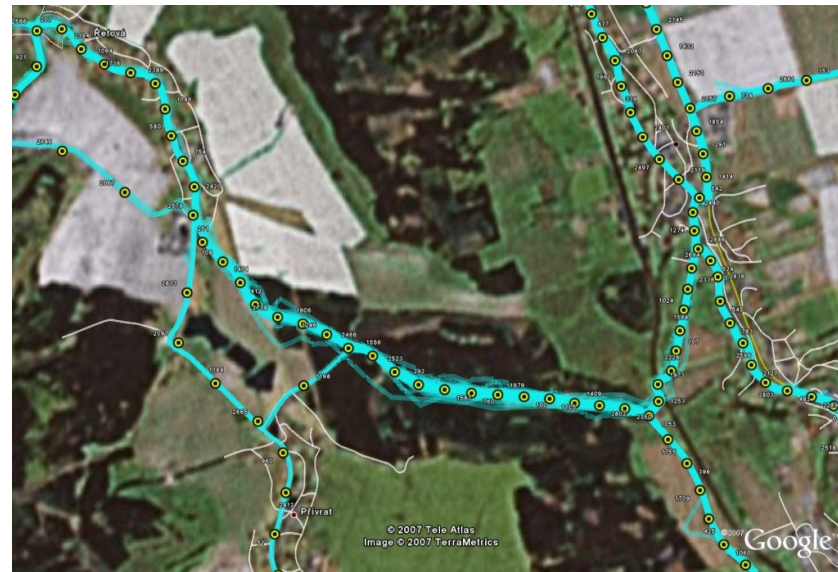
Parrot Speech (FEE CTU)

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



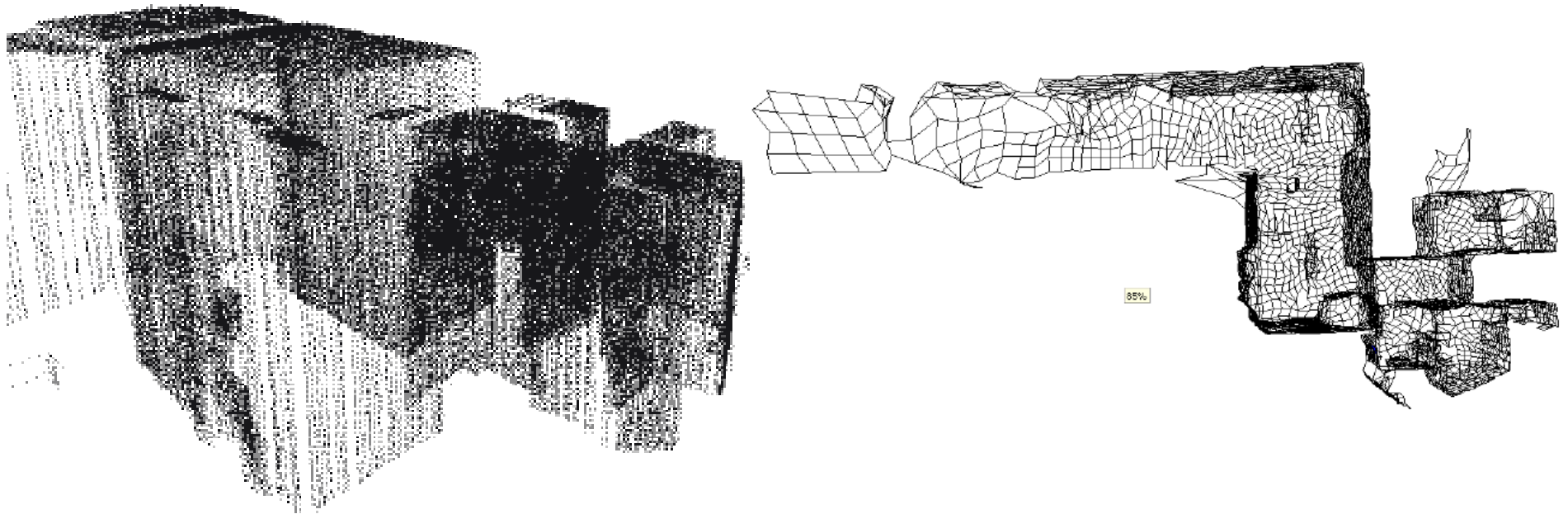
Colabroute (FEE CTU)

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



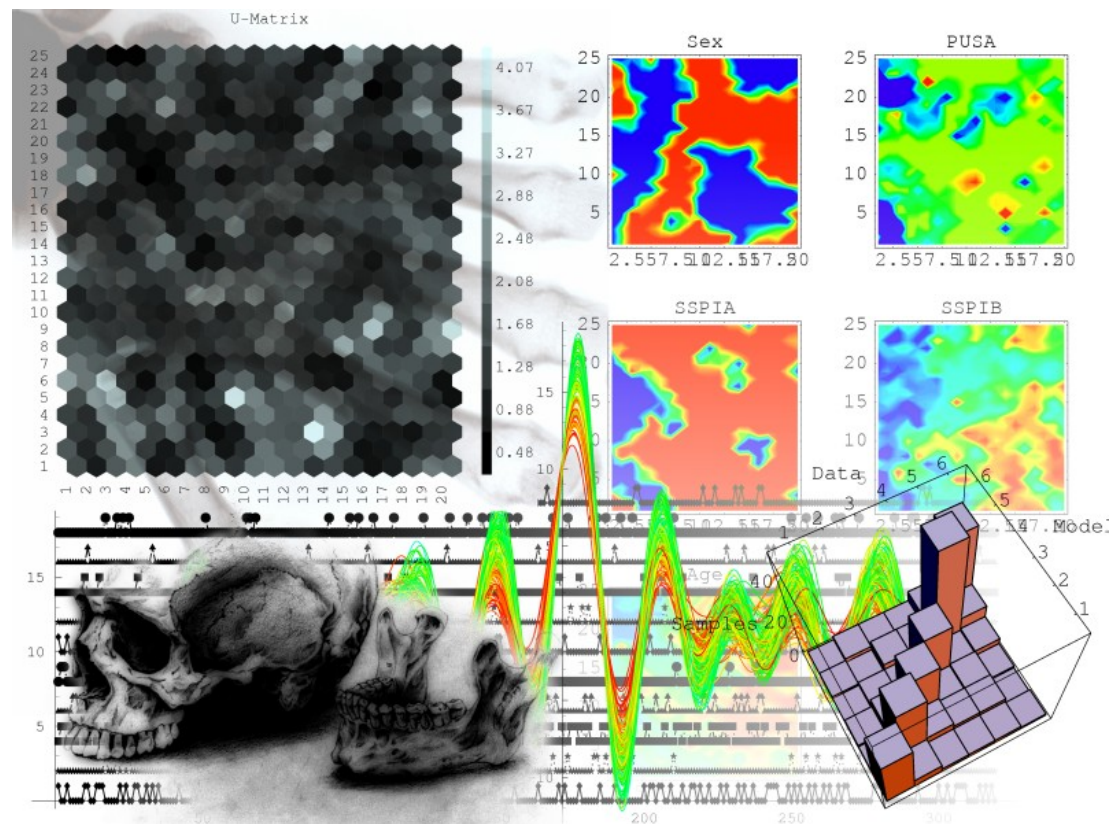
ShapeSOM (FEE CTU)

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



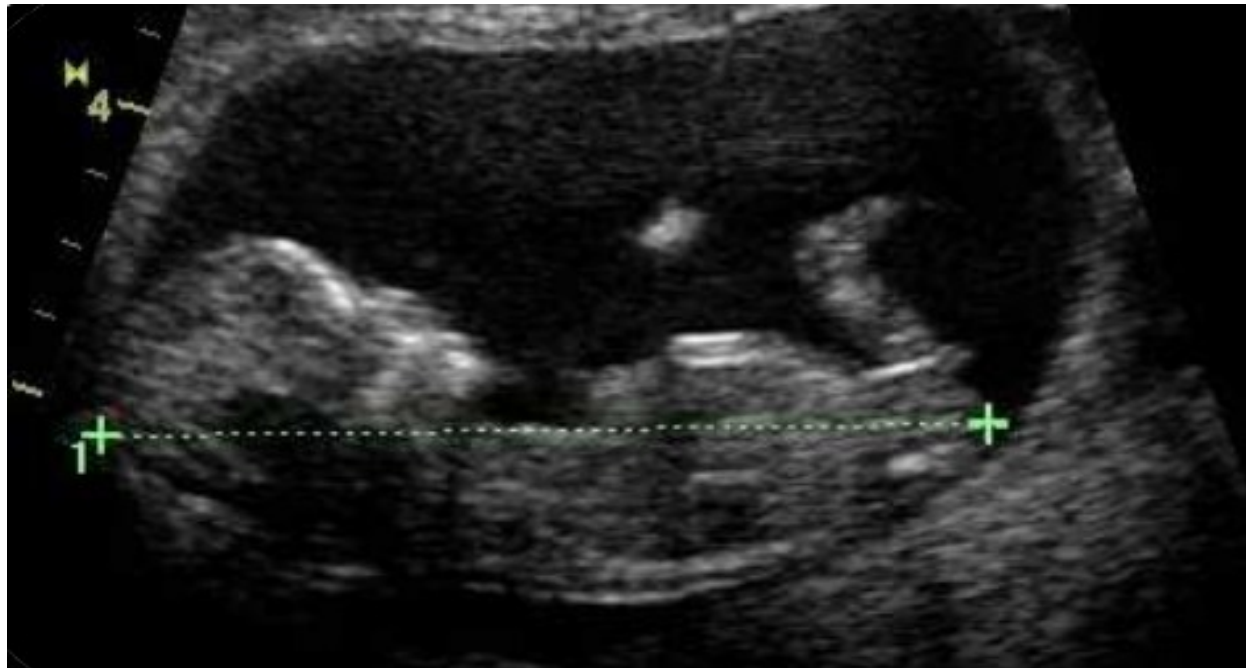
Bone Age Modelling (FEE CTU)

- 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.

