Modern Machine Learning

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TUT Research Profile in CS & EE

AI - applied

| Power Electronics and Smart Grids | Wireless Communications and Systems, 5G, Positioning | Data Processing, Signal Processing, Imaging, Analytics | Embedded Systems and Future Electronics | User Experience |

Pattern recognition

- Pattern recognition is rapidly growing field where signal processing has a critical role.

- The challenge is to distill the essential from large data masses.

- For example, the computer sees the signal as a vector/matrix of numbers, where individual entries do not matter.
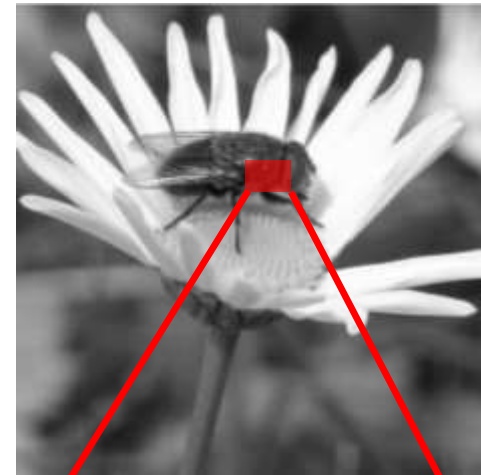

87	93	93	110	110	101	91	67	57	51	
60	60	72	84	87	75	69	58	52	50	
42	43	57	72	70	81	64	51	53	43	
61	50	49	51	56	117	97	66	56	47	
103	88	43	45	39	75	69	58	55	52	
76	69	45	39	37	38	39	43	46	53	
42	40	42	42	38	41	46	53	39	40	

What is a neural network?

- The NN processes data in layers
- The network is trained by presenting examples (for example characters)
- The network learns to distill the features essential to the task.

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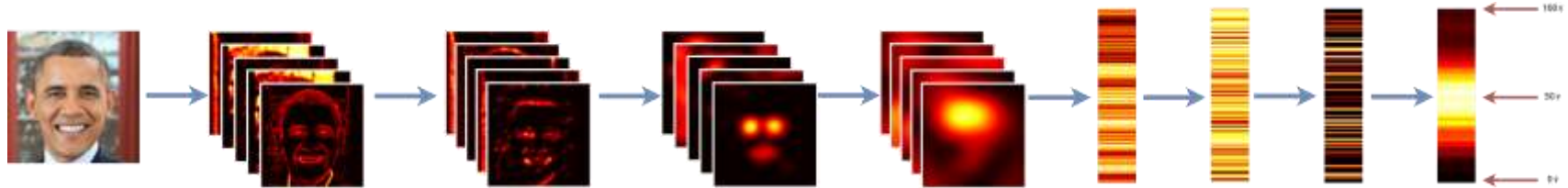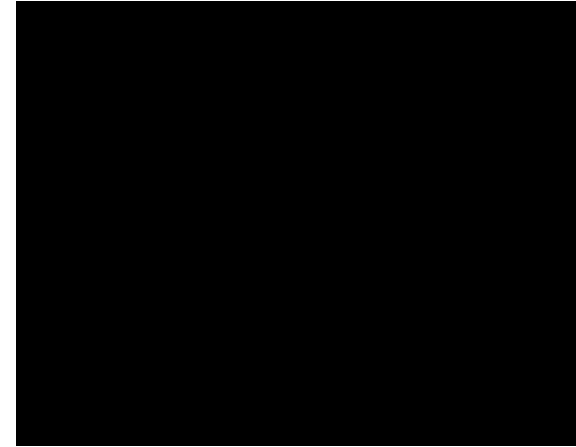
Example: License plate recognition

- License plate is a cost-efficient approach to access control.

- The system localizes the plate, and reads all symbols in it.

- The most challenging task is to find the plate and the symbols.

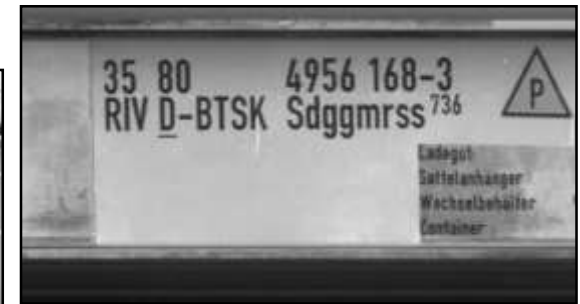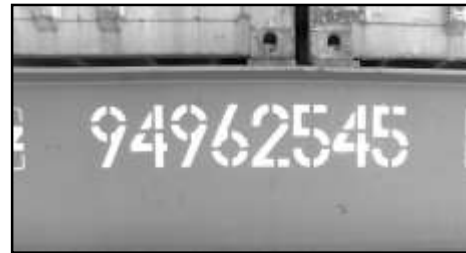- When the symbols are found, we classify them using a neural network

Kymmenistätuhansista autoista verot maksamatta – poliisin uusi laite käräytti 74 000 autoa

AUTO 8.12.2015 15.55 Päivitetty 8.12.2015 18.32

Jussi Sippola HELSINGIN SANOMAT

VESA RANTA

OCR Examples

- Some examples of what we can read today

- (but not 5 years ago)

What has changed in 20 years?

- In 1996:
  - Small images (10x10)
  - Few classes (< 50)
  - Small net (1-3 layers)
  - Few samples (< 50k)

- Today:
  - Large images(256x256)
  - Many classes (> 1k)
  - Deep net (> 100 layers)
  - Lots of samples (> 1m)

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Recent AI Highlights

Image synthesis

Image-to-Image Translation

CelebA-HQ
1024 × 1024

Generated images

Karras et al., "Progressive Growing of GANs for
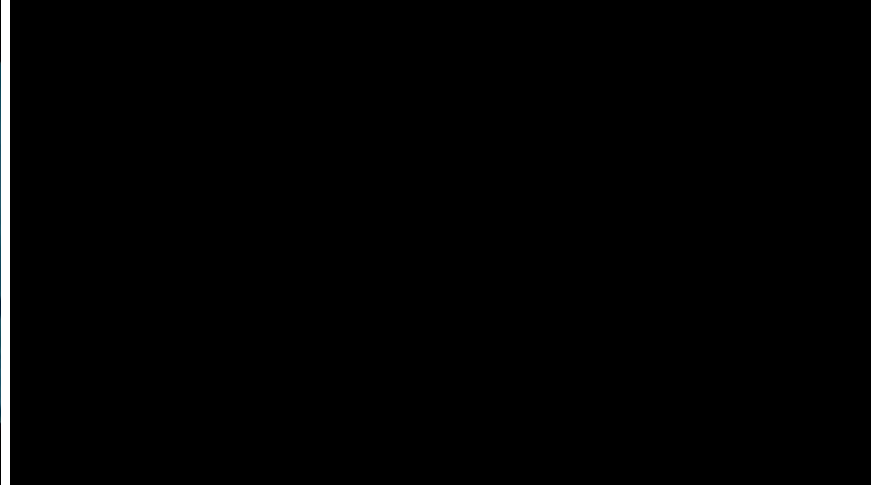Improved Quality, Stability, and Variation," *ICLR 2018*

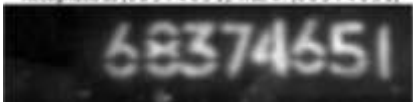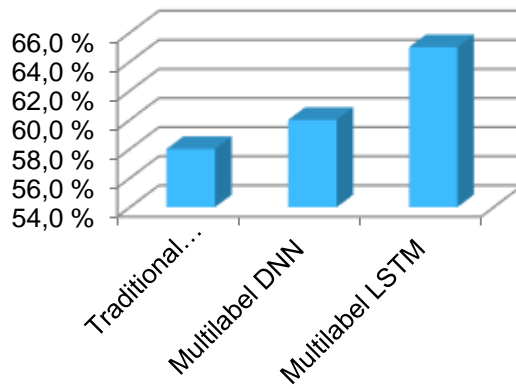Huang et al., "Multimodal Unsupervised Image-to-Image
Translation", 2018

DeepFakes

https://youtu.be/BU9YAHigNx8   https://youtu.be/cQ54GDm1eL0

Research at TUT

Images

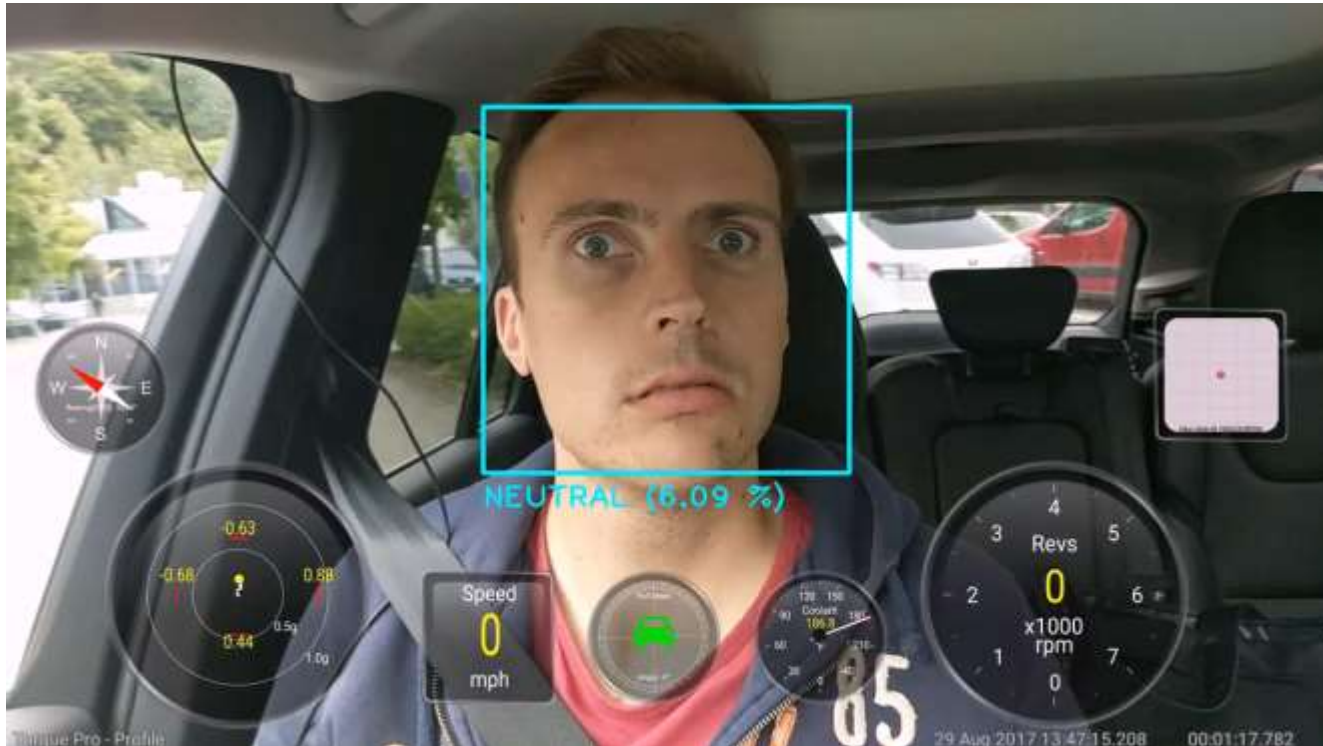TAMPERE UNIVERSITY OF TECHNOLOGY

Sound
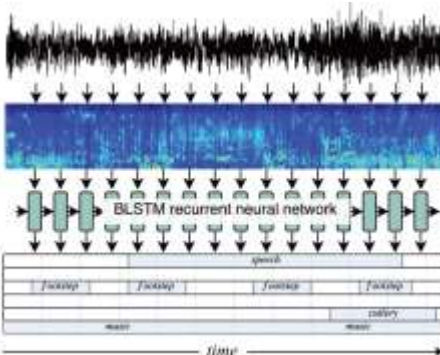
Text

Neural Net

Positive **Negative Neutral**

Smile Detection

Vehicle Tracking

- Low-cost solution for tracking vehicles throughout the entire facility

- Also check out www.citytrack.fi

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What can be achieved with huge resources

Achievements and Mission

- ICANN MEG Mind Reading Challenge, 2011: **Winner[1]**
- DREAM6 Molecular Classification of AML Challenge, 2011: **Best performer[2,3]**
- IEEE MLSP 2012 Amazon Data Science Challenge: **Second Place[4]**
- IEEE MLSP 2013 Birds Challenge: **Top 10%** [Kaggle]
- DecMeg2014 – Decoding the Human Brain: **2nd (of 269)** [Kaggle]
- Glaston Hackathon 2017: **Winner**

- **Mission:** Agile Applied Research for Customer Needs. Training Future Professionals.

[1]   H. Huttunen *et al.*, *Machine Vision and Applications*, pp. 1-15, November 2012.
[2]   N. Aghaeepour *et al.*, *Nature Methods*, February 2013.
[3]   T. Manninen *et al., PLOS ONE* 8(8). August 2013.
[4]   H. Huttunen *et al, Proc. IEEE MLSP2012*, Santander, Spain, September 2012.

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