SGN-13006 Introduction to Pattern Recognition and Machine Learning (5 cr)

Introduction

Joni-Kristian Kämäräinen

August 2018

Laboratory of Signal Processing
Tampere University of Technology

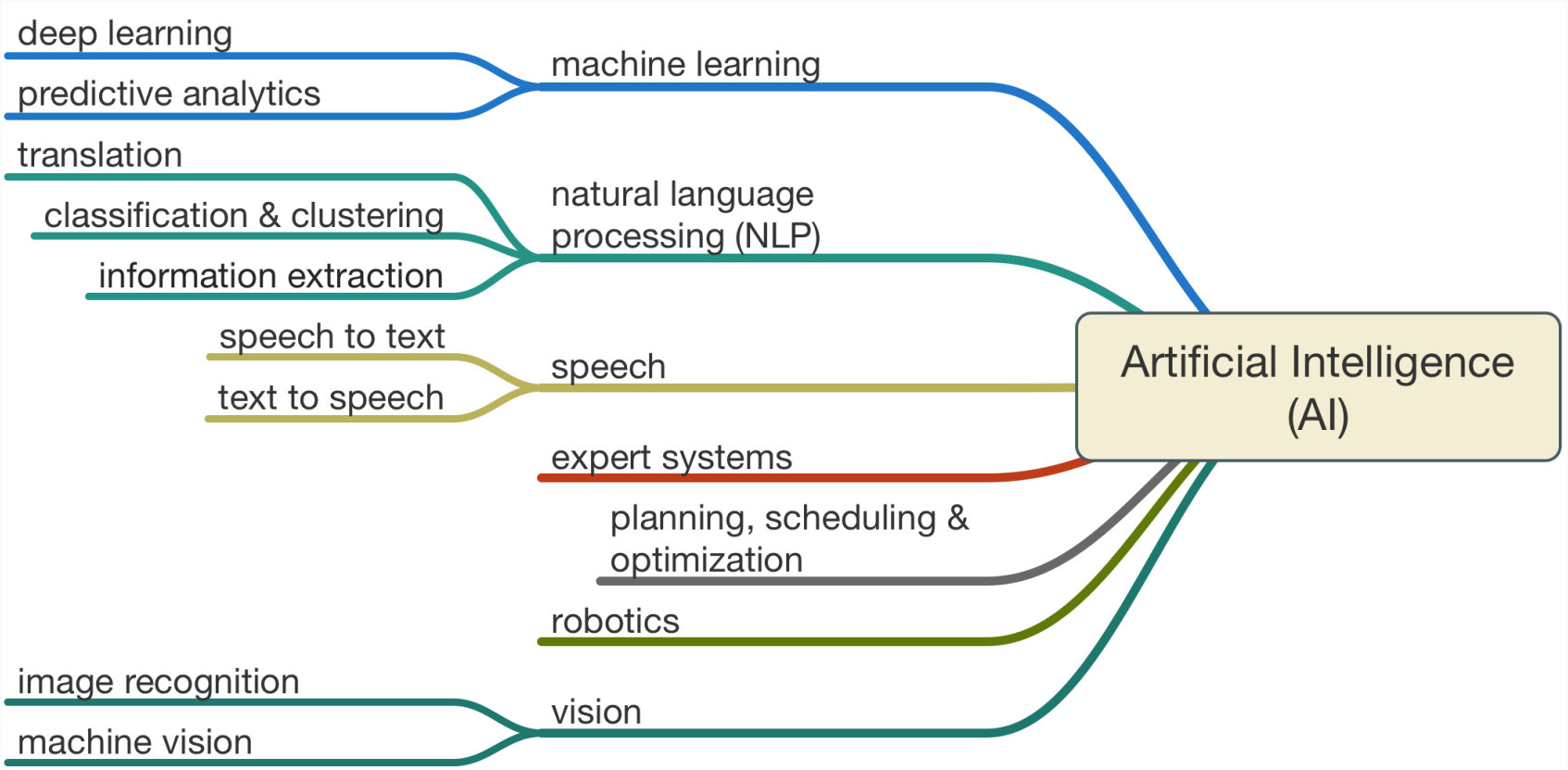
Contents

Introduction

Introduction

Where machine learning is needed?

A sub-field of artificial intelligence?



An application example: Apparent age estimation

Figure 1. Real / Apparent (age)

An application example: Apparent age estimation[1] (cont.)

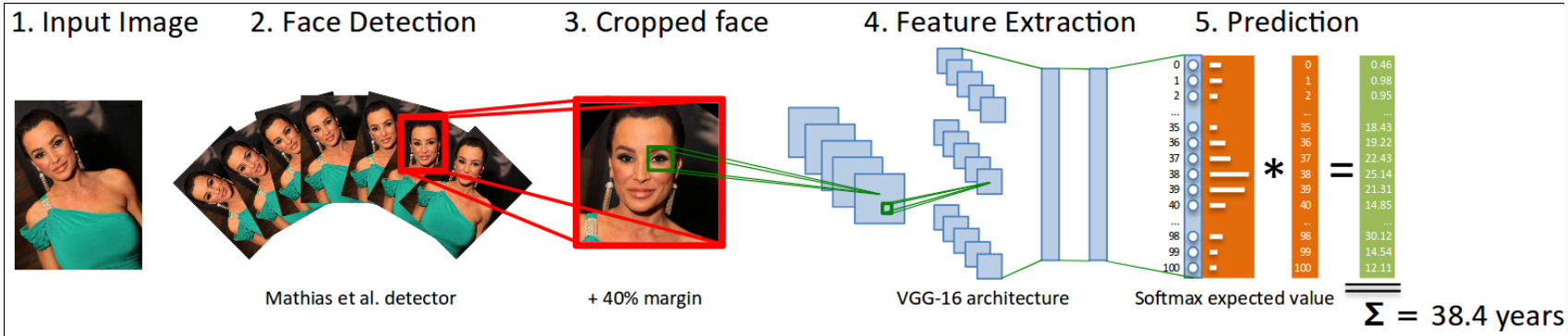


Figure 2. Pipeline of DEX method (with one CNN) for apparent age estimation.

[1] Rasmus Rothe, Radu Timofte, and Luc Van Gool. "Deep expectation of real and apparent age from a single image without facial landmarks". In: *International Journal of Computer Vision (IJCV)* (July 2016)

An application example: Apparent age estimation (cont.)

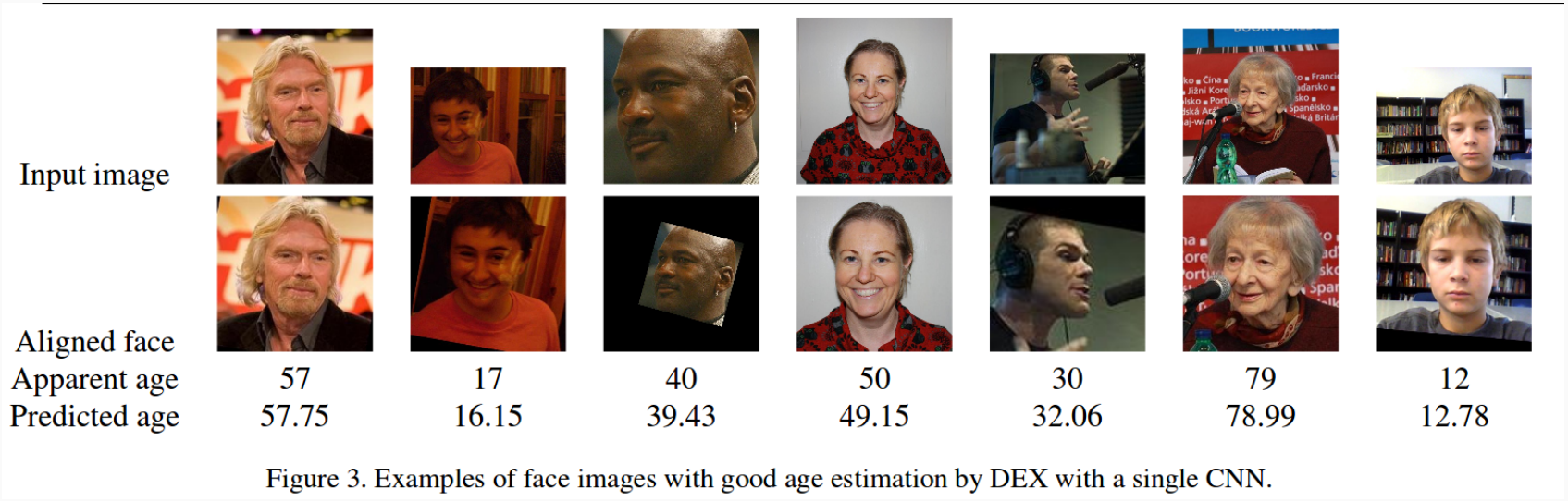


Figure 3. Examples of face images with good age estimation by DEX with a single CNN.

Machine learning is study of special algorithms

- You need to be a domain expert who knows how to use machine learning OR
- you need to be a machine learning expert who knows the domain BUT
- you anyway need to know how to program!

Introduction

Problem definition

What means machine learning or pattern recognition?

To scrutinise the otherwise too philosophical question about "what is learning" and "what is intelligence", we will use a definition that needs[2]:

1. Task (T) - what needs to be solved?
2. Performance measure (P) - how to measure success of a solution?
3. Experience (E) - how to acquire experience to improve (e.g. training data)?

[2] T.M. Mitchell. *Machine Learning*. McGraw-Hill, 1997

Introduction

Motivation

Must in the modern CS curriculum

Certain problems - such us autonomous cars and social robots - cannot be solved by traditional software engineering, but perhaps they can be by ML algorithms

The goal is that you will learn to sketch a machine learning based solution for a problem X and then measure how well it works

AI is the Holy Grail of computer science

- AI Robot which

AI is the Holy Grail of computer science

- AI Robot which
  - Learns similar to human (e.g. by watching, practising and discovering)

AI is the Holy Grail of computer science

- AI Robot which
  - Learns similar to human (e.g. by watching, practising and discovering)
  - Can replace or assist humans in almost any task

AI is the Holy Grail of computer science

- AI Robot which
  - Learns similar to human (e.g. by watching, practising and discovering)
  - Can replace or assist humans in almost any task
- Mechanical, electrical and computational elements are pretty much ready - core algorithms to establish true artificial intelligence (AI) are not

AI is the Holy Grail of computer science

- AI Robot which
  - Learns similar to human (e.g. by watching, practising and discovering)
  - Can replace or assist humans in almost any task
- Mechanical, electrical and computational elements are pretty much ready - core algorithms to establish true artificial intelligence (AI) are not

Example (Ultimate goal)

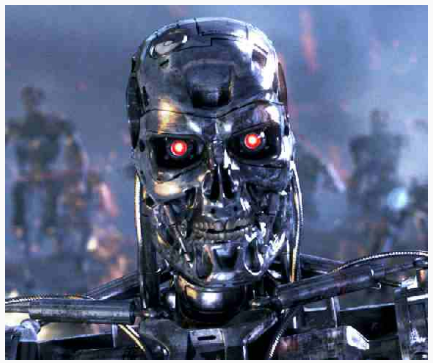


Figure 1: The ultimate goal (`www.collinder.com`) - t2-measure.avi

Introduction

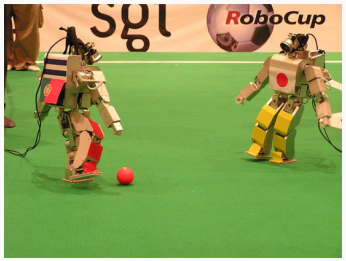
Examples of ML enabled technology

Machine learning in robotics

[3] Alessandro Giusti et al. "A Machine Learning Approach to Visual Perception of Forest Trails for Mobile Robots". In: *IEEE Robotics and Automation Letters* (2016)

Machine learning in robotics

Example (Robocup 2050)

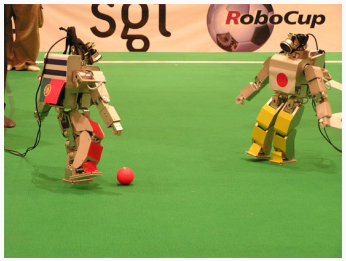


Video: RoboCup2017_final.mkv

[3] Alessandro Giusti et al. "A Machine Learning Approach to Visual Perception of Forest Trails for Mobile Robots". In: *IEEE Robotics and Automation Letters* (2016)

Machine learning in robotics

Example (Robocup 2050)



Video: RoboCup2017_final.mkv

Example (Learn to follow forest tracks[3])

Video: Quadcopter_Navigation_in_Forest_using_DCNN.webm

[3] Alessandro Giusti et al. "A Machine Learning Approach to Visual Perception of Forest Trails for Mobile Robots". In: *IEEE Robotics and Automation Letters* (2016)

Machine learning in robotics (cont.)

[4] L. Pinto and A. Gupta. "Supersizing self-supervision: Learning to grasp from 50K tries and 700 robot hours". In: *Int. Conf. on Robotics and Automation (ICRA)*. 2016

Machine learning in robotics (cont.)

Example (Urban challenge - Cars without drivers)

Video1: Self_Driving_GrandChallenge.avi Video2:

Junsheng_autonomous_driving_in_game.mp4 Video3:

Junsheng_lane_detection_CNN.mp4

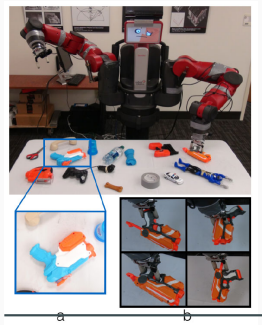
[4] L. Pinto and A. Gupta. "Supersizing self-supervision: Learning to grasp from 50K tries and 700 robot hours". In: *Int. Conf. on Robotics and Automation (ICRA)*. 2016

Machine learning in robotics (cont.)

Example (Urban challenge - Cars without drivers)

Video1: Self_Driving_GrandChallenge.avi Video2: Junsheng_autonomous_driving_in_game.mp4 Video3: Junsheng_lane_detection_CNN.mp4

Example (Learning to Grasp[4])



Video: Supersizing_Self-supervision-Learning_to_grasp.mp4

[4] L. Pinto and A. Gupta. "Supersizing self-supervision: Learning to grasp from 50K tries and 700 robot hours". In: *Int. Conf. on Robotics and Automation (ICRA)*. 2016

Machine learning and computer vision

Machine learning and computer vision

Example (Computer vision grand challenge: ImageNet)

URL: `http://www.image-net.org/`

Machine learning and computer vision

Example (Computer vision grand challenge: ImageNet)

IMAGENET

URL: `http://www.image-net.org/`

Example (RGB+D sensors: Kinect)

Video: 144455_project_natal.mp4

Machine learning and computer vision

Example (Computer vision grand challenge: ImageNet)

IMAGENET

URL: `http://www.image-net.org/`

Example (RGB+D sensors: Kinect)

Video: 144455_project_natal.mp4

Example (Real-Time Object Detection)

Video: YOLO_Watches_Nature_Part2.mkv

Light and Magic

Light and Magic

Example (2D to 3D conversion)

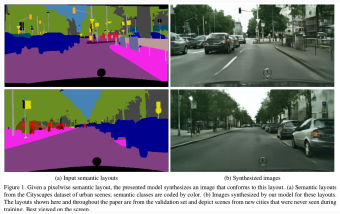
URL: `https://github.com/piiswrong/deep3d`

Light and Magic

Example (2D to 3D conversion)

URL: `https://github.com/piiswrong/deep3d`

Example (Photorealistic Image Synthesis)



(a) Input semantic layouts (b) Synthesized images

Figure 1. Given a pixelwise semantic layout, the presented model synthesizes an image that conforms to this layout. (a) Semantic layouts from the Cityscapes dataset of urban scenes; semantic classes are coded by color. (b) Images synthesized by our model for these layouts. The layouts shown here and throughout the paper are from the validation set and depict scenes from new cities that were never seen during training. Best viewed on the screen.

Video: iccv2017_image_synthesis.mp4

Your idea?

Summary

Summary

Summary

1. Definition of pattern recognition / machine learning

Summary

1. Definition of pattern recognition / machine learning
2. The scientific importance of the topic

Summary

1. Definition of pattern recognition / machine learning
2. The scientific importance of the topic
3. The practical (engineering) importance of the topic - application examples