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of Applied Sciences

InIT Institute of Applied Information Technology
Human Information Interaction
ICT Accessibility Lab

PROJECT: AUTOMATIC TRANSLATION FROM SIGN LANGUAGE

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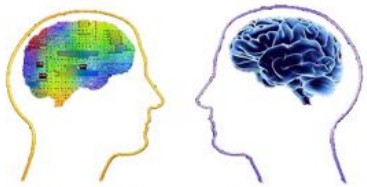
Conference Barrier-free Communication: Methods and Products

ZHAW Event, 14th September 2017



Overview

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- **Introduction** Motivation, Problem Definition
- **State of Art** Research, Practicality
- **Analysis** Demo, Results
- **Conclusion** Application Area, Technical Progress

Motivation

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- **Project Idea**
  - Relief for deaf and hard of hearing by automatic translation from sign language to text or audio
  - Evaluation project in 2013 with helping and usage of the available and different sensors for recognition of gestures
- **Proposals**
  - Useful as complement to barrier-free communication in sign language
  - Usage of modern technologies and research methods for the development of communication platform for people with hearing impairment
  - Innovative approaches for image processing, machine learning and deep learning

Problem Definition

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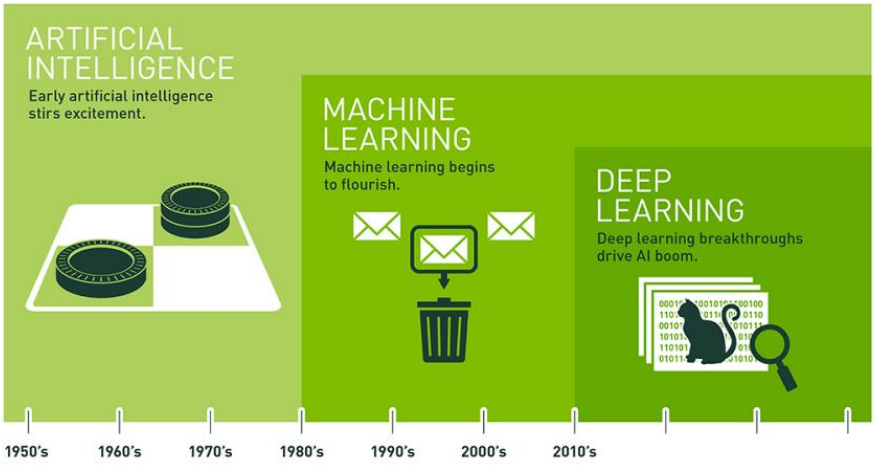
What is Sign Language?

- Body position = Association of Hands + Arms + Torso + Mimic
- Gestures mean language expression for thinking in flow images as movie or flip book, not primitive single image
- Visually perception by associative production of body position in three-dimensional space, that is some composited informations can reflect at once
- In contrast spoken language is a linear, sequential production of words by voice, hence notion for one-dimensional space
- Therefore this own grammatical structure in 3D and totally different to spoken language
- Sight contact always essential, otherwise break in communication

Research

What is State of the Art?

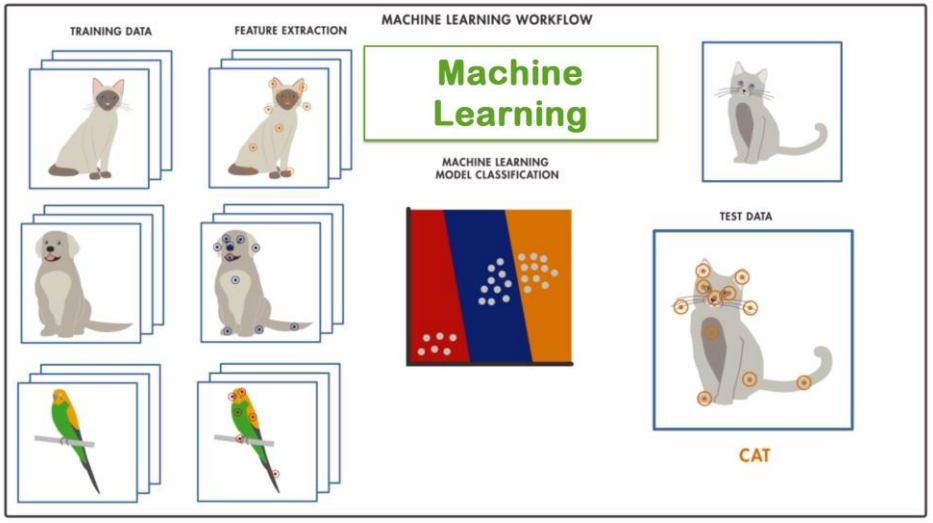


- **Artificial Intelligence**
  - IBM Deep Blue defeated world chess champion
  - Was an important fundament for development
- **Machine Learning**
  - Is always still current used and well established
  - Is considered as transition to Deep Learning
  - Uses different efficient algorithms for example as Adaptive Boosting and Random Forests
- **Deep Learning**
  - Is at present and has trend towards Big Data, Smart Data, Data Science etc.
  - Is a specialized form of Machine Learning
  - Uses different kind of neural networks such as Convolutional Neural Network

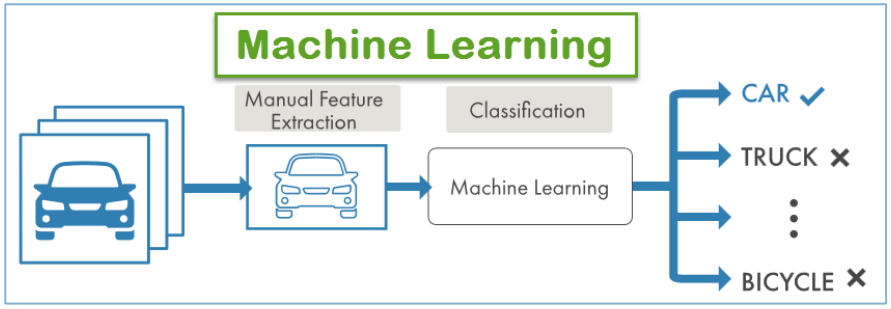
Research

Machine Learning (ML)

- Look at a cat, a dog or a parrot
- Learning for many images of animals as object to identify them over time
- Three objects are divided into classes as error free as possible
- Each object has relevant features of image as edges, corners, pointed ears, tails etc.



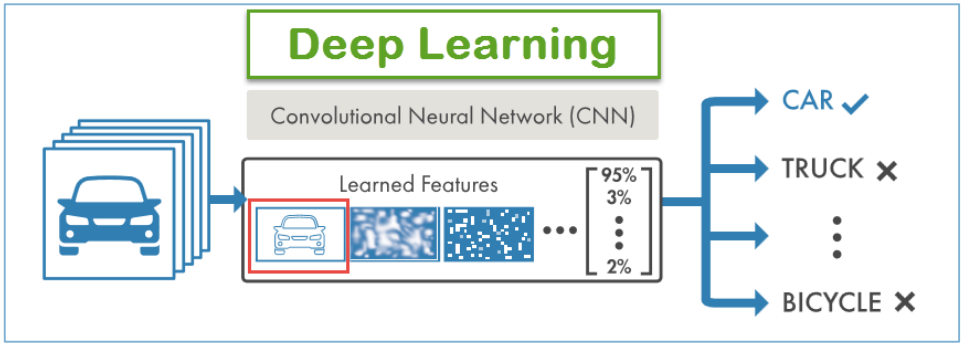
- ML requires manual feature extraction from images
- Features are used to create a model that categorizes the objects in the image



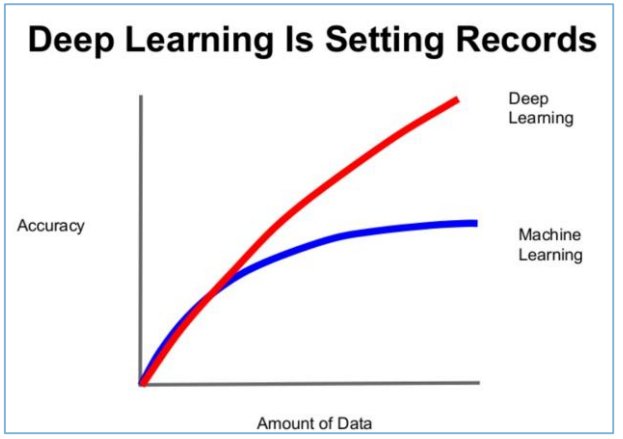
Research

Deep Learning (DL)

- Is generally more complex
  to get reliable results
- Eliminate manual feature extraction
- Can automatically and directly learn
  relevant features in data
- Performs «end-to-end-learning» in principle



- Key advantage of DL
  - Continue often to improve the accuracy
    as the amount of data increases



Practicality

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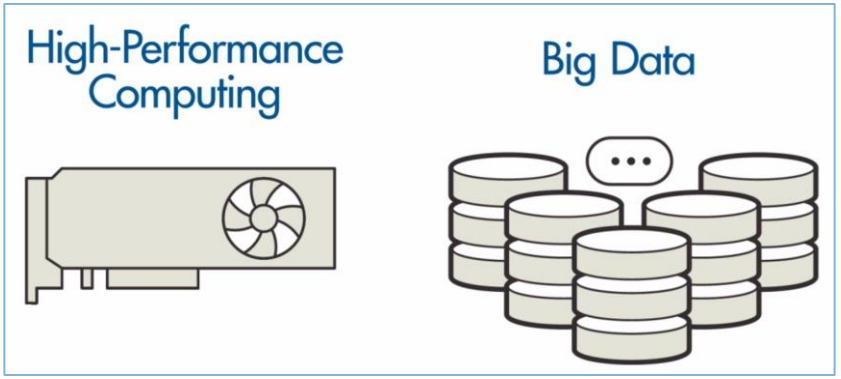
Comparison of Machine and Deep Learnings

- Conditions for decision between ML and DL
- **Pro ML**
  - Is suitable especially for a small amount of data to train
  - Can achieve a short training time
  - Is enough to use an efficient CPU
  - Is possible to define own features
- **Pro DL**
  - Requires a very large amount of data (thousands of images) to train
  - Needs a long training time
  - Needs less time to analyze all images
  - Requires a high-performance GPU to rapidly process image data



	Machine Learning	Deep Learning
Training dataset	Small	Large
Choose your own features	Yes	No
# of classifiers available	Many	Few
Training time	Short	Long

Analysis

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Which Methods?

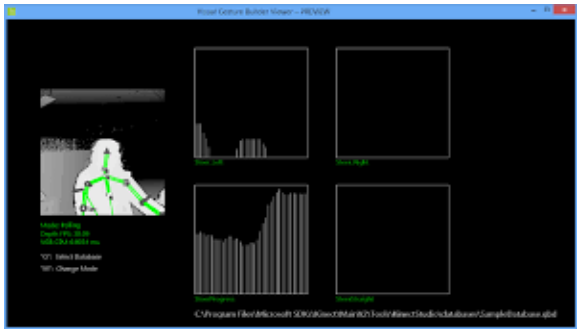
- Current usage of Kinect cam with 3D depth-sensor from Microsoft
- Current usage of tool Visual Gesture Builder (VGB) from Microsoft
  - Integral part of algorithms such AdaBoost and Random Forest
- Reasons for image processing algorithms with VGB
  - Minimum effort for record clips, tagged clips, without programming, non-engineering task etc.

Which Gestures for training data?

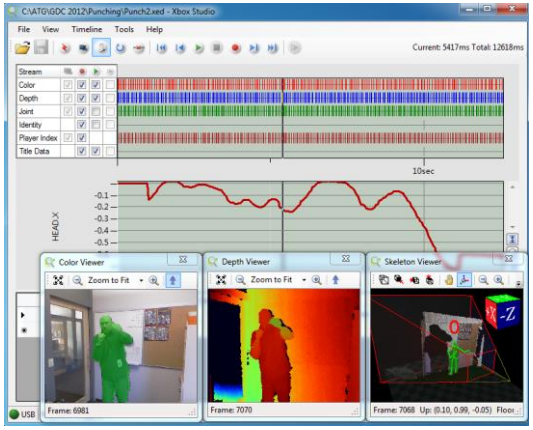
- Base idea for three different meaning of gestures
- But these motions relatively similar at first sight for example as Car, Thursday and Milk

Demo

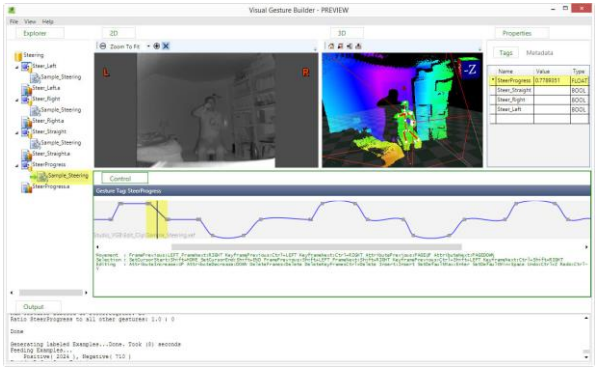
Data-driven process of creating a gesture detector using VGB



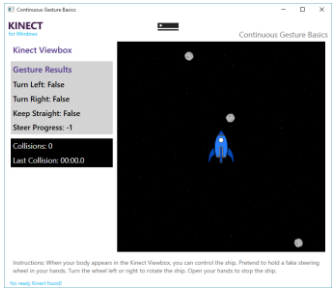
Preview gestures with VGBView



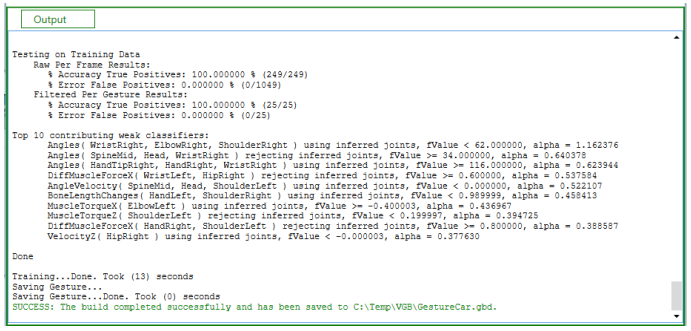
Record gestures using Kinect Studio



Tag and analyze gestures using VGB



Detect gestures in application



Build gestures using VGB to output

Demo

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How Gesture Recognition for Testing Data?

- Needs at least programming for own application and is an engineering task
- Therefore a good direct comparison between Steering and Car as gesture

Steering	Car
Actions	Detections
3 discrete states: *SteerLeft, SteerRight, KeepStraight*	2 discrete states: *CarHandUpLeft, CarHandUpRight*
1 continuous state: *SteerProgress*	no
• Actions by discrete states for change of direction • Action by continuous state for change of angle as more or less rotation	• Detections for start state and end state • Additional number of sequence: repeated twice
Used both AdaBoost and Random Forest	Used only AdaBoost

Demo

Gesture detection in application

- Correct display of a gesture data set of test examples
- Following illustration shows gestures for Car, Thursday and Milk

Results

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Result of Gesture Recognition

- Each gesture data contains nearly 5 similar clips by the same person
- Evaluation for results is subjective because training data is too little at the moment
- Accuracy
  - Mostly True Positives successful deteced (without specification of perecentage)
  - Rare False Positives detected
- Latency
  - Relatively very little to none, but speed of movement of gesture should be fair

Difficulties

- Examples for gestures as Ship and Plow are nearly identical because hand detection has only simple hand position as open, close and lasso
- Problem with triggering of lower confidence value at change of discrete state from false to true in the tagging frames

Conclusion

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Takeaways

- Use Visual Gesture Builder
  - Results speak for themselves: rapidly productivity with tagging data and non-engineering task
- Invest in quality assurance for tagging gesture data
  - Tagging plays an important role in good results and increased accuracy
- Improve Accuracy by
  - Using enough positive and negative training examples
  - Of a wide variety of different signing persons

Application Area

- Study course for Applied Linguistics in the Institute for Translation and Interpreting
- Knownledge transfer to research and teaching in the Institute for Information Technology

Technical Progress

- Possible usage of prototype with approach to Deep Learning
  - Better performance for complex grammatically structure of sign language

Questions

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