

What is Machine Learning and what can it be used for

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What is Machine Learning?

Google search results for "machine learning". The search bar shows "machine learning" and the results indicate "About 859,000,000 results (0.45 seconds)".

Machine Learning | Key Ingredients For Success | cognizant.com
www.cognizant.com/AI
 Only 15% of companies have successfully implemented an AI project. Surprising? Start your journey towards responsible AI applications by downloading our report today! Make An Inquiry. Highlights: We Support Lifelong Learning Around The World, Mobile App Available. Download Report · About Us · Industries Served · Services Offered

Machine learning - Wikipedia
https://en.wikipedia.org/wiki/Machine_learning
 Machine learning (ML) is the scientific study of algorithms and statistical models that computer systems use to effectively perform a specific task without using ...
 Timeline of machine learning · Machine learning · Machine Learning (journal)
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- Machine Learning for March Madness Is a Competition In Itself**
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Machine Learning | Coursera
<https://www.coursera.org/learn/machine-learning>
 Learn Machine Learning from Stanford University. Machine learning is the science of getting computers to act without being explicitly programmed. In the past ...
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Machine learning
 Field of study

Machine learning is the scientific study of algorithms and statistical models that computer systems use to effectively perform a specific task without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of artificial intelligence. [Wikipedia](#)

People also search for

- Artificial intelligence
- Natural language processing
- Algorithm
- Learning
- Internet of things

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See results about

Deep learning
 Deep learning is part of a broader family of machine learning methods based on learning data ...

Machine Learning is the scientific study of algorithms and statistical models that computer systems use to **effectively perform a specific task without using explicit instructions**, relying on *patterns* and *inference* instead. It is seen as a subset of **Artificial Intelligence**.

What is Artificial Intelligence?

The screenshot shows a Google search for 'Artificial intelligence'. The search bar at the top contains the text 'Artificial intelligence'. Below the search bar, the results are displayed. A red box highlights the search results count: 'About 399,000,000 results (0,41 seconds)'. Below this, there are two main result snippets. The first snippet is from 'futureoflife.org' and describes Artificial intelligence (AI) as an area of computer science that emphasizes the creation of intelligent machines that work and react like humans. It lists activities like speech recognition and learning. The second snippet is from 'Techopedia' and provides a definition of Artificial Intelligence (AI) as a field of study. Below these snippets, there is a 'People also ask' section with four questions: 'What is artificial intelligence with example?', 'What is artificial intelligence and how it works?', 'What is the difference between machine learning and artificial intelligence?', and 'What is AI stand for?'. At the bottom, there are two more links: 'Artificial intelligence - Wikipedia' and 'Benefits & Risks of Artificial Intelligence - Future of Life Institute'.

Google Artificial intelligence

All Images Videos News Books More Settings Tools

About 399,000,000 results (0,41 seconds)

Artificial intelligence (AI) is an area of computer science that emphasizes the creation of **intelligent** machines that work and react like humans. Some of the activities computers with **artificial intelligence** are designed for include: Speech recognition. Learning.

What is Artificial Intelligence (AI)? - Definition from Techopedia
<https://www.techopedia.com/definition/190/artificial-intelligence-ai>

About this result Feedback

People also ask

- What is artificial intelligence with example?
- What is artificial intelligence and how it works?
- What is the difference between machine learning and artificial intelligence?
- What is AI stand for?

Artificial intelligence - Wikipedia
https://en.wikipedia.org/wiki/Artificial_intelligence
In computer science, artificial intelligence (AI), sometimes called machine intelligence, is intelligence demonstrated by machines, in contrast to the natural ...
History of artificial intelligence · Artificial intelligence in gove... · Social intelligence

Benefits & Risks of Artificial Intelligence - Future of Life Institute
<https://futureoflife.org/background/benefits-risks-of-artificial-intelligence/>
Why do we need research to ensure that artificial intelligence remains safe and beneficial? What are the benefits and risks of artificial intelligence?

What is Artificial Intelligence (AI)? - Definition from Techopedia
<https://www.techopedia.com/definition/190/artificial-intelligence-ai>
Artificial intelligence (AI) is an area of computer science that emphasizes the creation of intelligent machines that work and react like humans. Some of the activities computers with artificial intelligence are designed for include: Speech recognition. Learning.

In computer science, Artificial Intelligence, sometimes called Machine Intelligence, is **intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans and other animals.**

Machine Learning is the field of science and engineering studying the process of making machines intelligent.

Impact of ML and AI in industry

Trends set to positively impact business growth up to 2022

Increasing adoption of new technology

Increasing availability of big data

Advances in mobile internet

Advances in artificial intelligence

Advances in cloud technology

Shifts in national economic growth

Expansion of affluence in developing economies

Expansion of education

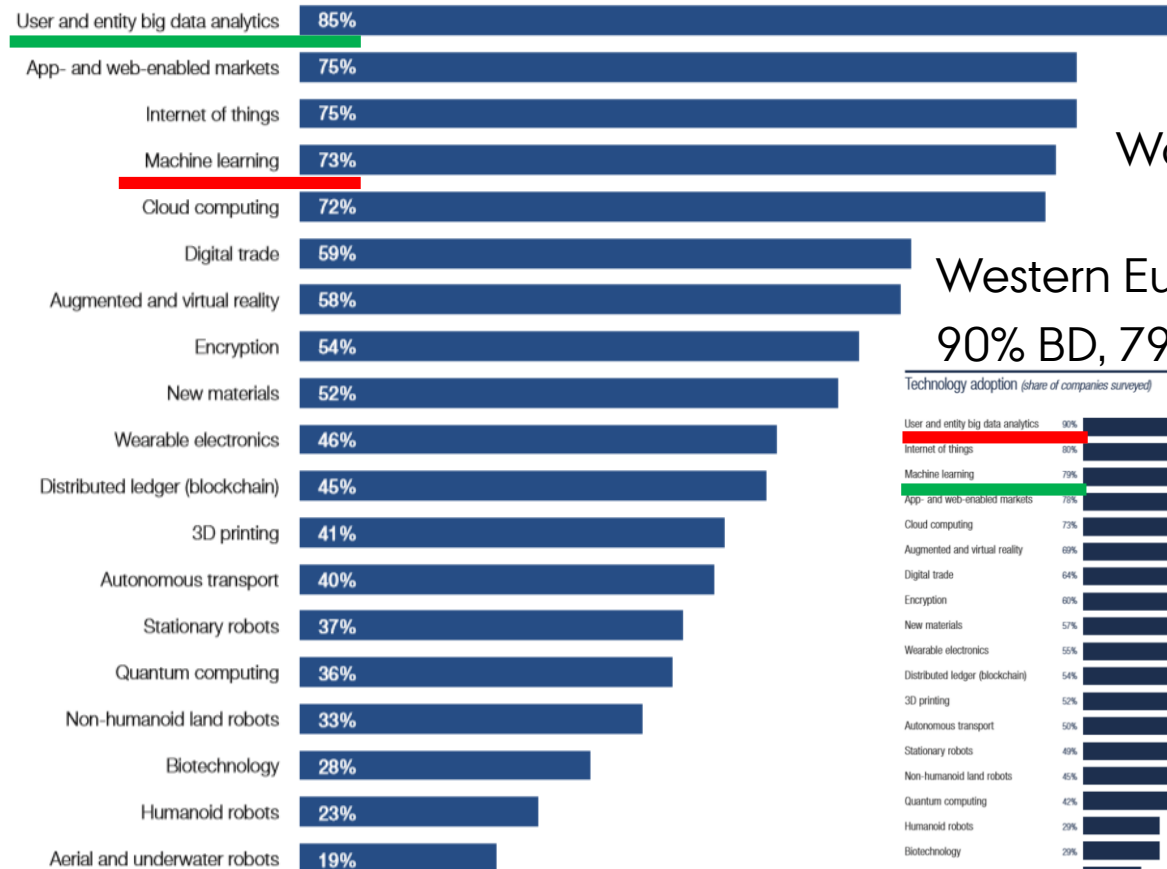
Advances in new energy supplies and technologies

Expansion of the middle classes

Source: Future of Jobs Survey 2018, World Economic Forum.

Impact of ML and AI in industry

Figure 2: Technologies by proportion of companies likely to adopt them by 2022 (projected)

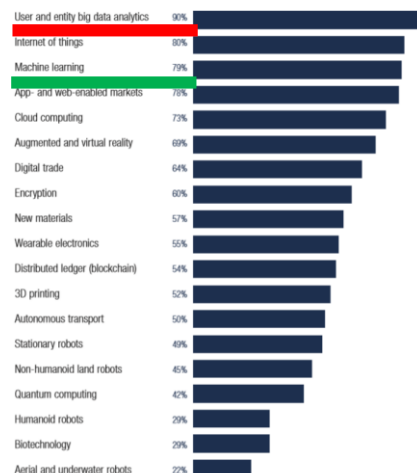


World-wide: 85% BD, 75% ML

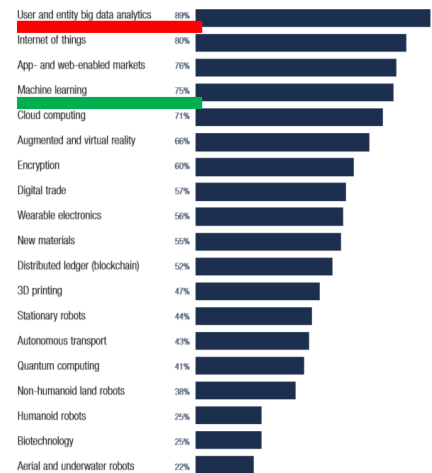
Western Europe:
90% BD, 79% ML

USA:
89% BD, 75% ML

Technology adoption (share of companies surveyed)



Technology adoption (share of companies surveyed)

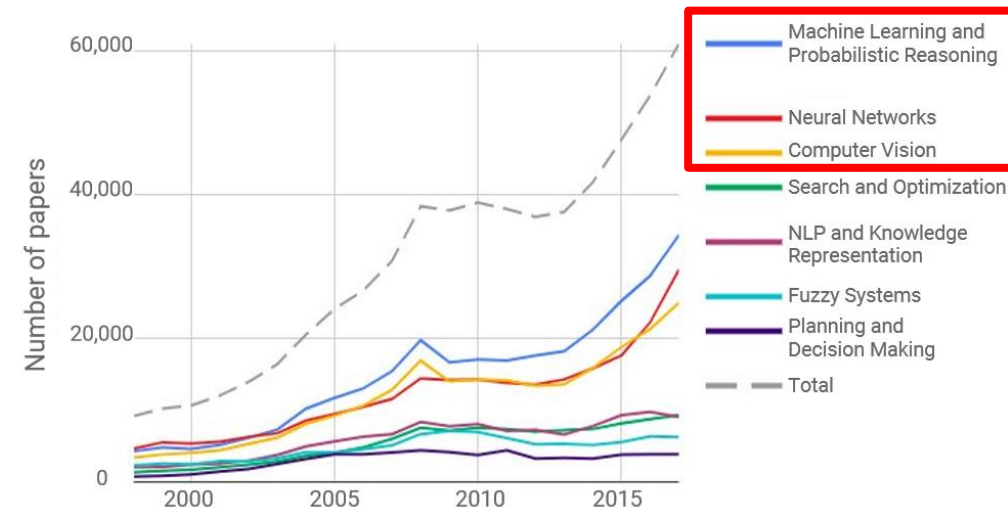


Attracting more researchers to work on ML & AI

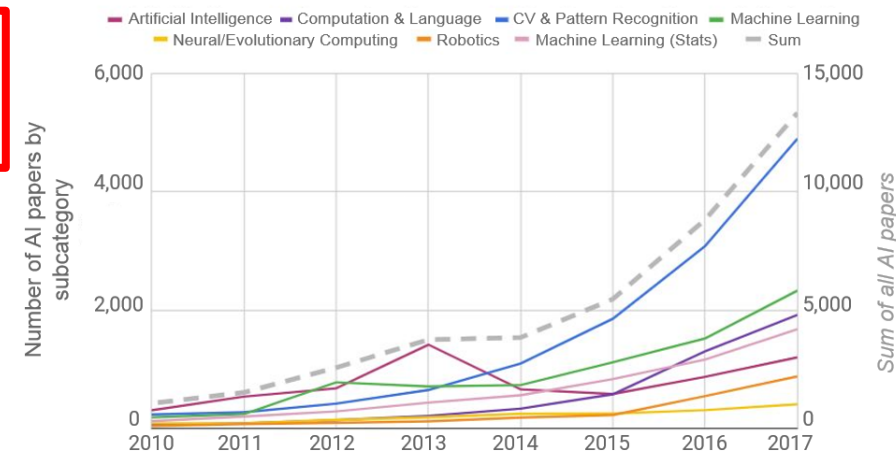
New research results

- › Exponential growth of papers focusing on and using ML, its subfields and connected topics

Number of AI papers on Scopus by subcategory (1998–2017)
Source: Elsevier



Number of AI papers on arXiv by subcategory (2010–2017)
Source: arXiv

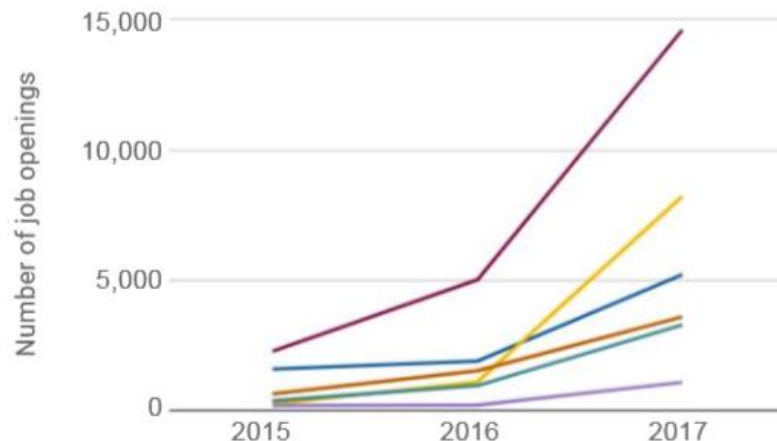


Need for more ML & AI scientists-engineers

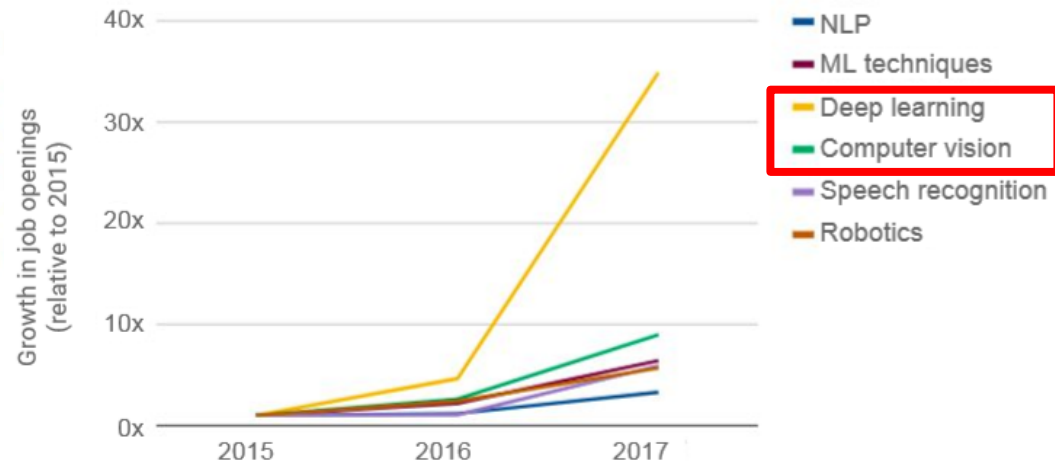
Job openings for AI scientists/engineers

- › Machine Learning is an essential skill
- › Deep Learning is the most active topic

Job openings by AI skills required (2015 – 2017)
Source: Monster.com



Growth of job openings by AI skills required (2015 – 2017)
Source: Monster.com



The current Machine Learning paradigm

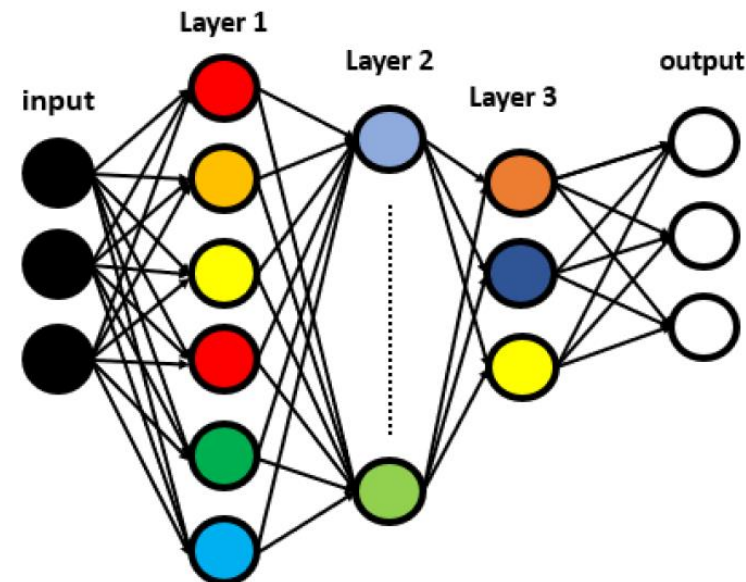
Deep Learning

- Machine Learning architectures which are formed by **multiple hierarchical transformation/mapping levels**, the parameters of which are **jointly optimized to achieve a goal** expressed in the form of an optimization function **defined on the training data** (and usually annotations of it)
- During the last seven years, they have achieved impressive performance in a wide range of applications.

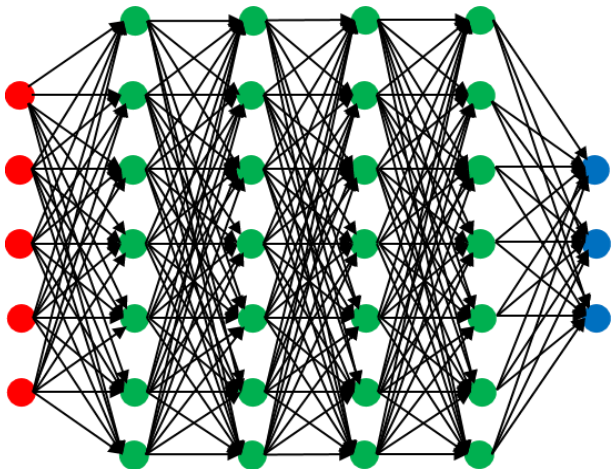
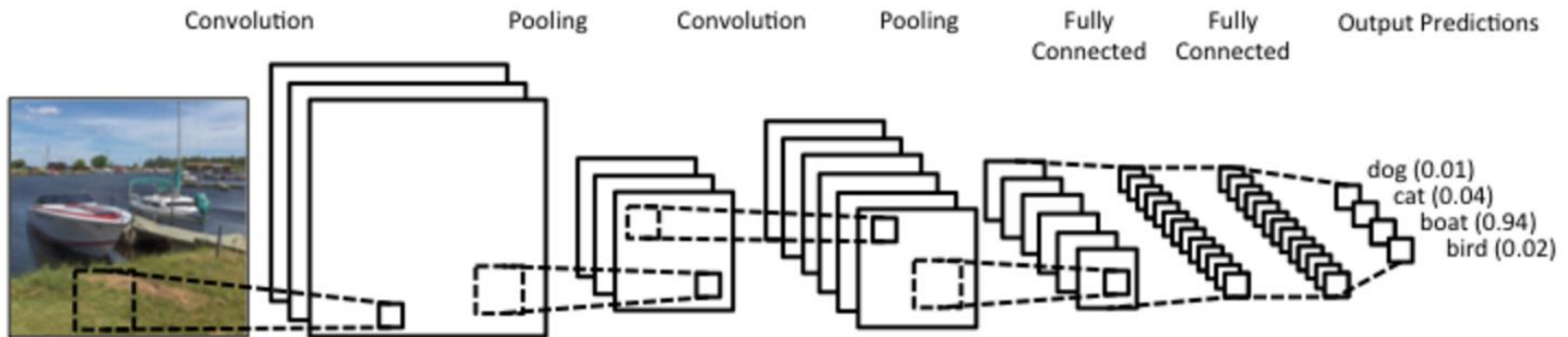
What DL model to use? Many decisions to make:

- Topology, type of neurons, optimization tricks, etc.

Some design patterns become standard, but not necessarily optimal for a new problem



Deep Learning



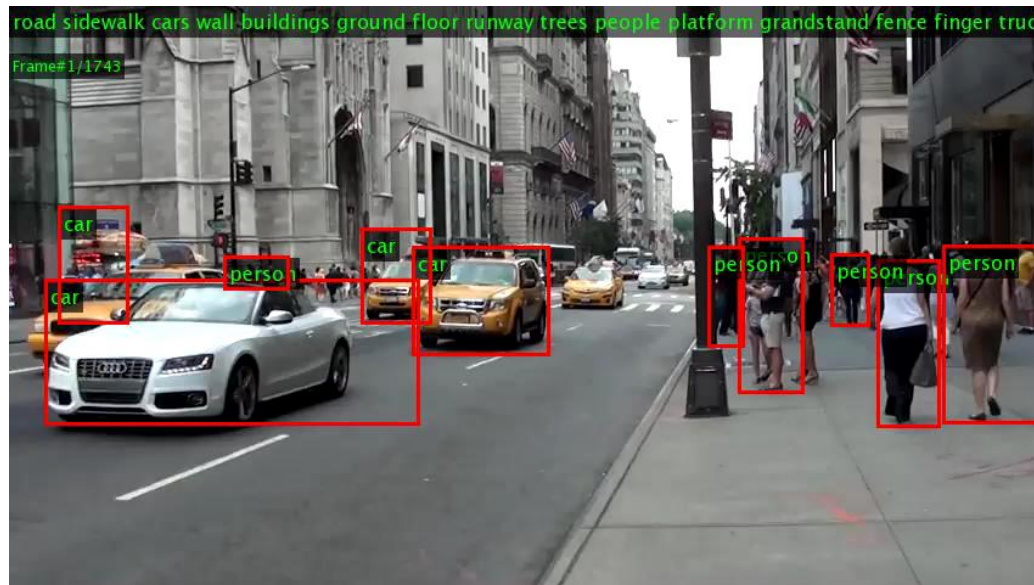
Automatic learning of data representations of increased level of abstraction at different layers of the Deep Learning model.

Let the DL model define which is the information needed for achieving the best performance on the specific task.

Applications of ML/DL

Problems which attracted public attention:

- › General scene and object detection/recognition



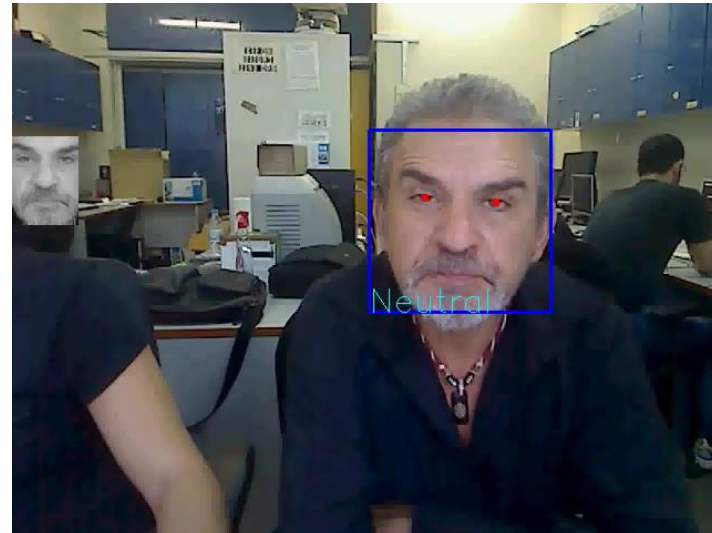
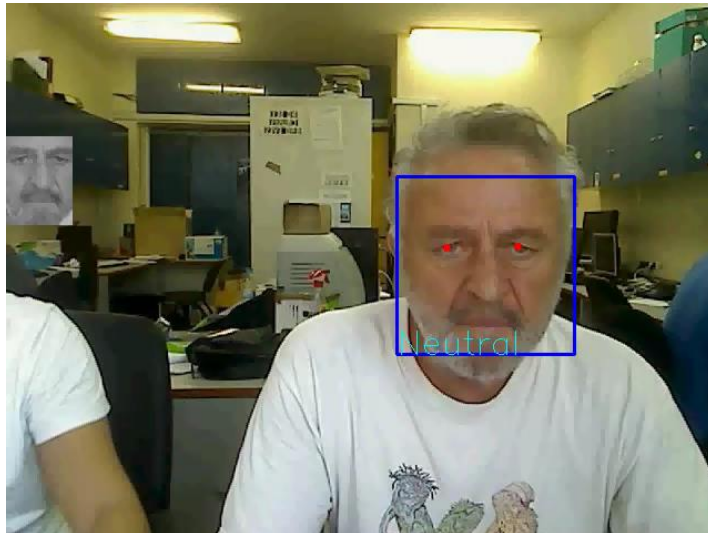
NSF-CVDI 2015

Applications of ML/DL

Problems which didn't receive much public attention yet:

- › Face analysis

MOBISERV FP7



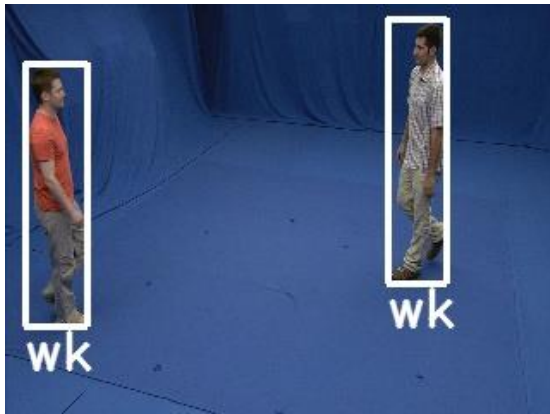
- A. Iosifidis and M. Gabbouj, "Class-Specific Kernel Discriminant Analysis revisited: further analysis and extensions", IEEE Transactions on Cybernetics, 2017
- A. Iosifidis and M. Gabbouj, "Scaling up Class-Specific Kernel Discriminant Analysis for large-scale Face Verification", IEEE Transactions on Information Forensics and Security, 2016
- A. Iosifidis, A. Tefas and I. Pitas, "Class-specific Reference Discriminant Analysis with application in Human Behavior Analysis", IEEE Transactions on Human-Machine Systems, 2015

Applications of ML/DL

Problems which didn't receive much public attention yet:

- › Face analysis
- › Action recognition

MOBISERV FP7



F. Patrona, A. Iosifidis, A. Tefas, N. Nikolaidis and I. Pitas, "Visual Voice Activity Detection in the Wild", IEEE Transactions on Multimedia, 2016

A. Iosifidis, A. Tefas and I. Pitas, "Distance-based Human Action Recognition using optimized class representations", Neurocomputing, 2015

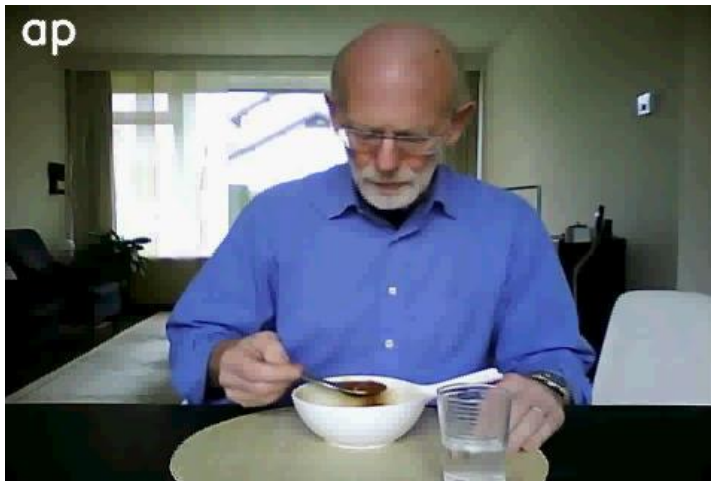
A. Iosifidis, A. Tefas and I. Pitas, "View-invariant action recognition based on Artificial Neural Networks", IEEE Transactions on Neural Networks and Learning Systems, 2012

Applications of ML/DL

Problems which didn't receive much public attention yet:

- › Face analysis
- › Action recognition
- › Action recognition in smart home environments

MOBISERV FP7



A. Iosifidis, E. Marami, A. Tefas, I. Pitas and K. Lyroutdia, "The MOBISERV-AIIA Eating and Drinking multi-view database for vision-based assisted living", J-IHMSP, 2015.

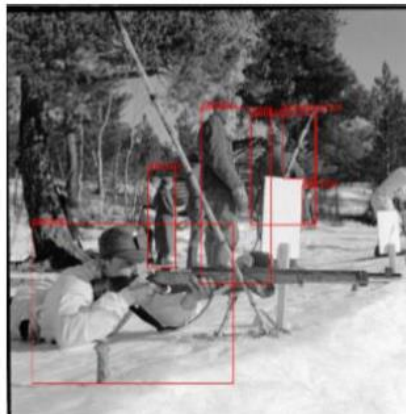
Applications of ML/DL

Problems which didn't receive much public attention yet:

- › Face analysis
- › Action recognition
- › Historic visual data analysis



(a) A close-up photo



(b) A mid-range photo



(c) An overview photo

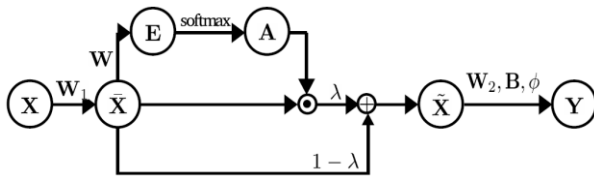
Figure 2. Examples of photos taken from different distance ranges and the corresponding bounding boxes

Time-series analysis

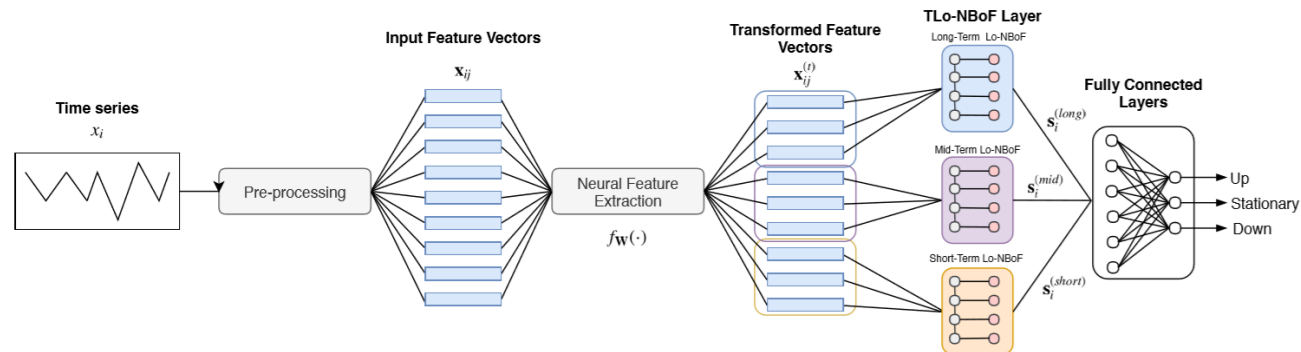
Proposal of new types of DL models

- › Exploiting properties of the input data, e.g. time-series data

Temporal Attention-augmented Bilinear Network



Temporal Logistic Neural Bag-of-Features with Long- and Short-Term memory



D.T. Tran, A. Iosifidis, J. Kannianen and M. Gabbouj, "Temporal Attention augmented Bilinear Network for Financial Time-Series Data Analysis", IEEE Transactions on Neural Networks and Learning Systems, 2019

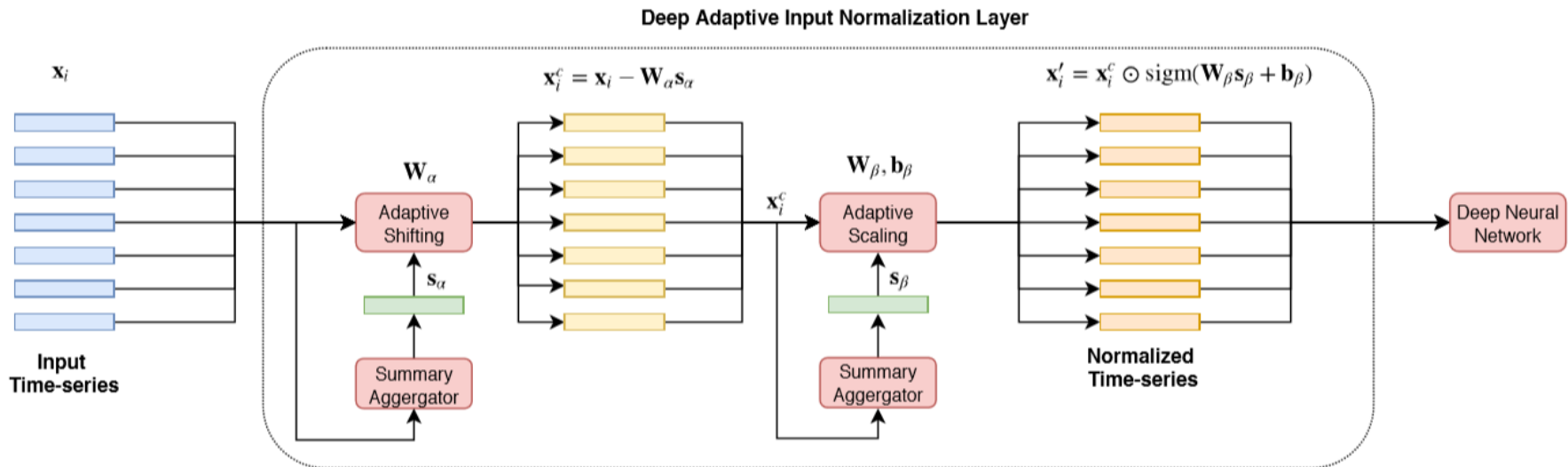
N. Passalis, A. Tefas, J. Kannianen, M. Gabbouj and A. Iosifidis, "Temporal Bag-of-Features Learning for Predicting Mid Price Movements using High Frequency Limit Order Book Data", IEEE Transactions on Emerging Topics in Computational Intelligence, 2019

Time-series analysis

Proposal of new types of data registration for DL models

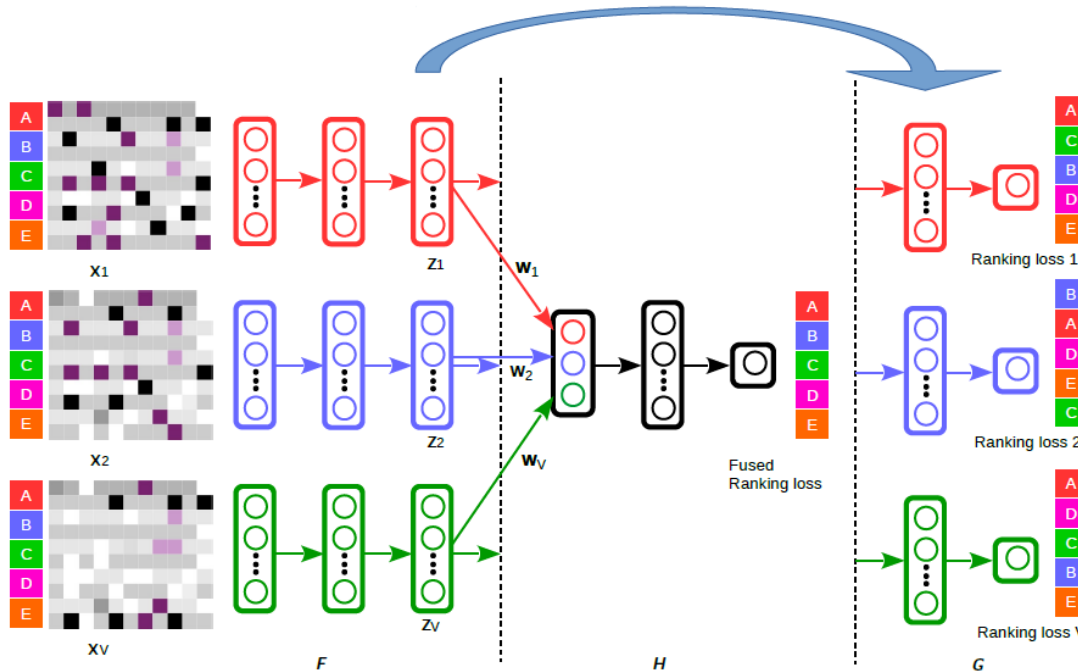
- › Automatic data-driven based pre-processing of data

Adaptive Input Normalization of DL models for time-series data



Recommendation systems

Multi-faceted and multi-objective data ranking



Safety/hazard Assessment

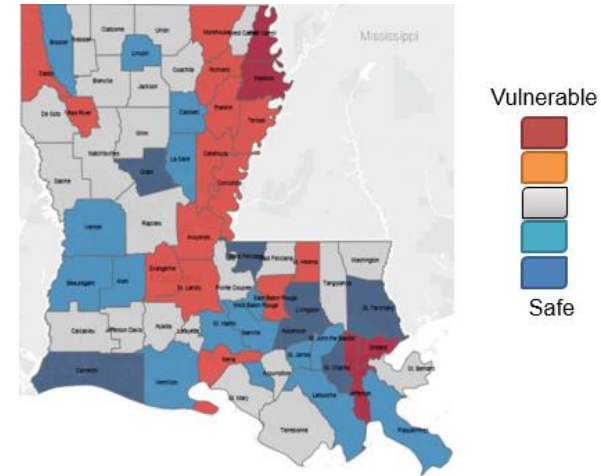
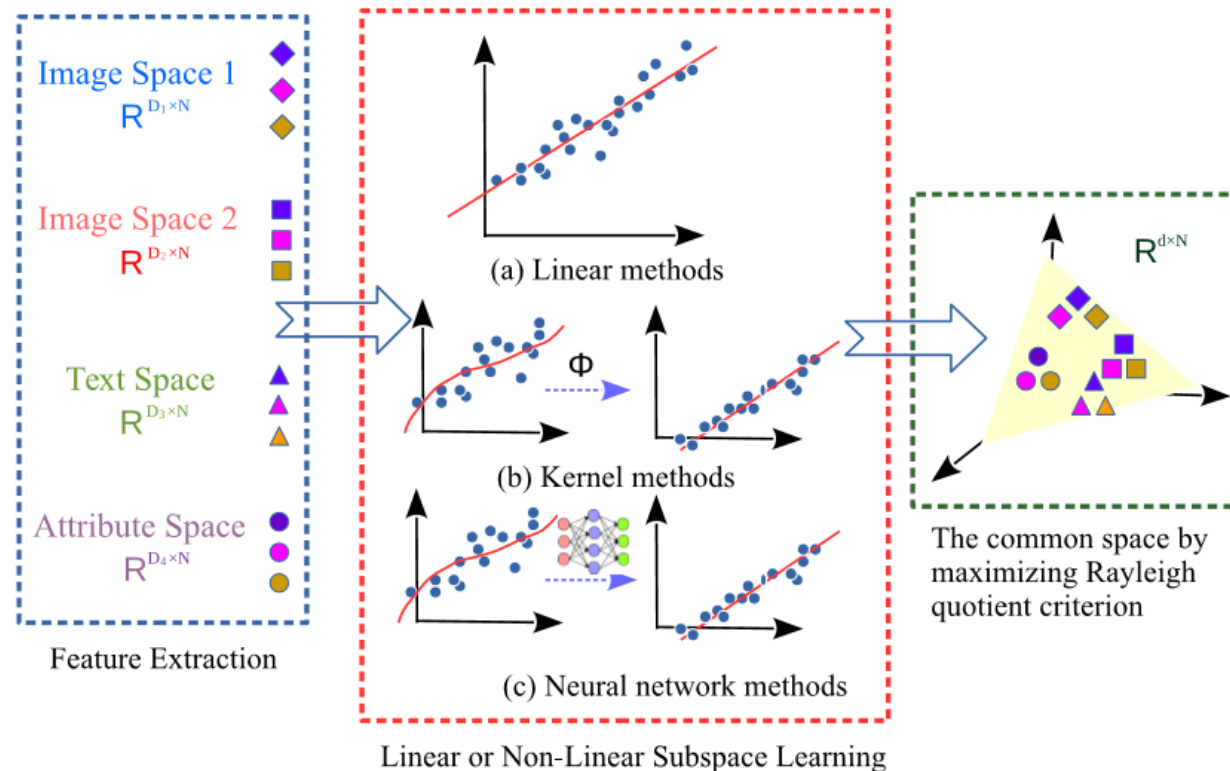


TABLE 1: Average Prediction Results (%) on 3 University Ranking Datasets in 2015.

Methods	Kendal's tau	Accuracy
Best Single View	65.38	-
Feature Concat	35.10	-
LMvCCA [5]	86.04	94.49
LMvMDA [5]	87.00	94.97
MvDA [6]	85.81	94.34
SmVR [8]	80.75	-
DMvCCA [5]	70.07	93.20
DMvMDA [5]	70.81	94.75
MvCCAe (ours)	75.94	94.01
MvMDAE (ours)	81.04	94.85
DMvDR (ours)	89.28	95.30

Multi-view/modal Data Analysis

Generalized Multi-view Embedding



Multi-view/modal Data analysis

Image and Text (I2T and T2I) Retrieval

NSF-CVDI 2016






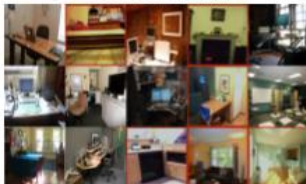


Image Query	Text Query	
	<ol style="list-style-type: none">1. A very big building with many windows and a clock on it.2. A very old tall building with a large clock tower sticking out of it.3. The clock tower stands high above the city.4. A clock that is on the side of a large building.5. The bridge is in front of a huge building with a clock tower in the middle of it.	
Precision: 53.33%	Precision: 86.67%	Precision: 100%
		
(a) Query by original image feature	(b) Query by projected image feature	(c) Query by text

Image Query	Text Query	
	<ol style="list-style-type: none">1. An open laptop sits on a desk in front of a window.2. An Apple laptop sitting on a wooden desk.3. An Apple laptop sitting on a wooden desk in an office.4. An Apple laptop on a desk in an office.5. A desk with a laptop sitting on top of it.	
Precision: 60.00%	Precision: 86.67%	Precision: 66.67%
		
(a) Query by original image feature	(b) Query by projected image feature	(c) Query by text

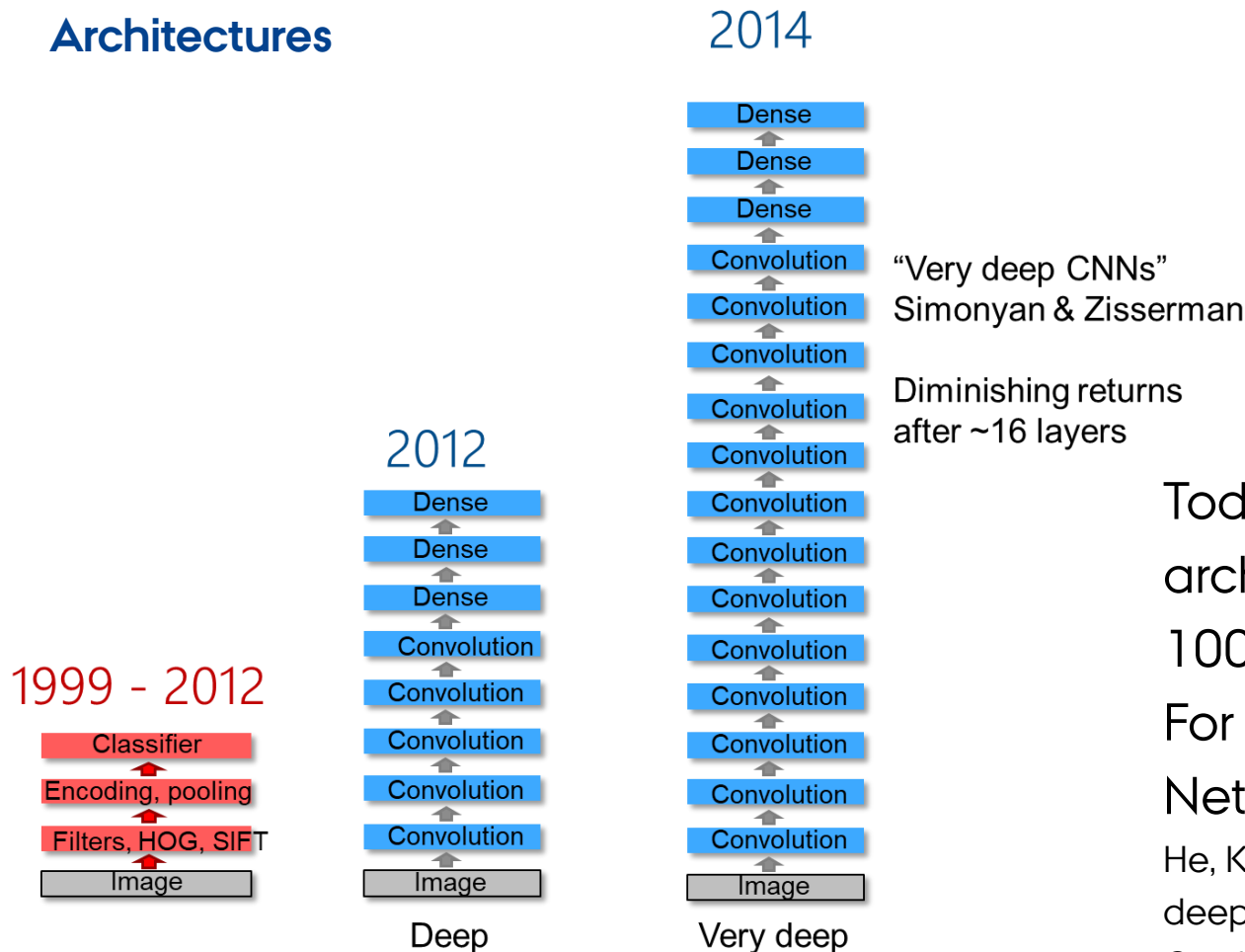
Is DL easy to train and deploy?

Challenges

- › High dependence on large and pre-processed (annotated) data sets
- › Enormous number of computations
 - › long training and evaluation times
 - › need for GPU powered computers
- › Need for human expertise to define the most suitable type of DL model for the specific problem
- › Highly specialized solutions which cannot be easily employed in other problems

Neural networks in Computer/Robotic Vision

Architectures

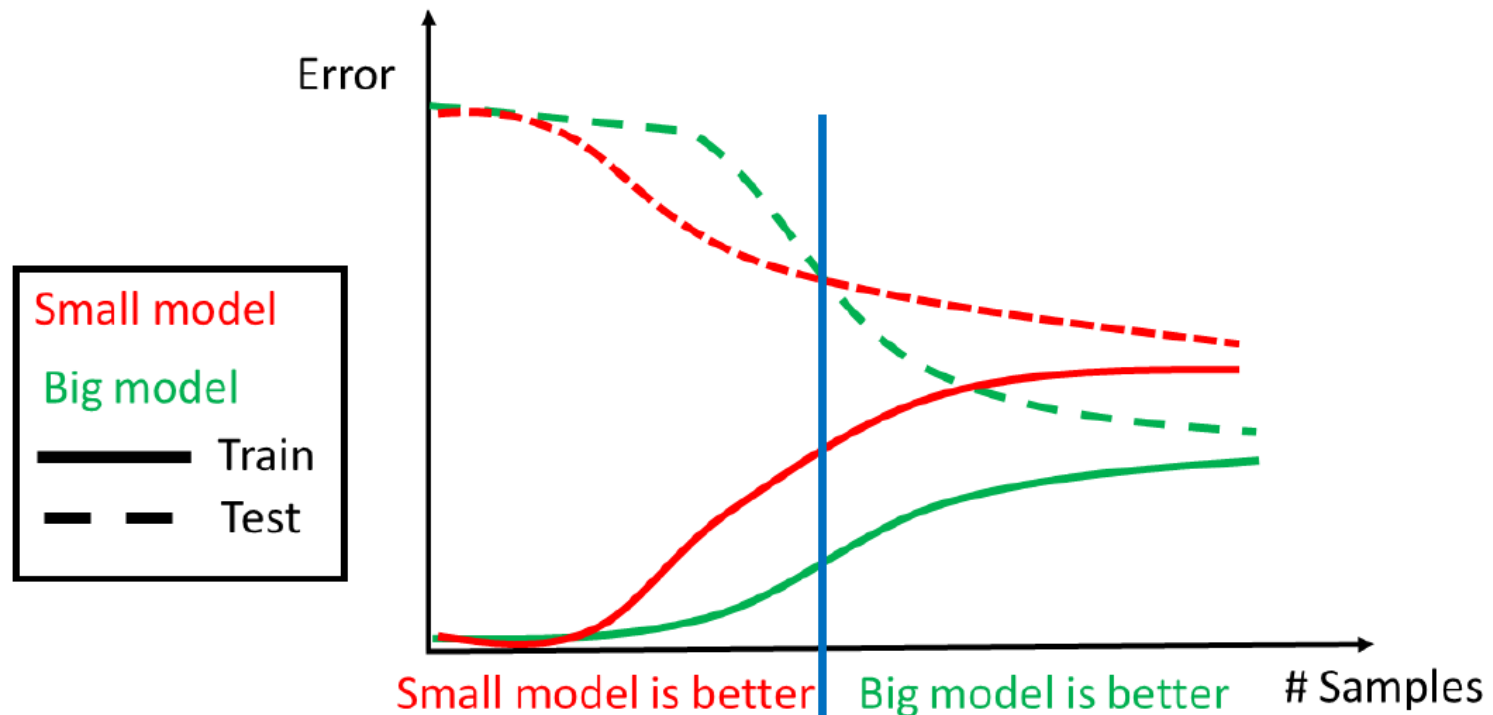


Today there exist network architectures with more than 100 convolution layers!

For example Residual Networks with 1000 layers in: He, Kaiming, et al. "Identity mappings in deep residual networks." Proc. European Conference on Computer Vision. 2016

The role of Big Data in ML and CV solutions

Shallow vs. Deep Learning models

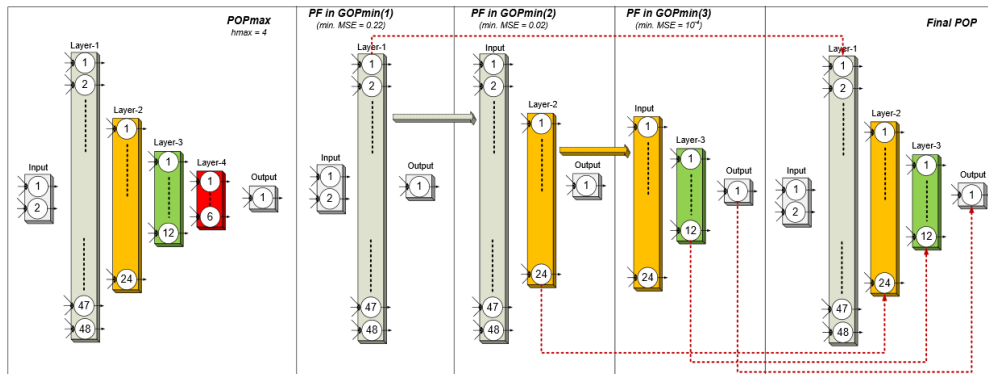


Automatic network design

Data-driven DL model learning

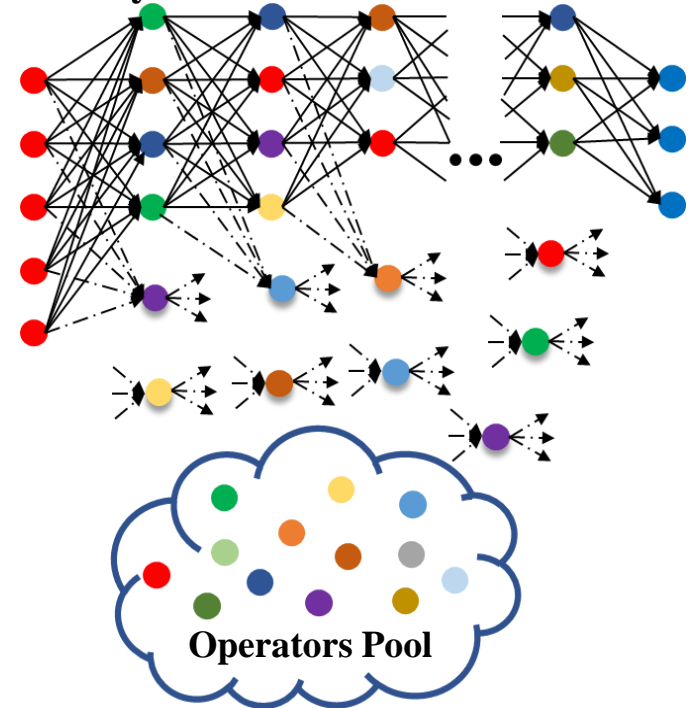
- › Automatic training of the structure and the parameters of the DL model
- › Data having the form of vectors and tensors

Progressive Operational Perceptrons



Heterogeneous Multilayer Generalized Operational Perceptron

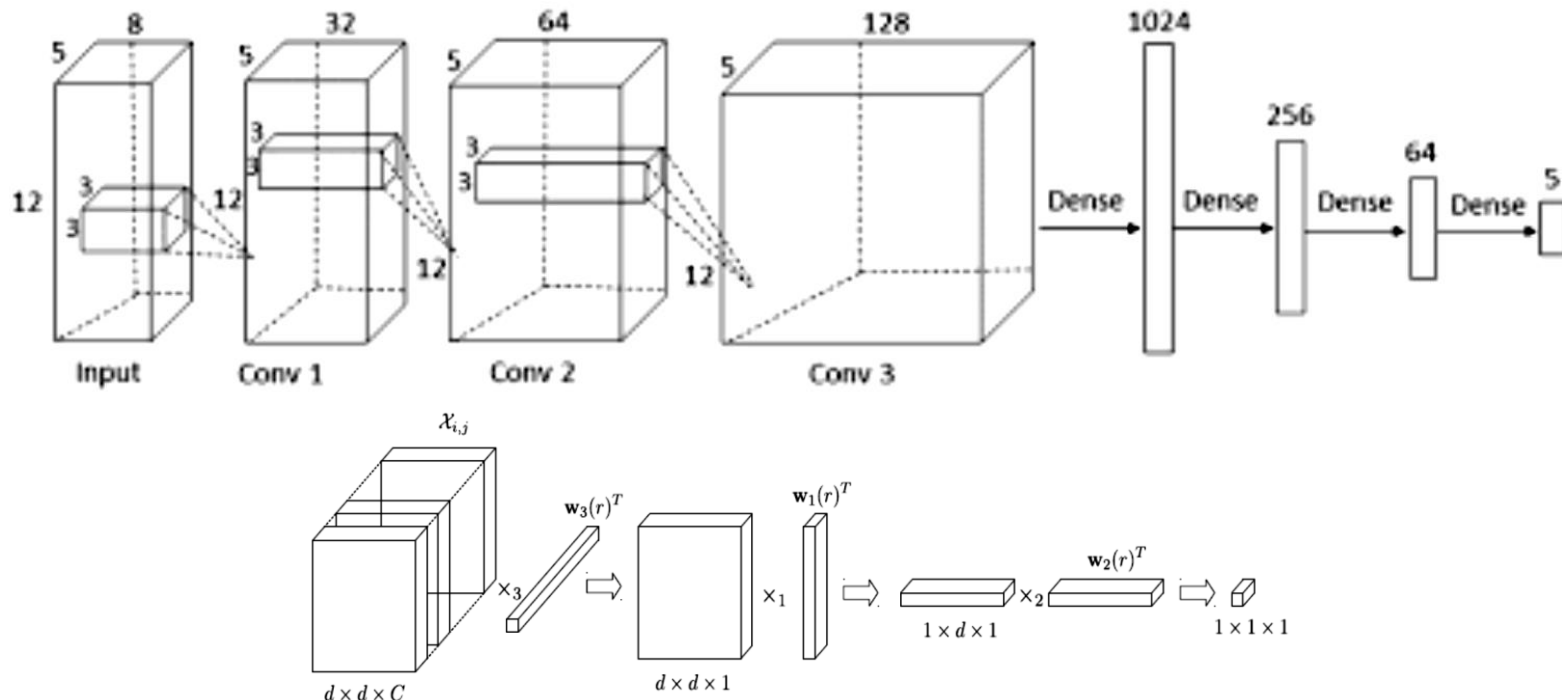
Layers and neurons selection



S. Kiranyaz, T. Ince, A. Iosifidis and M. Gabbouj, “Progressive Operational Preceptrons”, Neurocomputing, 2017
 D.T. Tran, S. Kiranyaz, M. Gabbouj and A. Iosifidis, “Heterogeneous Multilayer Generalized Operational Perceptron”, IEEE Transactions on Neural Networks and Learning Systems, 2019

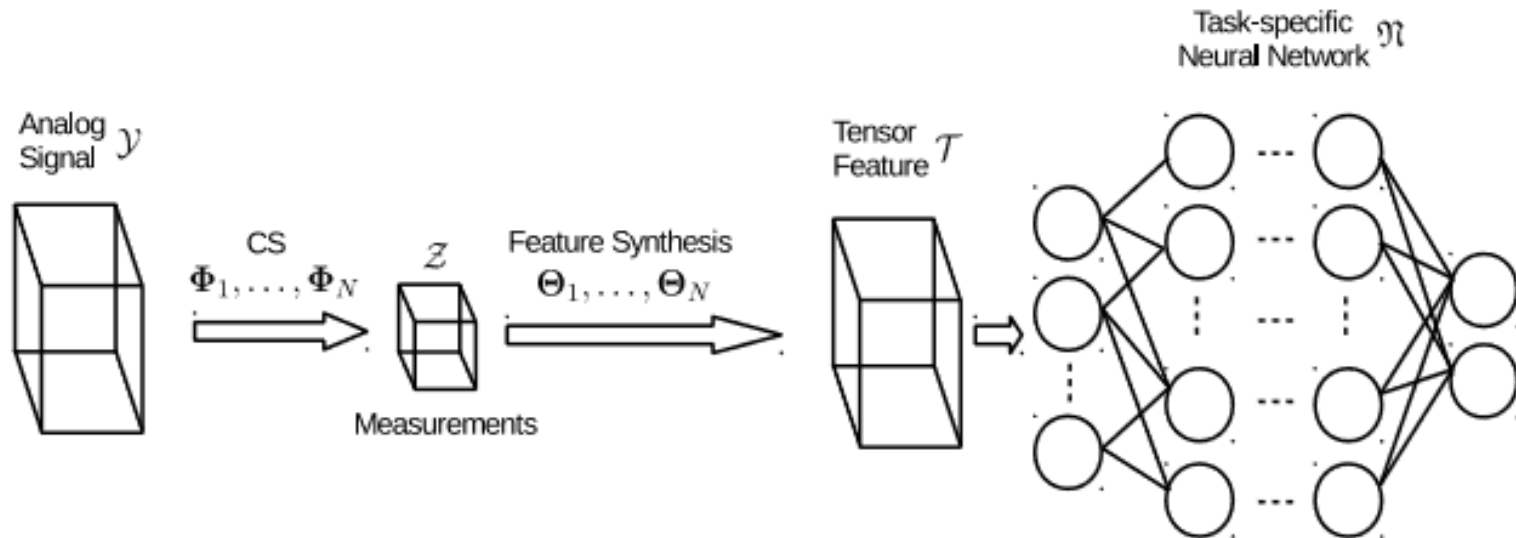
Acceleration of DL models

Exploitation of ideas from statistical Machine Learning for increasing efficiency of DL models



Efficient DL models

When computations need to be done on a server (not on the robotic platform) efficient end-to-end compression, transmission and recognition can be applied



D.T. Tran, M. Yamac, A. Degerli, M. Gabbouj and A. Iosifidis, “Multilinear Compressive Learning”, arXiv: 1905.07481, 2019

Data-Driven Analytics group at ENG

More information can be found in our websites:

- › Work in several topics of Machine Learning
- › Implementations in several applications, including
 - › human behavior analysis
 - › financial data analysis
 - › Computer Vision for Bioscience
- › ... au.dk/en/ai@eng.au.dk

sites.google.com/view/iosifidis

Alexandros Iosifidis Associate professor

Overview | CV | Press releases | Prizes | Activities | Research outputs

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Latest publications

- Temporal Attention-Augmented Bi-linear Network for Financial Time-Series Data Analysis
Research output: Contribution to journal/Conference contribution in journal/Contribution to newspaper · Journal article · Research · peer-review
- Temporal Box-of-Features Learning for Predicting Mid-Price Movements using High-Frequency Limit Order Book Data
Research output: Contribution to journal/Conference contribution in journal/Contribution to newspaper · Journal article · Research · peer-review
- Automatic Flower and Visitor Detection System
Research output: Contribution to journal/Conference contribution in journal/Contribution to newspaper · Conference article · Research · peer-review

View all (130) »

Latest activities

- 20th International Conference on Intelligent Systems and Sensor Networks (Event)
Activity: Membership types · Membership in committee, council, board
- IEEE International Conference on Image Processing 2018
Activity: Participating in or organising an event types · Participation in or organisation of a conference
- IEEE International Conference on Image Processing 2018
Activity: Participating in or organising an event types · Participation in or organisation of a conference

View all (87) »

Latest prizes

- Hans Christian Ørsted Forskningspris 2018
Prize: Prizes, scholarships, distinctions
- Best paper award
Prize: Prizes, scholarships, distinctions
- Best paper award
Prize: Prizes, scholarships, distinctions

Alexandros Iosifidis

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Research

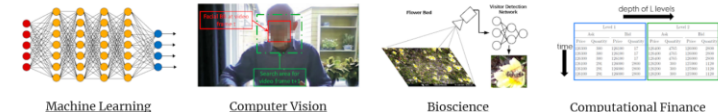
Journal articles

Conference papers

E-prints

Codes and datasets

Activities



Publications

- Journal articles
- Conference papers
- E-prints

Codes and datasets

- Codes
- Datasets

If you are unable to find any of my papers, you are welcome to contact me.

Data-Driven Analytics group at ENG

Current funding

> **OpenDR:**

- > H2020-RIA project (2020-2022) targeting to create the first Deep Learning toolkit for efficient solutions of Robotic problems (including visual data and sensor time-series)

> **DISPA:**

- > IRFD project (2019-2022) targeting at financial market time-series analysis for inter-stock predictive analytics

> **Interpretable Deep Learning:**

- > DIGIT project (2019-2022) targeting the proposal of new interpretable Deep Learning method

> **Industrial PhD:**

- > Project (2019-2023) targeting the proposal of new Deep Learning methods for weather forecasting

> **Efficient DL for UAVs:**


- > AU-ST project (2018-2022) targeting the proposal of new efficient Deep Learning methods for Computer Vision in drones

Aarhus University Centre for Digitalisation, Big Data and Data Analytics


Collaboration between the Departments


- › Engineering
- › Computer Science
- › Mathematics

RESEARCH





Big Data Analysis







Science and Engineering of Machine Intelligence







Smart Products with Focus on Cyber-Physical Systems







Blockchain







Cyber-Security







Internet of Things





Digital Business Development






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DIGITALISATION BIG DATA AND DATA ANALYTICS

Interdisciplinary thematic centres

DIGIT is one of Aarhus University's strategic research centres working on developing solutions to the World's Grand Challenges.





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