Lecture 1:
Introduction to Deep Learning

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Course Descriptor

Learning Outcomes

On successful completion of this course, students will be able to:

- Critically analyse state-of-the-art theory and practice of deep learning.
- Undertake rigorous analysis of how to solve problems in deep learning.
- Recommend how to conduct data collection, data augmentation, data labelling, data visualization.
- Design and analyse deep learning algorithms.
- Conduct quantitative evaluation of deep learning algorithms.

Course Descriptor

Content

- The emergence of deep learning
- Data collection for deep learning
- Theory, algorithms, and computational aspects of deep learning
- Design and implementation of deep neural networks (e.g., CNN, R-CNN, YOLO, ResNet, RNN)
- Machine learning algorithms (e.g., transfer learning, reinforcement learning, ensemble learning)
- Deep learning tools and applications

Course Structure and Assessment

Lectures

- Lecture 1: Introduction to deep learning
- Lecture 2: Data labelling, augmentation, and visualisation for deep learning
- Lecture 3: Artificial neural networks (ANNs)
- Lecture 4: Convolutional neural networks (CNNs or ConvNets)
- Lecture 5: Deep neural networks (DNNs)
- Lecture 6: Guest lecture
- ......

Course Structure and Assessment

Lectures

- ......
- Lecture 7: RNNs and time series analysis
- Lecture 8: GANs and reinforcement learning
- Lecture 9: Transfer learning and ensemble learning
- Lecture 10: Deep learning computing
- Lecture 11: Individual proposal Q&A
- Lecture 12: Individual report Q&A

Course Structure and Assessment

Course Structure

- Learning goals and objectives
- Learning assessments
- Learning environments
- Prescribed reading materials
- Availability of resources
- Relevance of course materials
- Effectiveness of course materials
- Individual feedback
- Communication systems
- Self-directed and teacher-directed learning
- Flipped classroom

Course Structure and Assessment

Assessments

- Individual proposal: 40% (attendance, 9 pages proposal, at least 9 references)
- Individual Report: 60% (attendance, 6 pages IEEE paper, at least 6 references)
- To pass this course, the students need at least a **C-**
- Project topics will be available prior to the course start.
- Assessment descriptions and criteria will be provided for each assessment.

Course Structure and Assessment

Grade Map

- **A+**: Pass with distinctions (89.50∼100.00)
- **A**: Pass with distinctions (84.50∼89.49)
- **A-**: Pass with distinctions (79.50∼84.49)
- **B+**: Pass with merit (74.50∼79.49)
- **B**: Pass with merit (69.50∼74.49)
- **B-**: Pass with merit (64.50∼69.49)
- **C+**: Pass (59.50∼64.49)
- **C**: Pass (54.50∼59.49)
- **C-**: Pass (49.50∼54.49)
- **D**: Specified fail

Course Structure and Assessment

Written Proposals

- Organisation (i.e., topic, name/ID, page number, abstract, introduction, related work/literature review, methodology, timetable, 9 pages, 9+ references)
- Content (i.e., datasets, maths background, methods/ approaches, flowcharts/algorithm, demos, evaluations, comparisons, result analysis, writing grammar & typos, document format, etc.).
- Correctly referencing using APA format. (i.e., 9+ references, APA format, reference page numbers, APA citings, recent 5 years publications, etc.)

Course Structure and Assessment

Written Reports

- Organisation (i.e., topic, name/ID, page number, abstract, introduction, related work/literature review, methodology, experiments, conclusion, future work, 6 IEEE pages, 6+ references)
- Content (i.e., datasets, maths background, methods/approaches, flowcharts/algorithm, demos, evaluations, comparisons, result analysis, writing (grammar & typos), document format, etc.).
- Correctly referencing using IEEE format. (i.e., 6+ references, using IEEE format, reference page numbers, IEEE citings, recent 5 years publications, etc.)

Course Structure and Assessment

Course Requirements and Regulations

- Absence
- Submitting assignments
- Extensions
- Late assignments
- Plagiarism/cheating
- Turnitin software
- ChatGPT and AI software
- Returning marks
- Reconsideration of assessment

Questions?

The Chronicle

- 2024: Open AI Sora
- 2023: YOLOv8, Diffusion Transformer(DiT), DALL · E
- 2022: ChatGPT, YOLOv7 & YOLOv6
- 2021: Vision Transformer (ViT)
- 2020: YOLOv4 & YOLOv5, GPT-3
- 2019: 2018 ACM Turing Award
- 2018: YOLOv3 & Mask R-CNN
- 2017: CapsNets & YOLO9000
- 2016: You Only Look Once (YOLO)
- 2015: ResNet, GoogLeNet, SSD, & Fast / Faster R-CNN
- 2014: GANs & VGG
- 2013: Region-Based CNN(R-CNN)
- 2012: AlexNet (ImageNet)
- 1997: Long Short-Term Memory (LSTM)
- 1990: Convolutional Neural Networks (CNNs or ConvNets)
- ...

The Chronicle

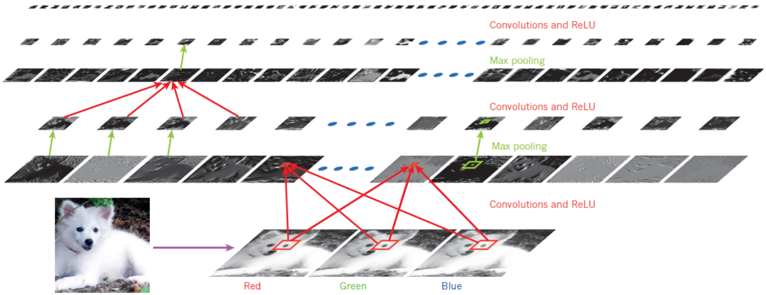
- …
- 1995: Support Vector Machine (SVM)
- 1986: Restricted Boltzmann Machine (RBM)
- 1986: Iterative Dichotomiser 3 (ID3) for generating decision trees.
- 1974: Multilayer Perceptron (MLP)
- 1970: Automatic Differentiation (AD, e.g., Chain Rule)
- 1969: XOR Logic Function
- 1960: Least Mean Squares (LMS)
- 1959: Machine Learning for the Game of Checkers.
- 1957: Perceptron (IBM 704).
- 1946: ENIAC (Electronic Numerical Integrator and Computer)

Deep Learning

- CNNs (ConvNets) and RNNs (LSTM/GRU)
- Transformer models
- Region-Based CNN (R-CNN)
- Fast R-CNN and Faster R-CNN
- YOLO and SSD models
- AlexNet, ResNet, GoogLeNet, etc.
- Generative Adversarial Networks (GANs)
- Autoencoder
- Reinforcement Learning
- Transfer Learning
- Ensemble Learning
- ……

ConvNets: Convolutional Neural Networks

ConvNets = Local Connections + Shared Weights + Pooling + Multilayers.



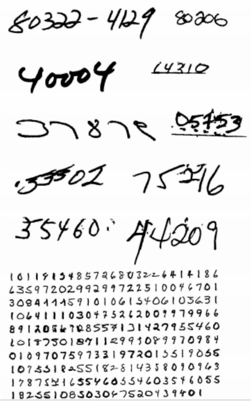
Y. LeCun, Y. Bengio, G. Hinton (2015) Deep learning, Nature, 521, pages 436 - 444.

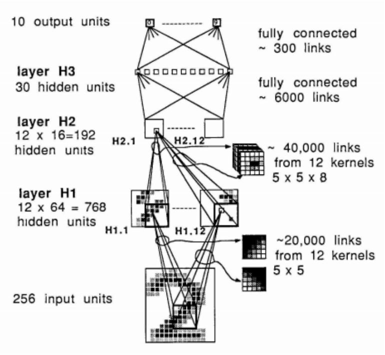
Deep Learning

- A deep-learning architecture is a multilayer stack of simple modules, many of which compute nonlinear input-output mappings.
- Each module in the stack transforms its input to increase both selectivity and invariance of the representation.
- With multiple nonlinear layers, a system can implement extremely intricate functions of its inputs that are simultaneously sensitive to minute details and insensitive to large irrelevant variations.

Y. LeCun, Y. Bengio, G. Hinton (2015) Deep learning, Nature, 521, pages 436 - 444.

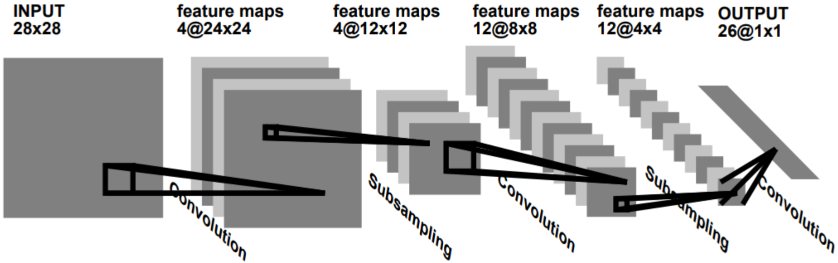
ConvNets: Convolutional Neural Networks





LeCun, Y., Bengio, Y. (1995) Convolutional networks for images, speech, and time series. The Handbook of Brain Theory and Neural Networks, pp. 255-258, MIT Press, USA.

ConvNets: Convolutional Neural Networks



LeCun, Y., Bengio, Y. (1990)Handwritten digit recognition with a back-propagation network. InAdvances in NIPS, pp. 396–404

CNN Demo: Caffe

Classification

Click for a Quick Example

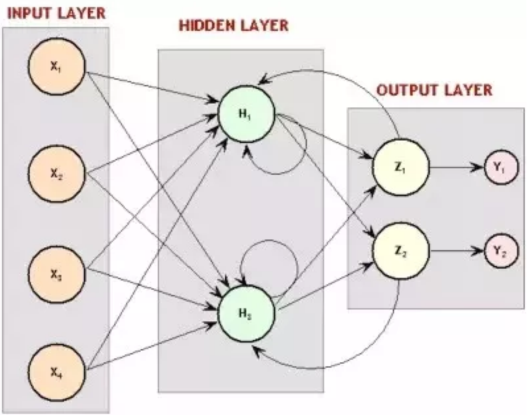
Maximally accurate | Maximally specific

- Windsor tie
- suit
- oboe
- bolo tie
- bow tie

CNN took 0.059 seconds.

Caffe Demo: http://demo.caffe.berkeleyvision.org

RNNs: Recurrent Neural Networks



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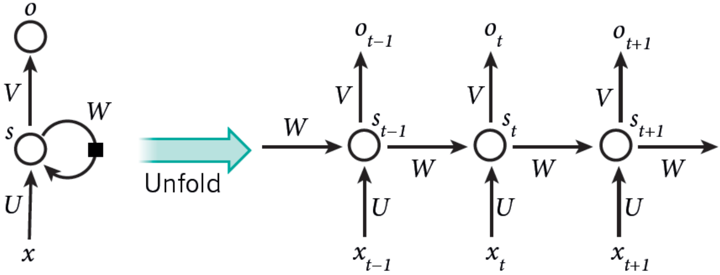
RNNs: Recurrent Neural Networks



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RNNs: Recurrent Neural Networks

- RNNs process an input sequence maintaining in the hidden units that implicitly contains information about the history of all the past elements of the sequence.
- RNNs can be seen as very deep feedforward networks in which all the layers share the same weights.
- Turing machines (e.g., FSM) and memory networks are being employed for the tasks that would normally require reasoning and symbol manipulations.

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Questions?

Learning Objectives

- To get organized for the course and to provide an overview of the core issues.
- Demonstrate advanced understanding of the state-of-the-art theory and practice of deep learning and machine intelligence.