Insight
Centre for Data Analytics

DEEP LEARNING WORKSHOP

Dublin City University
21-22 May 2018

DCU

#InsightDL2018

Day 1 Lecture 6

The Neural Network Zoo

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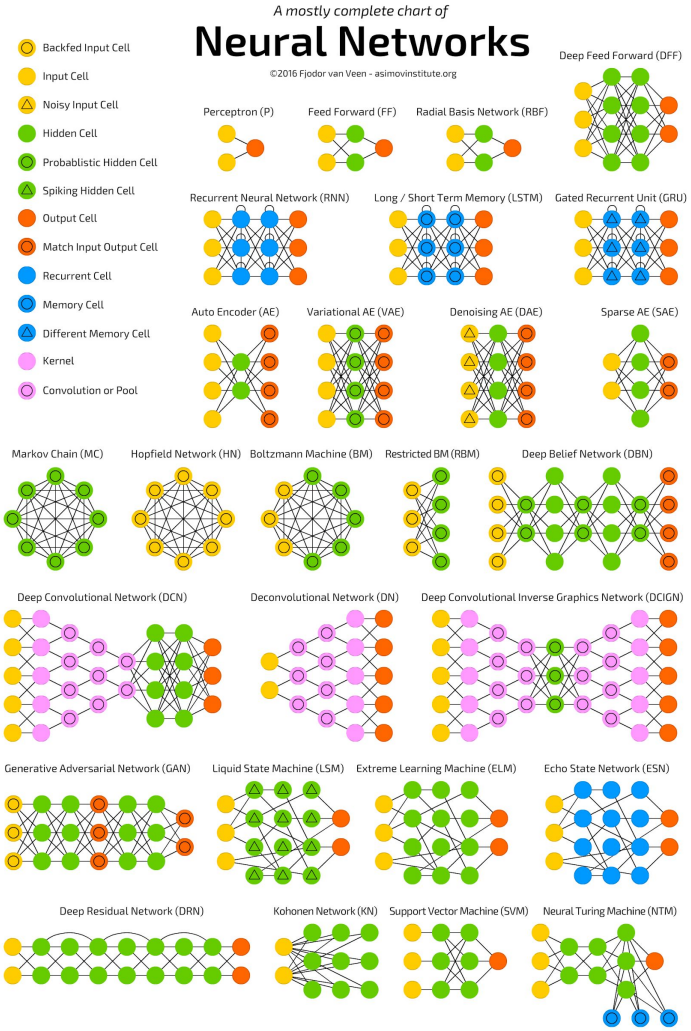
Intelligent Data Science and Artificial Intelligence Center
Universitat Politecnica de Catalunya (UPC)

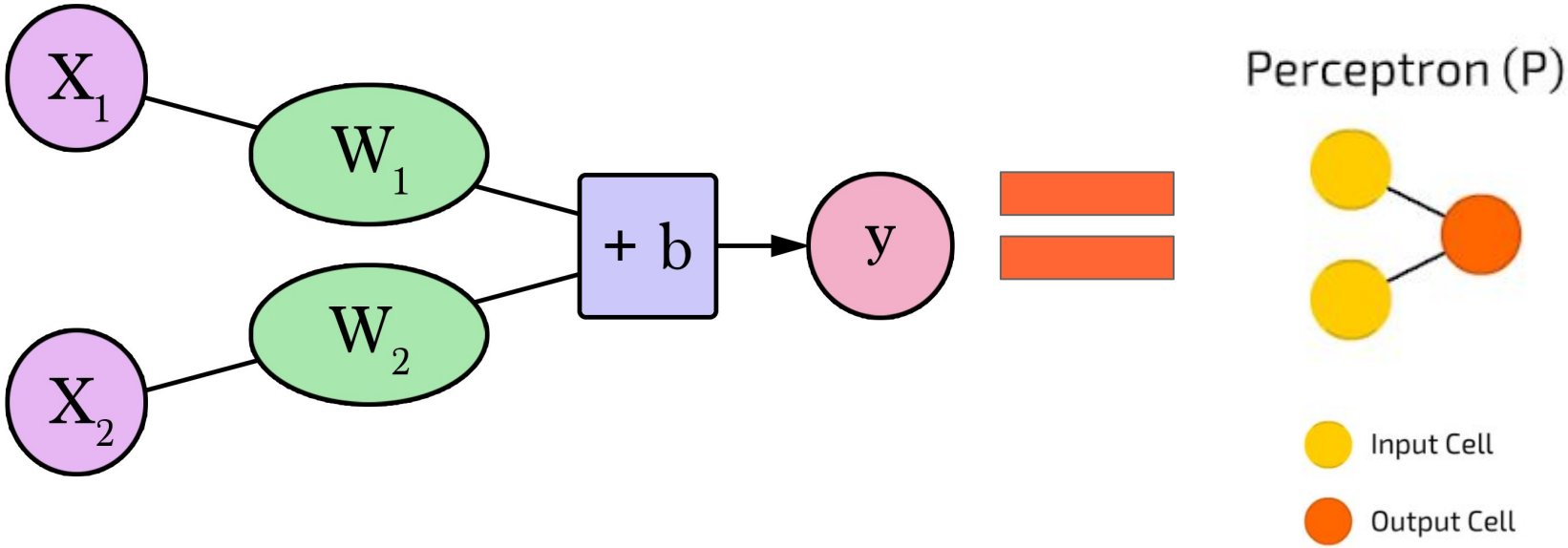
Acknowledgements

Fjodor Van Veen,
"The Neural Network Zoo"
The Asimov Institute (2016)



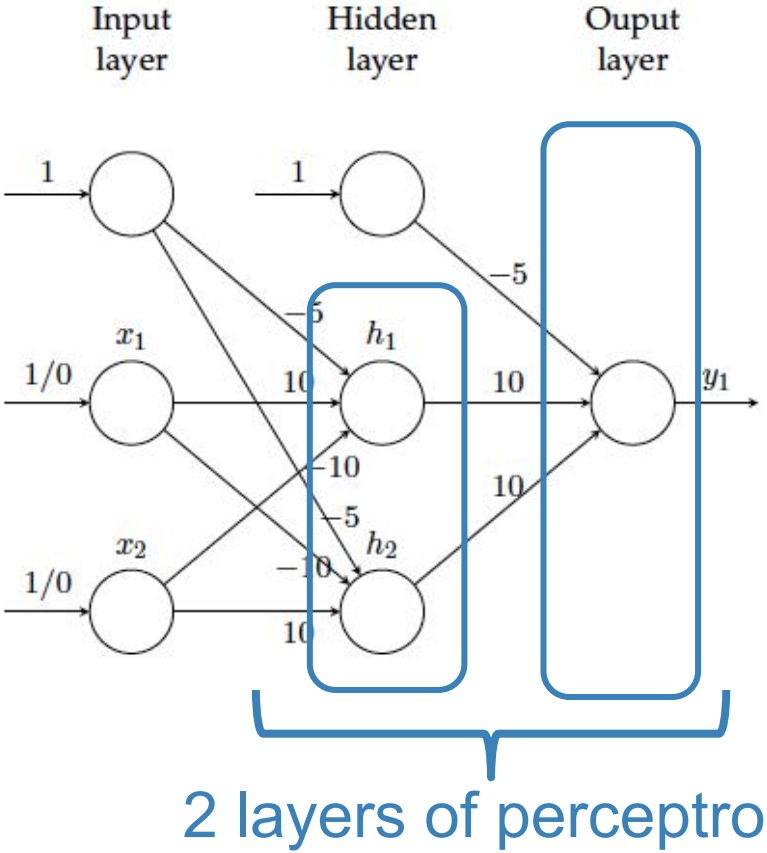
bit.ly/InsightDL2018
#InsightDL2018

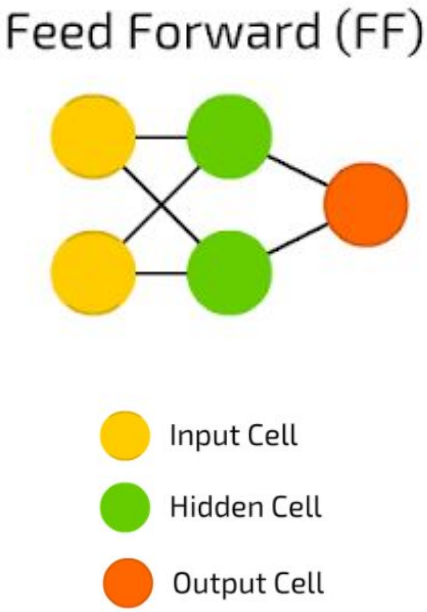
The Perceptron



J. Alammar, [“A visual and interactive guide to the Basics of Neural Networks”](#) (2016)
F. Van Veen, [“The Neural Network Zoo”](#) (2016)

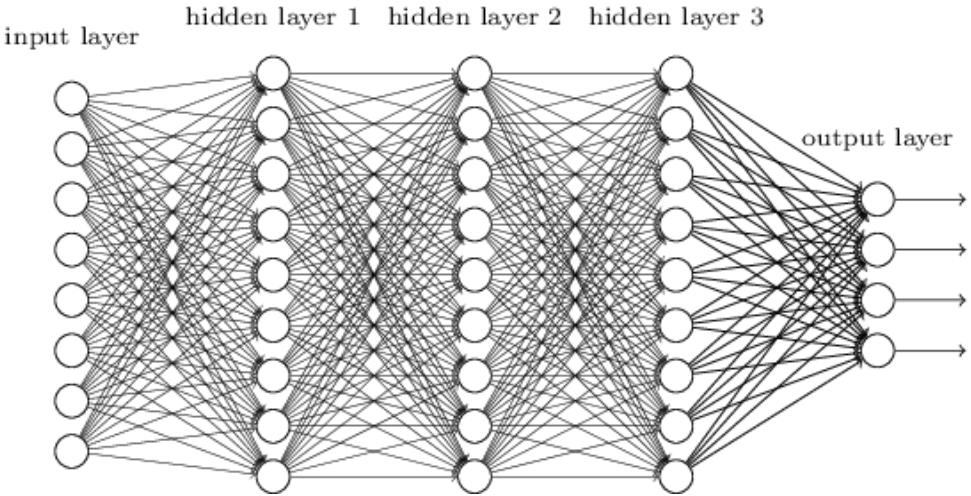
Neural Network = Multi-layer Perceptron

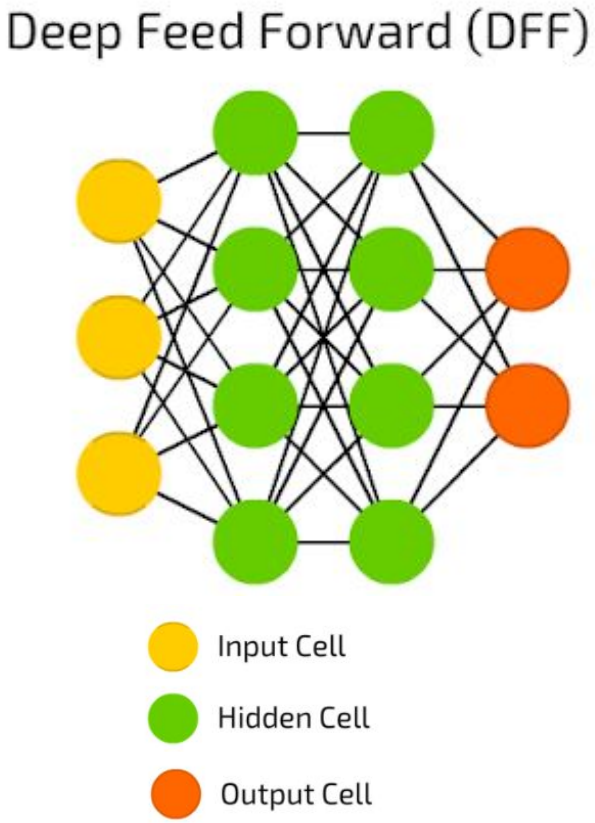




F. Van Veen, [“The Neural Network Zoo”](#) (2016)

Deep Neural Network (DNN)

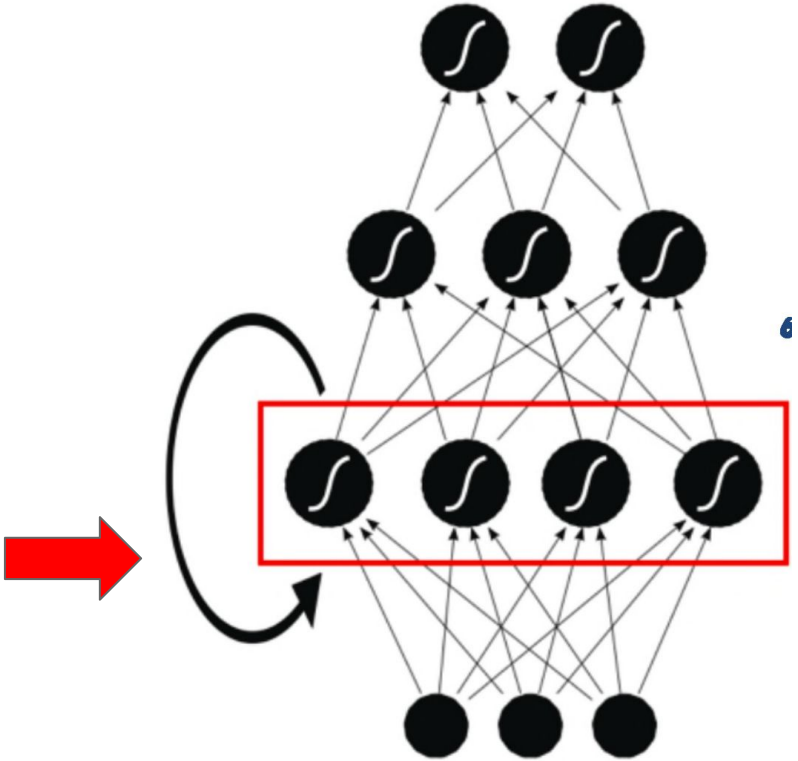




F. Van Veen, [“The Neural Network Zoo”](#) (2016)

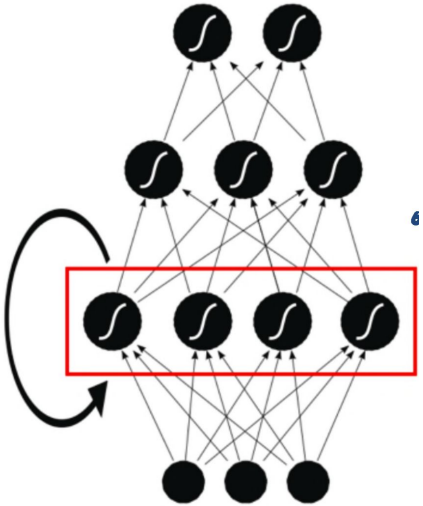
Recurrent Neural Network (RNN)

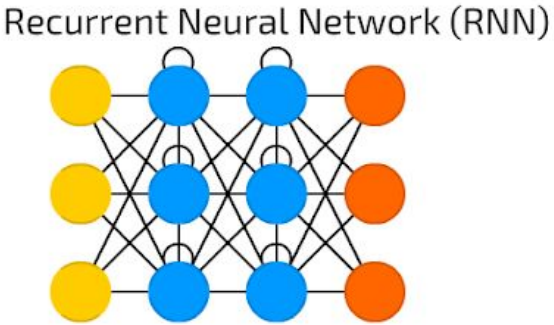
The hidden layers and the output depend from previous states of the hidden layers

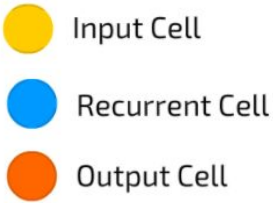


Alex Graves, [“Supervised Sequence Labelling with Recurrent Neural Networks”]

Recurrent Neural Network (RNN)

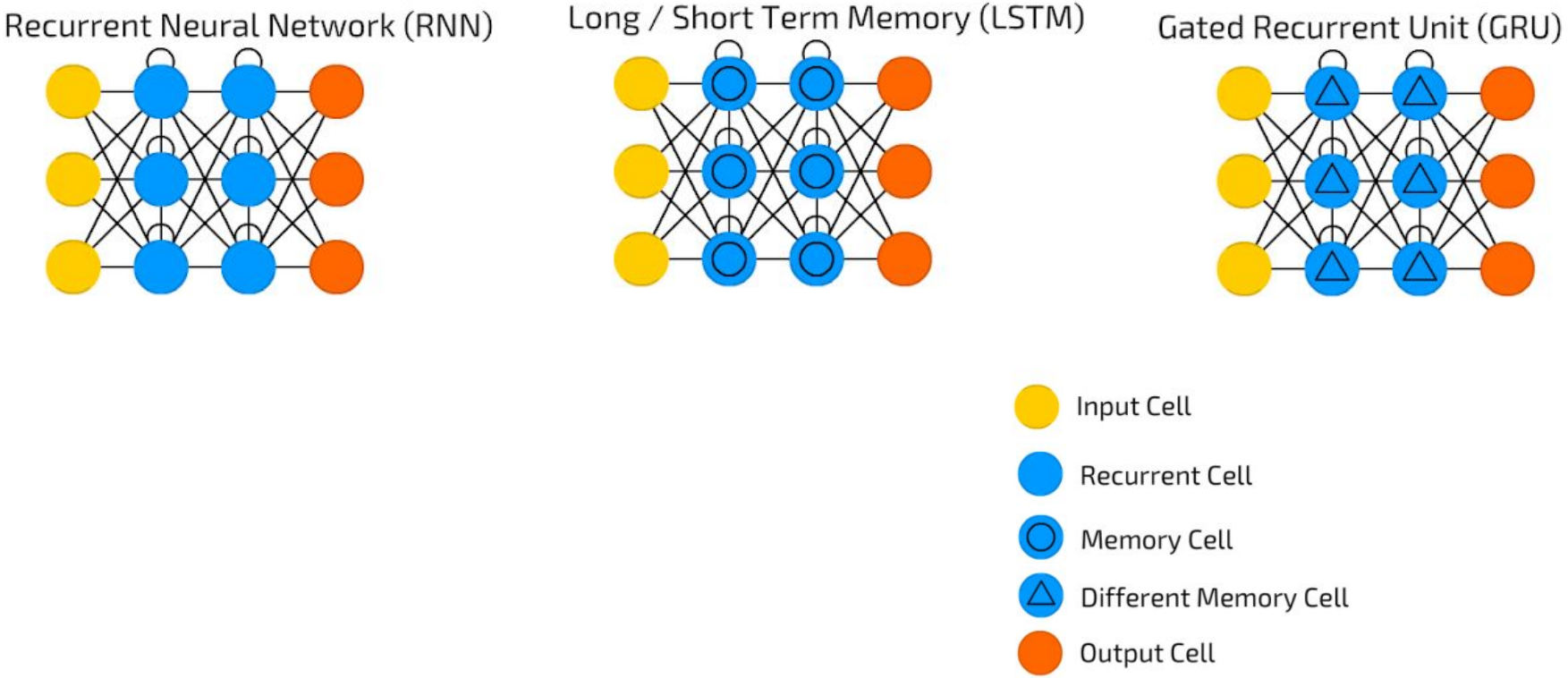






F. Van Veen, [“The Neural Network Zoo”](#) (2016)

Recurrent Neural Network (RNN)



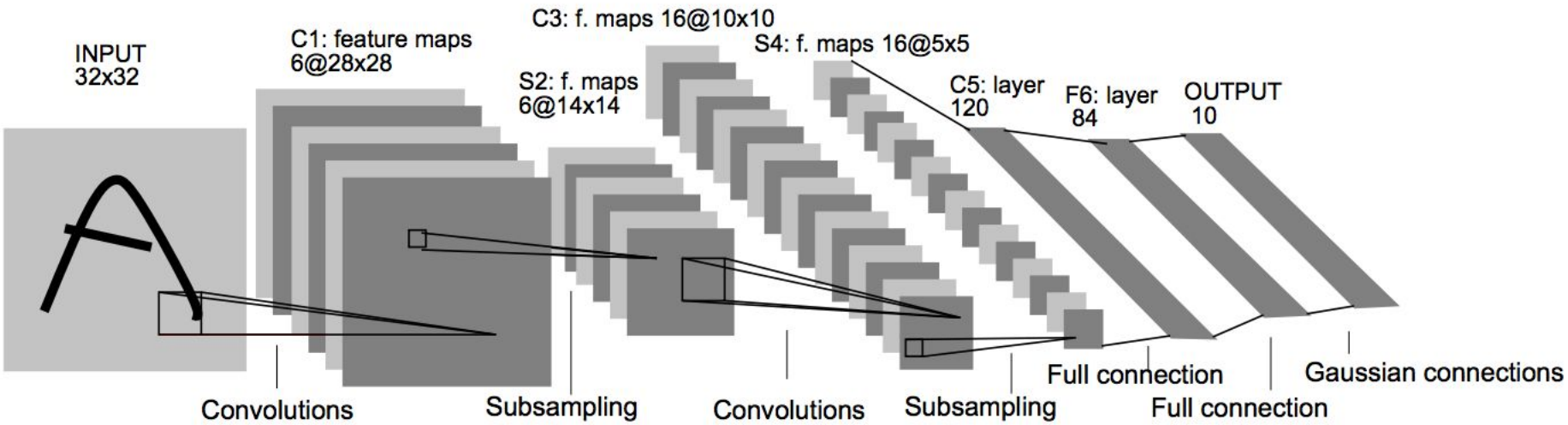
F. Van Veen, [“The Neural Network Zoo”](#) (2016)

Recurrent Neural Network (RNN)

Deep Learning TV, [“Recurrent Neural Networks - Ep. 9”]

Convolutional Neural Network (CNN)

LeNet-5

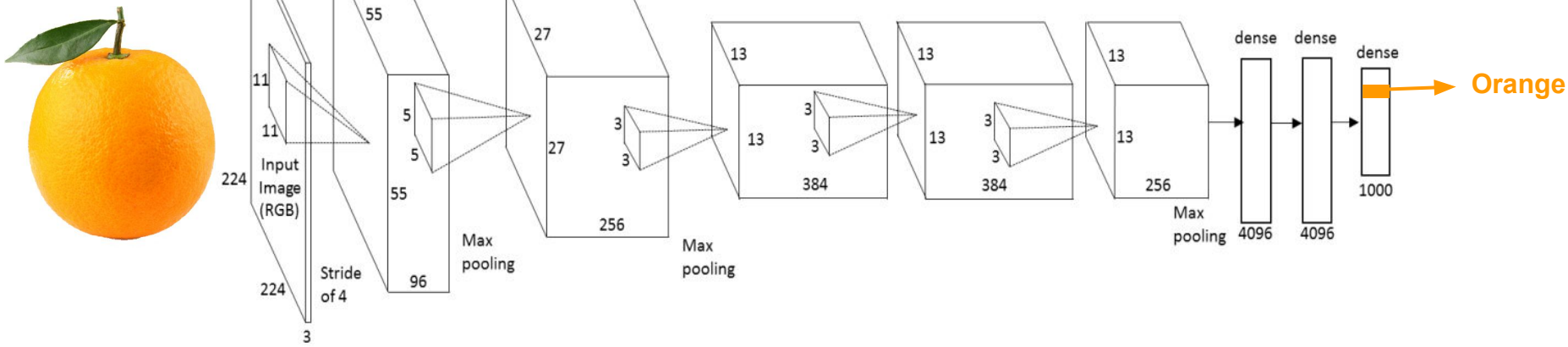


LeCun, Y., Bottou, L., Bengio, Y., & Haffner, P. (1998). Gradient-based learning applied to document recognition. *Proceedings of the IEEE*, *86*(11), 2278-2324.

Convolutional Neural Network (CNN)

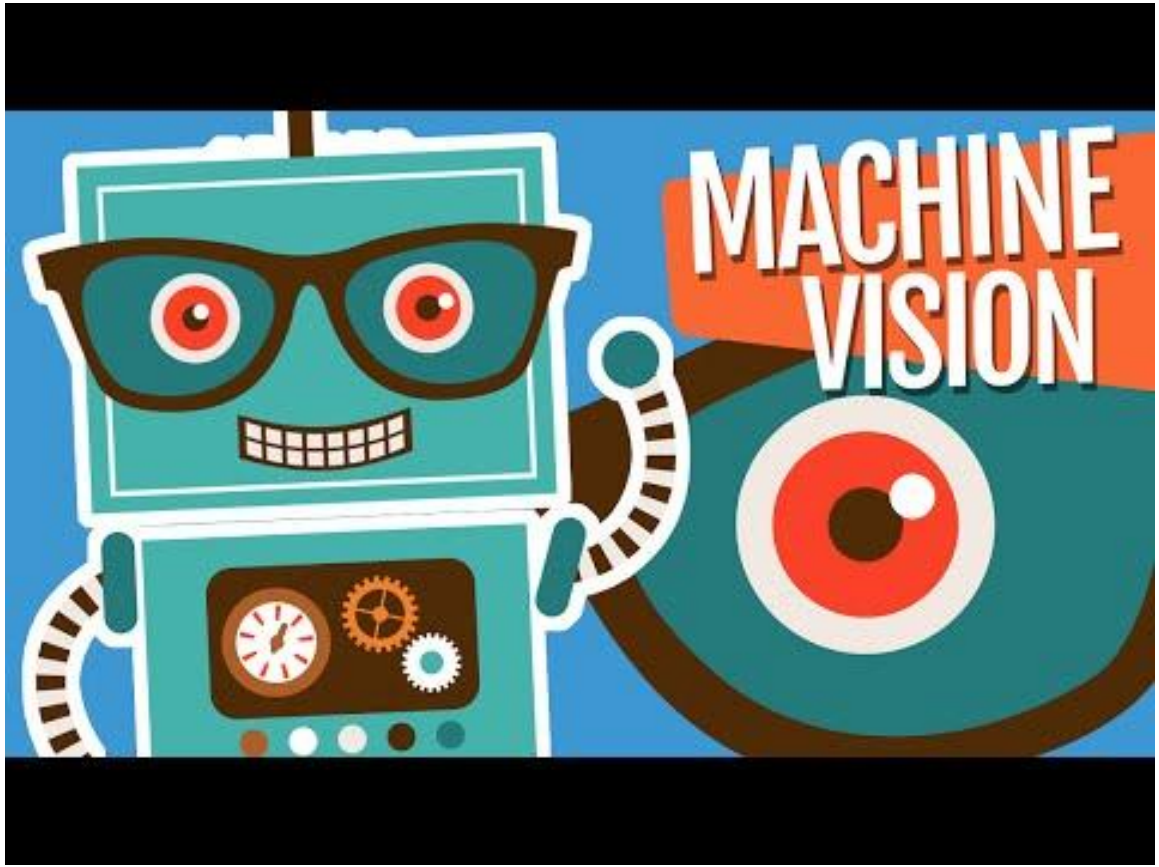
AlexNet

UNIVERSITY OF TORONTO



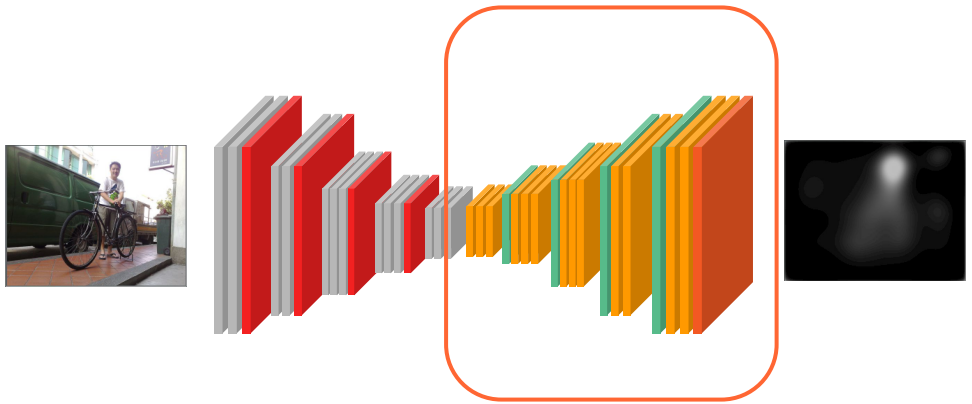
A Krizhevsky, I Sutskever, GE Hinton "Imagenet classification with deep convolutional neural networks" NIPS 2012.

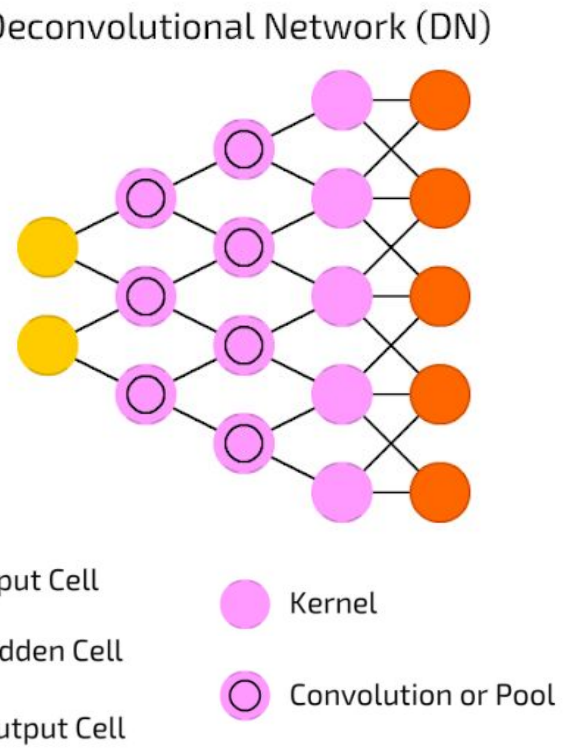
Convolutional Neural Network (CNN)



Deep Learning TV, “Convolutional Neural Networks - Ep. 8”

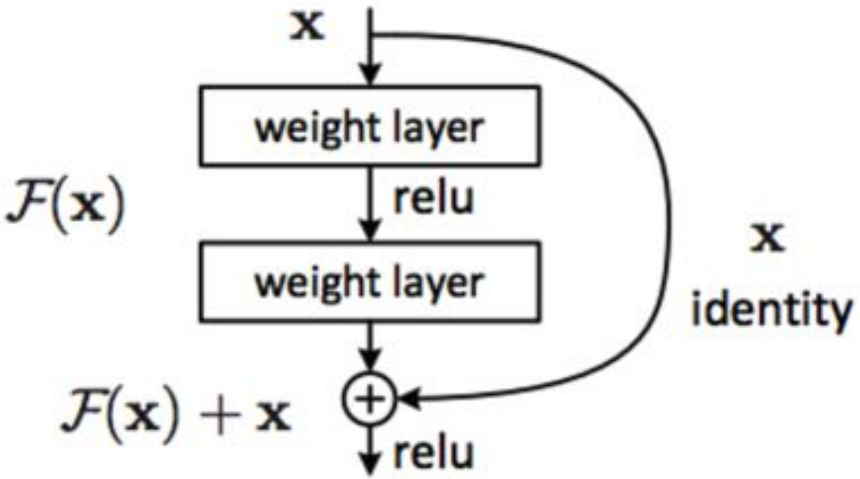
Deconvolutional Neural Network

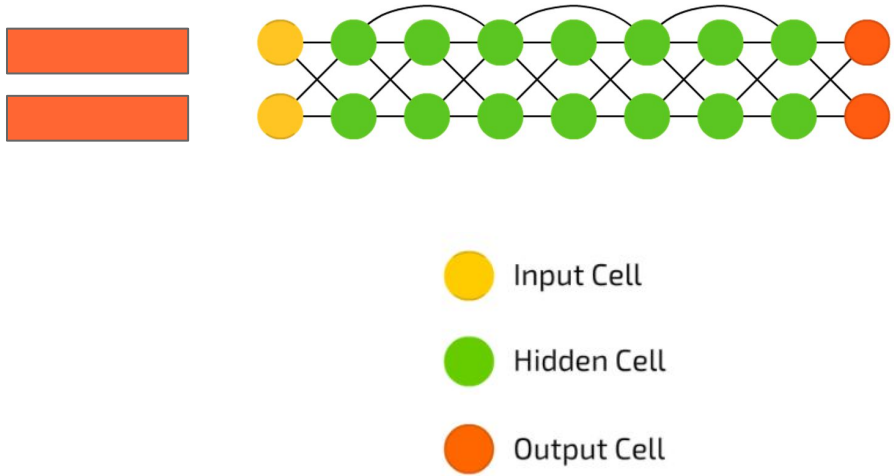




Junting Pan, SalGAN (2017)
F. Van Veen, "The Neural Network Zoo" (2016)

Deep Residual Network



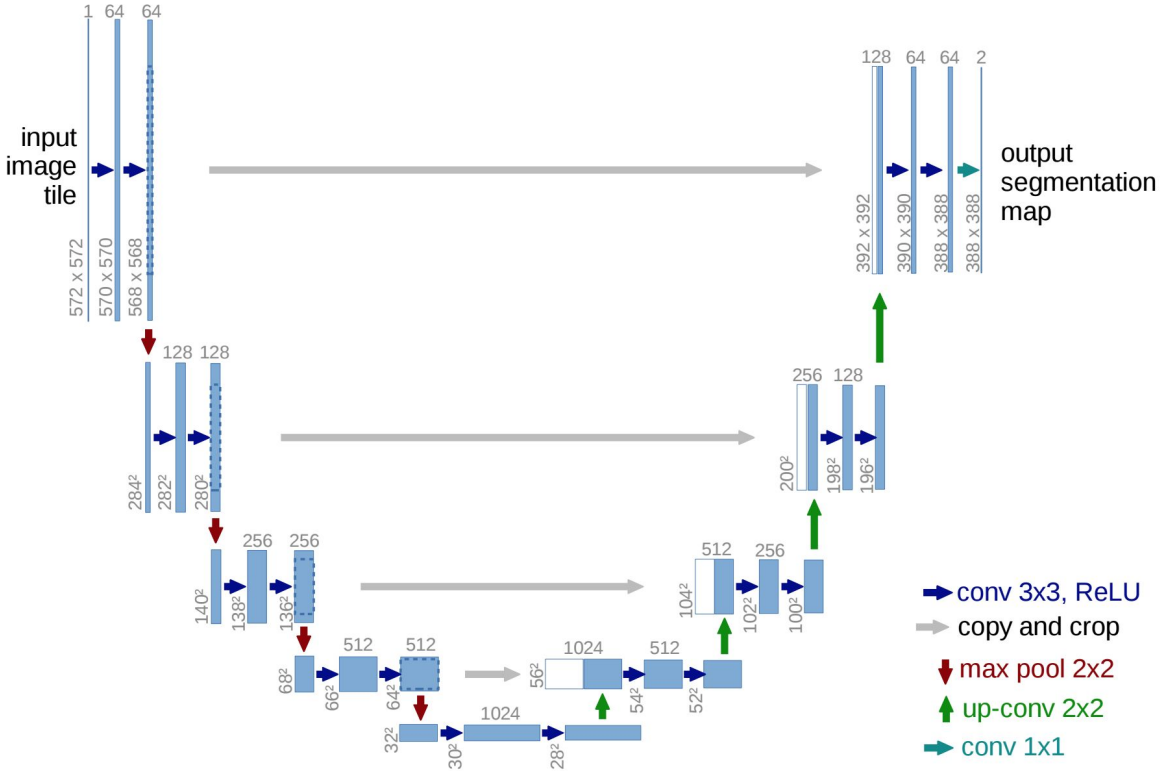


F. Van Veen, "The Neural Network Zoo" (2016)

He, Kaiming, Xiangyu Zhang, Shaoqing Ren, and Jian Sun. "Deep Residual Learning for Image Recognition." CVPR 2016 [slides]

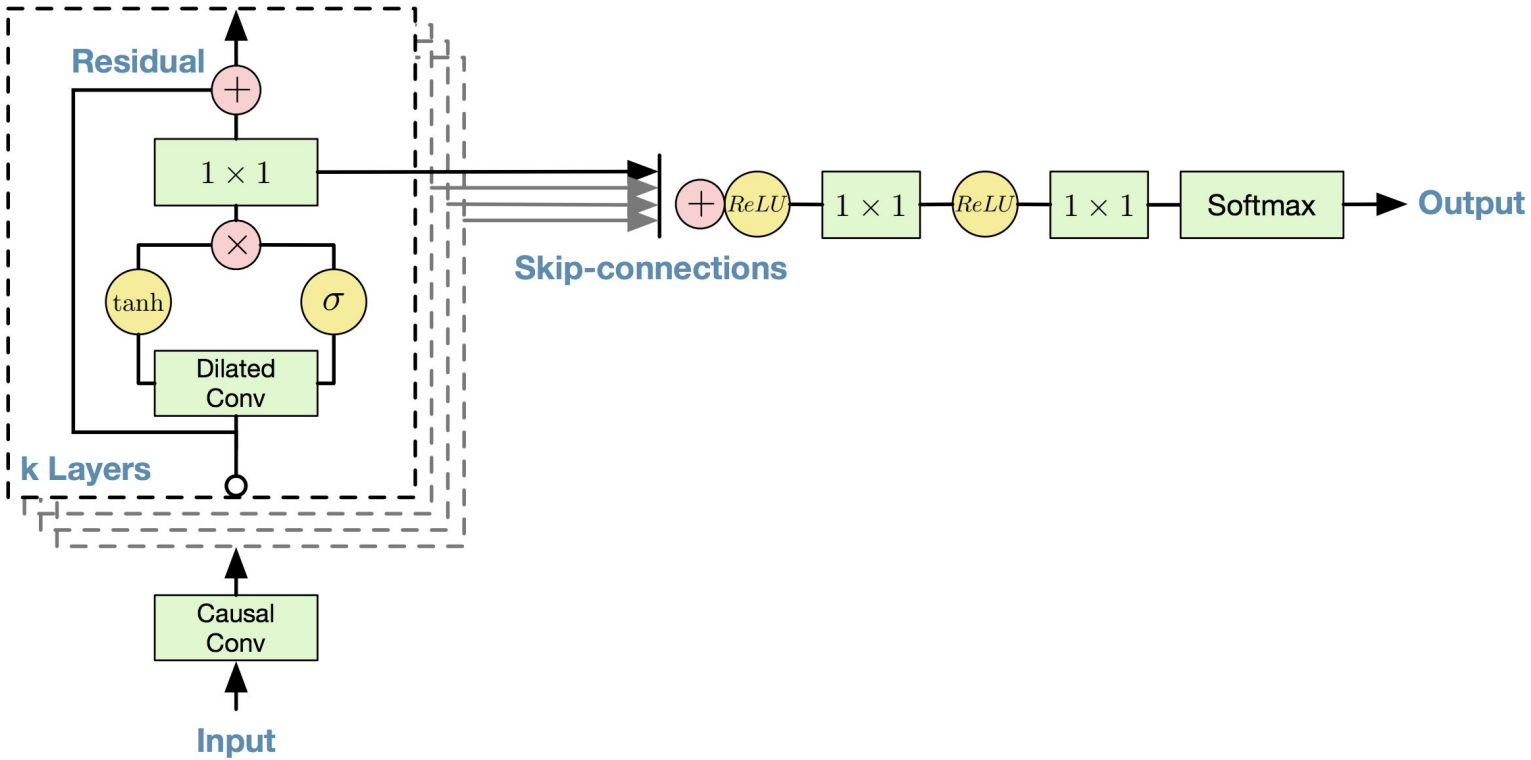
Skip Connections

U-Net



Ronneberger, Olaf, Philipp Fischer, and Thomas Brox. "U-net: Convolutional networks for biomedical image segmentation." MICCAI 2015

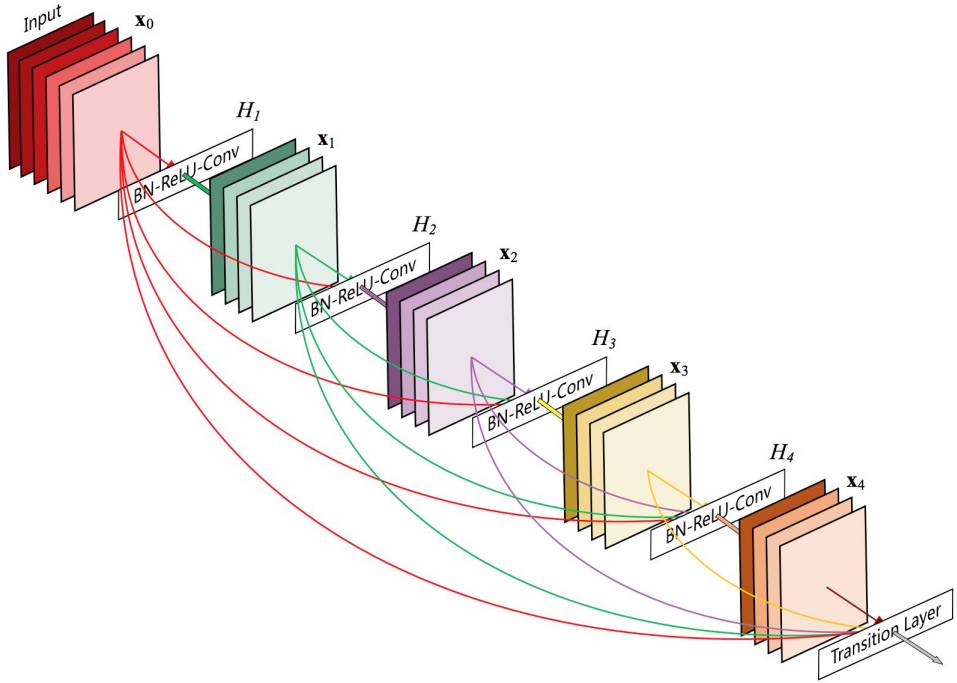
Skip Connections



Van Den Oord, Aaron, Sander Dieleman, Heiga Zen, Karen Simonyan, Oriol Vinyals, Alex Graves, Nal Kalchbrenner, Andrew Senior, and Koray Kavukcuoglu. "Wavenet: A generative model for raw audio." ISCA 2016.

Dense Connections

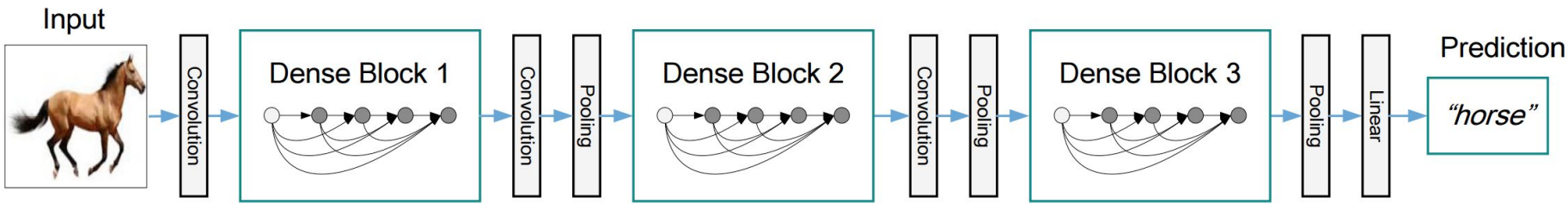
Connect every layer to every other layer of the same filter size.



Dense Block of 5-layers with a growth rate of k=4

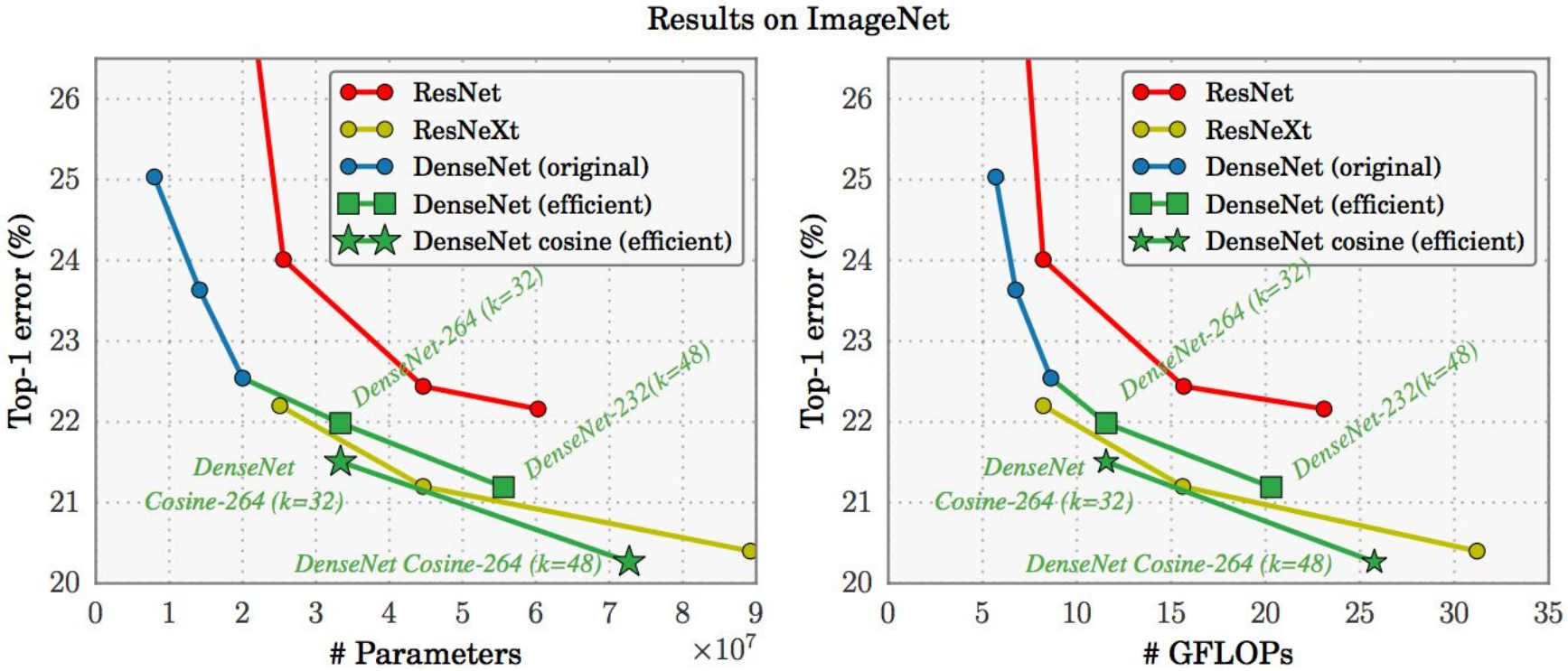
Huang, Gao, Zhuang Liu, Kilian Q. Weinberger, and Laurens van der Maaten. "Densely connected convolutional networks." CVPR 2017. [code]

Dense Connections



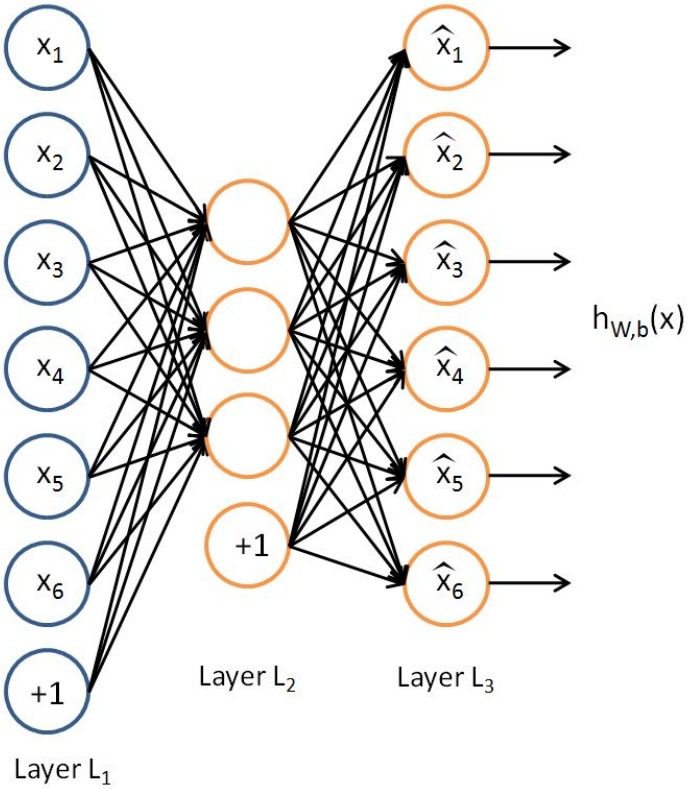
Huang, Gao, Zhuang Liu, Kilian Q. Weinberger, and Laurens van der Maaten. "Densely connected convolutional networks." CVPR 2017. [code]

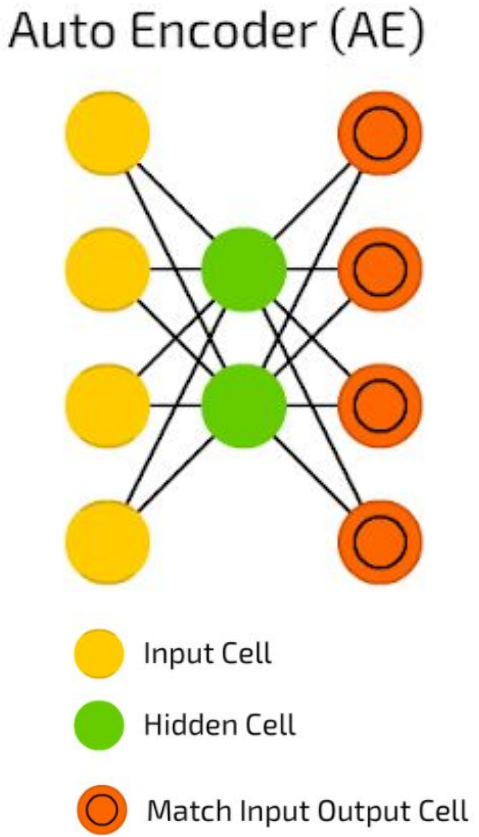
Dense Connections



Huang, Gao, Zhuang Liu, Kilian Q. Weinberger, and Laurens van der Maaten. "Densely connected convolutional networks." CVPR 2017. [code]

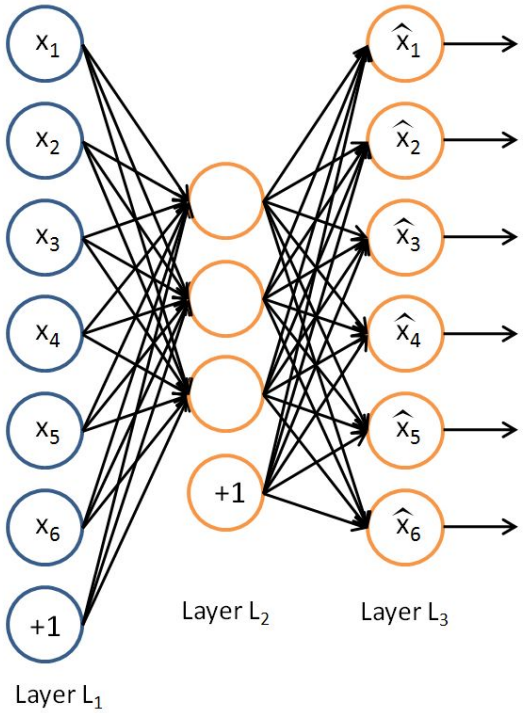
Autoencoder (AE)





F. Van Veen, "The Neural Network Zoo" (2016)

Autoencoder (AE)

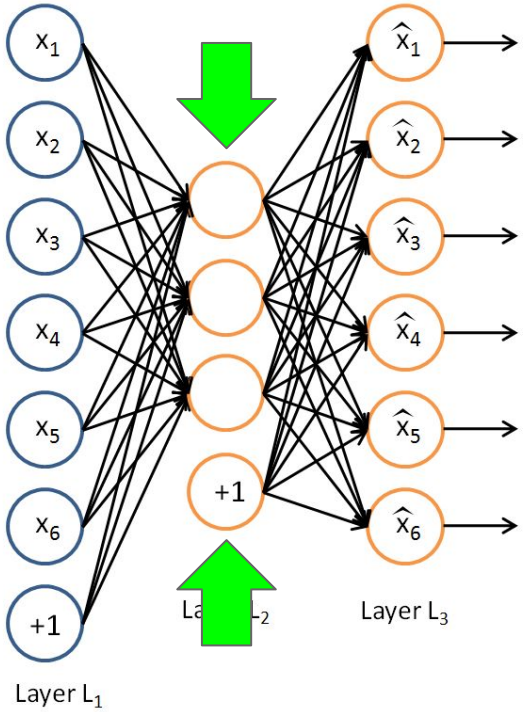


Autoencoders:

- Predict at the output the same input data.
- Do not need labels:

"Deep Learning Tutorial", Dept. Computer Science, Stanford

Autoencoder (AE)



Application #1

Dimensionality reduction:

- Use hidden layer as a feature extractor of any desired size.

"Deep Learning Tutorial", Dept. Computer Science, Stanford

Autoencoder (AE)

Application #2

WHY?

Pretraining:

1. Initialize a NN solving an autoencoding problem.

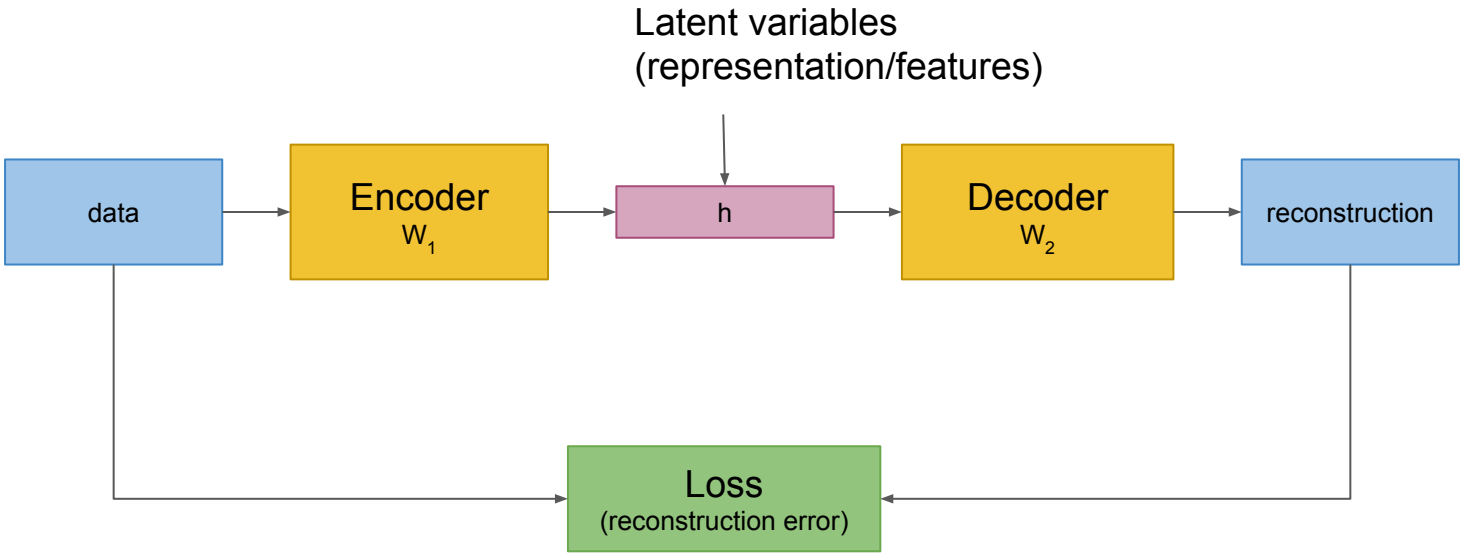


Figure: Kevin McGuinness (DLCV UPC 2017)

Autoencoder (AE)

Application #2

WHY?

Pretraining:

1. Initialize a NN solving an autoencoding problem.
2. Train for final task with “few” labels.

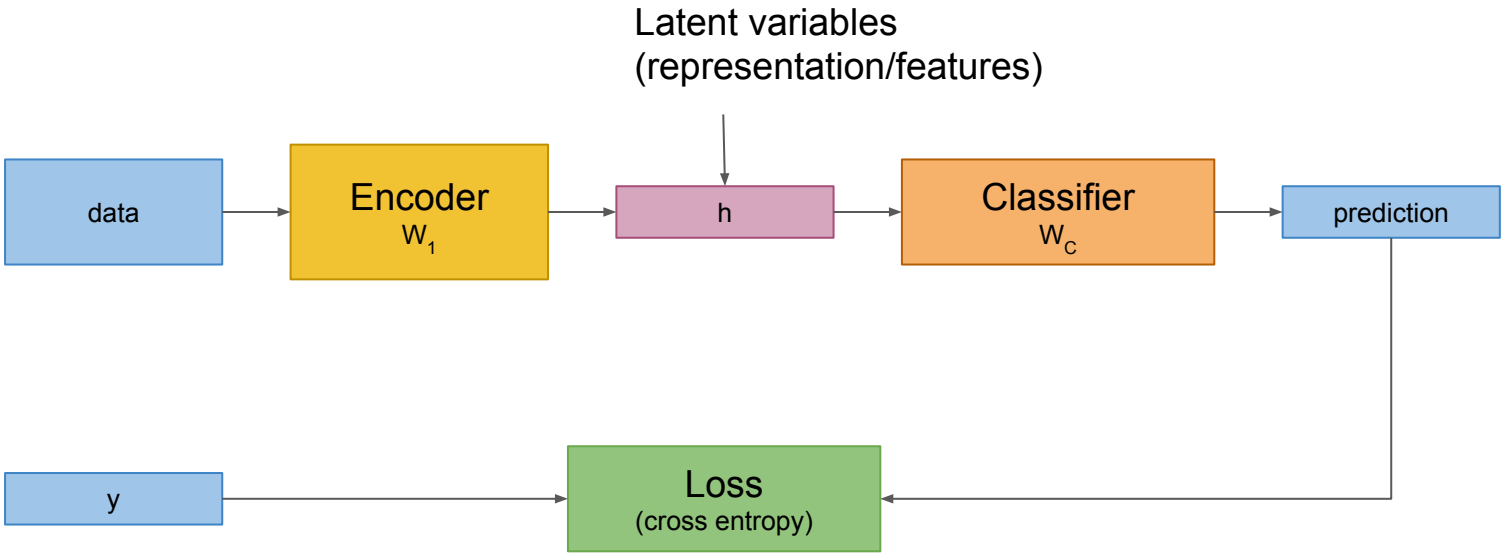
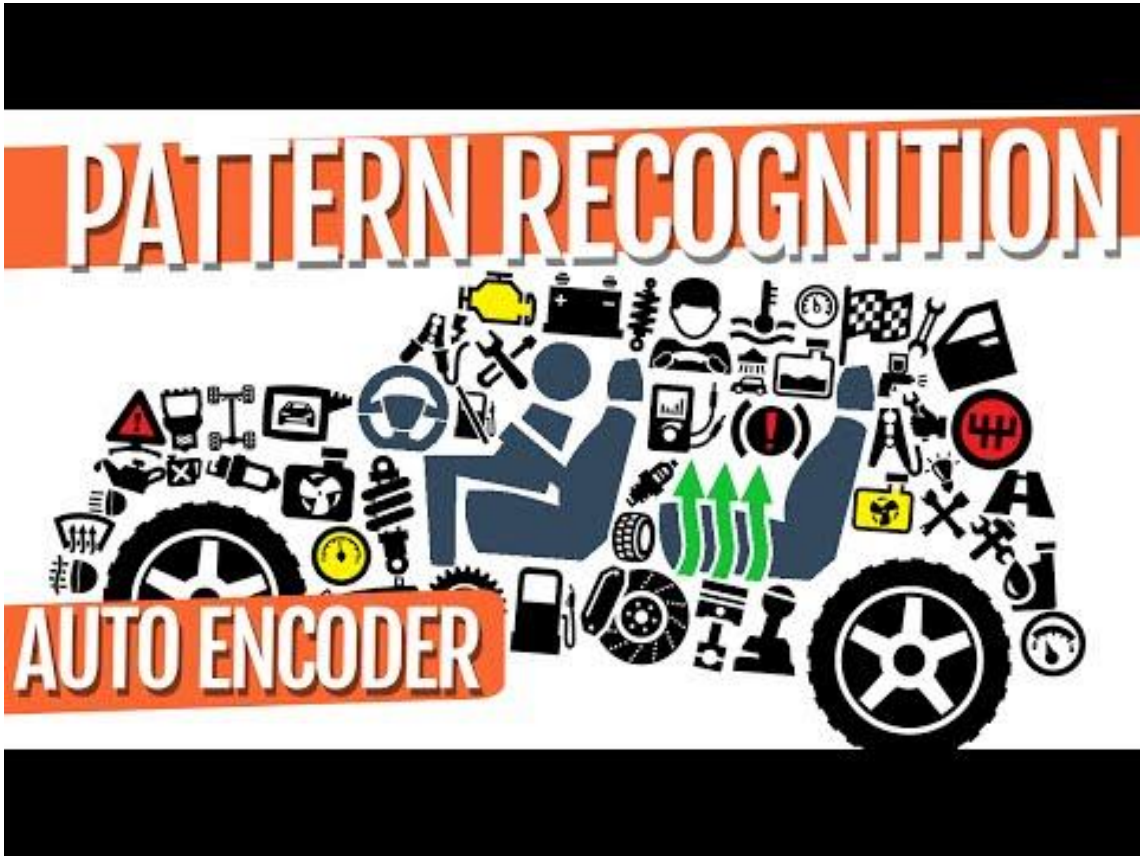


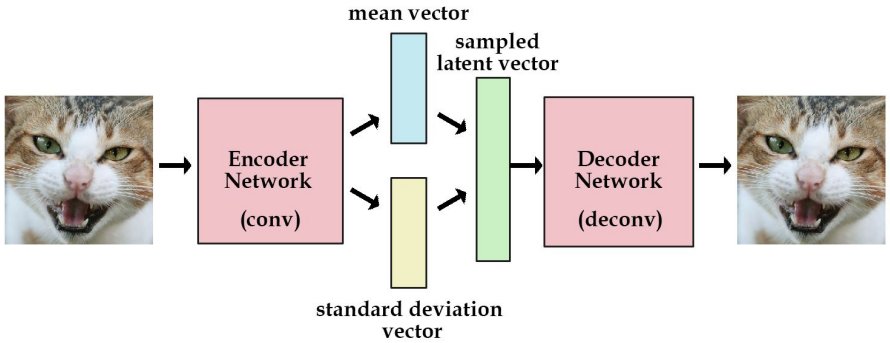
Figure: Kevin McGuinness (DLCV UPC 2017)

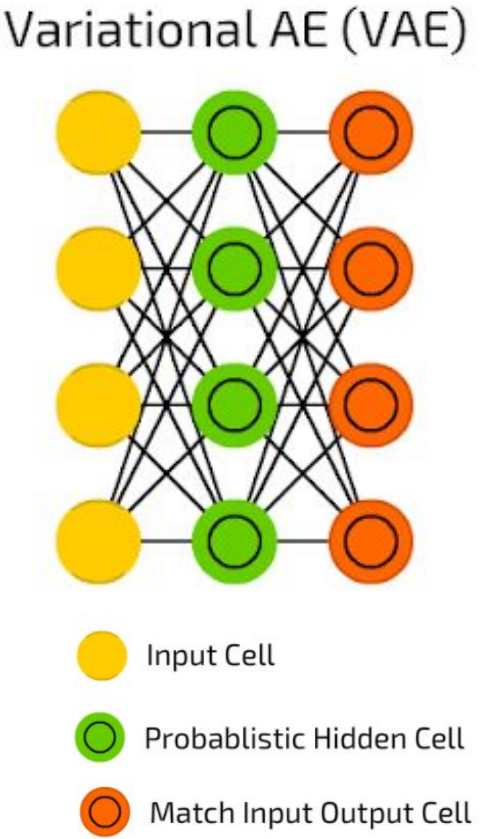
Autoencoder (AE)



Deep Learning TV, [“Autoencoders - Ep. 10”]

Variational Autoencoder (AE)



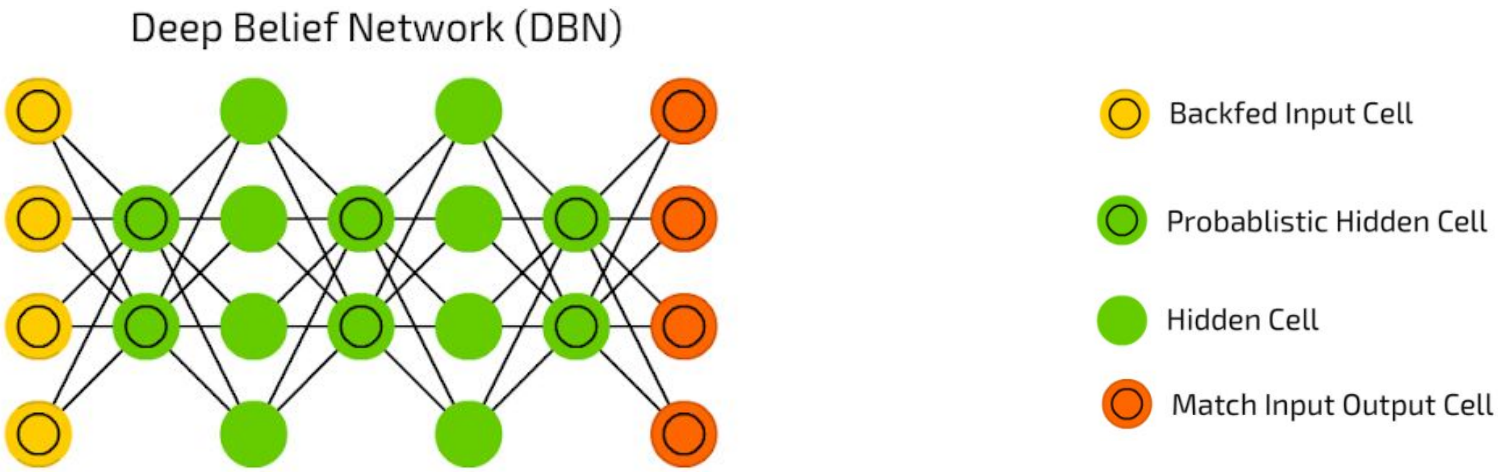


F. Van Veen, "The Neural Network Zoo" (2016)

Restricted Boltzmann Machine (RBM)

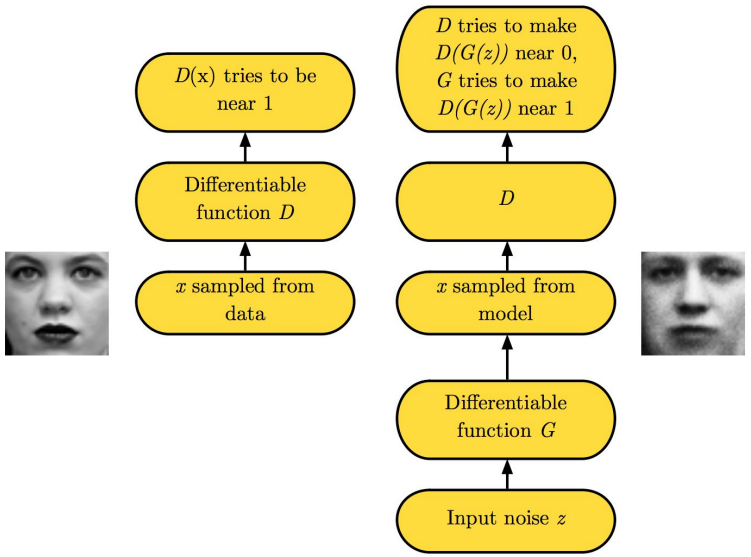
F. Van Veen, “The Neural Network Zoo” (2016)

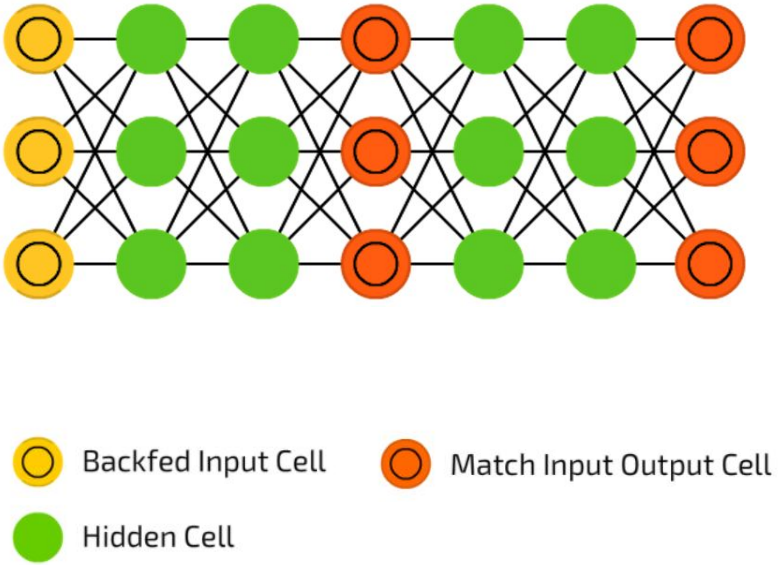
Deep Belief Network (DBN)



F. Van Veen, “The Neural Network Zoo” (2016)

Adversarial Networks

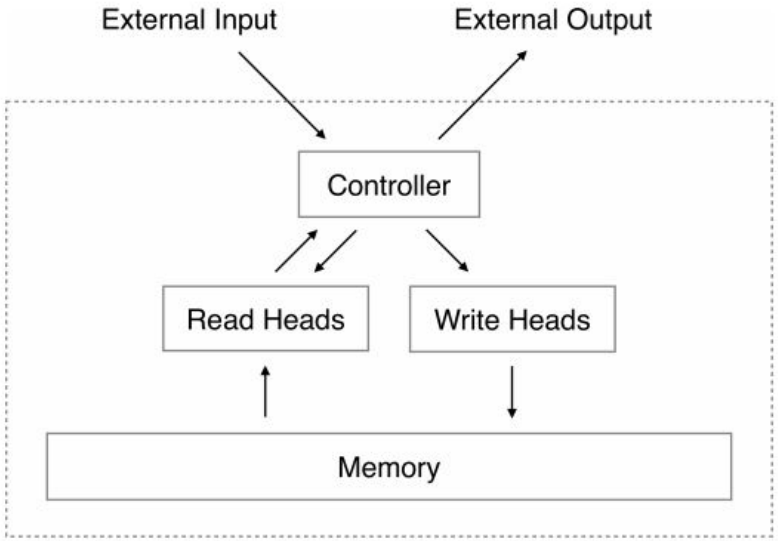


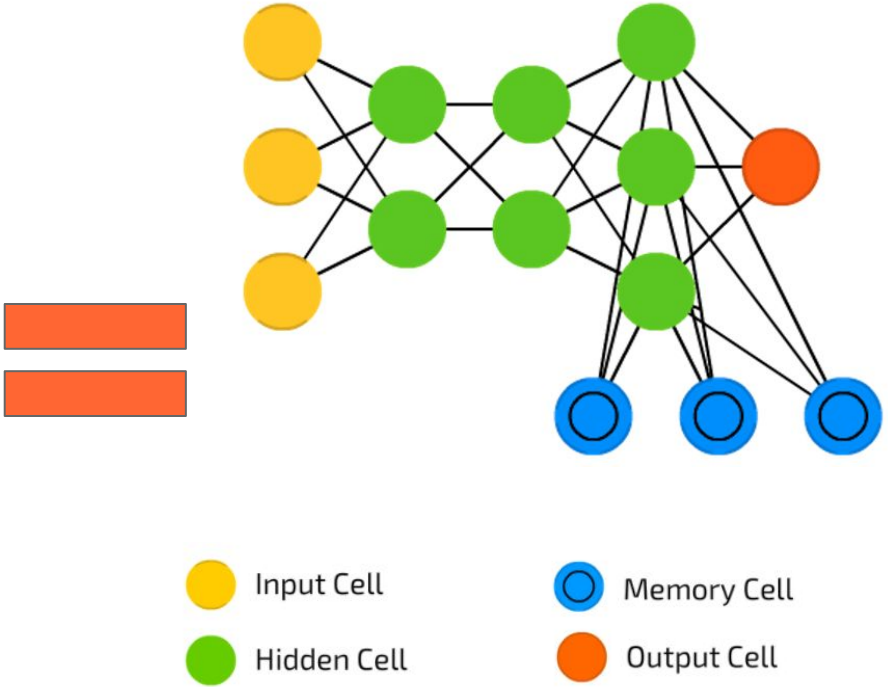


Goodfellow, Ian, Jean Pouget-Abadie, Mehdi Mirza, Bing Xu, David Warde-Farley, Sherjil Ozair, Aaron Courville, and Yoshua Bengio. "Generative adversarial nets." NIPS 2014
Goodfellow, Ian. "NIPS 2016 Tutorial: Generative Adversarial Networks." *arXiv preprint arXiv:1701.00160* (2016).

F. Van Veen, "The Neural Network Zoo" (2016)

Differentiable Neural Computers (DNC)

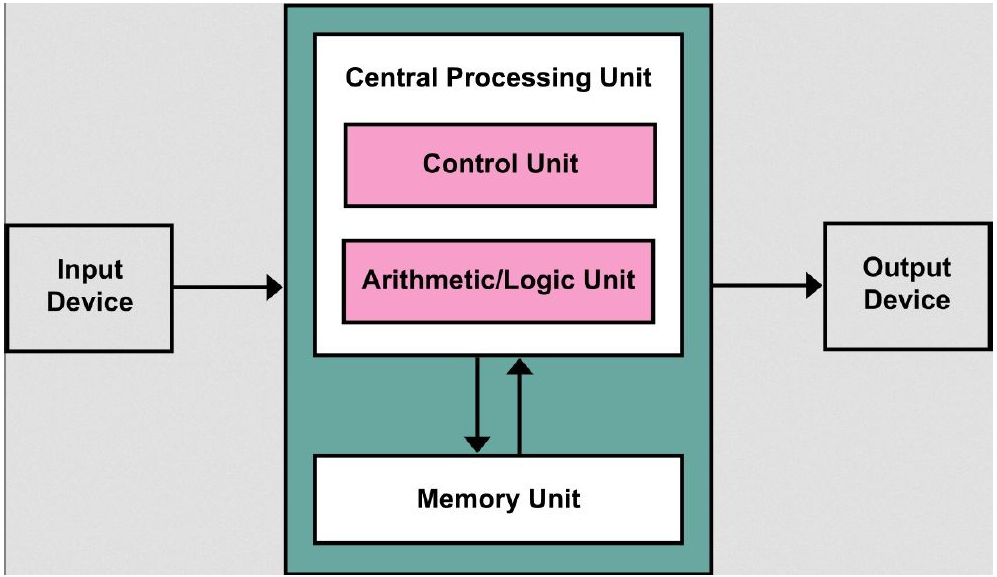




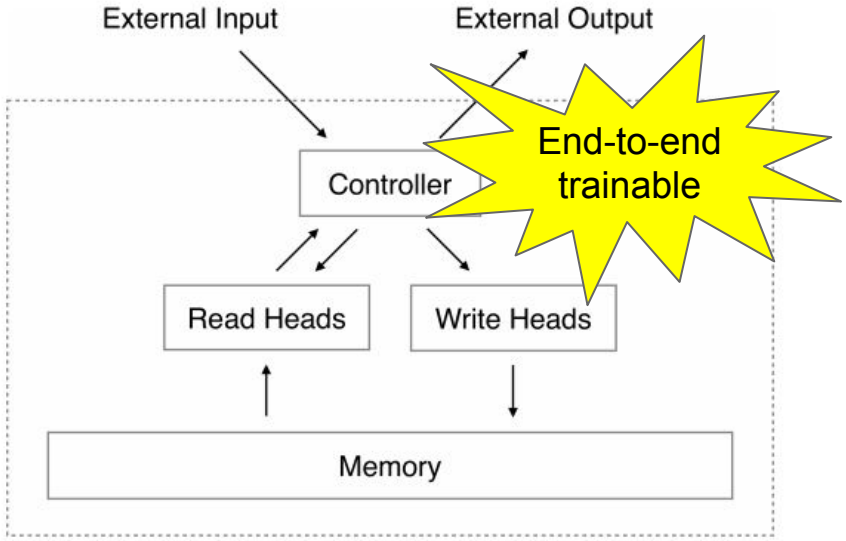
Graves, Alex, Greg Wayne, and Ivo Danihelka. "Neural turing machines." *arXiv preprint arXiv:1410.5401* (2014). [slides] [code]

F. Van Veen, "The Neural Network Zoo" (2016)

Differentiable Neural Computers (DNC)



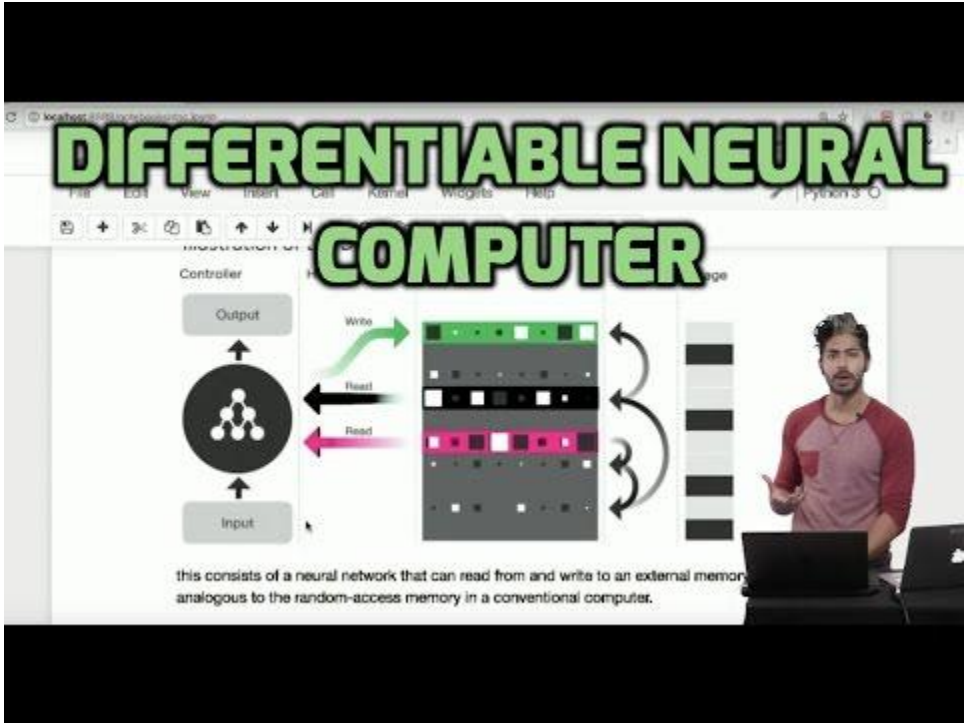
von Neumann architecture (1952)

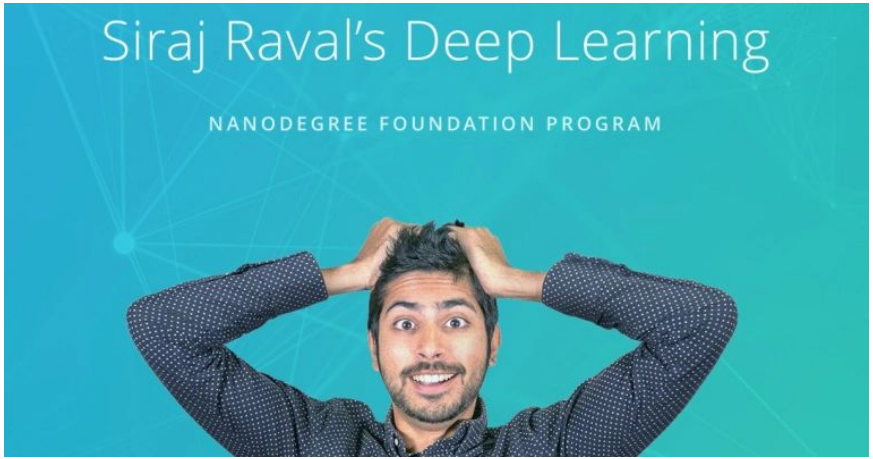


Neural Turing Machine (2014)

Graves, Alex, Greg Wayne, and Ivo Danihelka. "Neural turing machines." *arXiv preprint arXiv:1410.5401* (2014). [slides] [code]

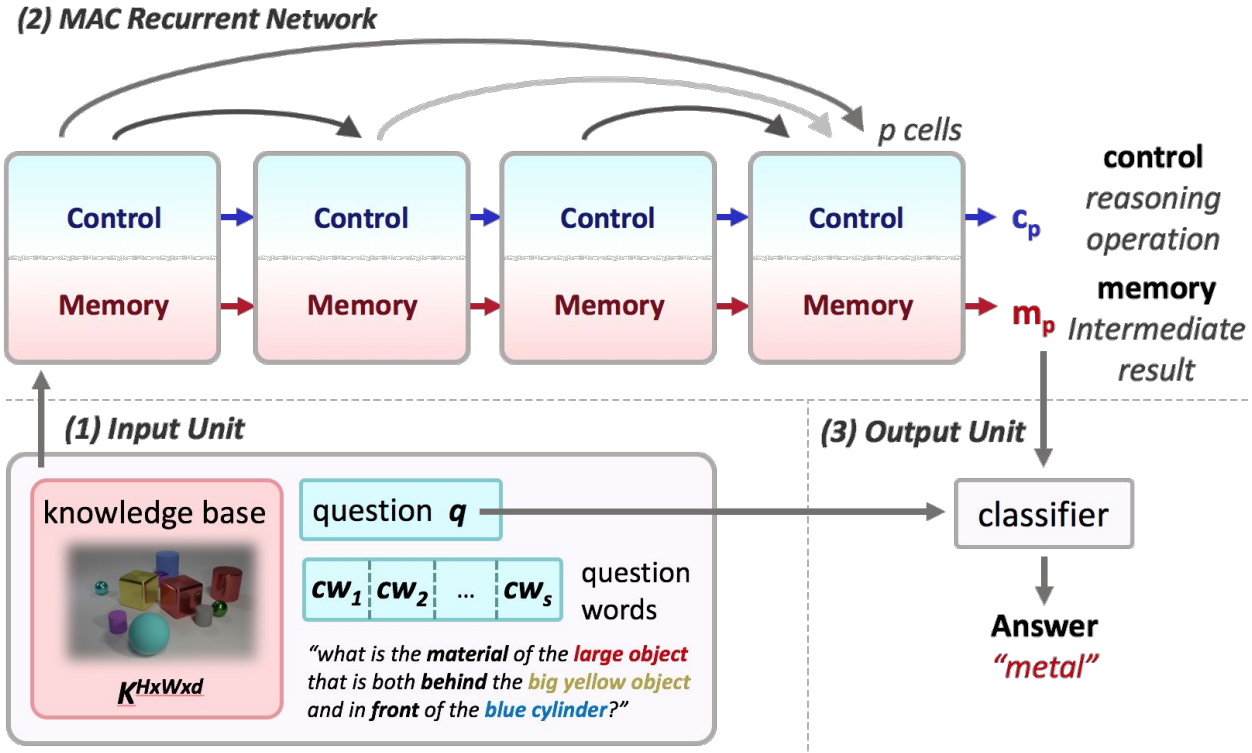
Differentiable Neural Computers (DNC)





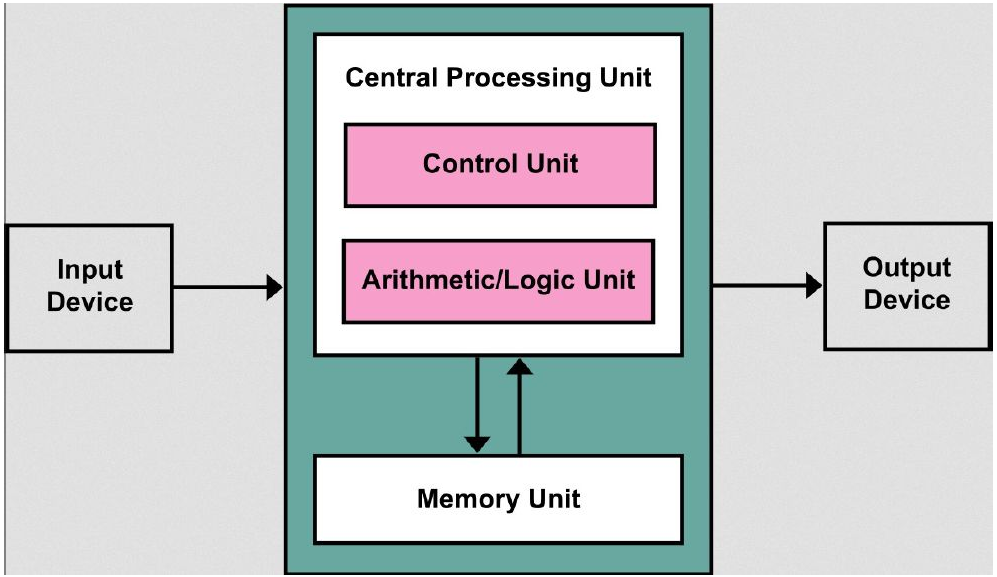
[Siraj Raval on YouTube]

MAC Network

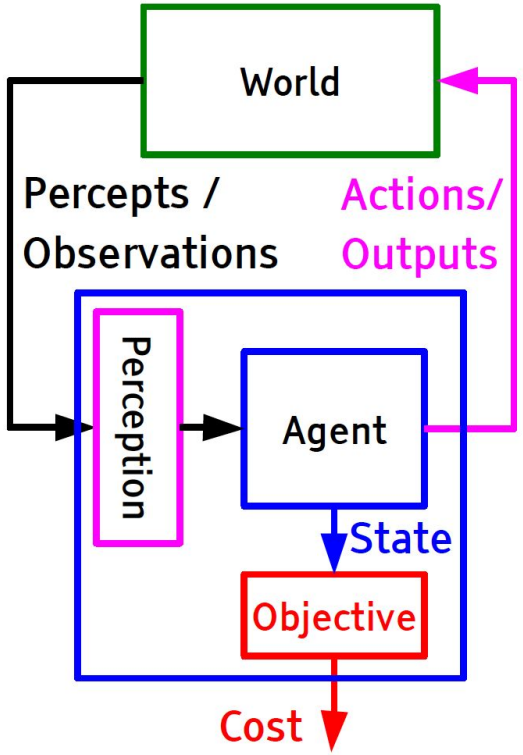


Hudson, Drew A., and Christopher D. Manning. "Compositional attention networks for machine reasoning." ICLR 2018.

More architectures to come...

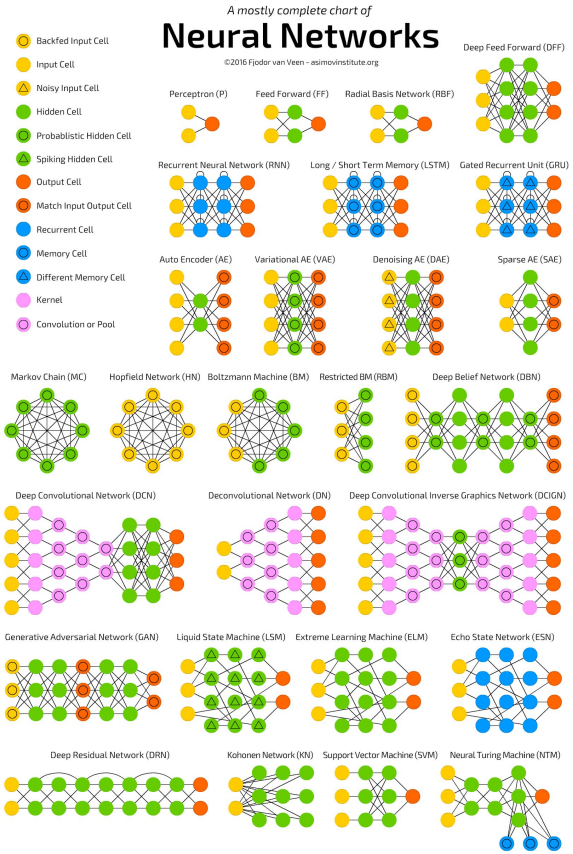


von Neumann architecture (1952)



Yann LeCun, "A Path to AI", Beneficial AI 2017.

The Full Story

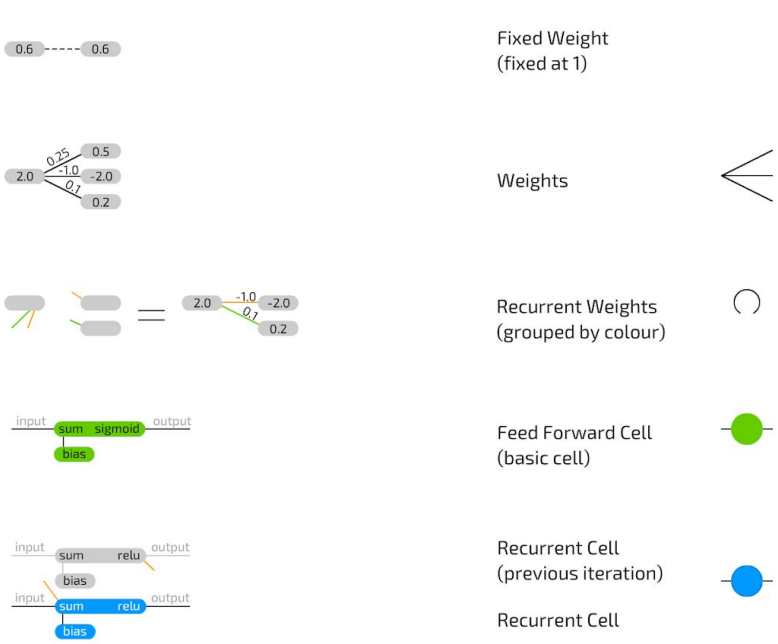


F. Van Veen, [“The Neural Network Zoo”](#) (2016)

The Prequel

An informative chart to build

Neural Network Cells



Fjodor Van Veen, [“Neural Network Zoo Prequel: Cells and Layers”](#)(2017)

Questions?