

DEEP LEARNING FOR COMPUTER VISION

Summer School at UPC TelecomBCN Barcelona. June 28-July 4, 2018



Instructors



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Day 1 Lecture 2

The Neural Network Zoo



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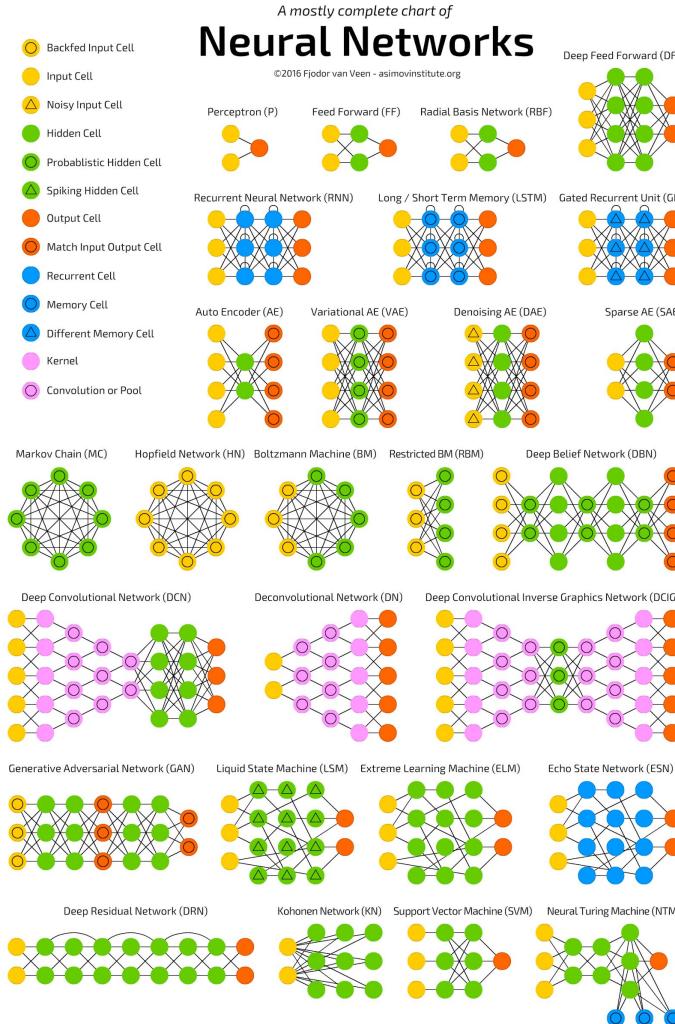
Associate Professor
Universitat Politècnica de Catalunya
Technical University of Catalonia



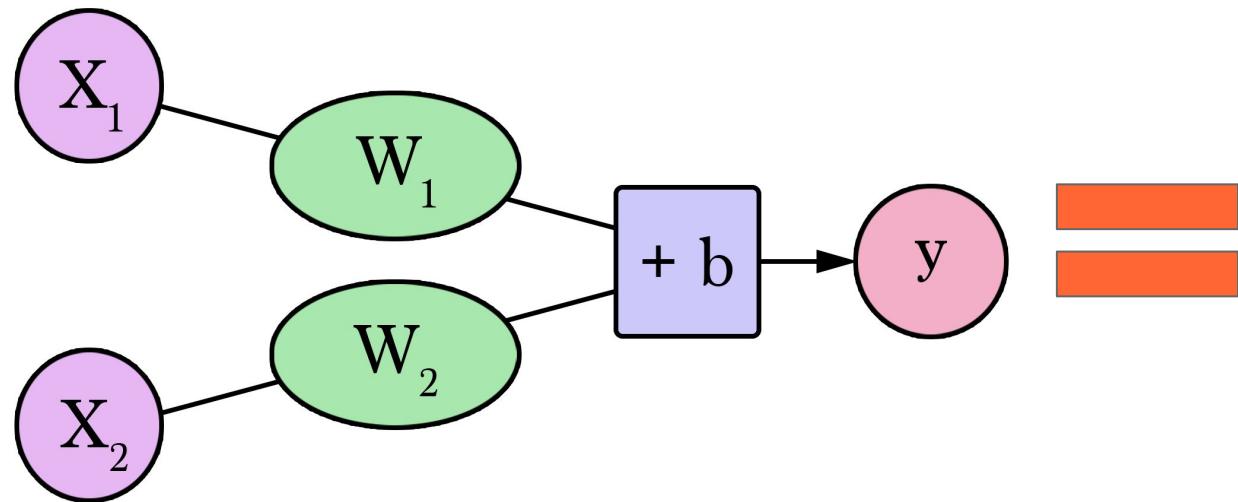
Acknowledgements



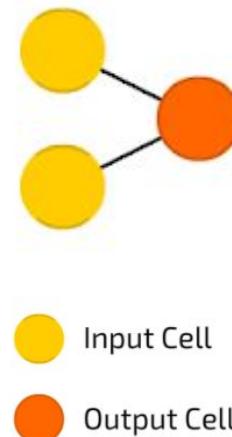
Fjodor Van Veen,
“The Neural Network Zoo”
The Asimov Institute (2016)



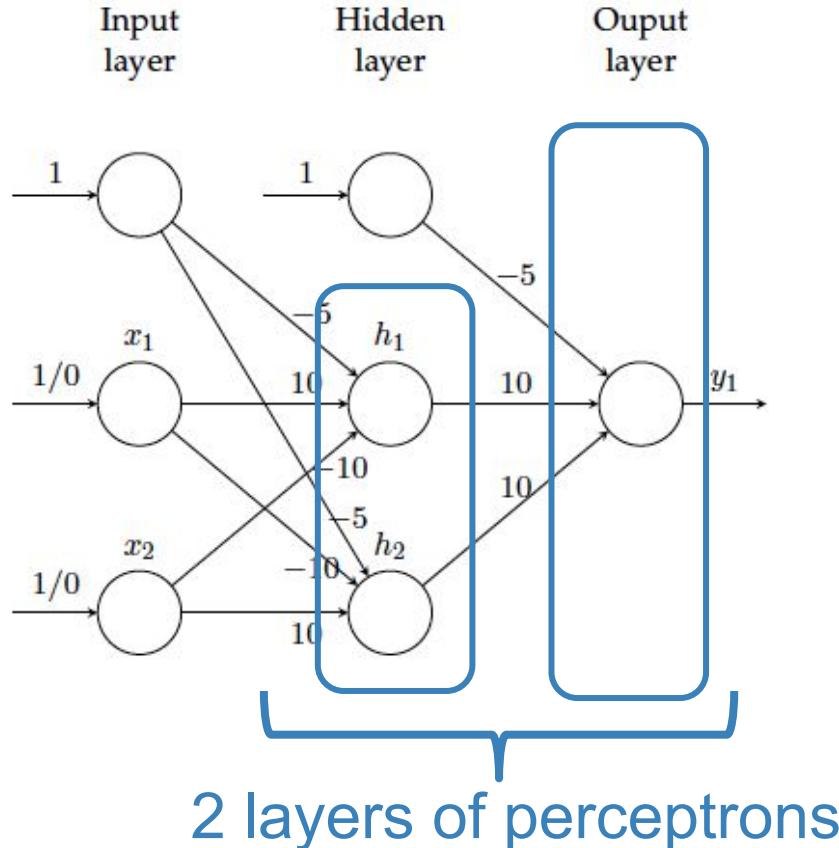
The Perceptron



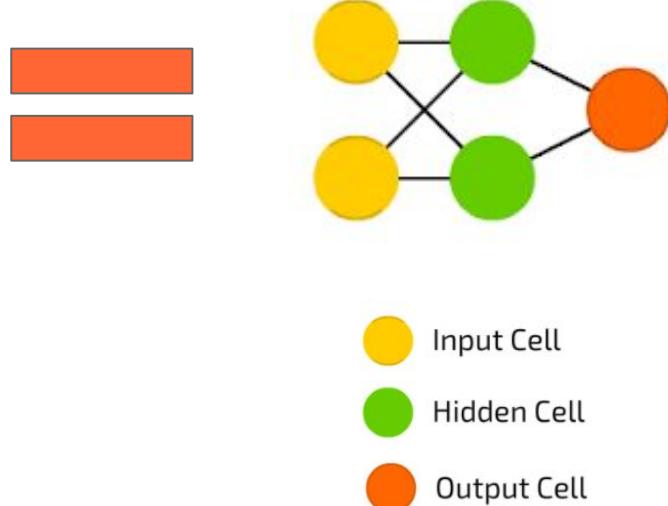
Perceptron (P)



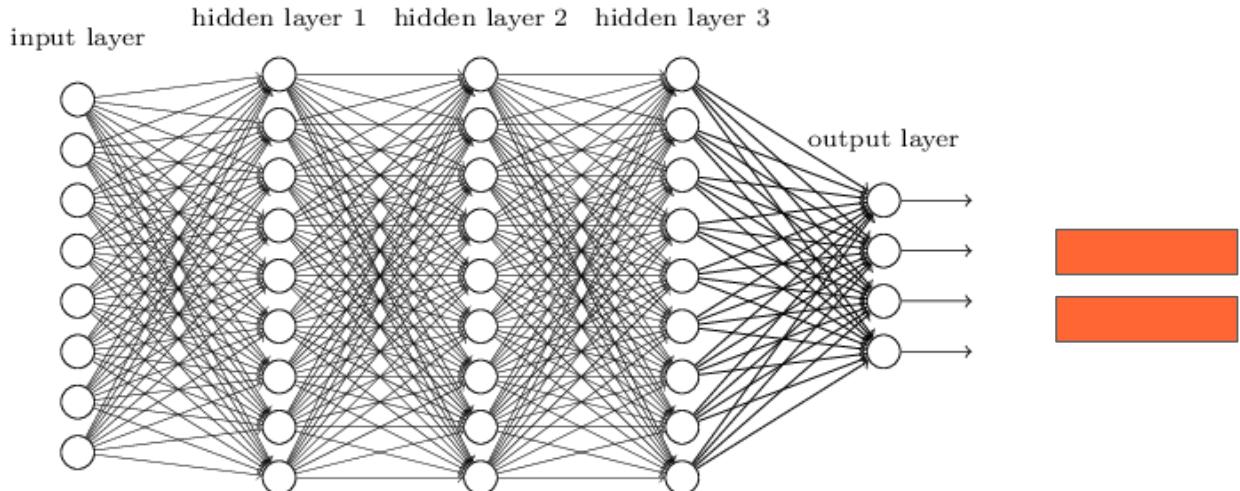
Neural Network = Multi-layer Perceptron



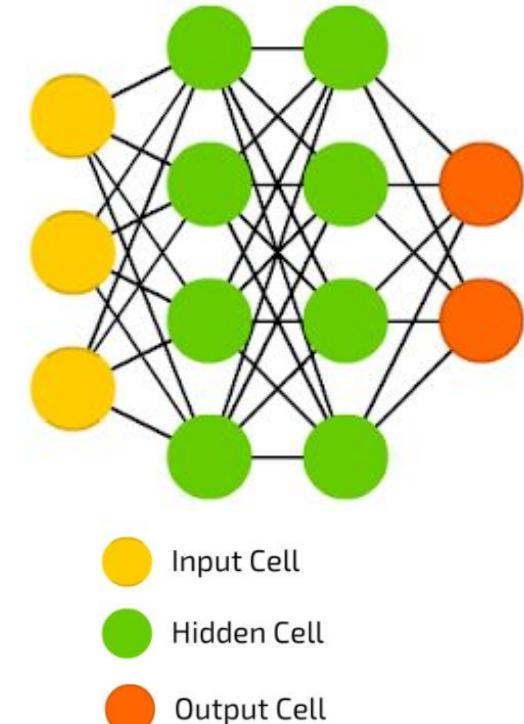
Feed Forward (FF)



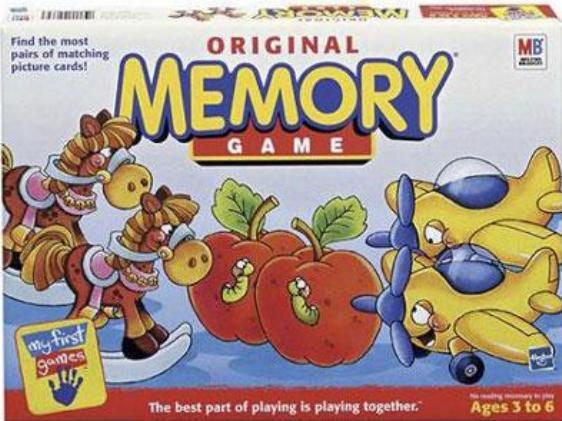
Deep Neural Network (DNN)



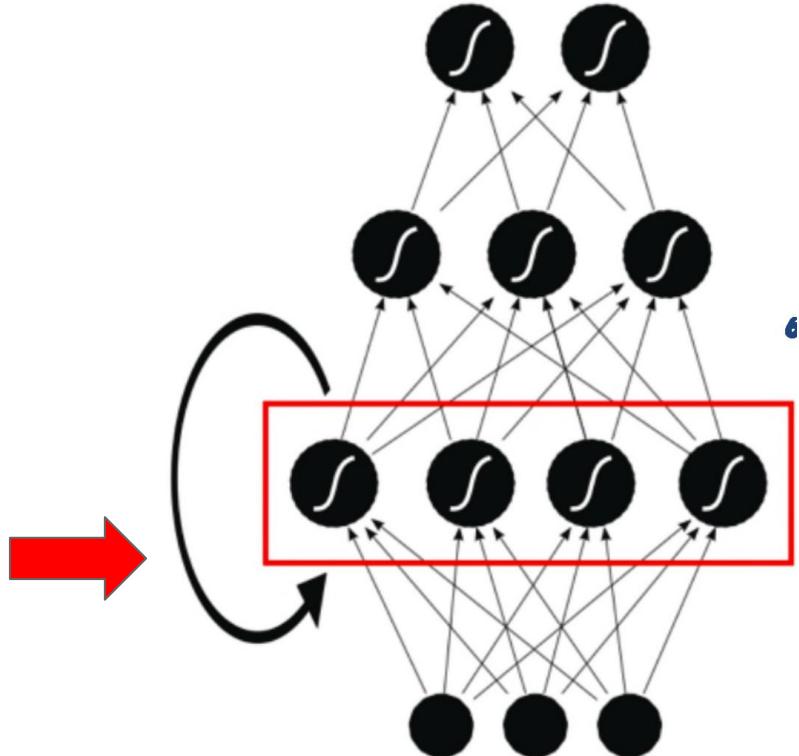
Deep Feed Forward (DFF)



Recurrent Neural Network (RNN)

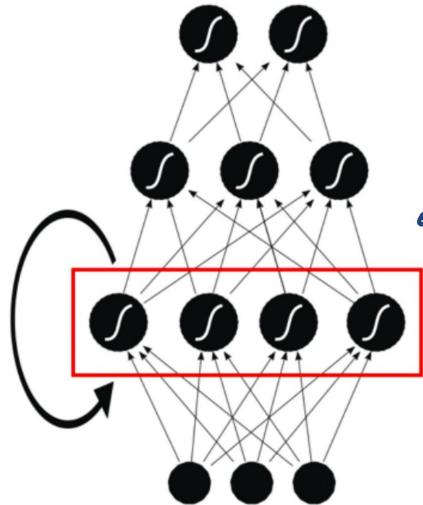


The hidden layers and the output depend from previous states of the hidden layers

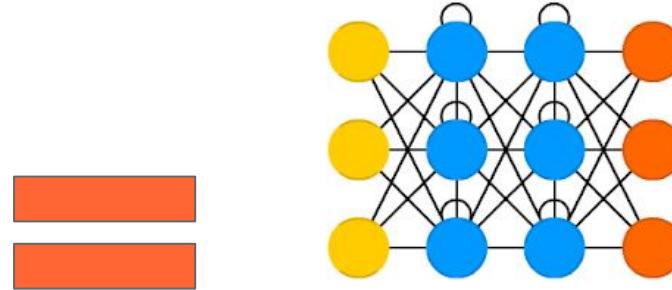




Recurrent Neural Network (RNN)



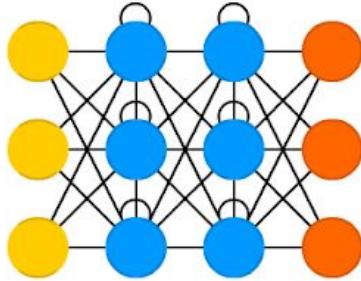
Recurrent Neural Network (RNN)



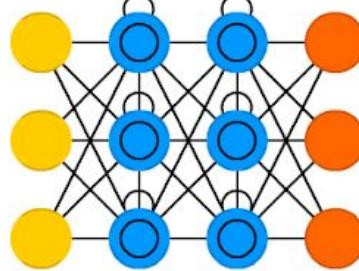
- Input Cell
- Recurrent Cell
- Output Cell

Recurrent Neural Network (RNN)

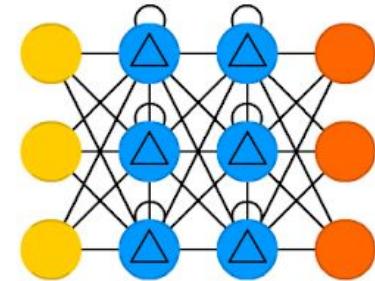
Recurrent Neural Network (RNN)



Long / Short Term Memory (LSTM)



Gated Recurrent Unit (GRU)



Input Cell

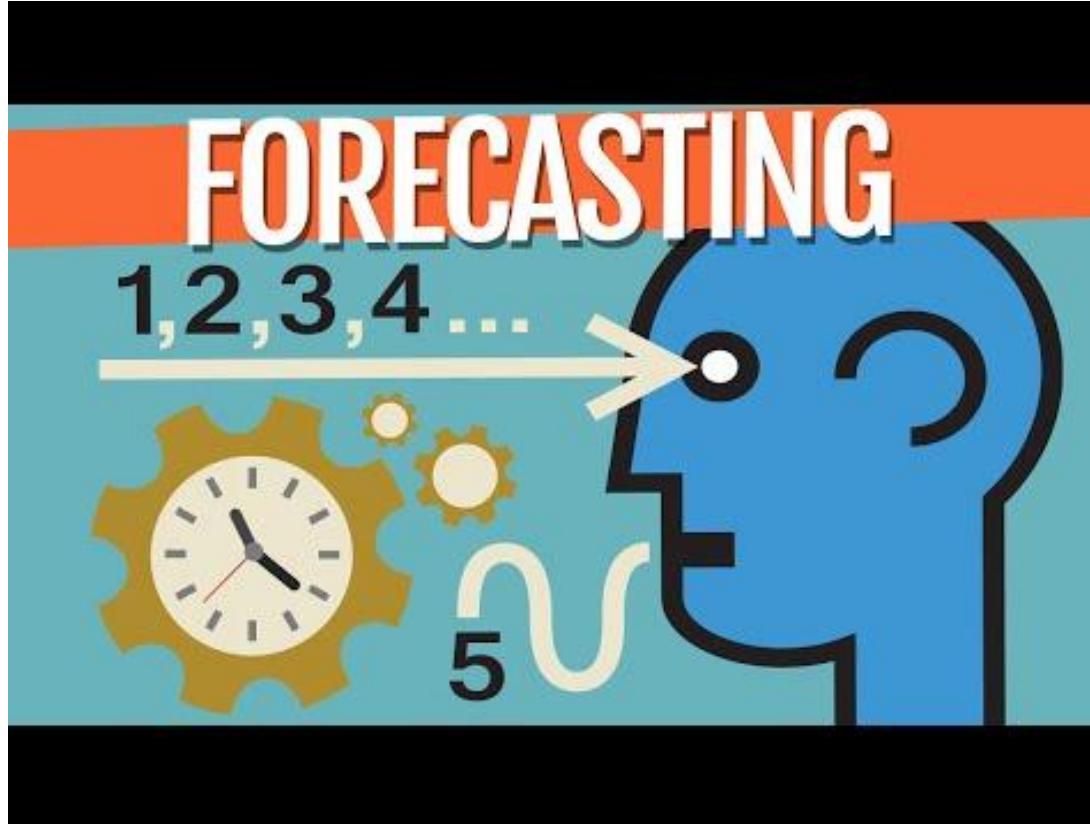
Recurrent Cell

Memory Cell

Different Memory Cell

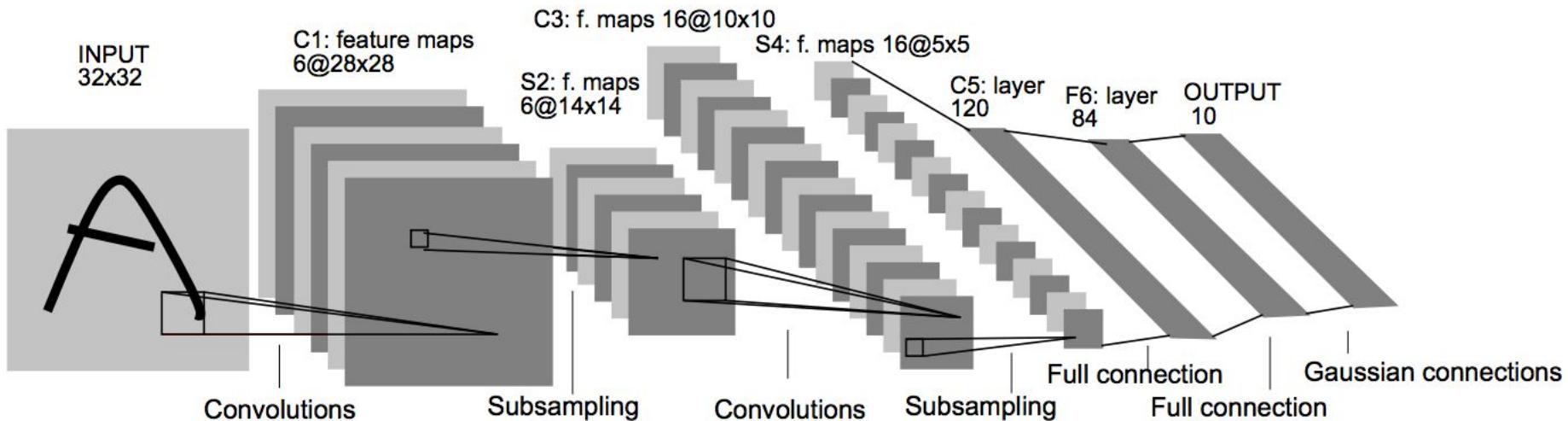
Output Cell

Recurrent Neural Network (RNN)



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.

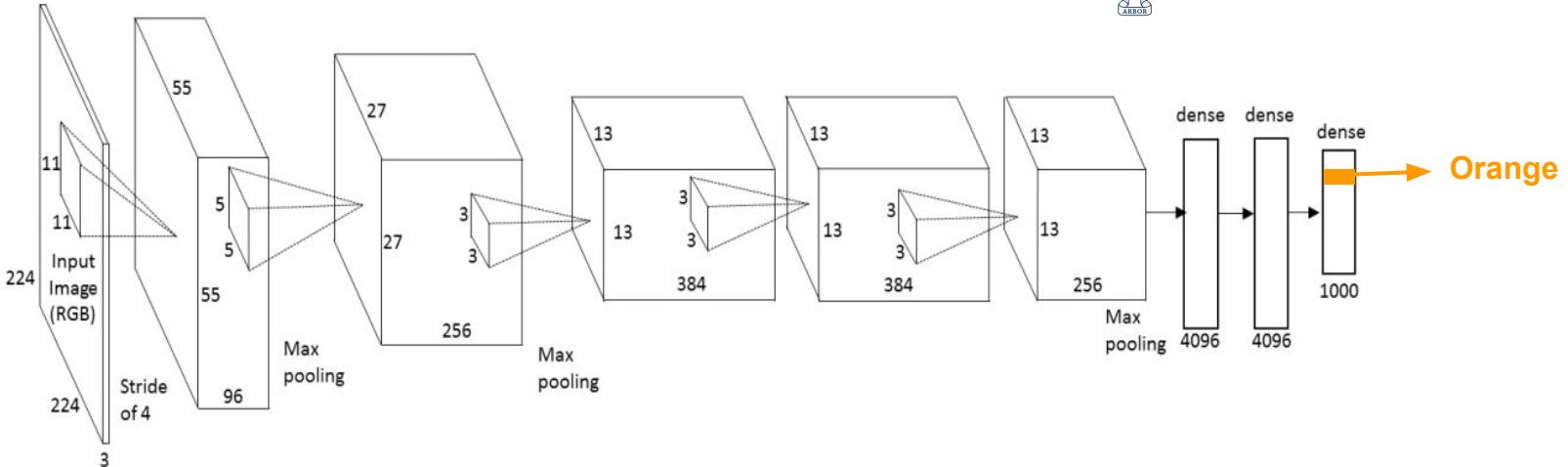


Convolutional Neural Network (CNN)

AlexNet

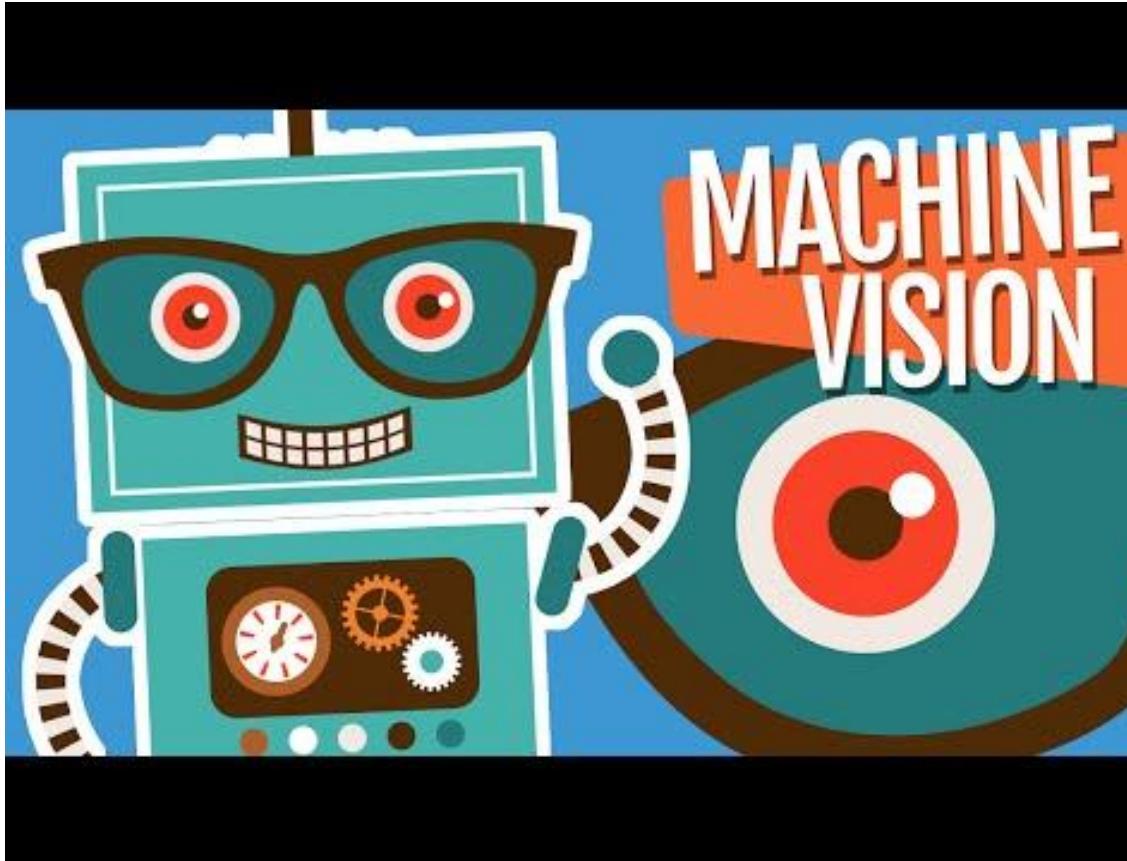


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A Krizhevsky, I Sutskever, GE Hinton “[Imagenet classification with deep convolutional neural networks](#)”
NIPS 2012.

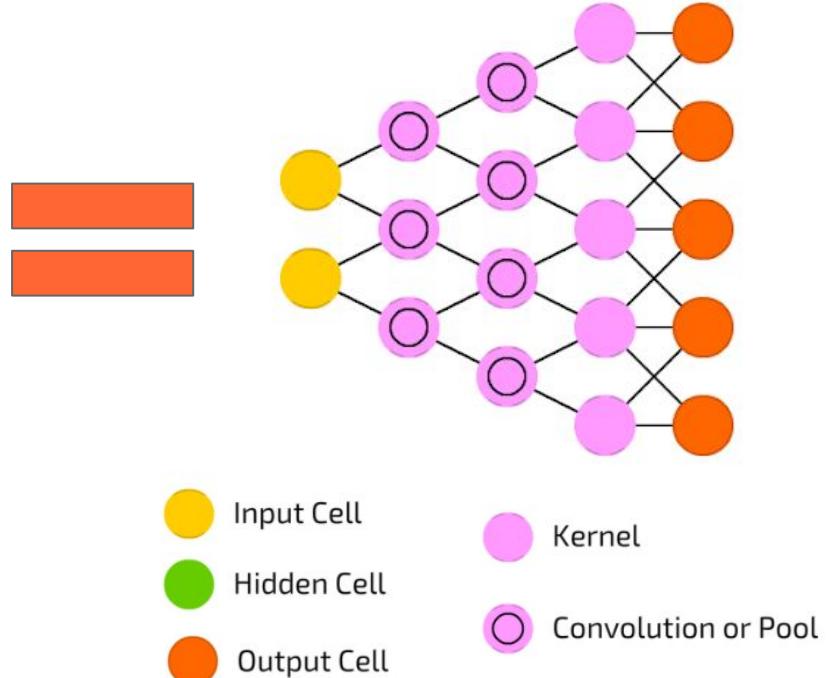
Convolutional Neural Network (CNN)



Deconvolutional Neural Network



Deconvolutional Network (DN)

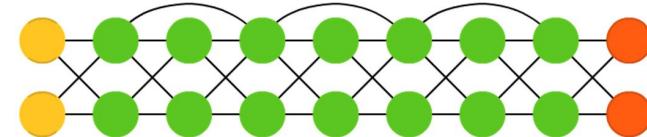
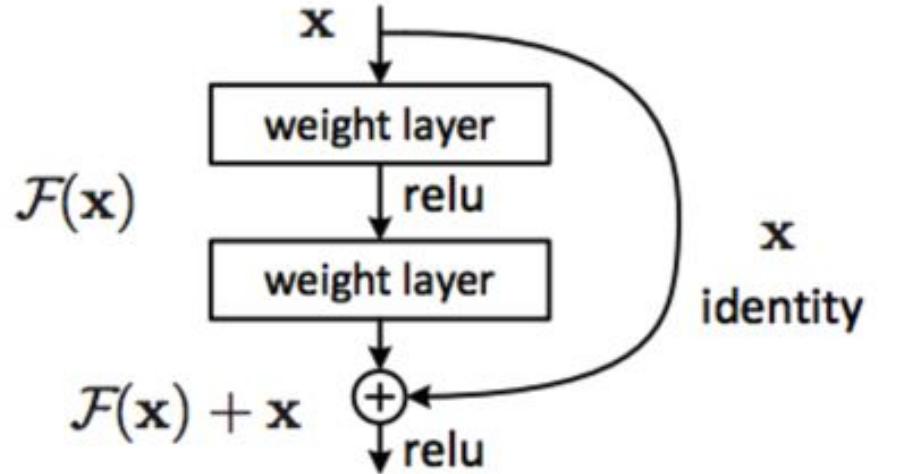


Junting Pan, [SalGAN](#) (2017)

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



Deep Residual Network



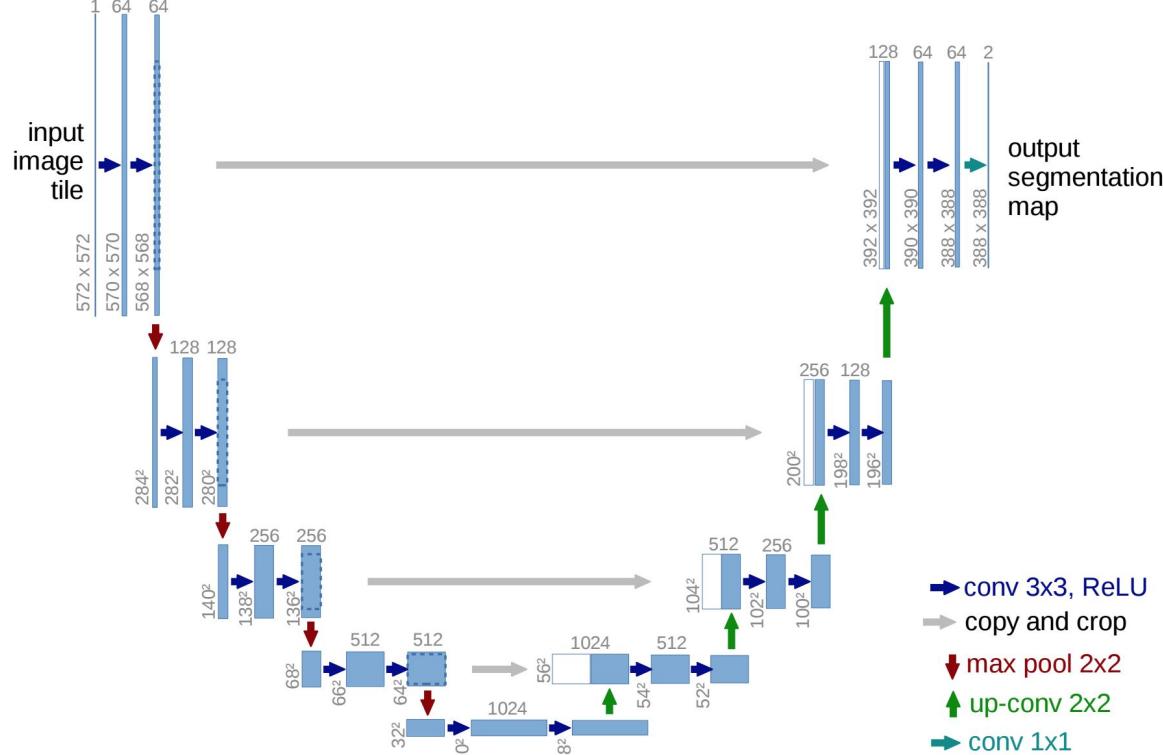
- Input Cell
- Hidden Cell
- Output Cell

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



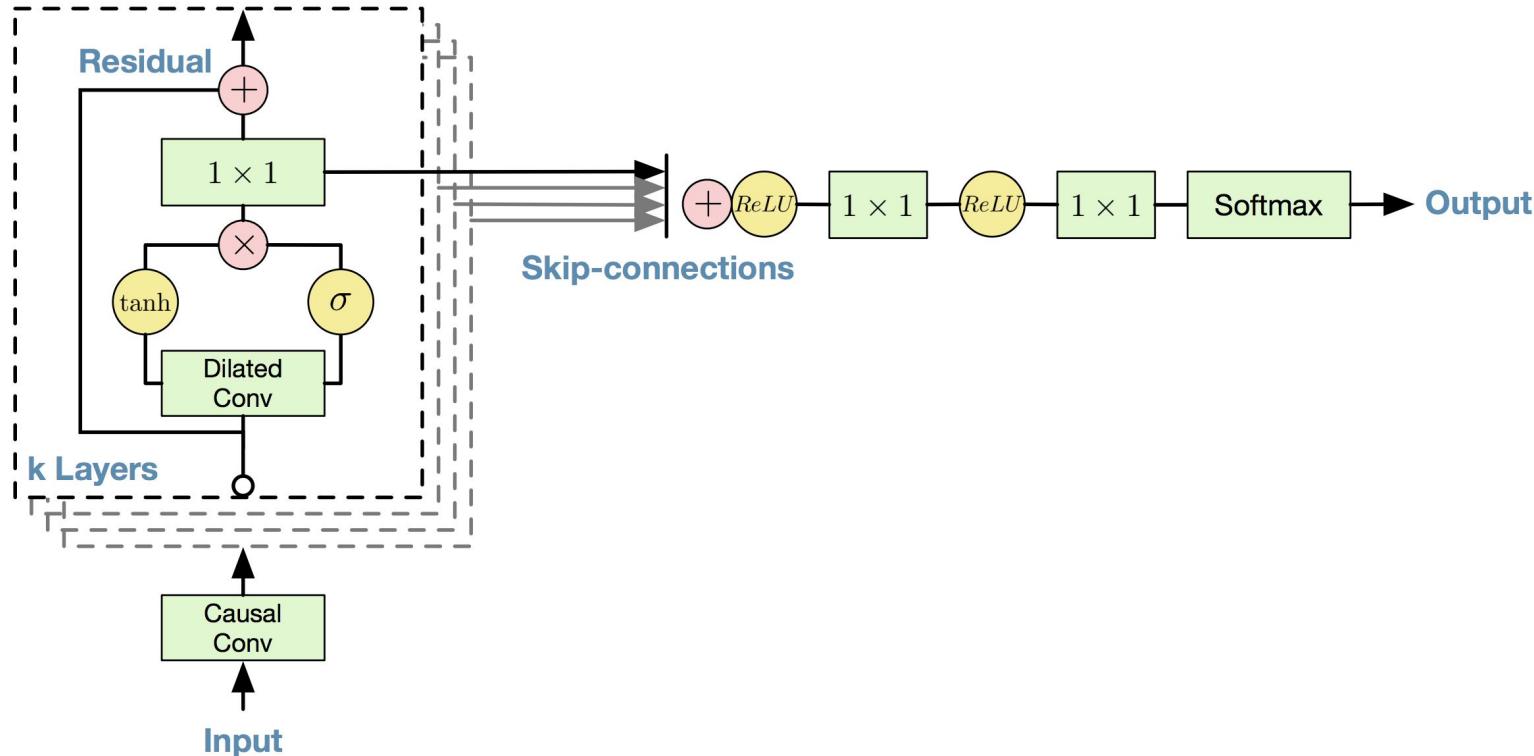
Skip Connections

U-Net





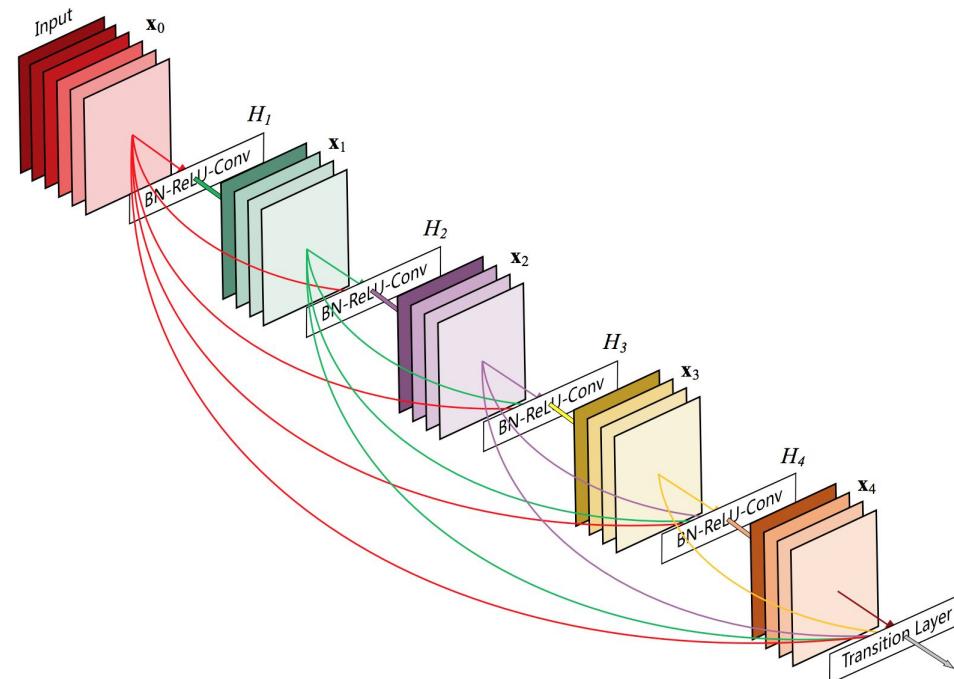
Skip Connections



Dense Connections

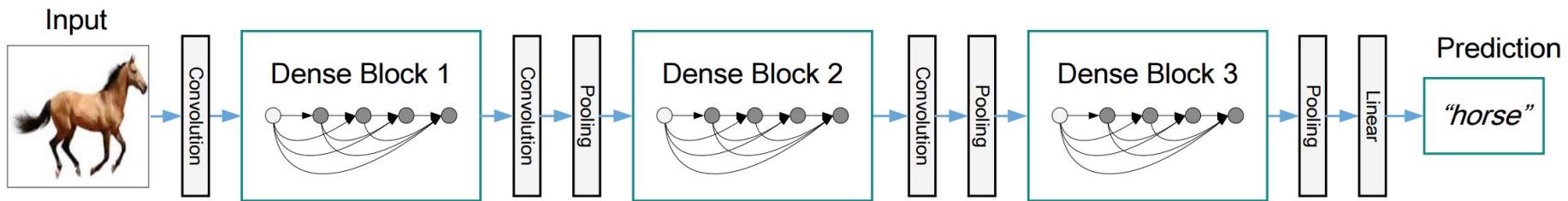
Connect every layer to every other layer of the same filter size.

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





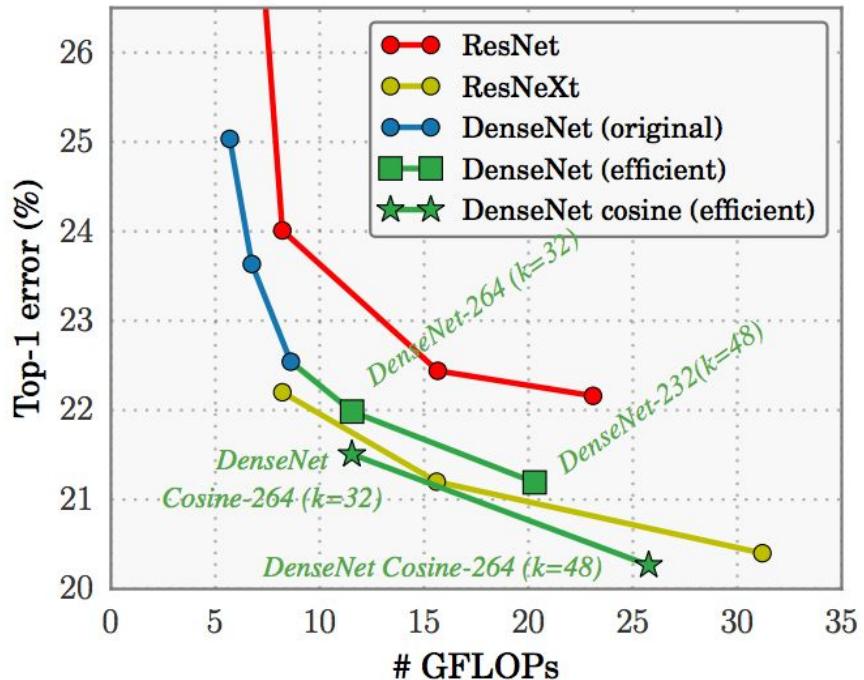
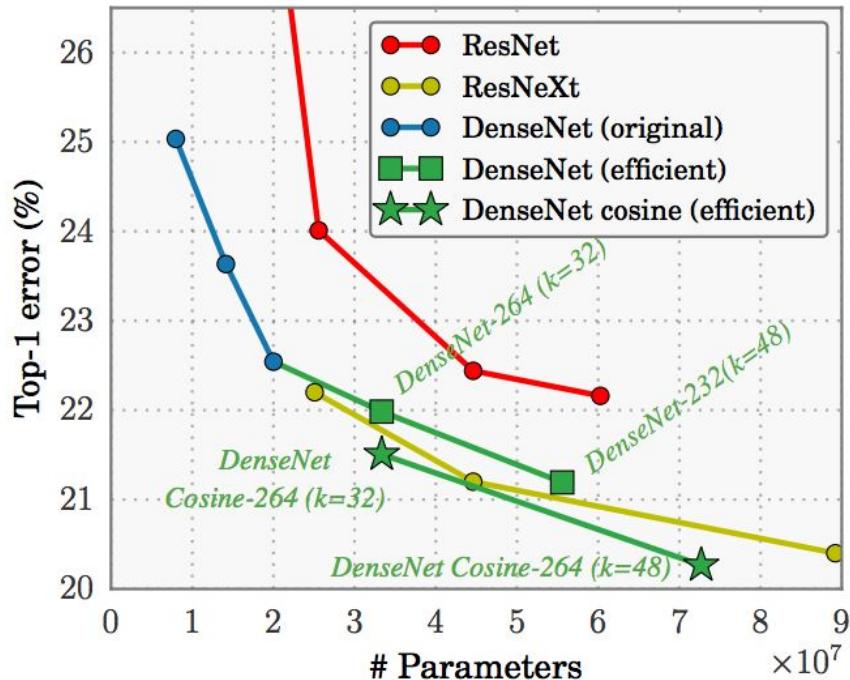
Dense Connections



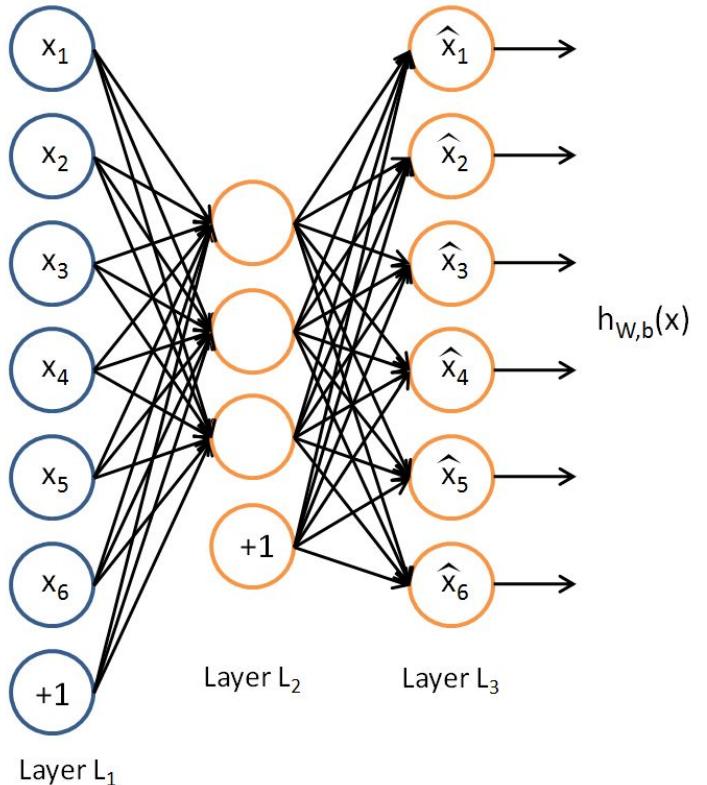


Dense Connections

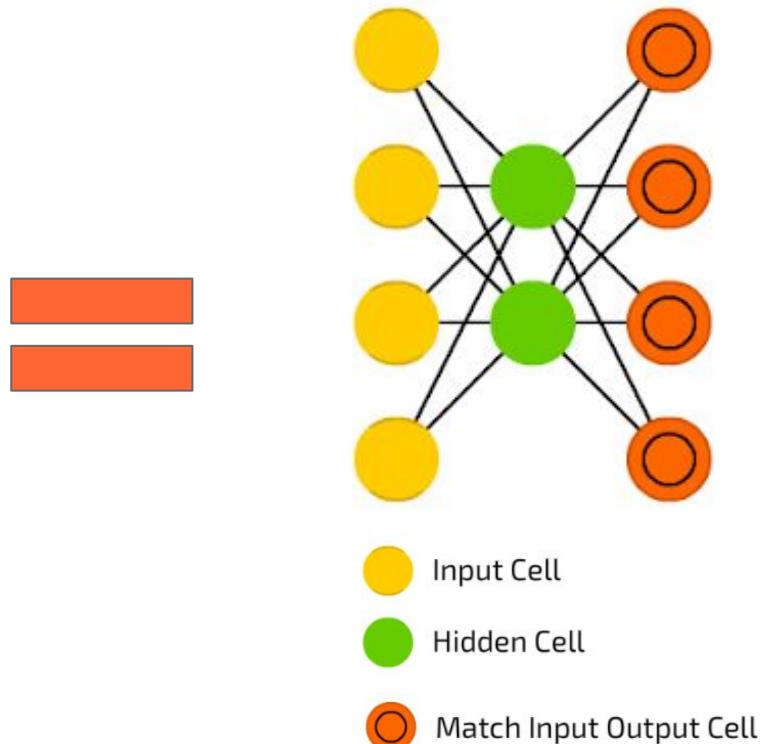
Results on ImageNet



Autoencoder (AE)

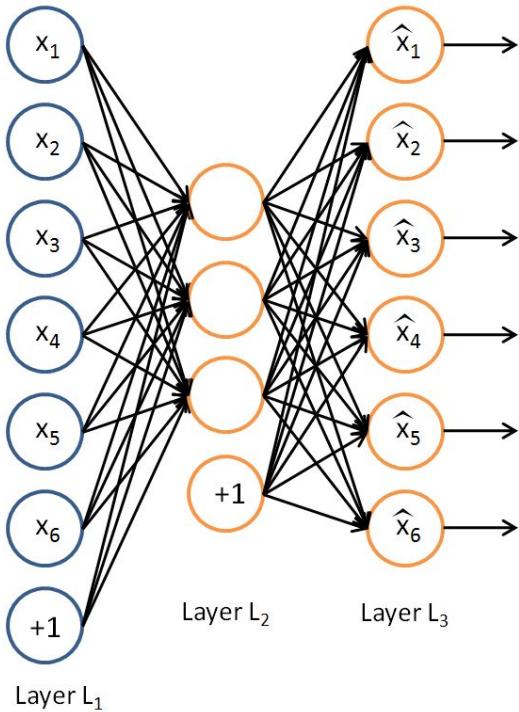


Auto Encoder (AE)





Autoencoder (AE)



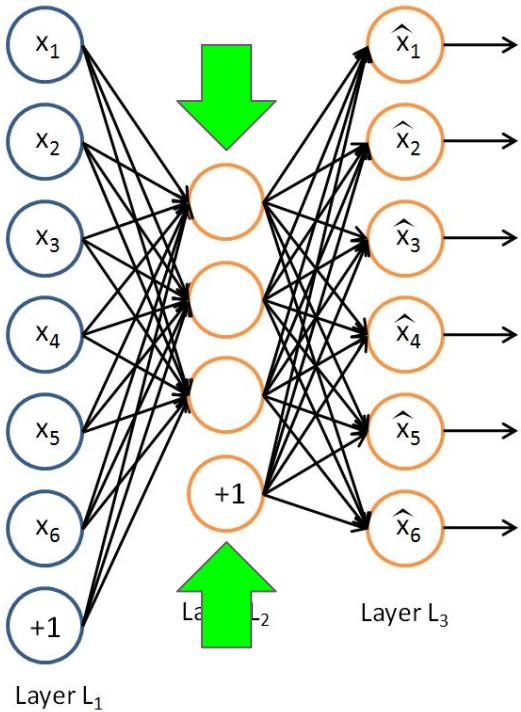
Autoencoders:

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



Autoencoder (AE)

WHY?



Application #1

Dimensionality reduction:

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

Autoencoder (AE)

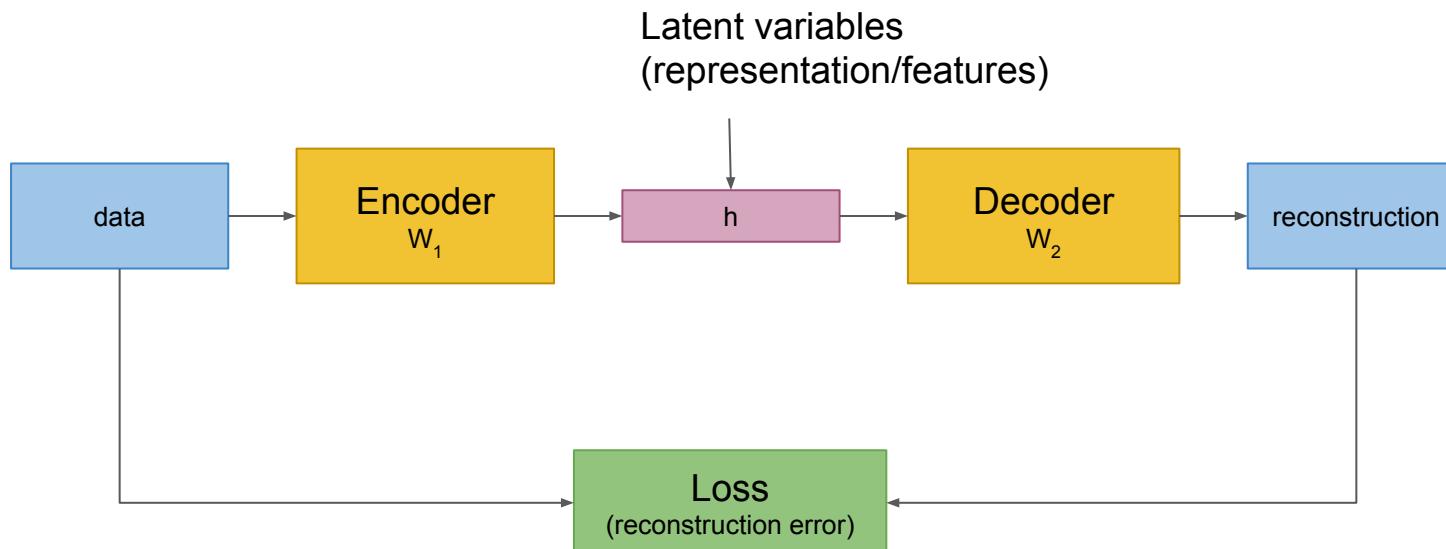
Application #2

WHY?



Pretraining:

1. Initialize a NN solving an autoencoding problem.



Autoencoder (AE)

Application #2

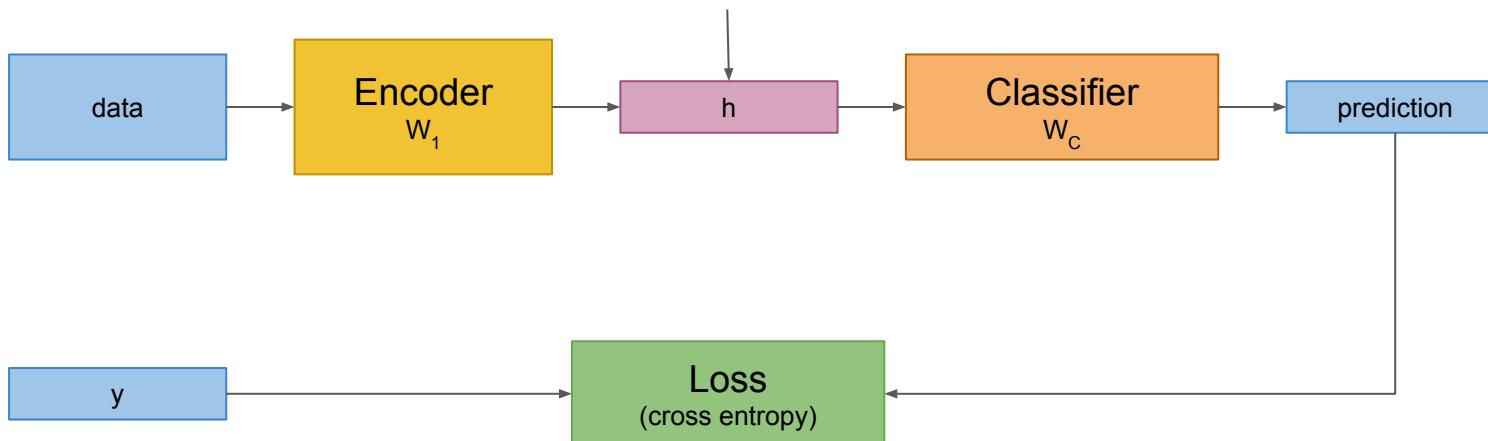
WHY?



Pretraining:

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

Latent variables
(representation/features)

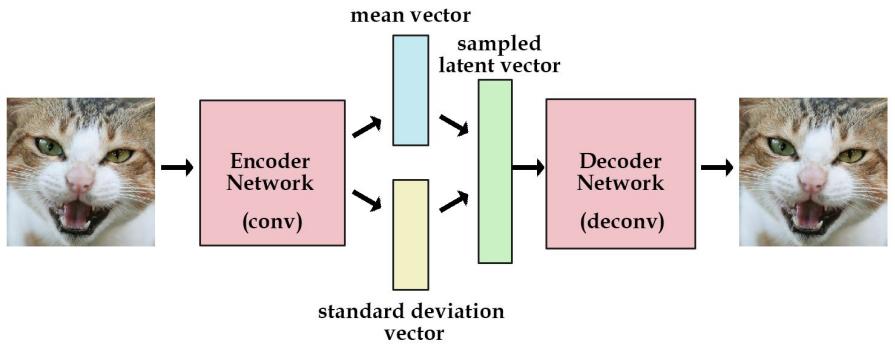




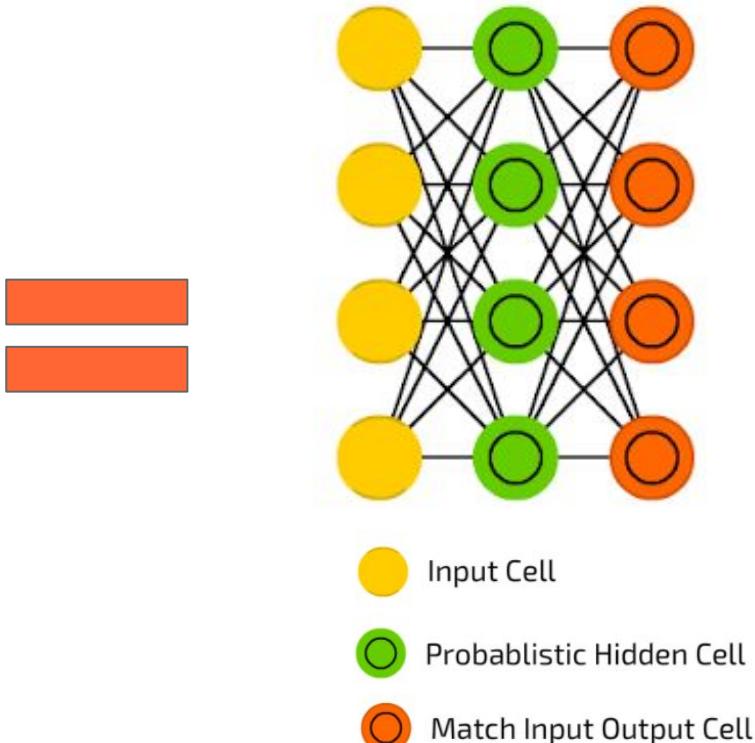
Autoencoder (AE)



Variational Autoencoder (AE)

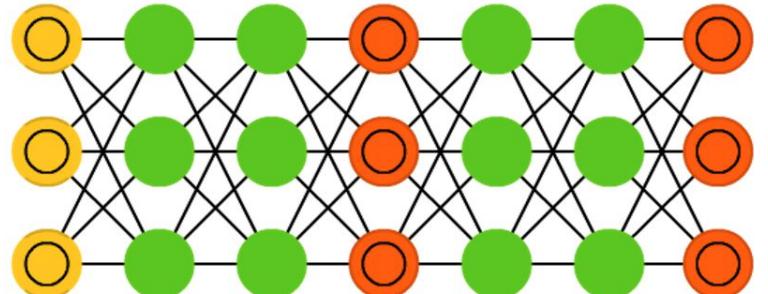
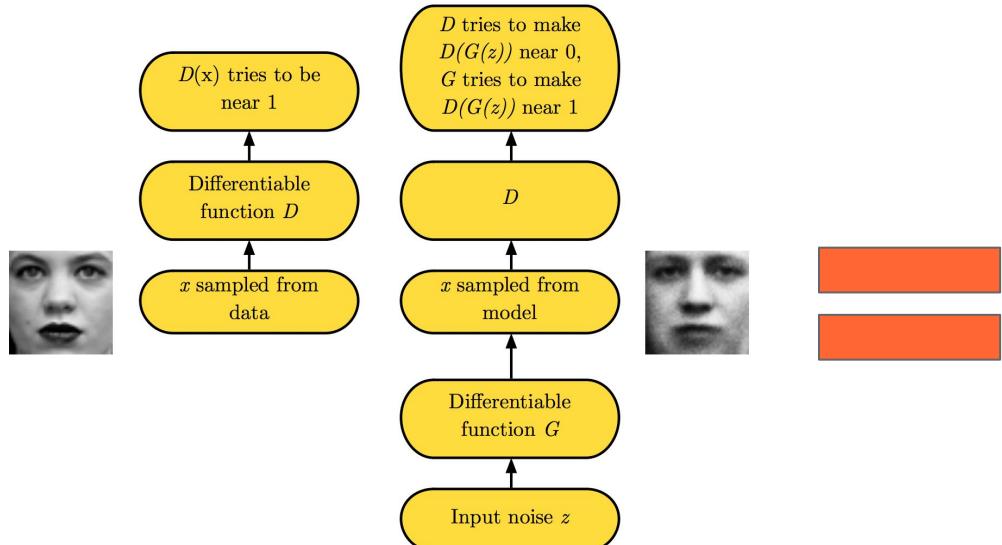


Variational AE (VAE)





Adversarial Networks



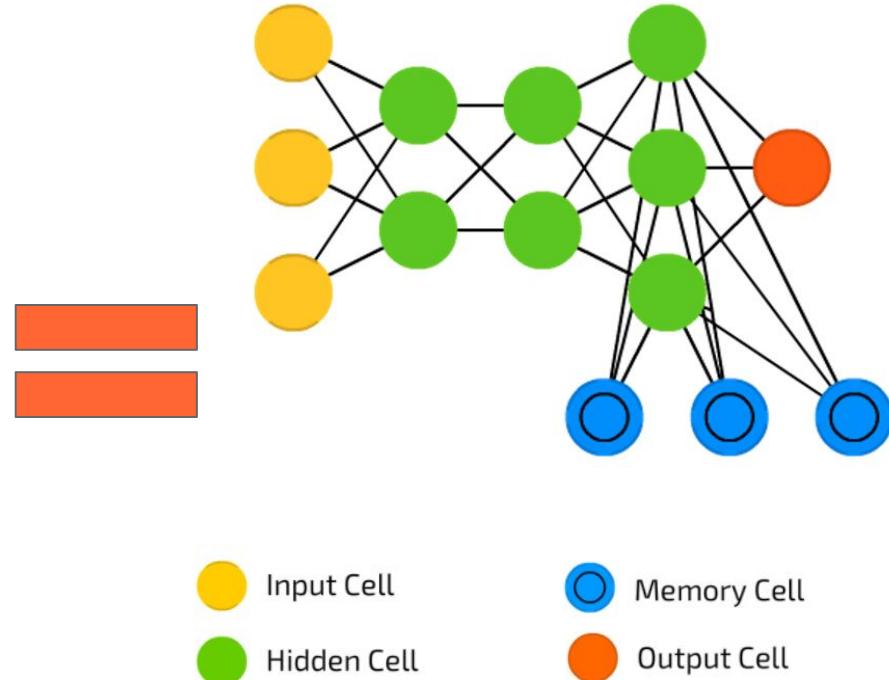
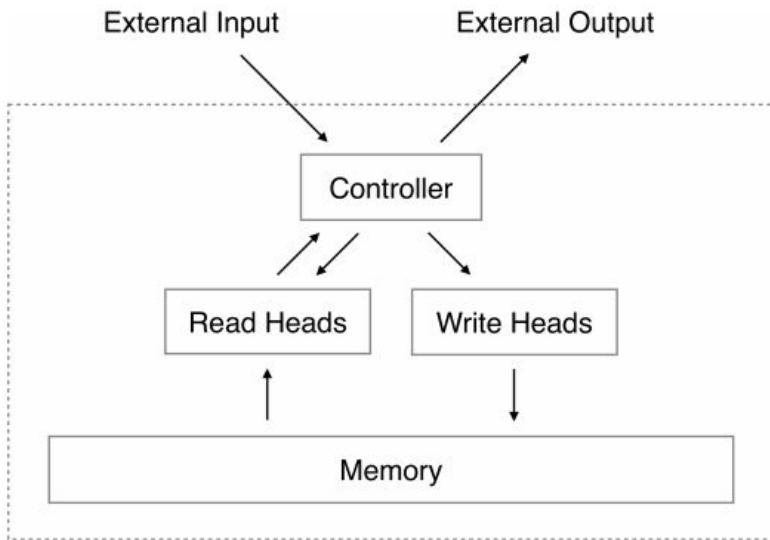
○ Backfed Input Cell
 ○ Match Input Output Cell
● Hidden Cell

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).

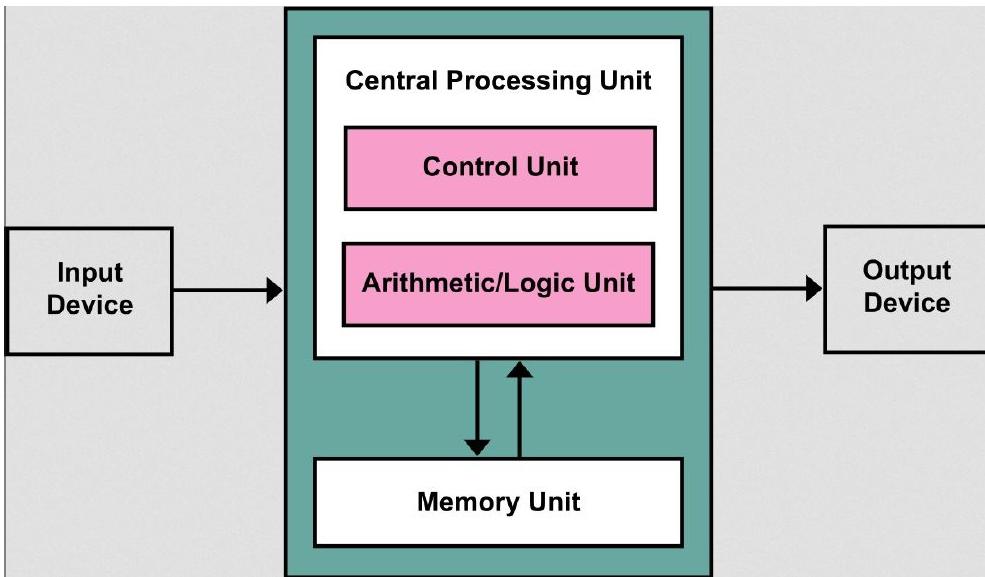


Differentiable Neural Computers (DNC)

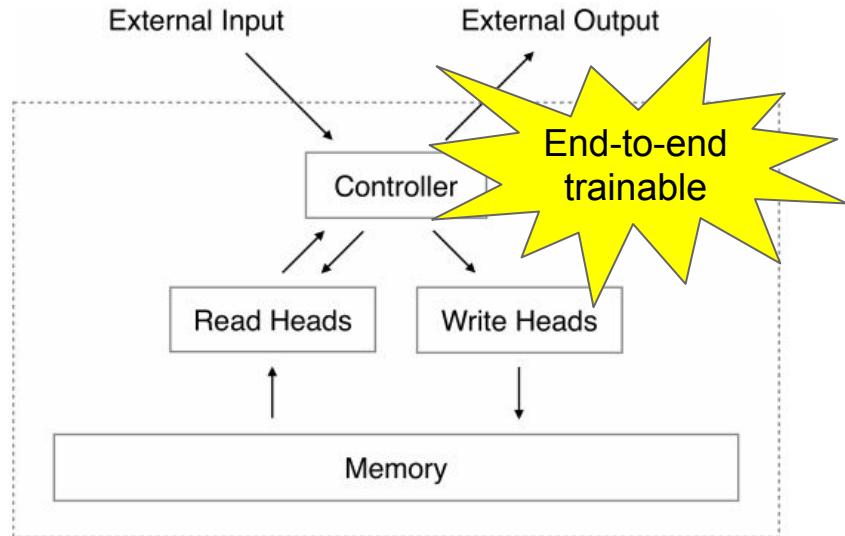


Graves, Alex, Greg Wayne, and Ivo Danihelka. ["Neural turing machines."](#) *arXiv preprint arXiv:1410.5401* (2014). [\[slides\]](#) [\[code\]](#)

Differentiable Neural Computers (DNC)



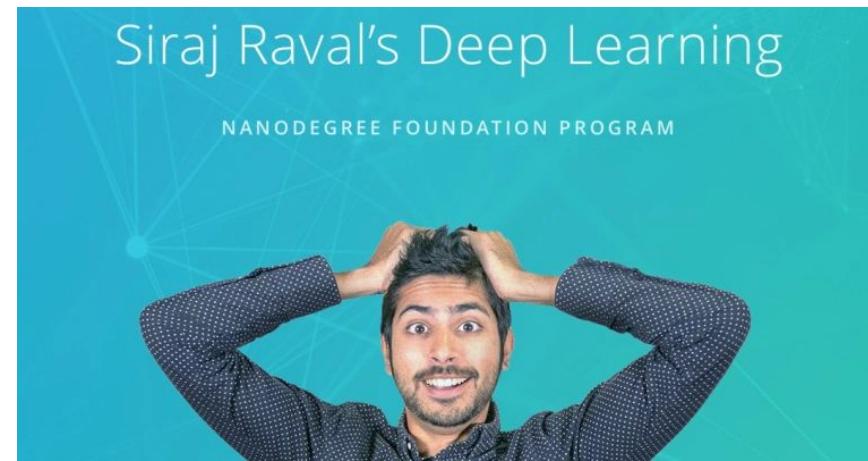
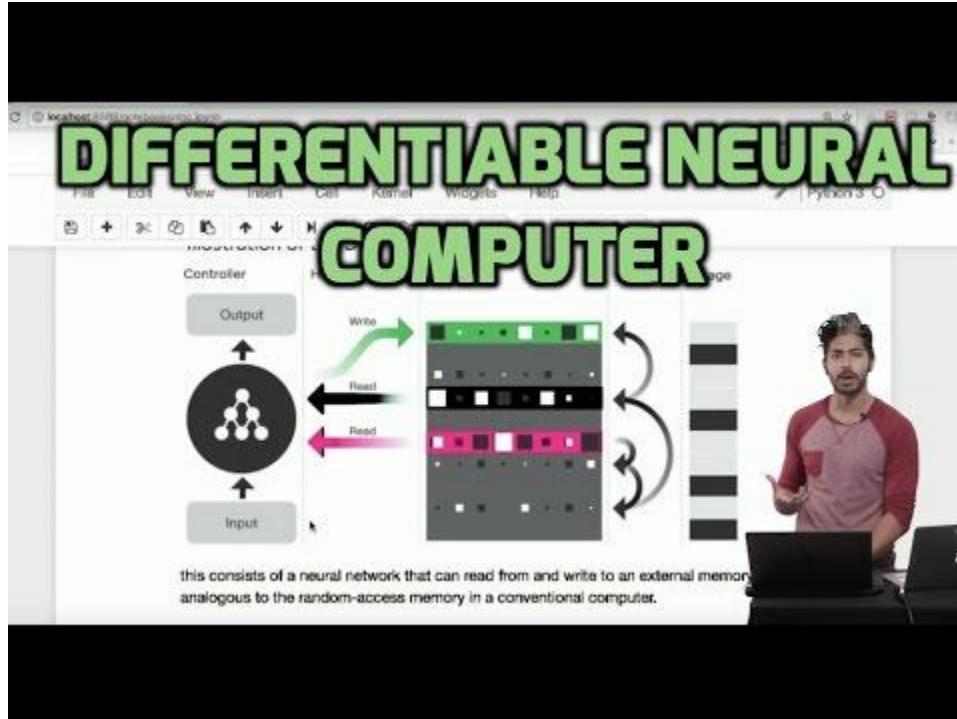
von Neumann architecture (1952)



Neural Turing Machine (2014)

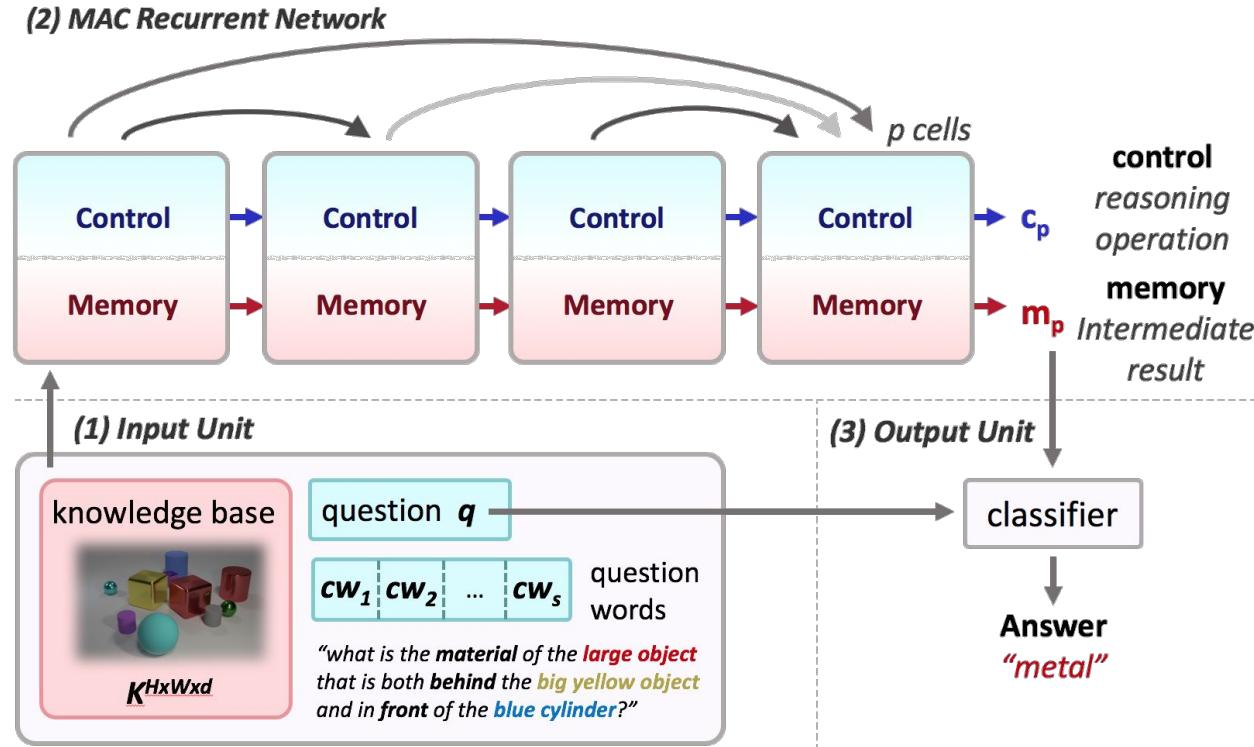
Graves, Alex, Greg Wayne, and Ivo Danihelka. "Neural turing machines." *arXiv preprint arXiv:1410.5401* (2014). [\[slides\]](#) [\[code\]](#)

Differentiable Neural Computers (DNC)

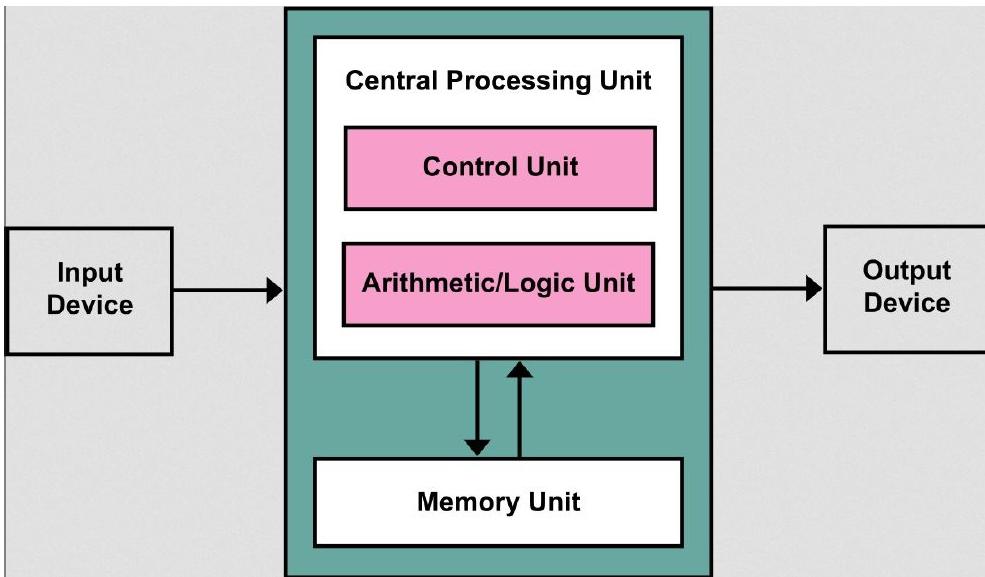




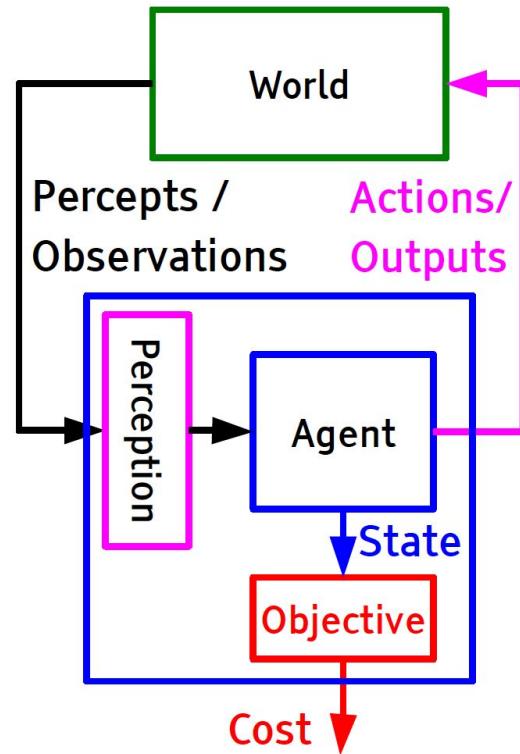
MAC Network



More architectures to come...



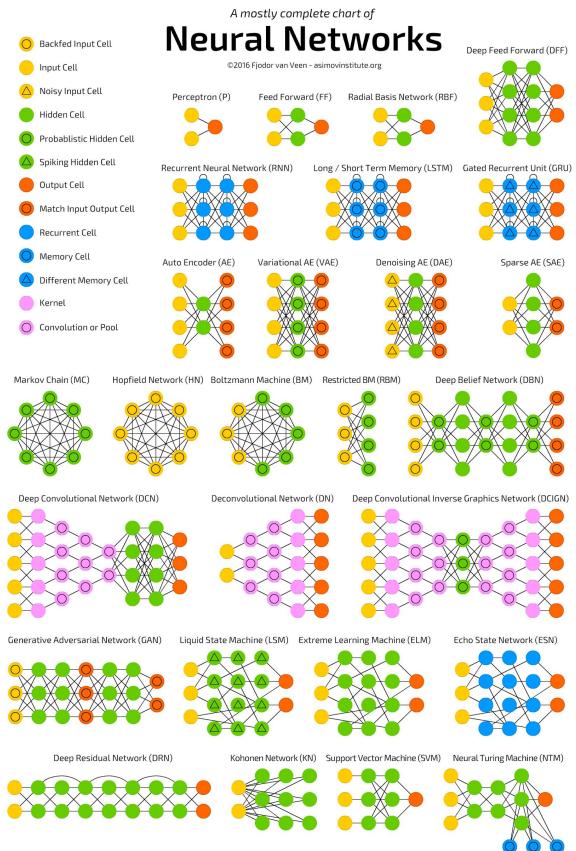
von Neumann architecture (1952)



Yann LeCun, [“A Path to AI”](#),
Beneficial AI 2017.



The Full Story

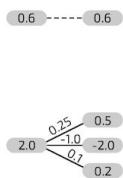


The Prequel

An informative chart to build

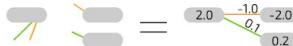
Neural Network Cells

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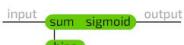


Fixed Weight
(fixed at 1)

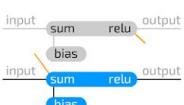
Weights



Recurrent Weights
(grouped by colour)



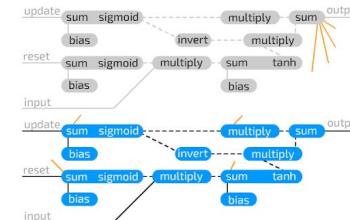
Feed Forward Cell
(basic cell)



Recurrent Cell
(previous iteration)



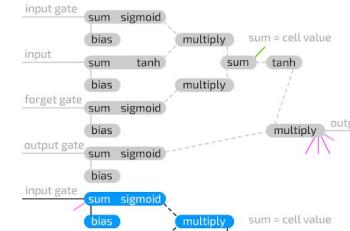
Recurrent Cell



GRU Cell
(previous iteration)



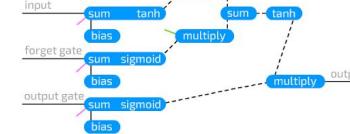
GRU Cell



LSTM Cell
(previous iteration)



LSTM Cell



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



Questions

Undergradese

What undergrads ask vs. what they're REALLY asking

"Is it going to be an open book exam?"

Translation: "I don't have to actually memorize anything, do I?"

"Hmm, what do you mean by that?"

Translation: "What's the answer so we can all go home."

"Are you going to have office hours today?"

Translation: "Can I do my homework in your office?"

"Can i get an extension?"

Translation: "Can you re-arrange your life around mine?"

"Is this going to be on the test?"

Translation: "Tell us what's going to be on the test."

"Is grading going to be curved?"

Translation: "Can I do a mediocre job and still get an A?"

