Comparing recurrent/convolutional neural networks
Data Science Zwolle

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Overview

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Object detection

Faster R-CNN

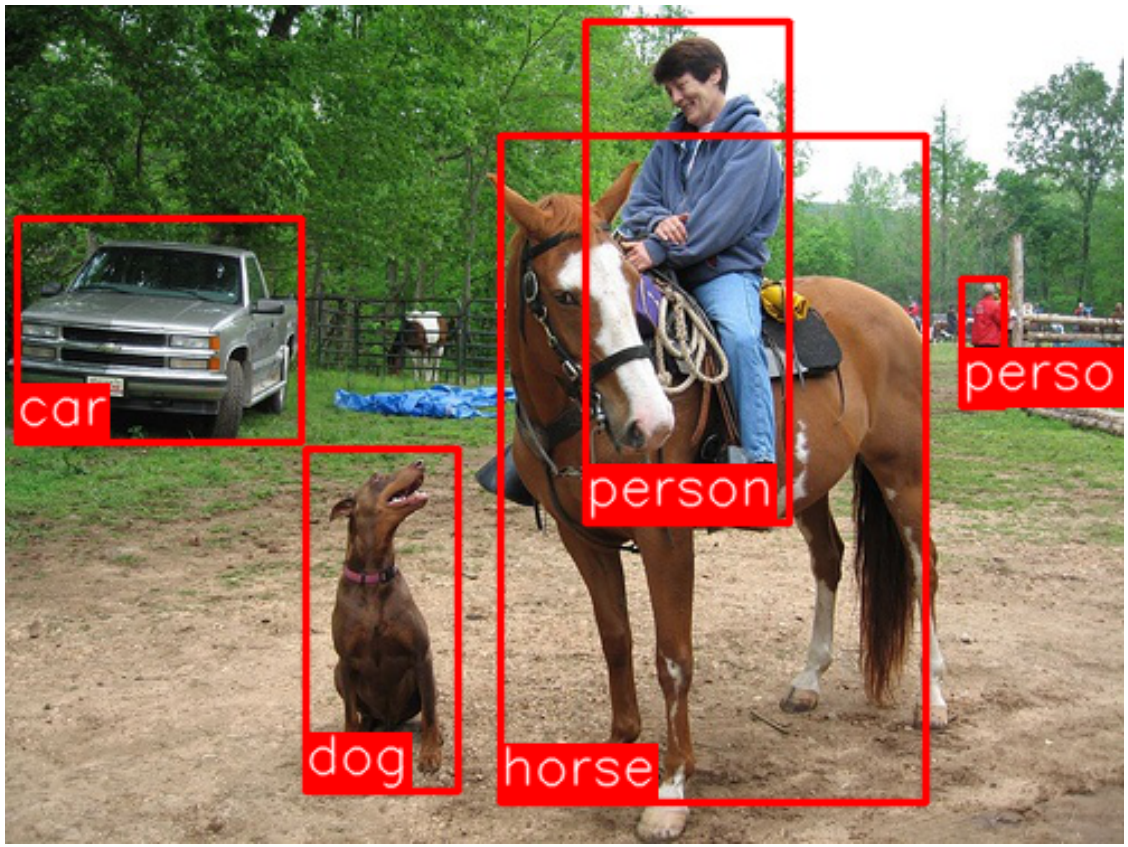


Figure: faster rcnn (image from Github *mitmul*)

Apple siri

Figure: Photo: cultofmac.com

GMail reply

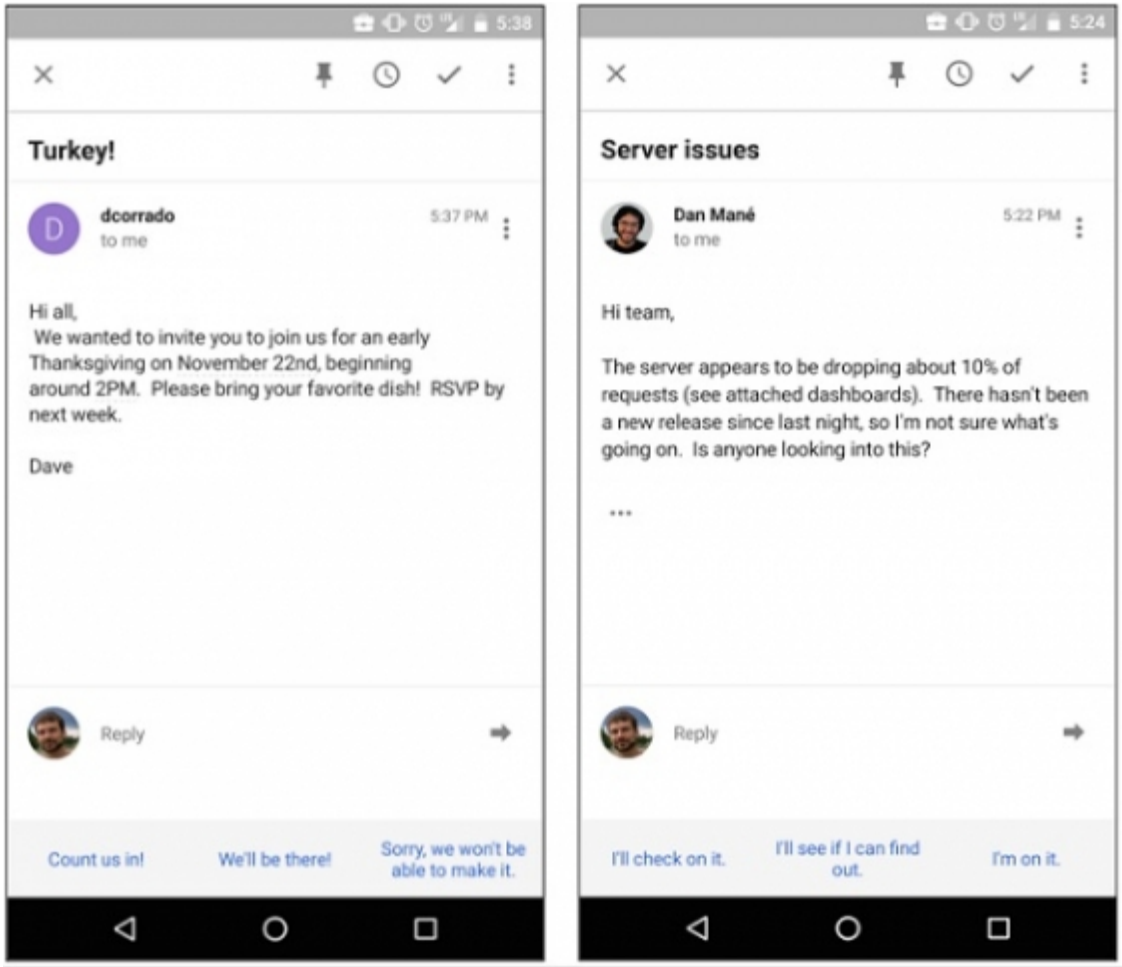


Figure: Photo: Greg Corrado, Google Research Blog

Segmentation

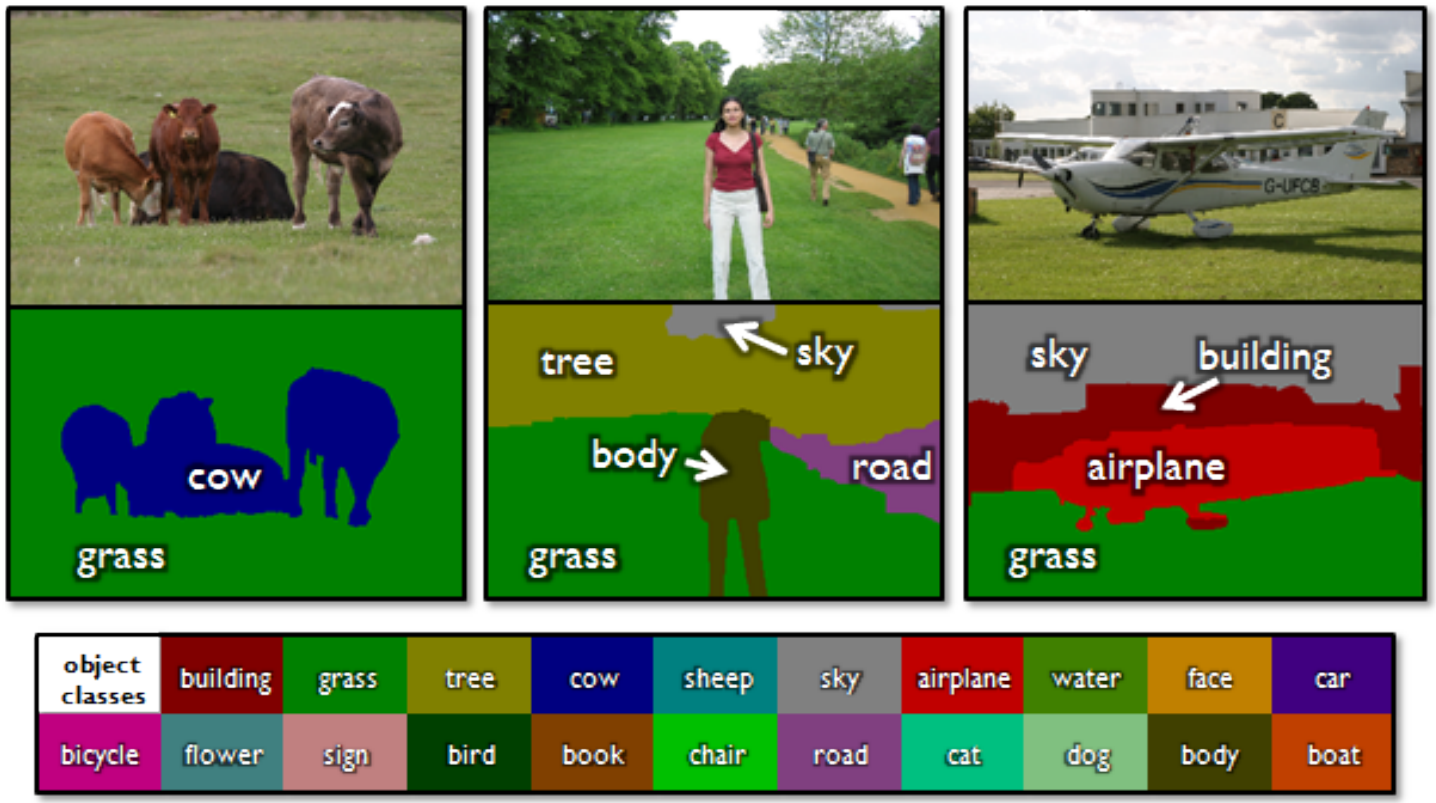
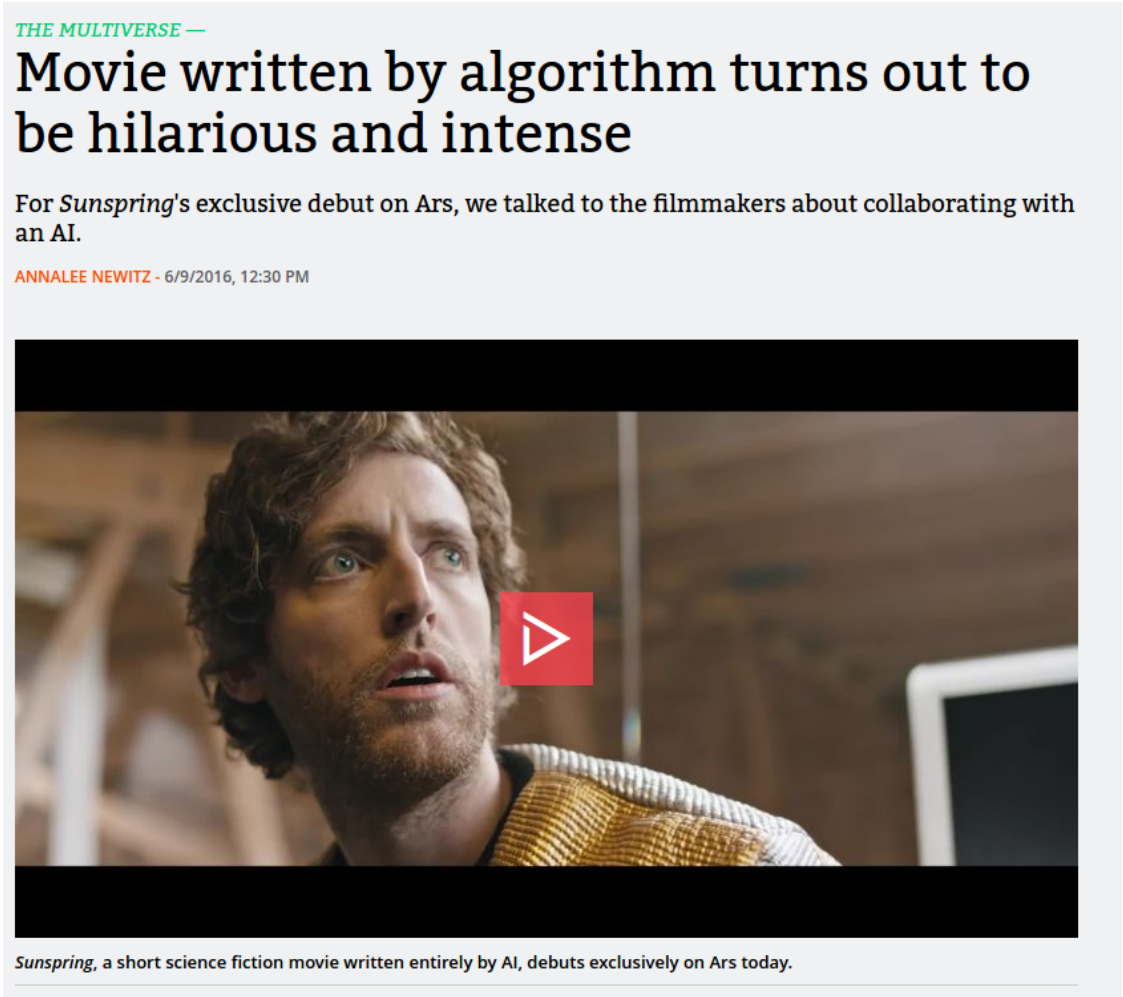


Figure: Semantic Segmentation with CNN (image from jamie.shotton.org)

Generation



THE MULTIVERSE —

Movie written by algorithm turns out to be hilarious and intense

For *Sunspring*'s exclusive debut on Ars, we talked to the filmmakers about collaborating with an AI.

ANNALEE NEWITZ - 6/9/2016, 12:30 PM

Sunspring, a short science fiction movie written entirely by AI, debuts exclusively on Ars today.

Figure: http://arstechnica.com/the-multiverse/2016/06/an-ai-wrote-this-movie-and-its-strangely-moving/

Why not

Which data not

1. YES: media type data
   1. Text, language, speech
   2. Images, video, maps
   3. time-series, stocks, valuta
2. NO: categorical data
   1. Properties of instances
   2. Features of instances
   3. Categories of products

Neural Networks

Neural nets

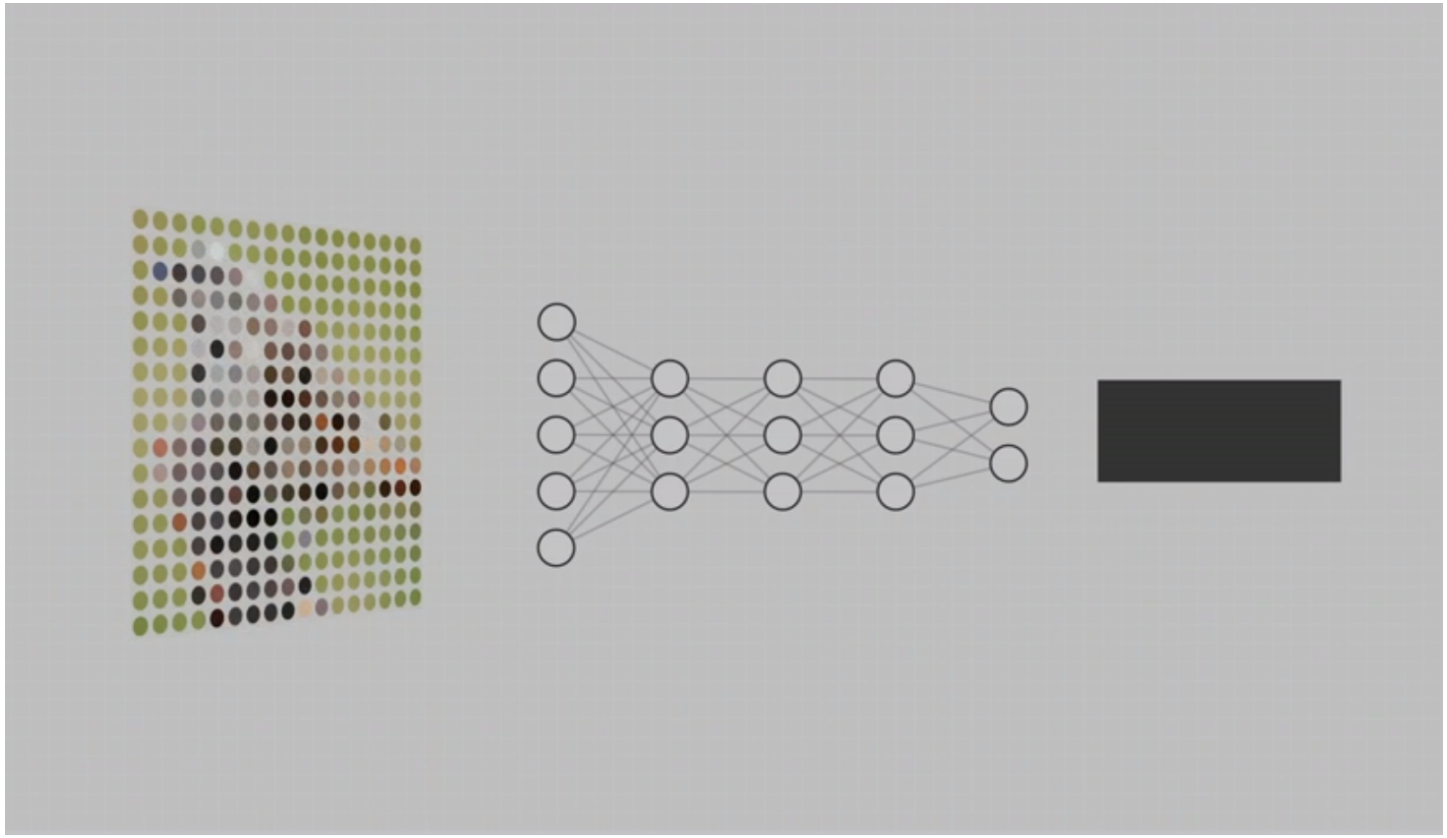


Figure: Neural network explained (credits: Blaise Aguera y Arcas)

Basic equation

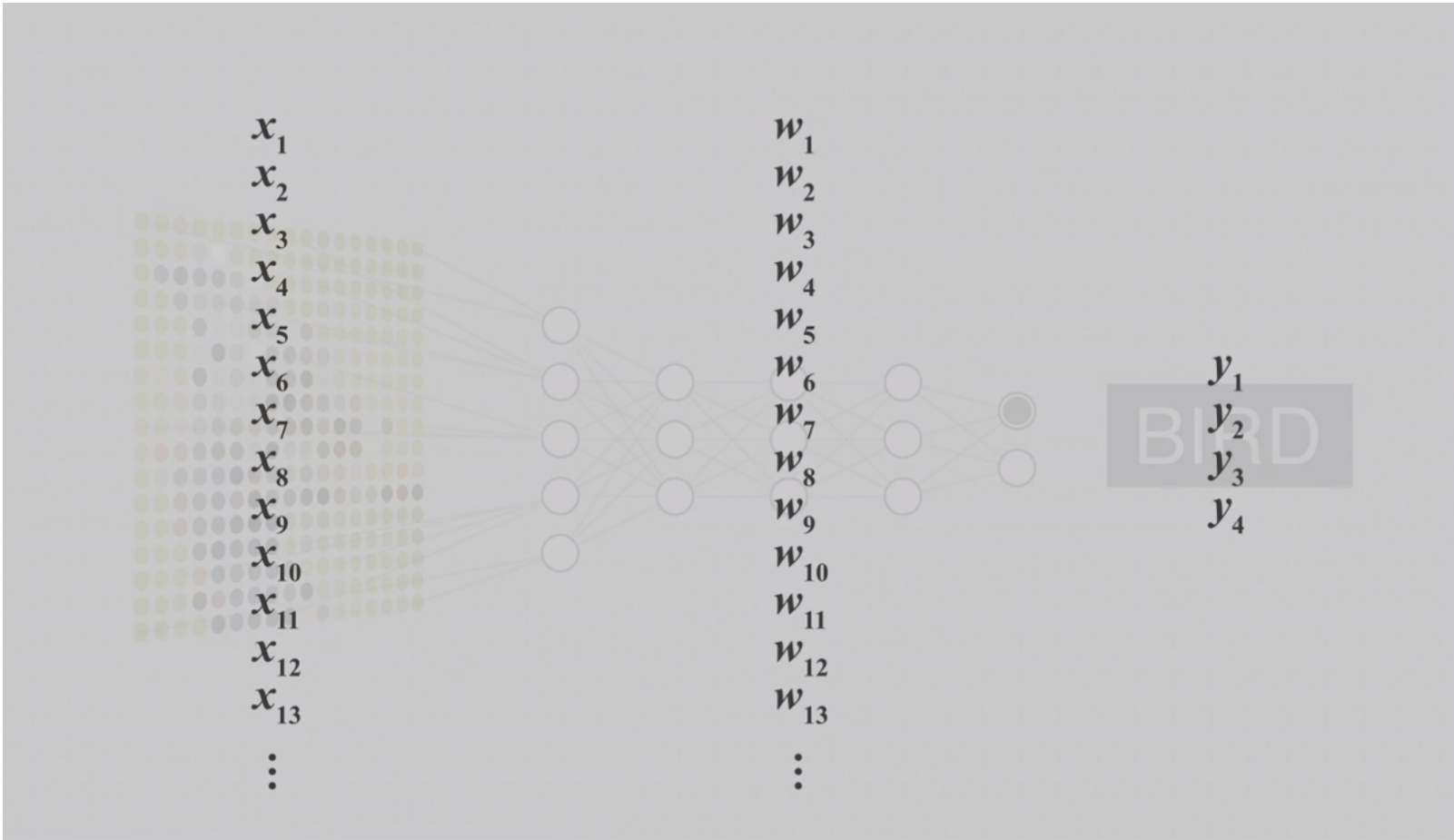


Figure: Neural net in algebraic form (credits: Blaise Aguera y Arcas)

Template equation

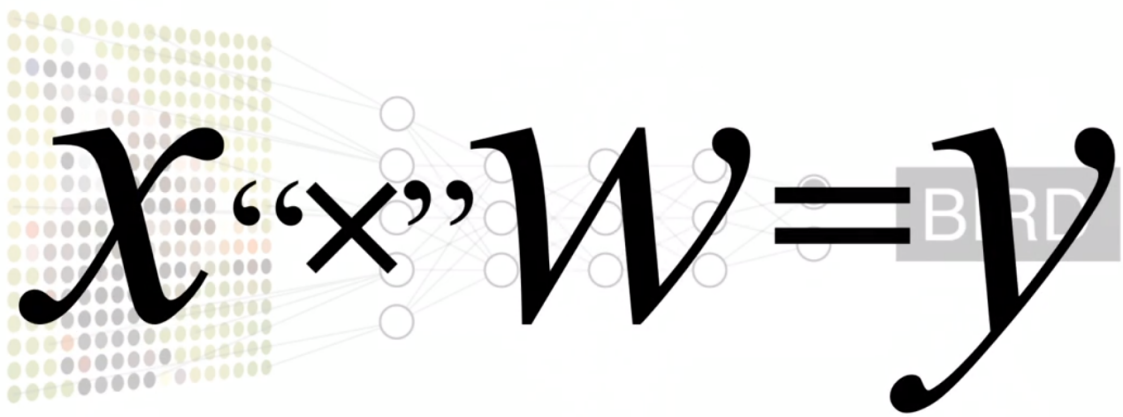


Figure: Template equation neural net (credits: Blaise Aguera y Arcas)

How to use

How to use them

$$w \cdot x = y$$

$$2 \cdot 3 = y$$

Forward inference

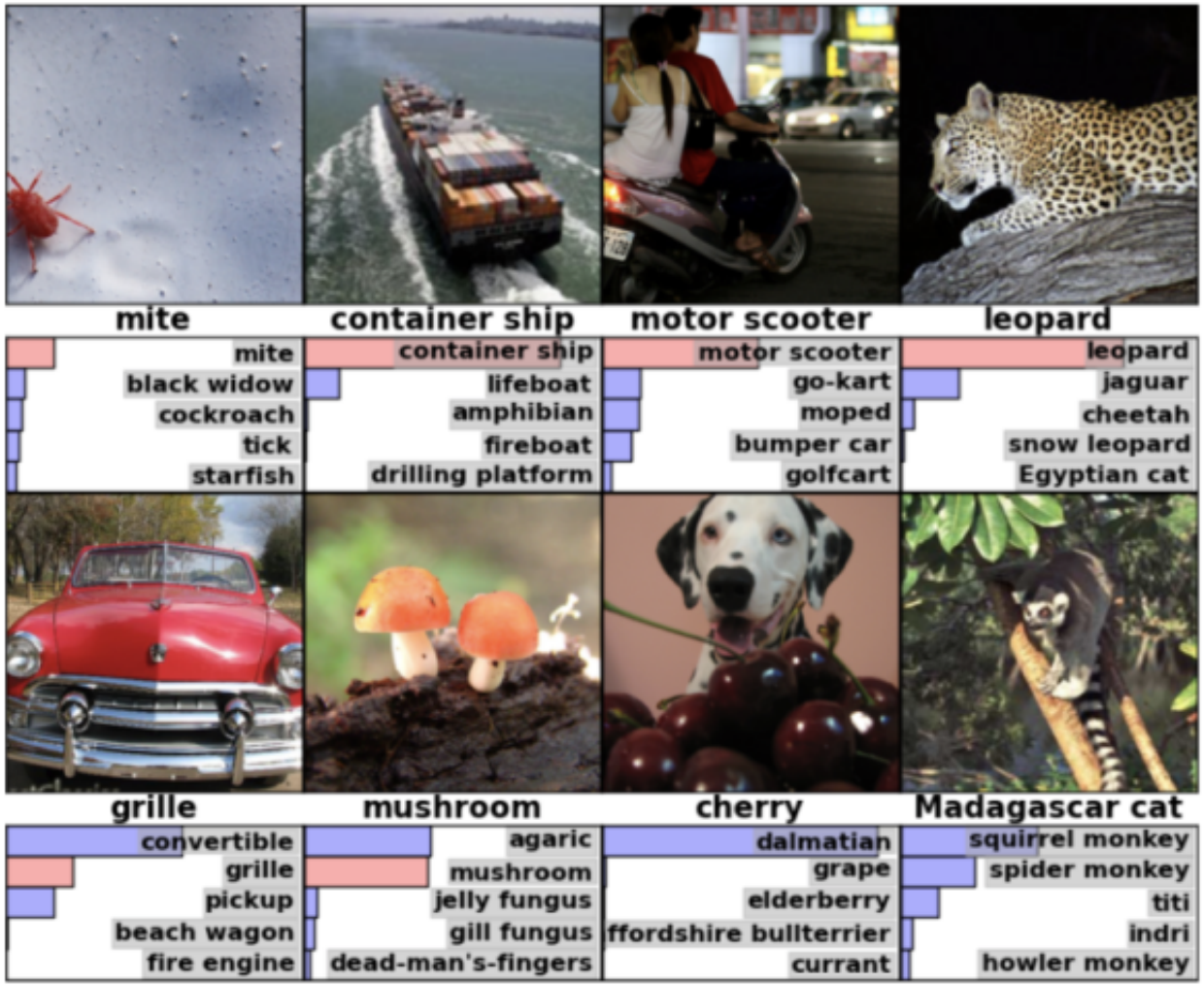


Figure: Forward inference CNN (Krizhevsky et al. 2012)

How to train

How to train them

$$w \cdot x = y$$

$$w \cdot 3 = 6$$

$$y \div x = w$$

$$0 = w \cdot x - y$$

$$0 = w \cdot 3 - 6$$

$$\text{error} = |w \cdot x - y| \Longrightarrow 0$$

Loss function

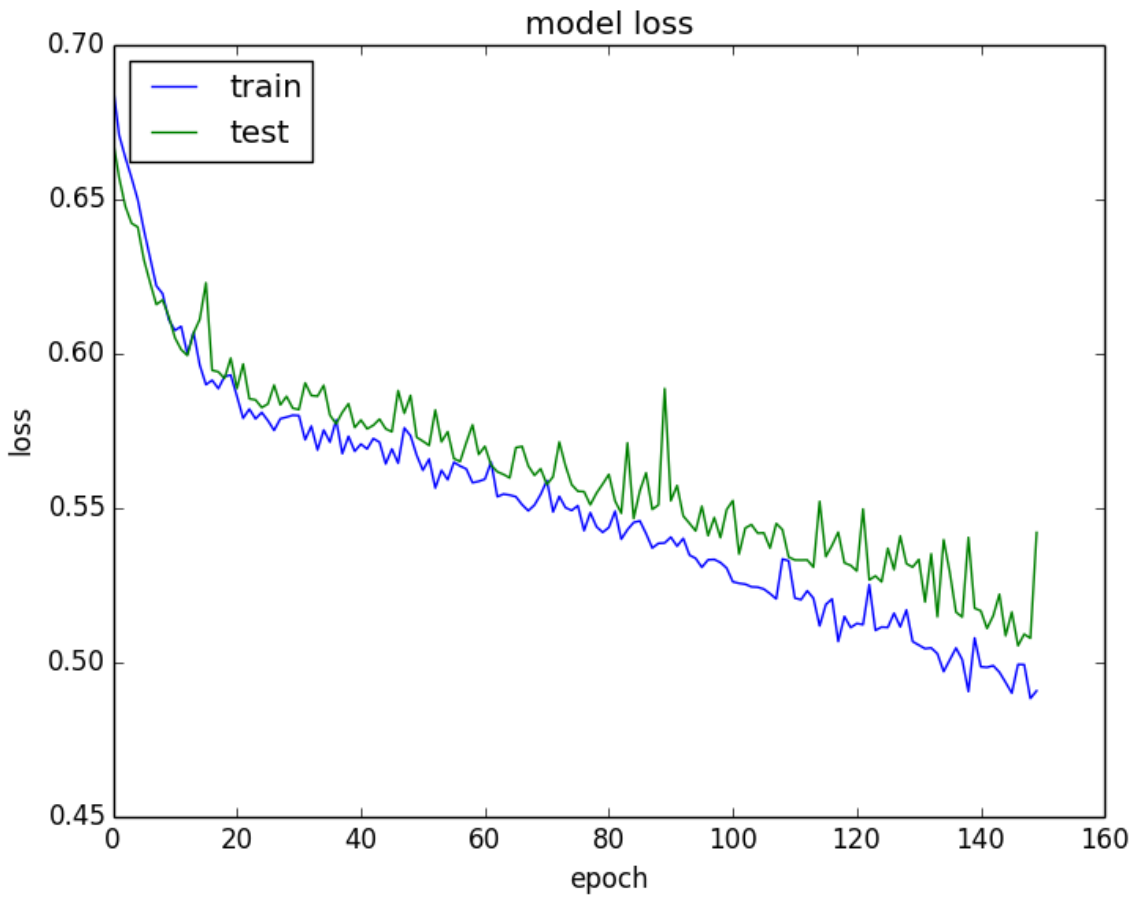


Figure: (http://machinelearningmastery.com/)

Architecture

Architecture

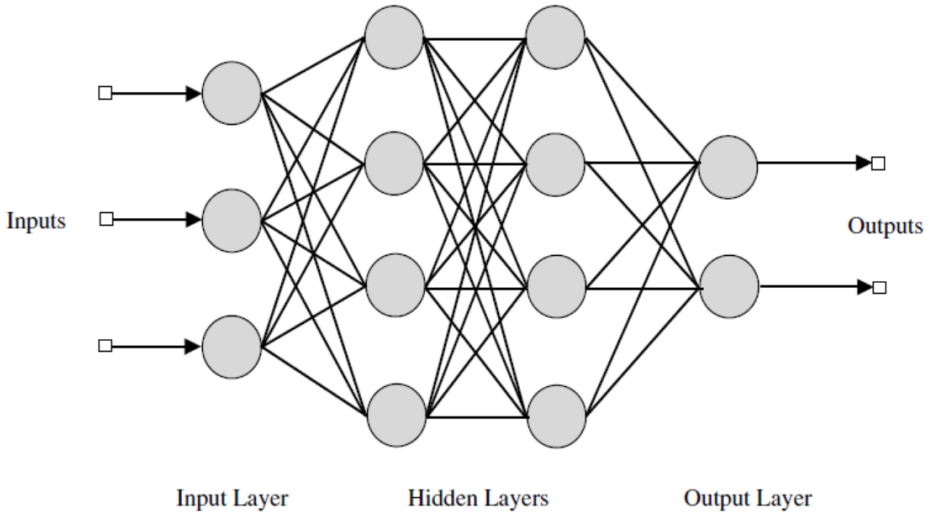


Figure: Feedforward neural network

$$y = w \cdot x$$

Two architectures

1 Convolution

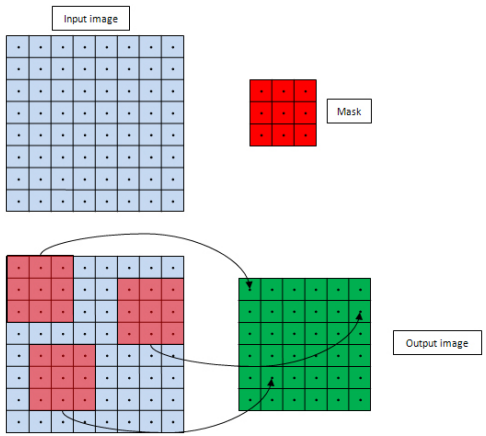


Figure: developer.amd.com

2 Recursion

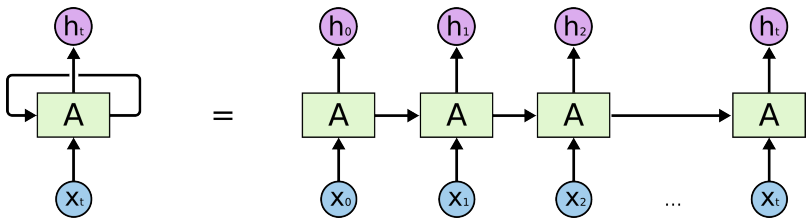


Figure: credits: colah.github.io

Convolution

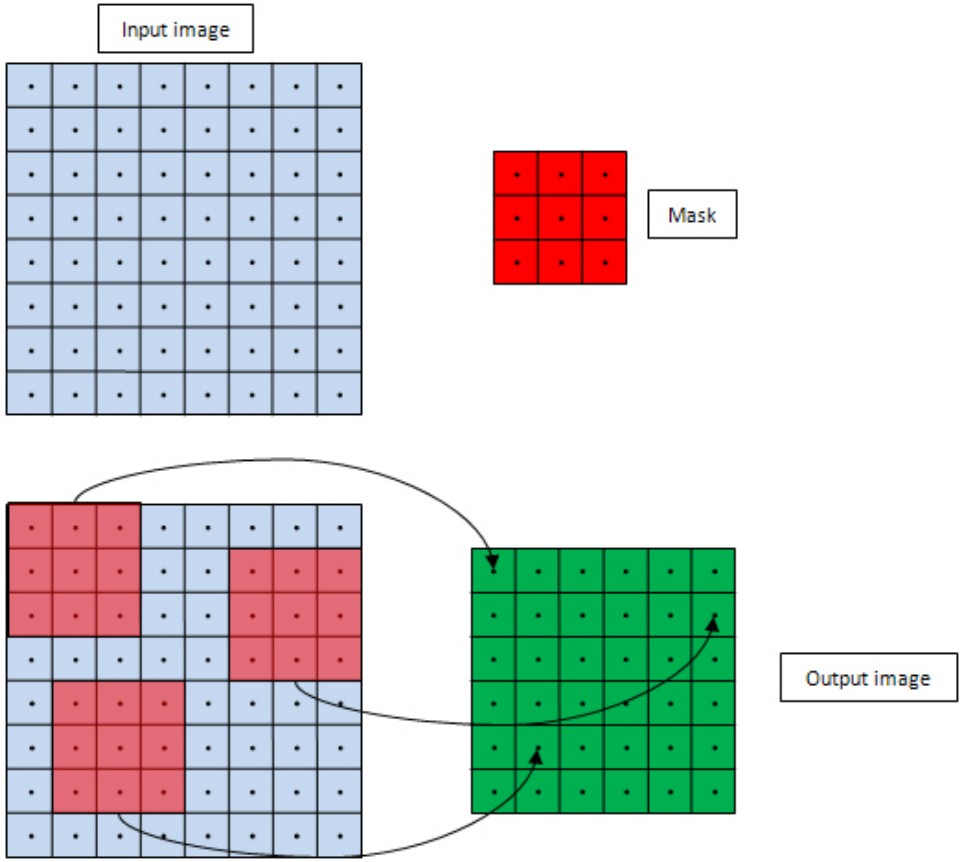


Figure: developer.amd.com

CNN

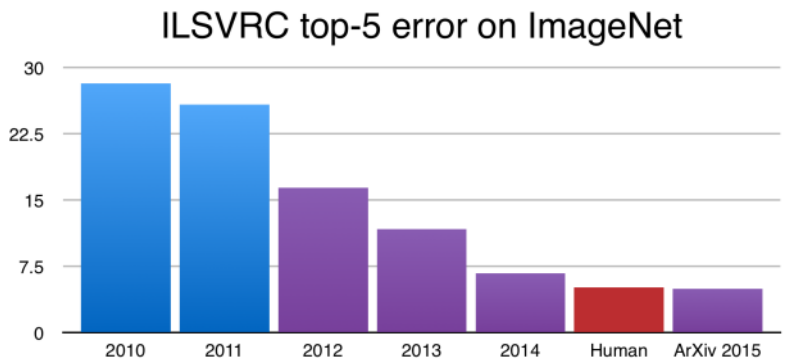


Figure: ImageNet results (credits jackkelly.github.io/)

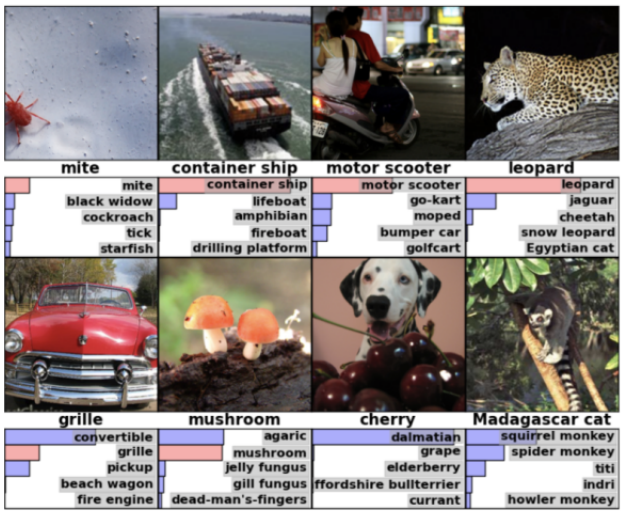


Figure: Forward inference CNN (Krizhevsky et al. 2012)

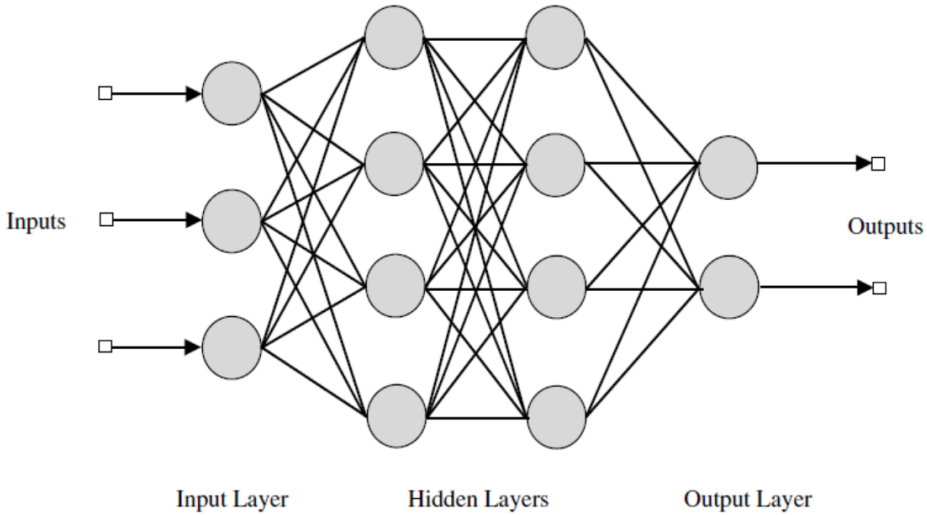


Figure: Feedforward neural netword

$$32 \cdot 32 \cdot 100 = 102400$$

$$5 \cdot 5 = 25$$

Recursion

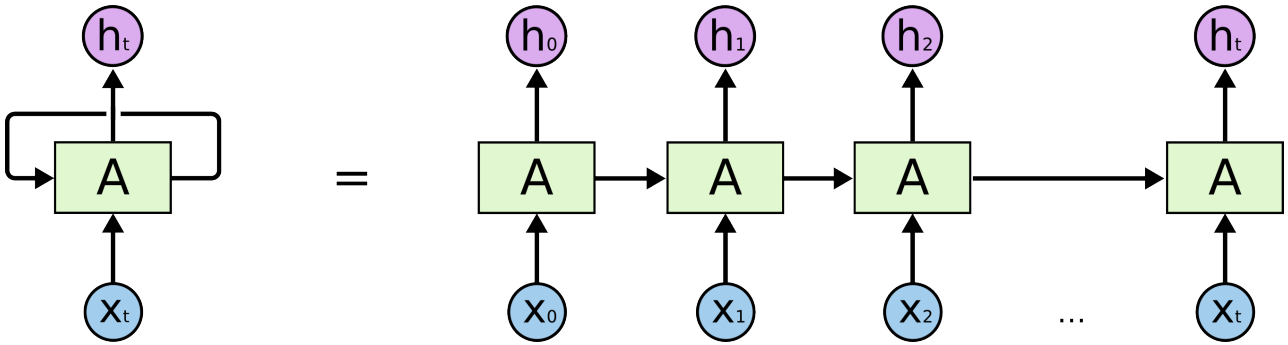


Figure: credits: colah.github.io

Template formula

$$y = w \cdot x$$

$$y_t = w \cdot (x_t, h_{t-1})$$

Formula

$$h = \phi(W_{xh}x) \qquad y = \phi(W_{hy}h)$$

$$h_t = \phi(W_{xh}x_t + W_{hh}h_{t-1}) \qquad y_t = \phi(W_{hy}h_t)$$

Python code


```
rnn = RNN()
y = rnn.step(x)
```

```
class RNN:
  def step(self, x):
      self.h = np.tanh(np.dot(self.W_hh,self.h)
                + np.dot(self.W_xh,x))
      y = np.dot(self.W_hy, self.h)
      return y
```

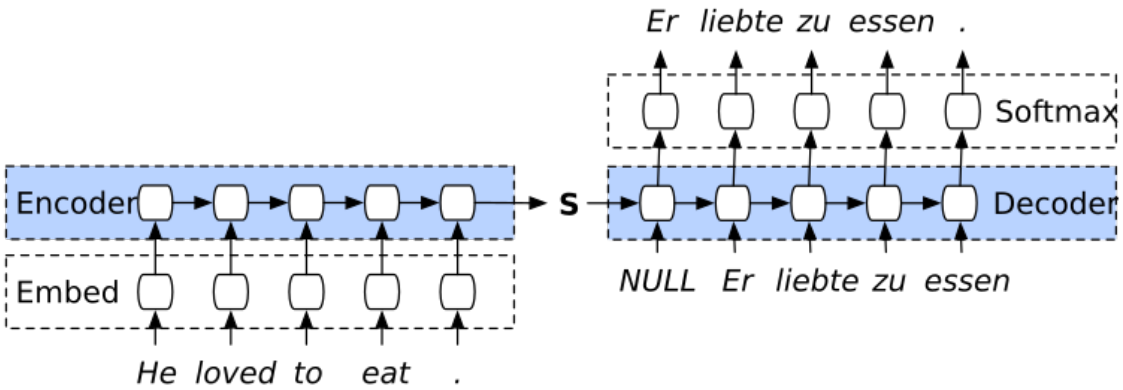


Figure: RNN for Machine Translation (credits: smerity.com)

Example

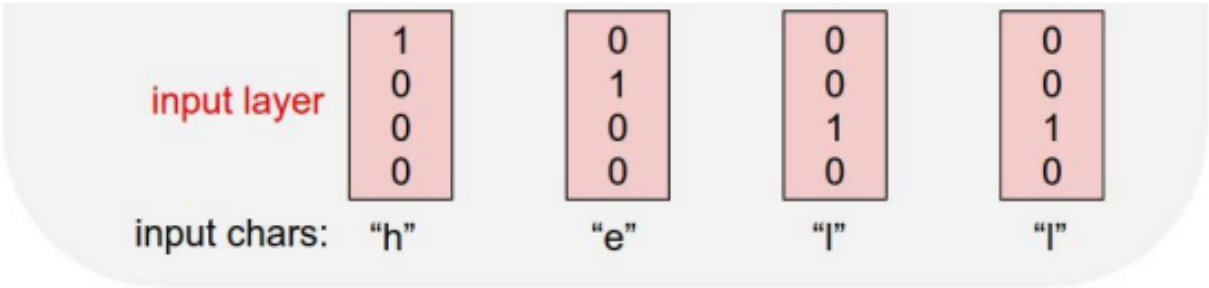


Figure: cs231n, Andrej Karpathy

Example

$$h_t = \tanh(W_{hh} h_{t-1} + W_{xh} x_t)$$

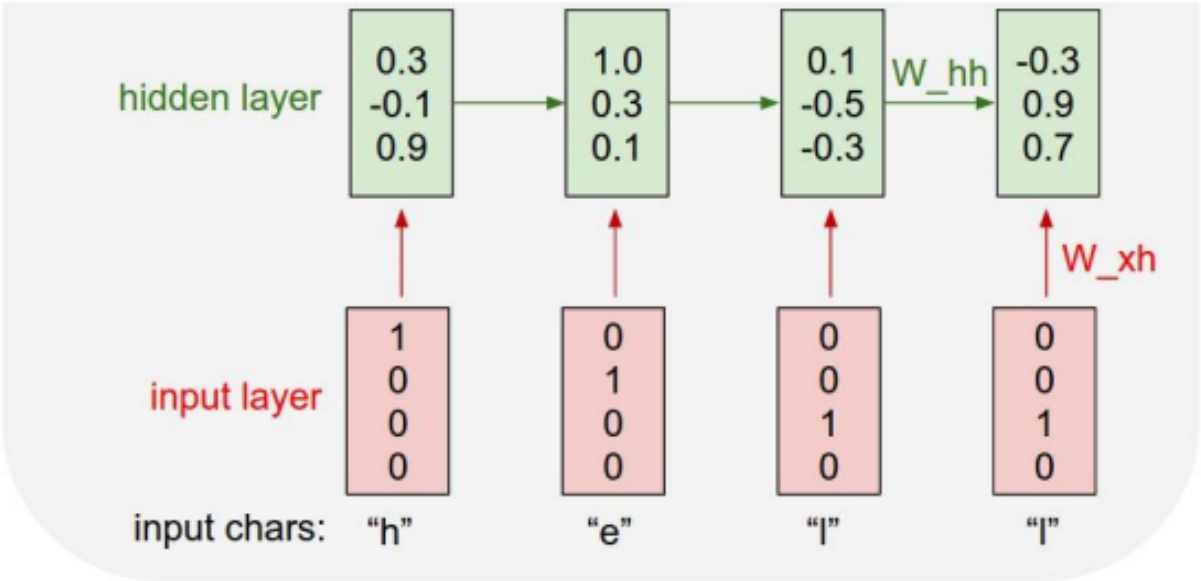


Figure: cs231n, Andrej Karpathy

Example

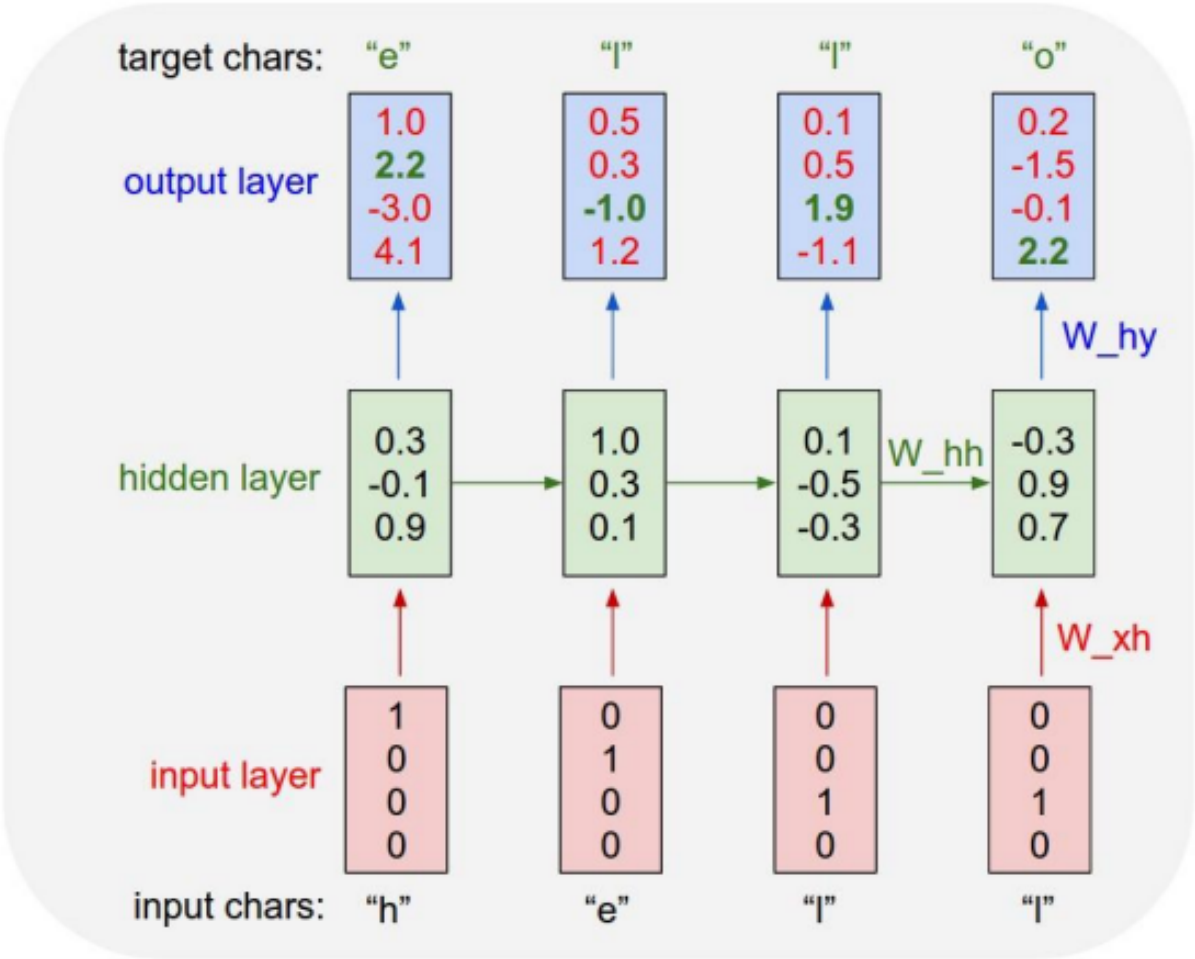


Figure: cs231n, Andrej Karpathy

Long Short-term memory

$$i_t = \sigma(W_{xi}x_t + W_{hi}h_{t-1} + b_i)$$
$$f_t = \sigma(W_{xf}x_t + W_{hf}h_{t-1} + b_f)$$
$$o_t = \sigma(W_{xo}x_t + W_{ho}h_{t-1} + b_o)$$

$$c_t = f_t c_{t-1} + i_t tanh(W_{xc}x_t + W_{hc}h_{t-1} + b_c)$$
$$h_t = o_t \ tanh(c_t)$$

LSTM

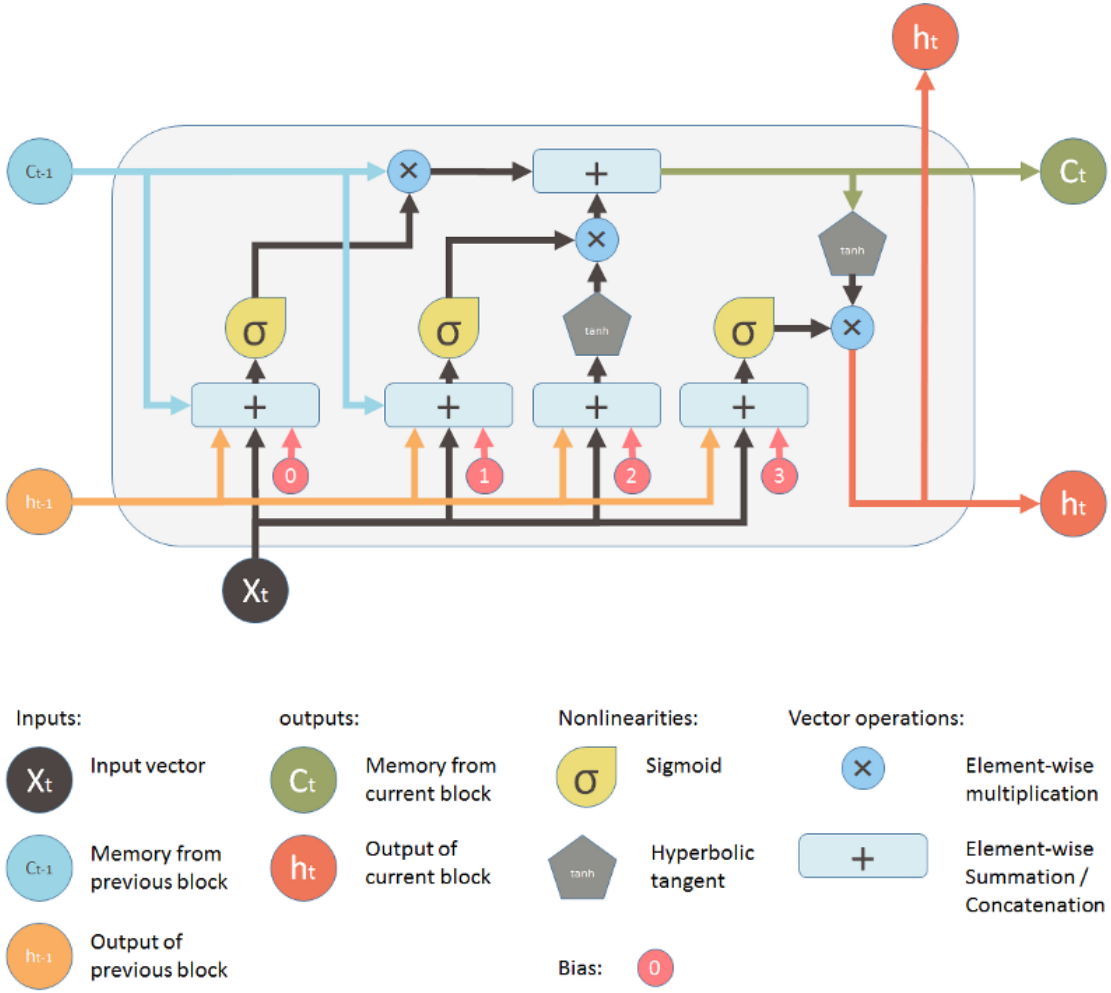


Figure: Diagram depicting LSTM block
Author: Shi Yan. Source: medium.com/@shiyan/

Overview			
	FF	RNN	CNN
- Basic computation	Matix multiplies	Recurrent multiplications	Convolutions
- Typical data	Embedding vectors	Sequences	Images
- Weights ties	No	Sequential	Spatial
- Effective span	Across input	Long term	Local receptive field
- Stationary		Seldom events	Frequent patterns
- How to train	Backprop	Backprop	Backprop
- Performance	No guarantee	No guarantee	No guarantee
- Typical examples	None	Machine translation, speech tagging, text generation	segmentation, image processing, object detection

Span

1 CNN

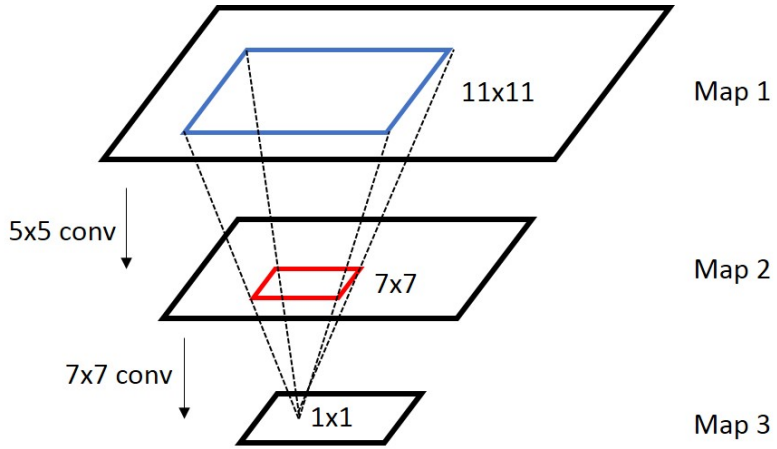


Figure: credits: cvmarcher.com/

2 RNN

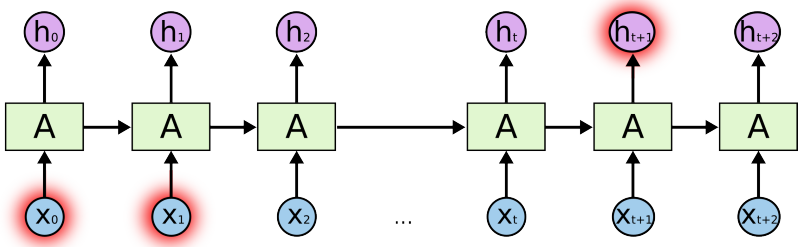


Figure: credits colah.github.io

DIY

1. Gather data
2. Choose architecture
3. Code up neural net
4. Train
5. Add bells and whistles
6. Post processing

Gather data

1. SMALL:
   1. MNIST: 60.000 samples
   2. TIMIT: 630 speakers, 10 sentences
2. NORMAL:
   1. Imagenet: 3.2 million images
   2. FLICKR: 1 million images
   3. Word vectors on all of Wikipedia

Amazon Mechanical Turk

Choose architecture

1 Convolution

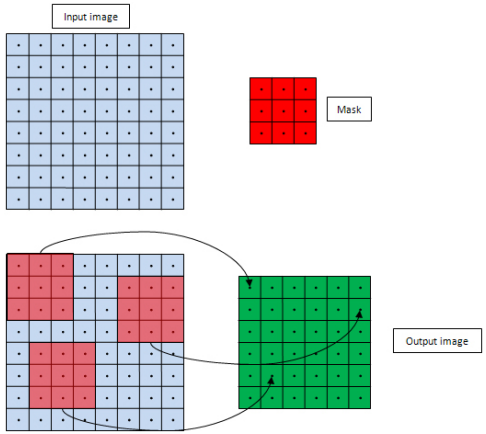


Figure: developer.amd.com

2 Recursion

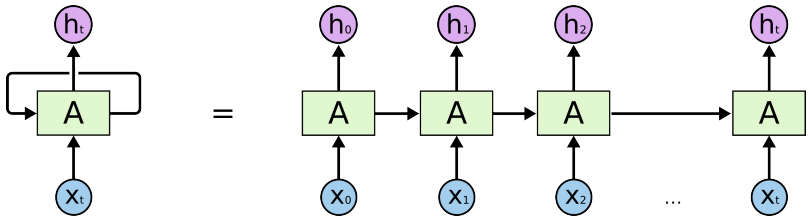


Figure: credits: colah.github.io

Code

1. Low level
    1. Tensorflow
    2. Torch, pyTorch
2. High level
    1. Keras
    2. Scikit flow, pretty tensor, tfslim, ...

Train

1. No bells and whistles
2. Small sub dataset
3. See if you can overfit

Bells and whistles

1. Batch normalization, layer normalization
2. Dropout
3. Add more data: semi supervised learning
4. Residual connections
5. etcetera, etcetera

Activation functions

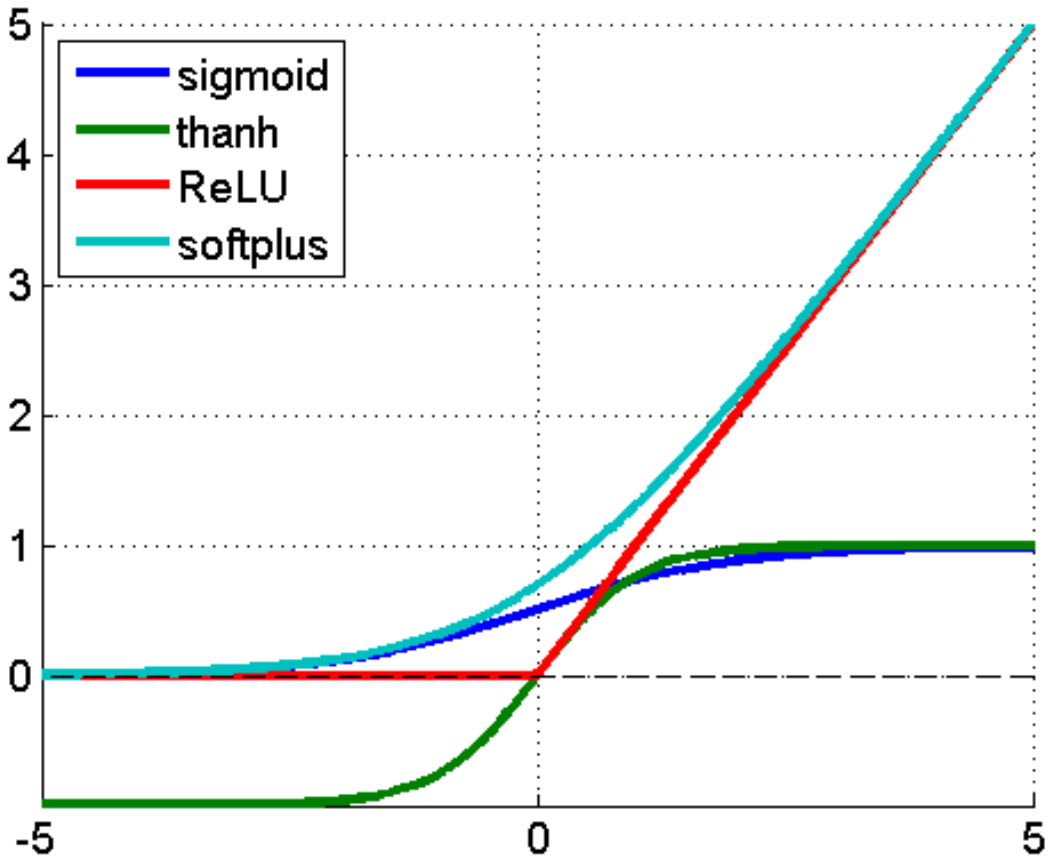


Figure: Common activation functions (credits Vanessa Imiloa)

Regularization

Figure: Example for regularization

MNIST

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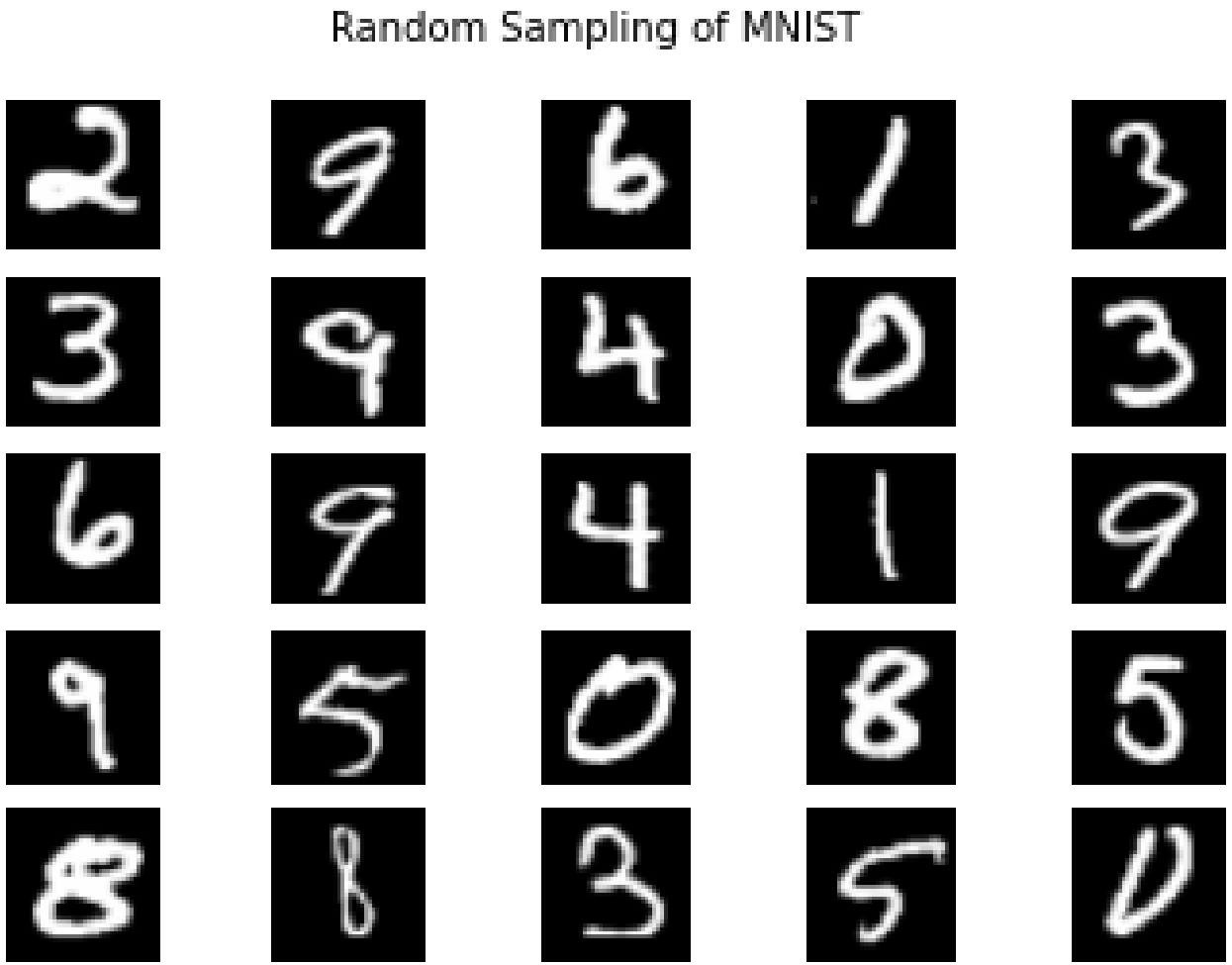

Figure: Caption

Post processing

1. Plot low confidence / high uncertainty
2. Plot confusion matrix
3. Inspect neurons

Two architectures

1 Convolution

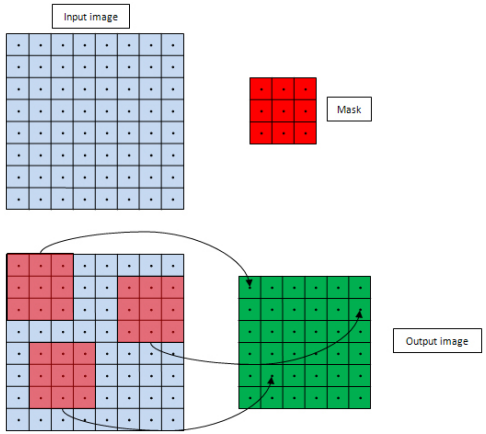

Figure: developer.amd.com

2 Recursion

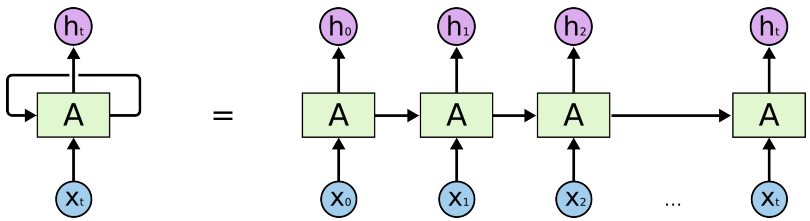

Figure: credits: colah.github.io

Questions

Further reading

1. RNN
    1. The Unreasonable Effectiveness of Recurrent Neural Networks, Andrej Karpathy
    2. Supervised sequence labelling with RNN, Alex Graves
    3. Colah's blog (colah.github.io)
2. CNN
    1. Course on CNN: cs231n (cs231n.stanford.edu/syllabus.html)
    2. Udacity on Deep learning (udacity.com/course/deep-learning–ud730)
3. My page (robromijnders.github.io)