



AI and Neural Networks

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Works Cited



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Works Cited - Images

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Brain Up! - Teaching an Old Dog New Tricks

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Wikipedia - Feedforward neural network

<https://ujwlkarn.files.wordpress.com/2016/08/screen-shot-2016-08-05-at-11-03-00-pm.png?w=342&h=562>

<https://i.imgur.com/sb8dHcY.png>



Overview

- > What are Neural Networks?
- > Types of Neural Networks
- > Some Special Neural Network Projects!
- > What can Neural Networks do next?

What are Neural Networks?

First of all, they're really *artificial neural networks*!

We want to emulate the human brain:

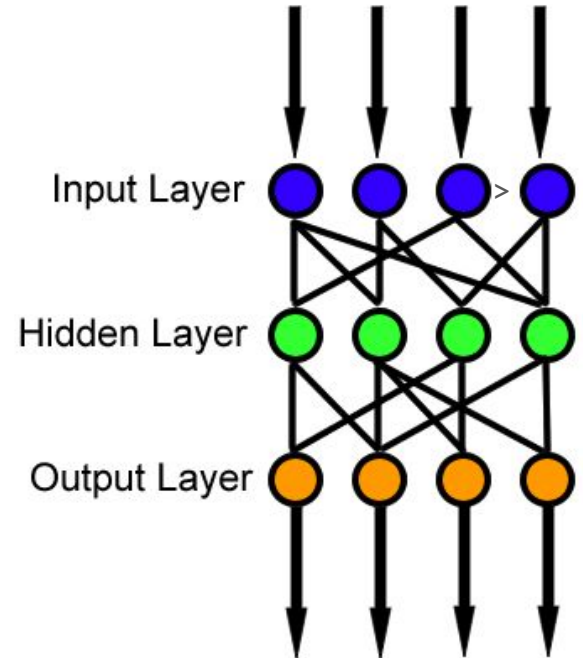
Neural networks are a biologically inspired mathematical model for processing data.

Can you beat me?



Types of Neural Networks - Feed Forward

- Connection between units DON'T form a cycle. Information only moves in one direction. Input layer > hidden layer (if applicable) output nodes.
- No cycles or loops in the network.
- Simplest type of neural network.



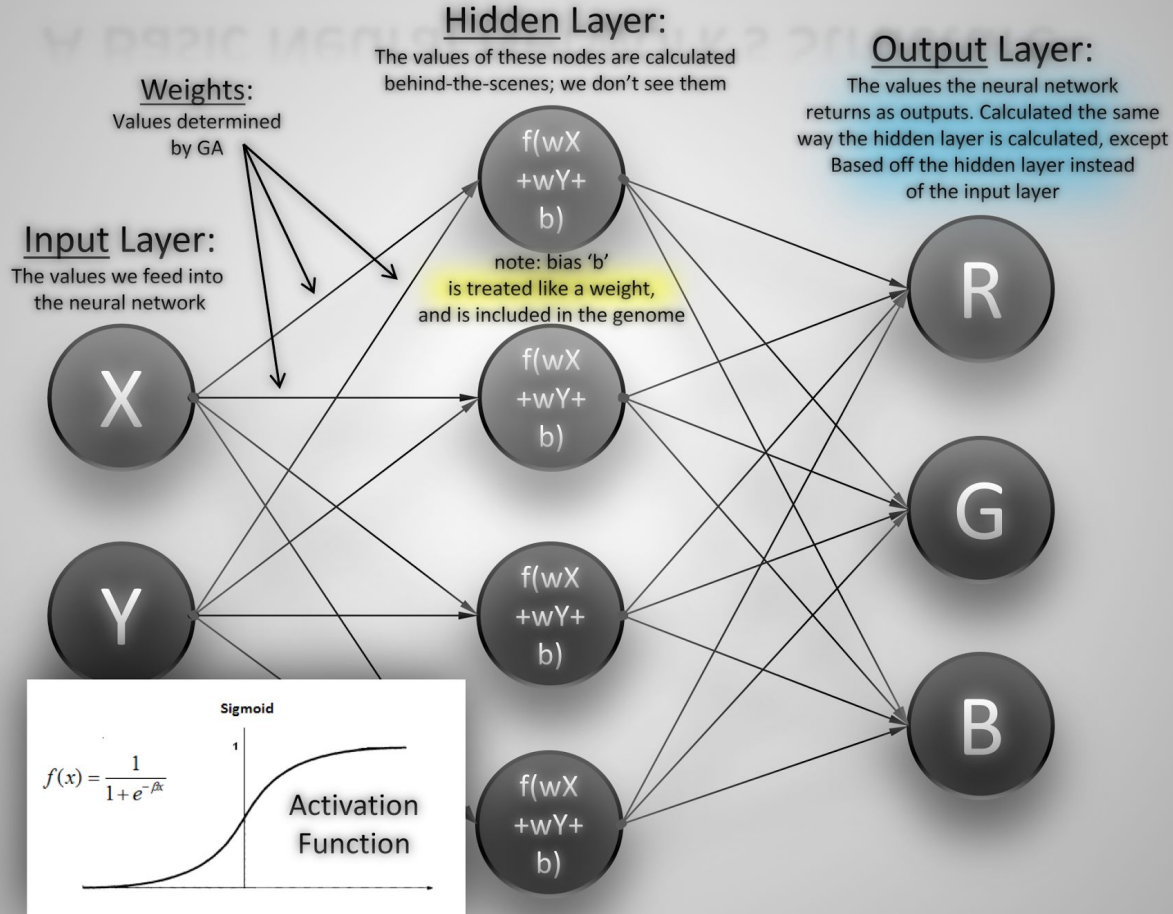



Types of Neural Networks - Feed Forward

Two types of feedforward neural networks:

- Single layer perceptron
 - Inputs are directly fed to outputs using a series of weights.
 - Can only learn patterns that can be separated linearly. Can't learn XOR function
 - Usually trained using the delta rule algorithm (error between expected and actual output).
- Multi layer perceptron
 - Consists of multiple layers of computational units
 - Can produce any boolean function, including XOR function
 - Usually trained using back-propagation algorithm (calculated output compared to expected output, error is fed back through network. Weights of connections are changed).

A Basic Neural Network's Structure





More layers, and more neurons and thus more connections let the network learn more complicated things! Below is a link to an interactive neural classifier:

Live, Interactive Example:

playground.tensorflow.org



How to train them?

- **Gradient Descent via Backpropagation**
 - Variations: Adagrad, Adadelata, Momentum, others
 - By far the most popular methods
- **Genetic Algorithms:**
 - Slower, but more suitable for unlabeled data, such as training an AI to walk

Types of Neural Networks - Recurrent Neural Network

- Connection between nodes form a cycle. More complex yet more useful.
- Can process arbitrary sequences of inputs using internal memory.
- Trained using gradient descent and global optimization algorithms.
- Are more difficult to train than other models
- Long-Short-Term-Memory or LSTM is a popular model

Examples that use recurrent neural networks:

- Generate text/guess next word in sentence
- Speech recognition
- Natural language processing
- Write music

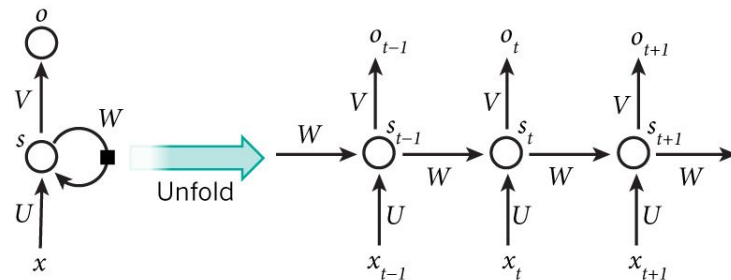


Image source: <http://www.wildml.com/2015/09/recurrent-neural-networks-tutorial-part-1-introduction-to-rnns/>

Types of Neural Networks - Recurrent Neural Network



Types of recurrent neural networks:

- Fully recurrent
- Long short term memory
- Recursive
- Hopfield
- Elman network
- Jordan Network
- Bi-directional
- And more!



Was this text written by Shakespeare or a RNN?

GUIDERIUS:

Why, my lord,
Shall not part well: but it shall have my hands;
Let us be taken that, thou weights return,
To mine ring ere I should be dangerous with a good way
To swear it: for the bears now he was kin to him,
But then his own island's sister's all speech would deny
And force I grant it.

Source: <http://cs.stanford.edu/people/karpathy/char-rnn/shakespear.txt>

At MIT, they trained a LSTM network off of Trump's tweets: twitter.com/deepdrumpf



DeepDrumpf @DeepDrumpf · 7 Oct 2016

Replying to [@thatRamosgirl](#)

[Women love] me. I'll make them Great Again, like in Iran. We have to have suppression, it's good for my business. [@thatRamosgirl](#)

104



DeepDrumpf @DeepDrumpf · 19 Oct 2016

[This election is rigged] I will give every American a solid gold nuclear weapon, we're going to defeat the world.

DeepDrumpf @DeepDrumpf · 11 Aug 2016

Replying to [@HeyTammyBruce](#)

If I don't win in the end, I'll fire the entire American people. You cannot achieve peace if I don't want it. [@HeyTammyBruce](#) [@McFaul](#)

4 162 259



DeepDrumpf @DeepDrumpf · 15 Jul 2016

Replying to [@DrJillStein](#)

We're killing tremendous people in this country. We have to cherish our Second Amendment. Very important. I'll need the ratings. [@DrJillStein](#)

4



DeepDrumpf
@DeepDrumpf

Follow

DeepDrumpf @DeepDrumpf · 8 Nov 2016

Replying to [@UlrichJvV](#)

Here's the thing, I horribly abuse women and LGBT citizens. You know that better than anybody. That's my plan to win. [@UlrichJvV](#) [#ElectionDay](#)

3 103 146

OK, it's amazing right now with ISIS, I tell you what? I don't want them to vote, the worst very social people. I love me.

3:49 PM - Mar 3, 2016

8 318 387



Types of Neural Networks - Physical Neural Network

Some computer scientists like to go all the way with their work!

We want to imitate the human brain after all. Why not build a system that LOOKS like how a brain works?

Electrically resistant material is used that can have charges run through it, allowing an imitation of a brain's neural synapses.

(usually called a memristor)



Types of Neural Networks - Convolutional Neural Network

- Abbreviated as CNN
- Commonly used for image classification and detection
- Four parts:
 - Convolution, non-linearity, pooling and classification
- An image is turned into a matrix of pixel values and another matrix (the filter) is applied to it to create a feature map
- The classification is done using a Multi-layer Perceptron
- Examples:
 - Google's DeepDream
 -

Convolutional Neural Networks



<http://scs.ryerson.ca/~aharley/vis/conv/flat.html> AKA goo.gl/Ky6bwe

The only difference between this and a normal neural network is the choice of which neuron connects to which. A convolutional neural network's architecture (specifically, which neurons are connected to which) gives it spatial awareness.

Used in image processing, and often outperform conventional methods for categorizing objects!








Fun fact: Was biologically inspired after analyzing a cat's visual cortex,

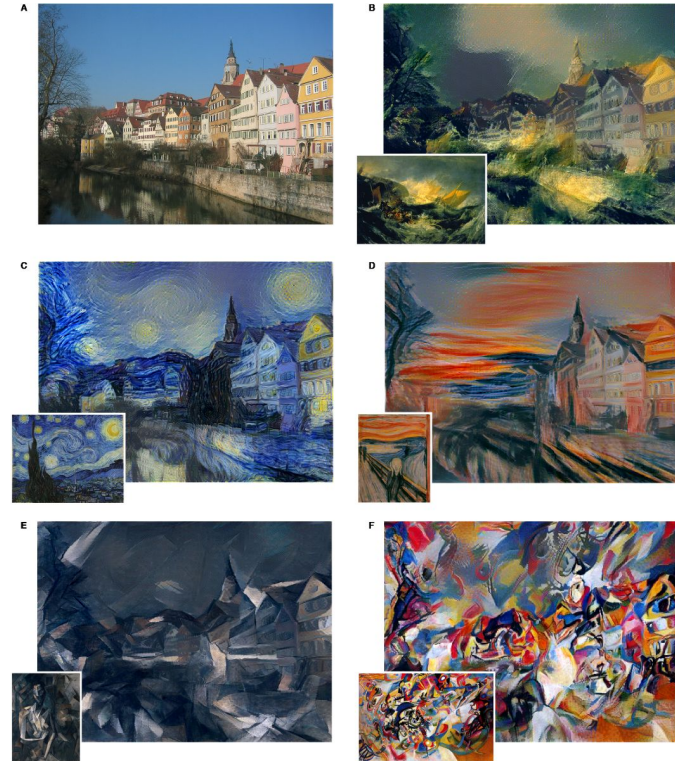
Wavenet: Google's Audio Synthesis Engine using Convolutional Neural Networks

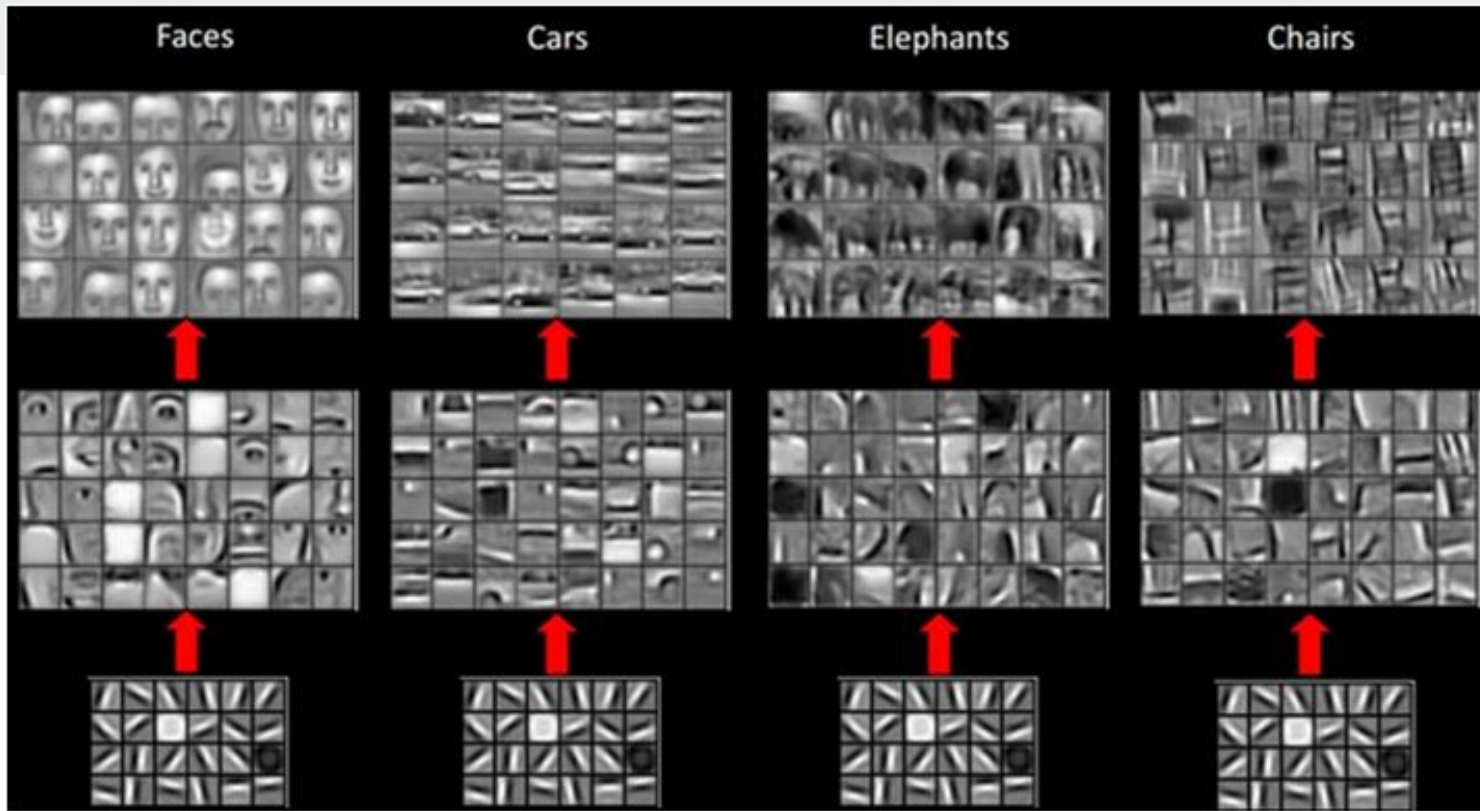
deepmind.com/blog/wavenet-generative-model-raw-audio

This is a special example because normally recurrent neural networks are used for data like this, but google managed to find a way...

Types of Neural Networks - Convolutional Neural Network

Operation	Filter	Convolved Image
Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Edge detection	$\begin{bmatrix} 1 & 0 & -1 \\ 0 & 0 & 0 \\ -1 & 0 & 1 \end{bmatrix}$	
	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$	
	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Box blur (normalized)	$\frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	
Gaussian blur (approximation)	$\frac{1}{16} \begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$	

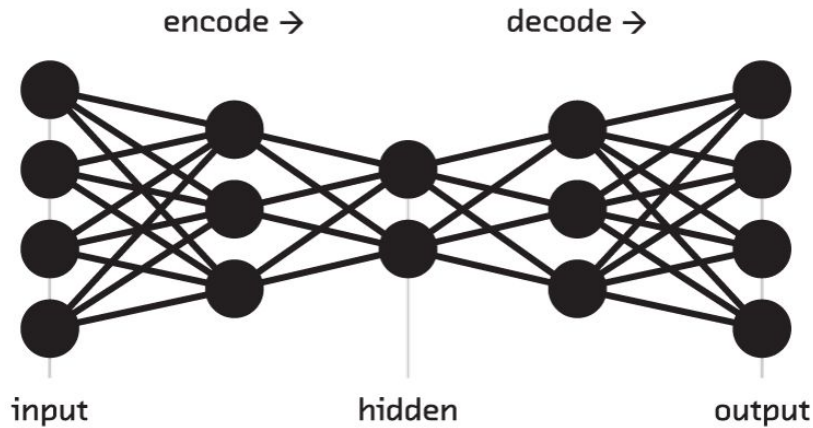




<https://dataskeptic.com/blog/episodes/2017/src-automated-feature-engineering/features.png>



Autoencoders: Compress entire images into a few numbers

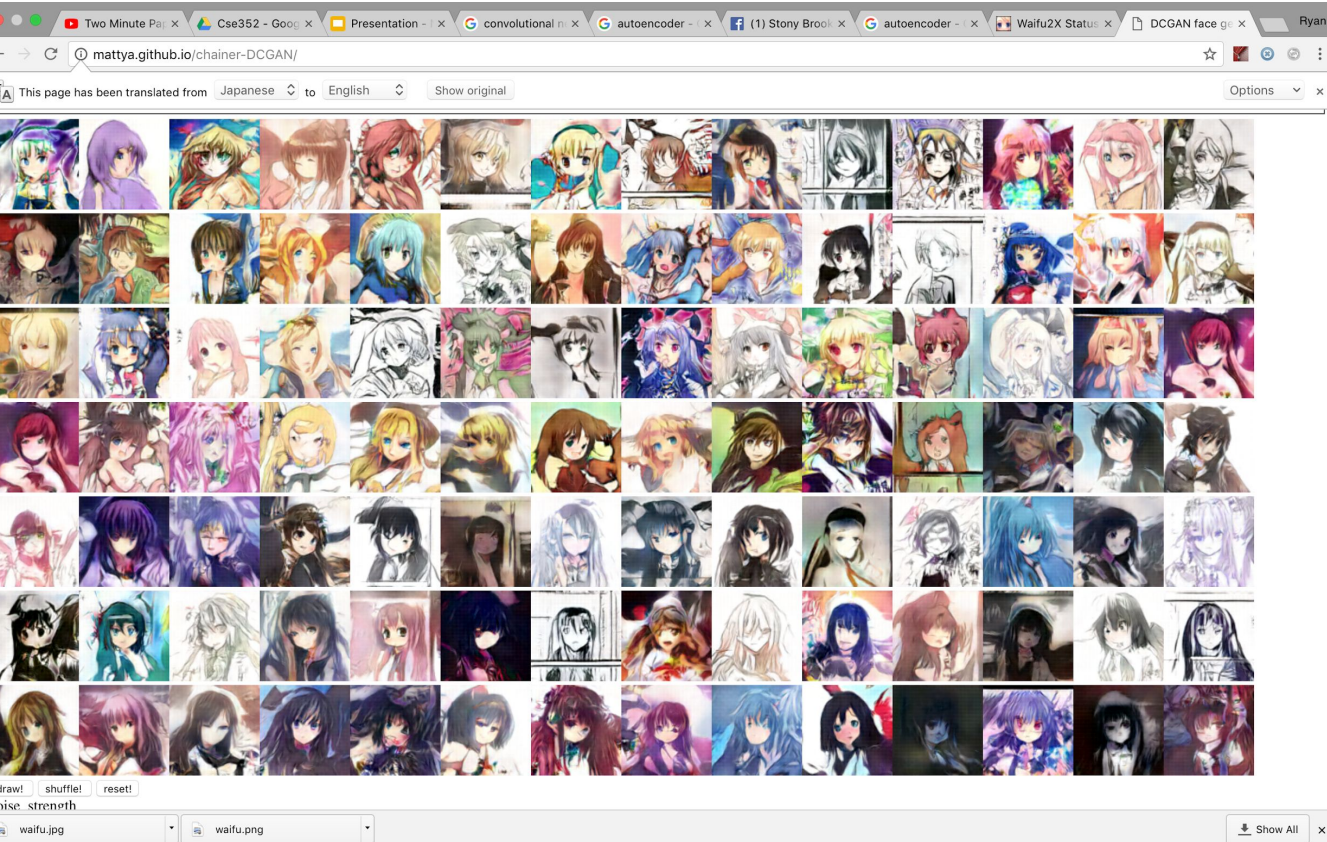


A form of unsupervised learning

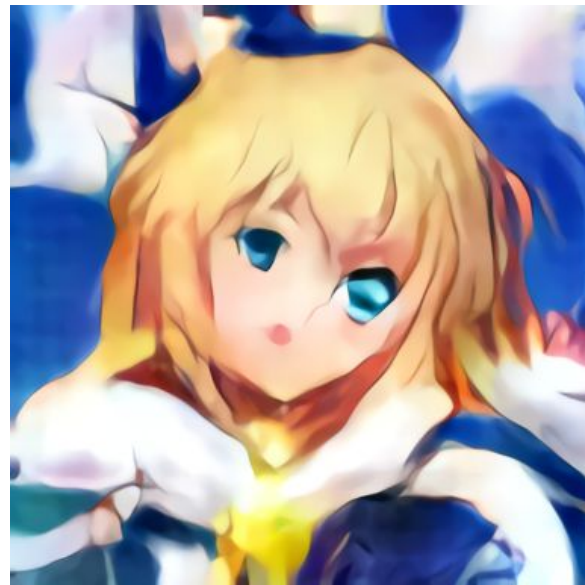
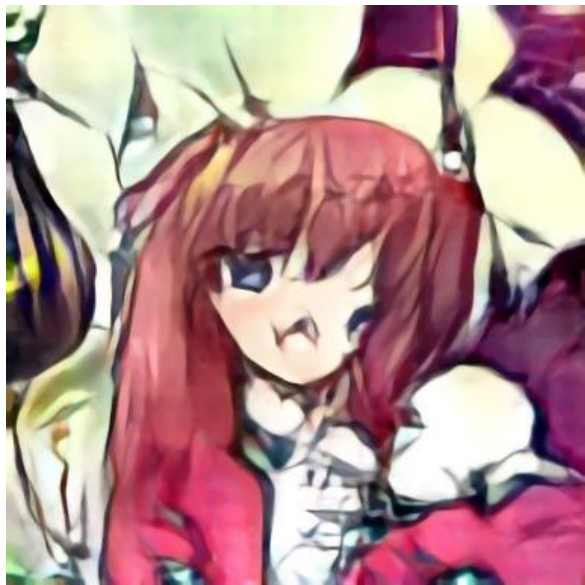
By exploring the latent space of the autoencoder, you can make anime characters! The bottleneck is just 50

perceptrons per image!

goo.gl/fC4B8u



Then you can use a convolutional neural network, at waifu2x.udp.jp to enhance their resolution!



Another autoencoder example: Human Faces

picklerick.io/morphing_faces/online_demo.html

(or just goo.gl/8CPvra)





Other Mind-blowing research projects:

goo.gl/SA3w67 ← Turning horses into zebras

goo.gl/nT55Lj ← Create video games from watching videos of people playing them

goo.gl/wdaESa ← World champion DOTA2 player beat by Elon Musk's Neural Net (You probably heard about it, but it's even more incredible to actually SEE it compete)



A Special Neural Network - *Quick, Draw!*

Can a neural network learn how to recognize art?

<https://quickdraw.withgoogle.com>

The answer: yes!

Experiments like these create new challenges for AI.

<https://quickdraw.withgoogle.com/data/horse>



Popular AI Frameworks



Caffe

Lasagne

theano



ELK



TensorFlow



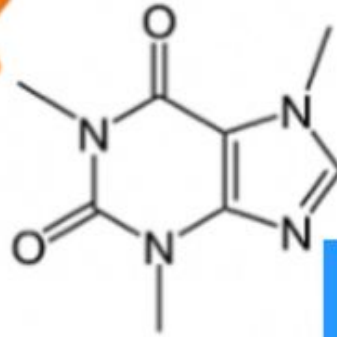
Keras



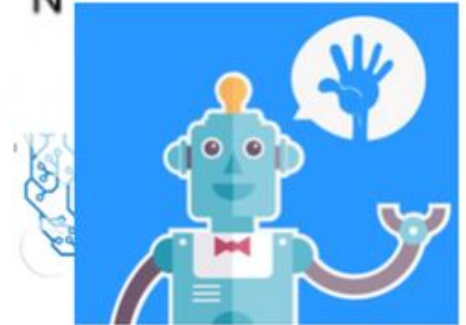
Torch



Spark



elastic





What's next?

One cool thing right around the corner:

Android's Oreo 8.1 Update, including a Neural Network API (NNAPI)

Pros:

- Increased productivity
- Data privacy
- Cost Effective

Cons:

- Increased battery usage
- Increased app size



Thanks for listening!