Introduction to Neural Networks

Applied DeepLearning from Developers to Developers

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Agenda

1. What is Artificial Intelligence?
2. Vision, Text and Speech
3. Motivation - Innovation with AI?
4. What is DeepLearning?
5. Why DeepLearning now?
6. Hardware for DeepLearning
7. Software for DeepLearning
8. First step - Developer Strategy
9. Development Environment
10. Labs/Companies/People/Resources

Human Intelligence

Human Intelligence

1. Humans can - **See**
2. Humans can communicate - **Read** and **Write**
3. Humans can communicate - **Listen** and **Talk**

"To power all this, **Humans** can **Think!**"

Artificial Intelligence

Artificial Intelligence

Machine being able to exhibit **Human Intelligence**

Human Intelligence ⟹ Artificial Intelligence

1. Humans can **See**
    a. Provide **Vision** to **Machines**
2. Humans can communicate - **Read** and **Write**
    a. Make **Machines** to **Read** and **Write** the **Natural Language**
3. Humans can communicate - **Listen** and **Talk**
    a. Make **Machines** to **Listen** and **Talk** the **Natural Language**

"To power all this, Machines should **Think!**"

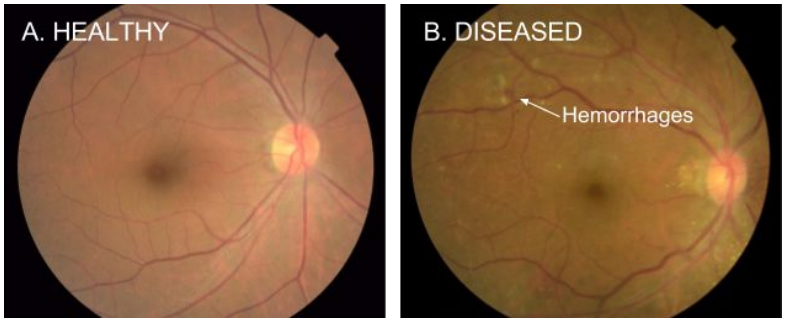
3 Broad Categories of AI

1. See -> Computer Vision (CV)
2. Read and Write the Natural Language -> Natural Language Processing (NLP)
3. Listen and Talk the Natural Language -> Automatic Speech Recognition (ASR)

Motivation - Computer Vision (CV) - 1

Diabetic Retinopathy

Problem: Leading cause of blindness in the working-age population of the developed world. It is estimated to affect over 93 million people. Can you detect it early enough?



https://www.kaggle.com/c/diabetic-retinopathy-detection

Motivation - Computer Vision (CV) - 2

Self Driving Cars

http://articles.sae.org/13996/

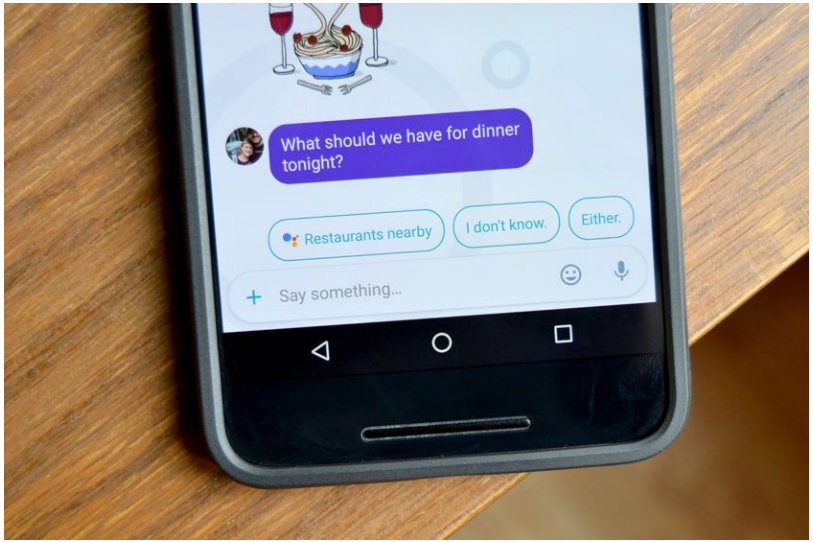
Motivation - Computer Vision (CV) - more....

- Security Cams - Intrusion Detection
- Google Sunroof - Predicting solar energy
- Face Recognition - Google/FB/Amazon auto photo tagging
- Character recognition - USPS auto address detection, Bank Cheque Reading
- Robotics - Fulfillment Center Bots: KIVA at Amazon Fulfillment Center

Google Maps, Security, Agriculture and many more…

Motivation - Natural Language Processing - 1

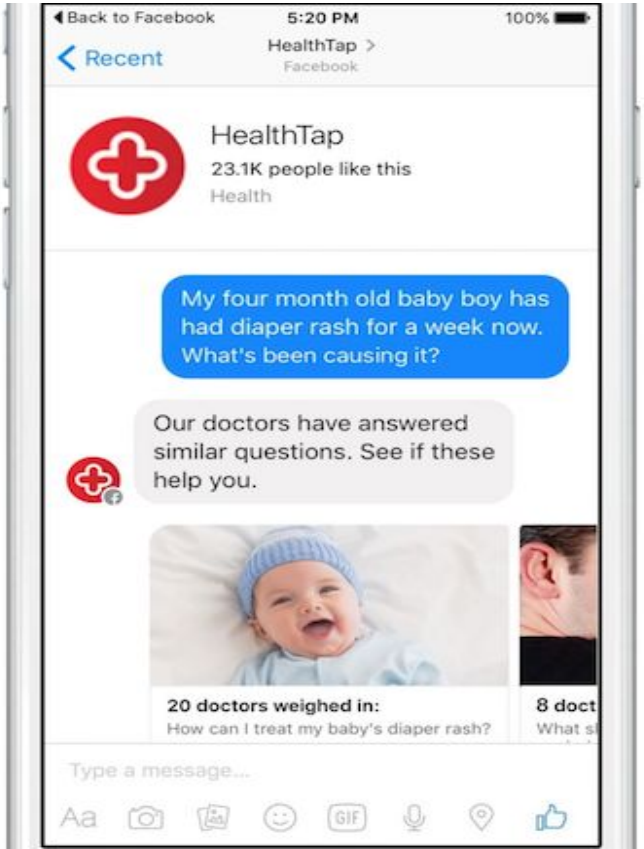
Smart Reply



https://www.blog.google/products/gmail/save-time-with-smart-reply-in-gmail/,
http://www.androidauthority.com/google-allo-717745/

Motivation - Natural Language Processing - 2

Chatbots



http://www.mobihealthnews.com/content/healthtap-creates-chat-bot-facebooks-messenger-app

Motivation - Natural Language Processing - More...

- Machine Translation
- Search Engines
- Summarization
- Medical record analysis

Smart Reply, AD relevance, Customer Care and many more...

Motivation - Automatic Speech Recognition - 1

Personal Assistants

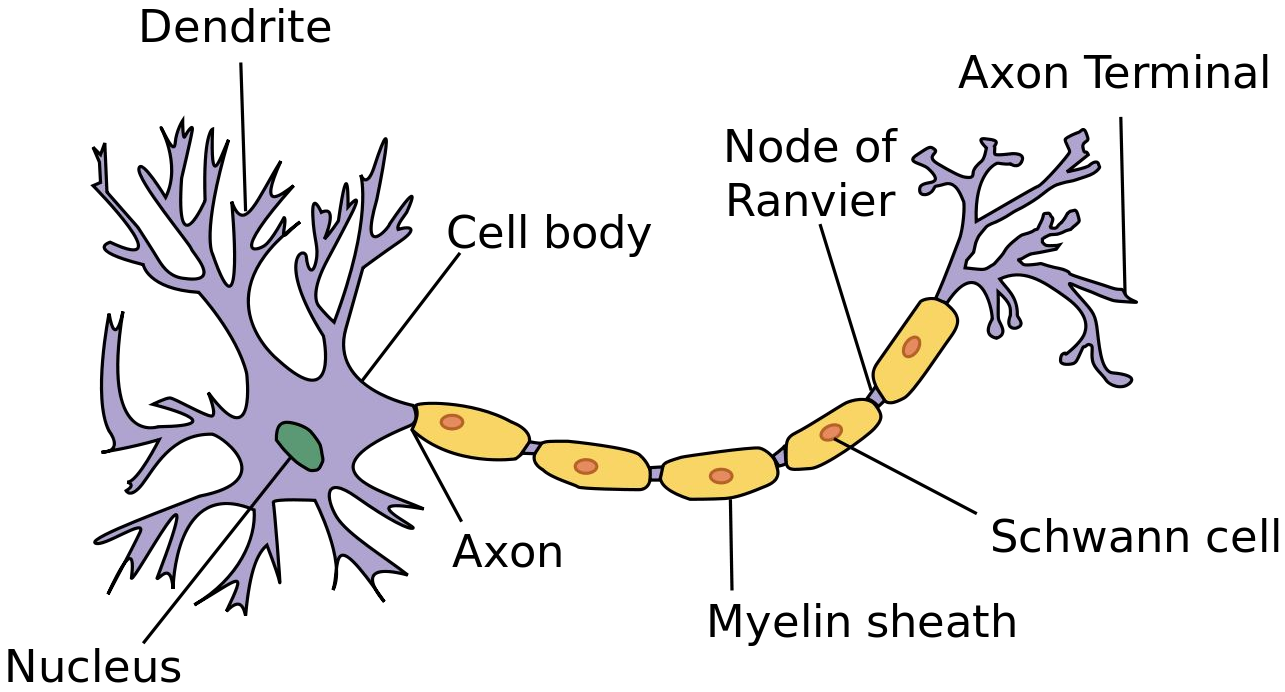
https://www.amazon.com/Amazon-Echo-Bluetooth-Speaker-with-WiFi-Alexa/dp/B00X4WHP5E
https://madeby.google.com/home/

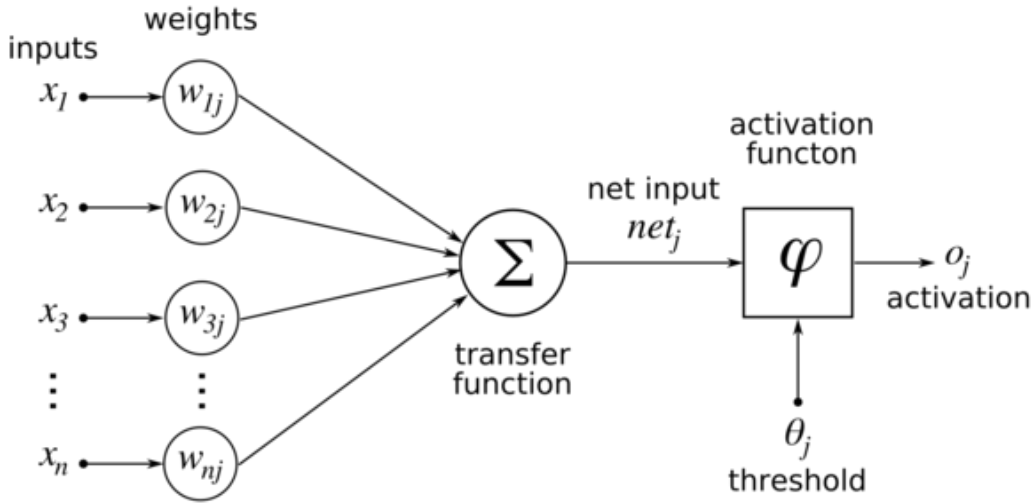
Motivation - Automatic Speech Recognition (ASR) - More...

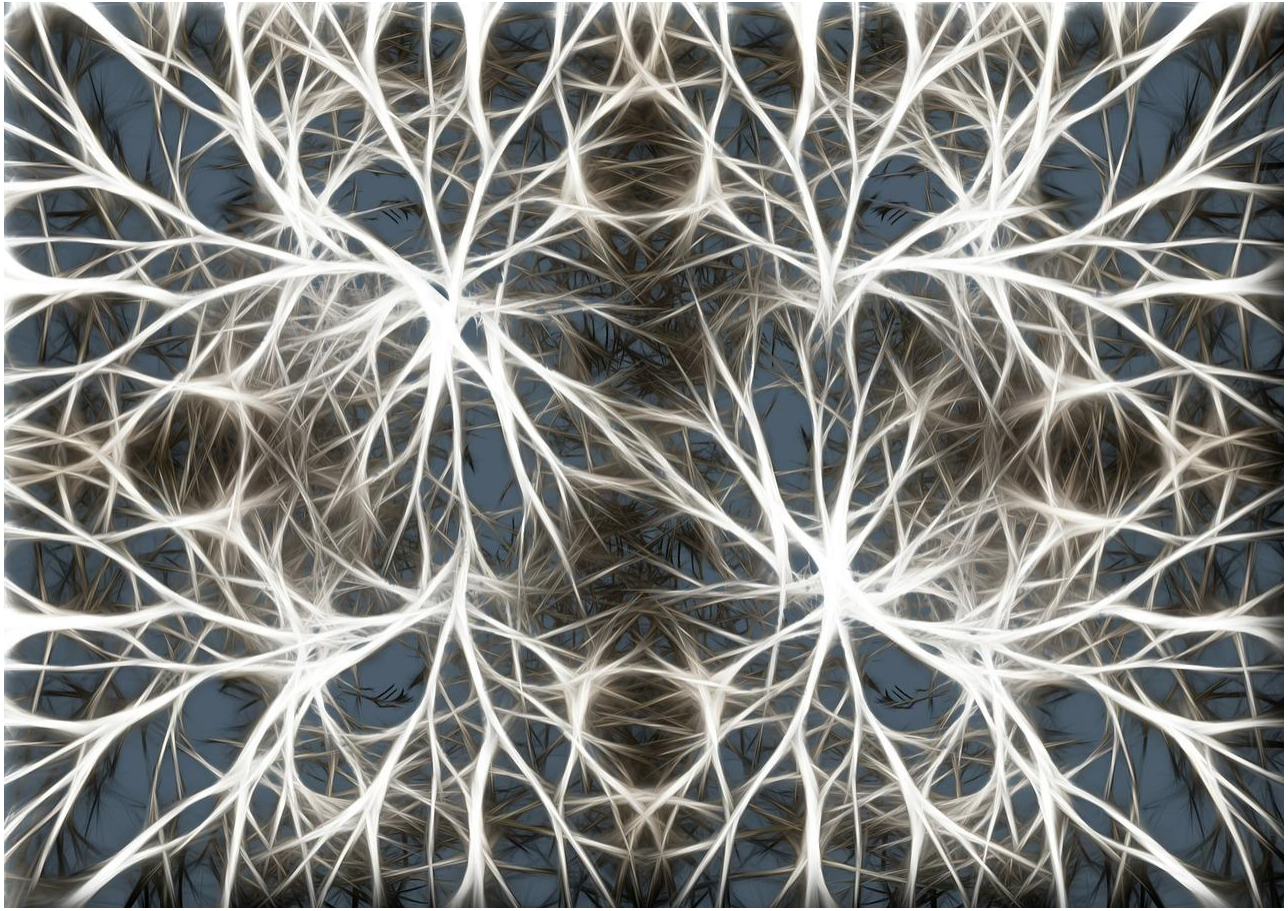
- Amazon Echo / Google Home / Google Now / Apple Siri and more personal assistants.
- Language Translation
- Auto Podcasts / Audio Books

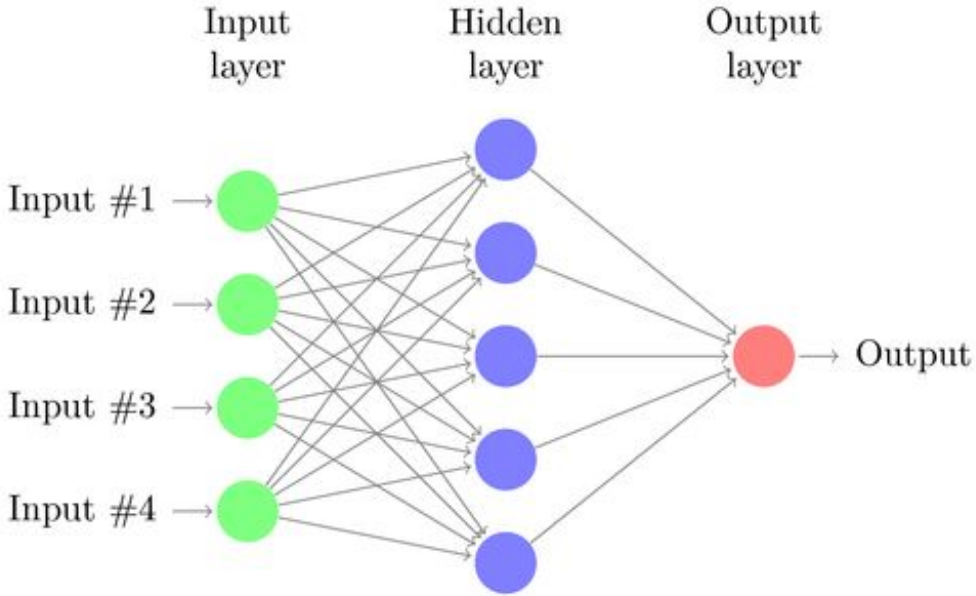
Consumer appliances, security bots, Customer Care and many more...

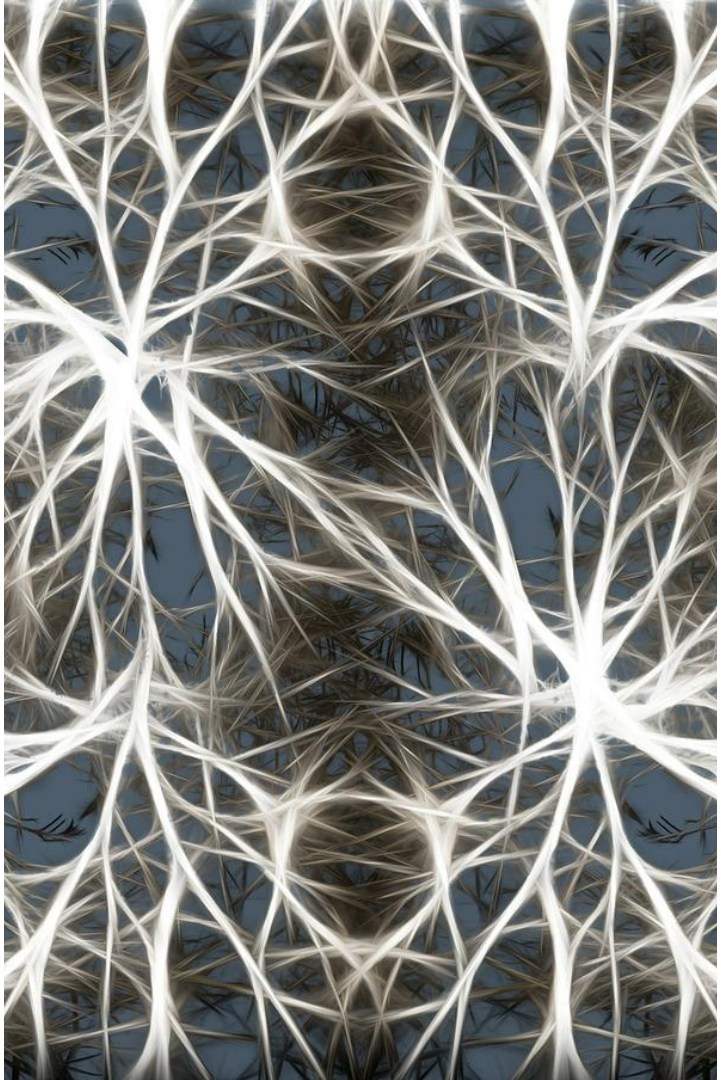
What is DeepLearning??


Dendrite
Axon Terminal
Node of
Ranvier
Cell body
Schwann cell
Axon
Myelin sheath
Nucleus


inputs
weights
x_1
x_2
x_3
x_n
w_{1j}
w_{2j}
w_{3j}
w_{nj}
Σ
transfer
function
net input
net_j
activation
functon
φ
o_j
activation
θ_j
threshold

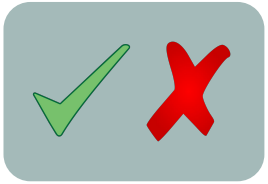



Input layer
Hidden layer
Output layer
Input #1
Input #2
Input #3
Input #4
Output



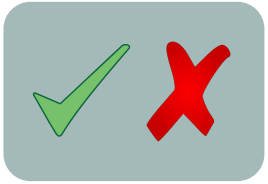
SIZES OF DIFFERENT NETWORKS

- Human: 10^11
- Octopus: 1.5 * 10^8
- Frog: 10^7
- 2011: 1.5 * 10^6
- Bee: 10^6
- 2012 (Multi-GPU CN) : 10^6

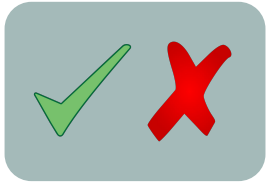


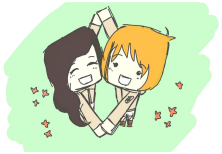
W1 = 0.5

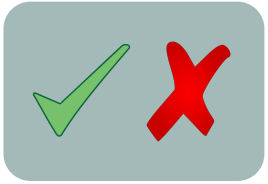
$$f(x) = \begin{cases} 1 & x \geq 0.5 \\ 0 & x < 0.5 \end{cases}$$



W2 = -0.5







W3 = 0.5

1

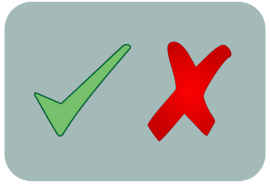
0

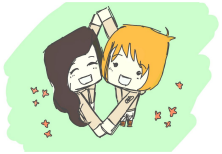
W1 = 0.5

$$x = 0.5 * 1 + -0.5 * 0 + 0.5 * 0 = 0.5$$

$$f(x) = \begin{cases} 1 & x \geq 0.5 \\ 0 & x < 0.5 \end{cases}$$

W2 = -0.5

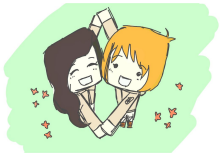


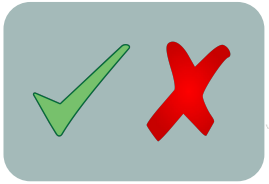


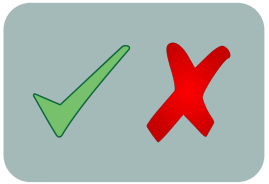
W3 = 0.5

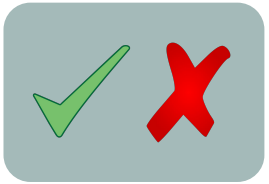
1

0









0.25

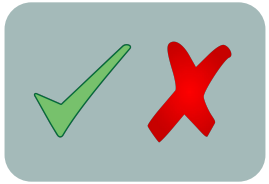
0.25

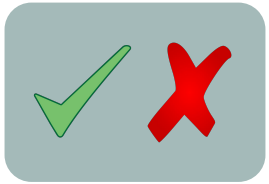
0

0.5

-0.4

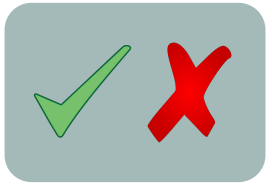
0.9





-1

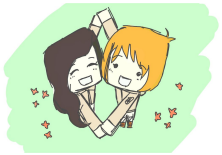
1



$$f(x) = \begin{cases} 1 & x \geq 0.5 \\ 0 & x < 0.5 \end{cases}$$

1

0



0.25

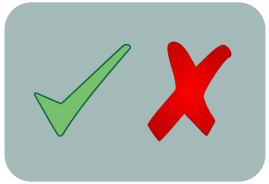
0.25

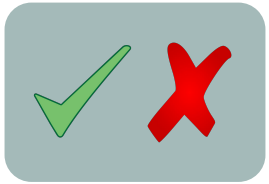
0

0.5

-0.4

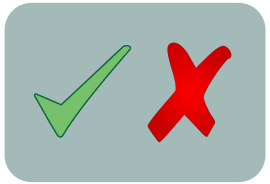
0.9





-1

1

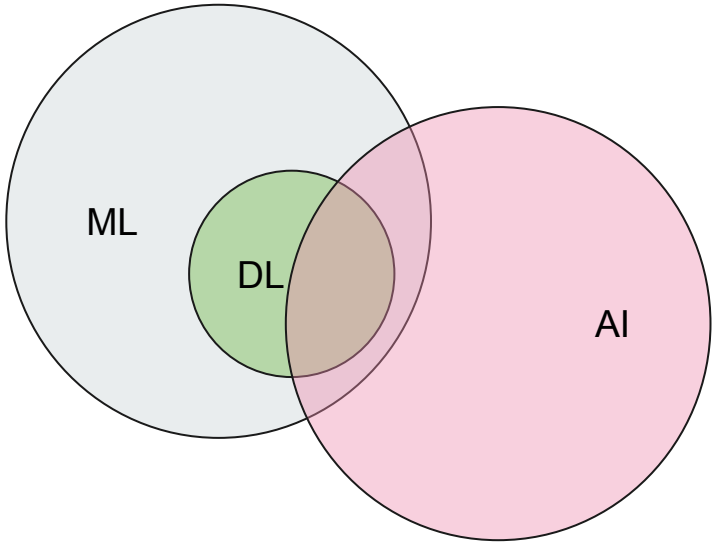


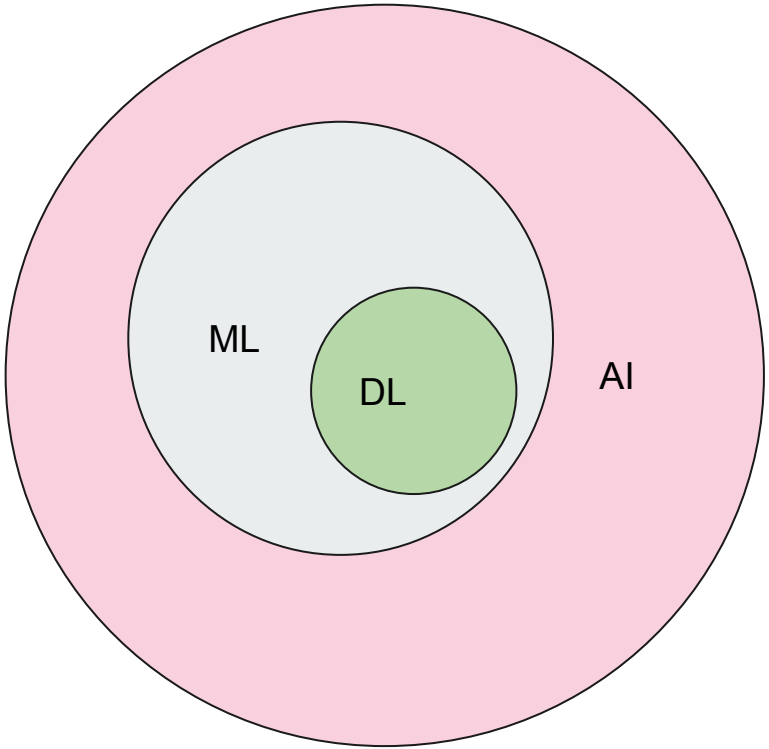
$$f(x) = \begin{cases} 1 & x \geq 0.5 \\ 0 & x < 0.5 \end{cases}$$

1

0

DL vs ML vs AI


ML
DL
AI

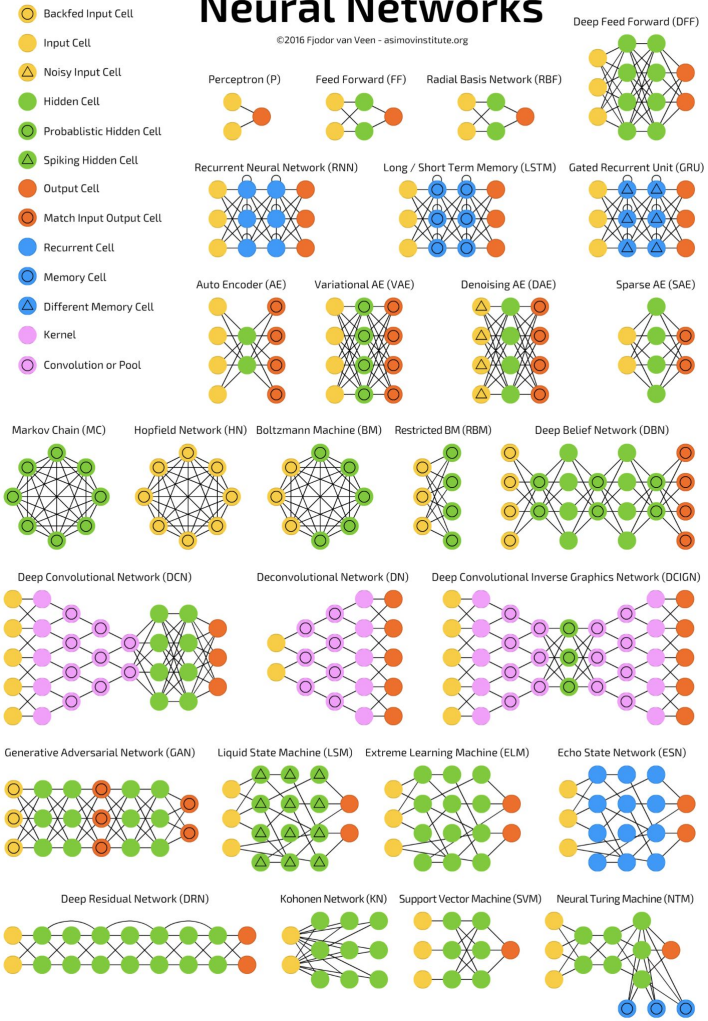

ML
DL
AI

DEMO TIME

A mostly complete chart of

Neural Networks

©2016 Fjodor van Veen - asimovinstitute.org



Why DeepLearning is booming?

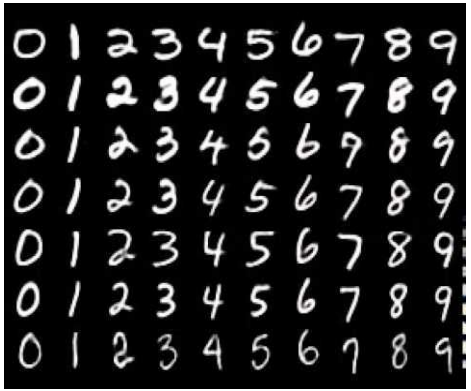
“Hardware Advances” is all the game when it comes to computation!

Power of GPUs: MNIST Handwritten Digit Recognition

- **Dataset:**
  - 60,000 images of size 28*28 for training,
  - 10,000 images of size 28*28 for validation.
- **Network:**
  - A simple 3 layer Convolutional Neural Network.

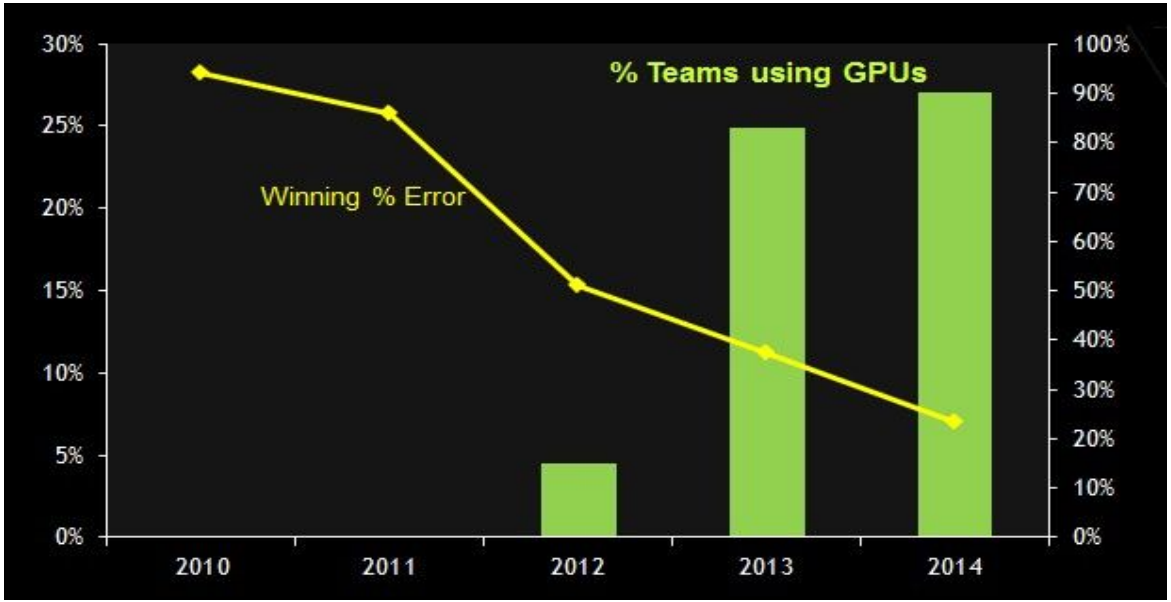
CPU -> 1 GPU **~15 times** speed up

	Training Time (secs)	Accuracy
CPU	1361 (~ 22 mins)	0.98
GPU (1)	96 (~ 2 mins)	0.98
GPU (2)	72 (~1.5 mins)	0.98



http://yann.lecun.com/exdb/mnist/

GPU and DeepLearning - ImageNet



https://devblogs.nvidia.com/parallelforall/accelerate-machine-learning-cudnn-deep-neural-network-library/

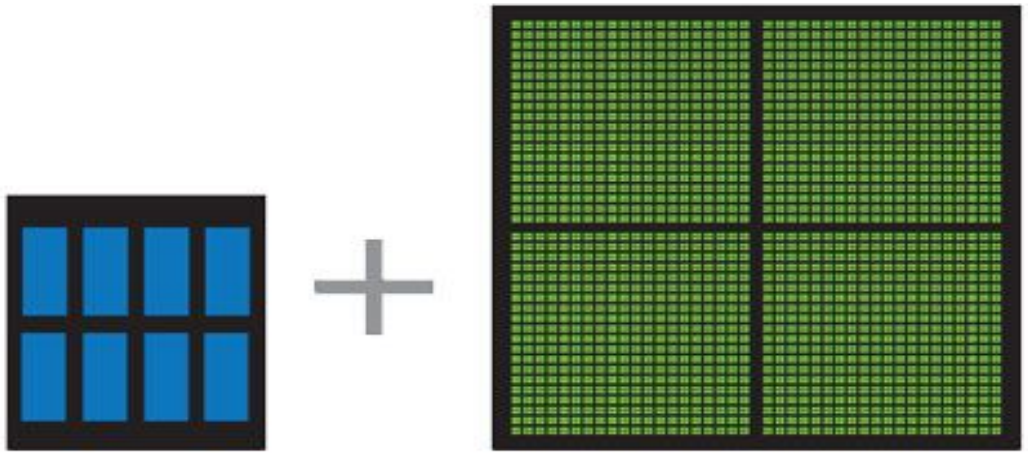
Graphical Processing Unit (GPU)

Early Days (Till **2010-11**)

- Mainly used in Game Rendering, 3D scene Rendering, Structural design, fluid dynamics and such applications.
- Basics: A color Image is a 3 (3 2D matrix for RGB) Dimensional matrix of pixel values.
- All operations are **matrix operations** in the order of **10^6 - 10^9**
- GPUs were built to massively parallelize matrix operations.

http://www.nvidia.com/object/what-is-gpu-computing.html

GPU Cores



http://www.nvidia.com/object/what-is-gpu-computing.html

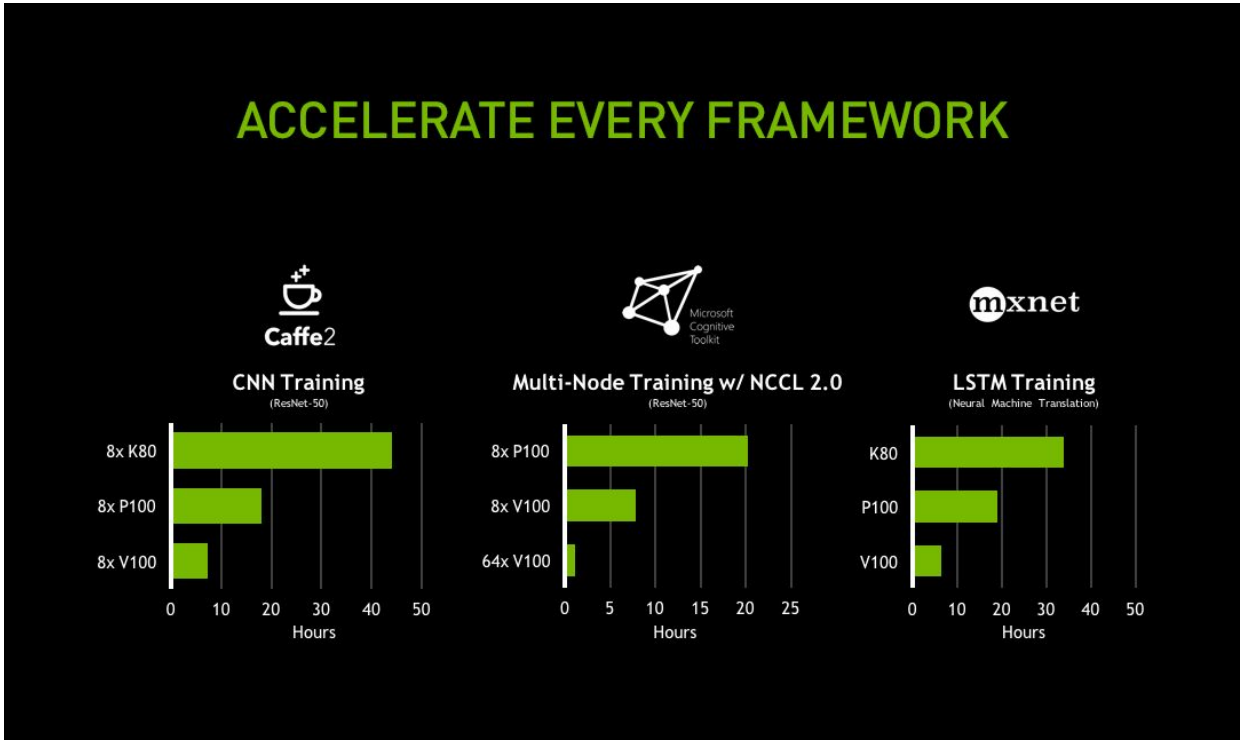
Graphical Processing Unit (GPU) (contd...)

2010-11

- In 2010, Dan Ciresan, a researcher at Swiss AI Lab, discovered that NVIDIA GPUs can be used to train deep neural networks and achieved a **speedup of 50 times over CPUs**.
- In 2011, Schmidhuber's lab used GPUs to develop the first pure deep neural networks that won international contests in handwriting recognition and computer vision.
- NVIDIA became an AI first company, focussing all its energy towards building **GPGPU (General Purpose GPU)** focussing on DeepLearning.

https://blogs.nvidia.com/blog/2017/04/10/ai-drives-rise-accelerated-computing-datacenter/
http://people.idsia.ch/~juergen/computer-vision-contests-won-by-gpu-cnns.html

NVIDIA GPU for AI - 2010-17



https://blogs.nvidia.com/blog/2017/05/24/ai-revolution-eating-software/

Software Tools You Should Know

- Anaconda - https://docs.continuum.io/anaconda/install/
- Jupyter Notebook - http://jupyter.org/install.html
- NumPy - http://www.numpy.org/
- Apache MXNet - https://mxnet.incubator.apache.org/get_started/install.html
- TensorFlow - https://www.tensorflow.org/install/
- GPU Software stack - CUDA, cuDNN - https://www.geforce.com/hardware/technology/cuda, https://developer.nvidia.com/cudnn,

(some more - PyTorch, Caffe2, CNTK, Apple CoreML)

Development Environment

Step 1: Install Anaconda - https://docs.continuum.io/anaconda/install/mac-os.html

Step 2: Prepare Anaconda Environment

```
$ conda create -n awsaiguru_dl_cpu_mxnet_env python=3 numpy jupyter
$ source activate awsaiguru_dl_cpu_mxnet_env
(awsaiguru_dl_cpu_mxnet_env) $ pip install mxnet
(awsaiguru_dl_cpu_mxnet_env) $ jupyter notebook
(awsaiguru_dl_cpu_mxnet_env) $ source deactivate
```

https://conda.io/docs/user-guide/index.html

DeepLearning on AWS Cloud

- AWS DeepLearning AMI - Launch an instance with all DeepLearning tools pre-installed and configured.
- Getting Started - http://docs.aws.amazon.com/mxnet/latest/dg/whatis.html

First Step - Developer Strategy - AI First

First step for any developer/team/company to get started with AI is to think:

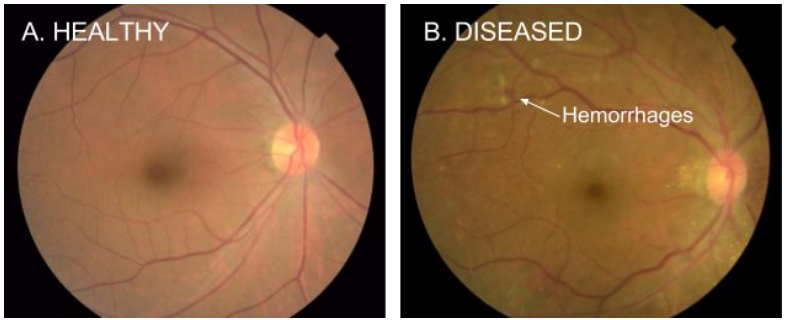
1. Should your applications/solutions **See**?
2. Should your applications/solutions **Read** and **Write** the **Natural Language**?
3. Should your applications/solutions **Listen** and **Talk** the **Natural Language**?

"To power all this, should your applications/solutions **Think??**"

(Earlier..) Motivation - Computer Vision (CV) - 1

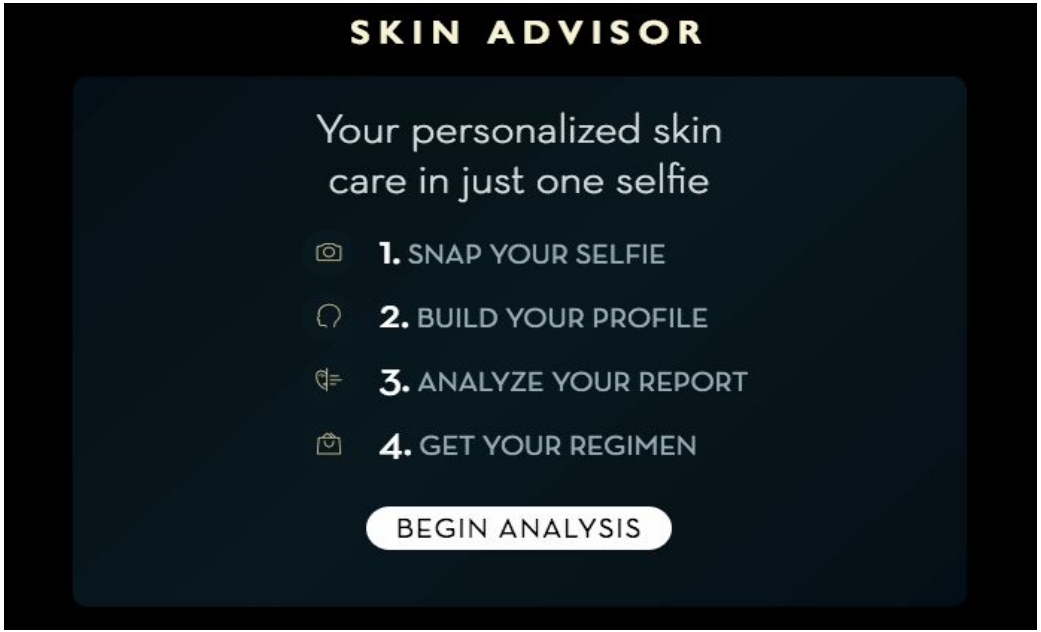
Diabetic Retinopathy

Problem: Leading cause of blindness in the working-age population of the developed world. It is estimated to affect over 93 million people. Can you detect it early enough?



https://www.kaggle.com/c/diabetic-retinopathy-detection

Mobile App for Skin Care?



https://www.olay.com/en-us/?skinadvisor

Labs/Companies to follow

- https://aws.amazon.com/blogs/ai/
- https://research.googleblog.com/
- http://bair.berkeley.edu/blog/
- http://allenai.org/
- https://wp.nyu.edu/cilvr/
- http://ai.stanford.edu/
- https://mila.umontreal.ca/en/
- https://blog.openai.com/
- https://research.fb.com/category/applied-machine-learning/
- https://www.ibm.com/blogs/watson/

* Not in any particular order
* Not an extensive list

Companies to Follow on Twitter

Baidu Research (@BaiduResearch),

NVIDIA AI(@NvidiaAI),

Open AI (@OpenAI),

DeepMind(@DeepMindAI),

DeepLearningHub(@DeepLearningHub),

Google Research(@googleresearch),

IBM Research(@IBMResearch)

* Not in any particular order
* Not an extensive list

People to Follow on Twitter

AndrewYNg, Ian Goodfellow, Fei-Fei Li, Greg Brockman, Yuanqing Lin, Ilya Sutskever, Rajat Monga, Alex Smola, Francois Chollet, Tianqi Chen, Soumith Chintala, Oren Etzioni, Andrej Karpathy,Pieter Abbeel, Russ Salakhutdinov, Yann LeCun

* Not in any particular order
* Not an extensive list

Other blogs / Resources

- http://colah.github.io/
- http://karpathy.github.io/neuralnets/
- http://www.wildml.com/
- https://distill.pub/
- http://neuralnetworksanddeeplearning.com/index.html
- https://www.deeplearning.ai/
- http://www.deeplearningbook.org/

* Not in any particular order
* Not an extensive list

Resources / Contact Us

Resources

- Github - https://github.com/awsaiguru
- PPT - https://github.com/awsaiguru/slides

People

- Sandeep Krishnamurthy - sandeep.krishna98@gmail.com, Github, LinkedIn, Twitter
- Viacheslav Kovalevskyi - viacheslav@kovalevskyi.com, @b0noi , http://blog.kovalevskyi.com

Next steps

- How to train NN?
- Real world example!
- Much more!