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AI for Every Developer

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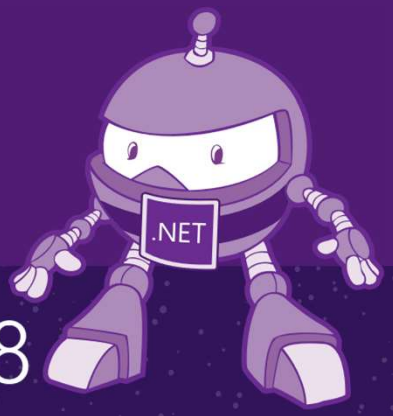

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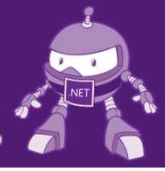
Goals

01. Define what AI, ML and DL are

02. Three ways of using AI

03. Core DL concepts, terminology and algorithms

04. Develop our first DL application



01 Define what AI, ML and DL are

1943 - the first work that is now generally recognized as AI was McCullouch and Pitts' formal design for Turing-complete "artificial neurons".

1959 - The name machine learning was coined by Arthur Samuel. Evolved from the study of pattern recognition and computational learning theory in artificial intelligence, machine learning explores the study and construction of algorithms that can learn from and make predictions on data

2012 – A group of built a network of 16,000 computer processors with one billion connectors and let it browse YouTube looking for cats. The "brain" simulation was exposed to 10 million randomly selected YouTube video thumbnails over the course of three days and, after being presented with a list of 20,000 different items, it began to recognize pictures of cats using a "deep learning" algorithm

A note on the computational power

1995: 5M transistors on a chip (the population of NYC at that time)
1995 was also the launch of the first Pentium and of Windows 95 everything changed

2005: 160M transistors on a single chip. This matches the population of the entire East Coast
Pentium 4 came out. Web was growing and there was the mobile around the corner

2010: 1 Billion transistor, post iPhone, post iPad, post connect world. We were doing gesture and voice recognition in our living room for 150 dollars!

2015: 7.6 Billions transistors on a chip, that's a transistor for every man, woman and child on Earth

2017: In two years we filled up another planet

It took 30 year to fill up NYC and 10 years to fill up the entire world

This is the compute that's changing the face of computation of ML and DL and driving it

Artificial Intelligence

Artificial Intelligence (AI) is the science of making things smart.
Can be defined as:

“Human Intelligence exhibited by machines”

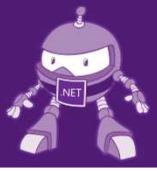
A board term of getting computers to perform human tasks.
The scope of AI is disputed and constantly changing over time.

Artificial Intelligence – the state of the art

System Implemented today are a form of narrow AI

A system that can do just one (or a few) defined things as well or better than humans

Like recognize object / detect a CC fraud in real time



AI Common Use Case

Object recognition
Speech recognition
Natural Language Processing
Creative (eg style transfer)
Prediction
Data Security
Financial (trading / fraud detection)

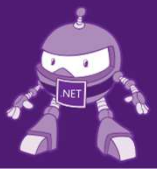
Healthcare
Marketing (custom ads/recommendations)
Online search
Smart Cars

Machine Learning

Machine Learning (ML) can be generally defined:

"An approach to achieve artificial intelligence through systems that can get better the more you run them"

ML involves teaching a computer to recognize patterns by example, rather than programming it with specific rules. These patterns can be found within data. In other words, ML is about creating algorithms (or a set of rules) that learn complex function (or pattern) from data and make prediction on it – form of "narrow AI"



How ML works

ML is about predicting stuff and it's intelligence because:

- It takes some data (to train the system)
- Learns patterns from this data
- Classifies new data it has not seen before for a best guess of what probably is based on knowledge gained in the learning process

Traditional programming

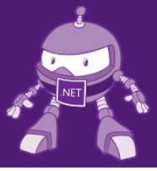
Write a computer program with explicit rules to follow

If email contains "Viagra"
    then mark as spam
If email contains ….
If email contains ….

Machine Learning Programs

Write a computer program that learn from examples

Try to classify some emails (training)
Apply learned model to classify



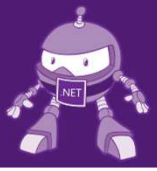
Deep Learning

Deep Learning (ML) can be generally defined:

"A technique for implementing ML"

One such DL technique is a concept known as Deep Neural Networks (DNNs)

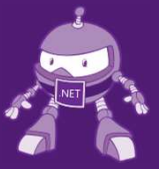
DL is the context of DNNs is where the code structures you write are arranged in layers that loosely mimic the brain, learning patterns of patterns



02. Three ways of using AI

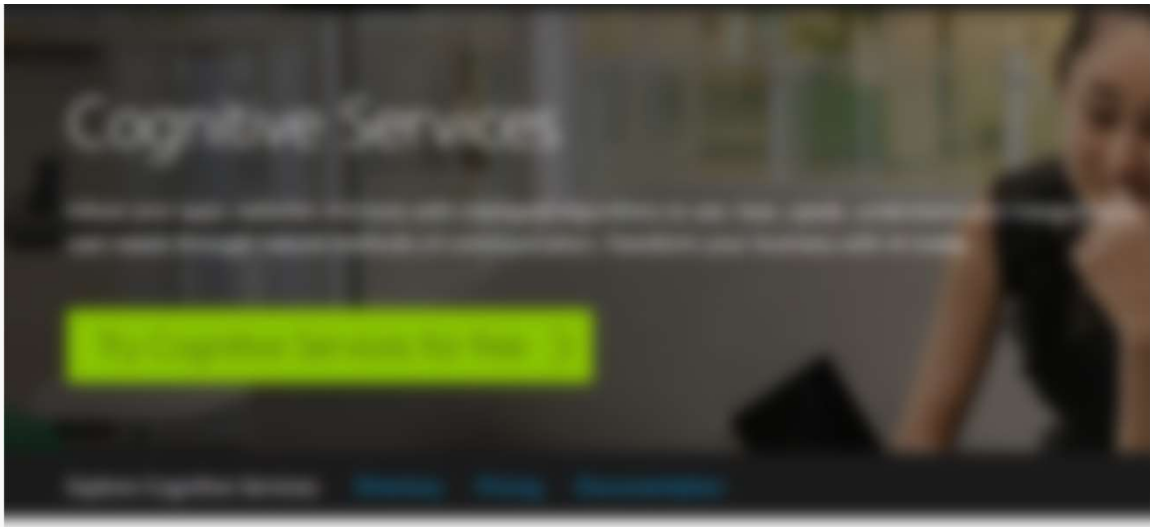
Option 1 – Easy

AI as Service



cognitive services

Infuse your apps, websites and bots with intelligent algorithms to see, hear, speak, understand and interpret your user needs through natural methods of communication



Use AI to solve business problems

Microsoft Cognitive Services updates

Vision	Speech	Language	Knowledge	Search
Video Indexer	Speaker Recognition	Text Analytics	QnA Maker	Bing Entity Search
Computer Vision	Bing Speech	Bing Spell Check		Bing Autosuggest
Face	Translator Speech	Translator Text		Bing Search
Emotion	Unified Speech			Bing Statistics add-in
Content Moderator				Bing Visual Search

Pre-built ML Models (Azure Cognitive Services)

Consume (C#, VB, F#)

e.g. Sentiment Analysis using Azure Cognitive Services

```
TextAnalyticsAPI client = new TextAnalyticsAPI();
client.AzureRegion = AzureRegions.Westus;
client.SubscriptionKey = "1bf33391DeadFish";

client.Sentiment(
new MultiLanguageBatchInput(
new List<MultiLanguageInput>()
{
new MultiLanguageInput("en","0",
    "This is a great movie")
}));
```

96% positive

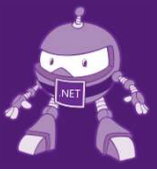
Easy / Less Control

Full Control / Harder

02. Three ways of using AI

Option 2 – Still easy, but more work

Custom Service



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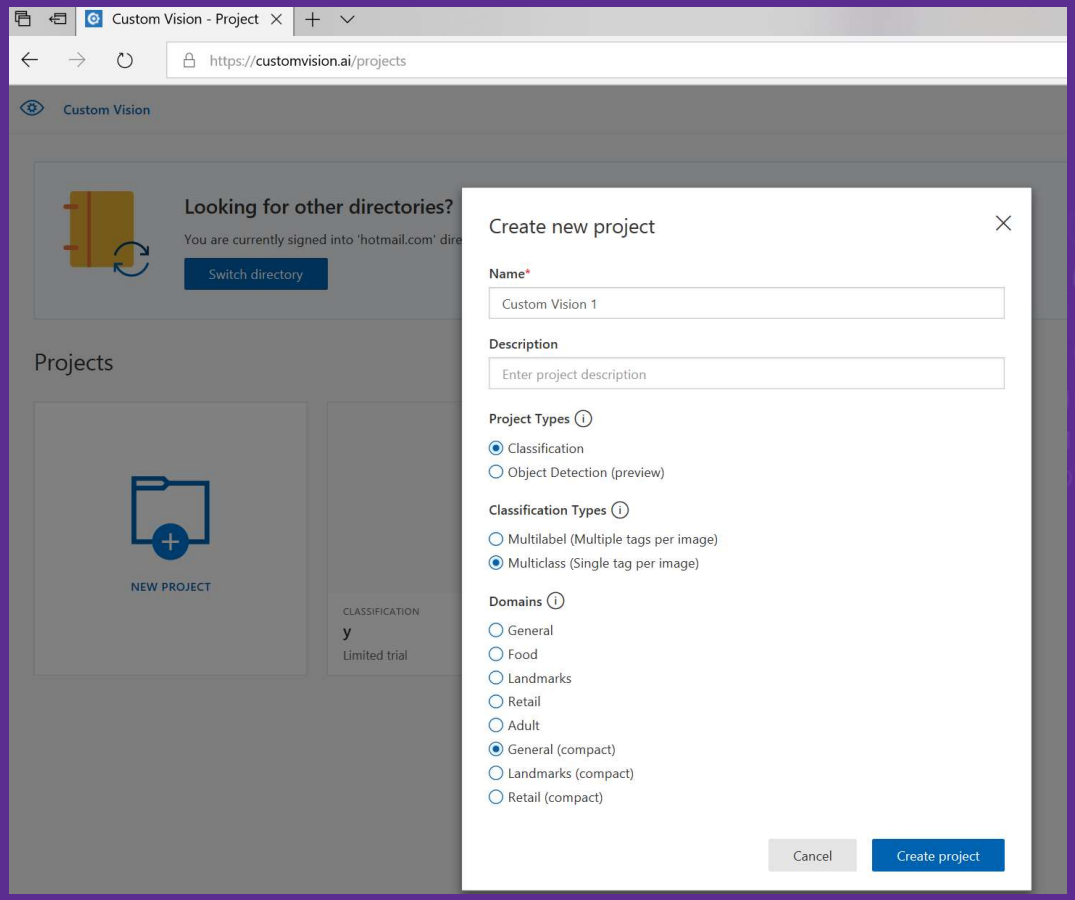
Emotion	Unified Speech			Bing Statistics add-in
Content Moderator				Bing Visual Search

Customization

Custom Vision	Custom Speech	Language Understanding (LUIS)	Custom Decision	Bing Custom Search

Using Custom Cognitive Services



Customvision.ai

Create new project

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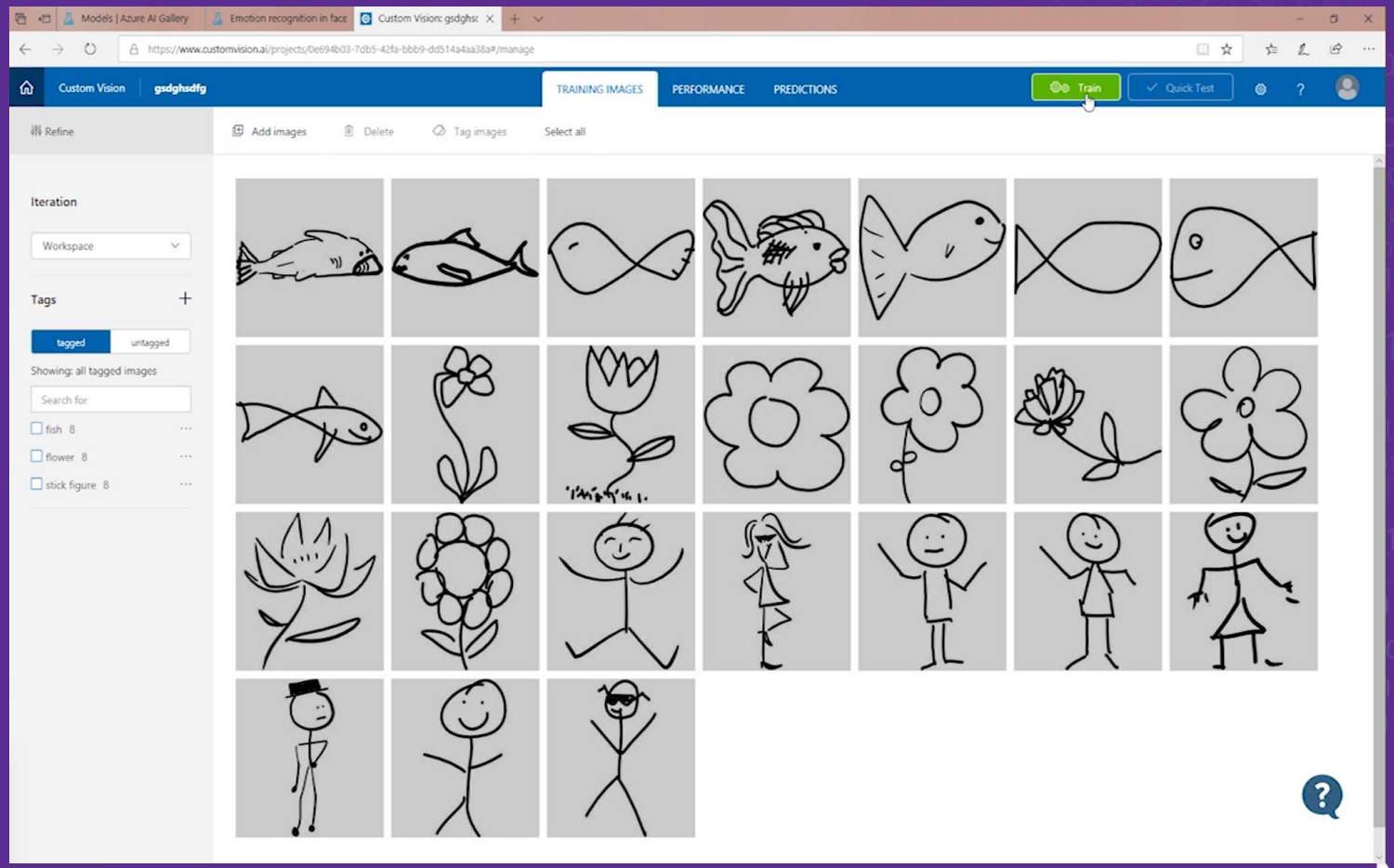
Using Custom Cognitive Services



Add your sample data

Train the model

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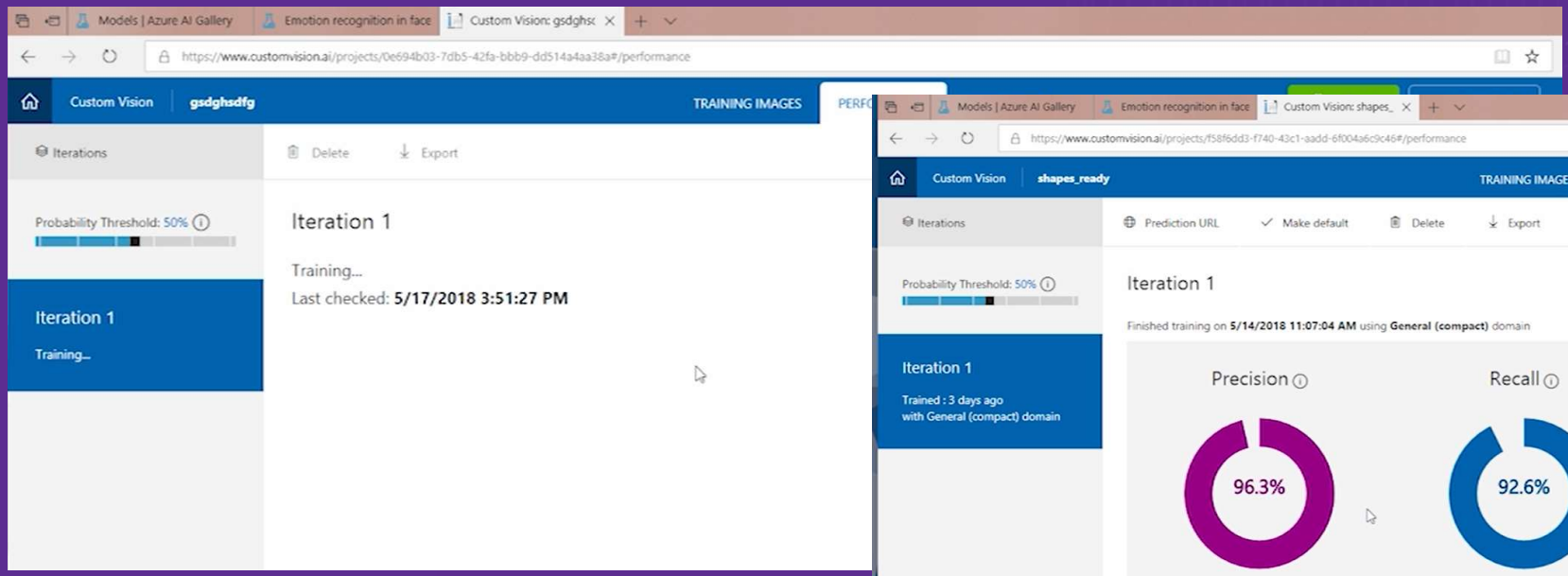
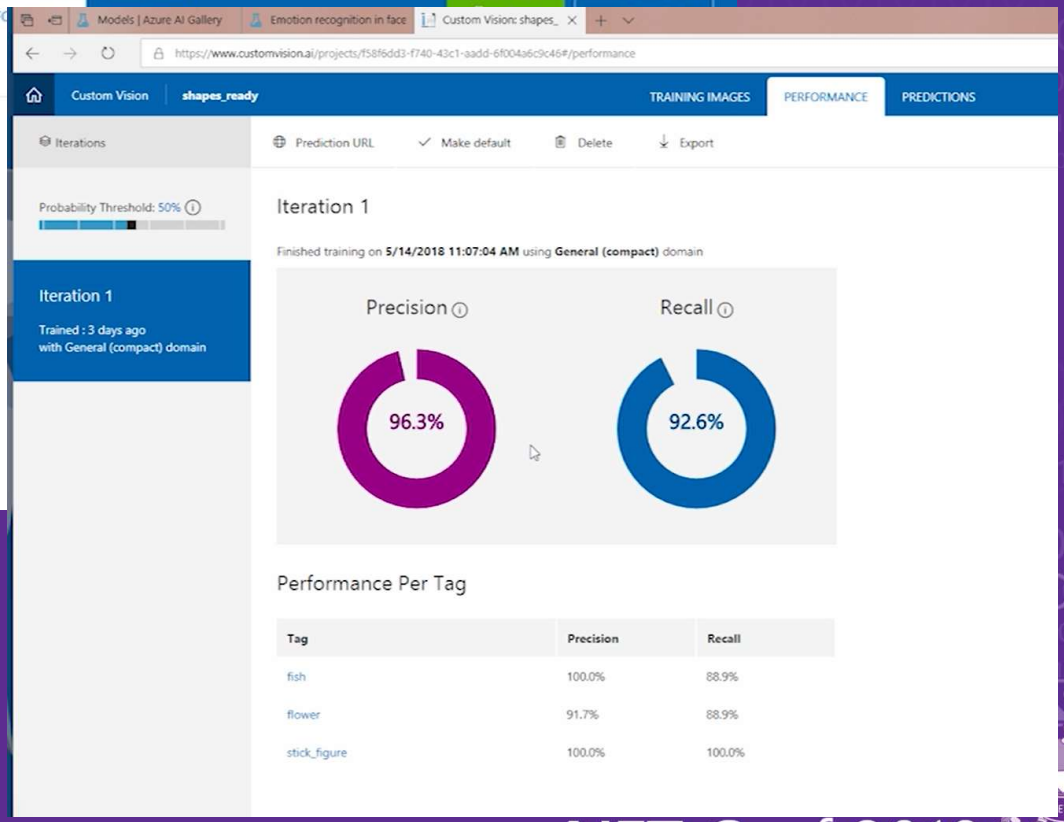
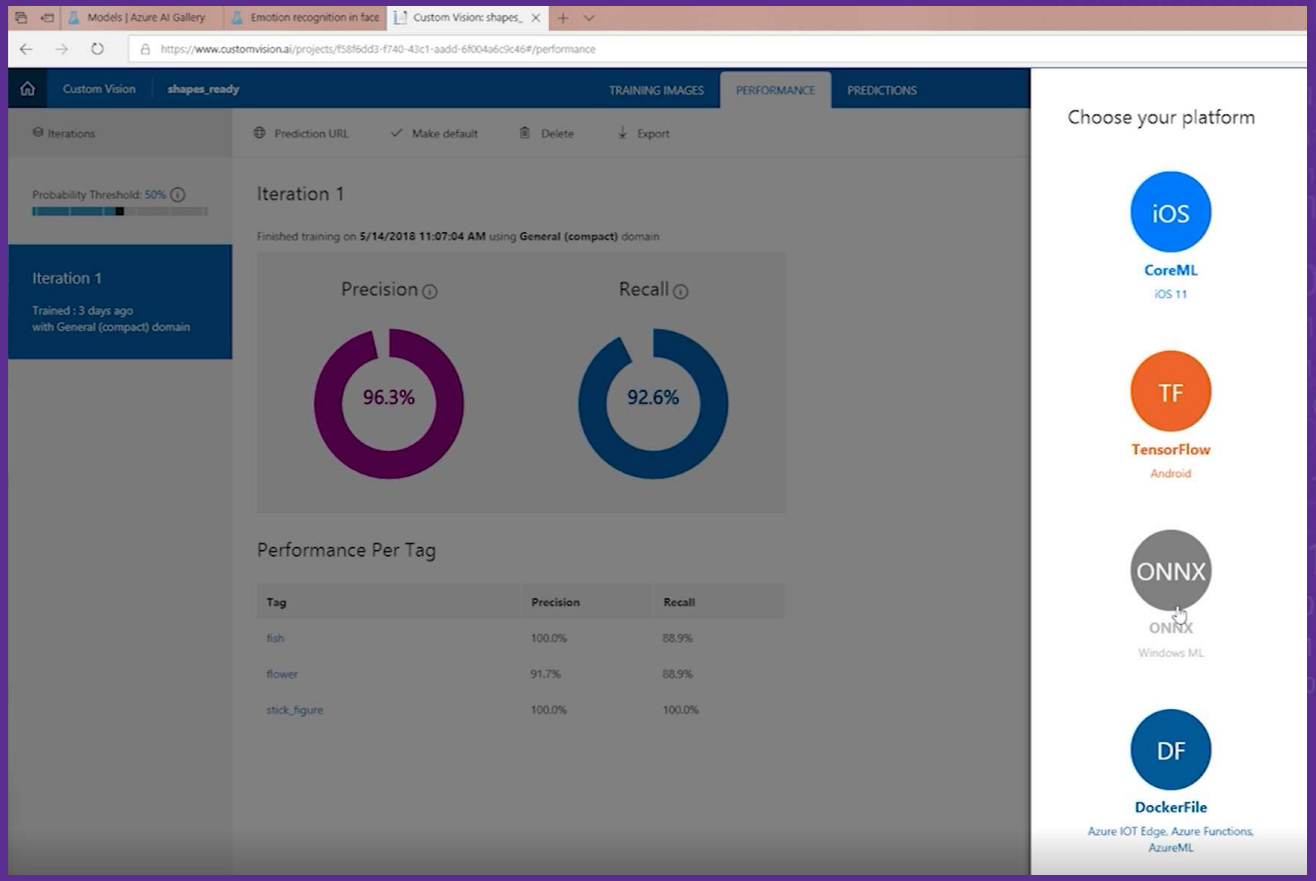
Using Custom Cognitive Services





Verify the result of your trained model until you are satisficed

Using Custom Cognitive Services



Export your model into the ONNX format

Save it locally on your project

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Using Custom Cognitive Services

```
protected async override void OnNavigatedTo(NavigationEventArgs e)
{
    // load Model
    var file = await StorageFile.GetFileFromApplicationUriAsync(new Uri("ms-appx:///inkshapes.onnx"));
    model = await Model.CreateModel(file);

    setup InkCanvs, sound and timers
}
```

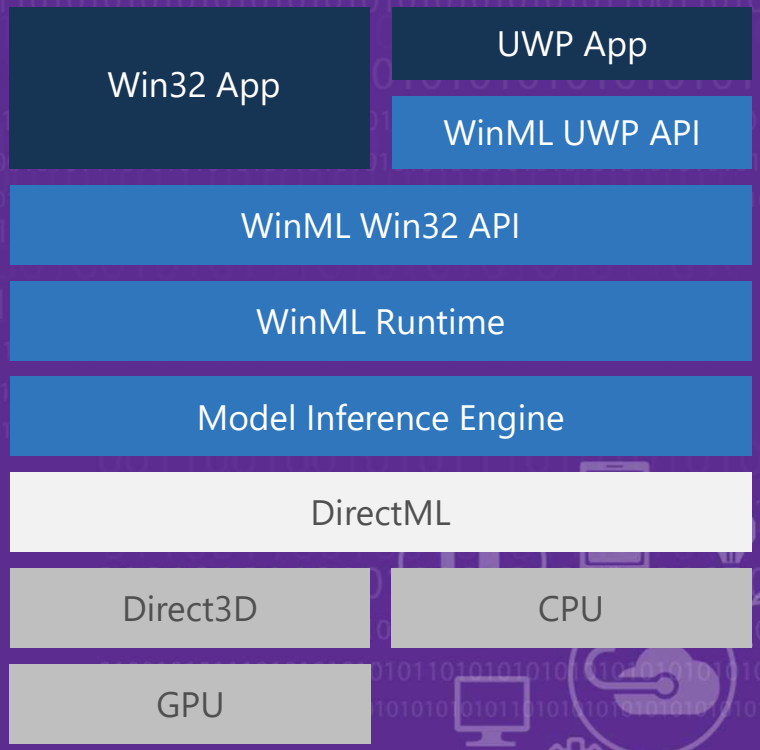
Import the model in your project and load it

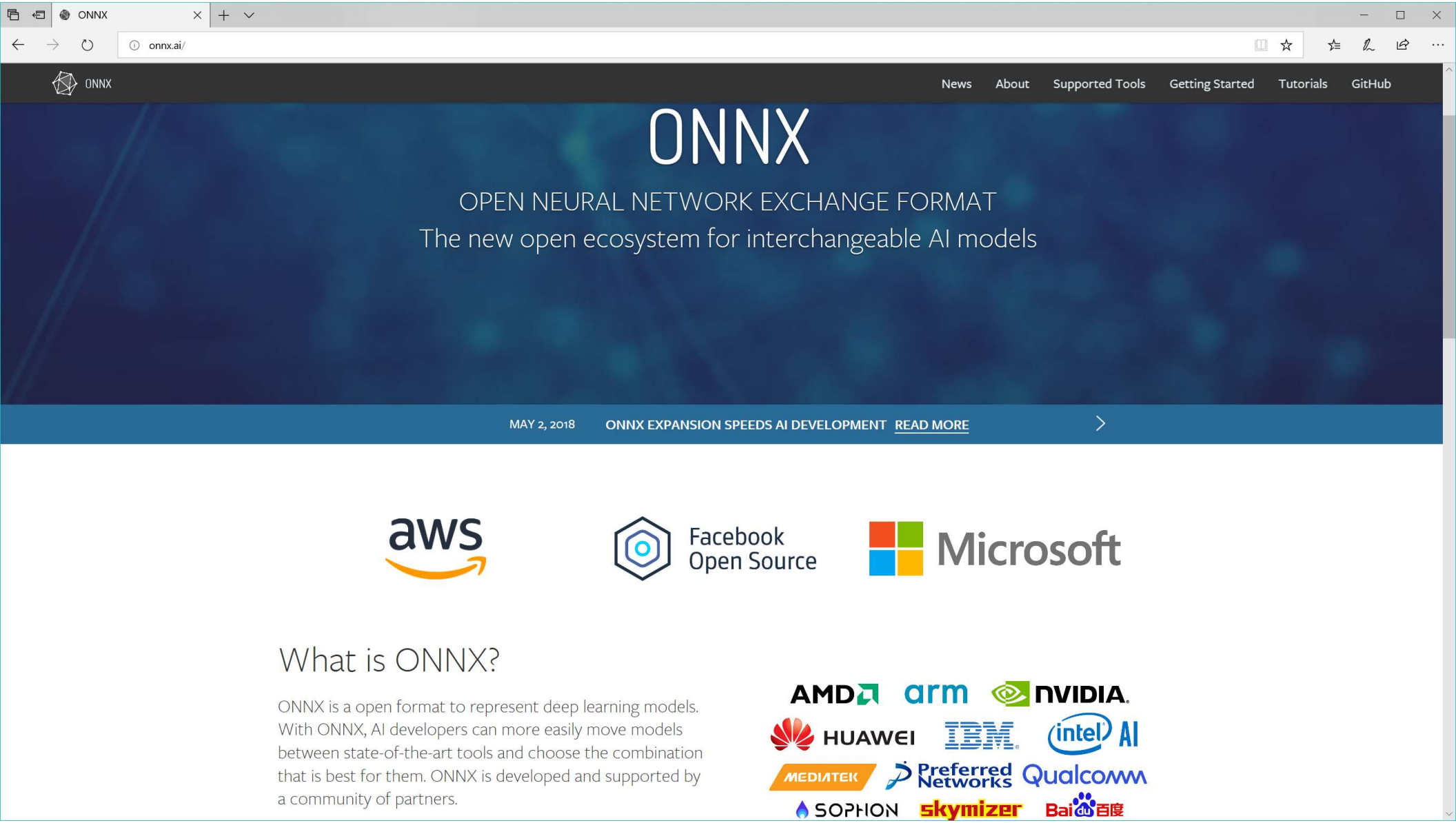
```
private async void InkPresenter_StrokesCollectedAsync(InkPresenter sender, InkStrokesCollectedEventArgs args)
{
    var bitmap = Inker.GetCropedSoftwareBitmap(newWidth: 227, newHeight: 227, keepRelativeSize: true);
    var frame = VideoFrame.CreateWithSoftwareBitmap(bitmap);
    var input = new ModelInput() { data = frame };

    var output = await model.EvaluateAsync(input);

    var guessedTag = output.classLabel.First();
    var guessedPercentage = output.loss.OrderByDescending(kv => kv.Value).First().Value;

    if (guessedPercentage < 0.9)
    {
        SubText.Text = $"draw {currentShape} to snooze - don't know what that is";
    }
    else if (guessedTag != currentShape)
```

Evaluate against your data

Windows ML solves three problems for you

1. Developers can focus on their data and their scenarios, using Windows ML for model evaluation
2. Enables using ML models trained with a diverse set of toolkits
3. Hardware acceleration gets fast evaluation results across the diversity of the entire Windows device ecosystem.

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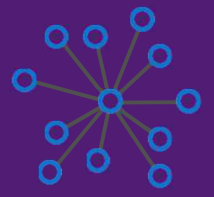
OPEN NEURAL NETWORK EXCHANGE FORMAT
The new open ecosystem for interchangeable AI models
MAY 2, 2018
ONNX EXPANSION SPEEDS AI DEVELOPMENT READ MORE
aws
Facebook
Open Source
Microsoft
What is ONNX?
ONNX is a open format to represent deep learning models. With ONNX, AI developers can more easily move models between state-of-the-art tools and choose the combination that is best for them. ONNX is developed and supported by a community of partners.
AMD
arm
NVIDIA
HUAWEI
IBM
intel AI
MEDIATEK
Preferred Networks
Qualcomm
SOPHON
skymizer
Baidu 百度

How do I get ONNX models to use in my application?

- Azure Machine Learning Services gives you an end-to-end solution to prepare data, and train your model in the Cloud.
- WinMLTools converts existing models from CoreML, scikit-learn, LIBSVM, and XGBoost
- Azure Custom Vision makes it easy to create your own image models - https://customvision.ai/

02. Three ways of using AI

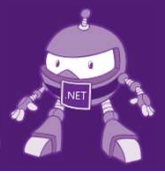
Option 3 – Hands will be dirtied



Coding your AI

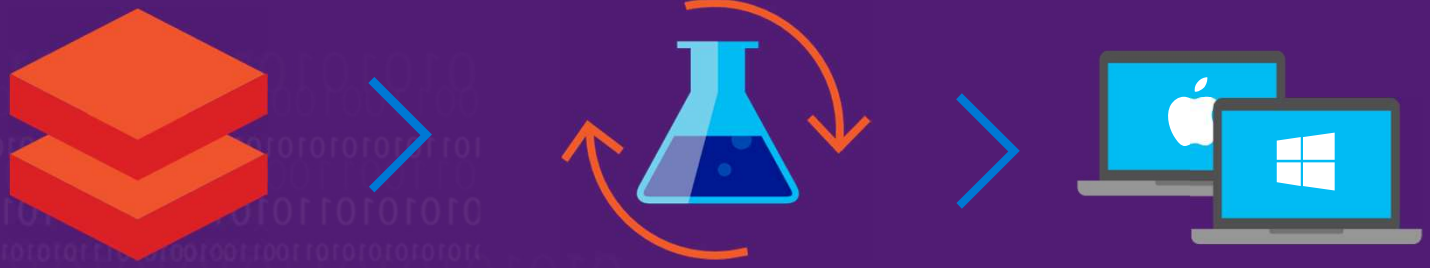
Core DL Concepts, Terminology and Algorithms

Develop our first DL application



03. Core DL Concepts, Terminology and Algorithms

AI development lifecycle



Prepare Data

Build & Train

Using...

Visual Studio 2017 with AI Tools
Visual Studio 2017 and ML.Net
Train on Azure

Deploy and use your model on client and server

Features and Attributes

Identify attributes of the things you are tring to classify

If I'm trying to classify fruit maybe is color and weight

Dimension usually refers to the number of attributes

Feature (or Attribute) is one particular "type of data" in your datapoints

Each datapoint (like fruit) contains many different attributes (like color, weight, shape)

The data challenge

Once you know features to use then the challenge is to find enough data to train the model

Imagine you need to recognize cats. You may need 10K sample images of cats if you want to get a good result

Data is any sort of features you need to classify your problem: it can be database rows, sound sample, video samples, text and so on

ML knowledge

An ML system cannot predict stuff it does not know about

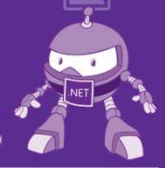
Let's image you train an ML system with a dataset containing features: animal name, number of legs, color, weight :

- Dog, 4, black, 10Kg
- Chicken, 2, orange, 5Kg

If you now ask the model to evaluate the row:

- Cow, 4, black, 200Kg

The model will predict "Dog" because it only knows about dogs and chickens and it got the nearest match

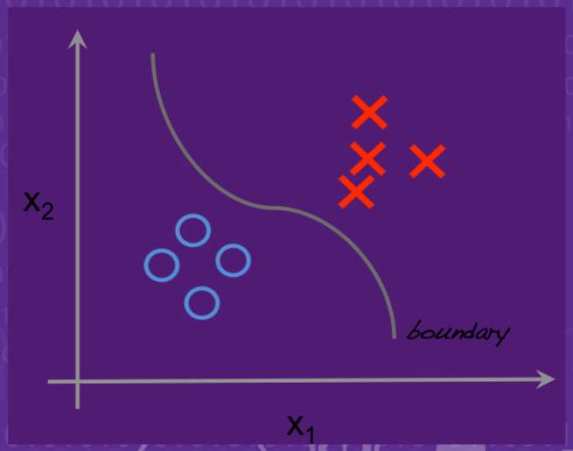


Ways to train a model – Supervised Learning

When the ML is trained with data, and those data are labelled

LABEL, number of legs, color, weight :

- Dog, 4, black, 10Kg
- Chicken, 2, orange, 5Kg



Give three inputs (number of legs, color, weight) we are telling the system what output label we do expect

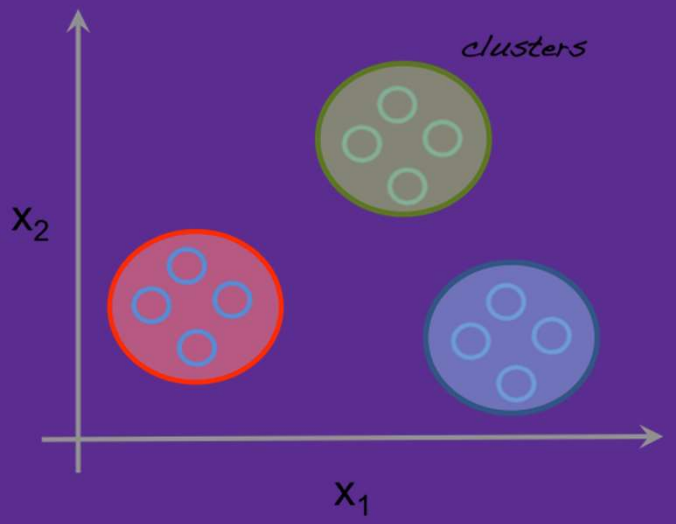
ML uses this data to predict future unseen data

Ways to train a model – Unsupervised Learning

ML learns from an unlabeled data set

Imagine we have some points on a graph representing 3 different things

ML must realize itself there are 3 distinct clusters and categorize them



This is tricky, because the number of clusters may not be known in advance, so it has to take a best guess.
Sometimes the clusters are not as clear as the ones shown here

Ways to train a model – Reinforcement Learning

Learning by trial-and-error reward punishment

ML learns by playing the game millions of times.

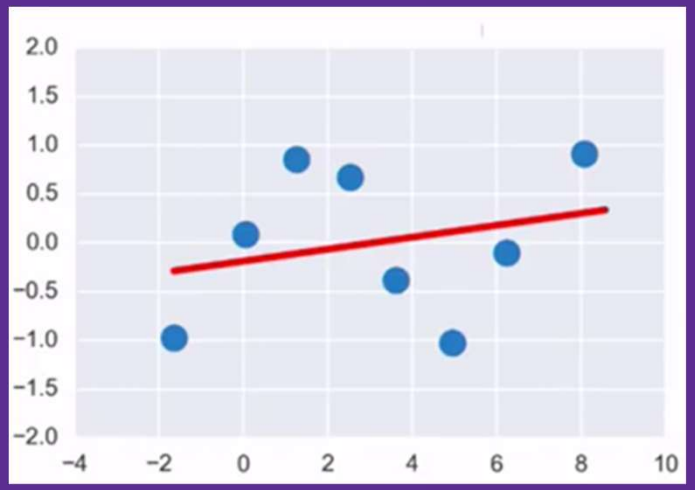
ML is rewarded when it makes a good move

When it loses we give him no (or negative reward)

Overtime ML learns to maximize reward without the human explicitly telling the rules. It can lead to better than human performance when it finds paths that no one thought of doing before.

How the model training works

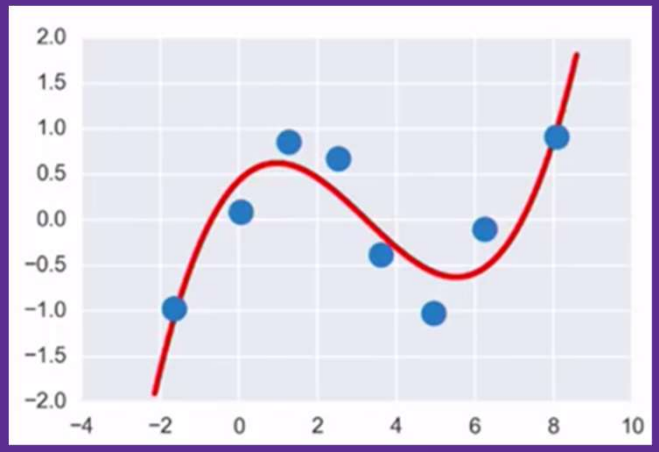
There are many ways a ML can learn pattern to classify data



In this example we use a line to divide two clusters.

We can predict future data saying anything above the line is owned by one cluster and anything below the line is owned by the other cluster

How the model training works



Cubic curve

Instead of a straight line we may use a cubic curve to identify clusters.

That way the ML will predict future points it has not seen before by understanding in witch area the point belongs

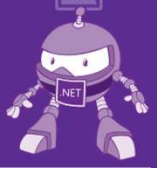
Neural Networks

Our brain consists of 86 billion or so interconnected neurons.

Each neuron responds to certain stimuli and passes output to another.

There may be a bunch of them dedicated to recognize cats (some for fur, eyes, whiskers, etc) each having a different weighting (based on how important the feature is) to the overall contribution. If all of those fire, your brain tells you saw a cat

In ML, Artificial Neural Networks (loosely modelled to the brain) are used to calculate the probabilities for features they are trained to look for.



Artificial Neuron

The 3 arrows correspond to the 3 inputs coming into the network

Values [0.7,0.6,1.4] are the weights assigned to the corresponding input

Inputs get multiplied with their respective weights and their sum is taken.

Consider 3 inputs as x1,x2,x3.

Consider 3 weights be w1,w2,w3

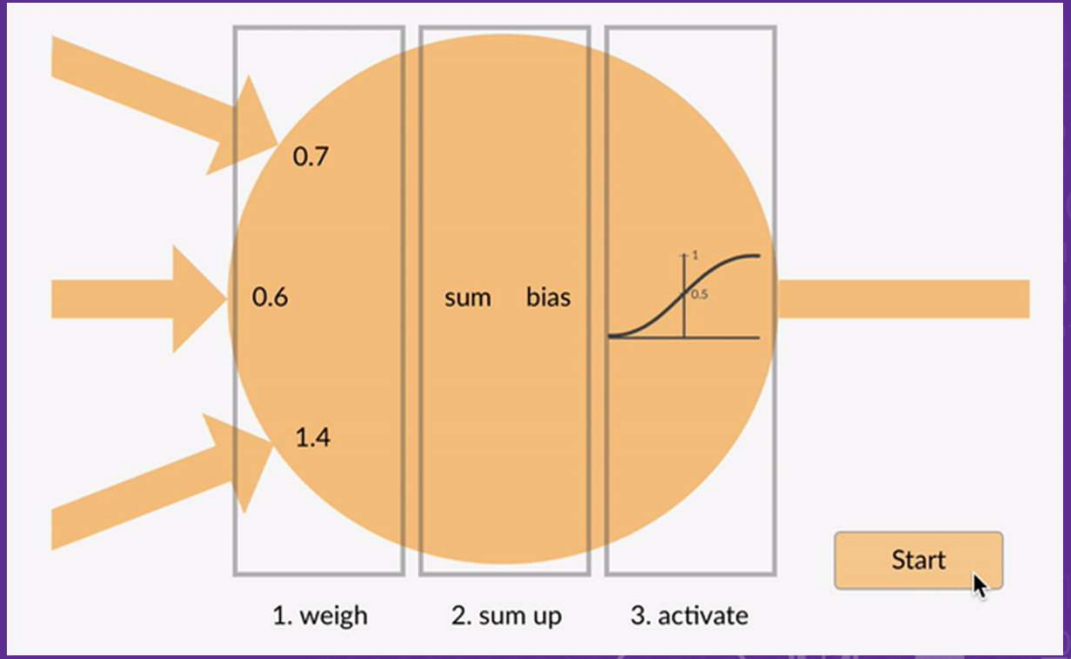
Sum = x1w1 + x2w2+x3w3.

i.e. Sum=x1(0.7) + x2(0.6) + x3(1.4)

After summing we add bias to the sum obtained.

This Bias is just a constant number say 1 which is added for scaling purposes.

NewSum=x1(0.7) + x2(0.6) + x3(1.4) + bias



Animation and definition courtesy of becominghuman.ai

It's not necessary to add bias but it is a good practice as it speeds up the process.

After adding bias, we reach at threshold step. If the newsum calculated is above the threshold value the neuron gets excited and it passes out the output.

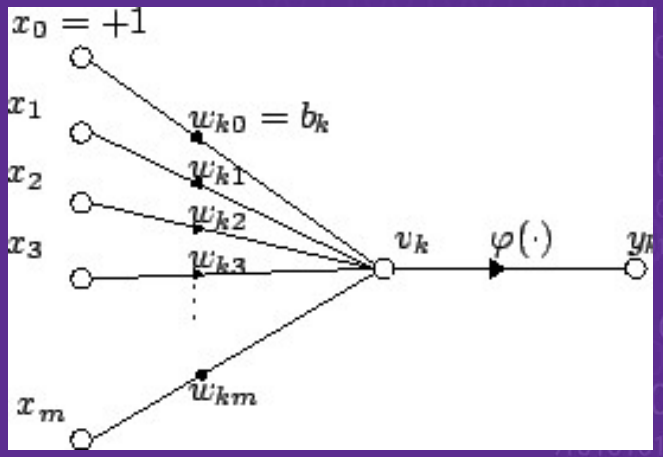
If it doesn't get excited it won't pass on the output

Artificial Neuron – the math behind

For a given artificial neuron, let there be m + 1 inputs with signals x_0 through x_m and weights w_0 through w_m. Usually, the x_0 input is assigned the value +1, which makes it a *bias* input with $w_{k0} = b_k$. This leaves only m actual inputs to the neuron: from x_1 to x_m

The output of the kth neuron is:

$$y_k = \varphi\left(\sum_{j=0}^{m} w_{kj} x_j\right)$$



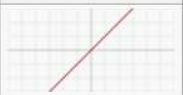
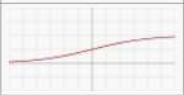
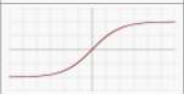
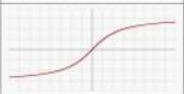
Where (phi) is the transfer function

The output is analogous to the axon of a biological neuron, and its value propagates to the input of the next layer, through a synapse. It may also exit the system, possibly as part of an output vector.

It has no learning process as such. Its transfer function weights are calculated and threshold value are predetermined.

Source Wikipedia

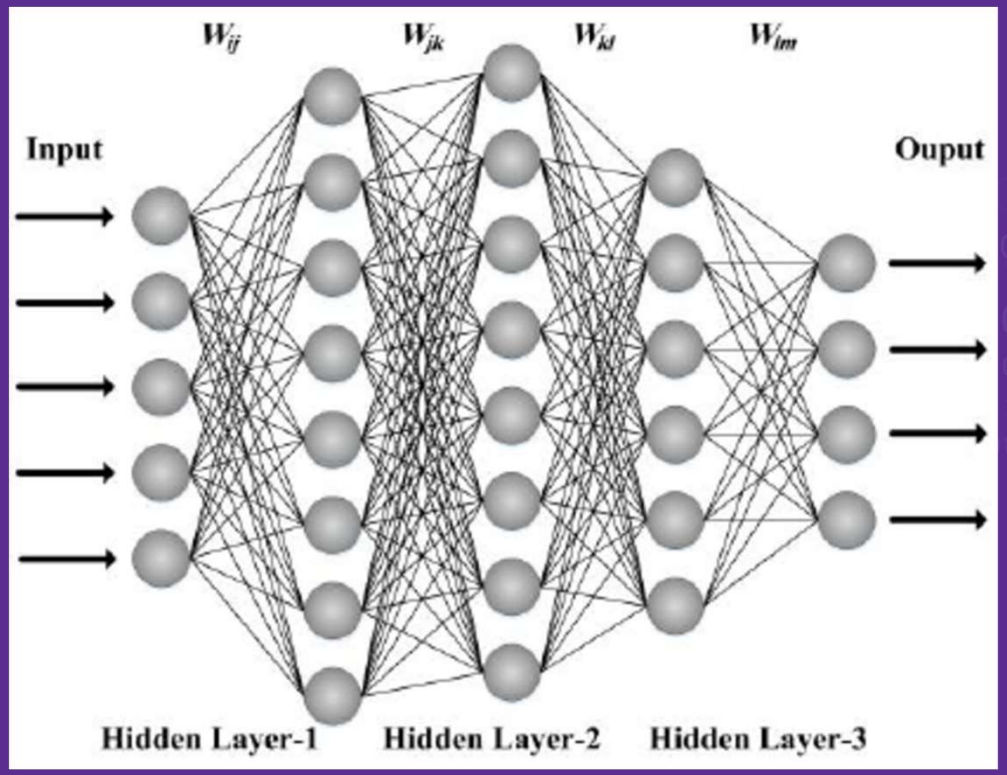
Artificial Neuron - Activation Functions

Name	Plot	Equation	Derivative
Identity		$f(x) = x$	$f'(x) = 1$
Binary step		$f(x) = \begin{cases} 0 & \text{for } x < 0 \\ 1 & \text{for } x \geq 0 \end{cases}$	$f'(x) = \begin{cases} 0 & \text{for } x \neq 0 \\ ? & \text{for } x = 0 \end{cases}$
Logistic (a.k.a Soft step)		$f(x) = \frac{1}{1+e^{-x}}$	$f'(x) = f(x)(1-f(x))$
TanH		$f(x) = \tanh(x) = \frac{2}{1+e^{-2x}} - 1$	$f'(x) = 1 - f(x)^2$
ArcTan		$f(x) = \tan^{-1}(x)$	$f'(x) = \frac{1}{x^2+1}$
Rectified Linear Unit (ReLU)		$f(x) = \begin{cases} 0 & \text{for } x < 0 \\ x & \text{for } x \geq 0 \end{cases}$	$f'(x) = \begin{cases} 0 & \text{for } x < 0 \\ 1 & \text{for } x \geq 0 \end{cases}$
Parameteric Rectified Linear Unit (PReLU) [2]		$f(x) = \begin{cases} \alpha x & \text{for } x < 0 \\ x & \text{for } x \geq 0 \end{cases}$	$f'(x) = \begin{cases} \alpha & \text{for } x < 0 \\ 1 & \text{for } x \geq 0 \end{cases}$
Exponential Linear Unit (ELU) [3]		$f(x) = \begin{cases} \alpha(e^x - 1) & \text{for } x < 0 \\ x & \text{for } x \geq 0 \end{cases}$	$f'(x) = \begin{cases} f(x) + \alpha & \text{for } x < 0 \\ 1 & \text{for } x \geq 0 \end{cases}$
SoftPlus		$f(x) = \log_e(1+e^x)$	$f'(x) = \frac{1}{1+e^{-x}}$

ReLu is the most used one

sigmoid/tanh rarely

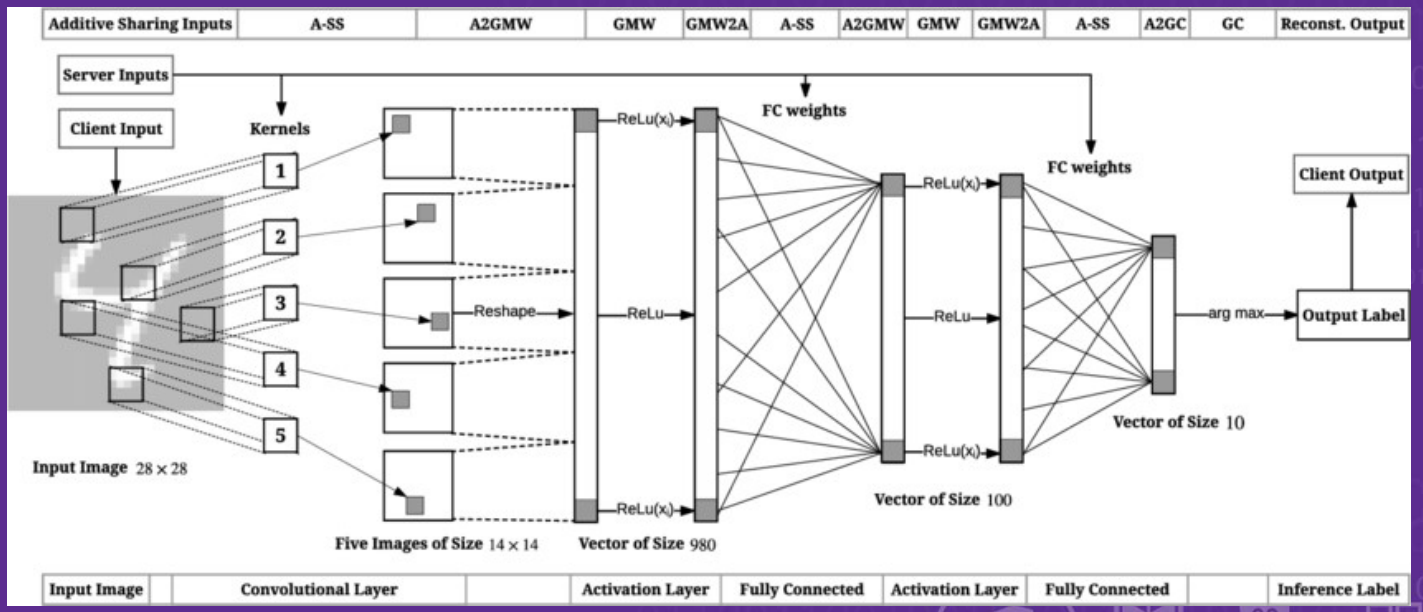
Multi layer neuron



Stacking up many Artificial Neuron help us to create Intelligent Systems

Deep Neural Network

A Deep Neural Network (DNN) simply consists of many "hidden layers" between the input and the output.
Each layer can learn from the one before.
Hidden layer are usually of a lower dimension so the can generalize better and not overfit input data.
Middle layers can learn features of for features.
For example bunches of edges can lead to "face parts" witch leads to "faces"



DN comes in two very popular flavors

CNN

Convolutional Neural Networks
Vision

RNN

Recurrent Neural Networks
Language

The two most popular types of Deep Networks

Common ML Output Types

Regression

Predict numerical values
(e.g. price of house)

Classification

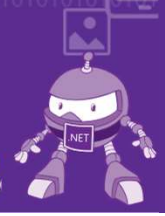
On of n labels..
Cat, dog, human

Clustering

Most similar other examples
(e.g. related products on Amazon)

Sequence Prediction

What comes next?
Given 1,2,3,4,5
Predict 6



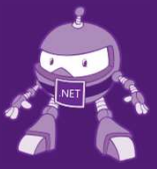
Tools

Visual Studio Tools For AI

Getting Started with Visual Studio Tools for AI:
https://channel9.msdn.com/events/Build/2018/THR3129
Sample repo: https://github.com/Microsoft/samples-for-ai

Win.ML

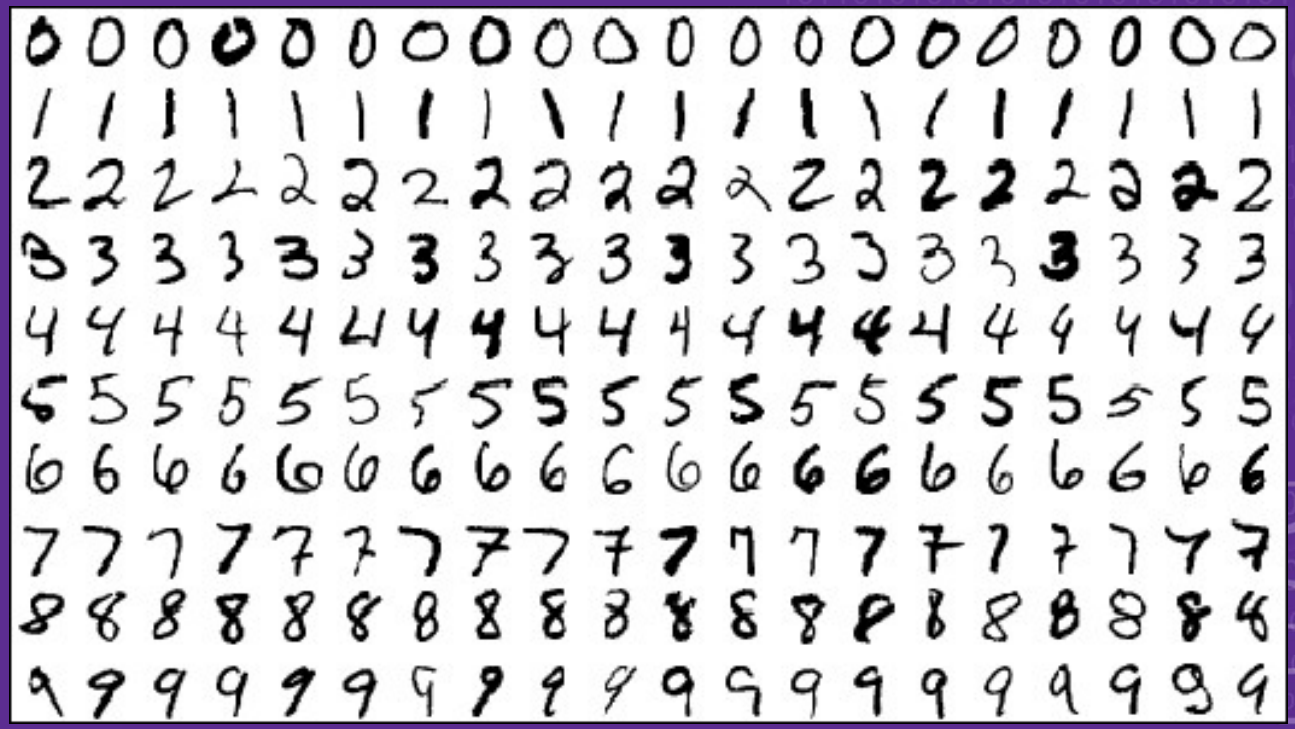
Introducing ML.Net: https://channel9.msdn.com/Events/Build/2018/BRK3203
Samples repo: https://github.com/dotnet/machinelearning-samples



Datasets

MNIST database of hand-written digits

(Modified) National Institute of Standards and Technology

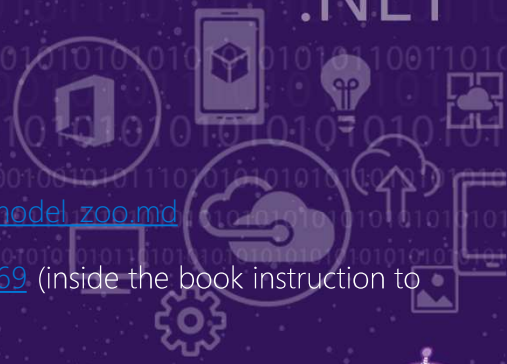


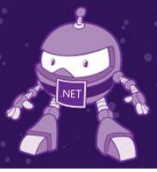
http://yann.lecun.com/exdb/mnist/

04. Develop our first DL application

Resources

Microsoft's official AI site for devs azure.com/ai
Microsoft's AI School https://aischool.microsoft.com/en-us/learning-paths
Rick Barraza – AI for Everyone! https://www.youtube.com/watch?v=xhp1m9thnbE
Jason Mayers – Machine Learning in 45 Minutes https://www.youtube.com/watch?v=X4I9QmcSEYo
Chris Lauren – Seth Juarez - Demystifying Machine and Deep Learning for Developers https://www.youtube.com/watch?v=cU7Wq5k8u-U
Introducing ML.NET https://www.youtube.com/watch?v=OhCysVU5RDA
Andrew Glassner – Deep Learning: A crash Course https://www.youtube.com/watch?v=r0Ogt-q956I
ONNX https://onnx.ai/
ONNX Model Zoo https://github.com/onnx/models
ONNX models for WinML https://docs.microsoft.com/en-us/windows/ai/get-onnx-model
Azure AI Gallery curates models for use with Windows ML - https://gallery.azure.ai/models
Ml.Net Samples https://github.com/dotnet/machinelearning-samples
CH9 – AI Show https://channel9.msdn.com/Shows/AI-Show
The MNIST Database http://yann.lecun.com/exdb/mnist/
Kaggle Datasets database https://www.kaggle.com/datasets
Getting started with TensorFlow https://tf.wiki/en/basic.html
Getting Started with Visual Studio Tools for AI https://www.youtube.com/watch?v=LLW_0MQoQ1g
Visual Studio Tools For AI https://docs.microsoft.com/en-us/visualstudio/ai/?view=vs-2017
Visual Studio Tools For AI GitHub Sample repo https://github.com/Microsoft/samples-for-ai
CNTK Examples https://docs.microsoft.com/en-us/cognitive-toolkit/Examples
TensorFlow model zoo https://github.com/tensorflow/models/blob/master/research/object_detection/g3doc/detection_model_zoo.md
Cafee model zoo https://github.com/BVLC/caffe/wiki/Model-Zoo
Yaser S. Abu-Mostafa – Learning from data https://www.amazon.com/Learning-Data-Yaser-S-Abu-Mostafa/dp/1600490069 (inside the book instruction to access whole semester course gave by prof. Yaser S. Abu-Mostafa at California Institute of Technology)
Christopher Olah's blog about DL http://colah.github.io/

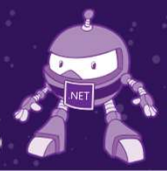




Credits

Special thanks to the following people and groups that contributed inspiration, ideas or support for this ever evolving talk / workshop:

https://twitter.com/jason_mayes
https://twitter.com/rickbarraza
https://twitter.com/sethjuarez
https://twitter.com/ankitasthana86
https://twitter.com/ch402
http://www.asimovinstitute.org/



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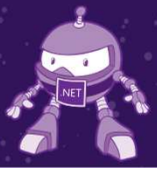
Thank You

Got questions?

Gian Paolo Santopaolo
CTO, IBV Solutions
gp@ibv.ch
@gsantopaolo



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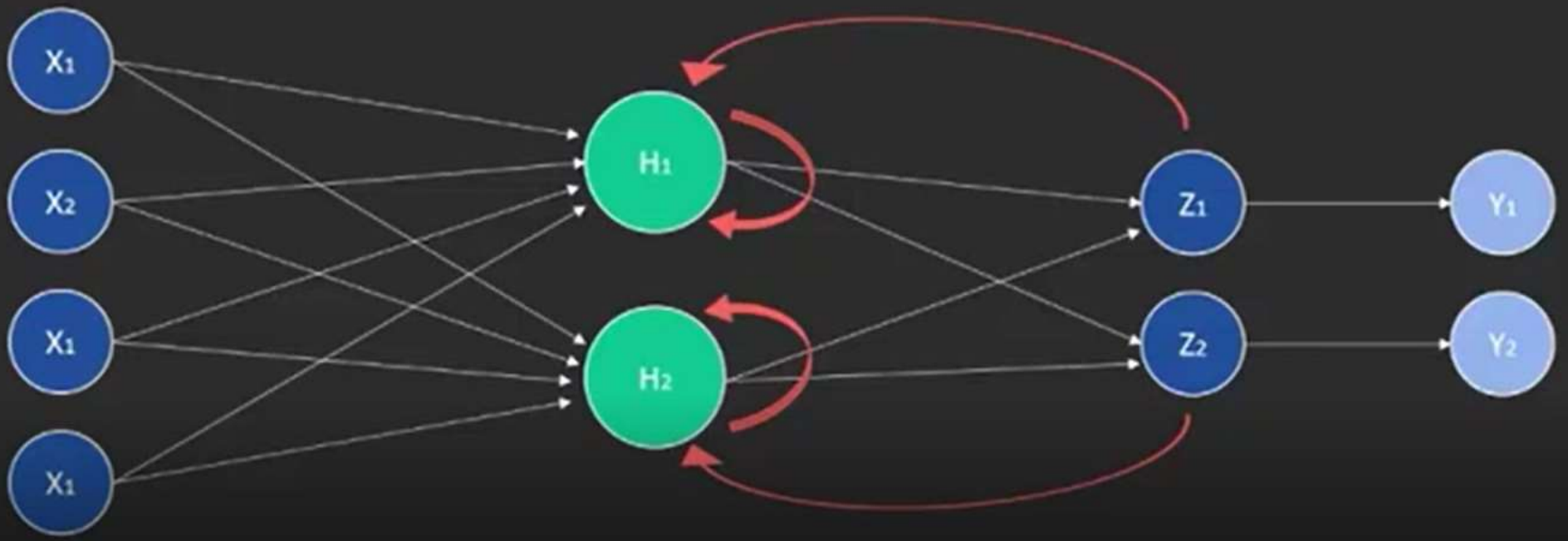
"ALL THE COFFEE SHE HAD HAD HAD HAD NO EFFECT."

NATURAL LANGUAGE

RECURRENT NEURAL NETWORKS



Machine learning ⊆ artificial intelligence

ARTIFICIAL INTELLIGENCE

Design an intelligent agent that perceives its environment and makes decisions to maximize chances of achieving its goal.
Subfields: vision, robotics, machine learning, natural language processing, planning, …

MACHINE LEARNING

Gives "computers the ability to learn without being explicitly programmed" (Arthur Samuel, 1959)

SUPERVISED LEARNING

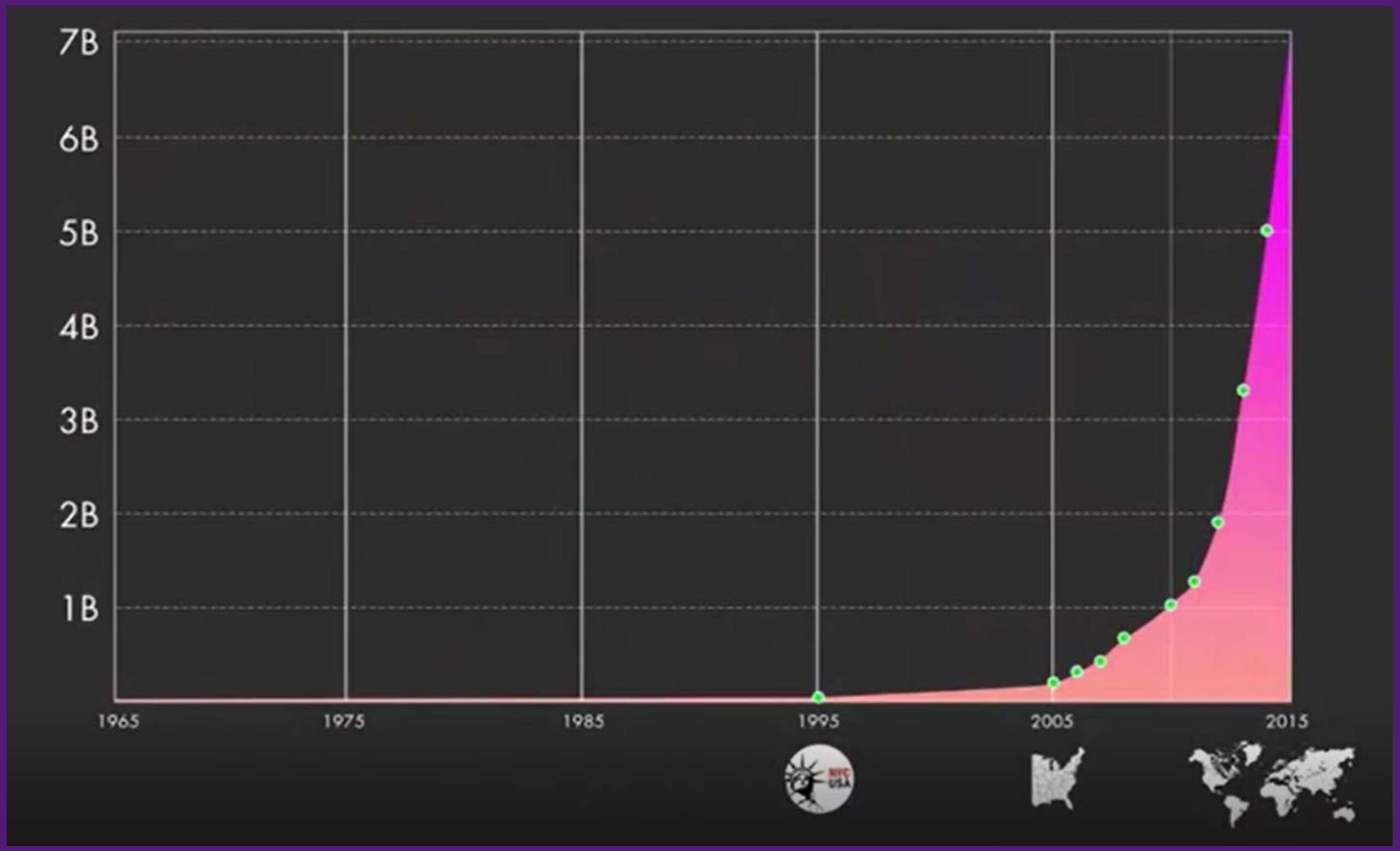
Classification, regression

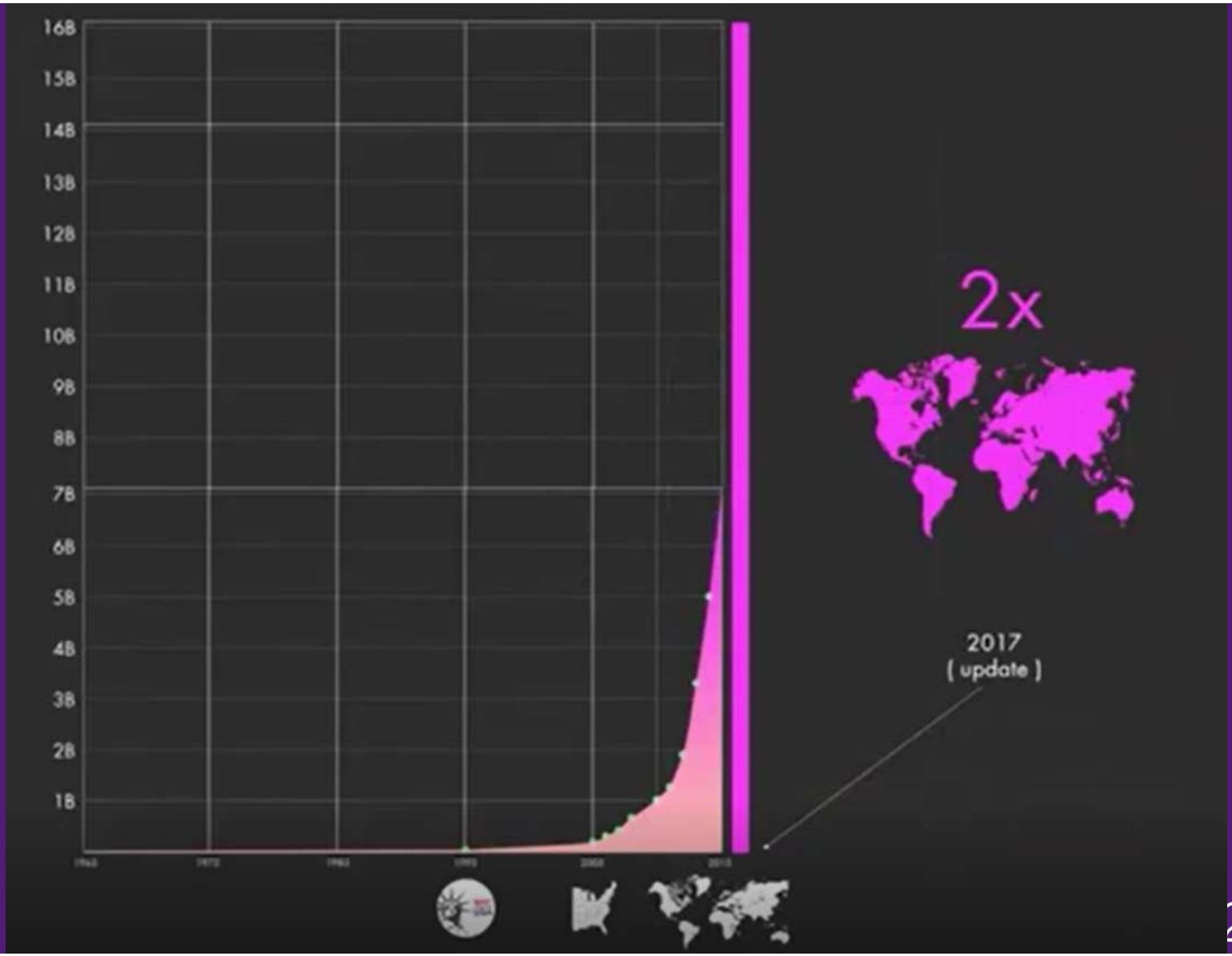
UNSUPERVISED LEARNING

Clustering, dimensionality reduction, recommendation

REINFORCEMENT LEARNING

Reward maximization


7B
6B
5B
4B
3B
2B
1B
1965
1975
1985
1995
2005
2015


168
158
148
138
128
118
108
98
88
78
68
58
48
38
28
18
2x
2017
(update)

2018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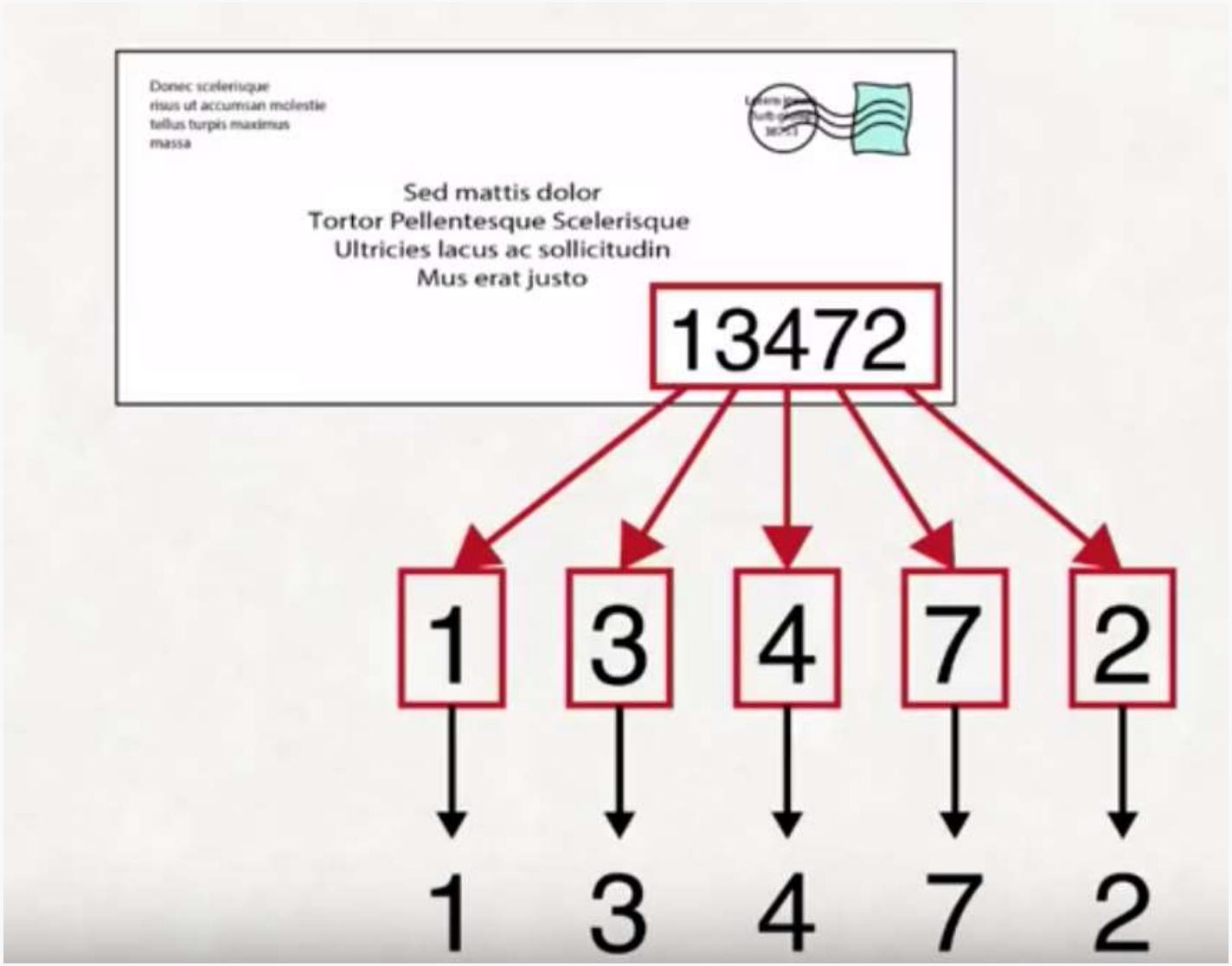
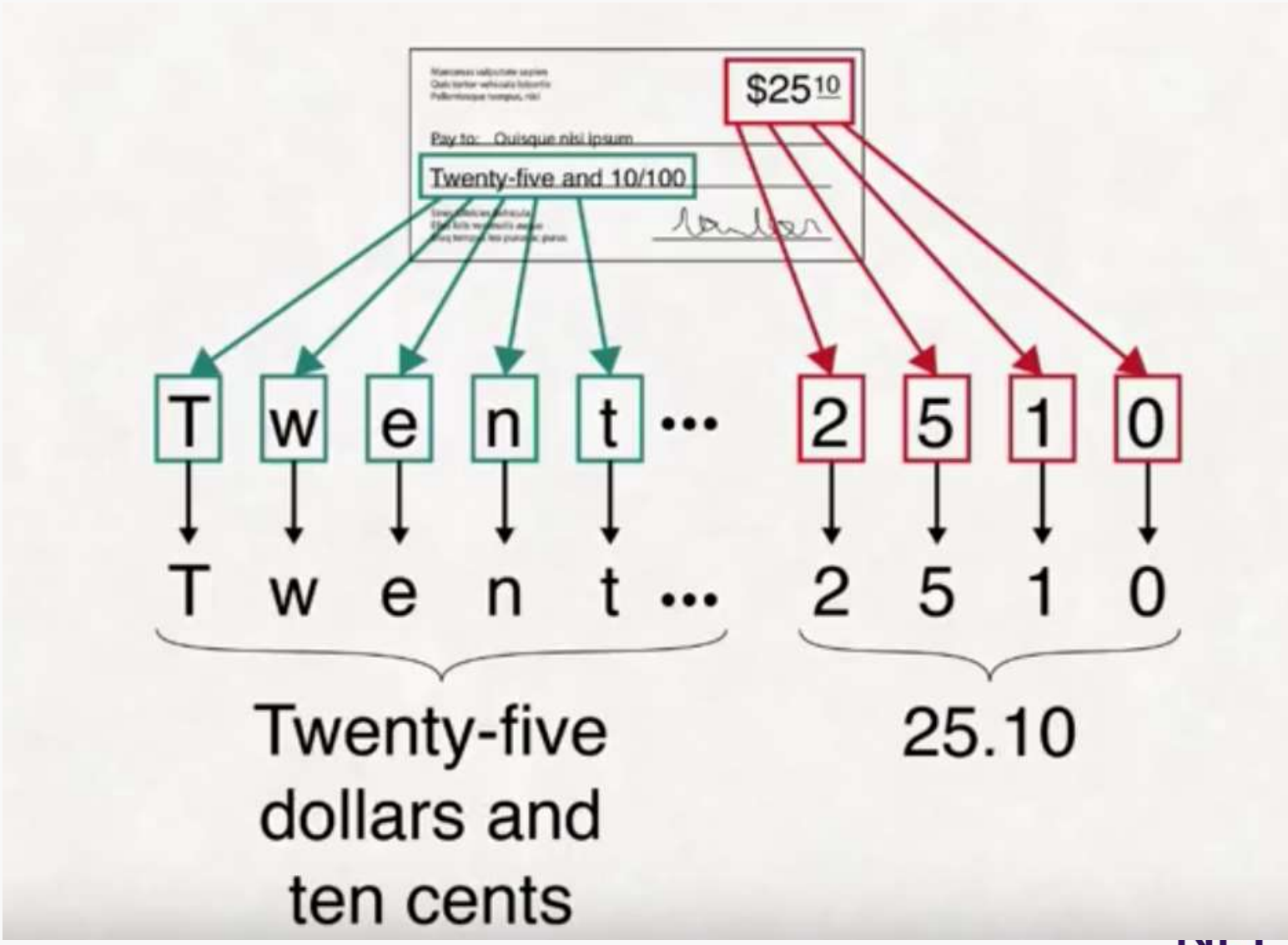
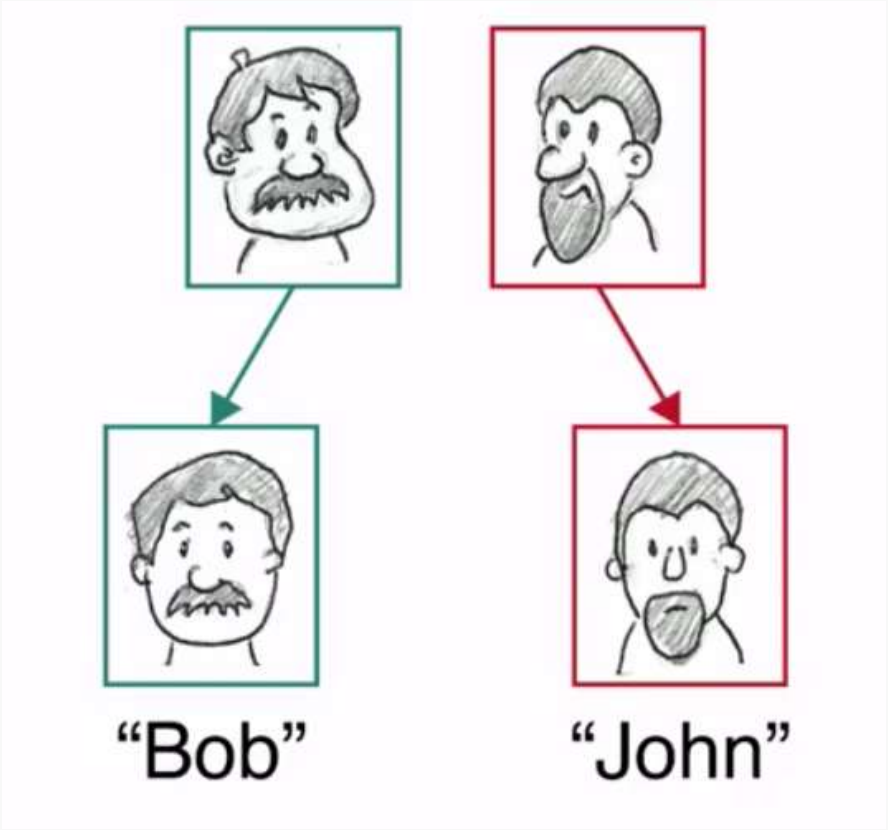
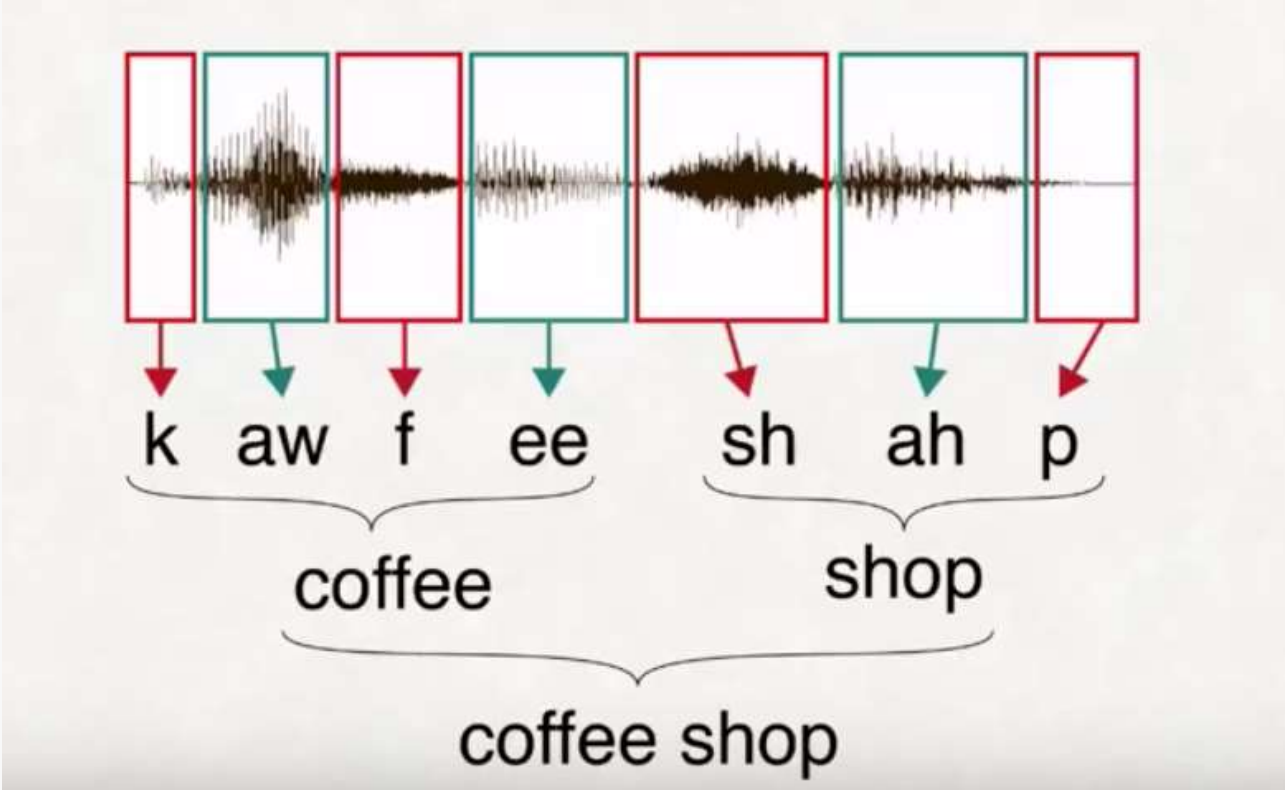
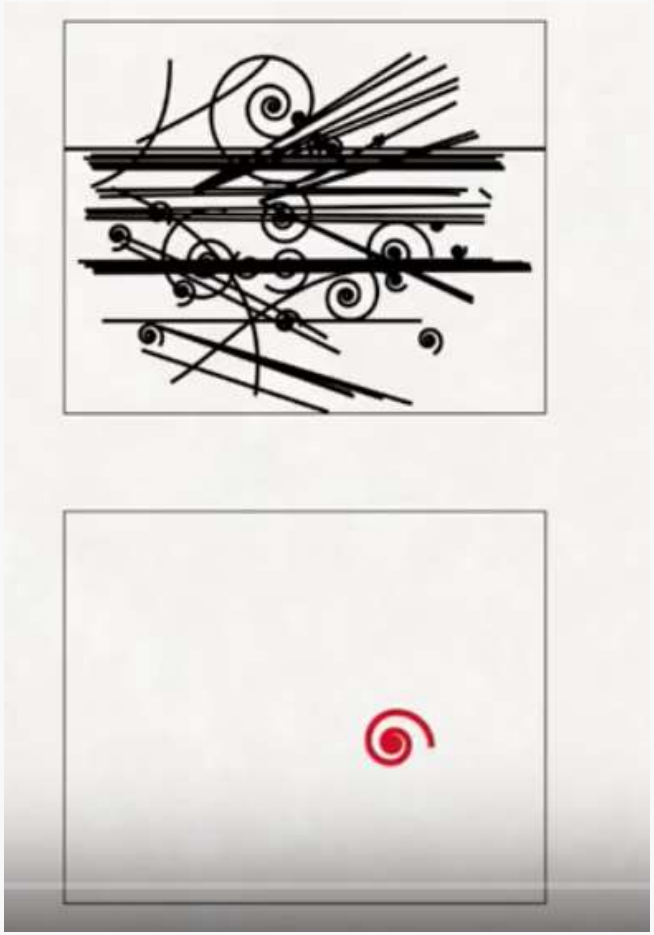

Donec scelerisque
risus ut accumsan molestie
tellus turpis maximus
massa
Sed mattis dolor
Tortor Pellentesque Scelerisque
Ultricies lacus ac sollicitudin
Mus erat justo
13472
1
3
4
7
2
1
3
4
7
2

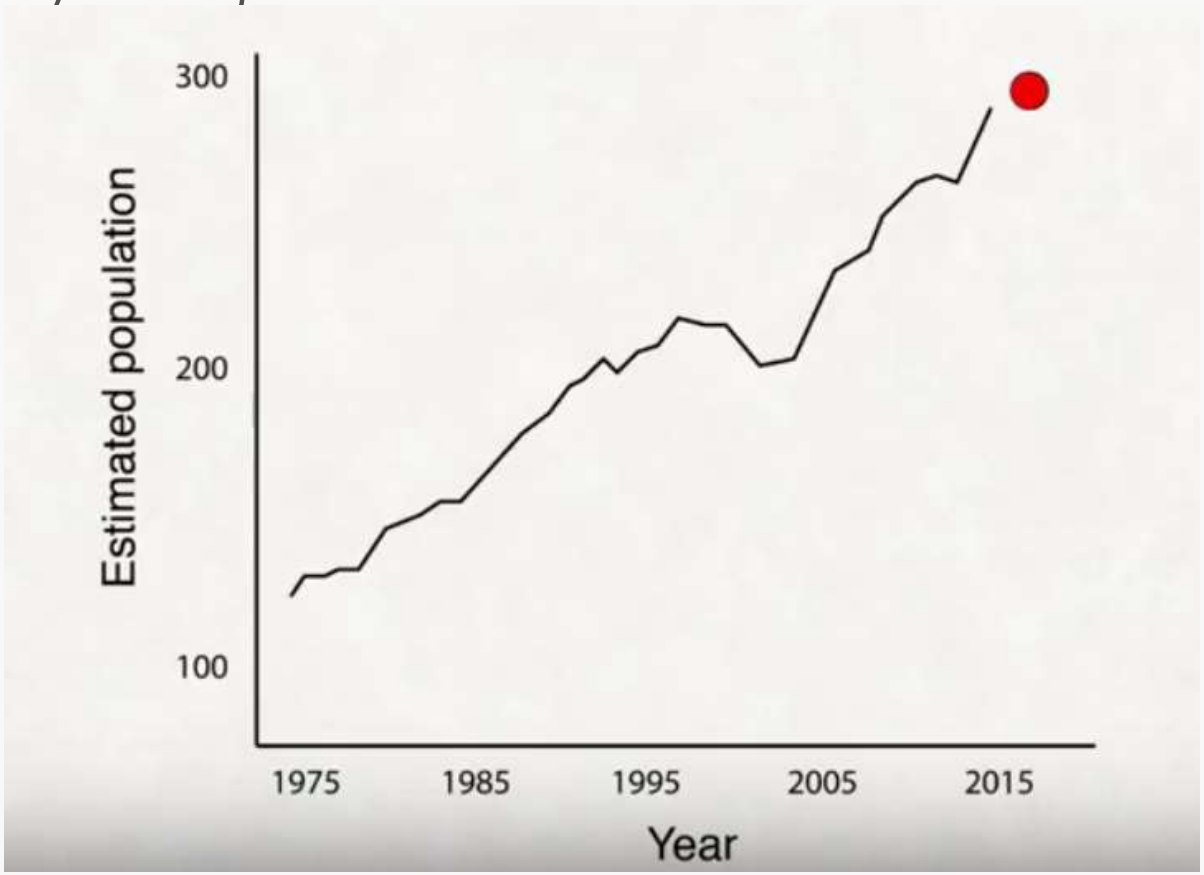

$25 10
Pay to: Quisque nisi ipsum
Twenty-five and 10/100
T w e n t ...
2 5 1 0
T w e n t ...
2 5 1 0
Twenty-five dollars and ten cents
25.10


“Bob”
“John”


k aw f ee sh ah p
coffee
shop
coffee shop



Prediction / regression



Denoise

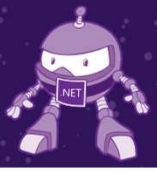
input

result

reference

Source: Interactive Reconstruction of Monte Carlo Image Sequences using a Recurrent Denoising Autoencoder , NVIDIA Research

Unsupervised Learning



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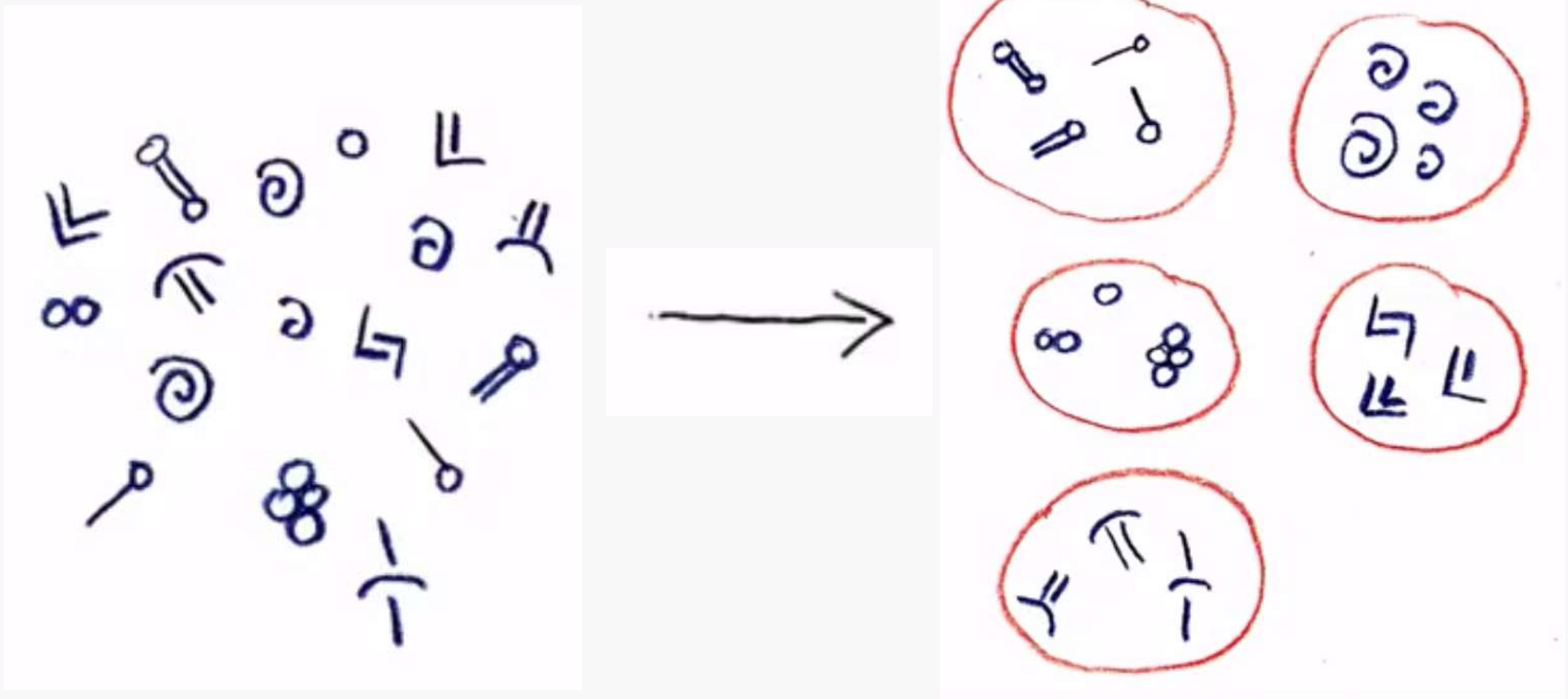
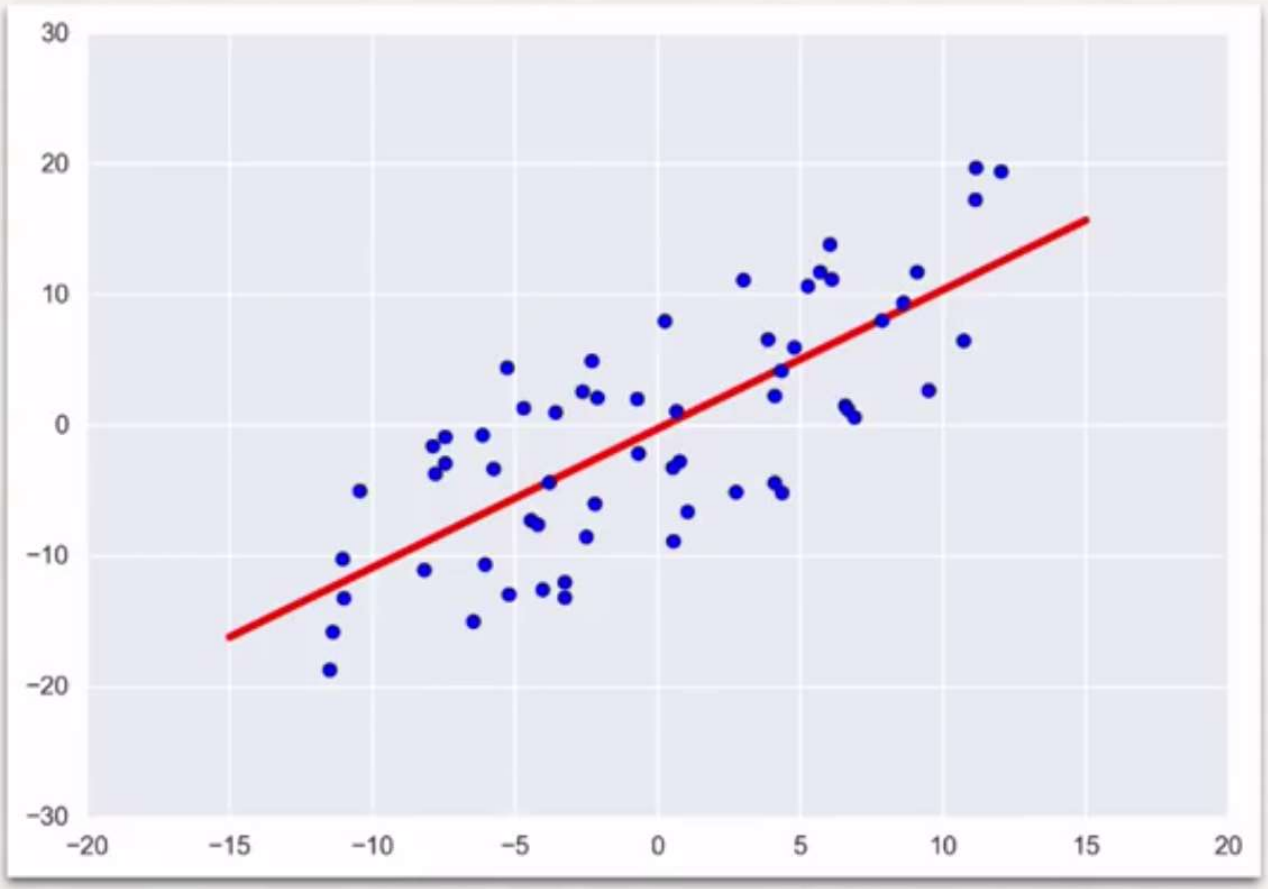
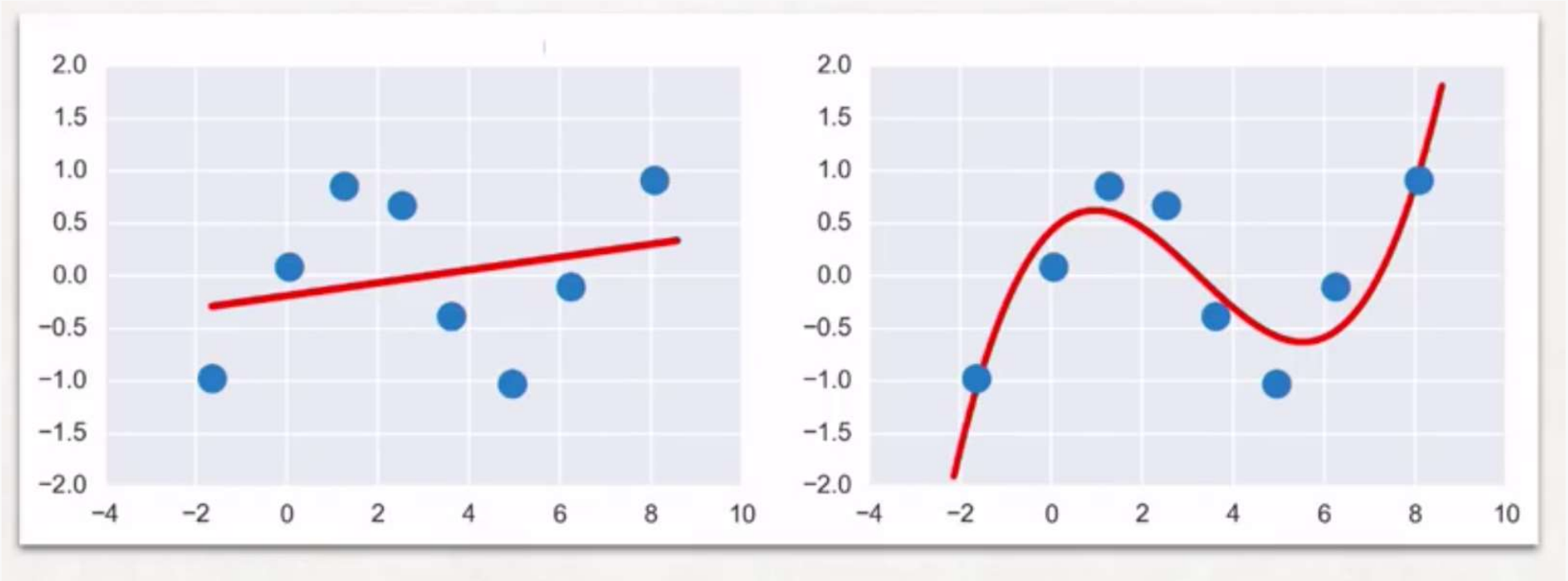
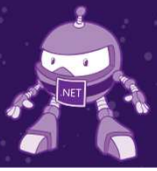
Unsupervised learning / clustering




30
20
10
0
−10
−20
−30
−20
−15
−10
−5
0
5
10
15
20


2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−4
−2
0
2
4
6
8
10
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
−4
−2
0
2
4
6
8
10

Reinforcement Learning



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Supervised Learning

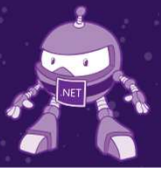
Hummingbird

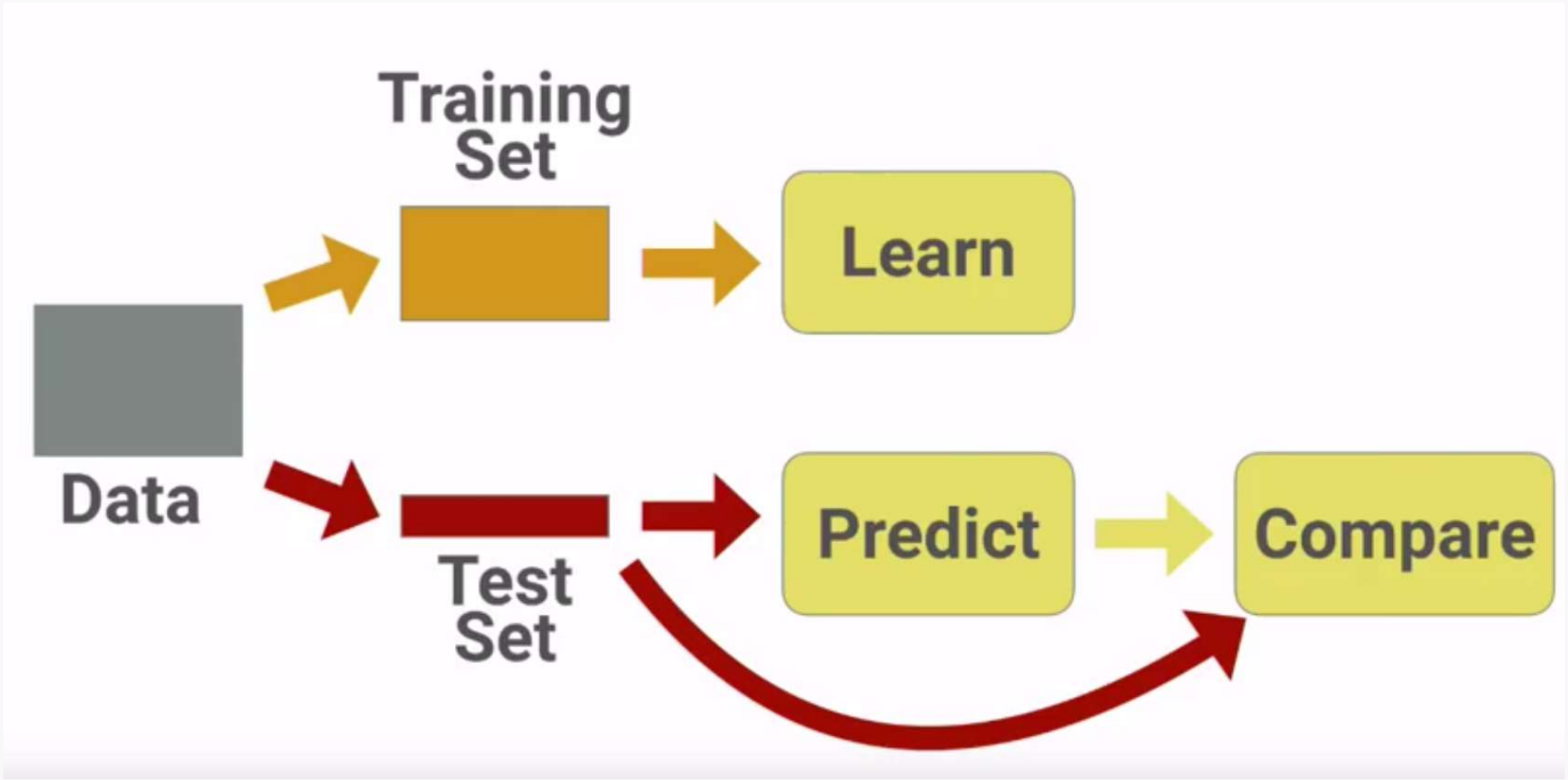
Spoon

Corkscrew

Headphones

How to train




Training Set
Learn
Data
Test Set
Predict
Compare

What it really means deep learning 25

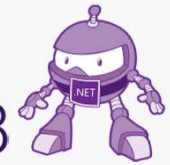
Deep learning is a

We take the building blocks of DL and we stack them up

Much of the time DL is just a series of modules and we stack them up like LEGO

And that's why is called deep: we make a tower of LEGO, standing at the top and looking at the bottom the tower is deep

tensor

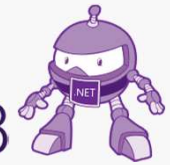


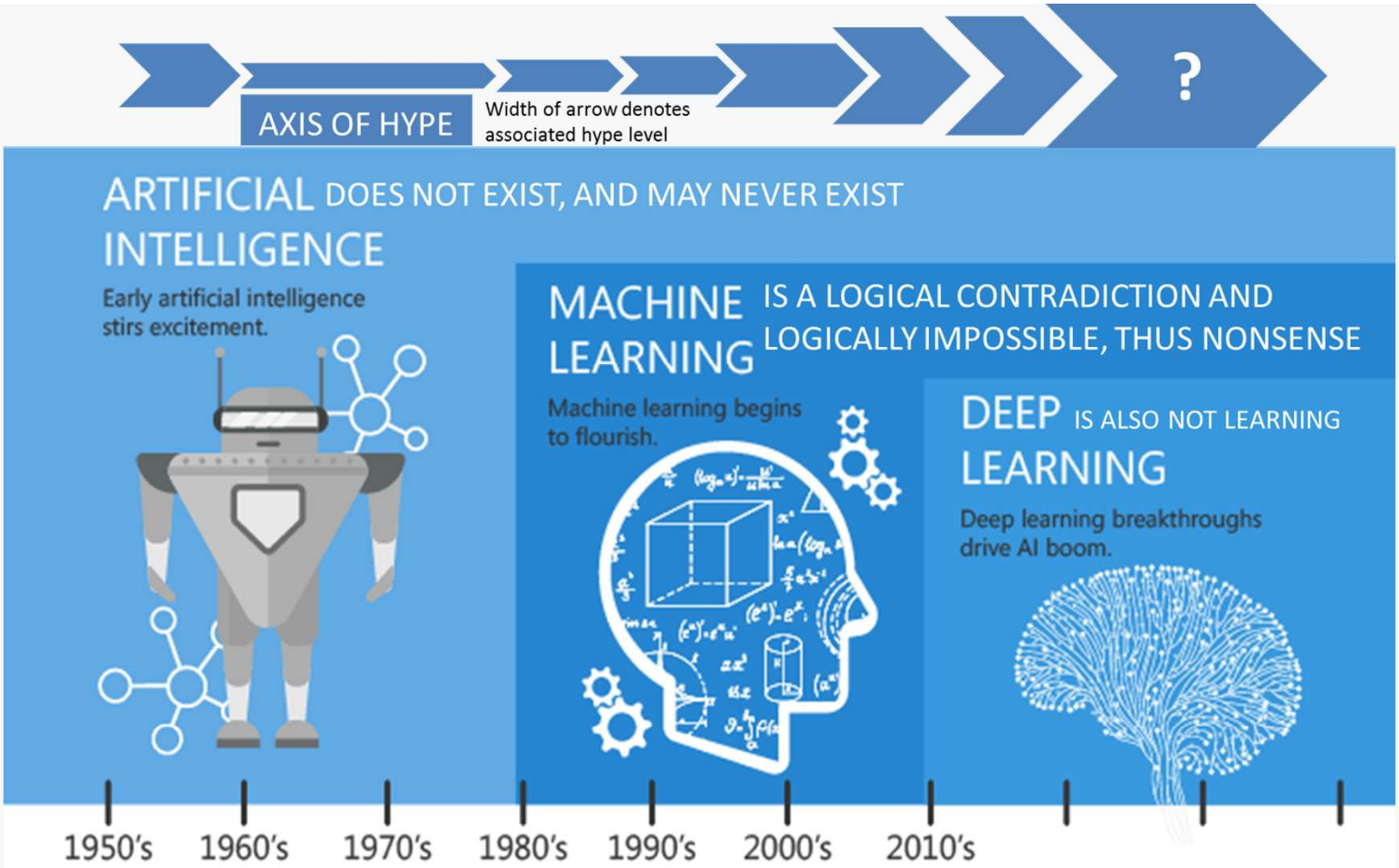
We are dev so we don’t like the math stuff.

We are download the library, look at a couple of sample and we are gonna write our code

Let’s see how to do it. Let’s say we want to look at some of this MNIST digits

It’s a square 28X28 (you are going to be familiar with that number (28x28)





Since AI has continued to not exist since it was first posited as possible, hype has become the only means of maintaining interest and funding in AI. By creating smaller subsets of something that has continuously failed to materialize we confuse the public and maintain our positions of influence in academia and technology. Who knows what made up term we will think of next. My money is on systems of intelligence although data science has gotten off to a really strong start.

2018