



"What is deep learning?"

Machine learning is turning things (data) into numbers and finding patterns in those numbers.

The computer does this part. How? Code & math. We're going to be writing the code.



Machine Learning vs. Deep Learning

Artificial Intelligence

Machine Learning

Deep Learning



Inputs





1. Cut vegetables

- 2. Season chicken
- 3. Preheat oven
- 5. Add vegetables

Starts with



Starts with

Rules

4. Cook chicken for 30-minutes

Output



Makes

Rules

- 1. Cut vegetables
- 2. Season chicken
- 3. Preheat oven
- 4. Cook chicken for 30-minutes
- 5. Add vegetables

Figures out





"Why use machine learning (or deep learning)?"

Good reason: Why not? Better reason: For a complex problem, can you think of all the rules? (probably not)





Yashaswi Kulshreshtha commented on your video



2020 Machine Learning Roadmap



Yashaswi Kulshreshtha

I think you can use ML for literally anything as long as you can convert it into numbers and program it to find patterns. Literally it could be anything any input or output from the universe

Source: <u>2020 Machine Learning Roadmap video</u>.

that."

— A wise software engineer... (actually rule 1 of <u>Google's Machine Learning Handbook</u>)

(maybe not very simple...) "If you can build a simple rule-based system that doesn't require machine learning, do



What deep learning is good for 😥 🗸

- Problems with long lists of rules—when the traditional approach fails, machine learning/deep learning may help.
- Continually changing environments—deep learning can adapt ('learn') to new scenarios.
- Discovering insights within large collections of data—can you imagine trying to hand-craft rules for what 101 different kinds of food look like?



What deep learning is not good for is in the second for the second

- learning model are typically uninterpretable by a human.
- When the traditional approach is a better option if you can accomplish what you need with a simple rule-based system.
- When errors are unacceptable since the outputs of deep learning model aren't always predictable.
- When you don't have much data deep learning models usually require a fairly large amount of data to produce great results.

(though we'll see how to get great results without huge amounts of data)

• When you need explainability—the patterns learned by a deep



Structured data



Algorithm: gradient boosted machine

Machine Learning

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8	Honda	Blue	45698	4	\$7,500			
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Machine Learning vs. Deep Learning



- Daniel Bourke @mrdbourke · Nov 1 "How do I learn #machinelearning?"
- What you want to hear:
- 1. Learn Python
- 2. Learn Math/Stats/Probability
- 3. Learn software engineering
- 4. Build

What you need to do:

- 1. Google it
- 2. Go down the rabbit hole
- 3. Resurface in 6-9 months and reassess

See you on the other side.





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Learn to edit	networks have been applied to fields including computer vision,	[show]
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Upload file	audio recognition, social network filtering, machine translation, Structured prediction	[show]
	bioinformatics, drug design, medical image analysis, material Anomaly detection	
Tools		[show]
	inspection and board game programs, where they have produced Artificial neural network	[show] [show]

Algorithm: neural

netwo



Deep Learning



Machine Learning vs. Deep Learning (common algorithms)

- Random forest
- Gradient boosted models
- Naive Bayes
- Nearest neighbour
- Support vector machine
- ...many more

(sínce the advent of deep learning these are often referred to as "shallow algorithms")

(depending how you represent your problem, many algorithms can be used for both)

Structured data +

- Neural networks
- Fully connected neural network
- Convolutional neural network
- Recurrent neural network
- Transformer
- ...many more

What we're focused on building (with PyTorch)

Unstructured data





"What are neural networks?"

Neura Networks



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- 2. Go down the rabbit hole
- Resurface in 6-9 months and reassess

See you on the other side.

(before data gets used with a neural network, ít needs to be turned ínto numbers)

[[116, 78, 15], [<u>117</u>, 43, 96], __→ [125, 87, 23],

••• 9

Each of these nodes is called a "hidden unit" or "neuron".

Inputs

Numerical encoding

[0.983, 0.004, 0.013], $[0.110, 0.889, 0.001], \rightarrow Not a diaster$ [0.023, 0.027, 0.985],

(choose the appropriate neural network for your problem)

••• ,

"Hey Siri, what's the weather today?"

Learns representation (patterns/features/weights)

Representation outputs

Outputs



(a human can

Anatomy of Neural Networks **Overall** architecture



Input layer (data goes in here) # units/neurons = 2

Note: "patterns" is an arbitrary term, you'll often hear "embedding", "weights", "feature representation", "feature vectors" all referring to similar things.

Output layer (outputs learned representation or prediction probabilities) # units/neurons = 1

Each layer is usually combination of linear (straight line) and/or nonlinear (not-straight line) functions

Hidden layer(s) (learns patterns in data) # units/neurons = 3



Types of Learning



Unsupervised & Self-supervised Learning

Supervised Learning

> We'll be writing code to do these, but the style of code can be adopted across learning paradigms.





Transfer Learning



USEC for?"

"What is deep learning actually



Yashaswi Kulshreshtha commented on your video



2020 Machine Learning Roadmap



Yashaswi Kulshreshtha

I think you can use ML for literally anything as long as you can convert it into numbers and program it to find patterns. Literally it could be anything any input or output from the universe

Source: <u>2020 Machine Learning Roadmap video</u>.

(some) Deep Learning Use Cases



Recommendation



To: daniel@mrdbourke.com Hey Daniel,

This deep learning course is incredible! Coongratu1ations! U win \$1139239230 I can't wait to use what I've learned!

Not spam

Computer Vision

Natural Language Processing (NLP)

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"Hey Siri, who's the biggest big dog of them all?"

Translation

Speech recognition

Sequence to sequence (seq2seq)

To: daniel@mrdbourke.com Hay daniel...

Spam

Classification/regression





"What is PyTorch?"



What is PyTorch?

- Most popular research deep learning framework*
- Write fast deep learning code in Python (able to run on a GPU/many GPUs)
- Able to access many pre-built deep learning models (Torch Hub/ <u>torchvision.models</u>)
- Whole stack: preprocess data, model data, deploy model in your application/cloud
- Originally designed and used in-house by Facebook/Meta (now opensource and used by companies such as Tesla, Microsoft, OpenAI)

***Source:** <u>paperswithcode.com/trends</u> February 2022

Why PyTorch?

Research favourite

Source: <u>paperswithcode.com/trends</u> February 2022

Repository Creation Date

Why PyTorch?

François Chollet

With tools like Colab, Keras, and TensorFlow, virtually anyone can solve in a day, with no initial investment, problems that would have required an engineering team working for a quarter and \$20k in hardware in 2014

7:03 AM \cdot Nov 21, 2020 \cdot Twitter for Android

Source: @fchollet Twitter

000

and PyTorch

	🔒 github.com

Author: <u>Chris Padwick</u>, Director of Computer Vision and Machine Learning at Blue

GPU (Graphics Processing Unit)

What is a GPU/TPU?

TPU (Tensor Processing Unit)

"What is a tensor?"

Daniel Bourke @mrdbourke · Nov 1 "How do I learn #machinelearning?"

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What you need to do:

1. Google it

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See you on the other side.

(before data gets used with an algorithm, it needs to be turned into numbers)

[[116.] 15], 78 [117, 43, 96] [125, 87, 23],

••• 9

Inputs

Numerical encoding

(patterns/features/weights)

Inputs

Numerical encoding

Learns representation (patterns/features/weights)

Representation outputs

Outputs

"What are we going to cover?"

Deus ex machine learning

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8:07 AM · Nov 18, 2020 · Twitter for iPhone

14.9K Retweets 2.3K Quote Tweets 188.4K Likes

What we're going to cover (broadly)

- Now:
 - PyTorch basics & fundamentals (dealing with tensors and tensor operations)
- Later:
 - Preprocessing data (getting it into tensors)
 - Building and using pretrained deep learning models
 - Fitting a model to the data (learning patterns)
 - Making predictions with a model (using patterns)
 - Evaluating model predictions
 - Saving and loading models
 - Using a trained model to make predictions on custom data

(we'll be cooking up lots of code!)

What we're going to cover A PyTorch workflow

- 5. Improve through experimentation
- 6. Save and reload your trained model

"How should I approach this course?"

How to approach this course

1	# 1. Construct a model class that subclasses nn.Module
2	<pre>class CircleModelV0(nn.Module):</pre>
3	<pre>definit(self):</pre>
4	<pre>super()init()</pre>
5	# 2. Create 2 nn.Linear layers
6	self.layer_1 = nn.Linear(in_features=2, out_features=5)
7	self.layer_2 = nn.Linear(in_features=5, out_features=1)
8	
9	# 3. Define a forward method containing the forward pass computation
10	<pre>def forward(self, x):</pre>
11	# Pass the data through both layers
12	<pre>return self.layer_2(self.layer_1(x))</pre>
13	
14	# 4. Create an instance of the model and send it to target device
15	<pre>model_0 = CircleModelV0().to(device)</pre>
16	model_0

1. Code along

Motto #1: if in doubt, run the code!

(including the "dumb" ones)

4. Ask questions

2. Explore and experiment

5. Do the exercises

Motto #3: visualize, visualize, visualize!

3. Visualize what you don't understand

6. Share your work

How not to approach this course

Avoid:

"

This course

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https://www.github.com/mrdbourke/pytorch-deep-learning

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https://www.github.com/mrdbourke/pytorch-deep-learning/ discussions

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The course is video based. However, the videos are based on the conten	ts of this online book.		
For full code and resources see the course GitHub.			
Expected release date: Early 2022.			
Get updates: Follow the pytorch-deep-learning repolog or sign up for	or emails.		
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https://learnpytorch.io

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things PyTorch				distributed	35 / month			

Let's code.

Tensor dimensions

tensor([[1, 2, 3],
dim=0
 [3, 6, 9],
 [2, 4, 5]])

tensor($[[1, 2, 3], \leftarrow 0]$ dim=1 $[3, 6, 9], \leftarrow 1$ $[2, 4, 5]]) \leftarrow 2$

Dimension (dim)

torch.Size([1, 3, 3])

Dot product

For a live demo, checkout <u>www.matrixmultiplication.xyz</u>

A*J + B*L + C*N	A*K + B*M + C*O
D*J + E*L + F*N	D*K + E*M + F*O
G*J + H*L + I*N	G*K + H*M + I*O

New size is same as outside numbers

Supervised learning

(overview)

1. Initialise with random weights (only at beginning)

[[116, 78, 15], ____ [117, 43, 96], ____ [125, 87, 23],

4. Repeat with more examples

••• •

Inputs

Numerical encoding

Learns representation (patterns/features/weights)

[[0.092, 0.210, 0.415],[0.778, 0.929, 0.030],[0.019, 0.182, 0.555],

[[0.983, 0.004, 0.013],Ramen, ▶[0.110, 0.889, 0.001], **__** Spaghetti [0.023, 0.027, 0.985],

3. Update representation outputs

> Representation outputs

Outputs

Tensor attributes

Meaning

Code

The length (number of elements) of each of the dimensions of a tensor.

tensor.shape

The total number of tensor dimensions. A scalar has rank 0, a vector has rank 1, a matrix is rank 2, a tensor has rank n.

tensor.ndim or tensor.size()

A particular dimension of a tensor.

tensor[0], tensor[:, 1]...

June 2, 2021

Facebook's AI models perform trillions of inference operations every day for the billions of people that use our technologies. Meeting this growing workload demand means we have to continually evolve our AI frameworks. Which is why, today we're announcing that we're migrating all our AI systems to PyTorch.

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			API	RESEARCH	BLOG	ABOUT

OpenAI Standardizes on PyTorch

We are standardizing OpenAI's deep learning framework on <u>PyTorch</u>. In the past, we implemented projects in many frameworks depending on their relative strengths. We've now chosen to standardize to make it easier for our team to create and share optimized implementations of our models.

January 30, 2020 1 minute read

SopenAI O' PyTorch

Facebook Al's Joelle

PyTorch \mathbf{O} Aug 7, 2020 · 11 min read · 🕑 Listen

Al for AG: Production machine learning for agriculture

Author: <u>Chris Padwick</u>, Director of Computer Vision and Machine Learning at Blue River Technology

How did farming affect your day today? If you live in a city, you might feel disconnected from the farms and fields that produce your food. Agriculture is a core piece of our lives, but we often take it for granted.

A 2017 prototype of See & Spray, Blue River Technology's precision weed control machine

Repository Creation Date

