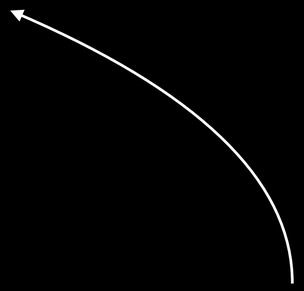
Deep Learning with TensorFlow

“What is deep learning?”

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



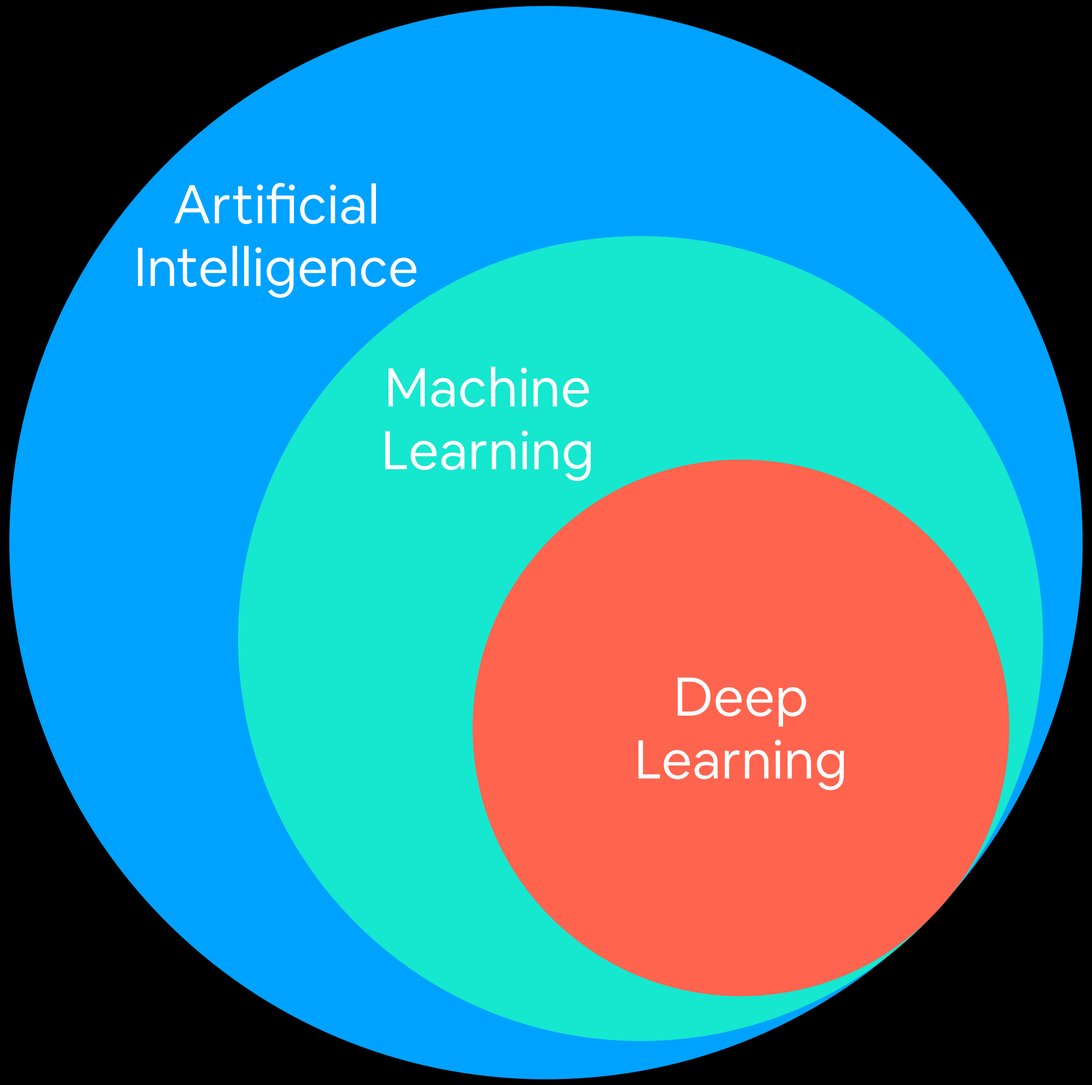
The computer does this part.

How?

Code & math.

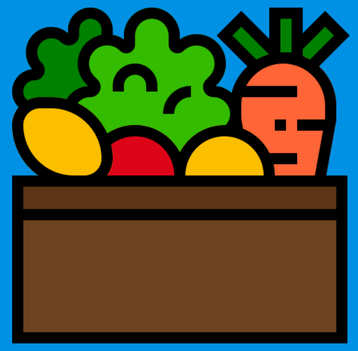
We're going to be writing the code.

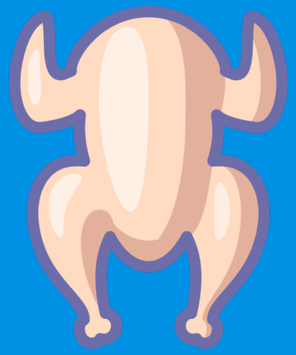
Machine Learning vs. Deep Learning



Traditional programming

Inputs

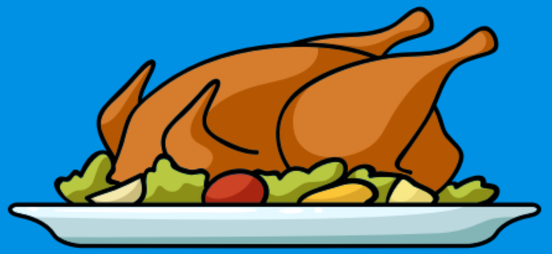




Rules

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

Output

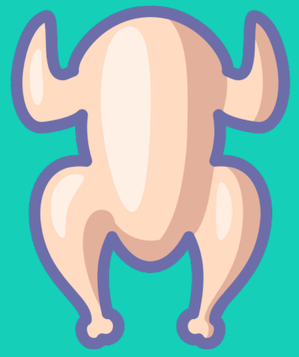


Starts with

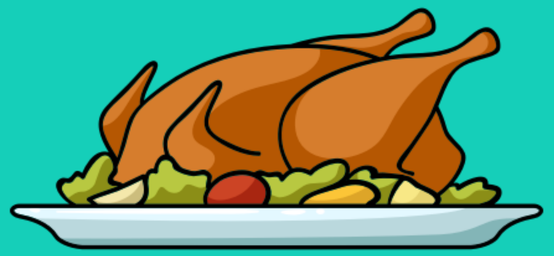
Makes

Machine learning algorithm

Inputs



Output



Rules

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

Starts with

Figures out

“Why use machine learning (or deep learning)?”

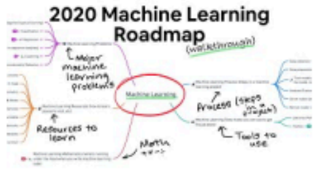
Good reason: ~~Why not?~~

Better reason: For a complex problem, can you think of all the rules?

(probably not)

YouTube

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: 2020 Machine Learning Roadmap video.

(maybe not very simple...)

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

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

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?

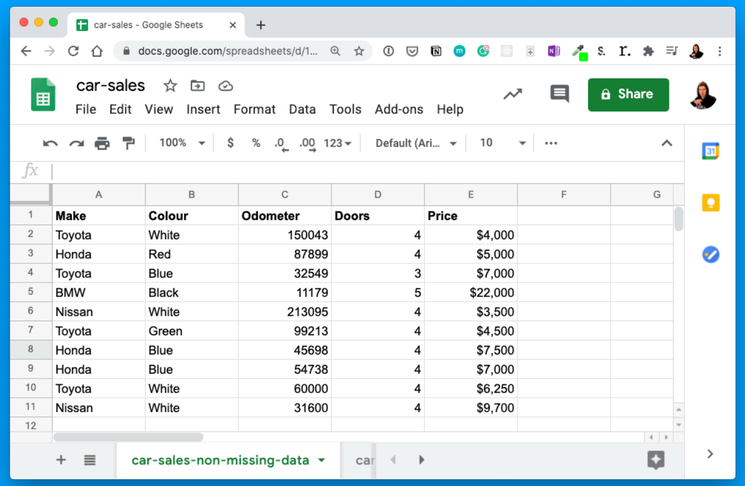
What deep learning is (typically) not good for 🤖🚫

- **When you need explainability**—the patterns learned by a deep 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)

Machine Learning vs. Deep Learning

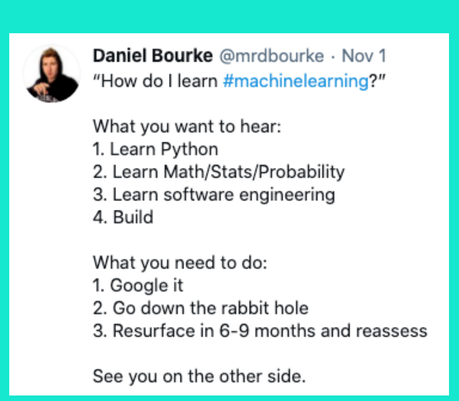
Machine Learning

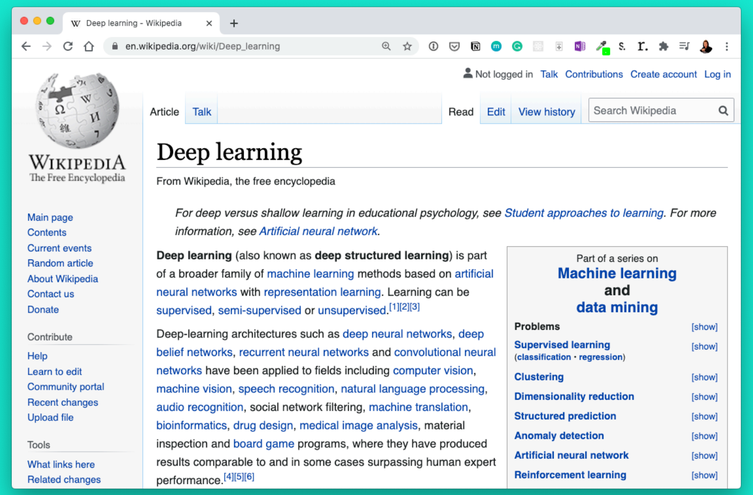


	A	B	C	D	E	F	G
1	Make	Colour	Odometer	Doors	Price		
2	Toyota	White	150043	4	$4,000		
3	Honda	Red	87899	4	$5,000		
4	Toyota	Blue	32549	3	$7,000		
5	BMW	Black	11179	5	$22,000		
6	Nissan	White	213095	4	$3,500		
7	Toyota	Green	99213	4	$4,500		
8	Honda	Blue	45698	4	$7,500		
9	Honda	Blue	54738	4	$7,000		
10	Toyota	White	60000	4	$6,250		
11	Nissan	White	31600	4	$9,700		
12							

Structured data

Deep Learning





Unstructured data

Machine Learning vs. Deep Learning

(common algorithms)

- Random forest
- Naive bayes
- Nearest neighbour
- Support vector machine
- ...many more

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

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

What we're focused on building (with TensorFlow)

we can use random forest algorithm for unstructured data as well depending on our problem

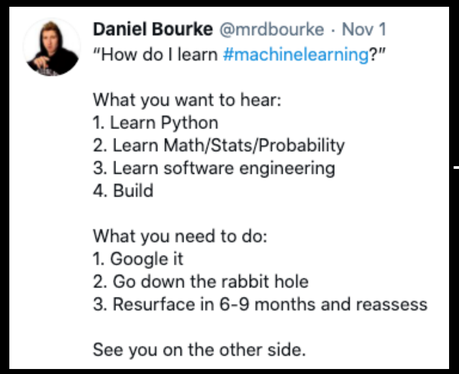
(depending how you represent your problem, many algorithms can be used for both)

Structured data ⟷ **Unstructured data**

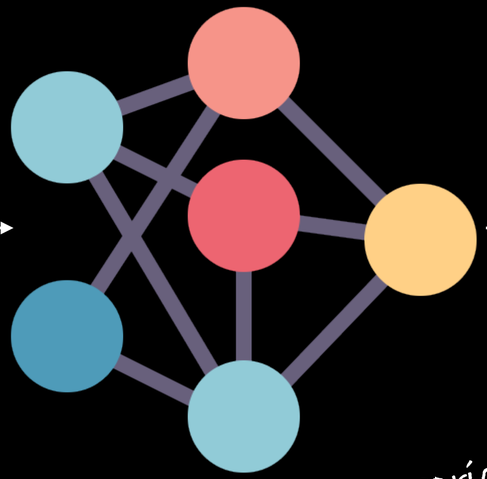
“What are neural networks?”

Neural Networks

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



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



(choose the appropriate neural network for your problem)

```
[[0.983, 0.004, 0.013],
[0.110, 0.889, 0.001],
[0.023, 0.027, 0.985],
...,
```

(a human can understand these)

Ramen, Spaghetti

Not a diaster

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

Inputs

Numerical encoding

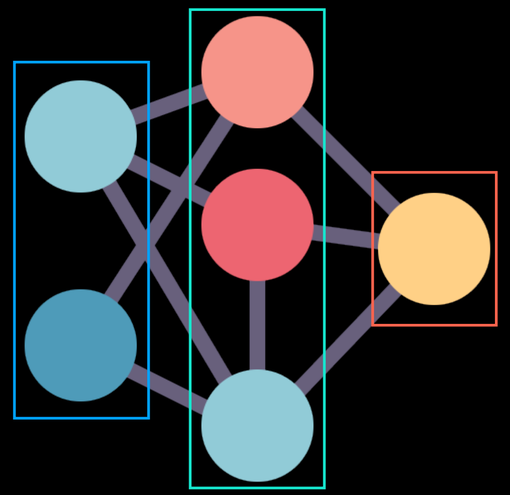
Learns representation (patterns/features/weights)

Representation outputs

Outputs

Anatomy of Neural Networks

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



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

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

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

Types of Learning

Data and labels associated to each of the data

Supervised Learning

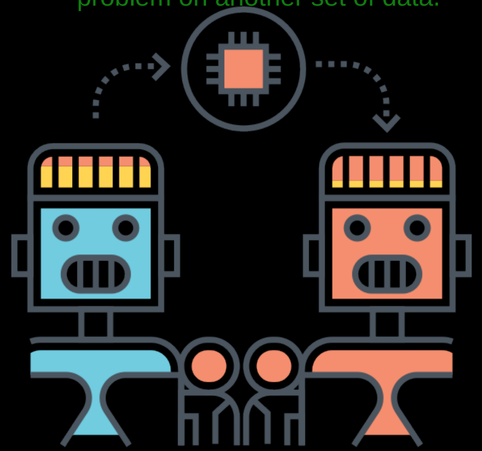
Data and labels associated to some of the data

Semi-supervised Learning

Only data

Unsupervised Learning

Taking what one deep learning model has learnt on some set of data and then using it in another problem on another set of data.



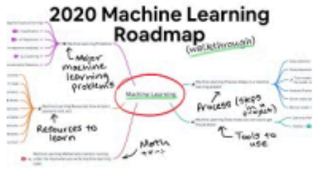
Transfer Learning

We'll be writing code to do these

“What is deep learning actually used for?”

YouTube

Yashaswi Kulshreshtha commented on your video



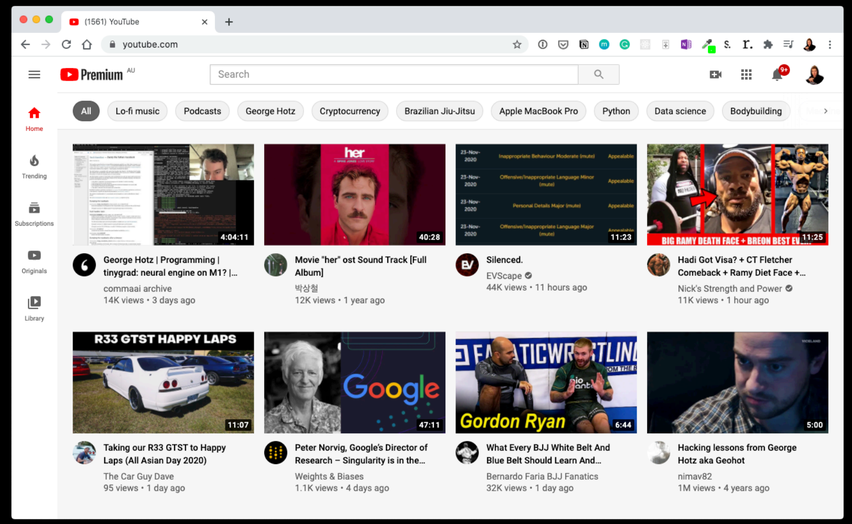
2020 Machine Learning Roadmap

Yashaswi Kulshreshtha

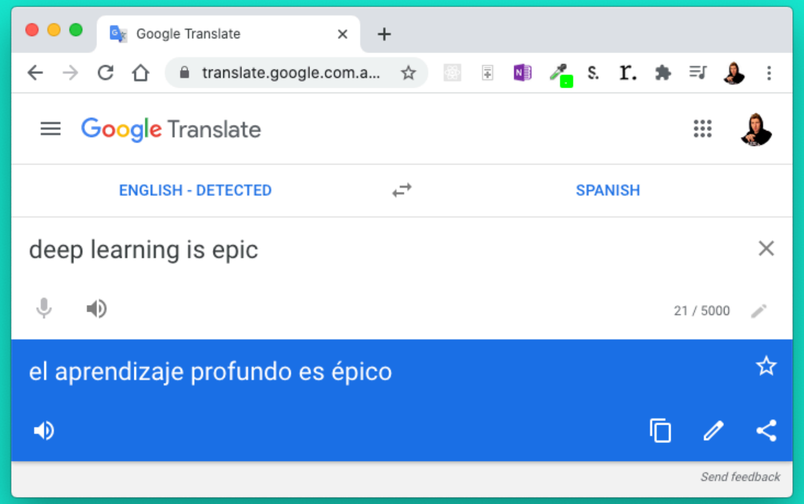
I think you can use ML for literally anything as long as you can convert it into numbers and program it to find patterns. Literally it could be anything any input or output from the universe

Source: 2020 Machine Learning Roadmap video.

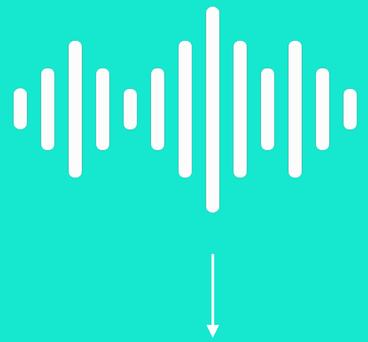
(some) Deep Learning Use Cases



Recommendation



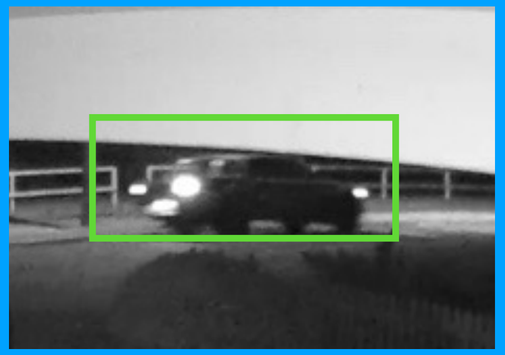
Translation



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

Speech recognition

Sequence to sequence (seq2seq)



Computer Vision

To: daniel@mrdbourke.com
Hey Daniel,

This deep learning course is incredible!
I can't wait to use what I've learned!

Not spam

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

C0ongratu1ations! U win $1139239230

Spam

Natural Language Processing (NLP)

Classification/regression

Spam Detection

Computer Vision

TensorFlow

“What is TensorFlow?”

What is TensorFlow?

- End-to-end platform for machine learning
- Write fast deep learning code in Python/other accessible languages (able to run on a GPU/TPU) Graphics processing unitT
- Able to access many pre-built deep learning models (TensorFlow Hub)
- Whole stack: preprocess data, model data, deploy model in your application
- Originally designed and used in-house by Google (now open-source)

Why TensorFlow?

Easy model building

Build and train ML models easily using intuitive high-level APIs like Keras with eager execution, which makes for immediate model iteration and easy debugging.

Robust ML production anywhere

Easily train and deploy models in the cloud, on-prem, in the browser, or on-device no matter what language you use.

your own server

Powerful experimentation for research

A simple and flexible architecture to take new ideas from concept to code, to state-of-the-art models, and to publication faster.

Source: TensorFlow.org

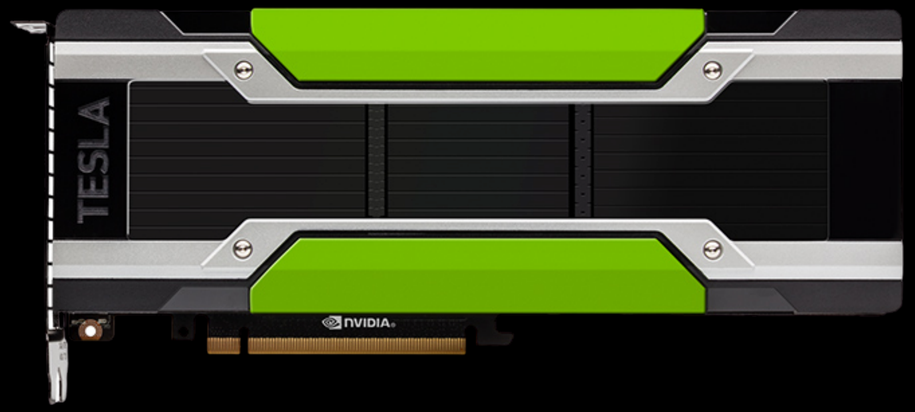
What we'll be doing (lots of)

and a little bit of this...

Why TensorFlow?

Source: @fchollet Twitter

What is a GPU/TPU?



GPU (Graphics Processing Unit)

TPU (Tensor Processing Unit)

“What is a tensor?”

Neural Networks

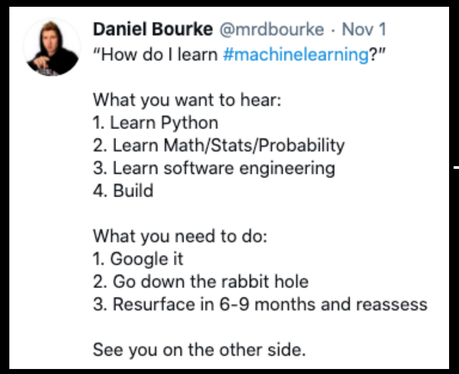
(before data gets used with an algorithm, it needs to be turned into numbers)

Tensors : Numerical way to represent information

These are tensors!

(a human can understand these)

Ramen, Spaghetti

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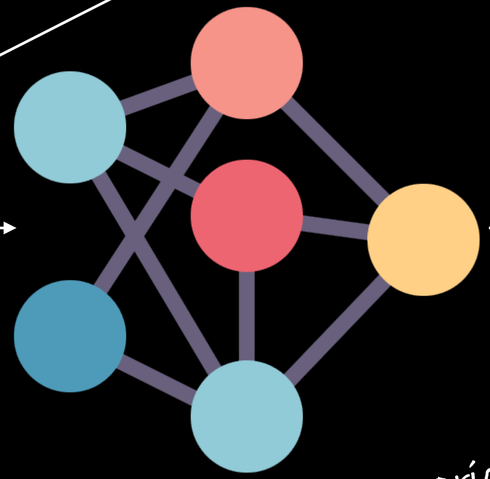

```
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[0.023, 0.027, 0.985],
...,
```
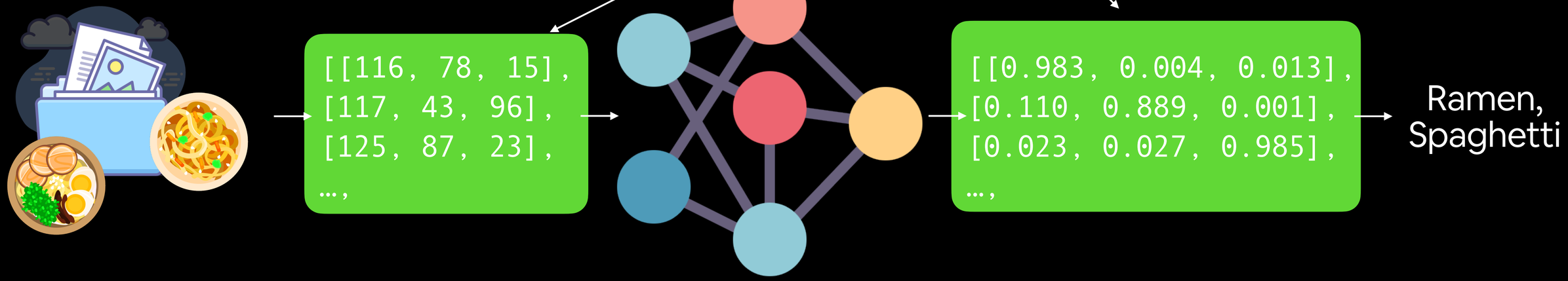

Not a diaster

(choose the appropriate neural network for your problem)

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

Inputs | **Numerical encoding** | **Learns representation (patterns/features/weights)** | **Representation outputs** | **Outputs**



Inputs

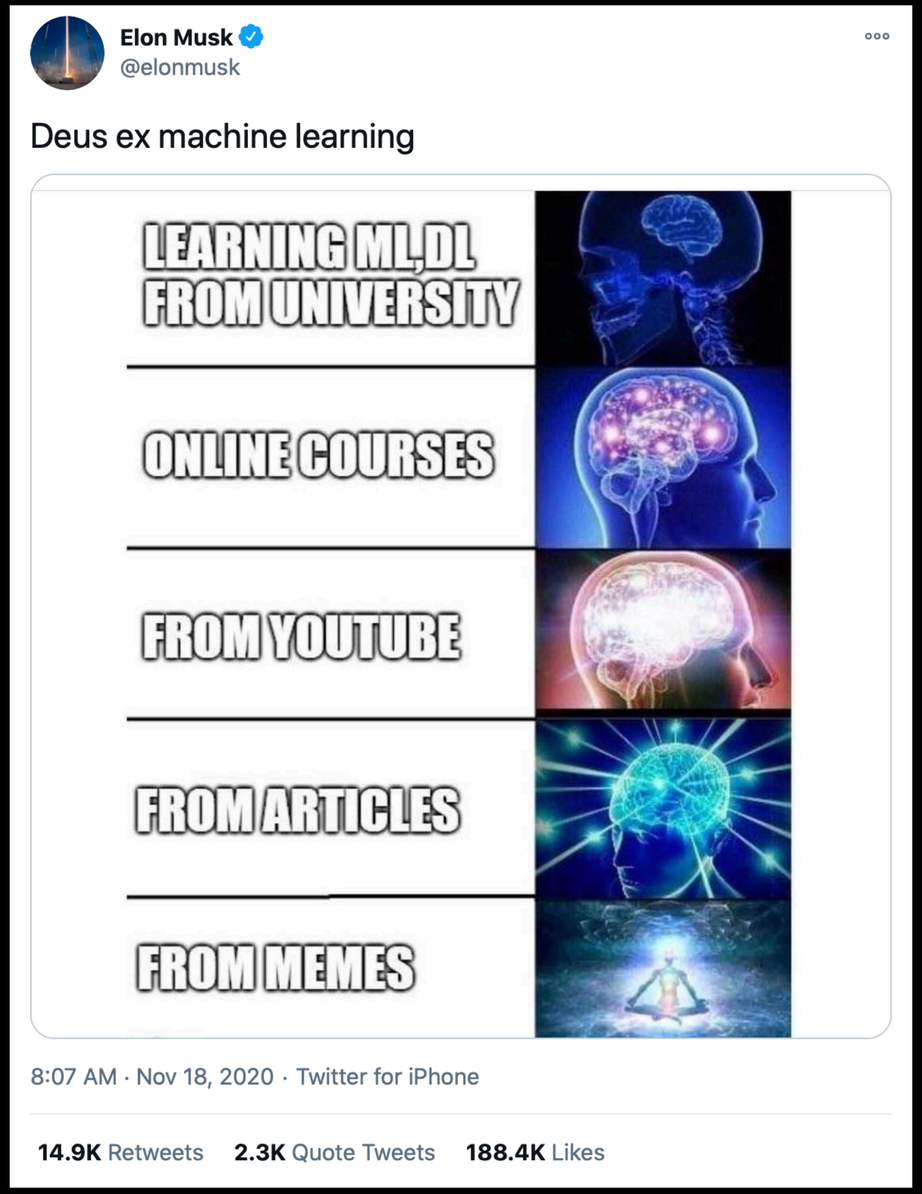
Numerical encoding

Learns representation (patterns/features/weights)

Representation outputs

Outputs

“What are we going to cover?”



Source: @elonmusk Twitter

What we're going to cover

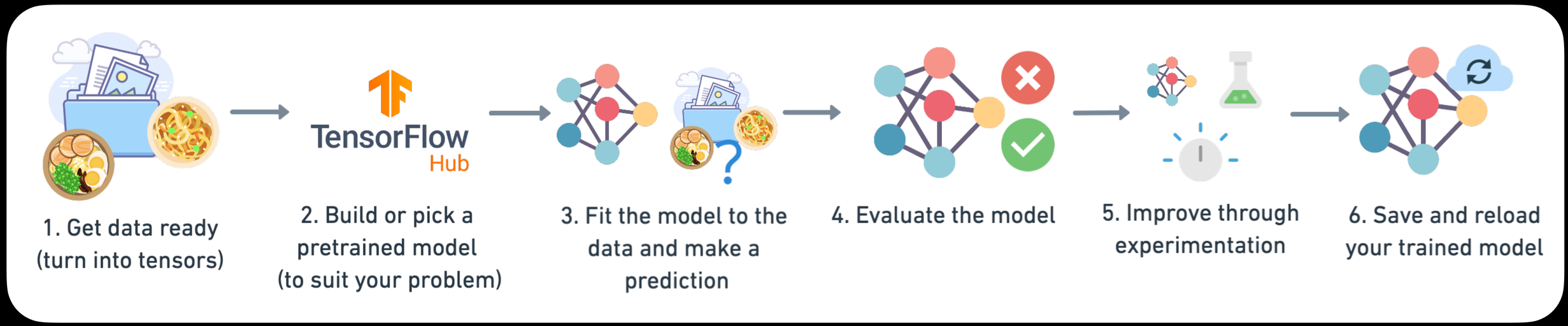
(broadly)

- TensorFlow basics & fundamentals
- 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!)

How:

What we're going to cover



A TensorFlow workflow

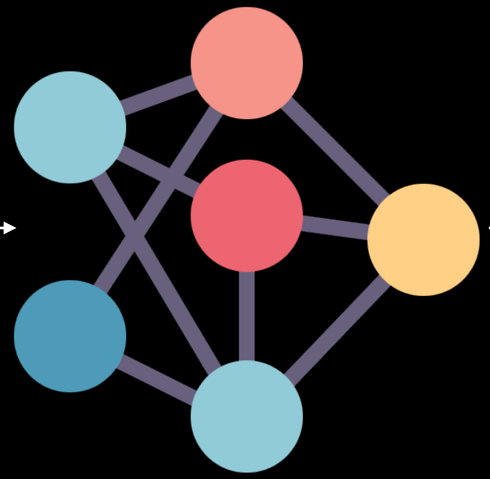
“How should I approach this course?”

How to approach this course

- Write code (lots of it, follow along, let's make mistakes together)
  - Motto #1: "If in doubt, run the code"
- Explore & experiment
  - Motto #2: "Experiment, experiment, experiment"
  - Motto #3: "Visualize, visualize, visualize" (recreate things in ways you can understand them)
- Ask questions (including the "dumb" ones) 🤔
- Do the exercises (try them yourself before looking at the solutions) 🛠️
  - This course doesn't cover everything, if you want to learn more on something, look it up
- Share your work
- 🚫 Avoid:
  - Overthinking the process
  - The "I can't learn it" mentality (that's bullsh*t)

Let’s code!

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



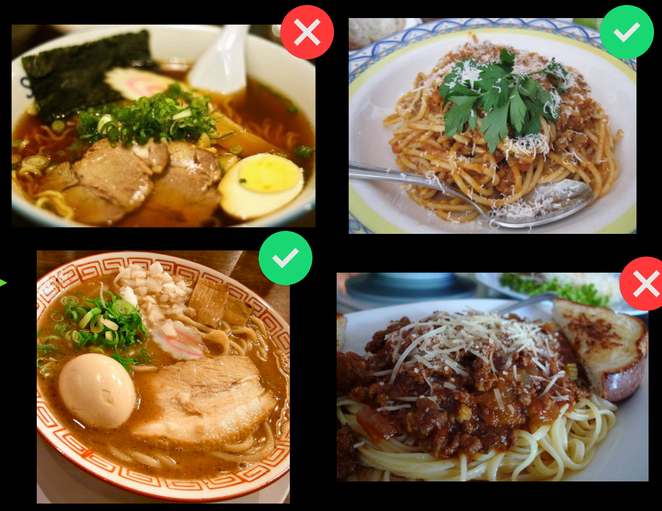
[[0.983, 0.004, 0.013],
[0.110, 0.889, 0.001],
[0.023, 0.027, 0.985],
…,

Ramen,
Spaghetti

1. Initialise with random weights (only at beginning)

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

2. Show examples



3. Update representation outputs

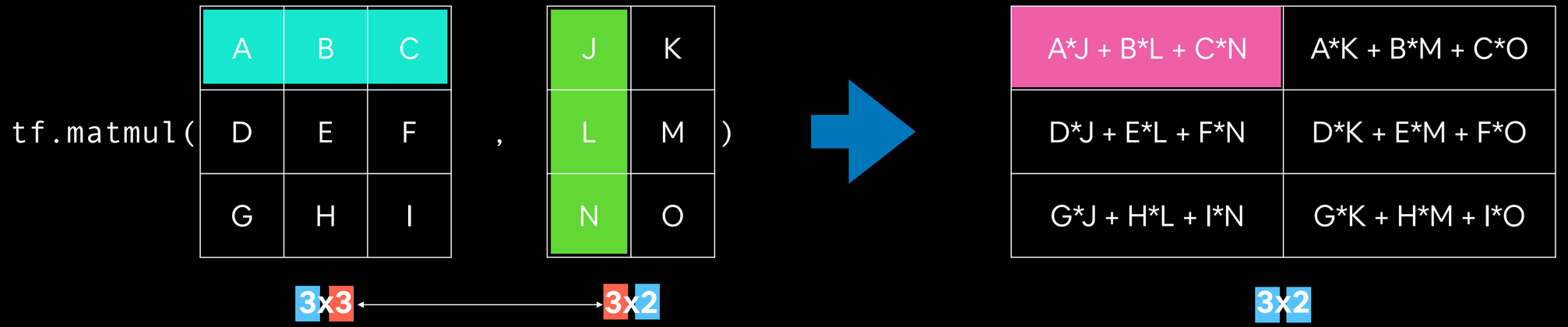
4. Repeat with more examples

Inputs | **Numerical encoding** | **Learns representation (patterns/features/weights)** | **Representation outputs** | **Outputs**

Tensor attributes

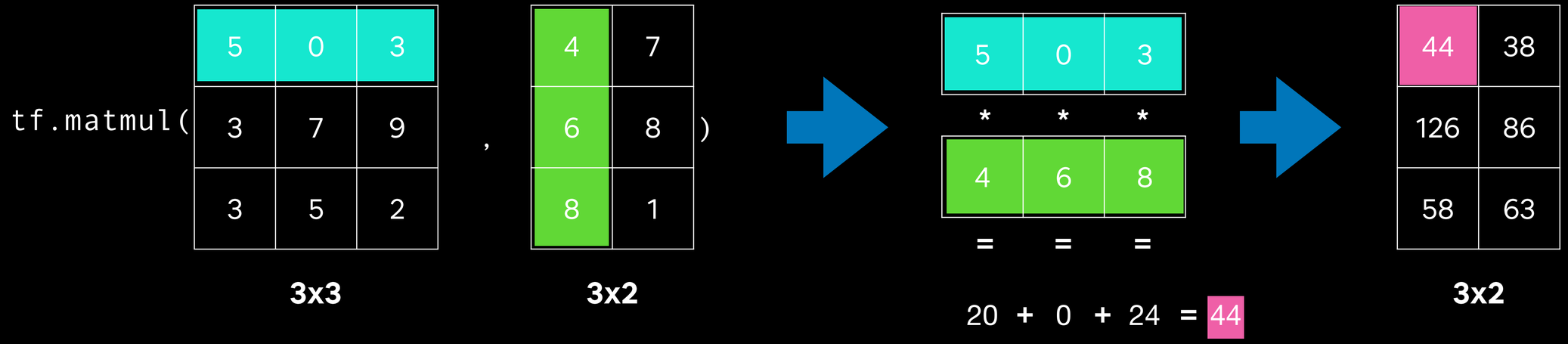
Attribute	Meaning	Code
Shape	The length (number of elements) of each of the dimensions of a tensor.	`tensor.shape`
Rank	The number of tensor dimensions. A scalar has rank 0, a vector has rank 1, a matrix is rank 2, a tensor has rank n.	`tensor.ndim`
Axis or dimension	A particular dimension of a tensor.	`tensor[0], tensor[:, 1]…`
Size	The total number of items in the tensor.	`tf.size(tensor)`

Dot product



Numbers on the inside must match

New size is same as outside numbers



For a live demo, checkout www.matrixmultiplication.xyz