What is ‘machine learning’?

MACHINE LEARNING

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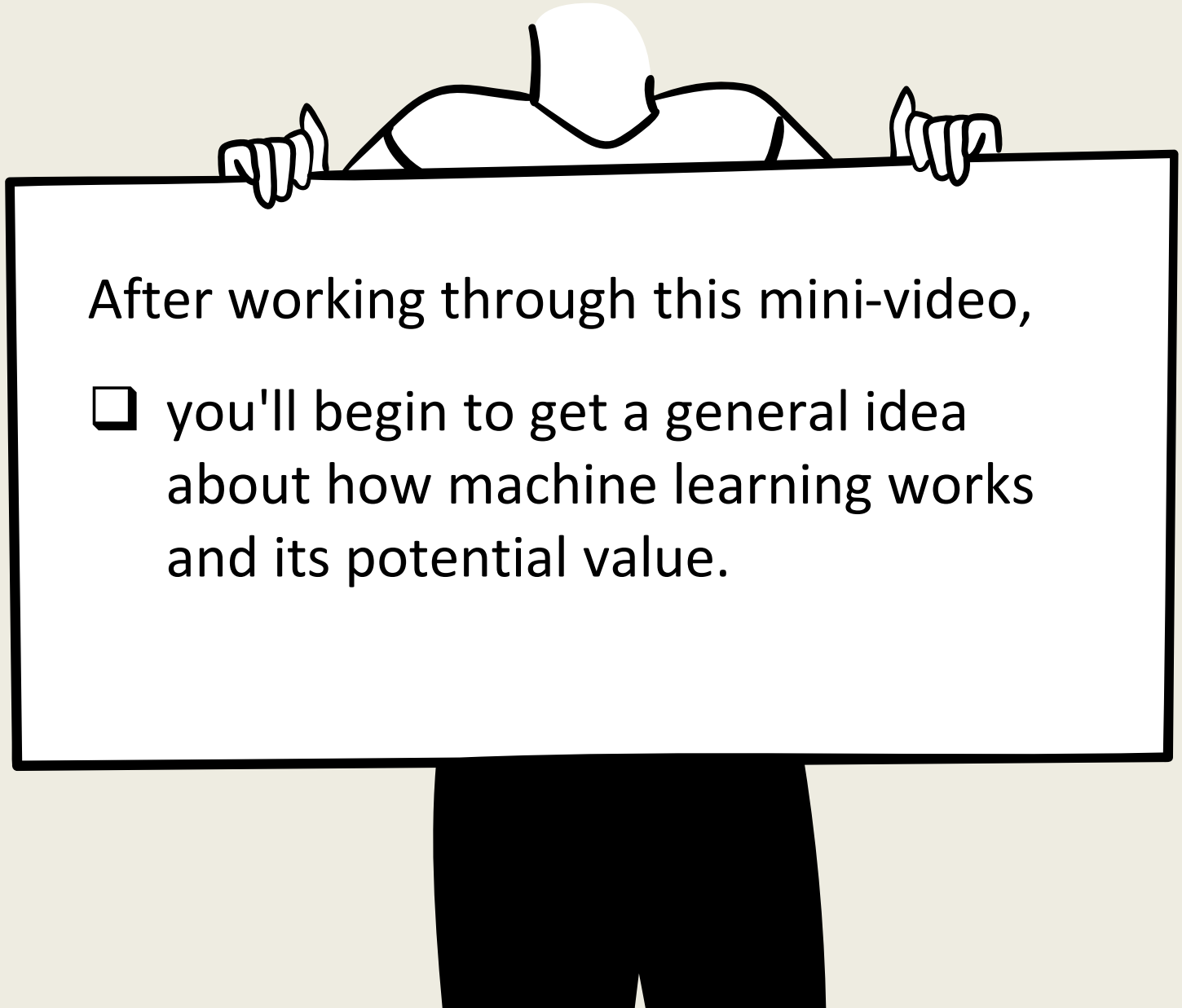
Learning outcome



After working through this mini-video,

- ❑ you'll begin to get a general idea about how machine learning works and its potential value.

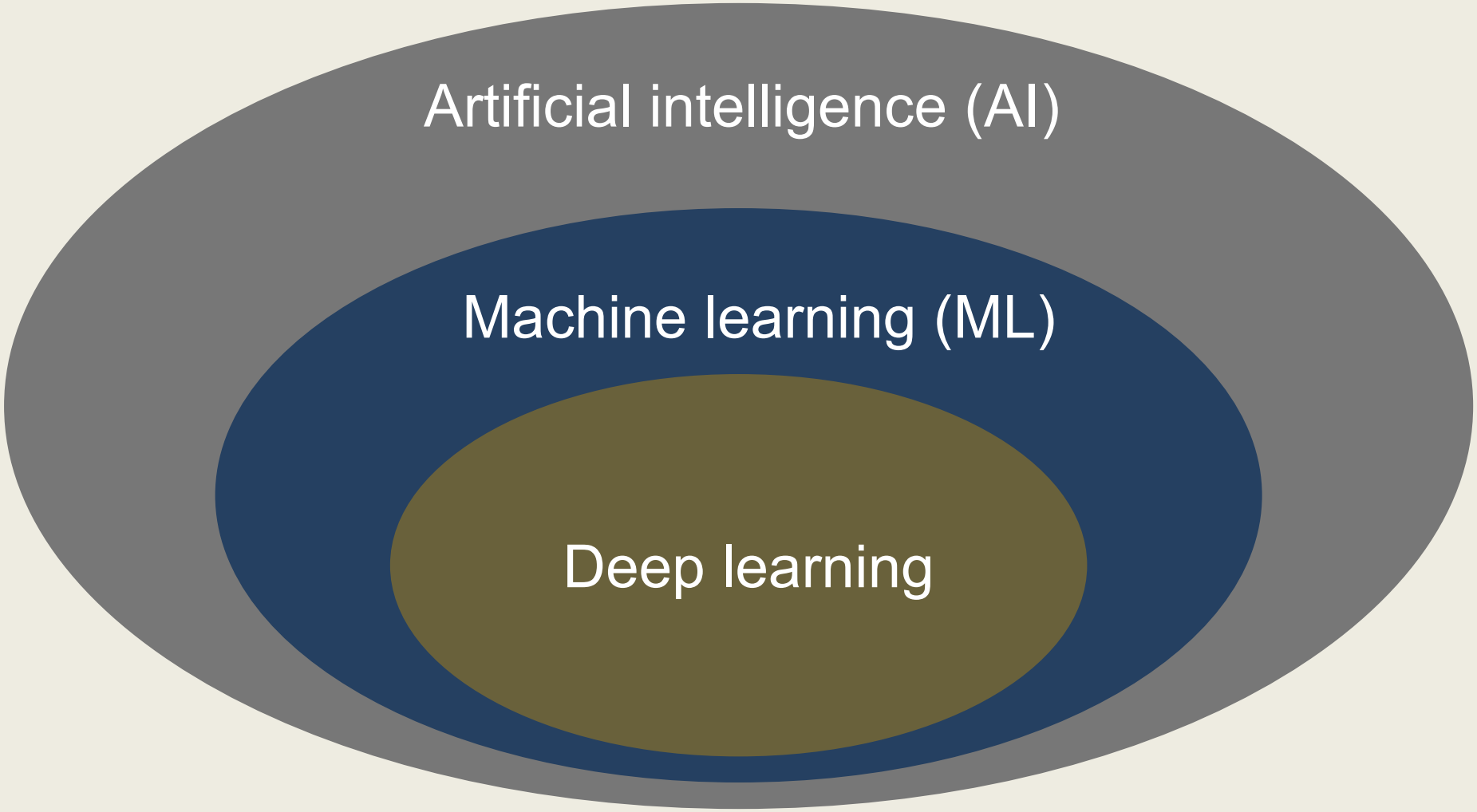
Lecture outline

- ❑ Describing machine learning
- ❑ Machine learning in our world

Describing machine learning

- ❑ **Describing machine learning**
- ❑ Machine learning in our world

ML, AI, and Deep learning



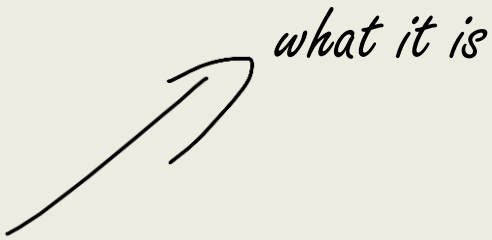
Other terminologies

What other terminologies have you come across in relation to AI?

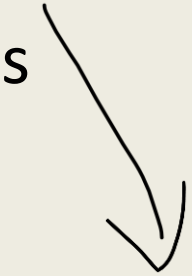
Machine learning

development of software that performs some task (or sets of tasks) based on its own learnt experience

Machine learning



development of **software** that **performs some task** (or sets of tasks) based on its own **learnt** experience



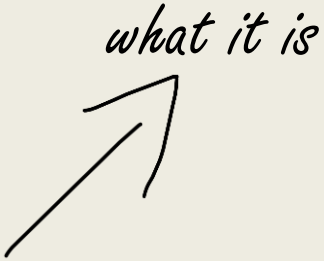
ML - Toy example

development of software that **can predict the likelihood of fire** based on its own learnt experience

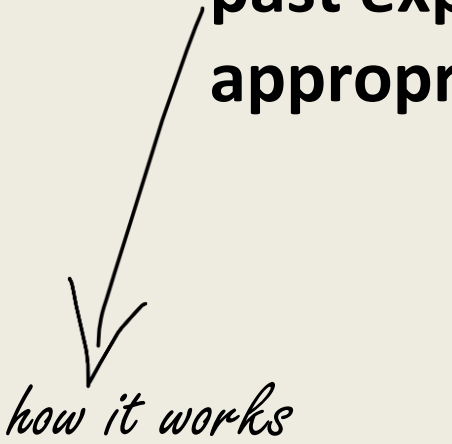
Machine learning

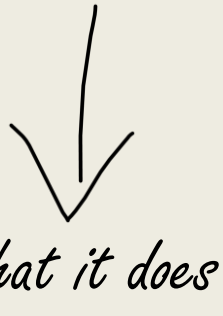
creation of a mathematical model that captures past experience and enables deduction of appropriate response to new stimuli

Machine learning



creation of a **mathematical model** that captures **past experience** and **enables deduction of appropriate response to new stimuli**





Goal

creation of a mathematical model that captures past experience and **enables deduction of appropriate response to new stimuli**

- The goal in ML is to find a model/function $f(\cdot)$ that takes in some input $\boldsymbol{x}_n$ and provides an appropriate output $\hat{\boldsymbol{y}}_n$

ML - Toy example (cont'd)

creation of a mathematical model that captures past experience and **enables prediction of the likelihood of fire given relevant environment data**

- The goal in ML is to find a model/function $f(\cdot)$ that takes in some input $\boldsymbol{x}_n$ and provides an appropriate output $\hat{\boldsymbol{y}}_n$

ML - Toy example (cont'd)

creation of a mathematical model that captures past experience and enables prediction of the likelihood of fire given relevant environment data

Environment data			
Temperature (°C)	**Relative humidity (%)**	**Wind speed (km/h)**	**Rain (mm)**
23	21	10	0
40	89	6	1
35	60	23	15

ML - Toy example (cont'd)

creation of a mathematical model that captures past experience and enables prediction of the likelihood of fire given relevant environment data

Environment data				Likelihood of a fire
Temperature (°C)	**Relative humidity (%)**	**Wind speed (km/h)**	**Rain (mm)**	**Fire weather index**
23	21	10	0	0
40	89	6	1	30
35	60	23	15	15

Data

creation of a mathematical model that captures **past experience** and enables deduction of appropriate response to new stimuli

- is the source of experience and 'learning' in ML
- it is typically of two parts:
  - label(s)/output - $\boldsymbol{y}$
  - features/input - $\boldsymbol{x}$

What is machine learning?

- Consider that you can and desire to automatically obtain some answer $\boldsymbol{y}_l$

- You would need to use N training data instances in pairs $(\boldsymbol{x}_n, \boldsymbol{y}_n)$, $1 \leq n \leq N$

  to find a model/function $f(\cdot)$ such that:

  - $f(\boldsymbol{x}_n) = \hat{\boldsymbol{y}}_n \approx \boldsymbol{y}_n$

i.e. model output $\hat{\boldsymbol{y}}_n$ is exactly or very close to $\boldsymbol{y}_n$

and

  - $f(\cdot)$ is **generalizable** beyond the training data

i.e. $f(\boldsymbol{x}_m) = \hat{\boldsymbol{y}}_m \approx \boldsymbol{y}_m$ where $\boldsymbol{x}_m$ is not part of the set $\{\boldsymbol{x}_n\}_{n=1}^{N}$

Toy training data

- Input data $\{\boldsymbol{x}_n\}_{n=1}^{3}$ with dimensionality $D_x = 4$

i.e. 3 data instances, each with 4 features

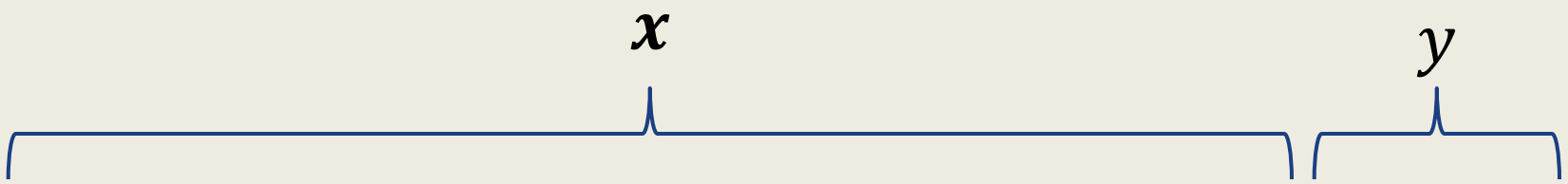
n	Temperature (°C)	Relative humidity (%)	Wind speed (km/h)	Rain (mm)
1	23	21	10	0
2	40	89	6	1
3	35	60	23	15

- Output data $\{y_n\}_{n=1}^{3}$ with dimensionality $D_y = 1$

i.e. 1 label for each of 3 data instances

n	Fire weather index
1	0
2	30
3	15

Generalizability



	Temperature (°C)	Relative humidity (%)	Wind speed (km/h)	Rain (mm)	Fire weather index
training data	23	21	10	0	0
	40	89	6	1	30
	35	60	23	15	15
unseen data	25	52	17	13	?
	41	48	9	8	?

Training data – Data used to train a model

Unseen data – Data not ‘seen’ by the model during training

Some more ML concepts

- **ML model** – software or mathematical model that:
  - takes in some input (features);
  - gives some output (label(s)); and
  - has capacity to learn from experience (data).

- **Training** – the ‘learning’ process when the ML model gains ‘experience’

- **Inference** – giving a (trained) ML model some input and prompting it to give appropriate output

What is machine learning?

- Consider that you can and desire to a… ically obtain some answer $\boldsymbol{y}_l$

- You would need to u… in pairs $(\boldsymbol{x}_n, \boldsymbol{y}_n)$ …

to fin… at:

… very close to $\boldsymbol{y}_n$

and

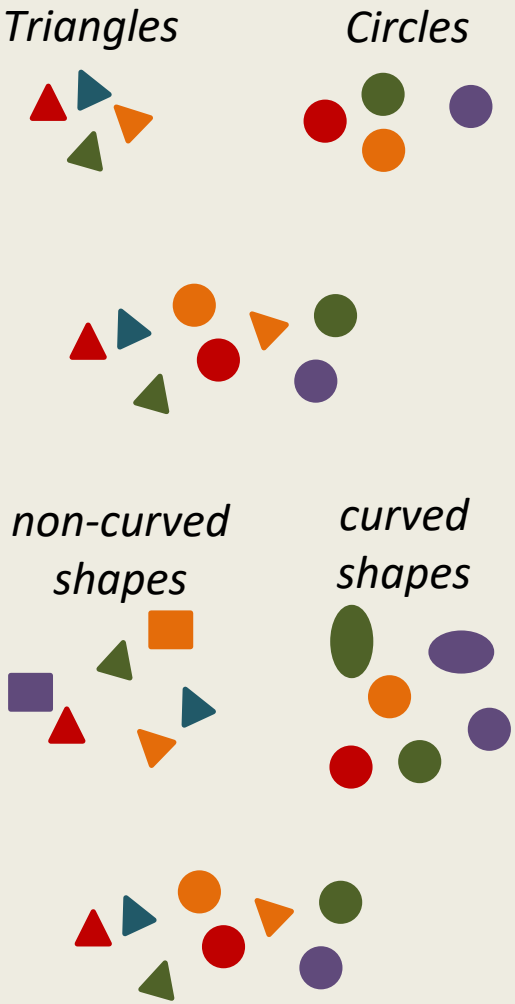
…**eneralizable** beyond the training data

i.e. … $= \hat{\boldsymbol{y}}_m \approx \boldsymbol{y}_m$ where $\boldsymbol{x}_m$ is not part of the set $\{\boldsymbol{x}_n\}_{n=1}^{N}$

SUPERVISED LEARNING

Types of learning

- Supervised learning
  - Training data includes labels
- Unsupervised learning
  - Training data does not include labels
- Semi-supervised learning
  - Training data includes labels but not those needed at inference time
- Self-supervised learning
  - The ‘labels’ are the features themselves, or some trivial derivative of the features



Supervised learning – Regression

Regression – output y_n is real valued or continuous

y

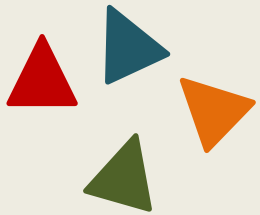
Temperature (°C)	Relative humidity (%)	Wind speed (km/h)	Rain (mm)	Fire weather index
23	21	10	0	0
40	89	6	1	30
35	60	23	15	15

Supervised learning – Classification

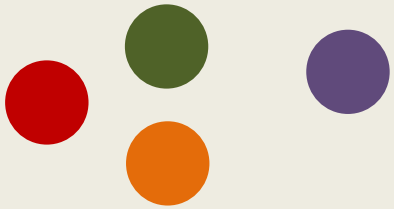
Classification – output y_n is categorical or ordinal

y is

Triangles



Circles



Machine learning in our world

- ❑ Describing machine learning
- ❑ **Machine learning in our world**

Bosch Dryad

Environment sensor data analysis for fire prediction

(https://www.youtube.com/watch?v=A4DK8jQnHbQ&t=1s)

Bosch Dryad: Dissect

- What would be the input to the model here?
- What would be the model's output

Bosch Dryad: Dissect

- What would be the input to the model here?

  Environmental sensor data

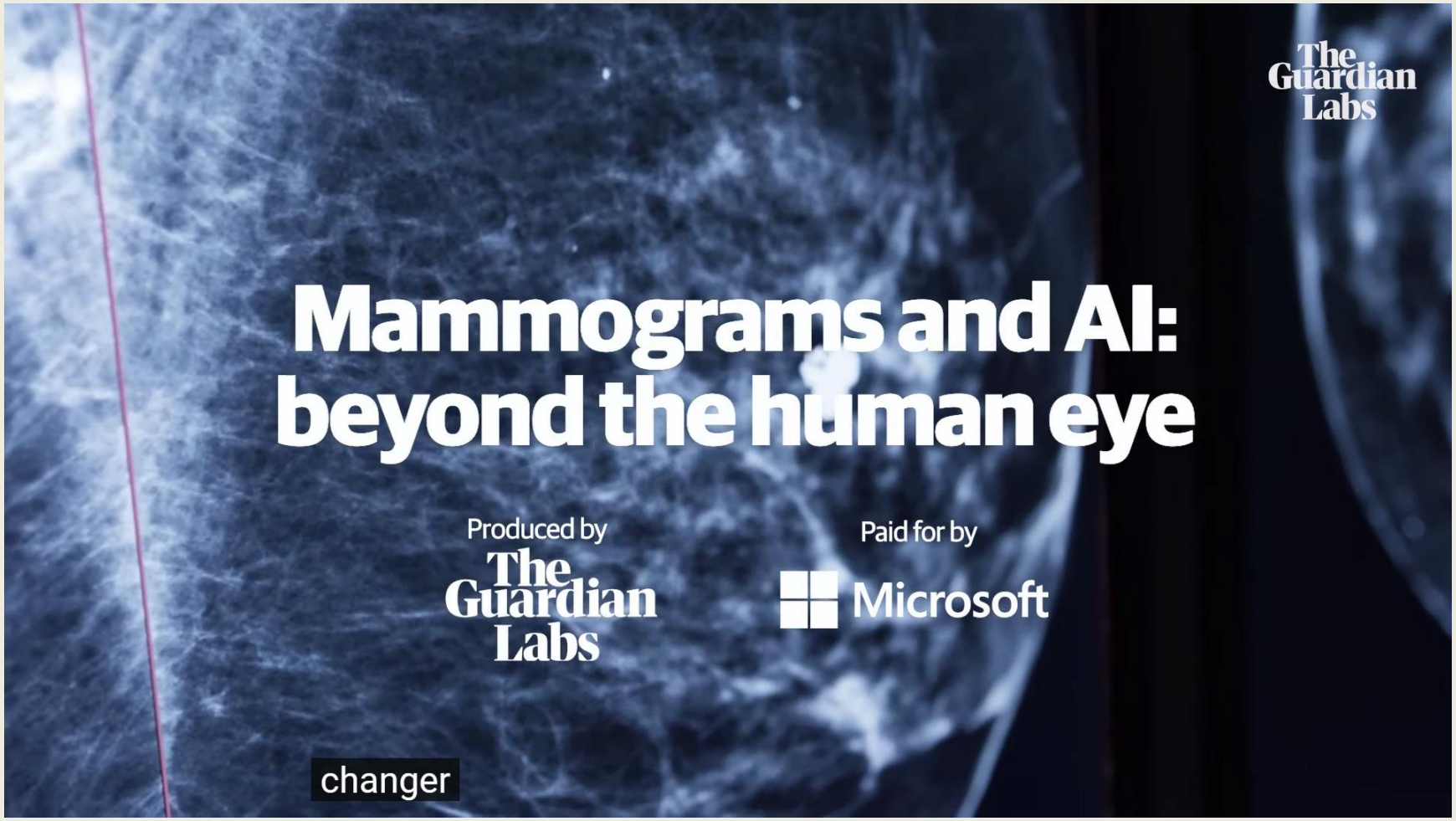
- What would be the model's output

  Likelihood of fire

Bosch Dryad video

Access the video on Canvas

Kheiron Mia



Computer vision for breast cancer detection
(https://www.youtube.com/watch?v=jUNo27MAfZM&t=1s)

Kheiron Mia: Dissect

- What would be the input to the model here?
- What would be the model's output

Kheiron Mia: Dissect

- What would be the input to the model here?

  Mammograms

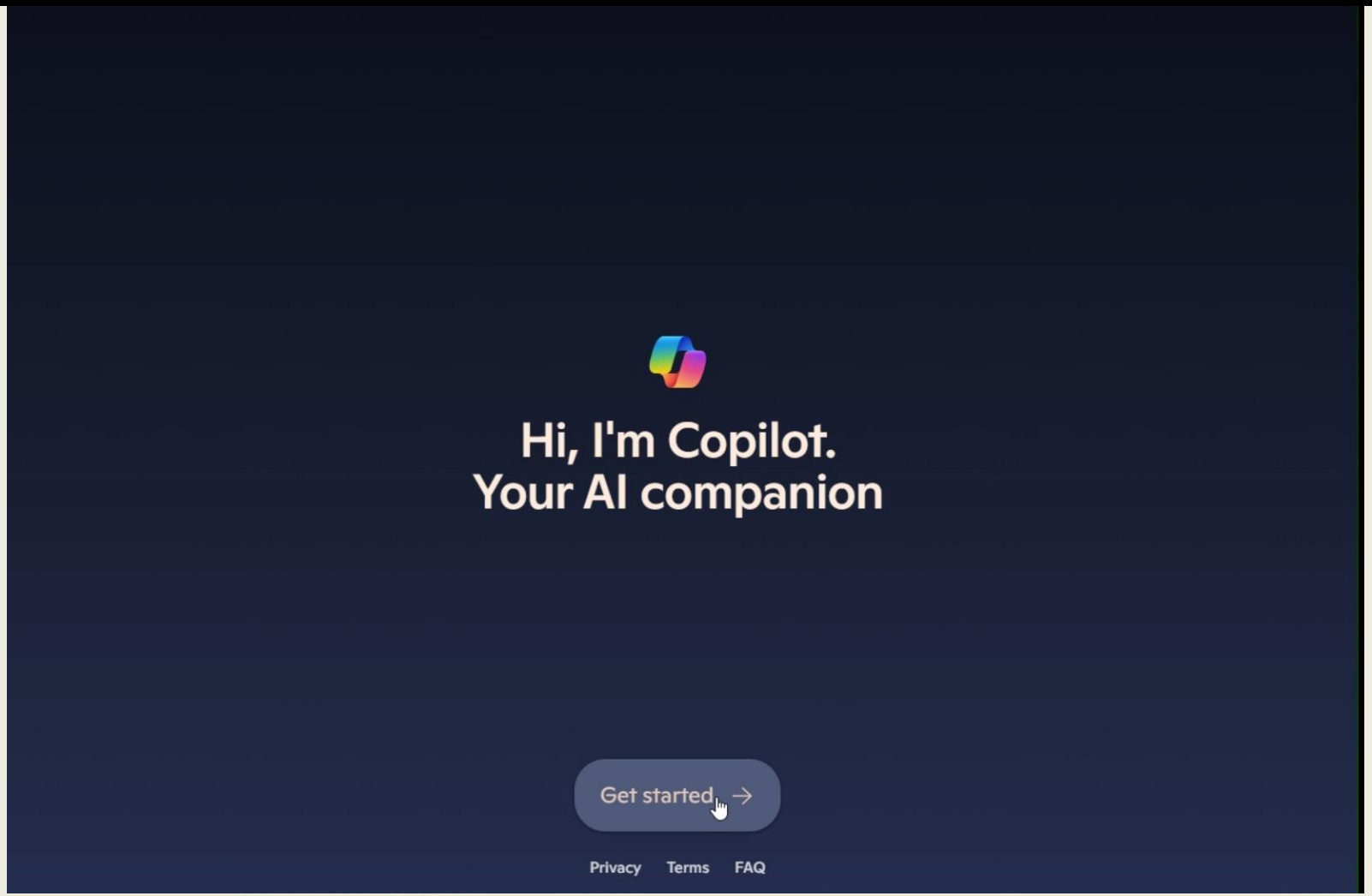
- What would be the model's output

  Presence of cancer

Kheiron Mia video

Access the video on Canvas

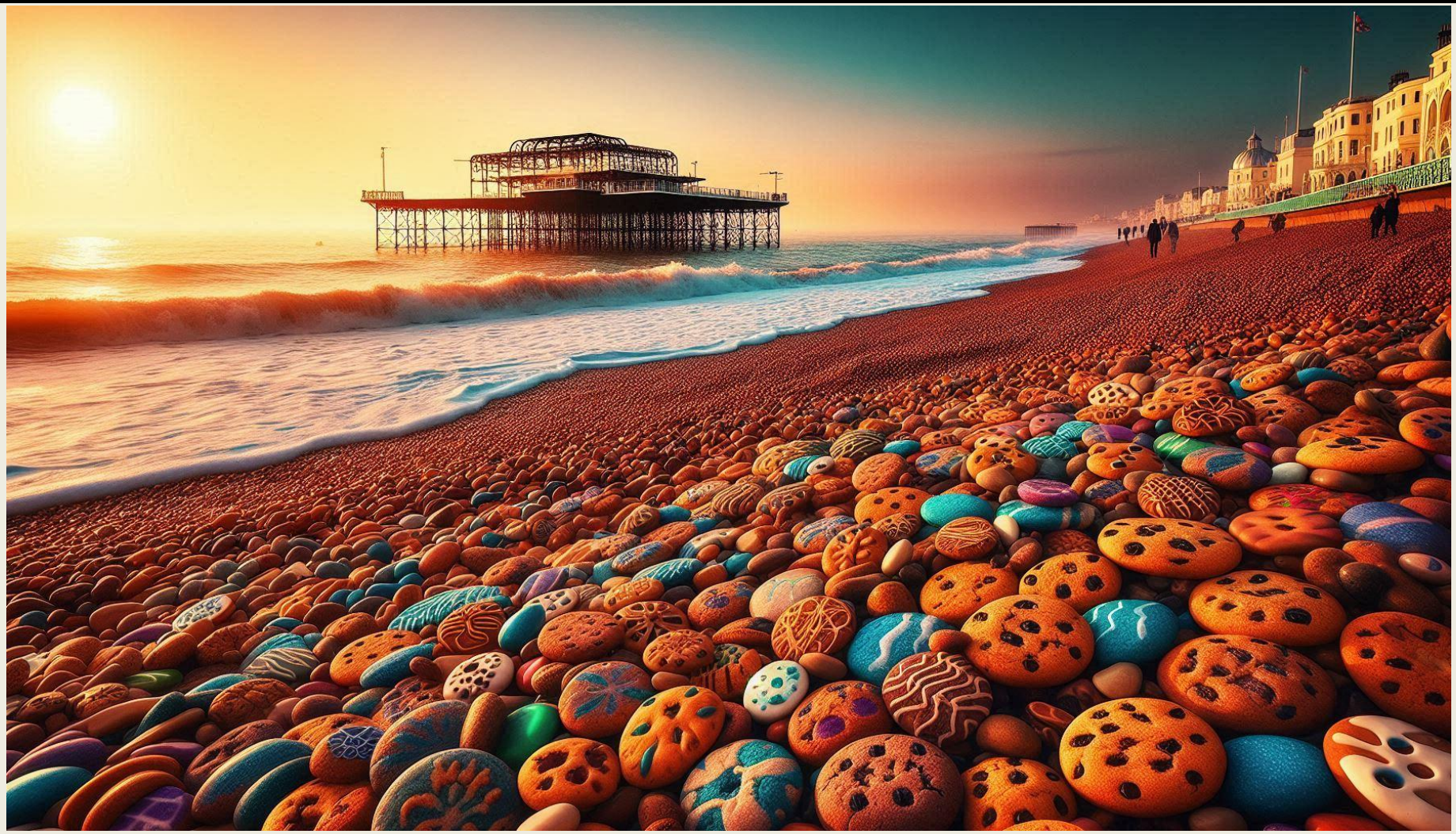
Microsoft Copilot



Natural language processing

(https://copilot.microsoft.com/)

ML in arts and design



Generated by AI – *Microsoft Designer*

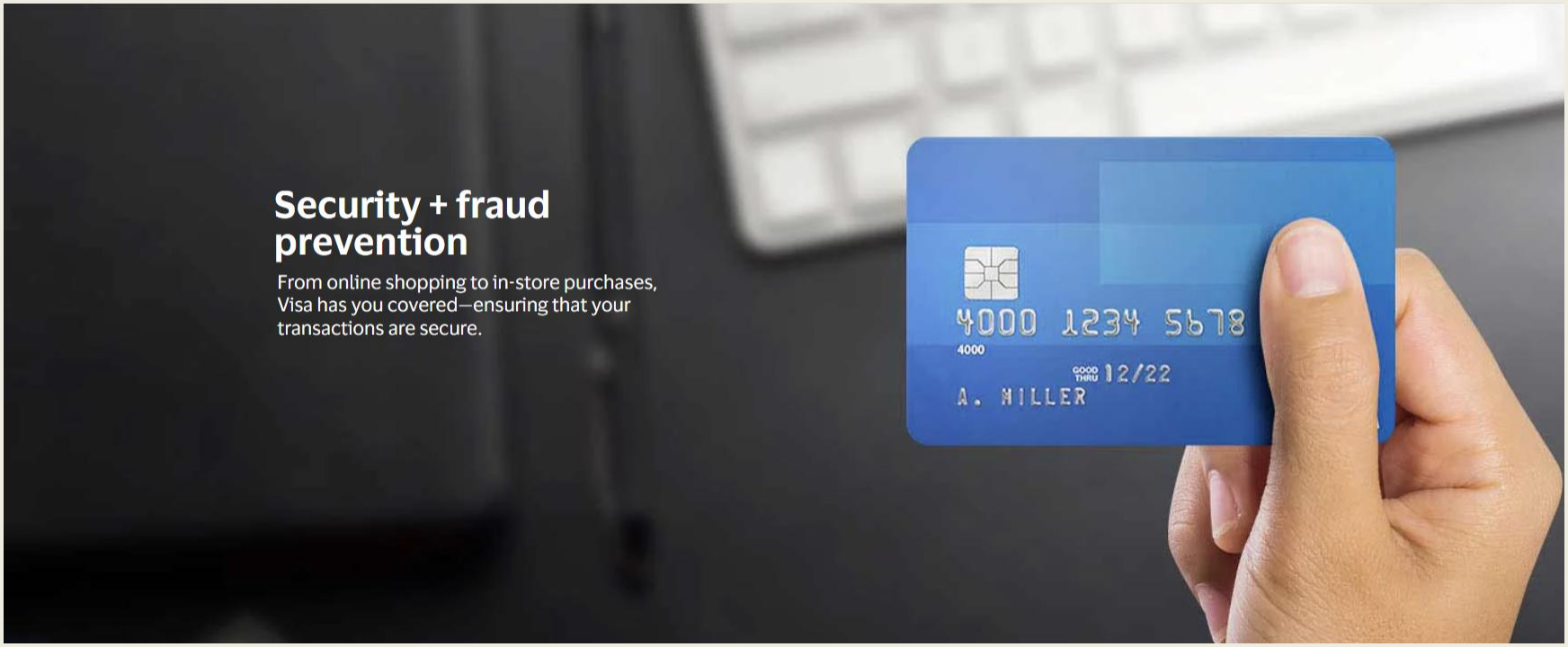
(**prompt** – “Brighton beach showing the West Pier with the pebbles looking like cookies on cold January morning with the sun setting on the sea and in warm colors in a hyper surreal style.”)

ML for surveillance and security

Veesion

(https://veesion.io/)

ML for banking and finance



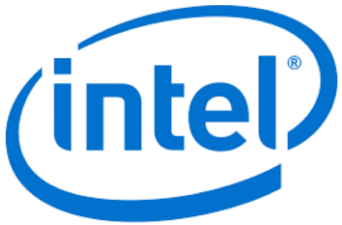
Visa
(https://usa.visa.com/run-your-business/visa-security/risk-solutions/authorization-optimization.html)

ML for transport

Tesla

(https://www.tesla.com/en_GB/autopilot/)

Example products & services that use ML



Summary

1. The most basic element of **machine learning** is a **model** that learns from data.
2. With **supervised learning**, data has both **features/input** & **labels/output**.
3. When the label/output are real valued or continuous, it is a **regression** task. Otherwise, it is **classification**.
4. An important goal in machine learning is **generalizability** to data not seen by the model during its training.

A glossary to help

https://developers.google.com/machine-learning/glossary

M

machine learning

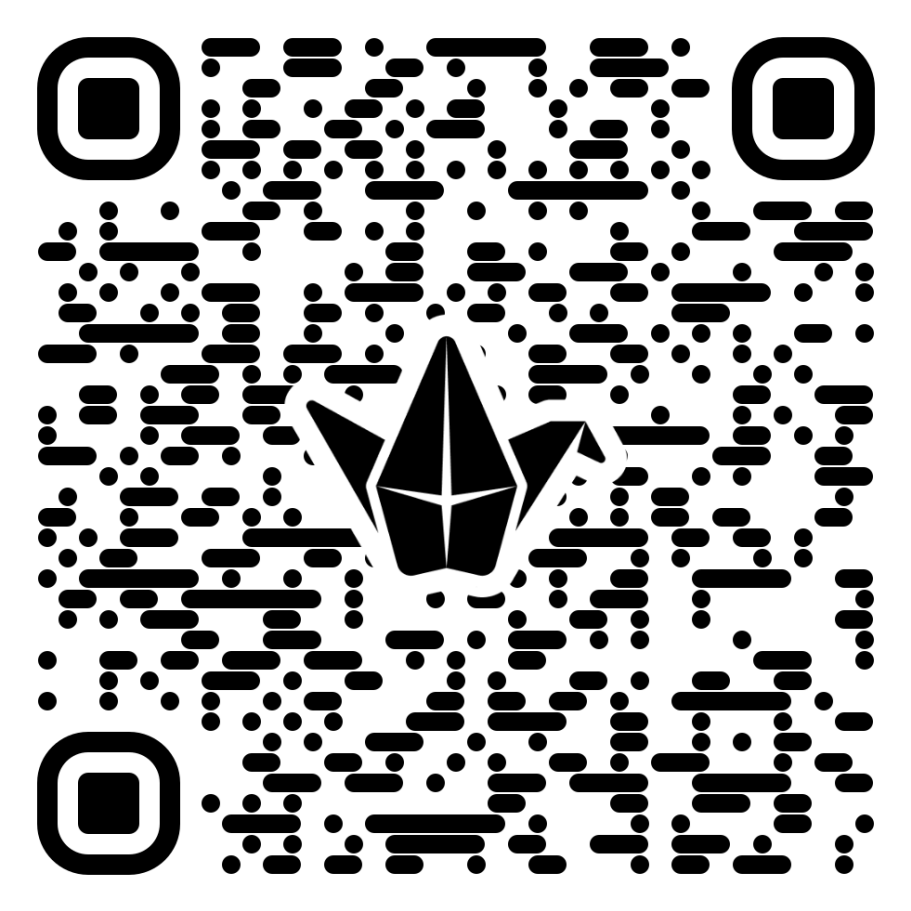
A program or system that **trains** a **model** from input data. The trained model can make useful predictions from new (never-before-seen) data drawn from the same distribution as the one used to train the model.

Machine learning also refers to the field of study concerned with these programs or systems.

See the Introduction to Machine Learning course for more information.

machine translation

Any questions???



scan the QR code to ask questions