

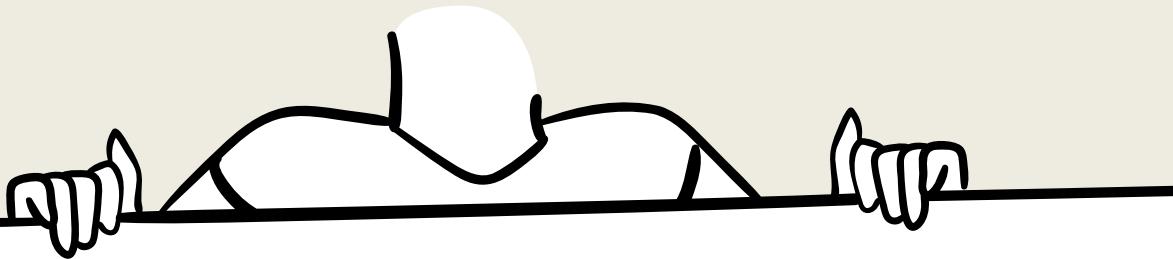
What is ‘machine learning’?

MACHINE LEARNING

Dr. Temitayo Olugbade



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



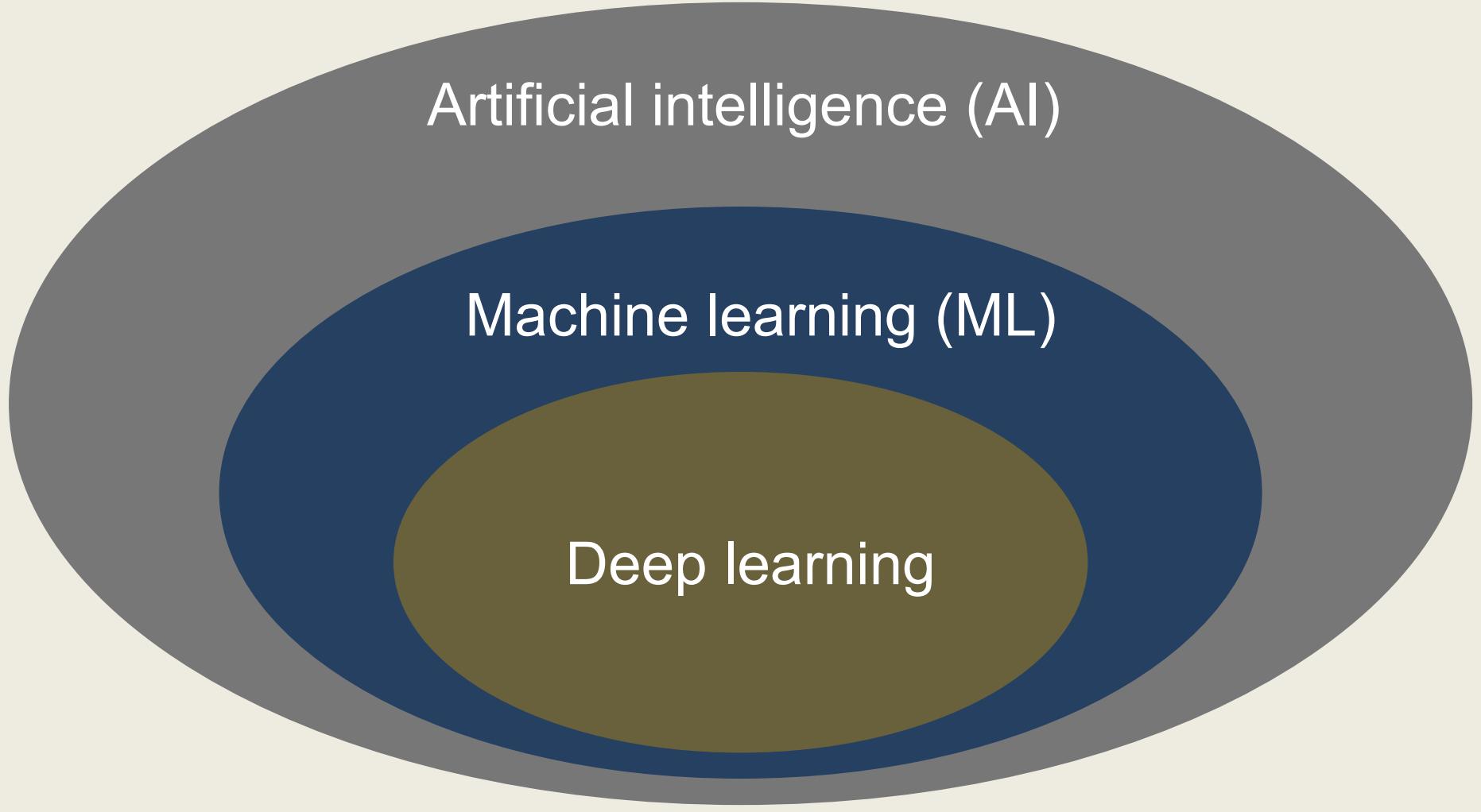
Describing machine learning

❑ Describing machine learning

❑ Machine learning in our world



ML, AI, and Deep learning



Artificial intelligence (AI)

Machine learning (ML)

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

The diagram consists of three main components: 1) A handwritten-style label 'what it is' positioned above the main text, with a hand-drawn arrow pointing towards the top right. 2) A handwritten-style label 'what it does' positioned below the main text, with a hand-drawn arrow pointing downwards. 3) A handwritten-style label 'how it works' positioned below the main text, with a hand-drawn arrow pointing downwards.

what it is

what it does

how it works

ML - Toy example

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



what it does

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

how it works

what it is

what it does

Goal

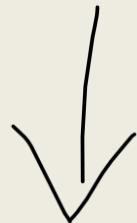
creation of a mathematical model that captures past experience and **enables deduction of appropriate response to new stimuli**



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



label/output



features/input

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



training data

- is the source of experience and ‘learning’ in ML
- it is typically of two parts:
 - label(s)/output - y
 - features/input - x

What is machine learning?

- Consider that you can and desire to automatically obtain some answer \mathbf{y}_l
- You would need to use N training data instances in pairs $(\mathbf{x}_n, \mathbf{y}_n)$, $1 \leq n \leq N$
 - to find a model/function $f(\cdot)$ such that:
 - $f(\mathbf{x}_n) = \hat{\mathbf{y}}_n \approx \mathbf{y}_n$
i.e. model output $\hat{\mathbf{y}}_n$ is exactly or very close to \mathbf{y}_n
and
 - $f(\cdot)$ is **generalizable** beyond the training data
i.e. $f(\mathbf{x}_m) = \hat{\mathbf{y}}_m \approx \mathbf{y}_m$ where \mathbf{x}_m is not part of the set $\{\mathbf{x}_n\}_{n=1}^N$

Toy training data

- Input data $\{x_n\}_{n=1}^3$ 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

The diagram illustrates a dataset for fire weather analysis. The columns represent various environmental factors: Temperature (x_1), Relative humidity (x_2), Wind speed (x_3), Rain (x_4), and the Fire weather index (y). The rows show five different data points. The first four columns are grouped under the label "unseen training data".

	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
	25	52	17	13	?
	41	48	9	8	?

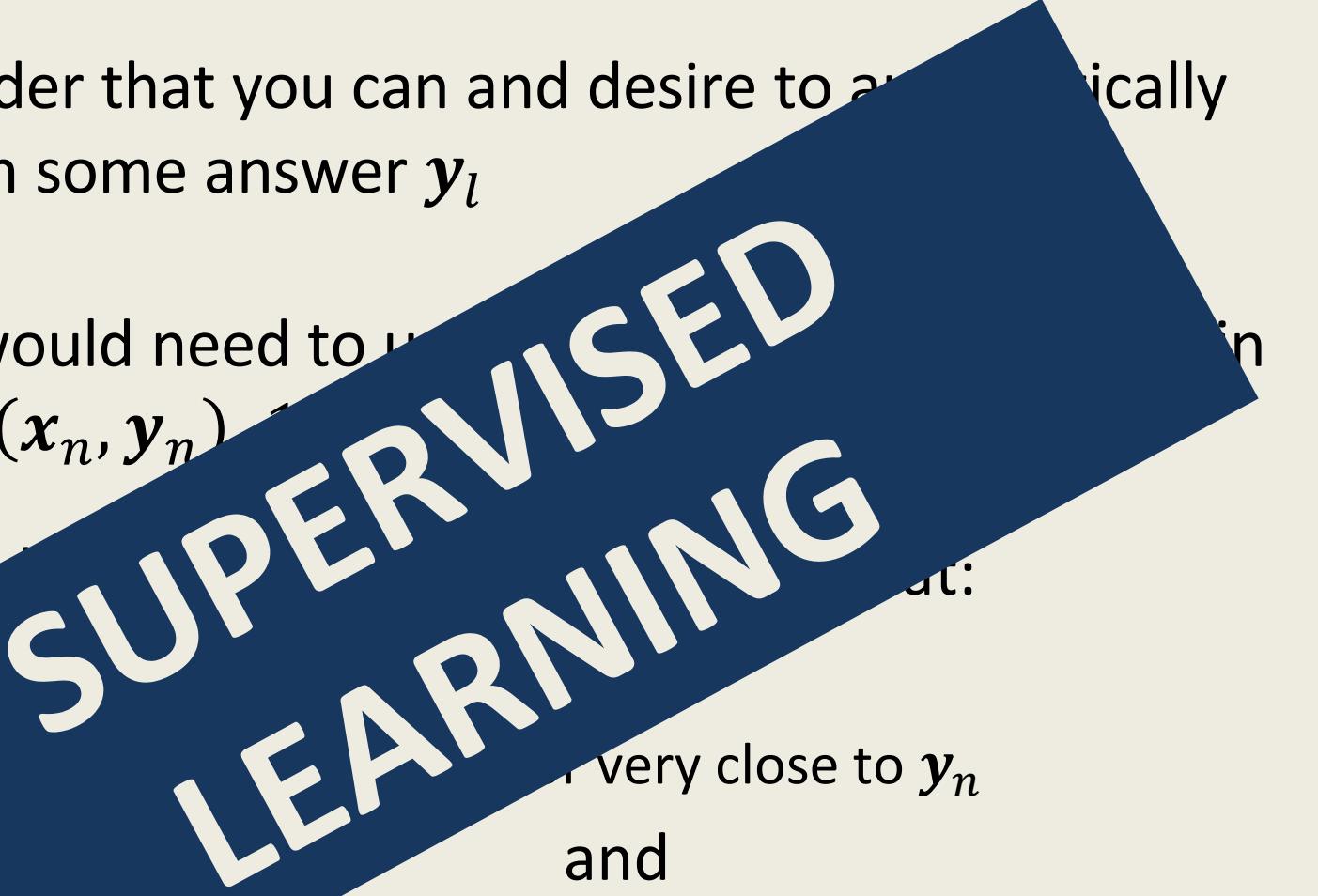
Training data – Data used to train a model

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 automatically obtain some answer y_l
 - You would need to have training pairs (x_n, y_n) for $n = 1, \dots, N$ to find a function that:
 - very close to y_n
 - and
- generalizable** beyond the training data
i.e. $y_m(x_m) = \hat{y}_m \approx y_m$ where x_m is not part of the set $\{x_n\}_{n=1}^N$
- 

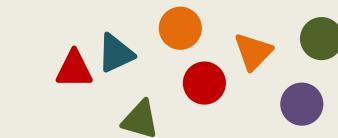
Types of learning

- 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

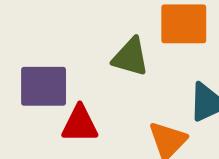
Triangles



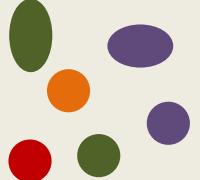
Circles



non-curved shapes

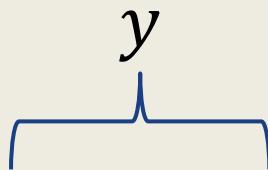


curved shapes



Supervised learning – Regression

Regression – output y_n is real valued or continuous



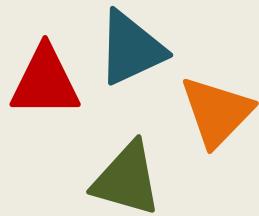
Temperature (°C)	Relative humidity (%)	Wind speed (km/h)	Rain (mm)	Fire weather index
23	21	10	0	0
40	89	6	1	30
35	60	23	15	15

Supervised learning – Classification

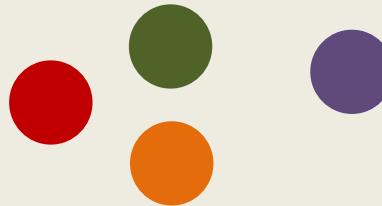
Classification – output y_n is categorical or ordinal

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

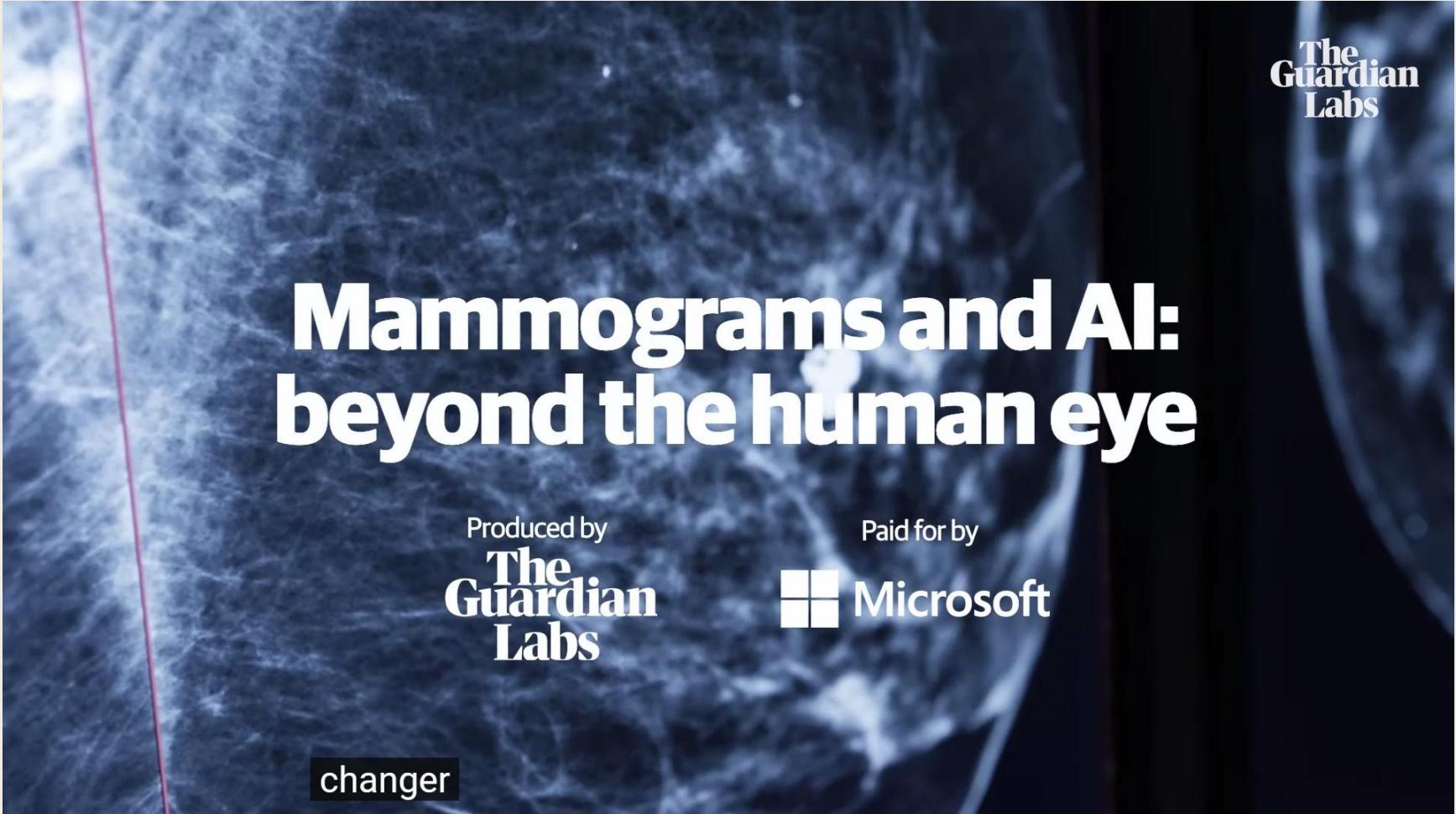
Bosch Dryad: Dissect

- 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

A close-up, high-contrast image of a mammogram, showing dense tissue and potential abnormalities in shades of blue and white.

The
Guardian
Labs

Mammograms and AI: beyond the human eye

Produced by

The
Guardian
Labs

changer

Paid for by

 Microsoft

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



**Hi, I'm Copilot.
Your AI companion**

Get started →

[Privacy](#) [Terms](#) [FAQ](#)

Natural language processing
[\(https://copilot.microsoft.com/\)](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



ML for banking and finance



Security + fraud prevention

From online shopping to in-store purchases, Visa has you covered—ensuring that your transactions are secure.

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

Google



Transport
for London

virgin
atlantic

BARCLAYS
CHASE



Cocado



amazon

Alibaba.com™



deliveroo

BBC

NETFLIX

gsk



facebook



Microsoft

SAMSUNG

zoom

intel®



NVIDIA®

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.

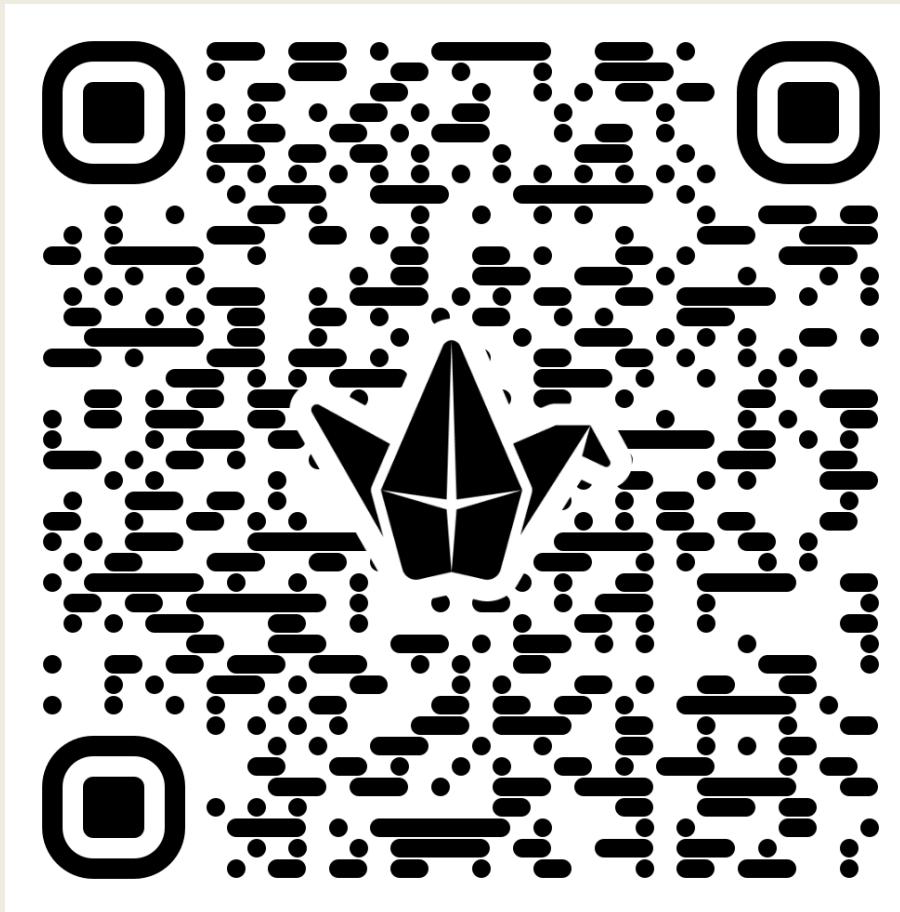
Machine learning also refers to the field of study concerned with these programs or systems.

See the [Introduction to Machine Learning](#) course for more information.

machine translation



Any questions???



scan the QR code to ask questions