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Introduction to Machine Learning

Foundations Course Winter Semester 2021

23rd September 2021

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What is Artificial Intelligence (AI)?

A revision from the previous session ….

Guessing time …. For AI!

Let’s play a game of Kahoot!

What is Machine Learning (ML)?

A new topic for today!!!

Guessing time …. For ML!

How about another game of Kahoot?

Machine learning

Figure 1: Applications of ML [1]

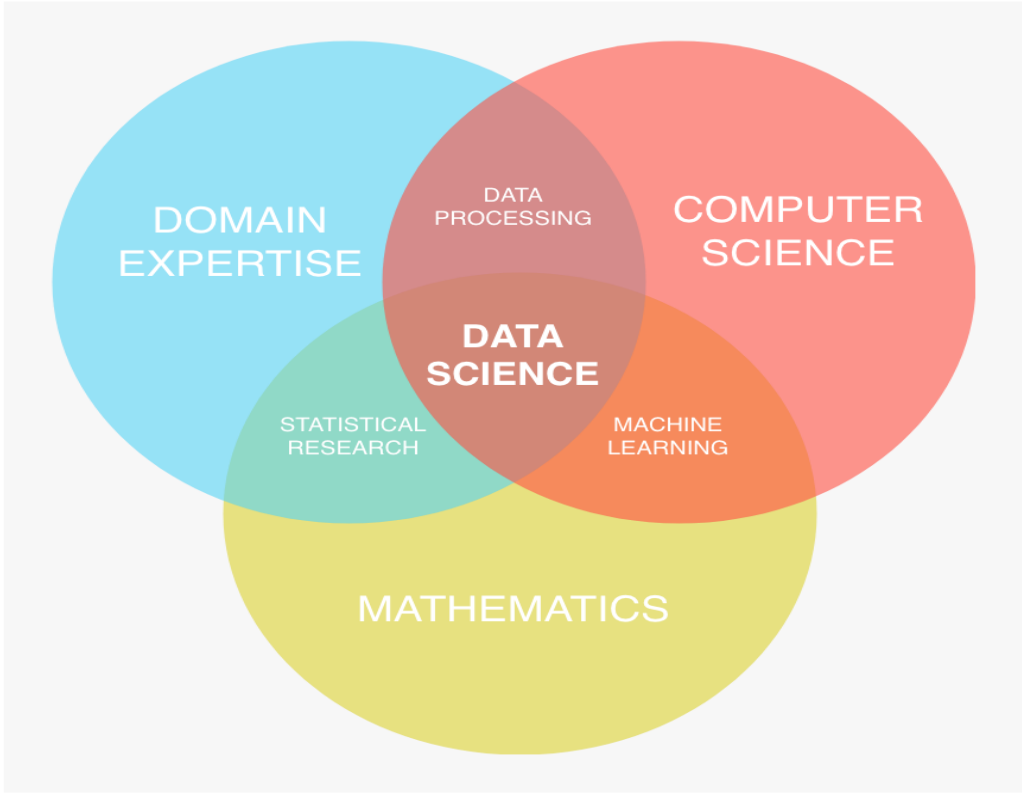


Figure 2: Overview of ML [2]

[1]https://swisscognitive.ch/2021/03/18/applications-of-machine-learning
[2] https://crate.io/a/machine-learning-cratedb-jupyter/

What is the difference between AI and ML?

Isn’t it the same?

AI vs ML

Formal definitions:

Artificial Intelligence…

Artificial intelligence (AI) is the ability of a computer or a robot controlled by a computer to do tasks that are usually done by humans because they require human intelligence and discernment [3].

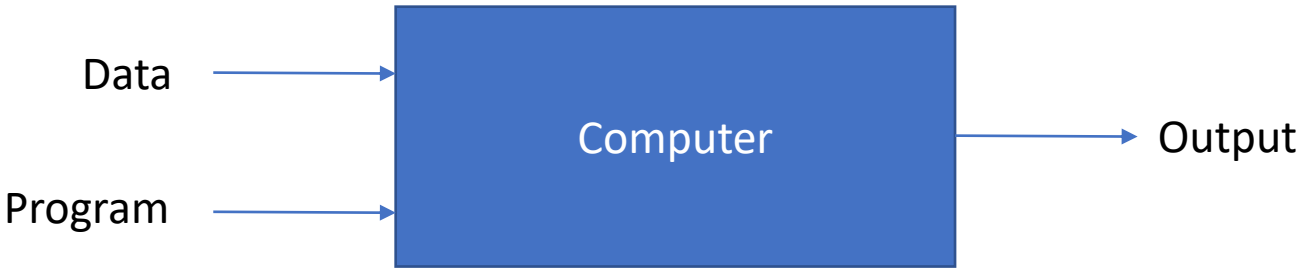
Machine Learning…

A machine is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E [4].

[3] https://www.aitimejournal.com/@nisha.arya.ahmed/what-is-artificial-intelligence-ai
[4] Mitchell, Tom. (1997). Machine Learning. McGraw Hill. p. 2. ISBN 0-07-042807-7.

Traditional programming vs ML

Traditional programming:



Machine learning:

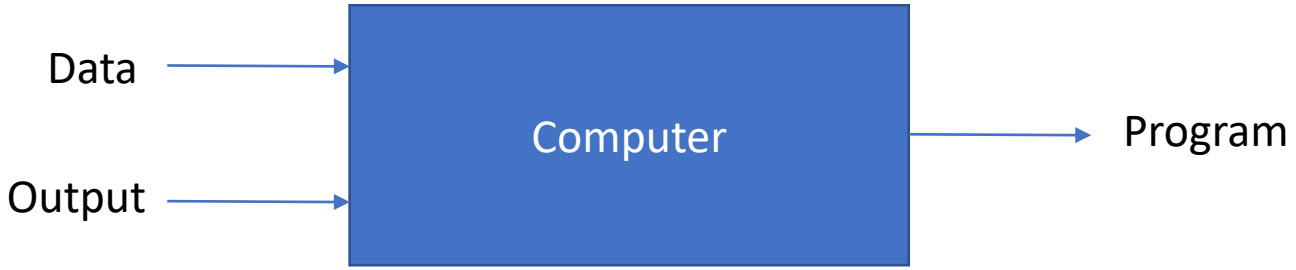


Figure 3: Traditional programming vs ML [5]

[5] Adapted from slides by Pedro Domingos

AI vs ML

In simple terms…

Artificial intelligence…
make intelligent systems that may or may not learn from data [6].

Machine learning…
make predictive systems that learn from data [6].

[6] https://brilliant.org/wiki/machine-learning/

AI vs ML

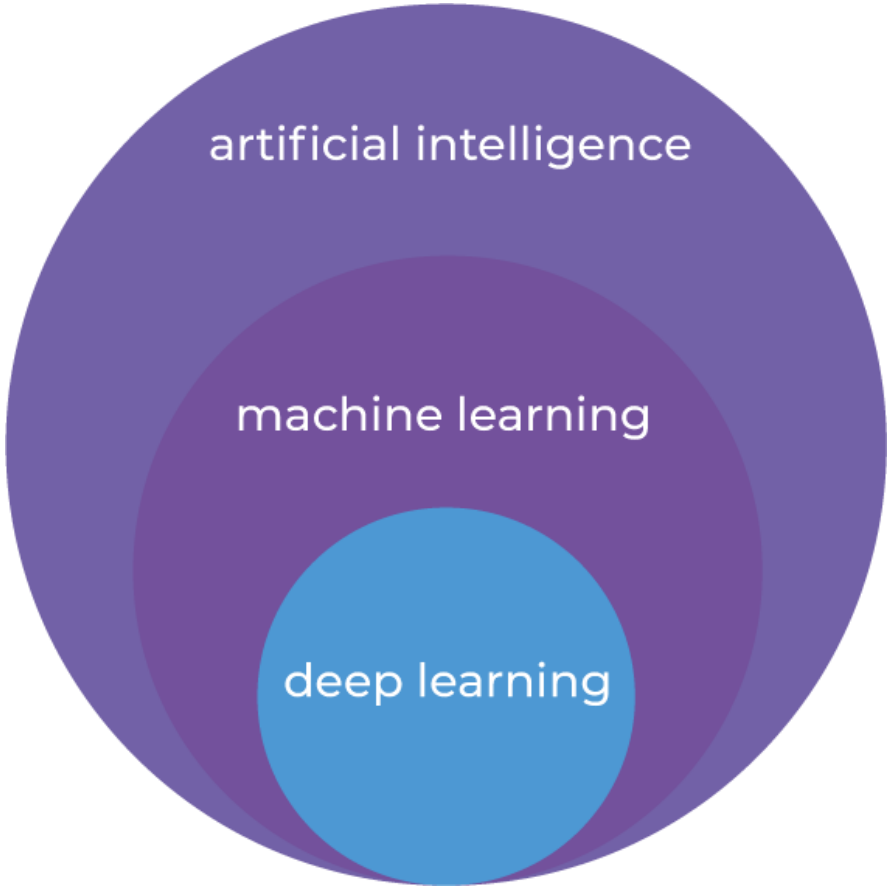


Figure 4: How AI and ML are related [7]

[7] https://neurospace.io/blog/2019/03/ai-and-ethics/

Are there multiple ML algorithms?

How can we classify them?

Exploring some ML algorithms…

Classifying algorithms based on how they learn:

- Supervised learning
- Unsupervised learning
- Reinforcement learning

Some other ML algorithms we will touch upon today:

- Artificial neural networks
- Deep learning algorithms

Machine Learning Paradigms

Grouping ML algorithms by learning technique

Supervised Learning

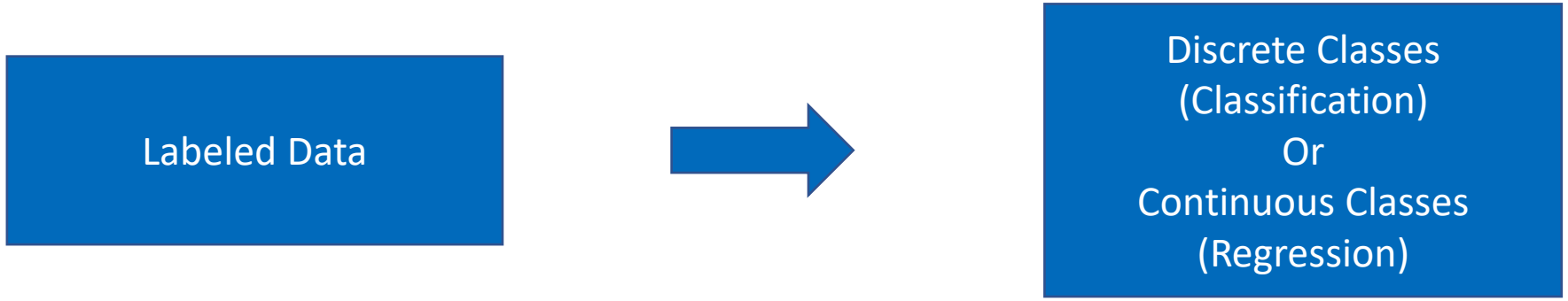


Figure 5: Overview of supervised learning [8]

[8] Adapted from "Machine Learning 10-401, Spring 2018" by Maria-Florina (Nina) Balcan

Supervised Learning

Time for some examples!

Supervised Learning – Example of Labeling

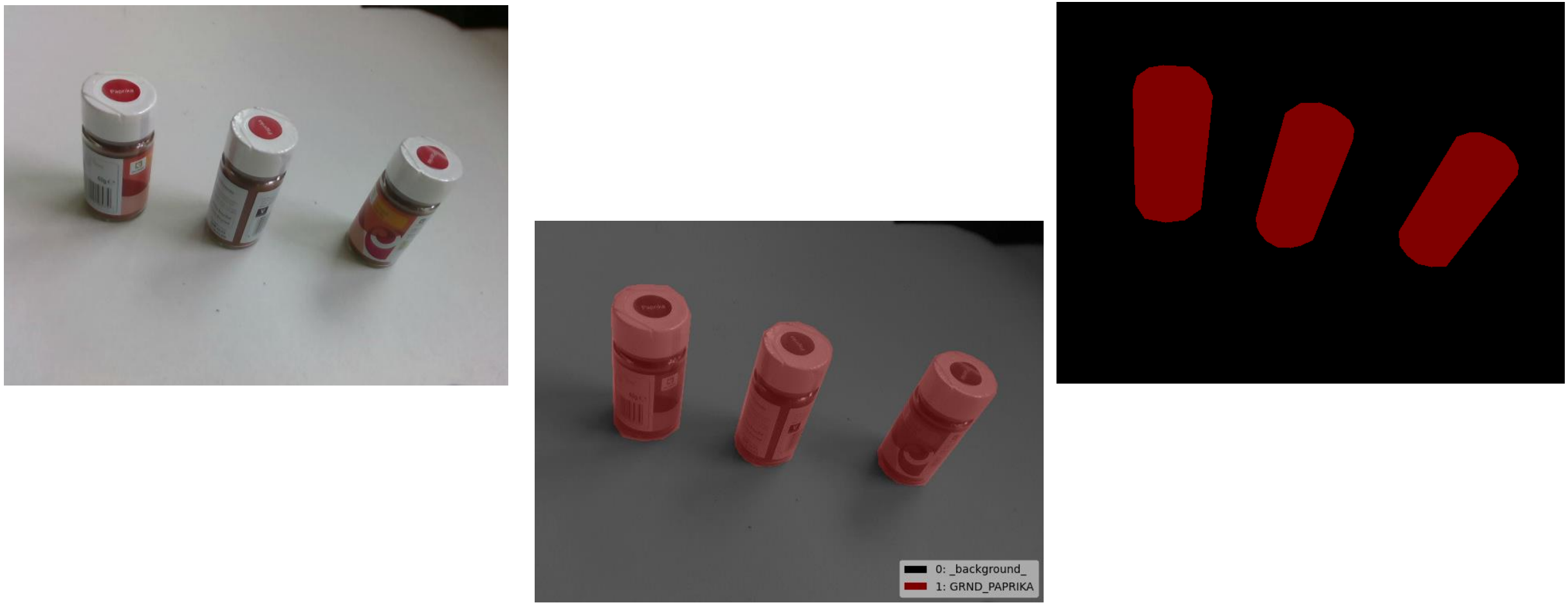


Figure 6: Supervised learning – labeled data – RoboCup@Work

Supervised Learning - Classification

Examples:

- 1. Spam detection

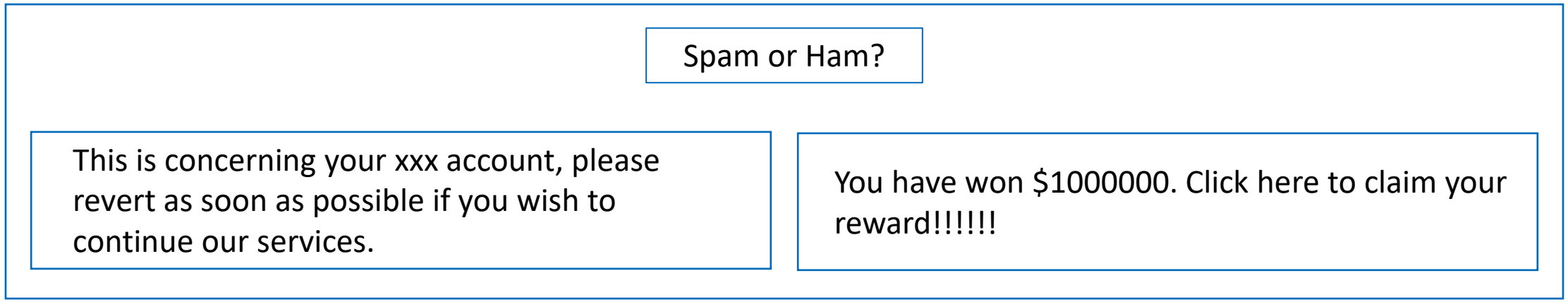


Figure 7: Spam email classification [9]

[9] Adapted from "Machine Learning 10-401, Spring 2018" by Maria-Florina (Nina) Balcan

Supervised Learning - Classification

Examples:

- 1. Spam detection

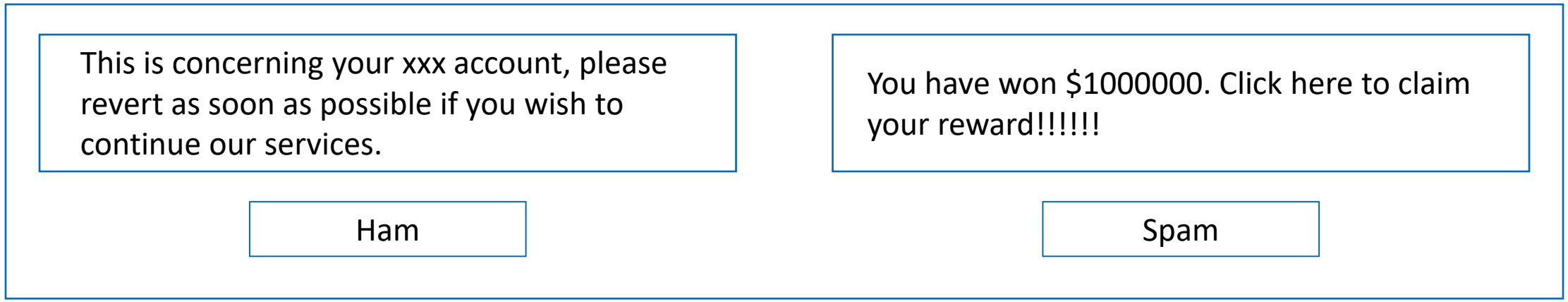


Figure 7: Spam email classification [9]

[9] Adapted from "Machine Learning 10-401, Spring 2018" by Maria-Florina (Nina) Balcan

Supervised Learning - Classification

Examples:

- 1. Spam detection

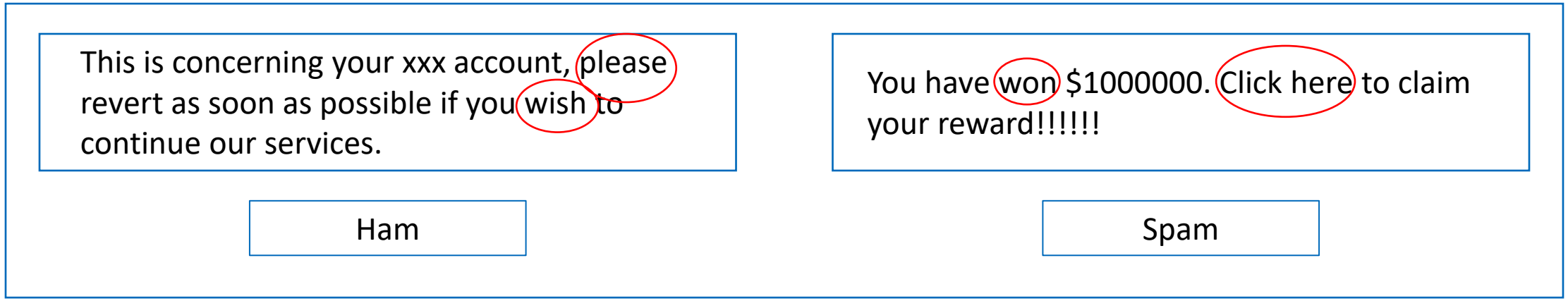


Figure 7: Spam email classification [9]

[9] Adapted from "Machine Learning 10-401, Spring 2018" by Maria-Florina (Nina) Balcan

Supervised Learning - Classification

Examples:

- 1. Spam detection

Steps involved in spam detection:

a. Create classes (spam or ham)
b. Represent each message by features (keywords, spelling, etc.)
c. Create reasonable rules.

Supervised Learning - Classification

Examples:

1. Spam detection
2. Image classification

Example for image classification

Follow this link

Supervised Learning - Regression

Example:

1. Predicting the temperature

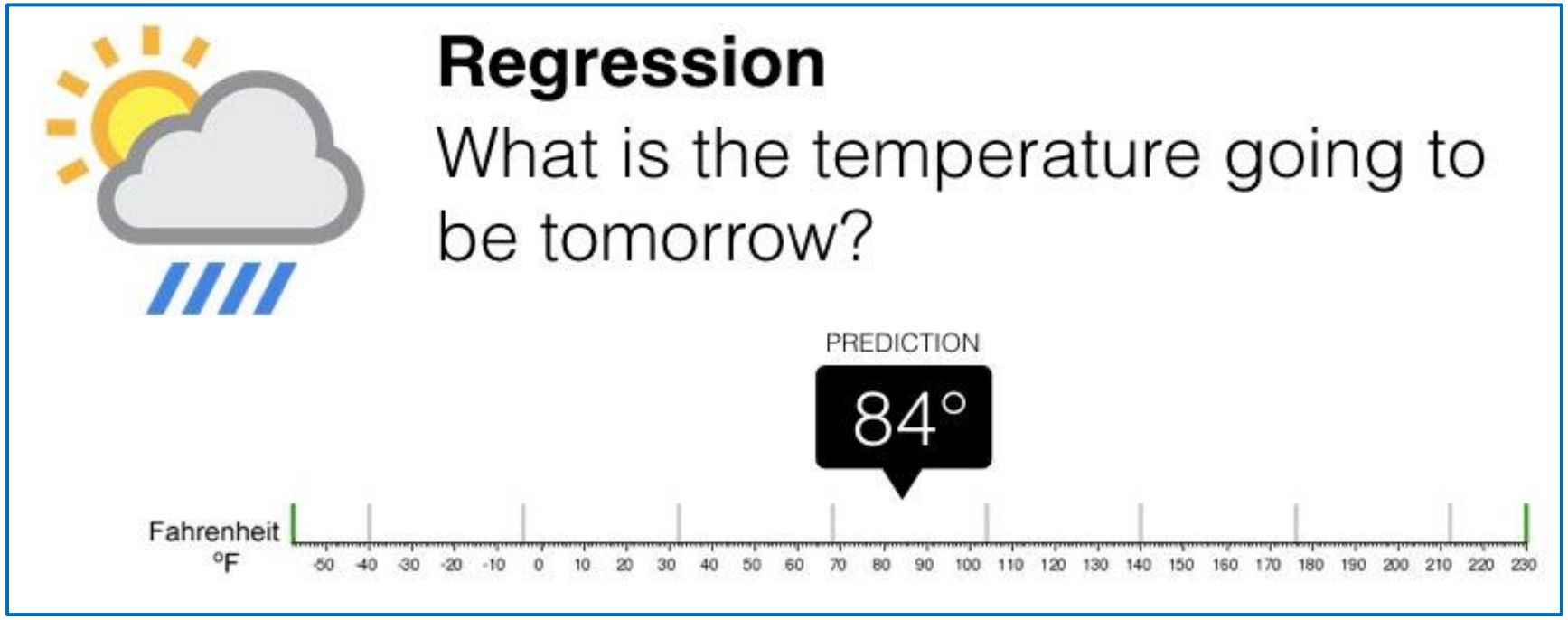


Figure 8: Predicting the temperature – regression example [10]

[10] https://in.springboard.com/blog/regression-vs-classification-in-machine-learning/

Unsupervised Learning

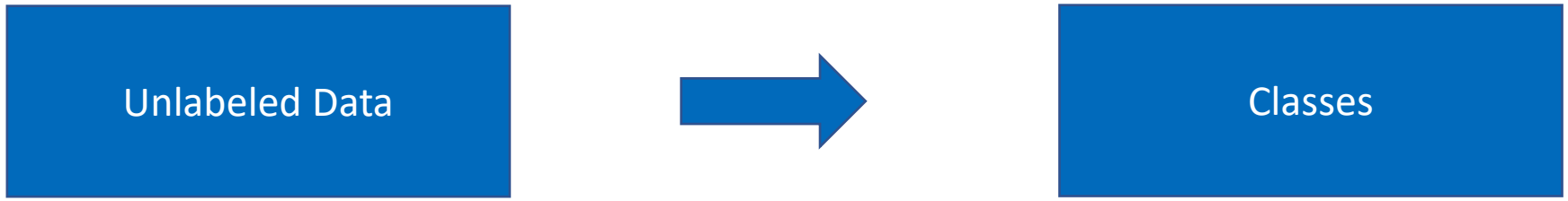


Figure 9: Overview of unsupervised learning [8]

[8] Adapted from "Machine Learning 10-401, Spring 2018" by Maria-Florina (Nina) Balcan

Unsupervised Learning

Time for some examples!

Unsupervised Learning - Clustering

Examples:

- 1. Customer segmentation

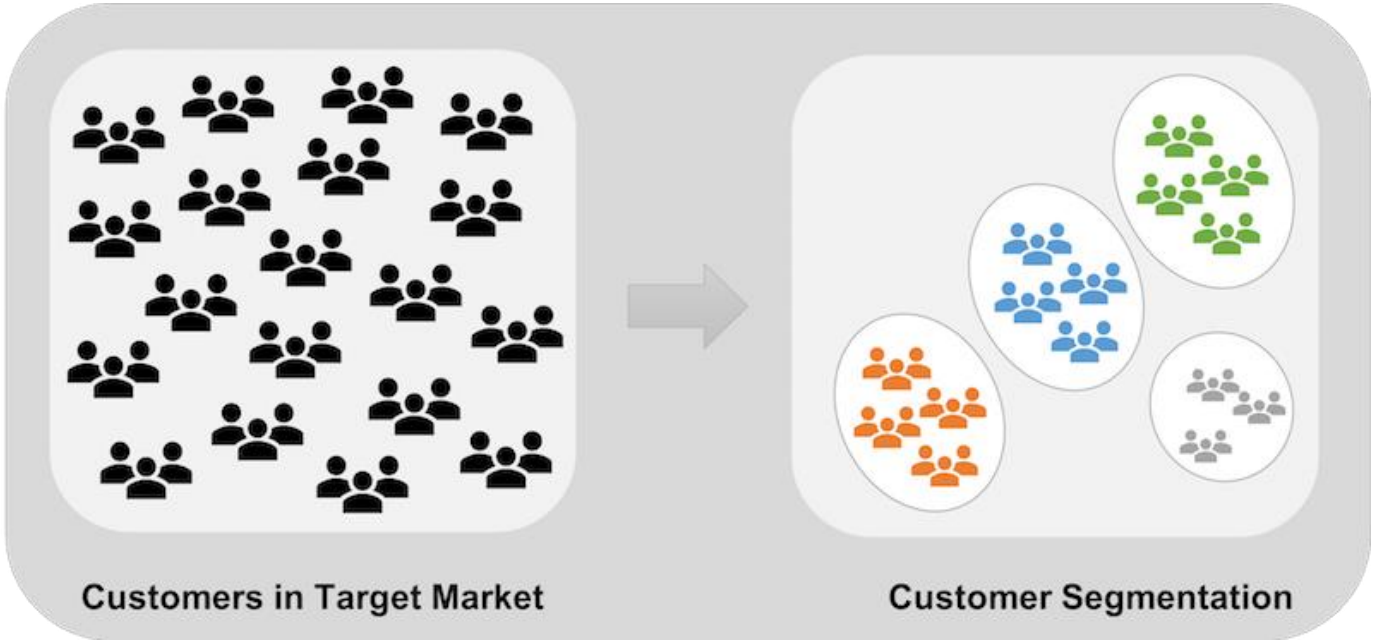


Figure 10: Clustering customers [11]

[11] https://datalya.com/customer-segmentation-services.php

Unsupervised Learning - Clustering

Examples:

1. Customer segmentation
2. Social network analysis

Figure 11: Analysis social connections

Unsupervised Learning – Anomaly Detection

Examples:
1. Golf cart – anomaly

Figure 12: Golf cart as an anomaly [12]

[12] https://towardsdatascience.com/prototyping-an-anomaly-detection-system-for-videos-step-by-step-using-lstm-convolutional-4e06b7dcdd29

Unsupervised Learning – Anomaly Detection

Examples:

1. Golf cart
2. Credit card fraud detection

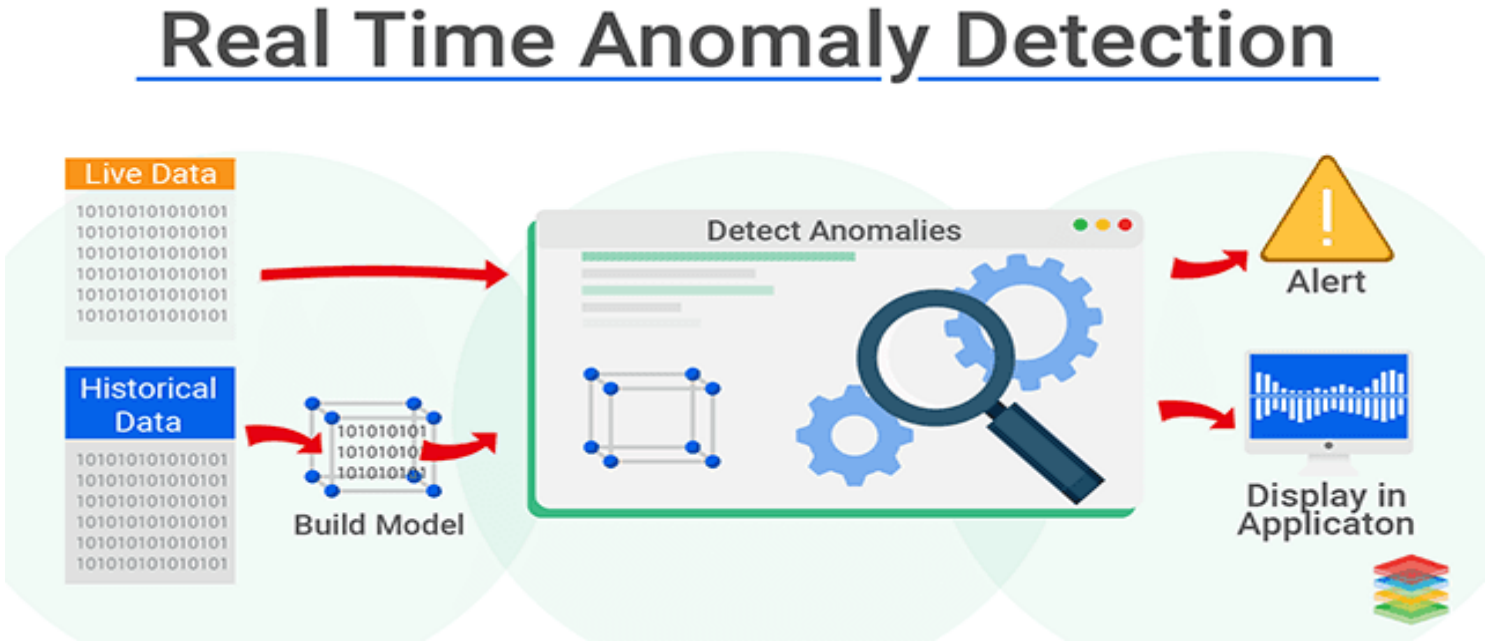


Figure 13: Credit card fraud detection [13]

[13] https://www.xenonstack.com/blog/real-time-anomaly-detection

Reinforcement Learning

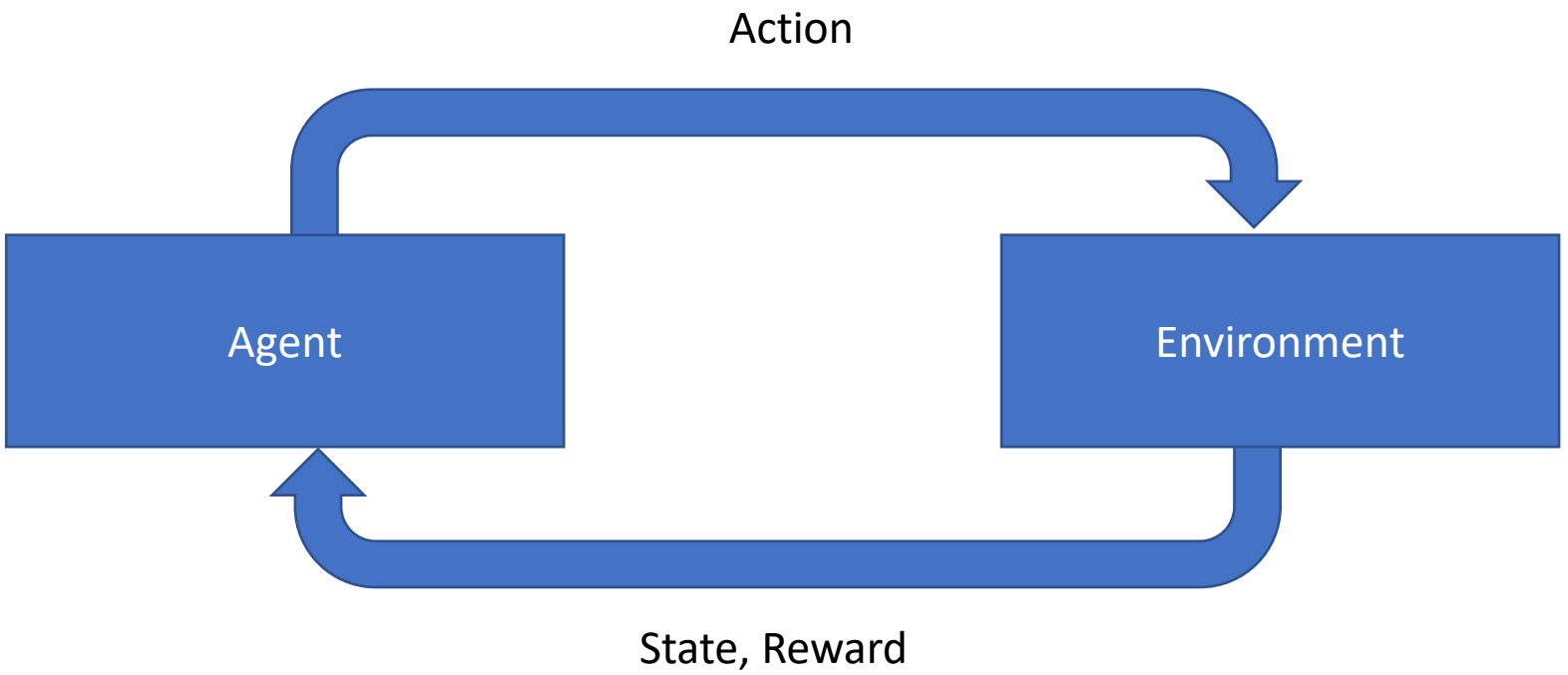


Figure 14: Overview of reinforcement learning [8]

[8] Adapted from "Machine Learning 10-401, Spring 2018" byMaria-Florina (Nina) Balcan

Reinforcement Learning

Time for some examples!

Reinforcement Learning

Video 1: Deep Q Learning - reinforcement learning example [8]

[8] Adapted from "Machine Learning 10-401, Spring 2018" byMaria-Florina (Nina) Balcan

A bit more about Machine Learning

Exploring the basics of neural networks!

Neural Networks

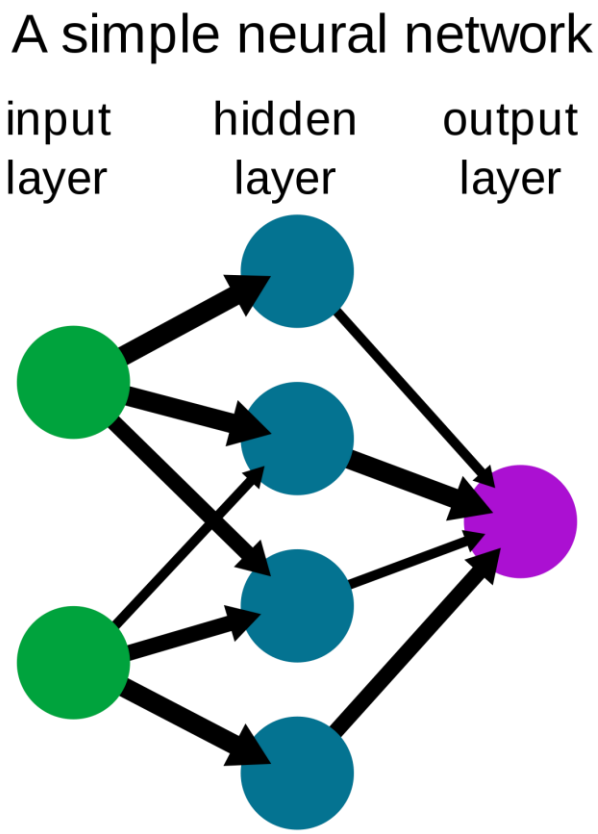


Figure 15: Structure of neural networks [14]

[14] https://en.wikipedia.org/wiki/Neural_network/

Let’s train a Neural Networks model!

Open this link in your browser!

Deep Neural Networks

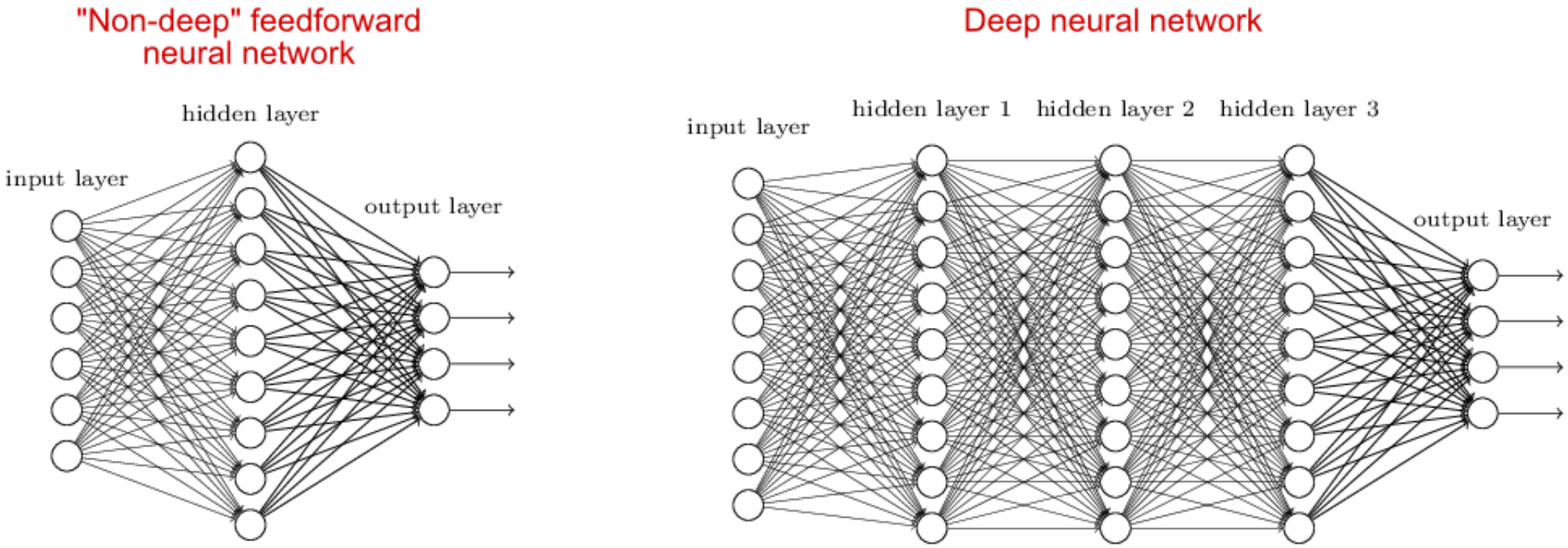


Figure 16: Structure of deep neural networks [15]

[15] https://stats.stackexchange.com/a/184921

Tools and Frameworks for ML

A quick overview

Frameworks and Tools for ML

- Programming languages
  - Python
  - R
  - C++
  - …
- Machine learning libraries:
  - scikit-learn - For Classical ML
  - PyTorch
  - TensorFlow
  - Keras
  - For Deep Learning
  - ⋮
- Data visualization:
  - Matplotlib
  - Seaborn
  - plotly
  - …
- Data loading/pre-processing
  - numpy
  - pandas
  - ⋮

List 1: Some useful tools for machine learning [16]

[16] Adapted from "Introduction to machine learning/AI" byGeert Jan Bex, Jan Ooghe, Ehsan Moravveji

What are the limitations?

Or are there any?

Data hungry models

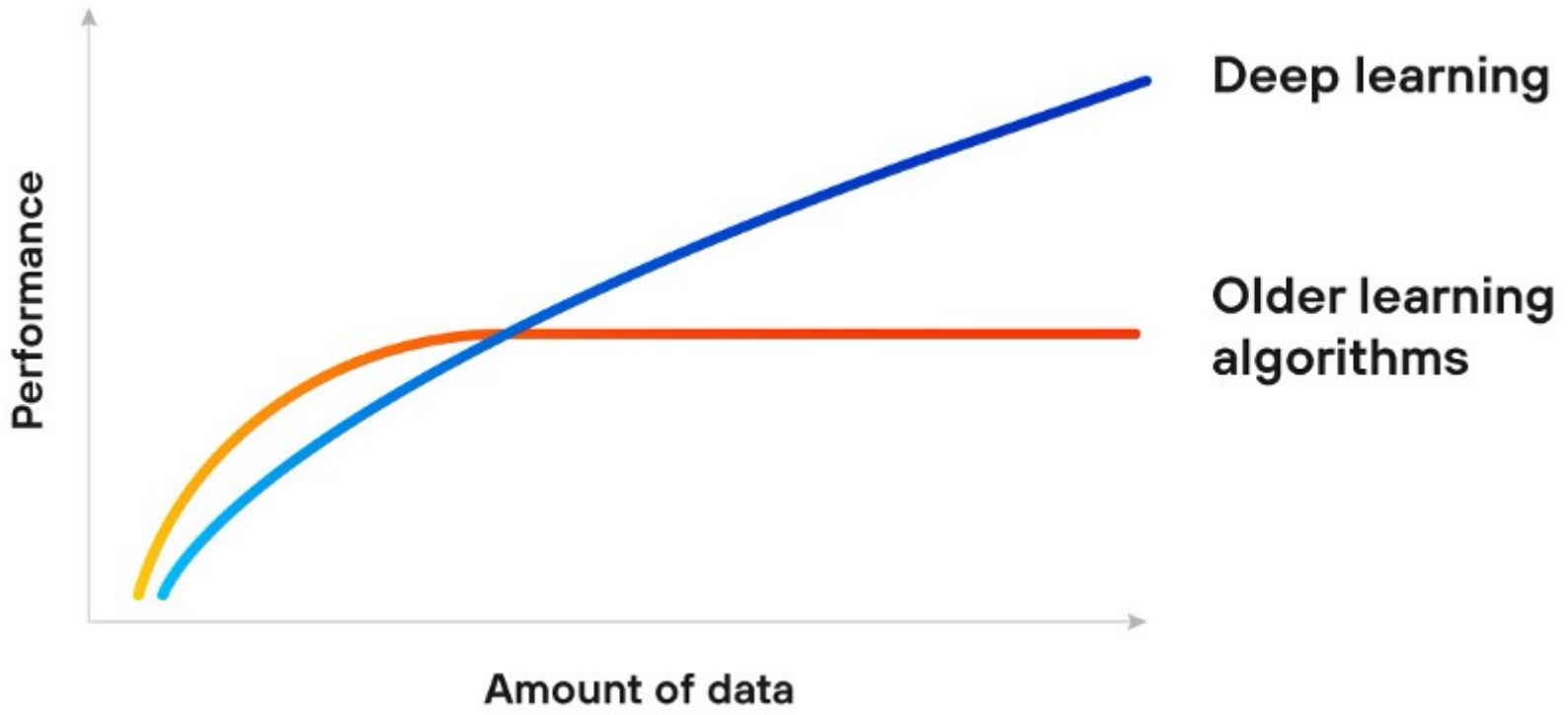


Figure 17: Huge volume of data – deep learning [17]

[17] https://towardsdatascience.com/is-deep-learning-hitting-the-wall-d2f560419daf

Narrow vs General AI

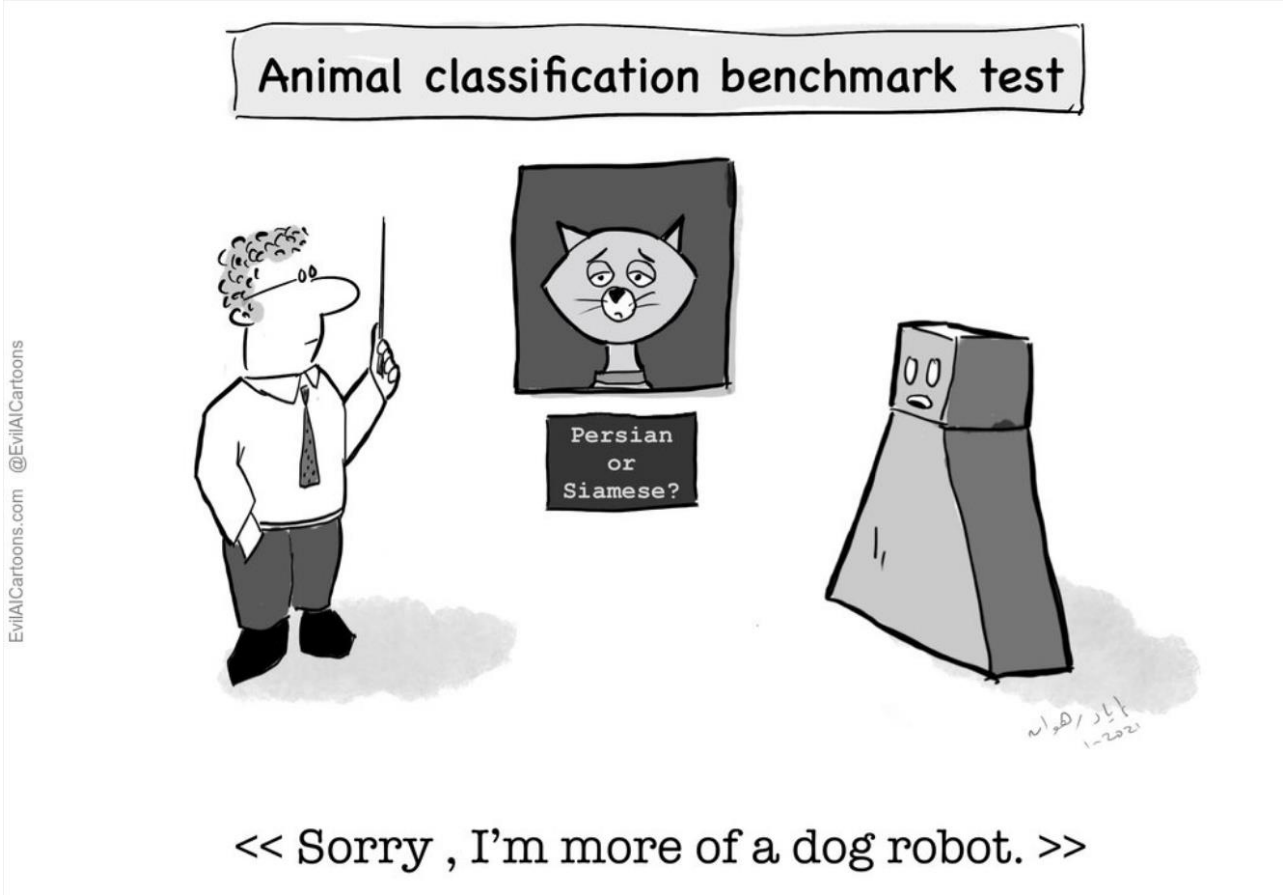
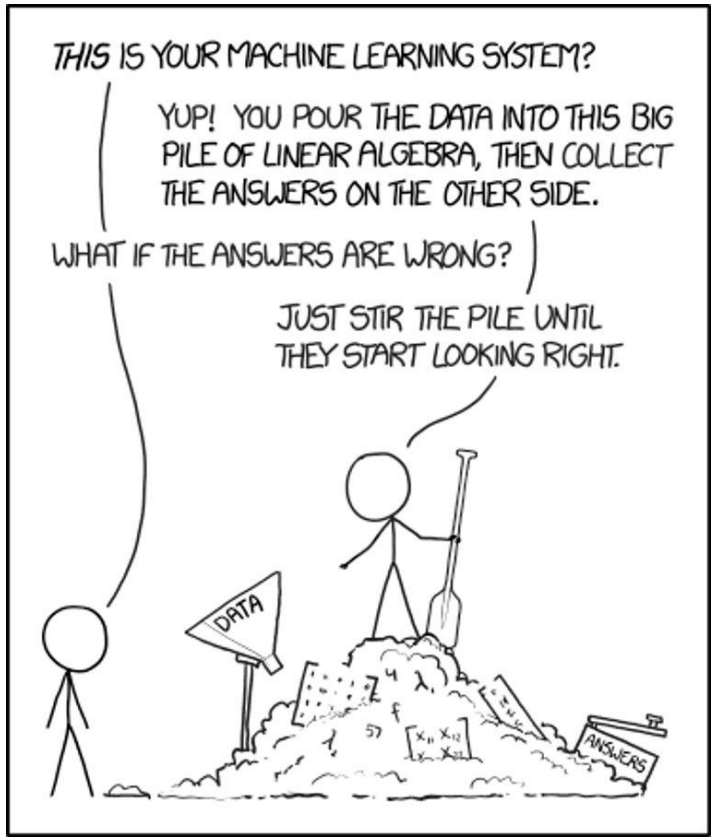
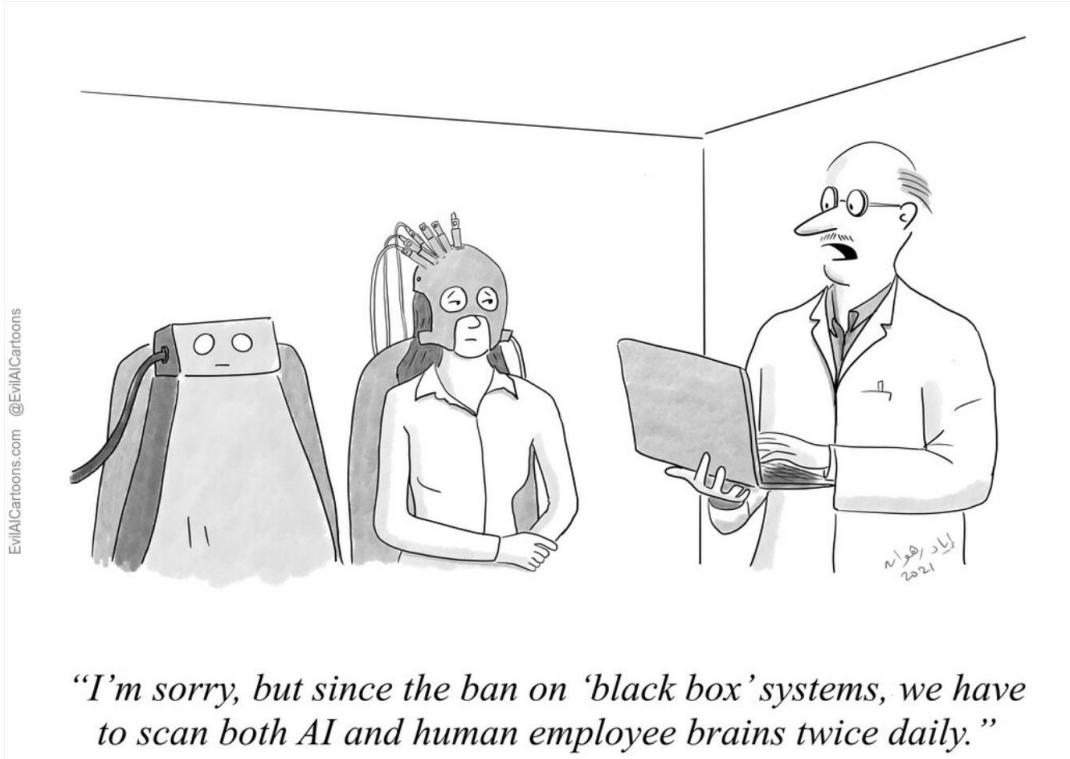


Figure 18: Limiting models to specific tasks [18]

[18] https://www.evilaicartoons.com/archive/terminology-narrow-vs-general-ai/

ML as a Black Box





"I'm sorry, but since the ban on 'black box' systems, we have to scan both AI and human employee brains twice daily."

Figure 19: Machine learning as a black box [19] [20]

[19] https://www.evilaicartoons.com/archive/terminology-black-box
[20] https://xkcd.com/1838/

Ethics & AI

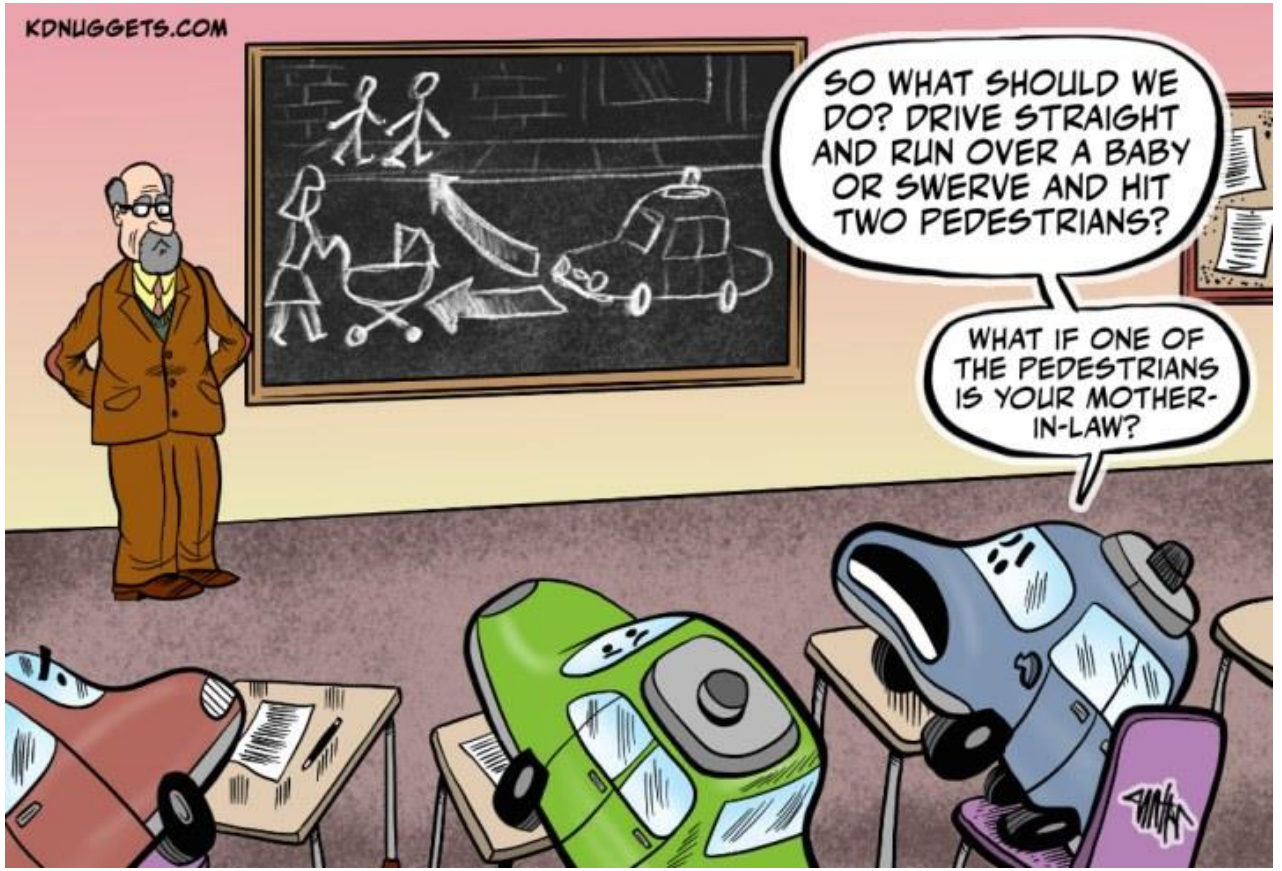


Figure 20: Creating ethical models [21]

[21] https://www.kdnuggets.com/2020/01/cartoon-teaching-ethics-ai.html/

Some failures regarding ML projects

Such failures occur because you are …

- Asking the wrong question
- Trying to solve the wrong problem
- Not having enough data
- Not having the right data
- Having too much data
- Using the wrong tools
- Not having the right model
- ⋮

List 2: Common reasons for ML project failure [16]

[16] Adapted from "Introduction to machine learning/AI" byGeert Jan Bex, Jan Ooghe, Ehsan Moravveji

References (1/6)

[1] https://swisscognitive.ch/2021/03/18/applications-of-machine-learning

[2] https://crate.io/a/machine-learning-cratedb-jupyter/

[3] https://www.aitimejournal.com/@nisha.arya.ahmed/what-is-artificial-intelligence-ai

[4] Mitchell, Tom. (1997). Machine Learning. McGraw Hill. p. 2. ISBN 0-07-042807-7.

References (2/6)

[5] Adapted from slides by Pedro Domingos

[6] https://brilliant.org/wiki/machine-learning/

[7] https://neurospace.io/blog/2019/03/ai-and-ethics/

[8] Adapted from "Machine Learning 10-401, Spring 2018" by Maria-Florina (Nina) Balcan

References (3/6)

[9] Adapted from "Machine Learning 10-401, Spring 2018" by Maria-Florina (Nina) Balcan

[10] https://in.springboard.com/blog/regression-vs-classification-in-machine-learning/

[11] https://datalya.com/customer-segmentation-services.php

[12] https://towardsdatascience.com/prototyping-an-anomaly-detection-system-for-videos-step-by-step-using-lstm-convolutional-4e06b7dcdd29

References (4/6)

[13] https://www.xenonstack.com/blog/real-time-anomaly-detection

[14] https://en.wikipedia.org/wiki/Neural_network/

[15] https://stats.stackexchange.com/a/184921

[16] Adapted from "Introduction to machine learning/AI" by Geert Jan Bex, Jan Ooghe, Ehsan Moravveji

References (5/6)

[17] https://towardsdatascience.com/is-deep-learning-hitting-the-wall-d2f560419daf

[18] https://www.evilaicartoons.com/archive/terminology-narrow-vs-general-ai/

[19] https://www.evilaicartoons.com/archive/terminology-black-box

[20] https://xkcd.com/1838/

References (6/6)

[21] https://www.kdnuggets.com/2020/01/cartoon-teaching-ethics-ai.html/

Further Reading(s)