

Chapter 1: The AI Landscape

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Programmers House

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What is AI?

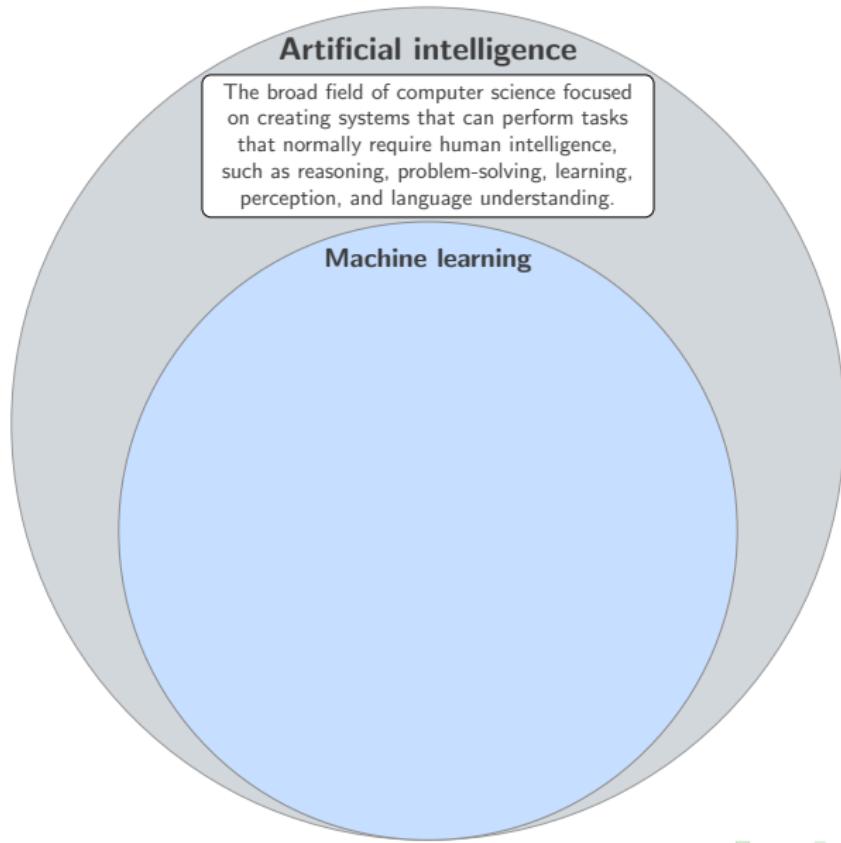
Artificial intelligence

What is AI?

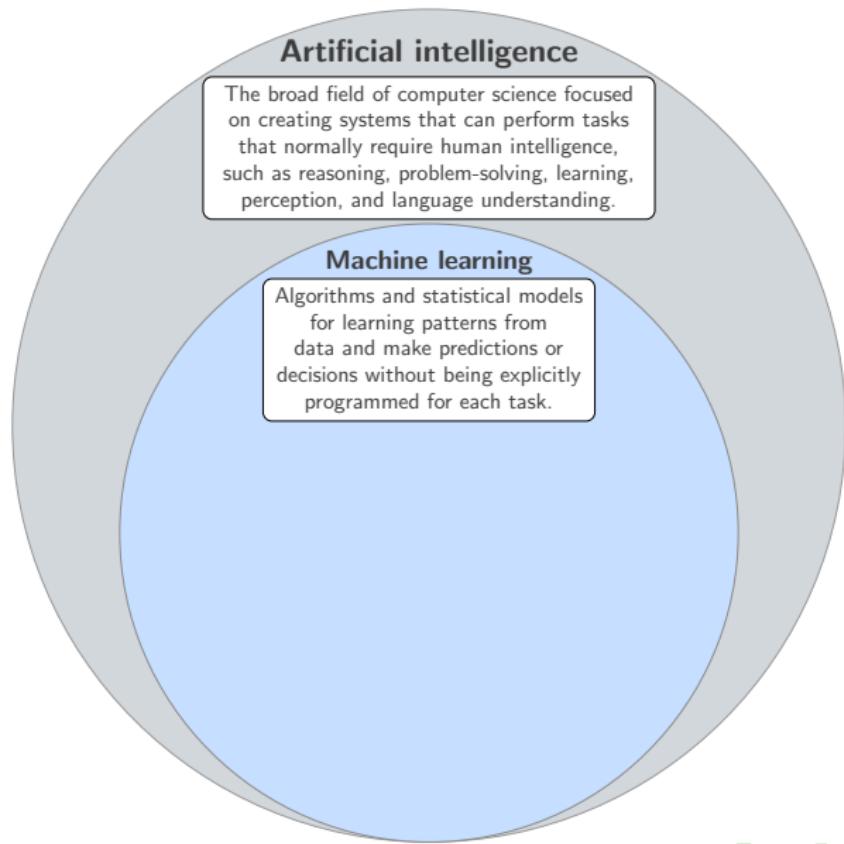
Artificial intelligence

The broad field of computer science focused on creating systems that can perform tasks that normally require human intelligence, such as reasoning, problem-solving, learning, perception, and language understanding.

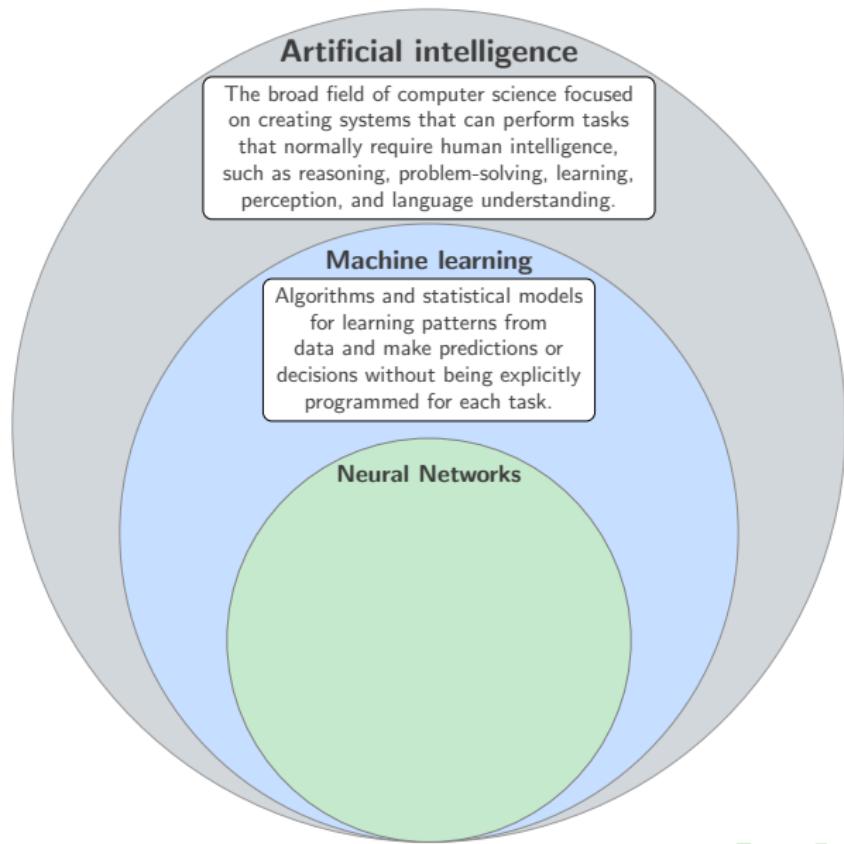
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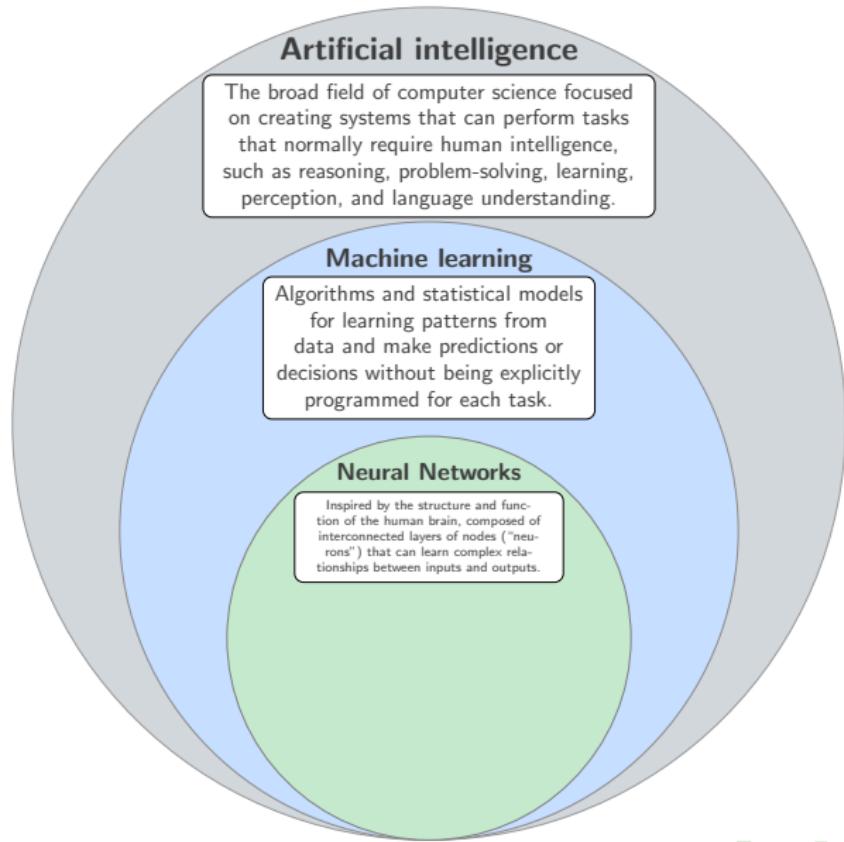
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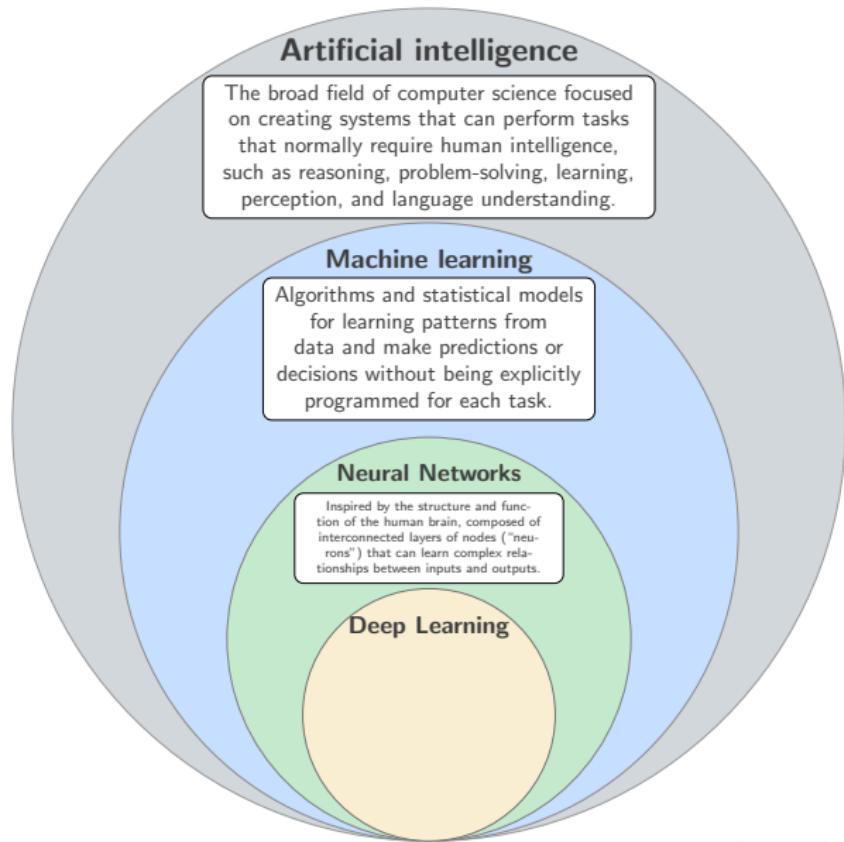
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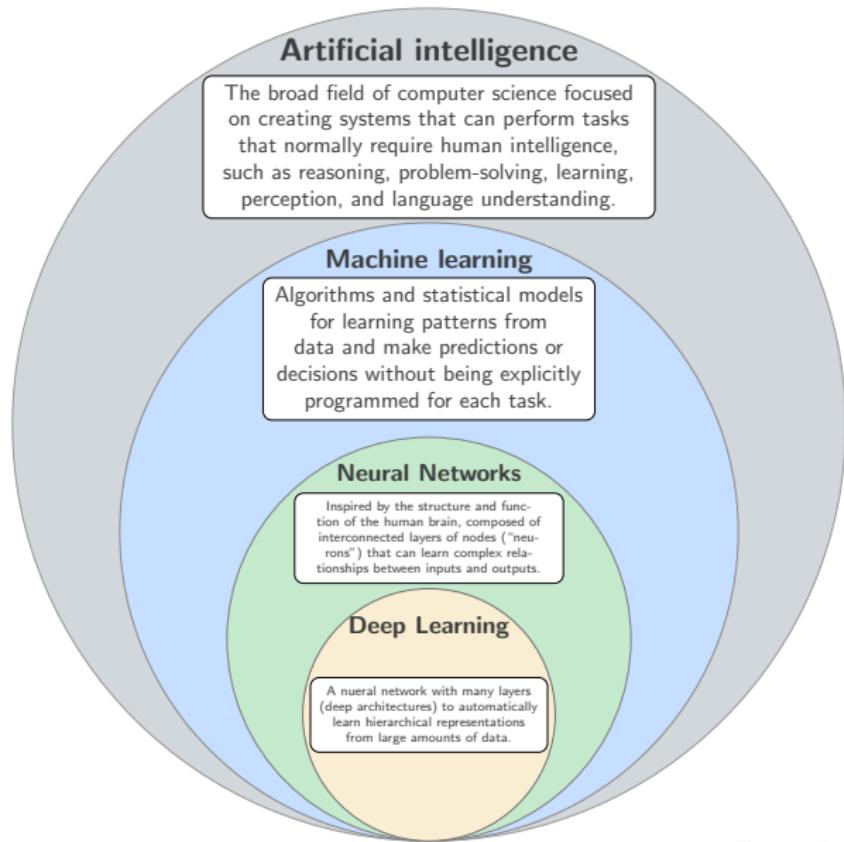
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What is AI?



Quick Quiz — The Big Picture

Which relationship is correct?

(Hint: think nesting of circles)

- ① AI ⊂ ML ⊂ NN ⊂ DL
- ② ML ⊂ NN ⊂ DL ⊂ AI
- ③ DL ⊂ NN ⊂ ML ⊂ AI
- ④ NN ⊂ DL ⊂ ML ⊂ AI

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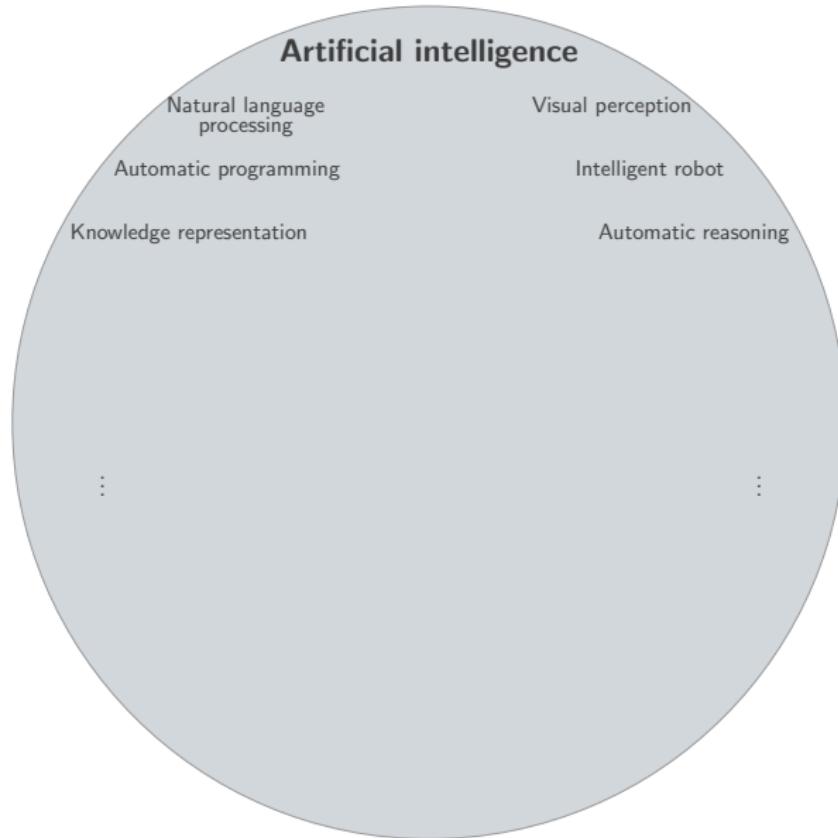
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Answer: (3) DL ⊂ NN ⊂ ML ⊂ AI.

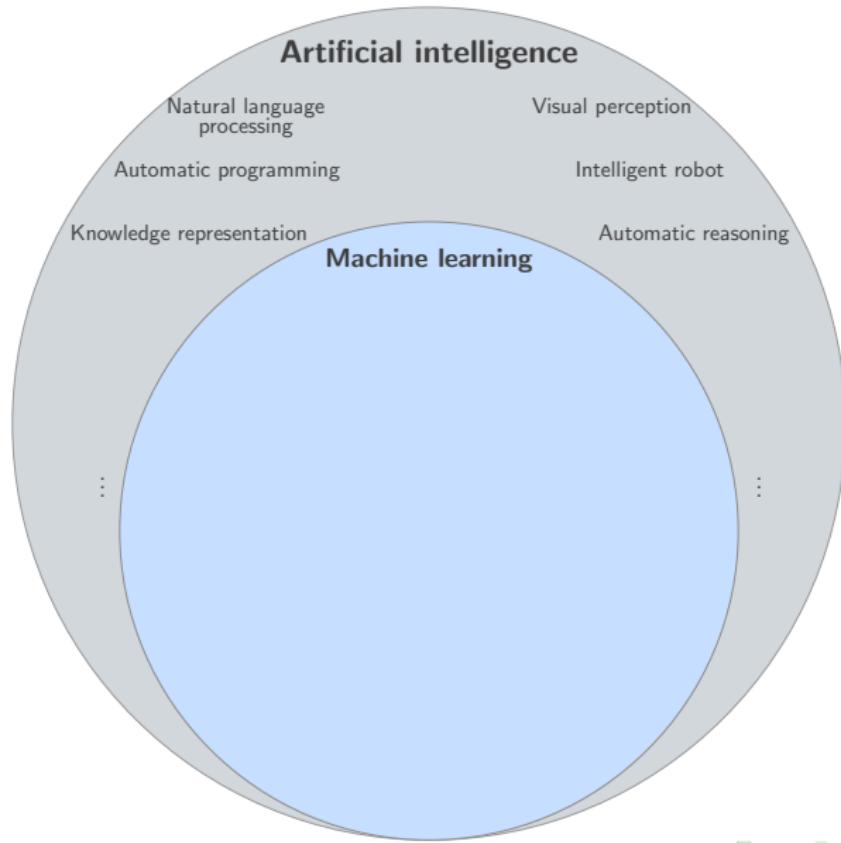
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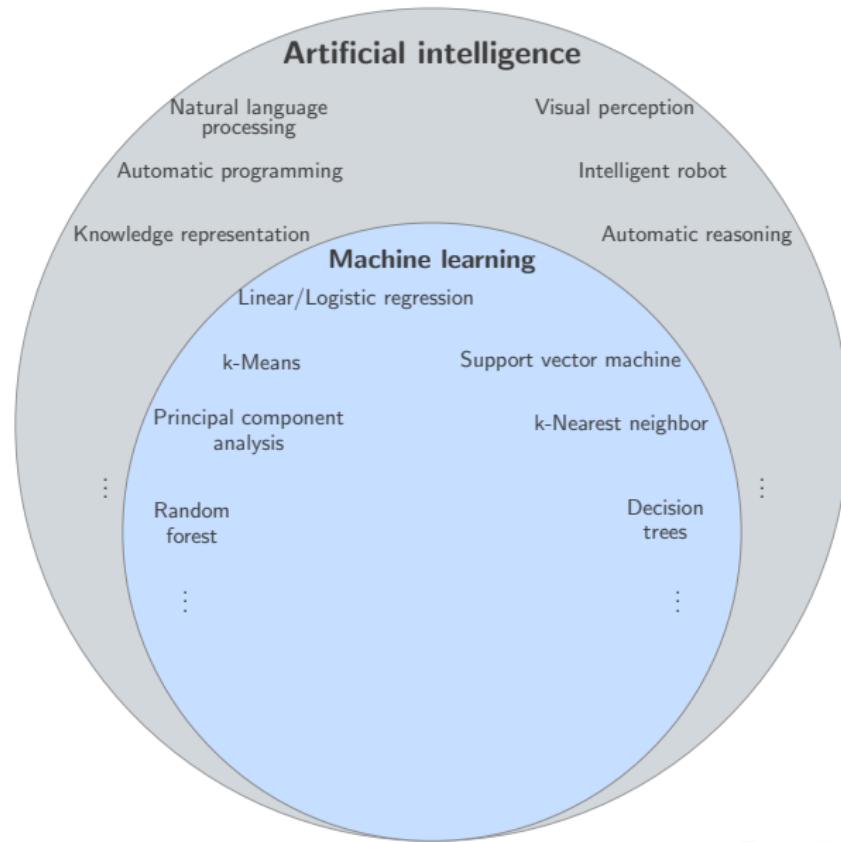
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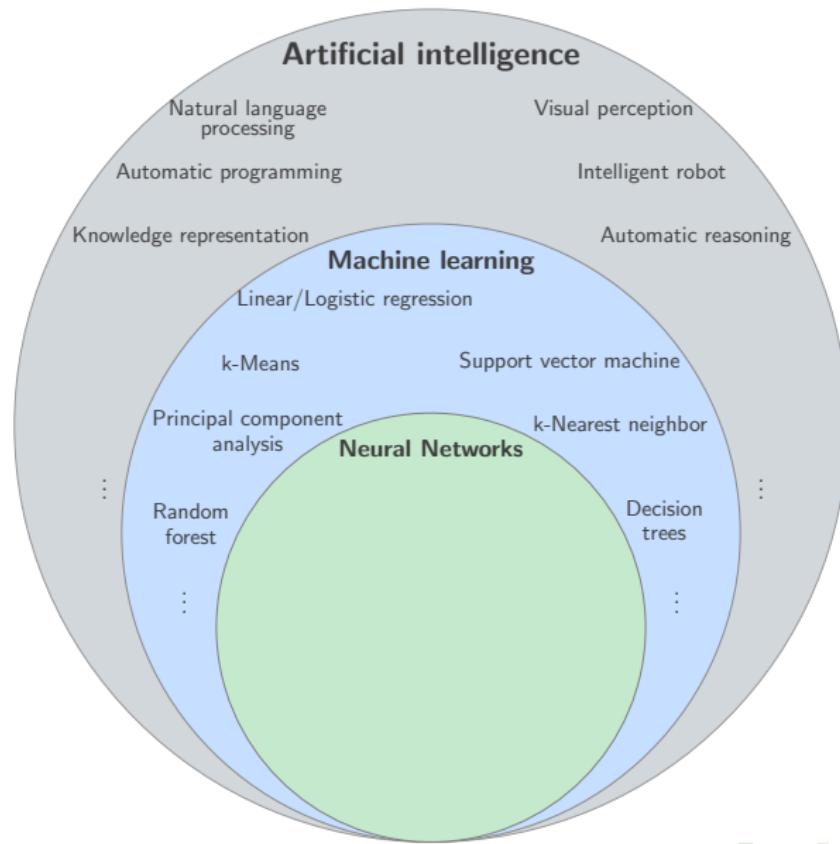
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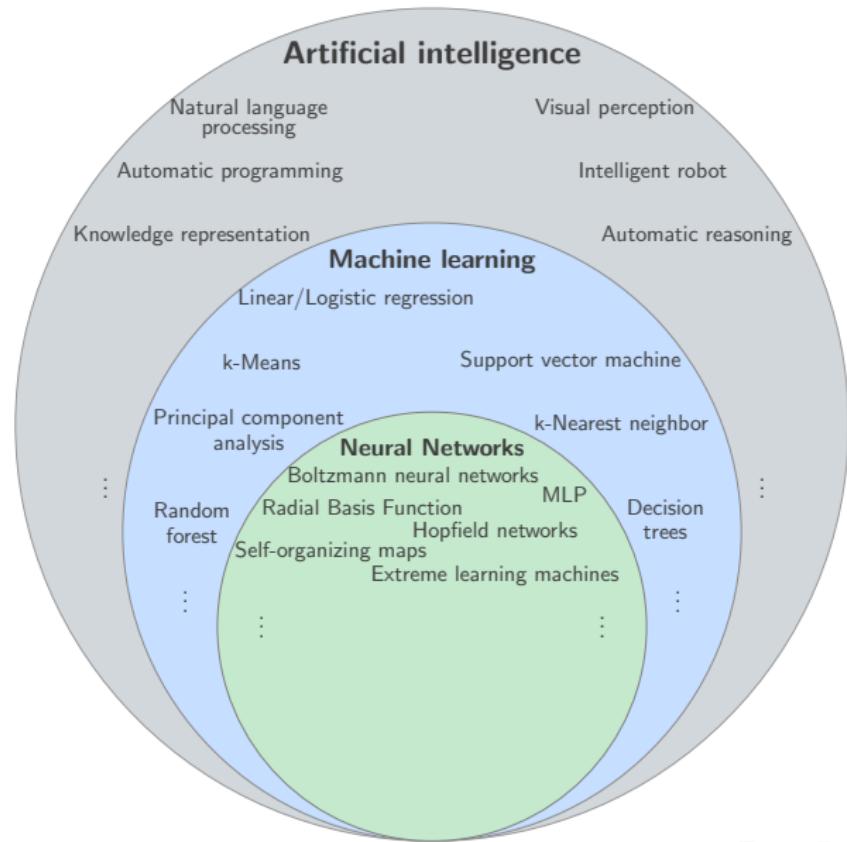
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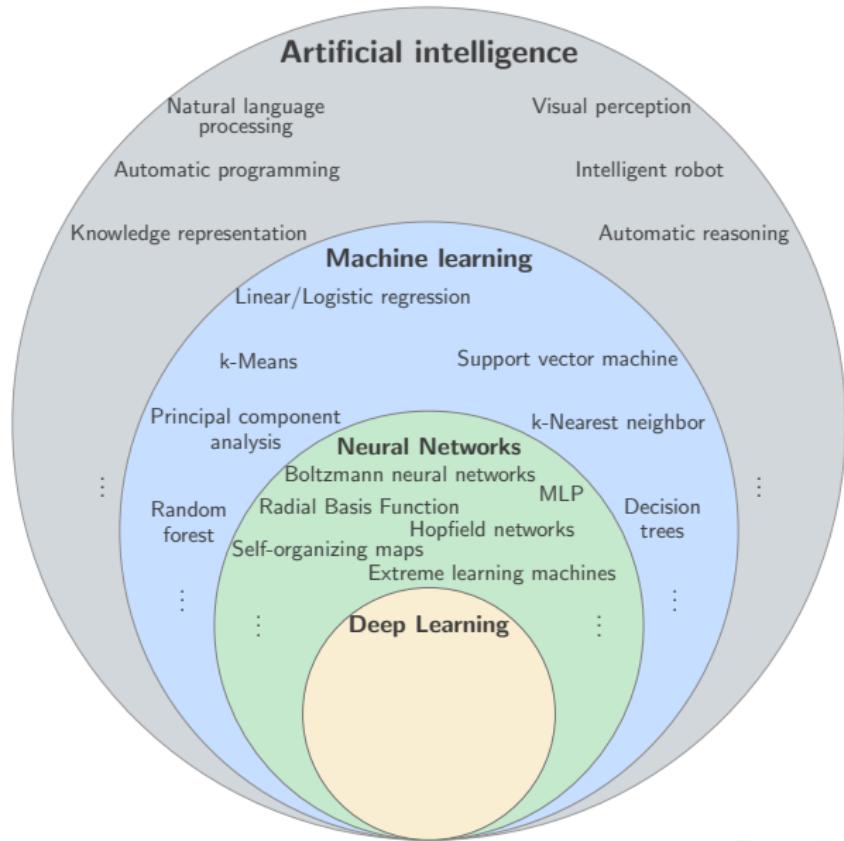
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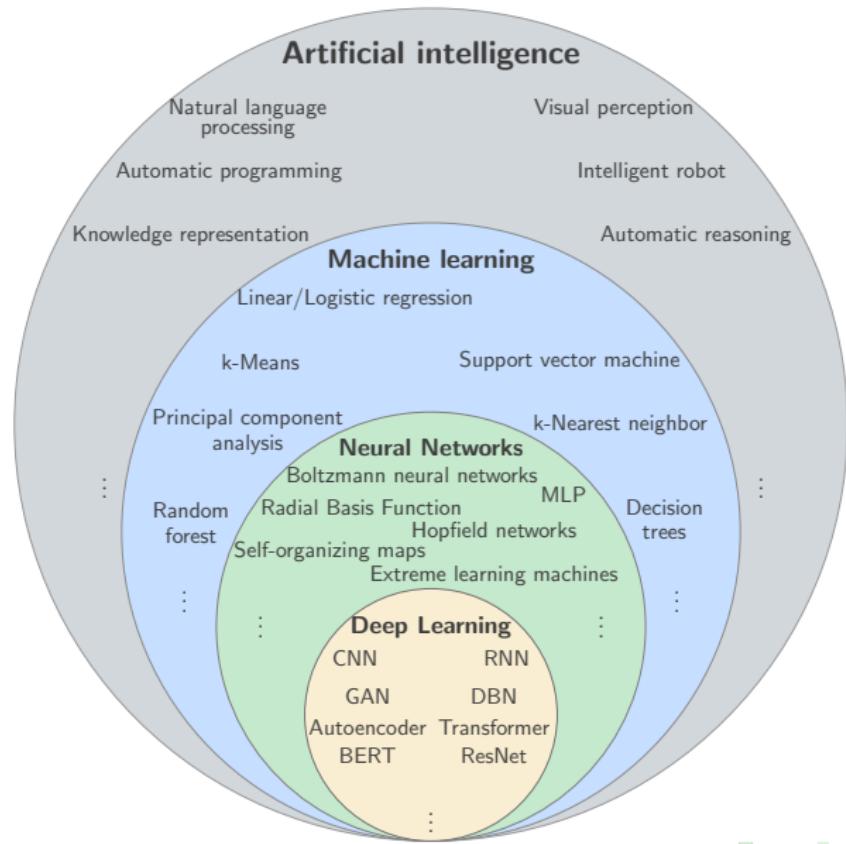
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What is AI?



What is AI?



Quick Quiz — Spot the Category

Which of the following is **not** typically a **deep learning** model?

- ① CNN
- ② Transformer
- ③ k-Means
- ④ Autoencoder

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Answer: (3) k-Means (unsupervised ML, not DL).

What is AI?

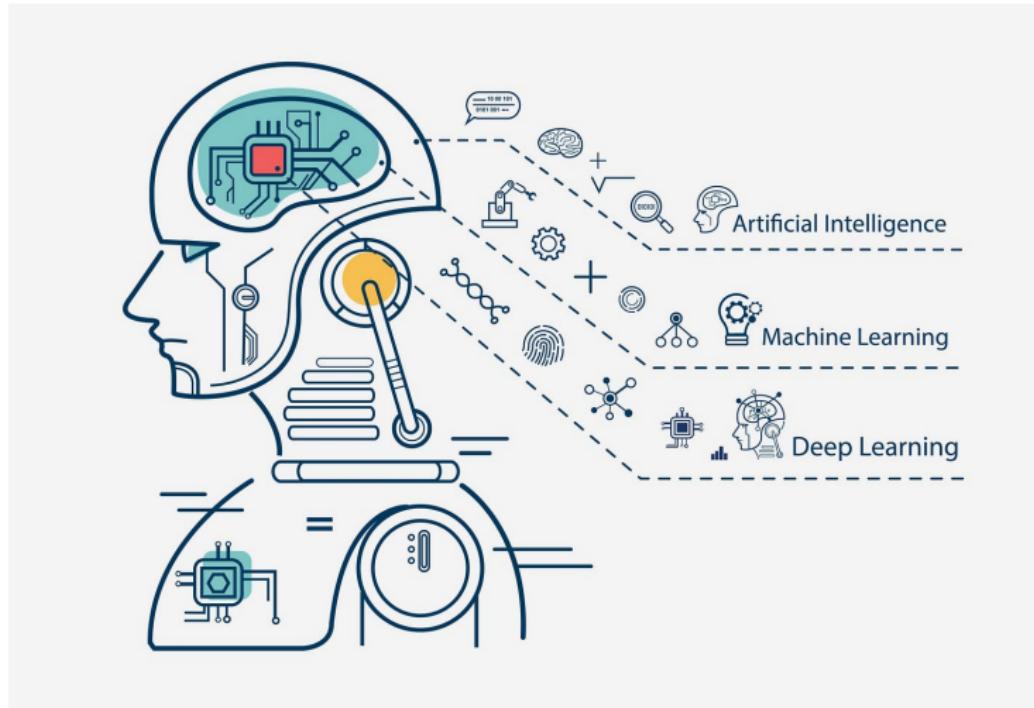


Figure: <https://robots.net/fintech/how-to-start-machine-learning/>

Prerequisites for Machine Learning

- **Mathematics:**

- Probability and Statistics (e.g., Bayes' theorem, distributions)
- Linear Algebra (e.g., vectors, matrices, eigenvalues)
- Calculus (e.g., derivatives, gradients)

- **Programming:**

- Proficiency in Python.
- Familiarity with packages like NumPy, Pandas, Matplotlib, and Scikit-Learn.

- **Basic Machine Learning Concepts:**

- Understanding of supervised and unsupervised learning.
- Knowledge of datasets and their structure.

Introduction to Machine Learning

- Machine learning is about programming computers to learn from data.
- Definitions:
 - "*Field of study that gives computers the ability to learn without being explicitly programmed.*" – Arthur Samuel, 1959
 - "*A computer program is said to learn from experience E with respect to some task T and some performance measure P if its performance on T, as measured by P, improves with experience E.*" – Tom Mitchell, 1997
- Example: Spam filtering as a learning task.

Quick Quiz — E, T, P

In Tom Mitchell's definition, what does **P** stand for?

- ① Parameters
- ② Performance measure
- ③ Prior
- ④ Precision

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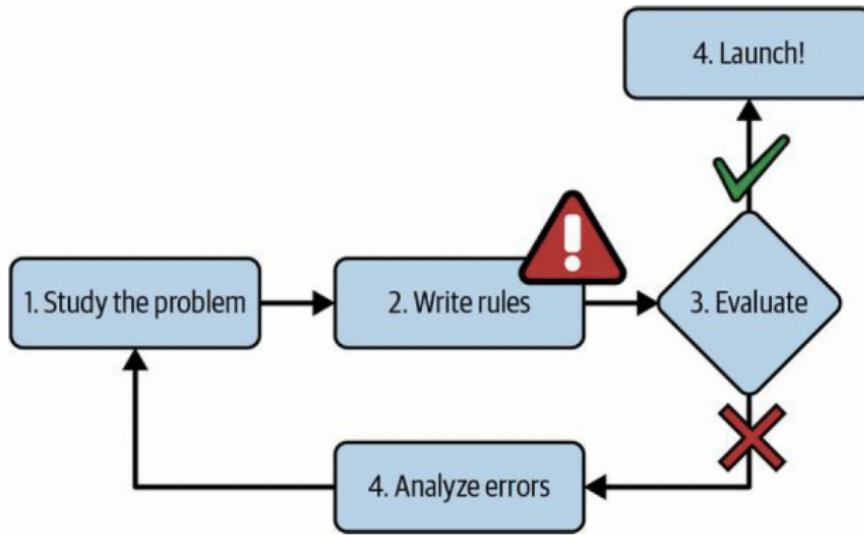
Answer: (2) Performance measure.

Why Machine Learning?

- Solving the problems which are too complex for traditional approaches.
- Dealing with fluctuating environments (e.g., spam filter adapting to new spam).
- Gaining insights from large datasets (data mining).

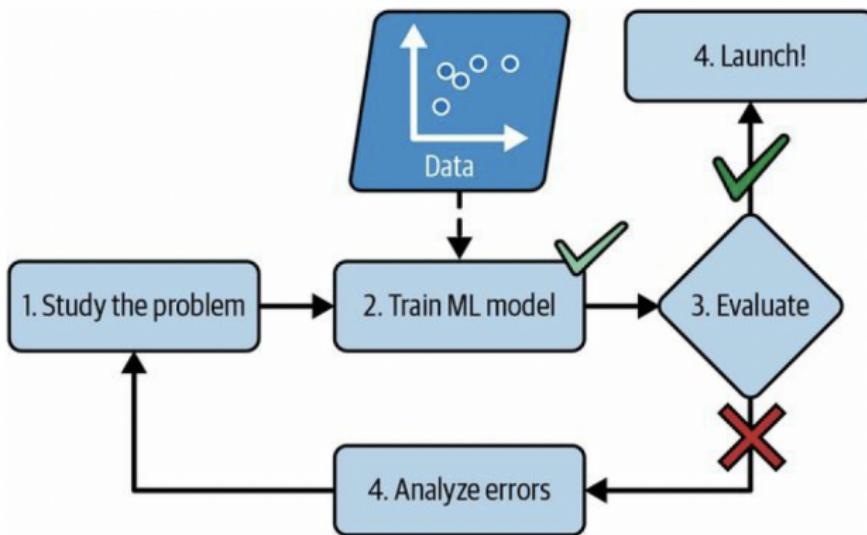
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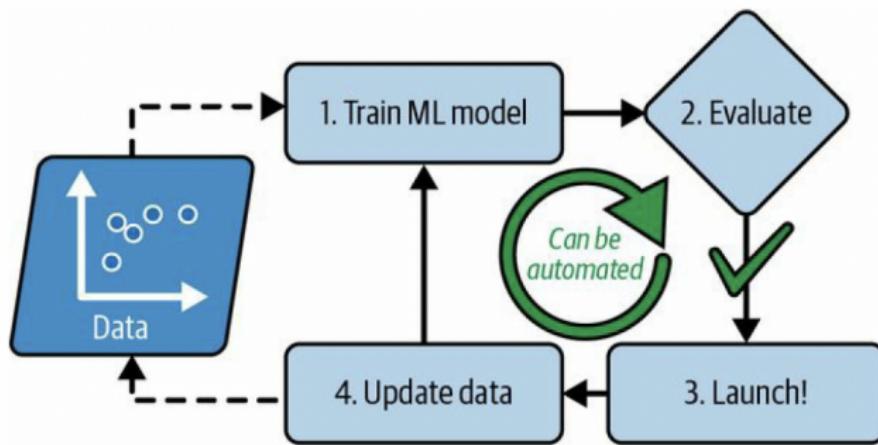


Figure: The machine learning approach - Automatic Adaption.

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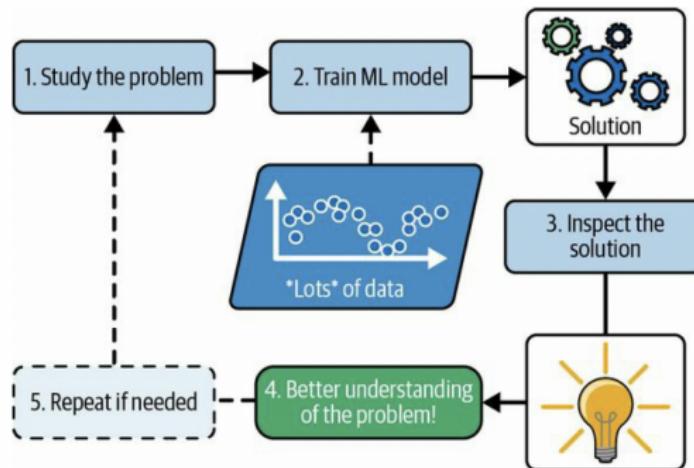


Figure: Machine learning can help humans learn.

Quick Quiz — Why ML?

Which is the **best** ML use case below?

- ① Writing a fixed set of email rules once and never updating
- ② Detecting new spam patterns that change every week
- ③ Manually labeling every incoming email forever
- ④ None of the above

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Answer: (2).

Types of Machine Learning Systems

- **Supervised Learning:** Training with labeled data.

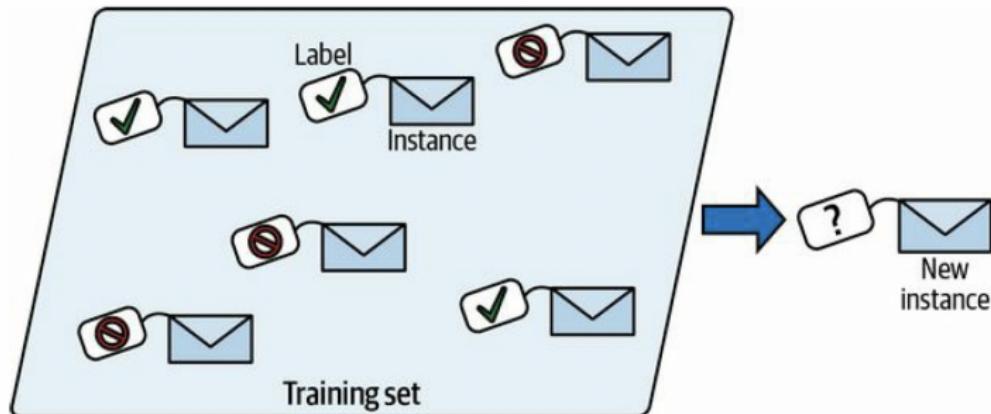


Figure: Classification Problem.

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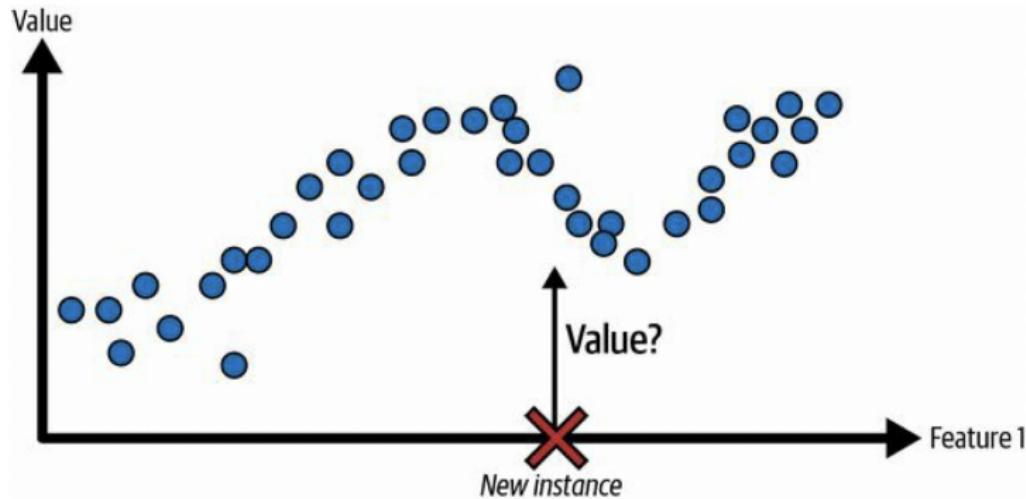


Figure: Regression Problem.

Types of Machine Learning Systems

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- **Unsupervised Learning:** Discovering patterns without labels.

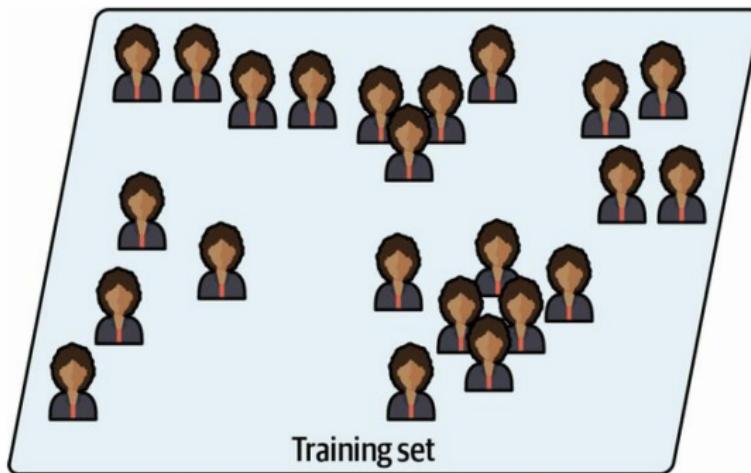


Figure: Unlabeled Data.

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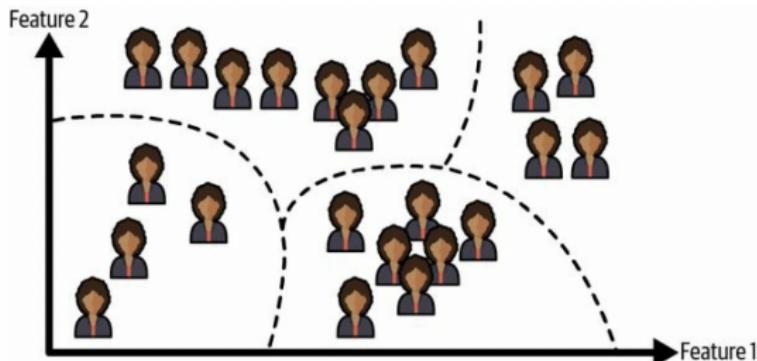


Figure: Clustering.

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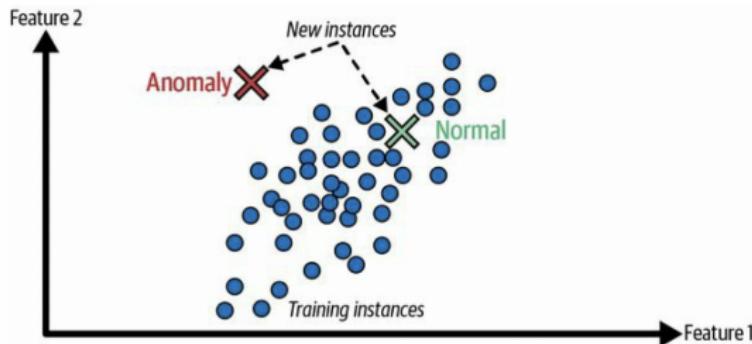


Figure: Anomaly Detection.

Types of Machine Learning Systems

- **Supervised Learning:** Training with labeled data.
- **Unsupervised Learning:** Discovering patterns without labels.
- **Semi-supervised Learning:** Using a mix of labeled and unlabeled data.

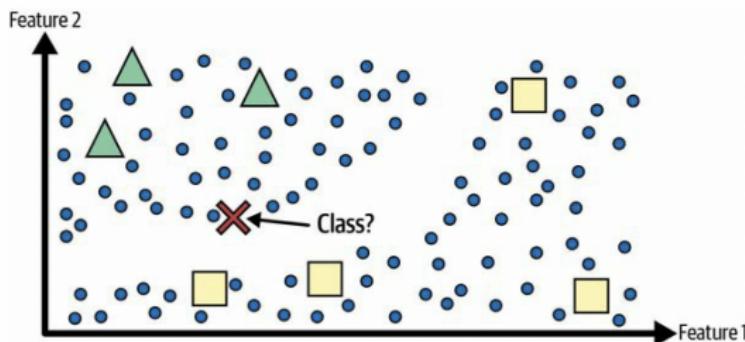


Figure: Semi-supervised.

Types of Machine Learning Systems

- **Reinforcement Learning:** Learning through rewards and penalties.

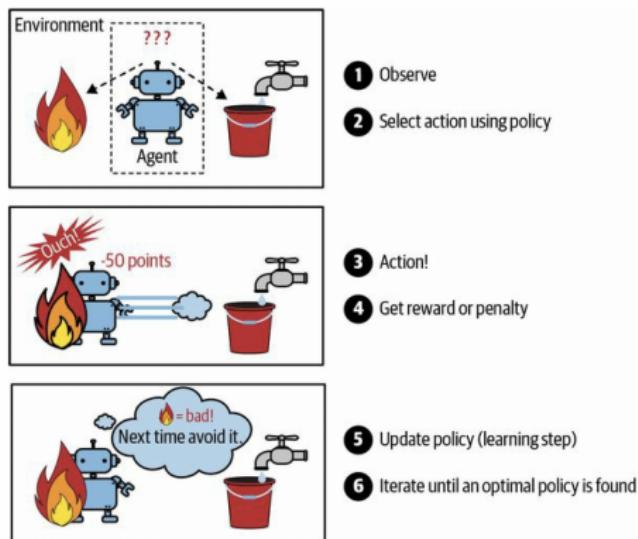


Figure: Reinforcement Learning.

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Quick Quiz — Types

Which pairing is **mismatched**?

- ① Image classification — Supervised
- ② Customer segmentation — Unsupervised
- ③ Text emotion labeling — Unsupervised
- ④ Robot navigation — Reinforcement Learning

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Answer: (3) Hyperparameter tuning is not RL by default (often search/optimization).

Workflow of a Machine Learning Project

- ① Gather and prepare data.
- ② Choose a model.
- ③ Train the model.
- ④ Evaluate and fine-tune the model.
- ⑤ Deploy and monitor the model.

Quick Quiz — Order of Operations

Which order makes the most sense?

- ① Deploy → Train → Evaluate
- ② Choose model → Gather data → Train
- ③ Gather data → Train → Evaluate
- ④ Monitor → Deploy → Evaluate

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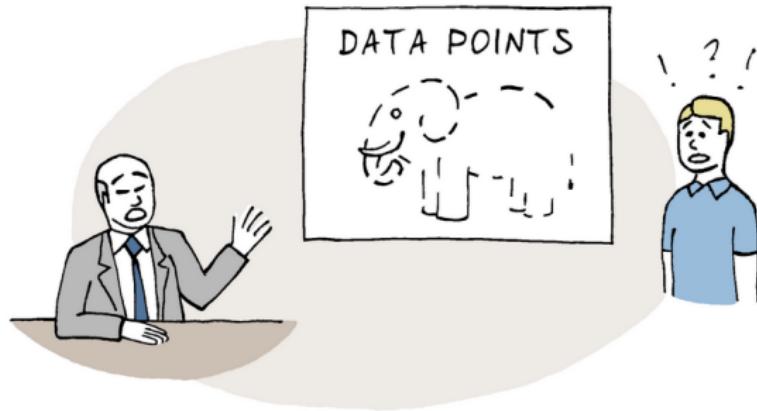
Challenges in Machine Learning

- Insufficient or poor-quality data.



Challenges in Machine Learning

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- Nonrepresentative data.

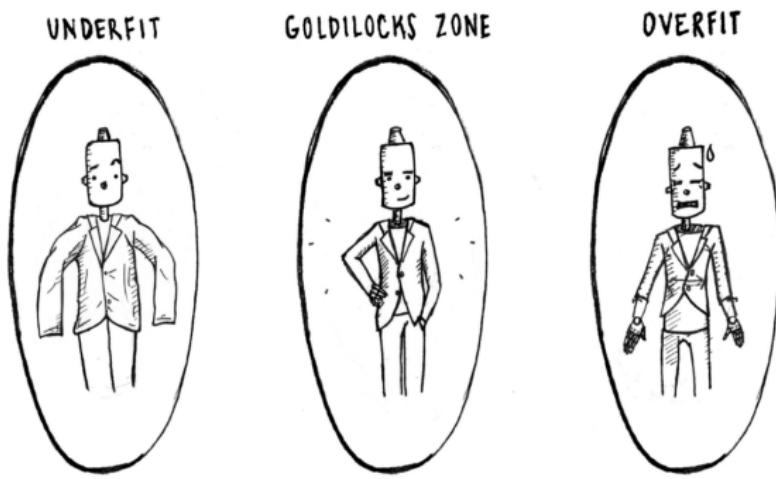


BEFORE WE HAVE ALL THE DATA POINTS,
IT COULD BE ANYTHING...

Challenges in Machine Learning

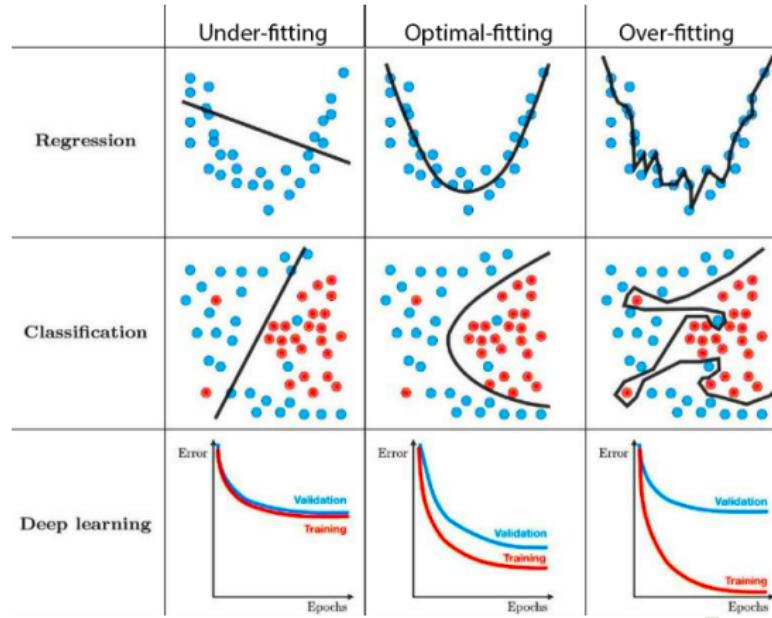
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- Nonrepresentative data.
- Generalization (Overfitting or underfitting).

MACHINE LEARNING GENERALIZATION FINDING THE PERFECT FIT



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Challenges in Machine Learning

- Insufficient or poor-quality data.
- Nonrepresentative data.
- Generalization (Overfitting or underfitting).
- Selecting appropriate features.

Quick Quiz — Overfitting

Which action is most effective against **overfitting**?

- ① Use a more complex model
- ② Add regularization or collect more data
- ③ Train longer without validation
- ④ Reduce training data

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Answer: (2).

Testing and Validation

- Split data into training, validation, and test sets.
- Avoid overfitting by using validation sets to fine-tune hyperparameters.
- Generalization error indicates real-world performance.

Quick Quiz — Test Set

The test set should be used to:

- ① Tune hyperparameters
- ② Select features
- ③ Report final unbiased performance
- ④ Balance classes

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Answer: (3).

Conclusion

- Machine learning involves iterative improvement through data and algorithms.
- Understanding the ML landscape helps in designing robust systems.
- Next steps: Dive deeper into specific models and algorithms.

Lightning Quiz — 3-in-30s

- ① (T/F) Deep Learning is a subset of Machine Learning.
- ② The test set is used for:
- ③ One way to fight overfitting:

Lightning Quiz — 3-in-30s

- ① (T/F) Deep Learning is a subset of Machine Learning. **True.**
- ② The test set is used for: **final evaluation**
- ③ One way to fight overfitting: **regularization / more data / early stopping**