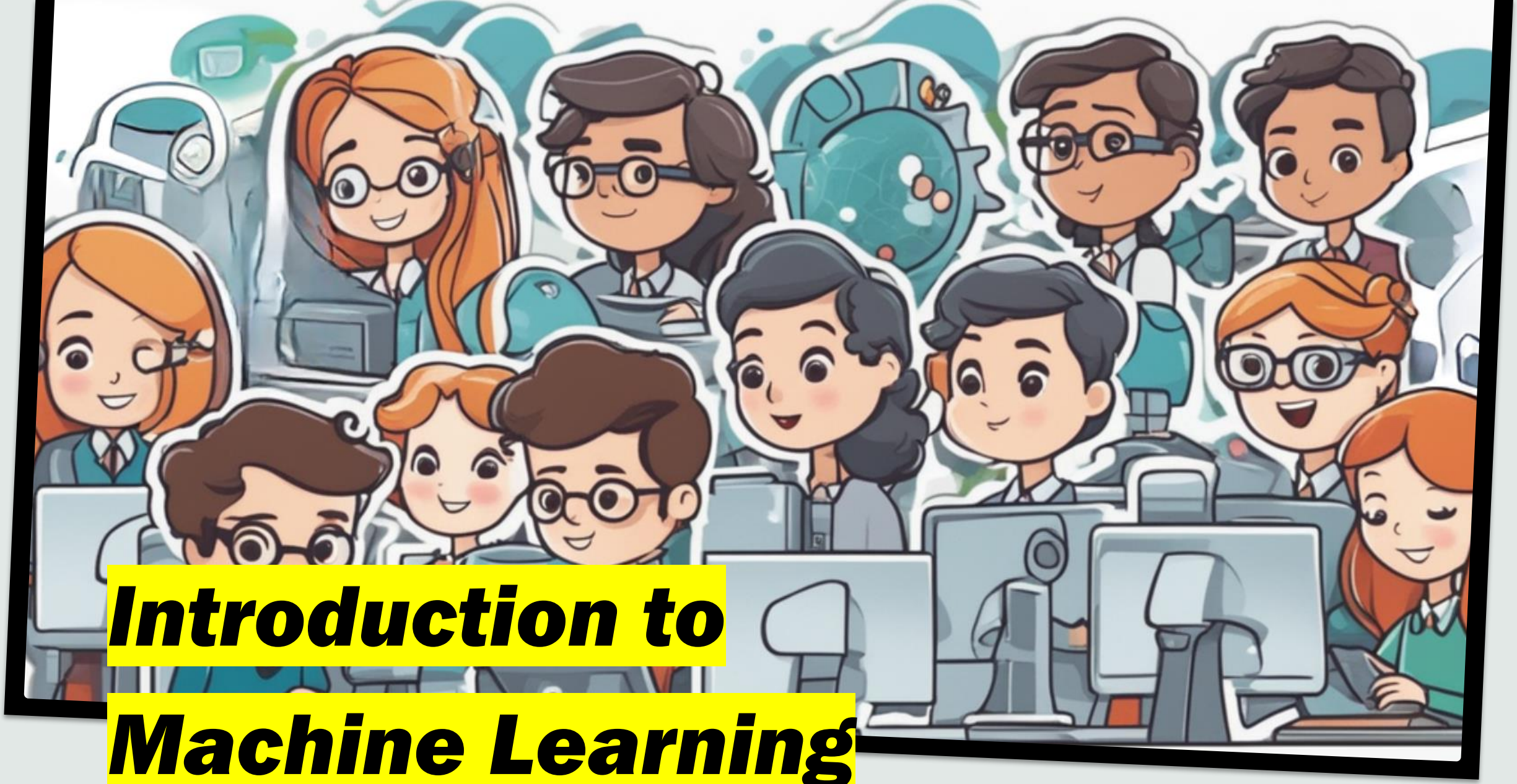


Introduction to Machine Learning

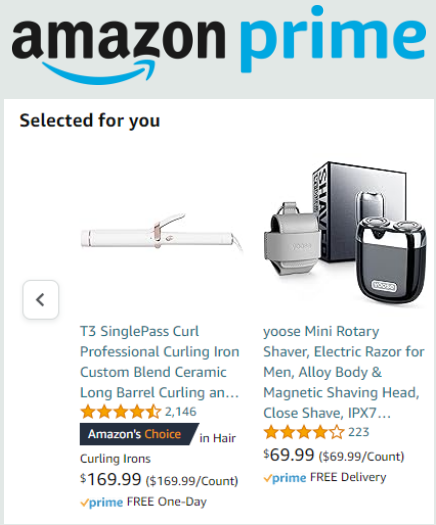
ECEGR4750: Machine Learning I

Week 1

Instructor

- Astrini Sie, PhD
- Lead Machine Learning Research Engineer, Store No. 8, Walmart
- Email: astrini.sie@gmail.com
- Zoom Link: TBD
- Office hours:
  + Tuesdays and Thursdays, Bannan, 12p – 1p
  + Wednesdays, Zoom, 7p – 9p
  + Fridays, Zoom, 9a – 9.45a

Examples of Machine Learning in real life



What is Machine Learning?

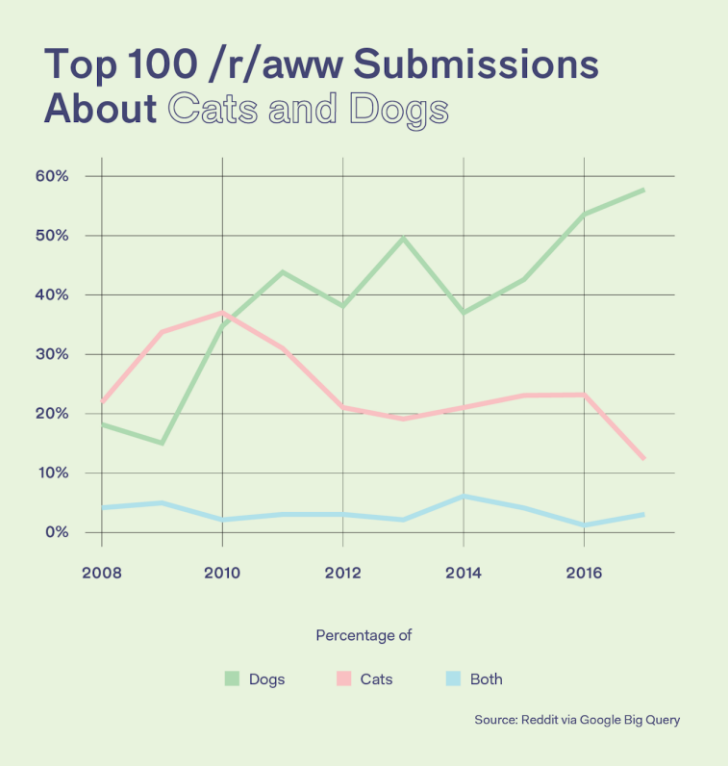
- The quest to make the perfect hard-boiled eggs

Photo: Ella Quitner

Traditional vs Machine Learning Algorithm

Traditional Algorithm

- Write a program that separates posts into those containing ‘cat’, ‘dog’, or ‘others’




```
cats = []
dogs = []
others = []

for post in posts:
    if 'cat' in post:
        cats.append(post)
    elif 'dog' in post:
        dogs.append(post)
    else:
        others.append(post)
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Slides adapted from Kevin Jamieson and Simon Du. Graphic source: https://theoutline.com/post/3128/dogs-cats-internet-popularity?zd=1

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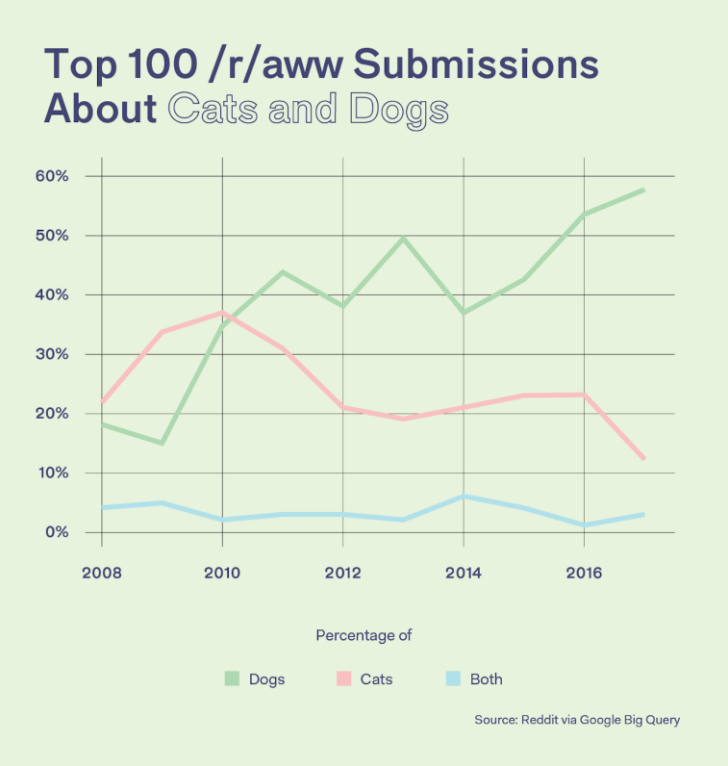


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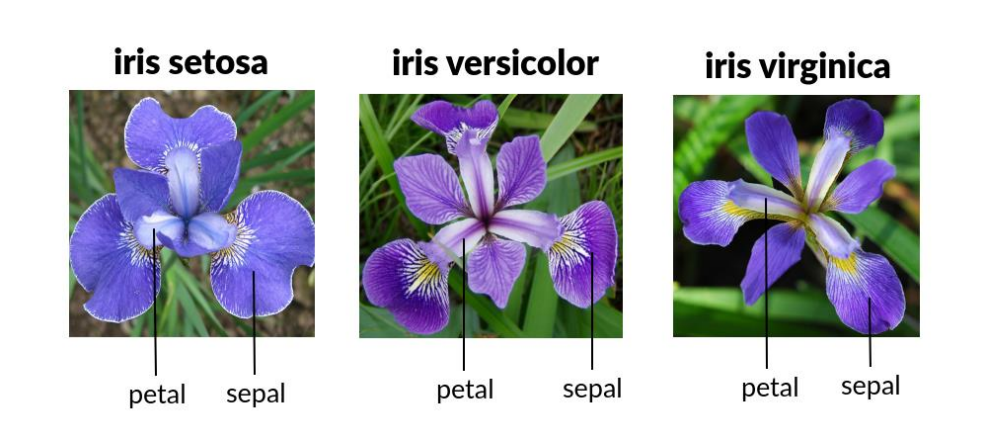
- The decision rule of if “cat” in post: hard coded by expert

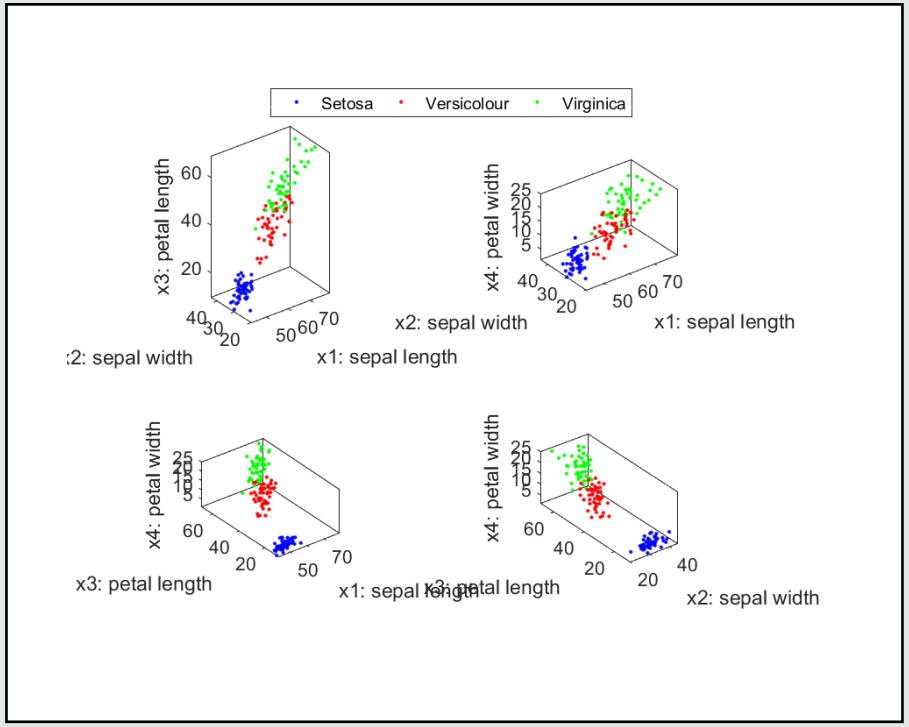
Slides adapted from Kevin Jamieson and Simon Du. Graphic source: https://theoutline.com/post/3128/dogs-cats-internet-popularity?zd=1

Traditional vs Machine Learning Algorithm

Machine Learning Algorithm

- Write a program that separates images into those ‘setosa’, ‘versicolor’, ‘virginica’





Graphics source: https://www.analyticsvidhya.com/blog/2022/06/iris-flowers-classification-using-machine-learning/ and http://mirlab.org/jang/books/dcpr/dataSetIris.asp?title=2-2%20Iris%20Dataset

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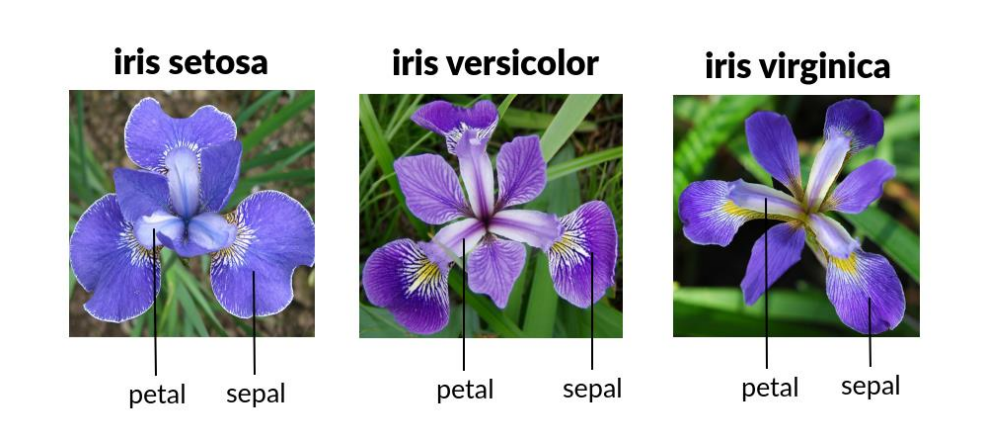
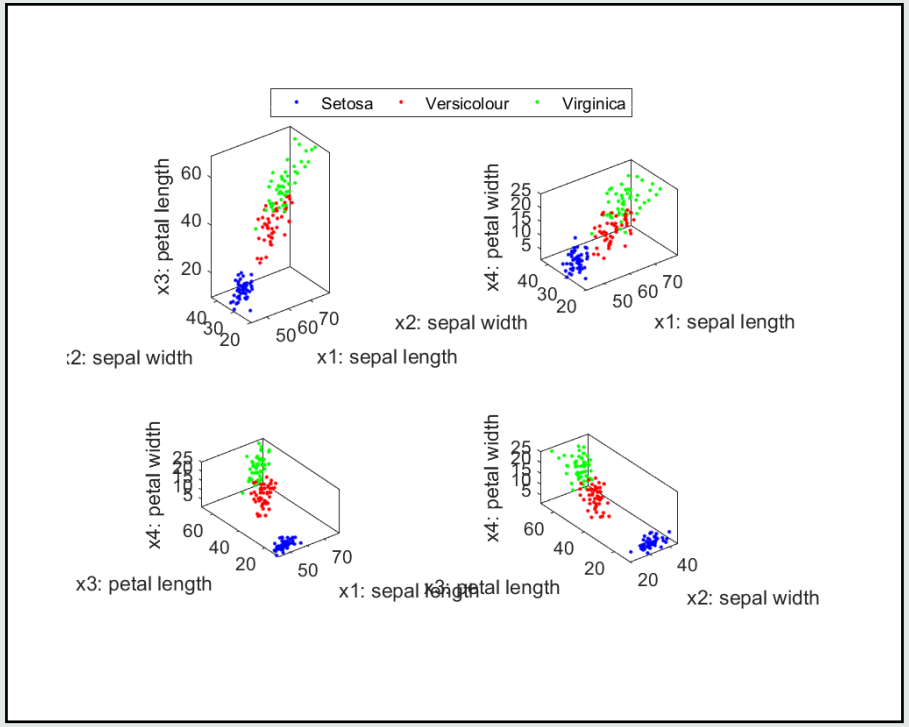




- The decision rule of iris species image: learned from data

Graphics source: https://www.analyticsvidhya.com/blog/2022/06/iris-flowers-classification-using-machine-learning/ and http://mirlab.org/jang/books/dcpr/dataSetIris.asp?title=2-2%20Iris%20Dataset

Schedule

- Tuesdays and Thursdays
- Lecture: 1.30p – 3.10p
- Lab: 3.20p – 4.20p
- Location: Bannan 201

Textbook

- Machine Learning Refined: Foundations, Algorithms, and Applications
  + by Jeremy Watt, Reza Borhani, and Aggelos K. Katsaggelos
  + Cambridge University Press
  + first published 2020
  + hardcover
  + ISBN: 978-1-108-48072-7

- Supplemental readings sent as the course progresses

Outline

Week, Date	Topics	Textbook Sections	Topics, Applications	Labs
Week 1 Sep. 21	Intro to Machine Learning			
Week 2 Sep. 26 & 28	Supervised Learning: Regression			
Week 3 Oct. 3 & 5	Guest Lecture Series			L1 due
Week 4 Oct. 10 & 12	Supervised Learning: Classification			2 papers
Week 5 Oct. 17 & 19	Evaluation Metrics			L2 due 1 paper
Week 6 Oct. 24 & 26	Naïve Bayes			2 papers
Week 7 Oct. 31 & Nov. 2	Neural Network Fundamentals			L3 due 1 paper
Week 8 Nov. 7 & 9	Regularization, Feature Selection			2 papers
Week 9 Nov. 14 & 16	Language, Vision, Time Series			L4 due 1 paper
Week 10 Nov. 21	Language, Vision, Time Series			2 papers
Week 11 Nov. 28 & 30	Generative Models			L5 due 1 paper

Assignments and Projects

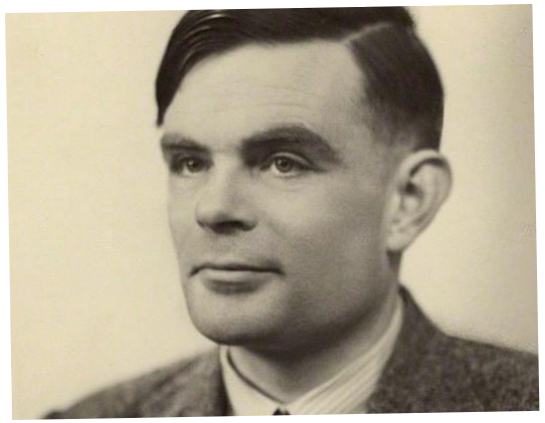
- Assignments – 60%
  + 5 Labs – 9% each
  + 1 Paper Presentation (15 minutes) – 15%

- Final Project – 40%

Prerequisite

- MATH2320 Linear Algebra
- MATH2310 Probability & Statistics
- Basic Python programming

Please review these topics independently offline. Machine Learning is all about math and that's the beauty of it.



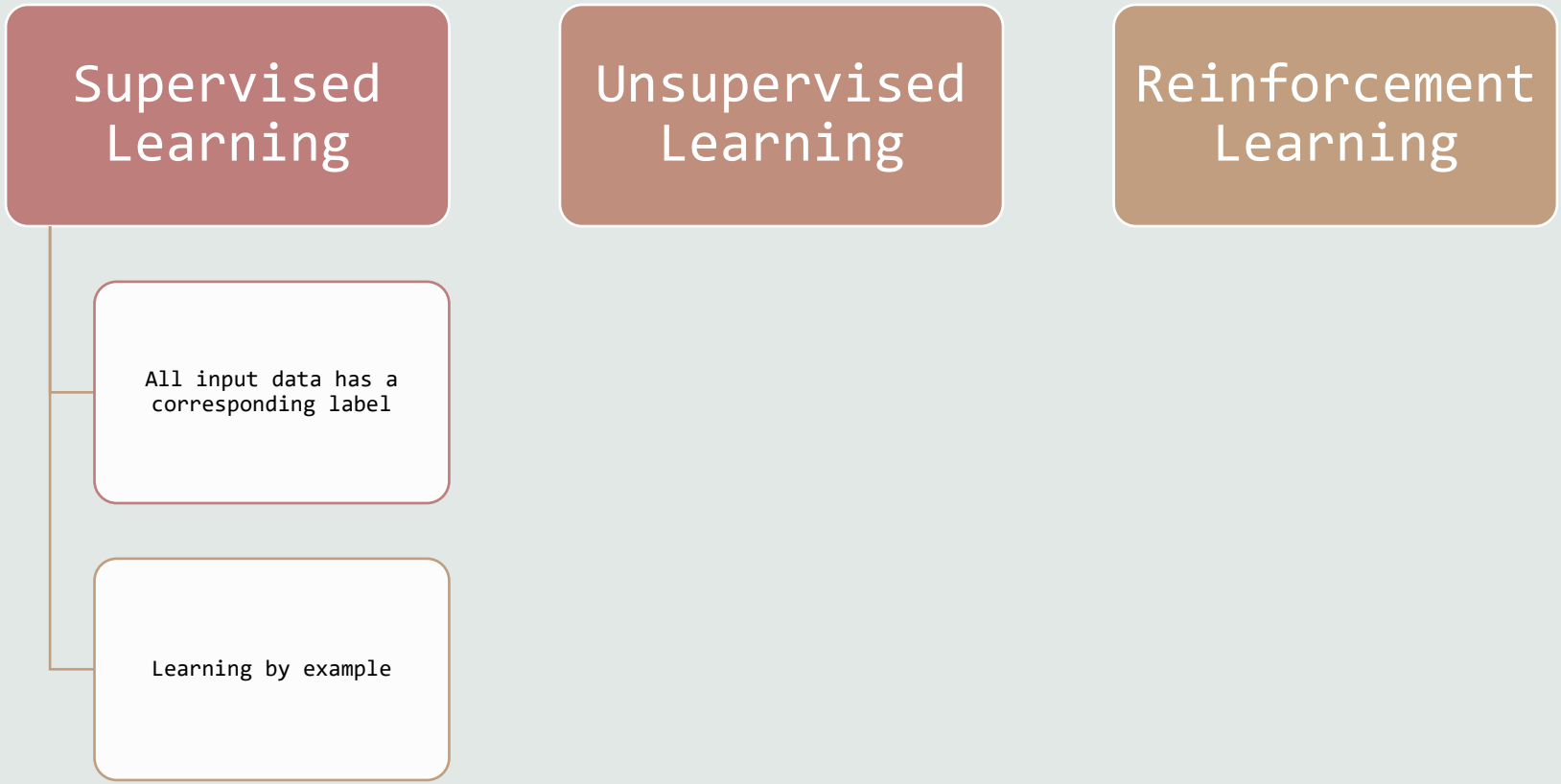
Machine Learning, defined by the experts

- **Alan Turing (1950):** Can machines do what we (as thinking entities) can do?
- **Arthur Samuel (1959):** Machine Learning is the field of study that gives the computer the ability to learn without being explicitly programmed.
- **Tom Mitchell (1998):** A computer program 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.

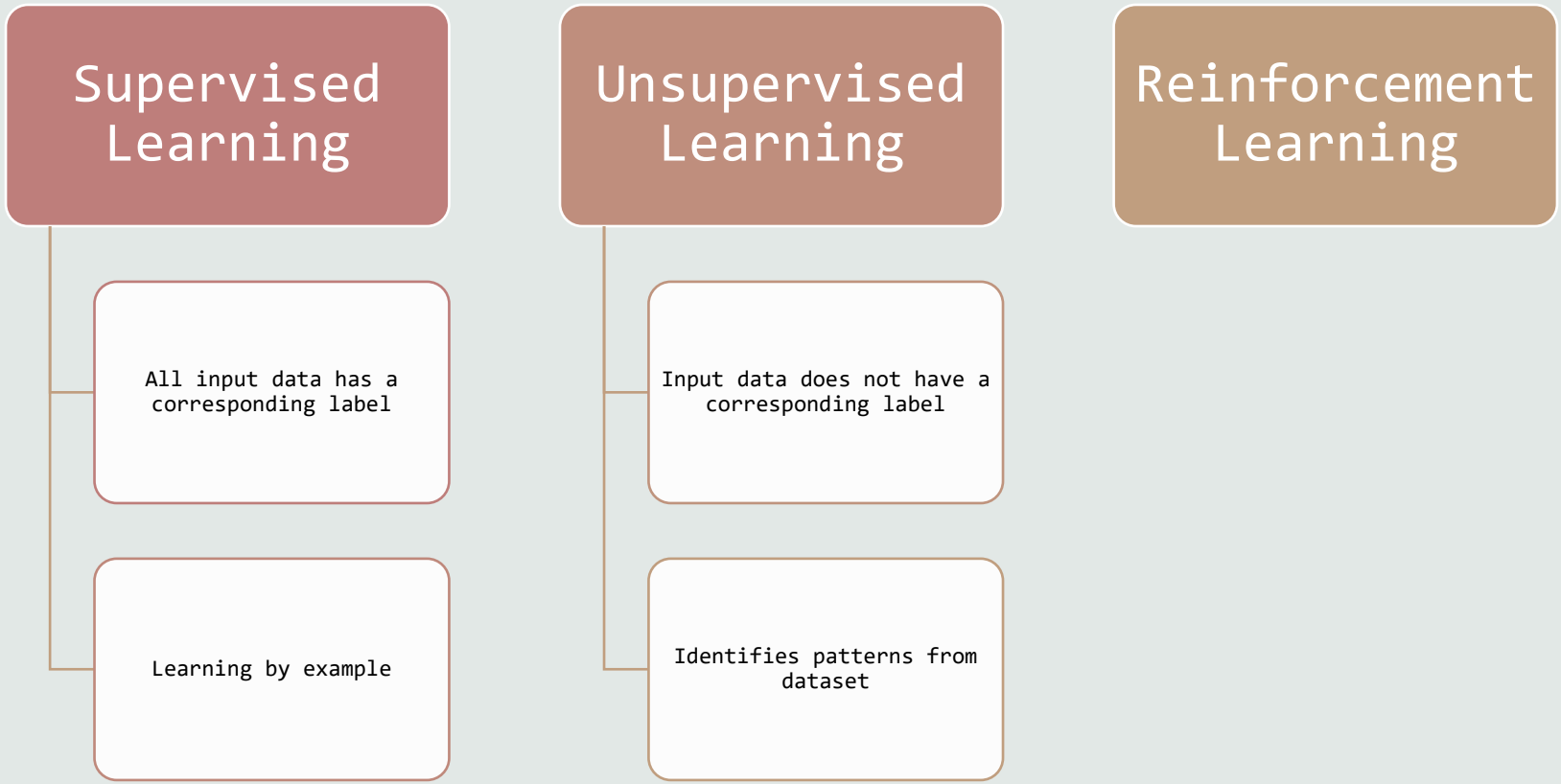
Taxonomy of Machine Learning, by tasks

- Supervised Learning
- Unsupervised Learning
- Reinforcement Learning

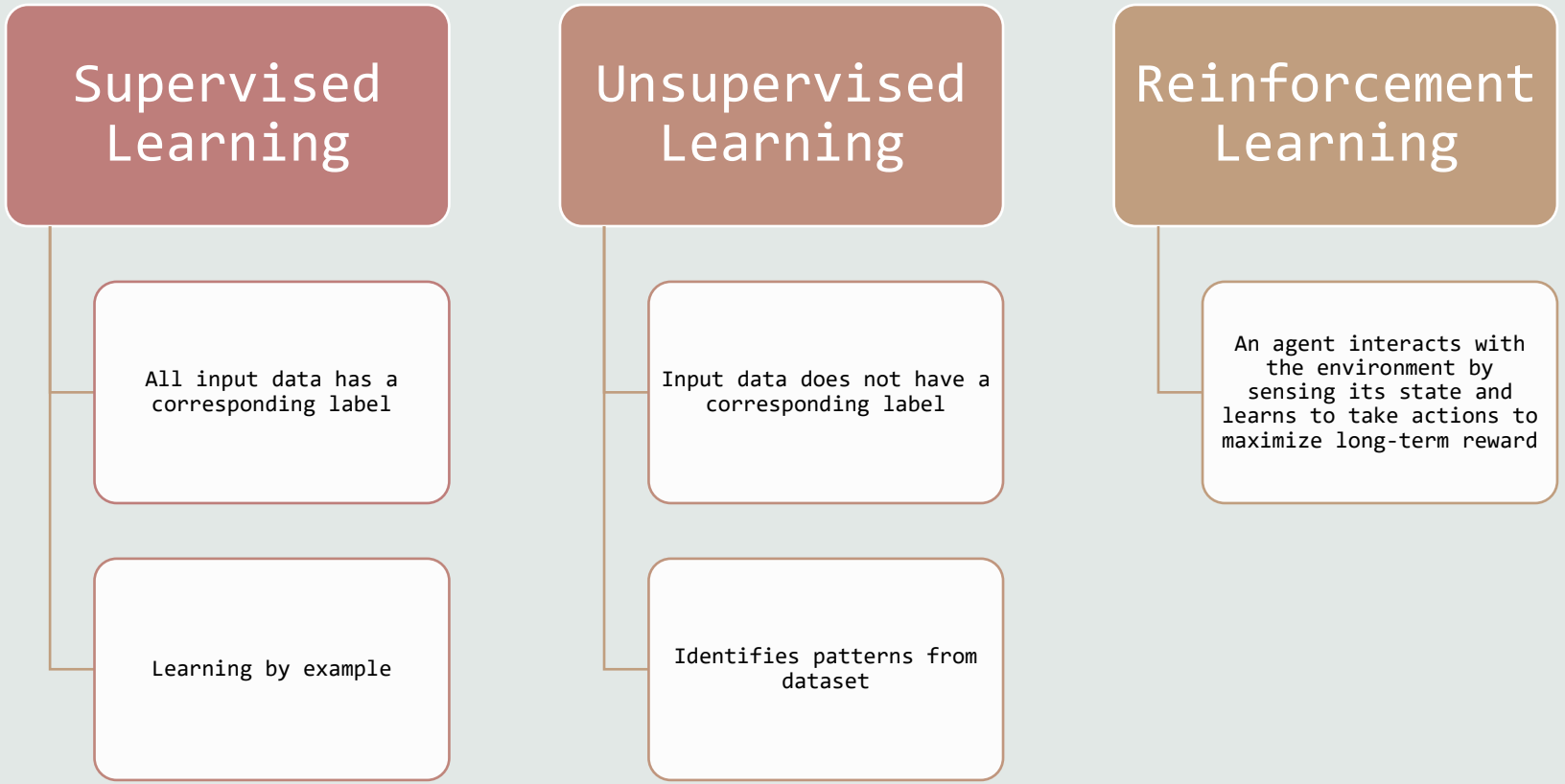
Taxonomy of Machine Learning, by tasks



Taxonomy of Machine Learning, by tasks



Taxonomy of Machine Learning, by tasks



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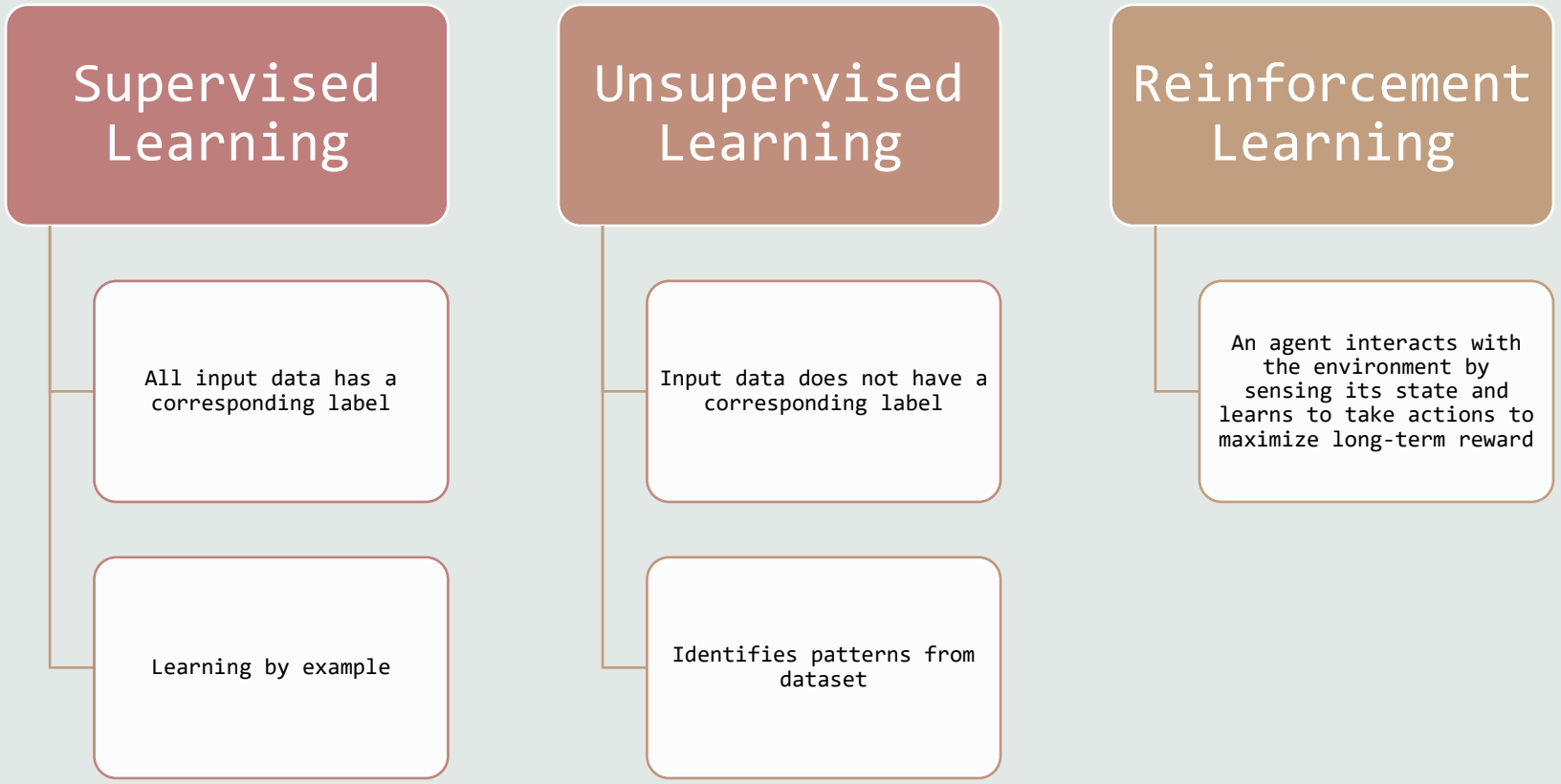


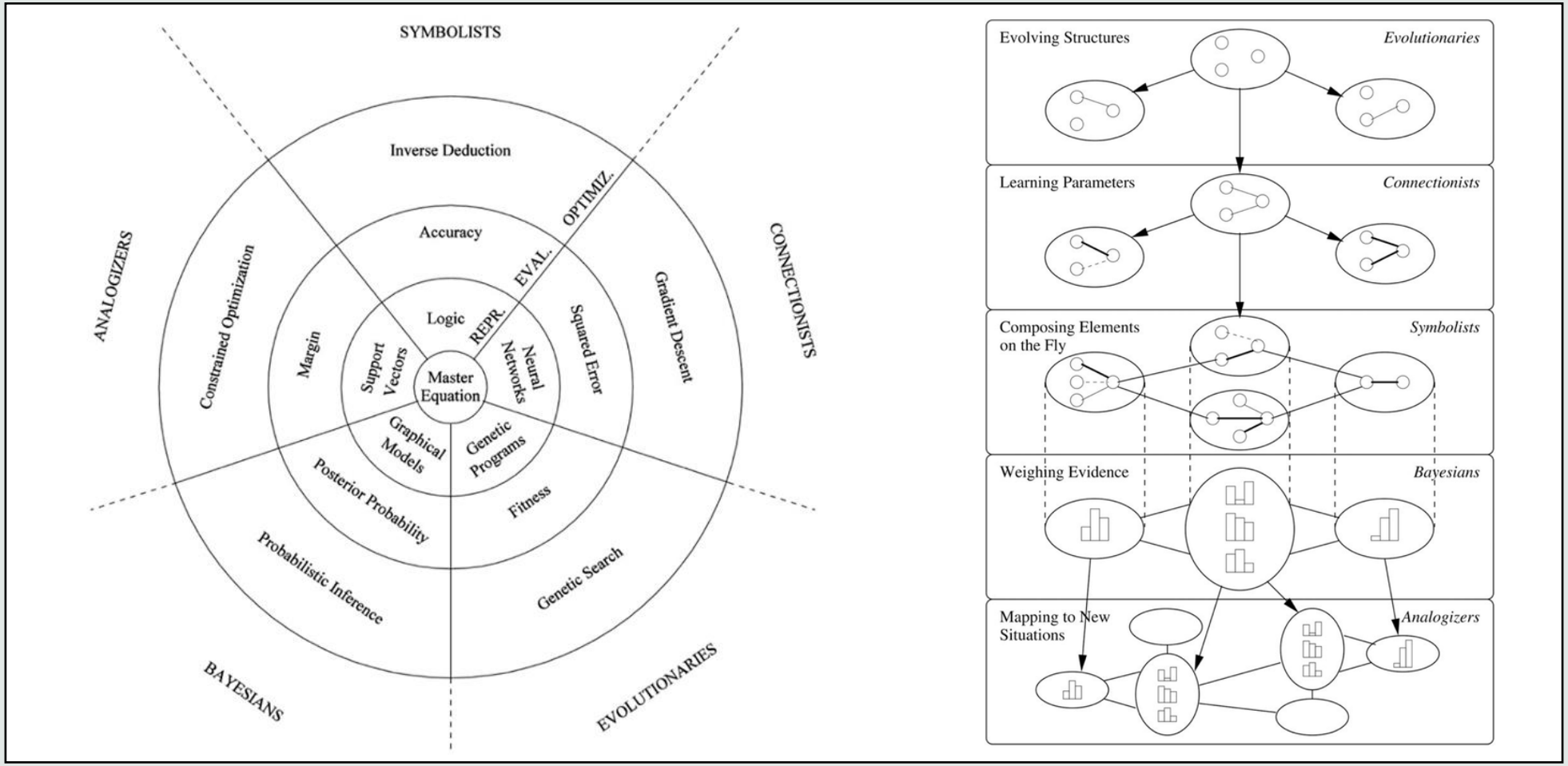
Predict outcomes for new data belonging to the same domain

Gain insights from unlabeled data

Goal-oriented, learn sequences of **actions** in an uncertain **environment** to maximize future **rewards**

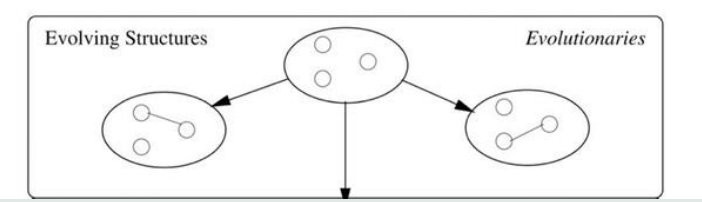
The 5 tribes of Machine Learning

- Concept introduced by Pedro Domingos in “The Master Algorithm”: an algorithm capable of finding knowledge and generalizing from any kind of data. The algorithm must use paradigms and techniques from each and every tribe.



The 5 tribes of Machine Learning

The Evolutionaries

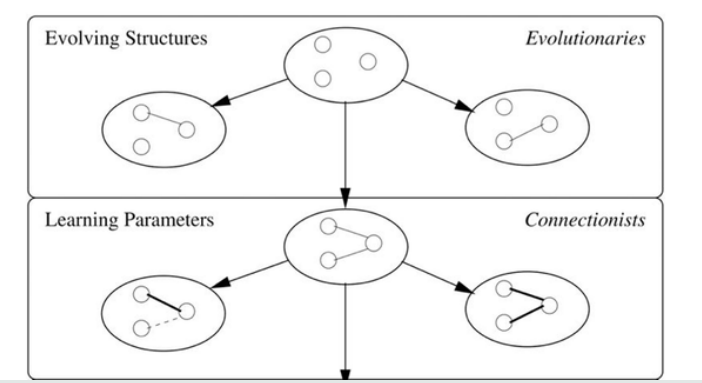


- Applying the idea of genomes and DNA in the evolutionary process to data processing: the algorithms will constantly evolve and adapt to unknown conditions and processes.

- Represented: Using genetic programming.
- Evaluated: Using fitness function, chooses the best solution from pool of solutions.
- Optimized: Using genetic search, this helps select the most optimized solution for the problem at hand.
- Example: Genetic Algorithm

The 5 tribes of Machine Learning

The Connectionists



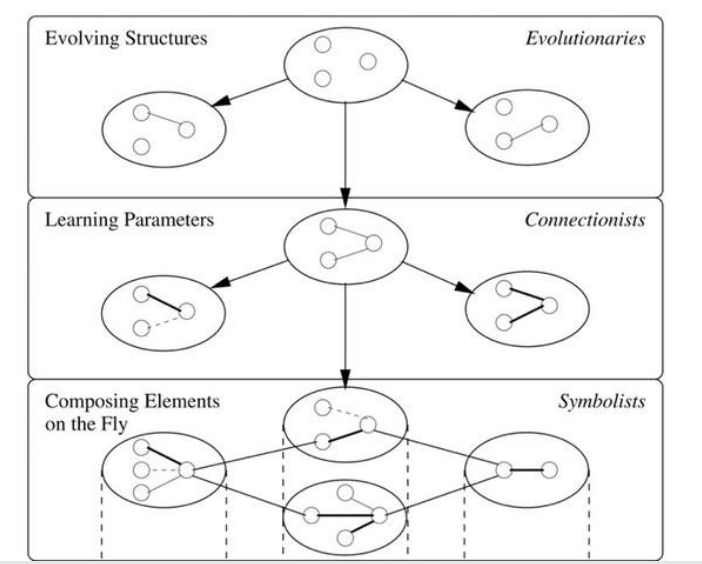
- Focusing on concepts of how a human brain functions and tries to mimic its functionalities by reverse-engineering and trying to build the neurons in the brain artificially (perceptrons) and all of its connections in a neural network.

- Represented: Using neural networks, which are layers of perceptrons passing input from one layer to the next.
- Evaluated: Using squared error, lower the error, better the performance of the neural network.
- Optimized: Using gradient descent, where the neural network uses the concept of weights and adjusts them to reduce the error and optimizes the neural network.
- Example: Neural Network algorithms

The 5 tribes of Machine Learning

The Symbolists

- Focusing on symbol manipulation where questions can be presented as equations and can be answered using expressions. Inverse deduction: starting with a set of premises and conclusions and work backwards to fill in the gaps.

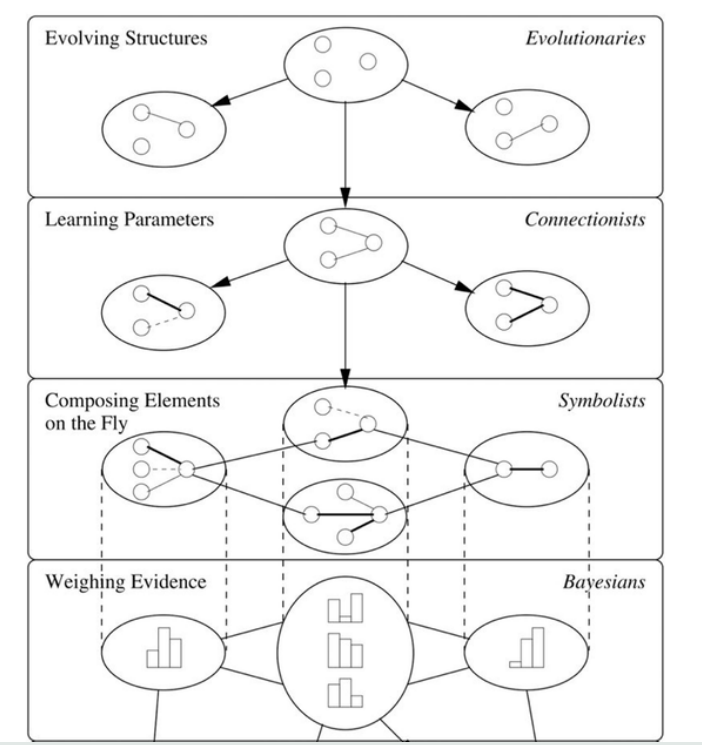


- Represented: Using logic, which is a tree like structure which makes it easier for humans to interpret.
- Evaluated: Using accuracy, which describes how accurate the result of the tree is.
- Optimized: Using inverse deduction, where the decision tree uses the concept of pruning.
- Example: Decision Tree

The 5 tribes of Machine Learning

The Bayesians

- Taking a hypothesis and apply a type of “a priori” thinking, believing that there will be some outcomes that are more likely, and then update the hypothesis as more data is available.



- Represented: Using graphical models, such as directed acyclic graphs.
- Evaluated: Using posterior probability, which helps determine that an event will happen after all evidence or background information has been considered.
- Optimized: Using probabilistic inference, which can be defined as the task of deriving the probability of one or more random variables taking a specific value or set of values.
- Example: Naïve Bayes

The 5 tribes of Machine Learning

The Analogizers

- Identifying similarities between situations or things. The main challenge is to identify how similar these situations are.

- Represented: Using support vectors, these vectors differentiate between two data points for the task at hand.
- Evaluated: Using margins, which acts as a boundary line to decide the category of a data point.
- Optimized: Using constrained optimization, which is the K factor in KNN.
- Example: k Nearest Neighbors, Recommendation System