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Introduction to Machine Learning

Module 1

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Outline

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1. The General Concept of Machine Learning
2. Types of Learning and Basic Terminology
3. Supervised Learning
   - Classification
   - Regression
4. Unsupervised Learning
   - Dimensionality Reduction for Data Compression
5. Reinforcement Learning
   - Example of Chess Program
6. The building blocks of successfully designing machine learning systems
7. Summary and Conclusion

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The General Concept of Machine Learning

Part I

Defining Machine Learning

- Machine learning is a subfield of artificial intelligence that allows computers to learn from data and improve their performance without being explicitly programmed.
- The goal of machine learning is to develop models and algorithms that can make predictions or decisions based on data.
- These models and algorithms can be used for a wide range of applications such as image recognition, natural language processing, and fraud detection.

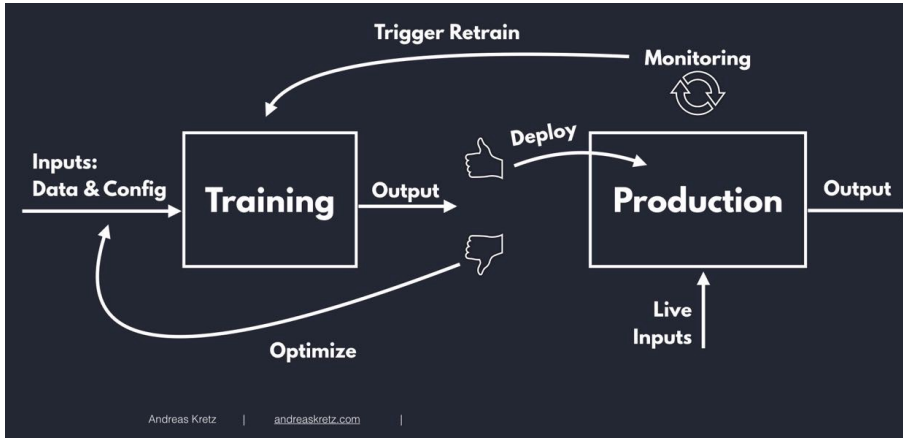

Figure 1: Machine Learning Workflow - From Andreas Kertez's Medium article 'A Simple Explanation of the Machine Learning Workflow'

Example Daily Applications

- Spam Filter
- Voice recognition software
- Movie recommendation
- Mobile check deposit
- Estimated meal delivery time
- (soon to be added to the list): safe self-driving car
- Medical application: skin cancer detection with near human accuracy, 3D Protein Structure prediction, Predicating oxygen needs of COVID-19 patients up to 4 days in advance

The three types of learning and basic terminology

Part II

Three different types of machine learning

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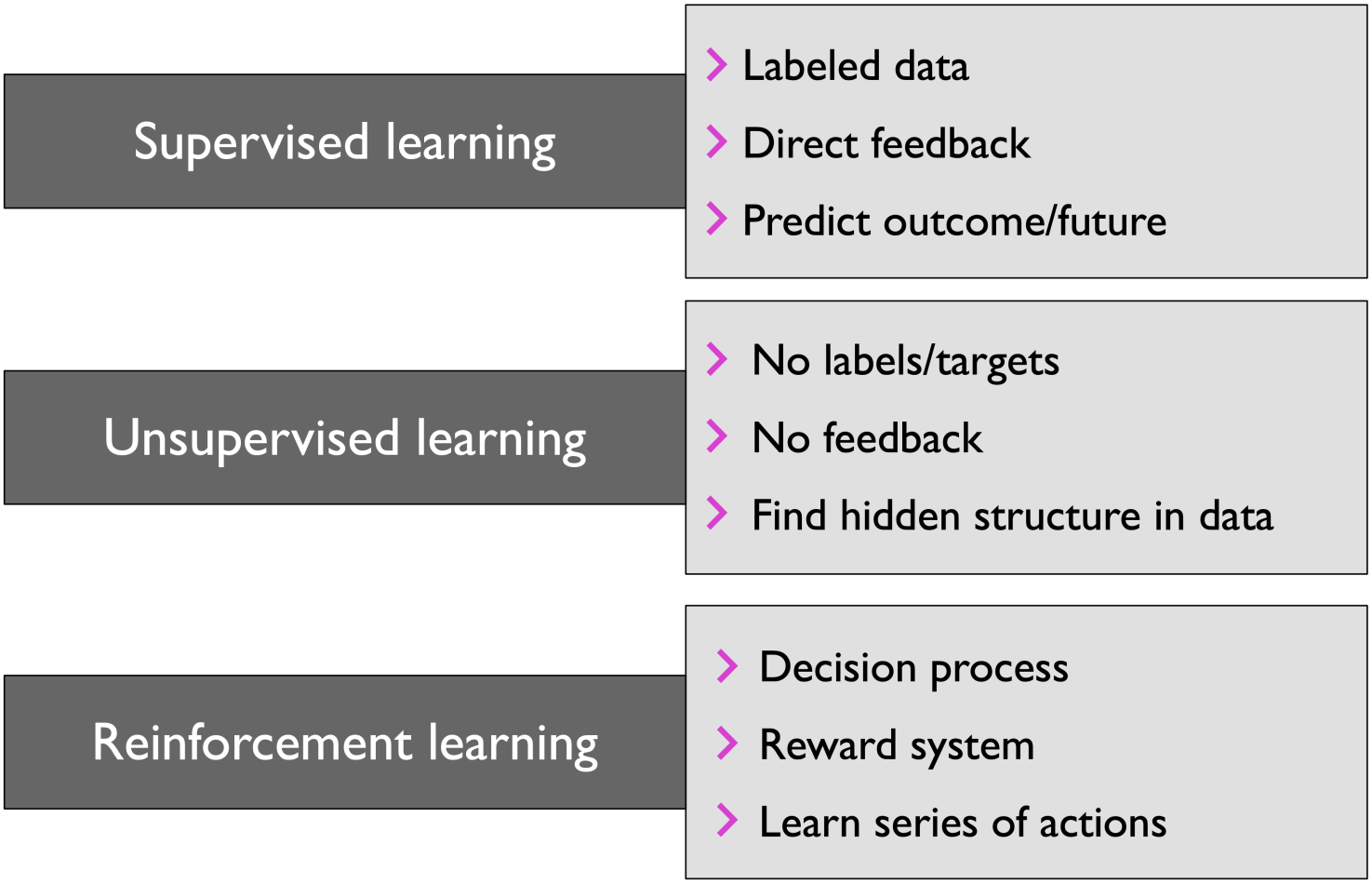
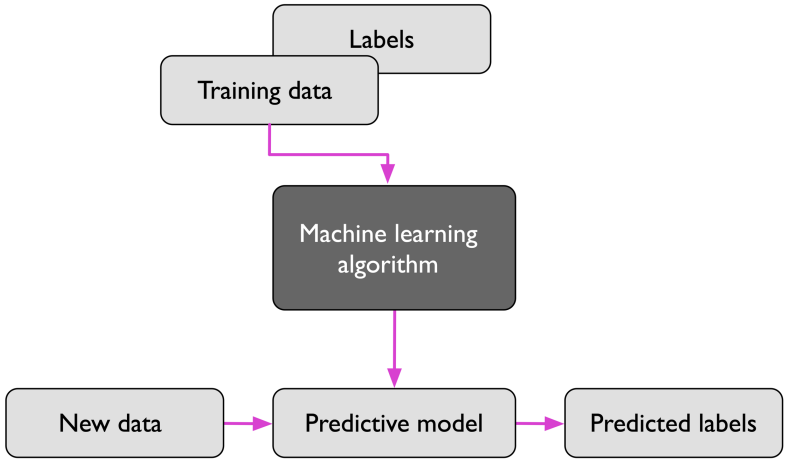


Supervised ML Workflow



- Data collection and preparation: Collecting and preparing the data that will be used to train the model. This includes splitting the data into training and test sets.
- Feature extraction: Identifying and extracting relevant features from the data that will be used as inputs to the model.
- Model selection: Selecting the appropriate algorithm and tuning its parameters to best fit the data.
- Evaluation: Evaluating the performance of the model on the test dataset using various evaluation metrics.

Classification vs Regression

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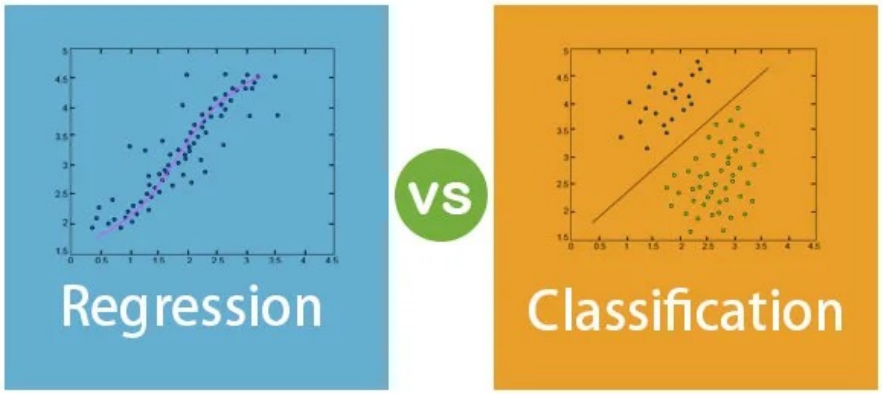
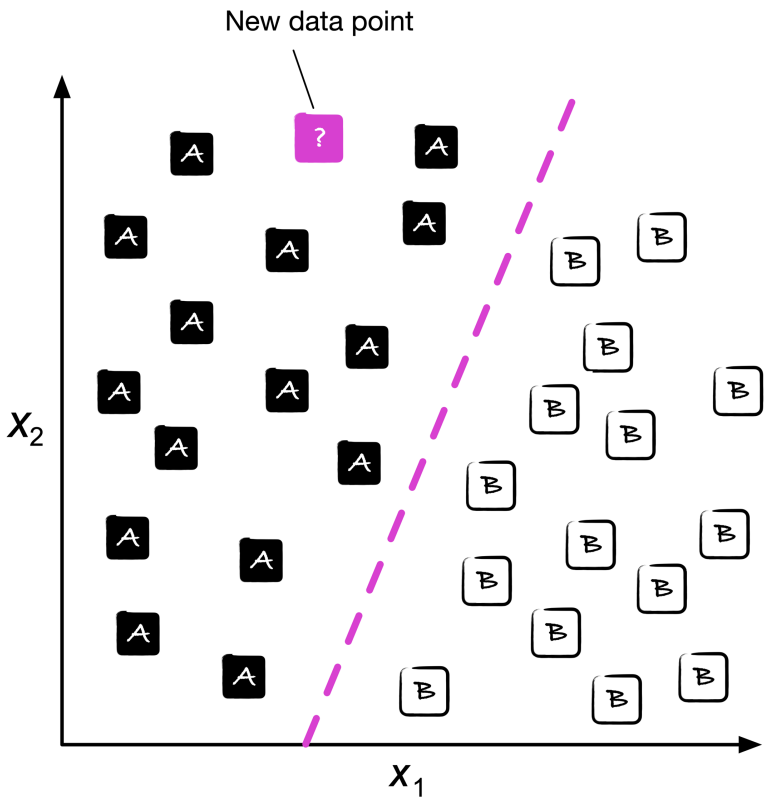
- Supervised learning tasks: Two common tasks of supervised learning are classification and regression.
- Classification: In classification, the goal is to predict a categorical label or class for a given input.
- Regression: In regression, the goal is to predict a continuous value for a given input.



Classification

- Classification: a subcategory of supervised machine learning
- Goal: predict the categorical labels of new instances or data points based on past observations
- Class labels: unordered and can be understood as the group membership of data points
- Example: spam filter is a binary classification, where the machine learning algorithm learns to distinguish between two possible classes: spam and non-spam



Regression

- Regression: a subcategory of supervised machine learning
- Goal: predict a continuous outcome based on a set of predictor or explanatory variables
- Inputs: predictor variables (also known as features) and a continuous response or target variable
- Example: stock price prediction, where the goal is to predict the closing price of a stock based on its historical data

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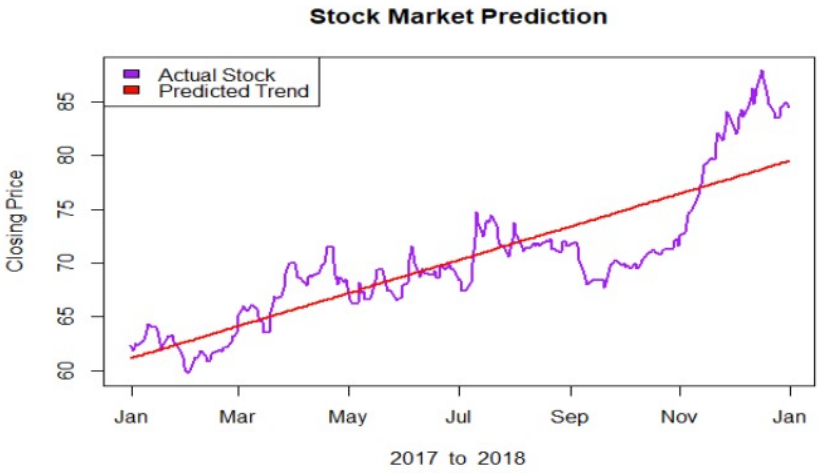
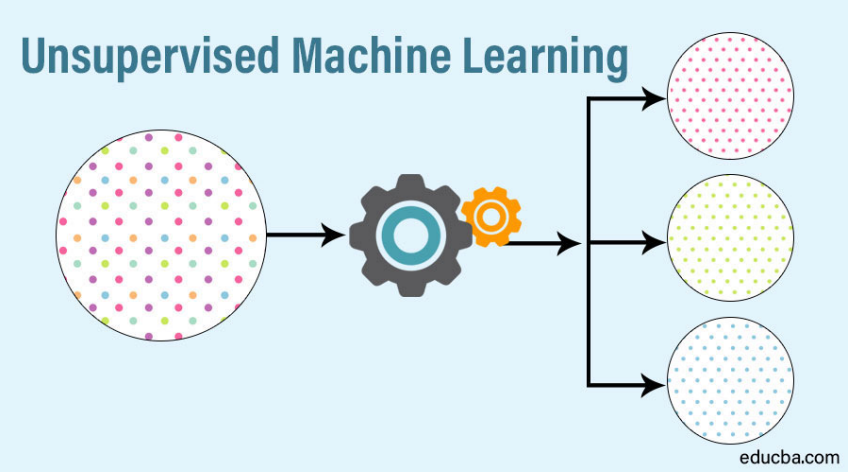
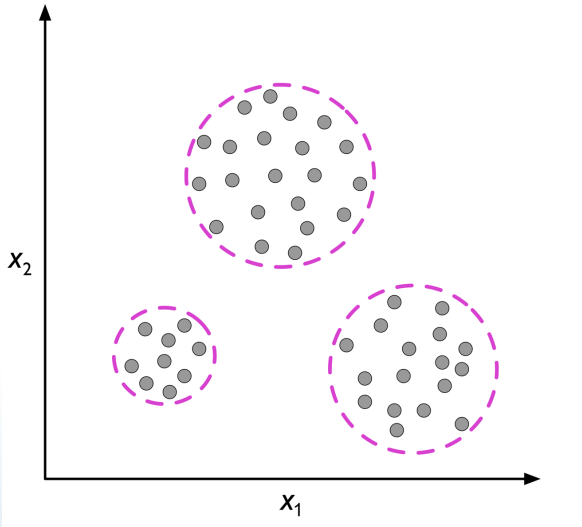


Fig. 2. Stock Prediction of Coca-Cola using Linear Regression

Unsupervised Learning

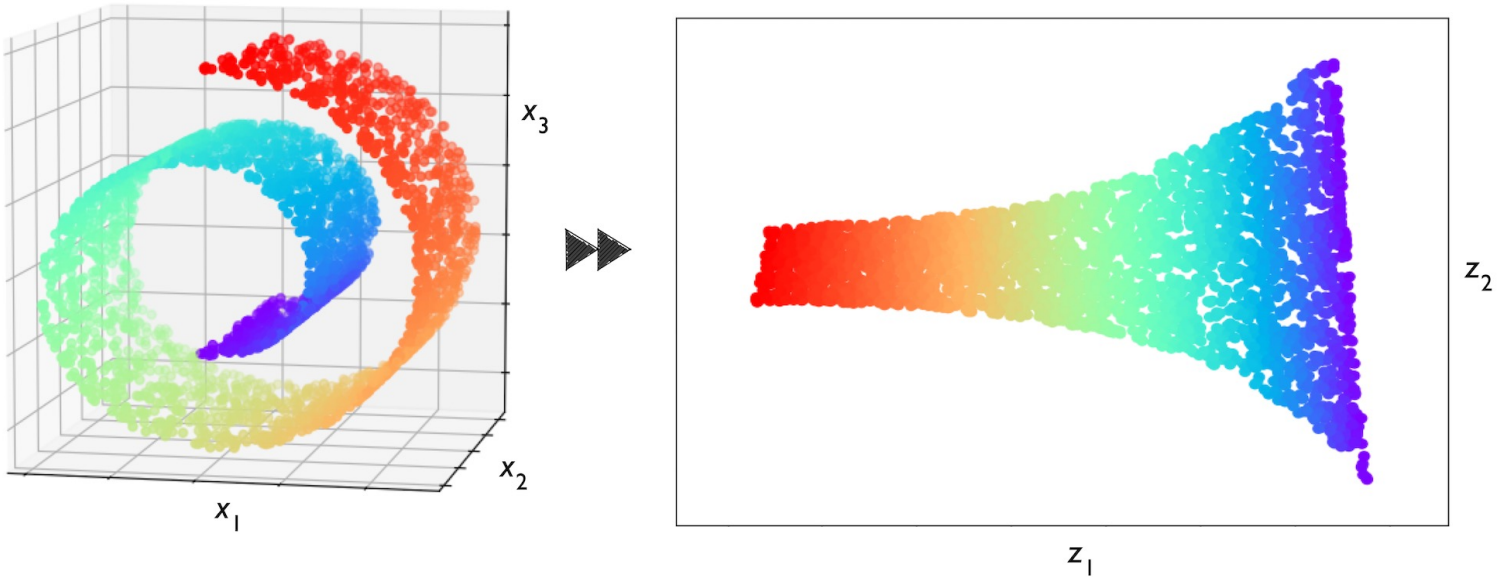
- Unsupervised learning: a subcategory of machine learning that deals with unlabeled data or data of an unknown structure
- Goal: to explore the structure of the data and extract meaningful information without the guidance of a known outcome variable or reward function
- Inputs: unlabeled data or data of an unknown structure
- Example: clustering, where the goal is to group similar data points together





Dimensionality reduction for data compression

- Dimensionality reduction: a subfield of unsupervised learning
- Goal: to reduce the number of features or dimensions in the data while retaining most of the relevant information
- Inputs: high-dimensional data
- Example: Principal Component Analysis (PCA), a technique used to reduce the dimensionality of the data while retaining most of the relevant information



Reinforcement Learning

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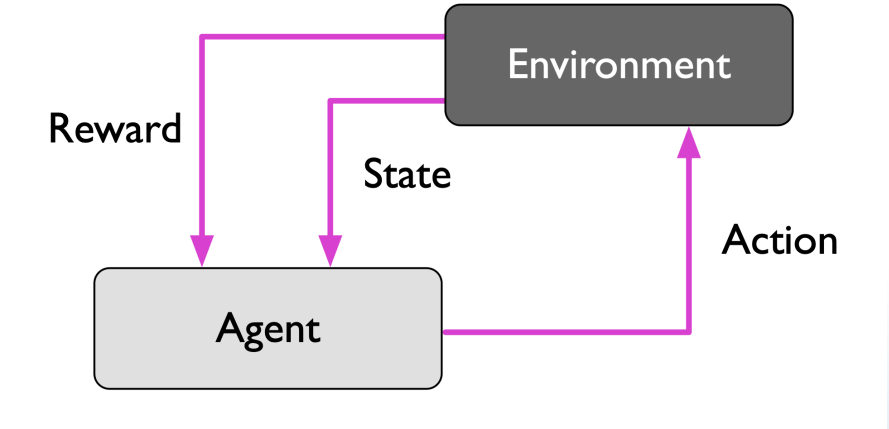
- Reinforcement learning: a subcategory of machine learning that deals with learning from an environment through trial and error
- Goal: to develop an agent that improves its performance based on the interaction with the environment
- Inputs: a reward signal that provides information about the current state of the environment
- Reward function: a measure of how well the agent's actions align with the desired outcome
- Example: game playing agents, where the goal is to learn a strategy that maximizes the reward or score



Reinforcement Learning Example: Chess Program

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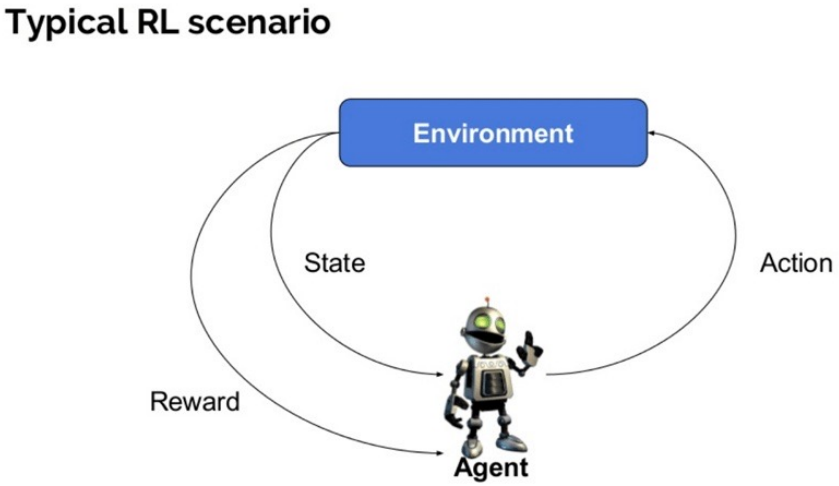
- Reinforcement learning example: chess program
- Agent: a chess program that decides on a series of moves based on the state of the board
- Reward: the outcome of the game, win or lose
- Reward function: a measure of how well the agent's actions align with the desired outcome, which is to win the game
- Learning: the agent learns to choose a series of actions that maximize the total reward, which is the outcome of the game



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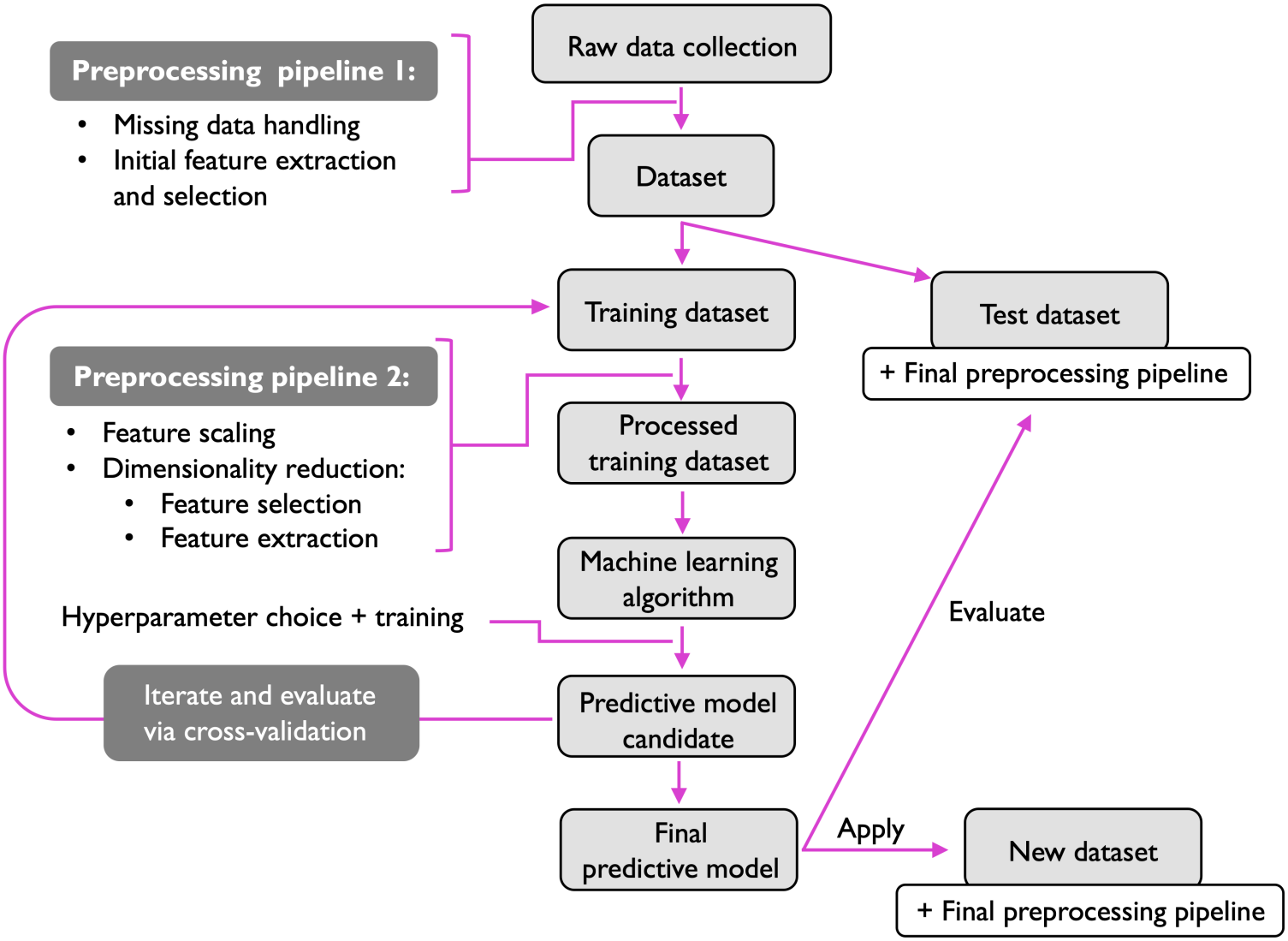
The building blocks of successfully designing machine learning systems

Part III

ML Workflow for predictive Modeling



Summary of Introduction to Machine Learning

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- Recap of the general concept of machine learning, and the three types of learning: supervised, unsupervised, and reinforcement learning
- Overview of the building blocks of successfully designing machine learning systems, including the predictive modeling workflow
- Discussion of the examples of daily applications of machine learning, such as spam filters and medical applications
- Overview of the key terms and concepts discussed in the lecture, including classification, regression and dimensionality reduction
- Additional resources for self-study and further learning.