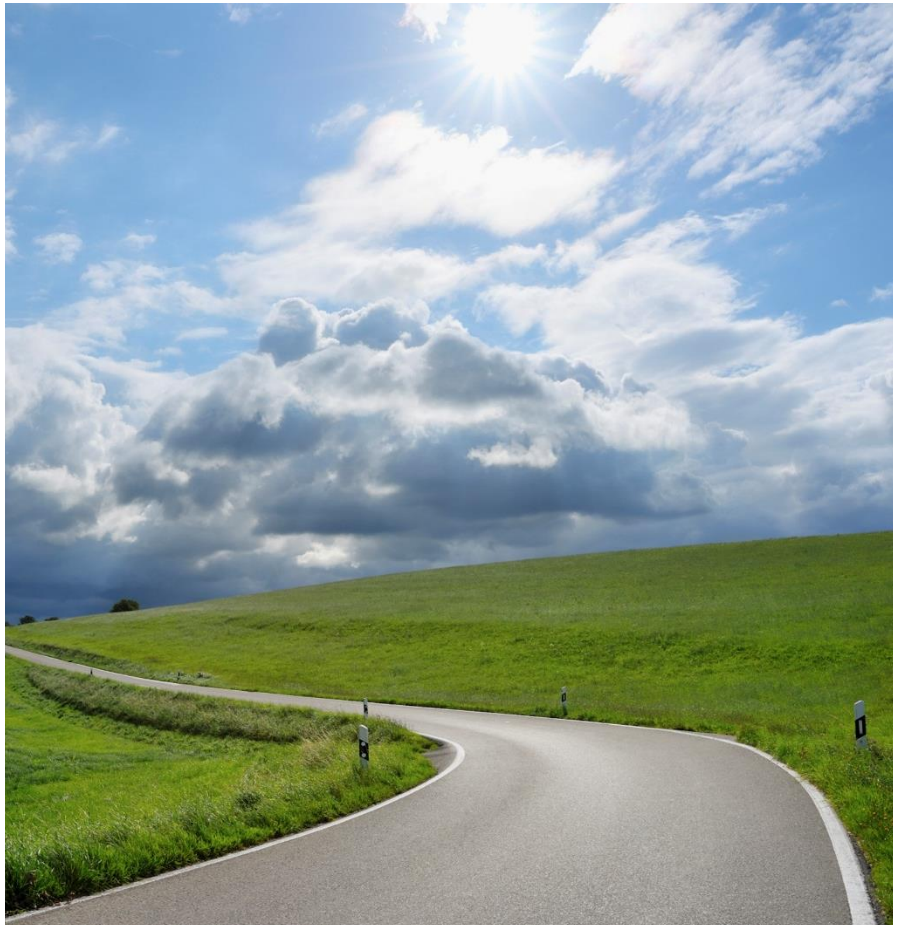
Week 1 Unit 1: **Intelligent Applications Powered by Machine Learning**

Intelligent Applications Powered by Machine Learning

Objectives

- Realize recent advances in machine learning
- Understand the impact on enterprise computing and knowledge work
- Explain the outline of the course



Intelligent Applications Powered by Machine Learning

Software is becoming intelligent

- **Machine learning is sweeping the world**
  - Computers are beginning to learn from data without being explicitly programmed
  - Examples: personal assistants, self-driving cars
- **Possible now because of advances in machine learning**
  - Deal with unstructured information in a new way
  - Learn complex functions from examples

Chair

Dining Table

Person

Intelligent Applications Powered by Machine Learning

Computer vision is surpassing human abilities

Chair

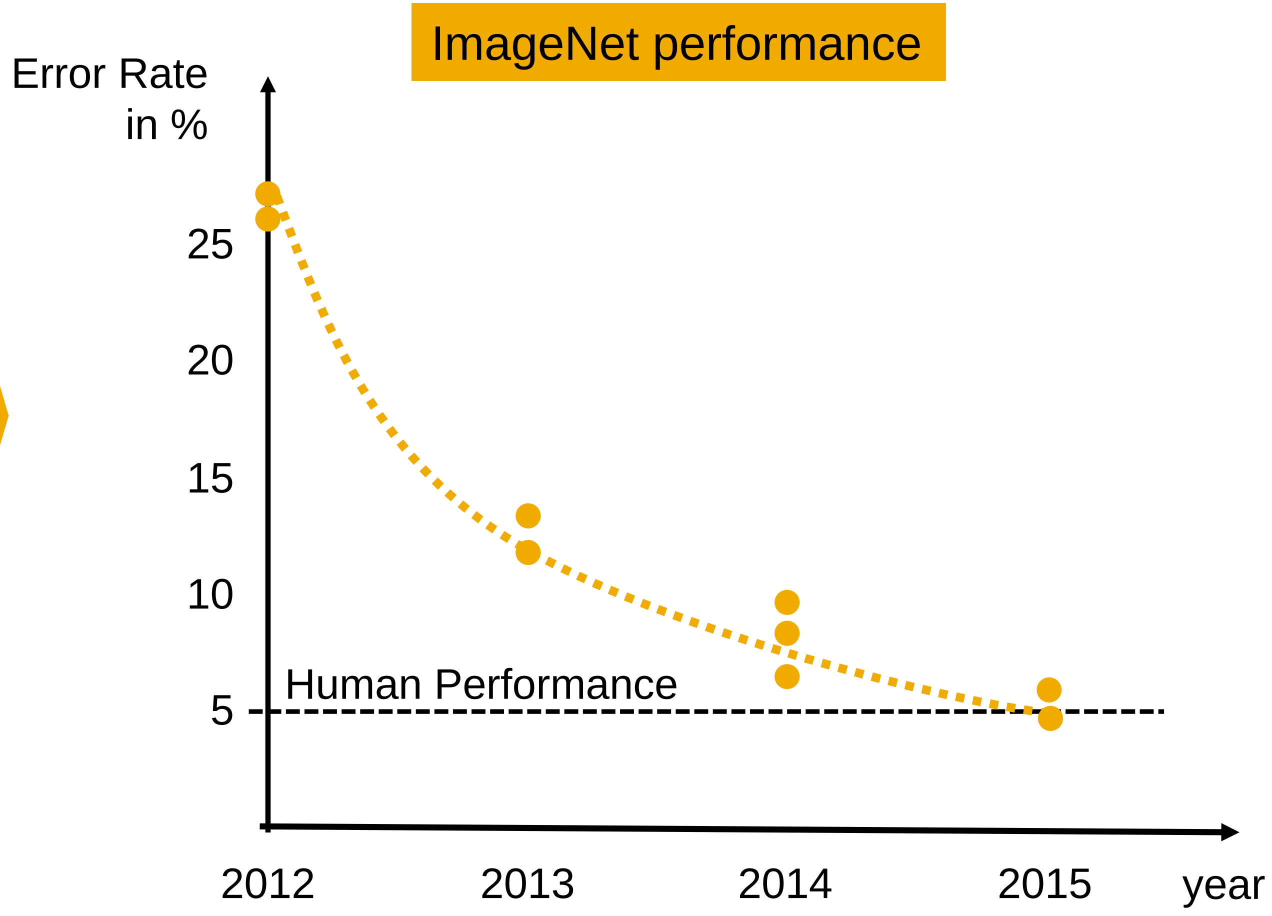
Dining Table

Person

Dog

Person

Leaves



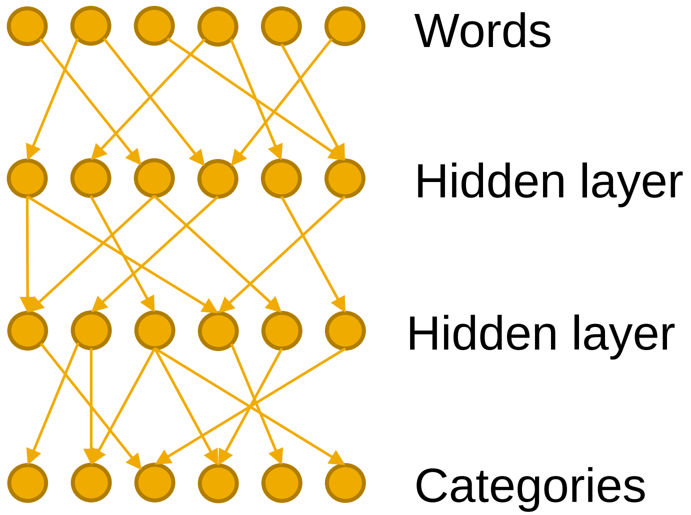
Intelligent Applications Powered by Machine Learning

Trained, not programmed

- **Traditional computer program**
  - Explicitly programmed to solve problem
  - Decision rules are clearly defined by humans

```
if (..) then {
   ..
} else {
   ..
}
```

- **Machine learning**
  - Trained from examples
  - Decision rules complex or fuzzy
  - Rules are not defined by humans but learned by the machine from data



Intelligent Applications Powered by Machine Learning

Future of knowledge work

- **Machine learning can become another industrial revolution**
  - Enterprise machine learning projected to grow at 56% to $4bn in 2020
- **Automate knowledge work**
  - Computers will enhance or automate repetitive knowledge work
  - Today’s ML can automate a large number of work activities
- **Do the impossible**
  - New applications and business models

Intelligent Applications Powered by Machine Learning

Why now?

- **Key drivers behind machine learning progress**
  - **"Big Data"** – data sets magnitudes larger today than they used to be
  - Better **algorithms**, e.g. deep learning neural networks
  - Massive **compute power**, e.g. GPU computing
- **Machine learning is beginning to transform enterprise computing**
  - Digital transformation creates wealth of data
  - Real-time applications and cloud make data actionable

Intelligent Applications Powered by Machine Learning

Outline of this course

Unit 1: Introduction (this session)

Unit 2: Explain the basic concepts behind ML

Unit 3: Transforming business use cases
into machine learning challenges

Unit 4: Understand how machine learning fits
into enterprise computing landscape

Unit 5 and 6: End-to-end examples

Unit 7: Key Takeaways

Thank you

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Week 1 Unit 2:
What Is Machine Learning?

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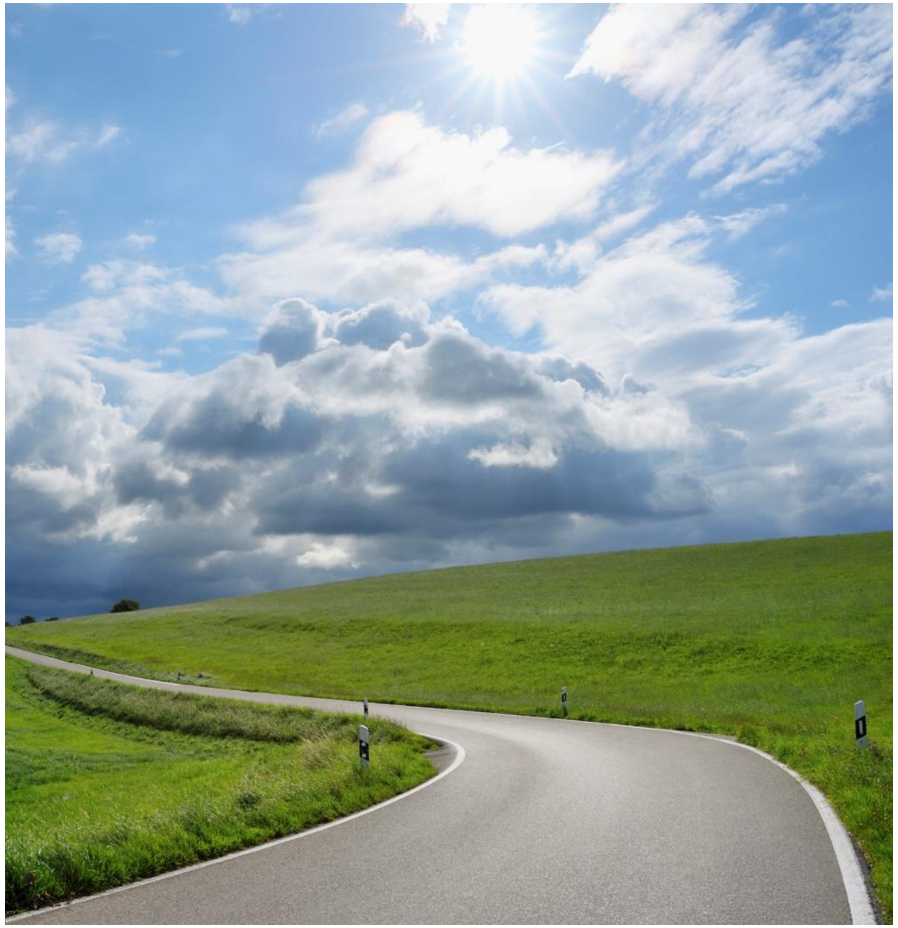
What Is Machine Learning?
Objectives

- Provide a definition of machine learning
- Explain machine learning capabilities and typical tasks
- Advantages of machine learning's 'data-driven' approach over the traditional 'rule-based' approach



What Is Machine Learning?

Definition

> “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**.“

Mitchell, T. (1997). Machine Learning, McGraw Hill

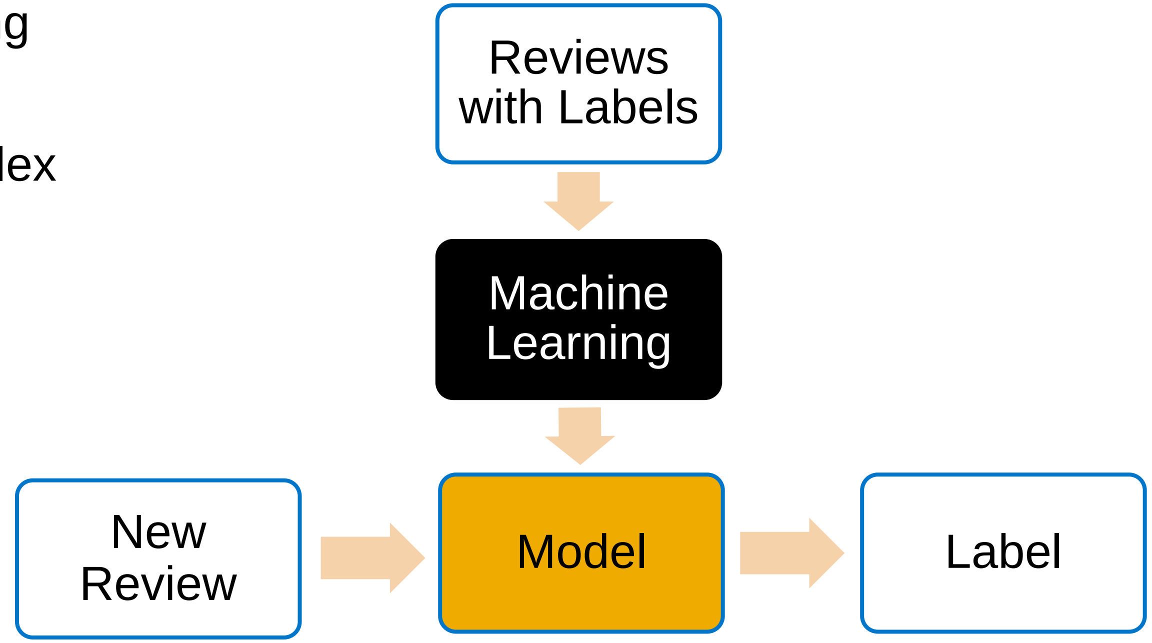
What Is Machine Learning?
Definition

Machine learning:

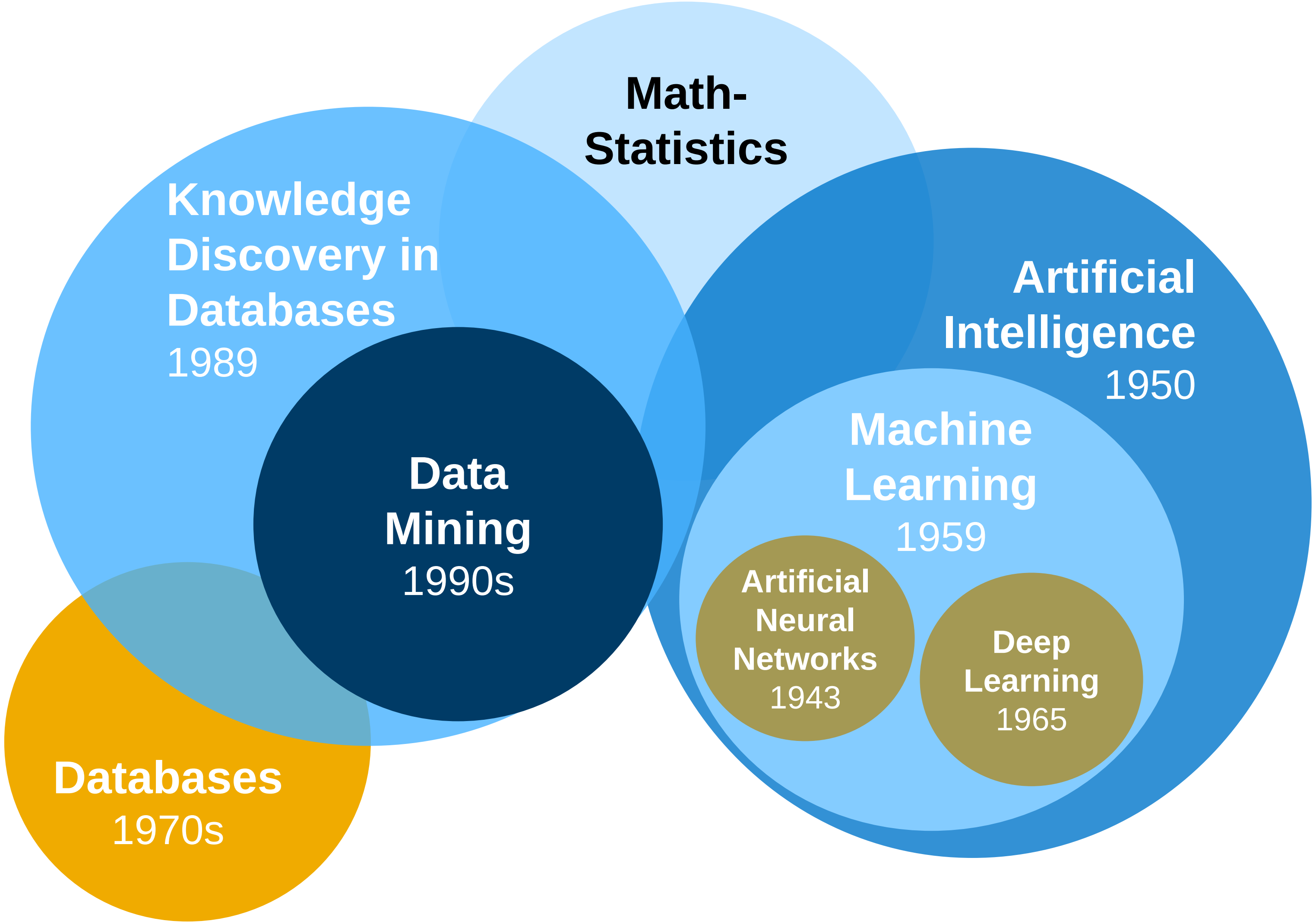
- Provides computers with the ability to learn without being explicitly programmed
- Learning means that computers can approximate complex decision functions based on data

Example: sentiment analysis

- Training data: reviews with labels
- Model: function (review) → label
- New data: review
- Predictive result: label



What Is Machine Learning?
The machine learning and AI landscape



What Is Machine Learning?

Machine learning capabilities

Machine learning is used in many applications

- Computer vision: face recognition, object recognition
- Natural language processing: machine translation, sentiment analysis
- Recommender systems

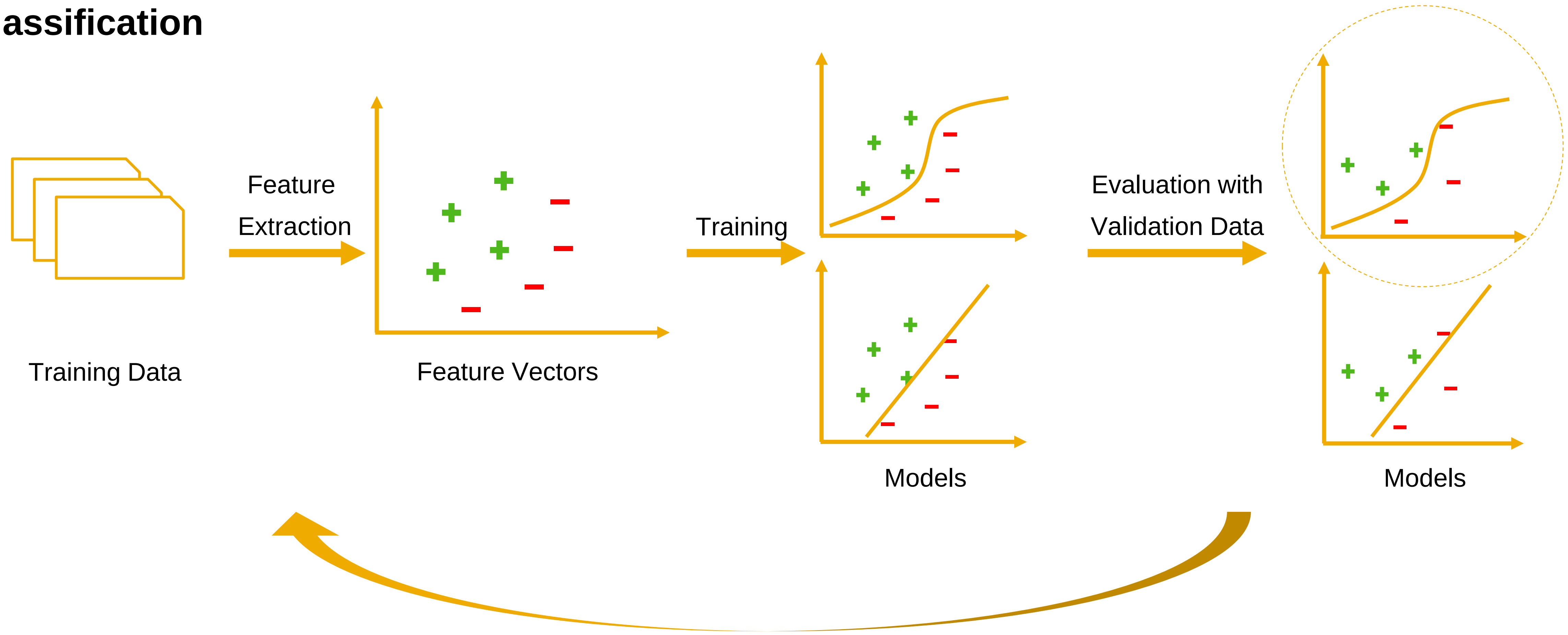
Recent breakthroughs using deep learning

- Automatically generate image captions
- AlphaGo: AI beats the world’s top Go player

What Is Machine Learning?

Typical machine learning tasks

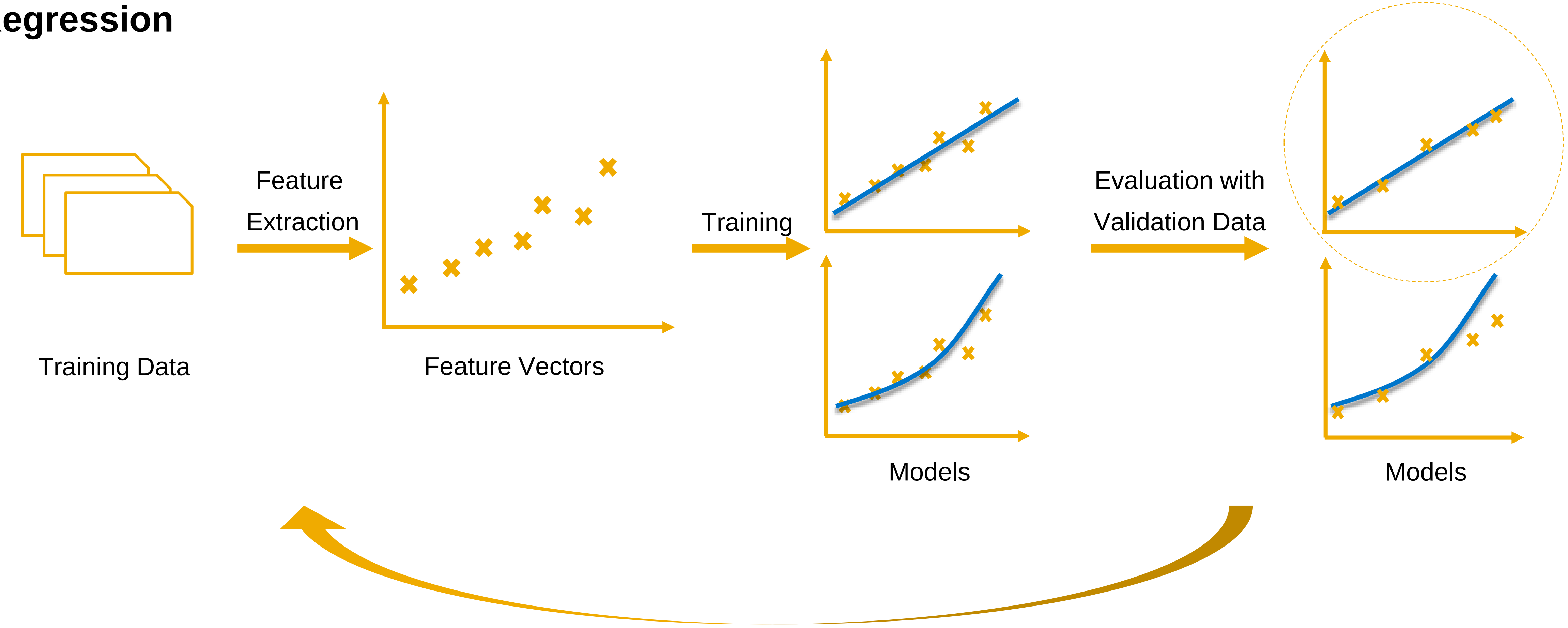
Classification



What Is Machine Learning?

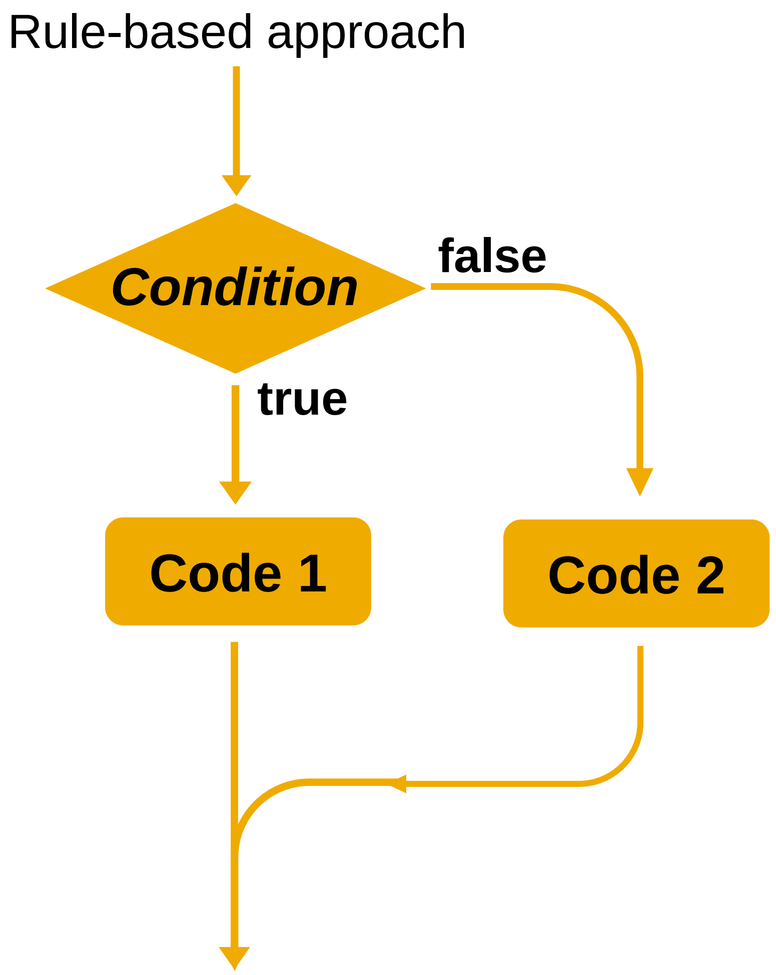
Typical machine learning tasks

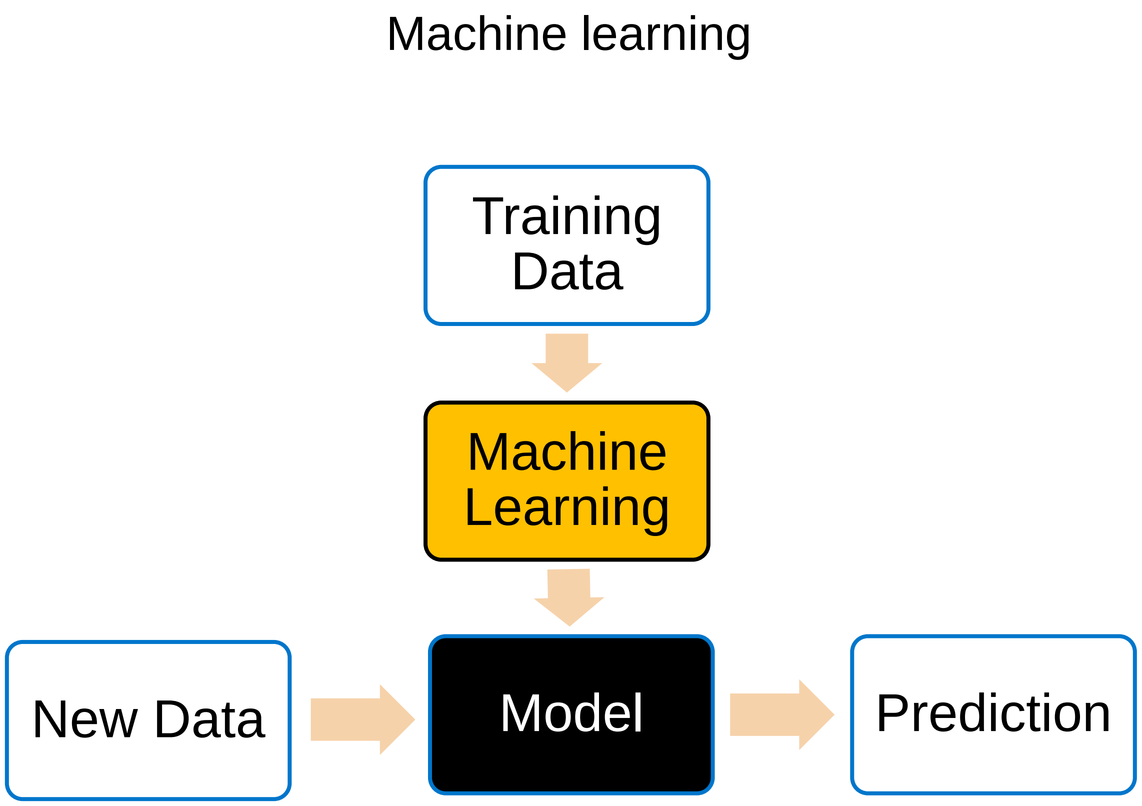
Regression



What Is Machine Learning?

Traditional rule-based approach vs. machine learning





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Week 1 Unit 3: **From Business Problem to Machine Learning Problem: A Recipe**

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From Business Problem to Machine Learning Problem: A Recipe

Objectives

Step-by-step "recipe" for qualifying a business problem as a machine learning problem

1. Do you need machine learning?
2. Can you formulate your problem clearly?
3. Do you have sufficient examples?
4. Does your problem have a regular pattern?
5. Can you find meaningful representations of your data?
6. How do you define success?

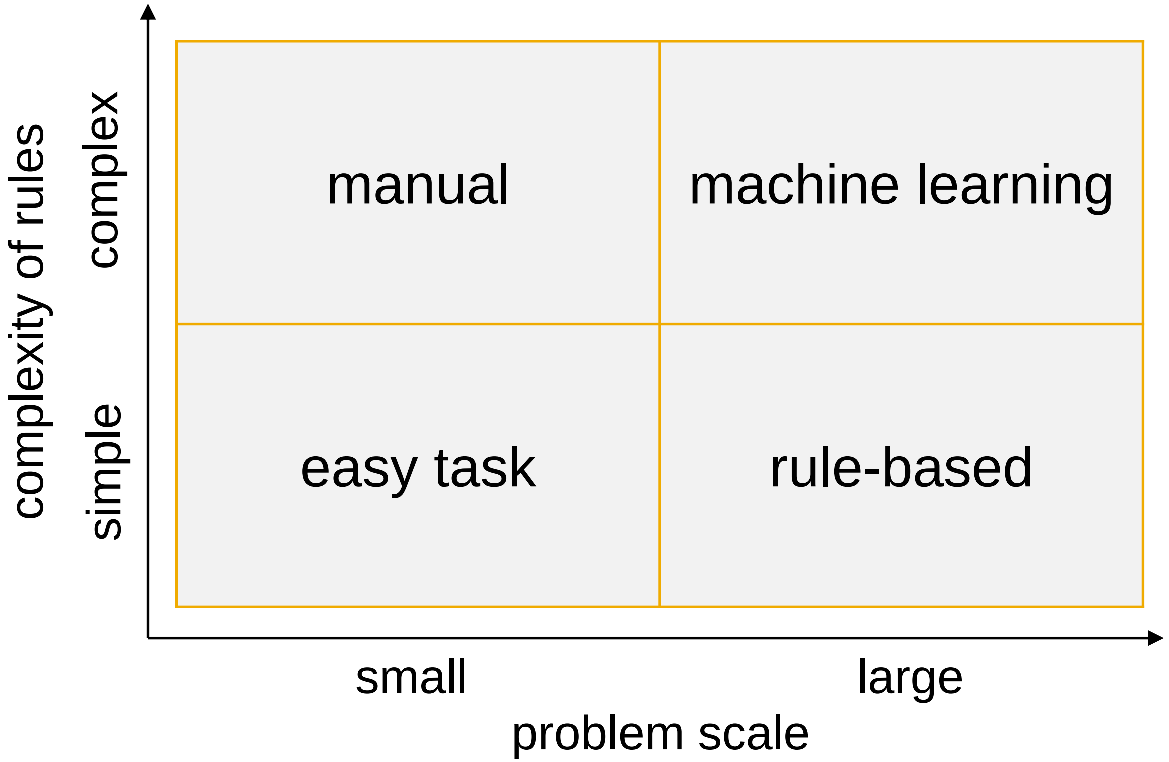
From Business Problem to Machine Learning Problem: A Recipe

When to use machine learning

1. **Do you need machine learning?**
   - Do you need to automate the task?
   - High volume tasks with complex rules and unstructured data are good candidates

Example: sentiment analysis

- High volume of reviews on the Web
- Unstructured text
- Human language is complex and ambiguous



From Business Problem to Machine Learning Problem: A Recipe

Problem formulation

2. **Can you formulate your problem clearly?**
   - What do you want to predict given which input?
   - Pattern: “given X, predict Y”
     - What is the input?
     - What is the output?

Example: sentiment analysis

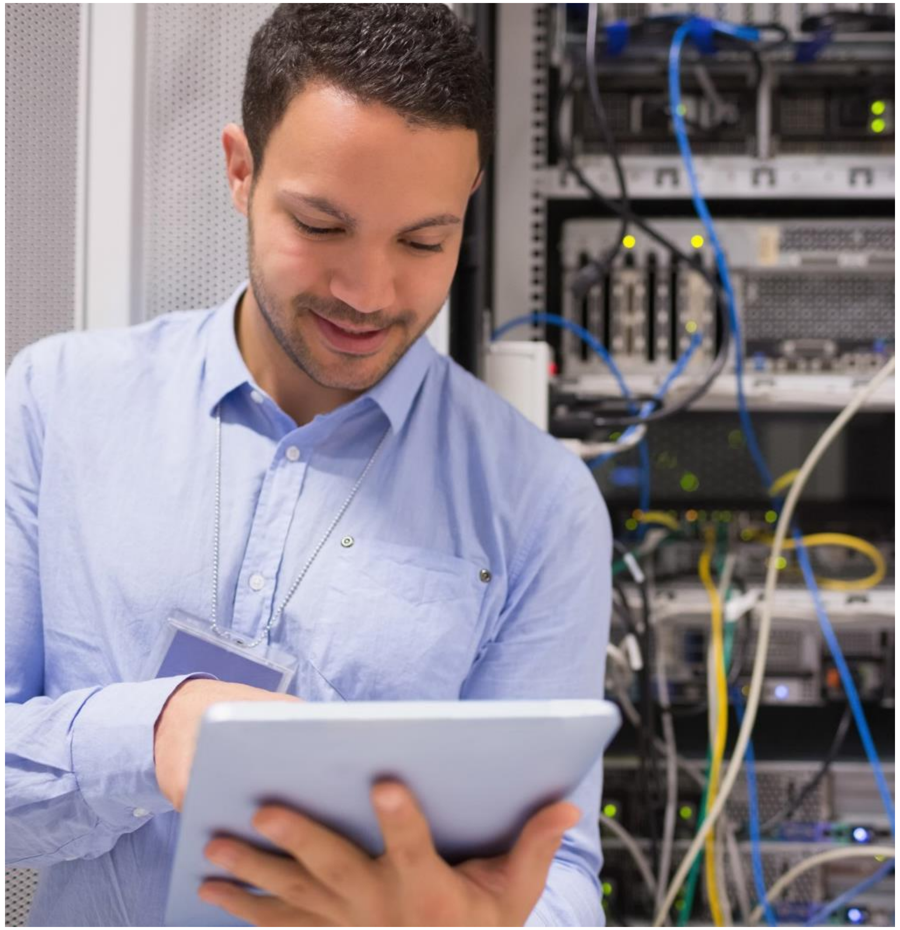
- Given a customer review, predict its sentiment
- Input: customer review text
- Output: positive, negative, neutral

From Business Problem to Machine Learning Problem: A Recipe
Collecting data

3. **Do you have sufficient examples?**
   - Machine learning always requires data!
   - Generally, the more data, the better
   - Each example must contain two parts (supervised learning)
     - Features: attributes of the example
     - Label: the answer you want to predict

Example: sentiment analysis

- Thousands of customer reviews and ratings from the Web



From Business Problem to Machine Learning Problem: A Recipe

Regularities in the data

4. **Does your problem have a regular pattern?**
   - Machine learning learns regularities and patterns
   - Hard to learn patterns that are rare or irregular

Example: sentiment analysis

- Positive words like *good*, *awesome,* or *love it* appear more often in highly-rated reviews
- Negative words like *bad*, *lousy,* or *disappointed* appear more often in poorly-rated reviews

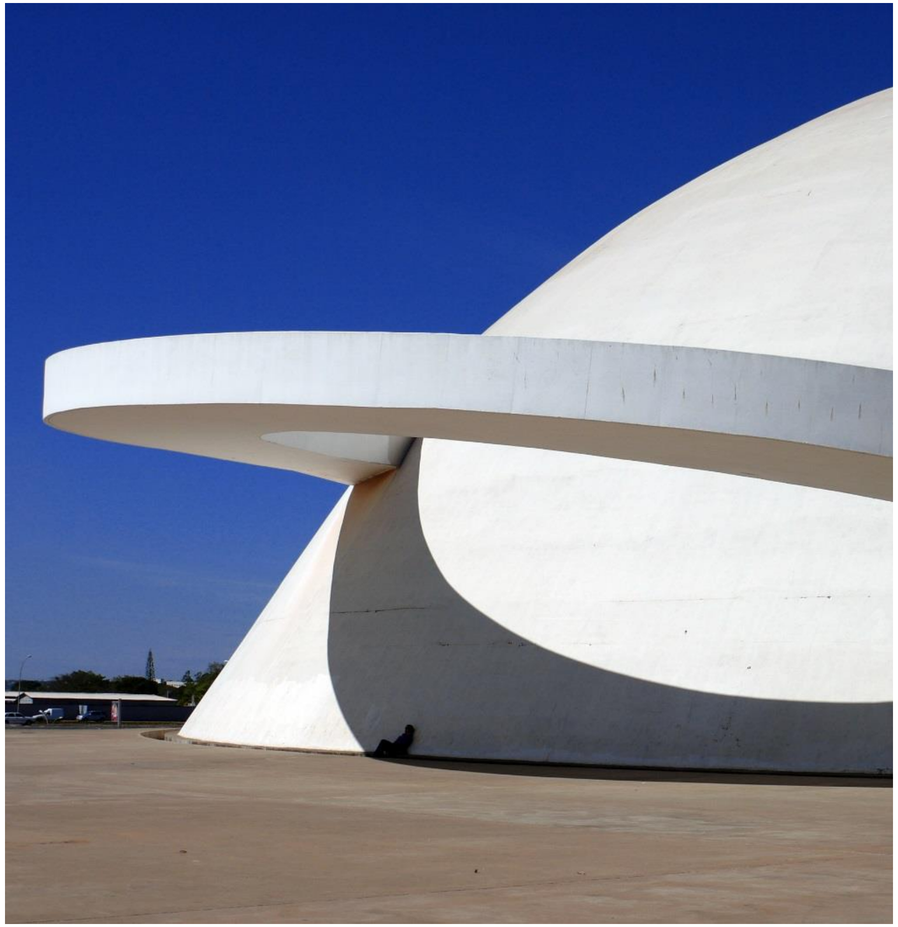
From Business Problem to Machine Learning Problem: A Recipe

Representations and features

5. **Can you find meaningful representations of your data?**
   - Machine learning algorithms ultimately operate on numbers
   - Generally, examples are represented as feature vectors
   - Good features often determine the success of machine learning

Example: sentiment analysis

- Represent customer review as vector of word frequencies
- Label is positive (4-5 stars), negative (1-2 stars), neutral (3 stars)



From Business Problem to Machine Learning Problem: A Recipe

Evaluating success

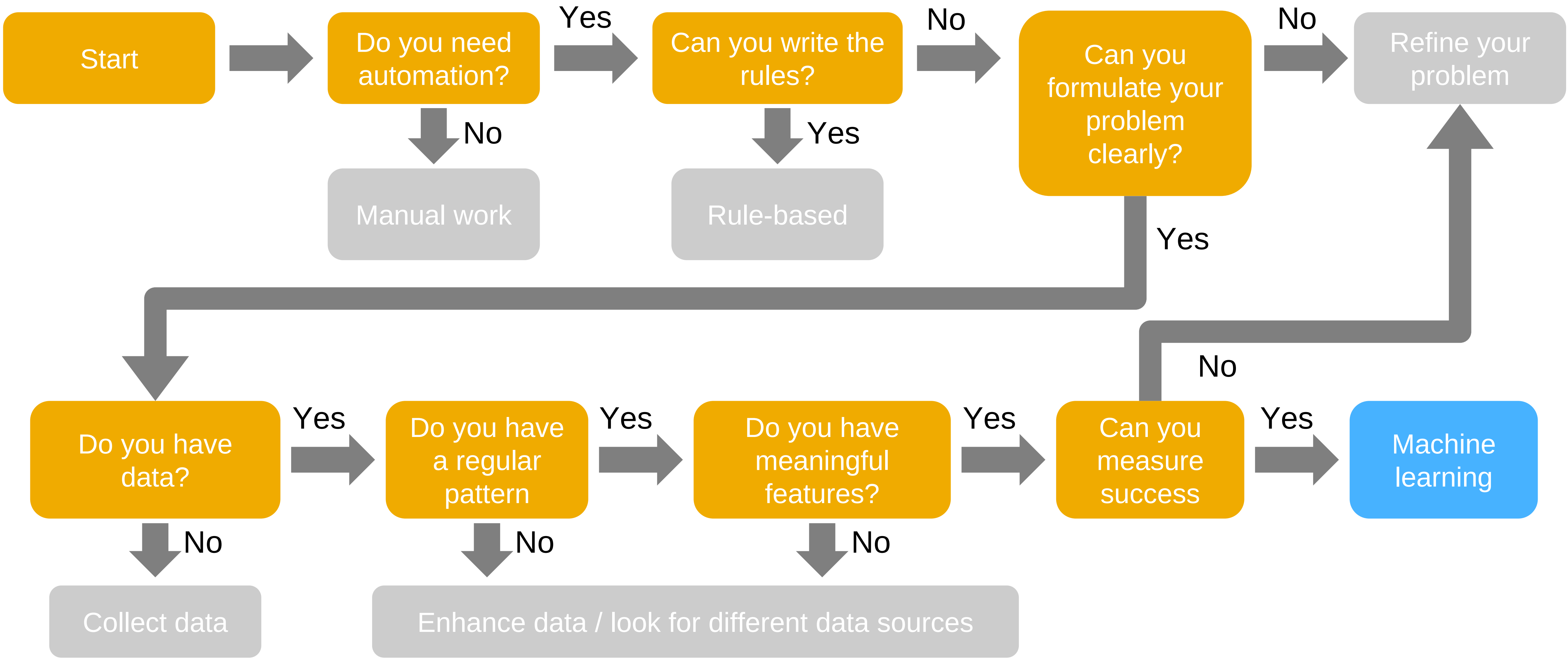
6. **How do you define success?**
    - Machine learning optimizes a training criteria
    - The evaluation function has to support the business goals

Example: sentiment analysis

- Accuracy: percentage of correctly predicted labels

From Business Problem to Machine Learning Problem: A Recipe

The “cheat sheet”



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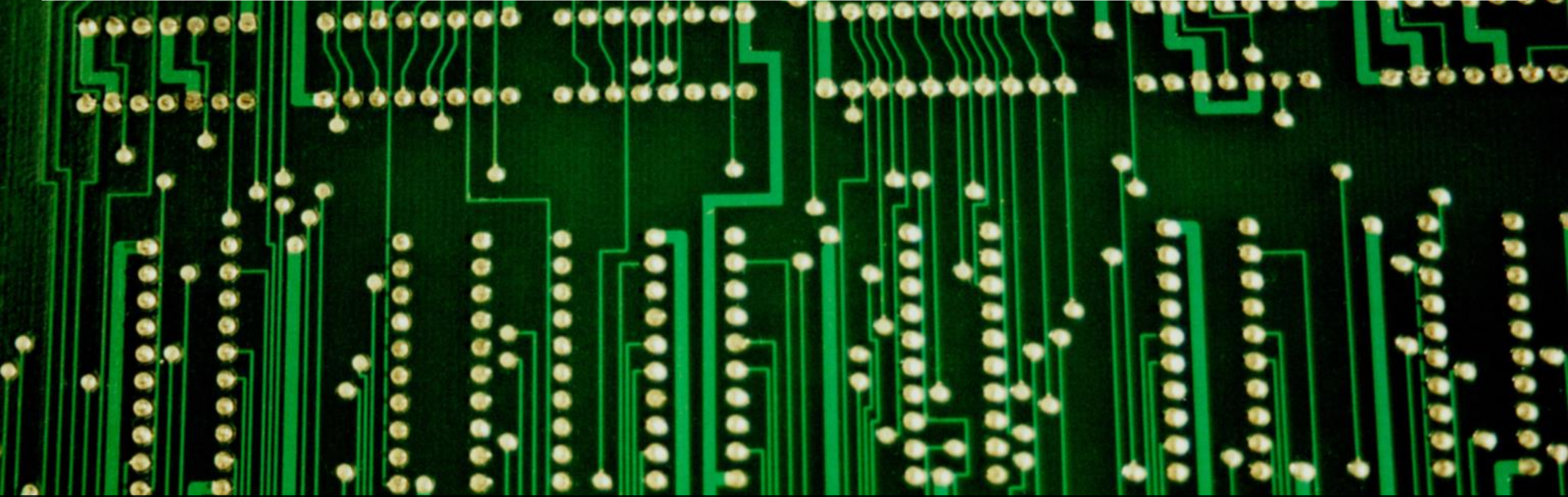
Week 1 Unit 4: **Machine Learning in Enterprise Computing**



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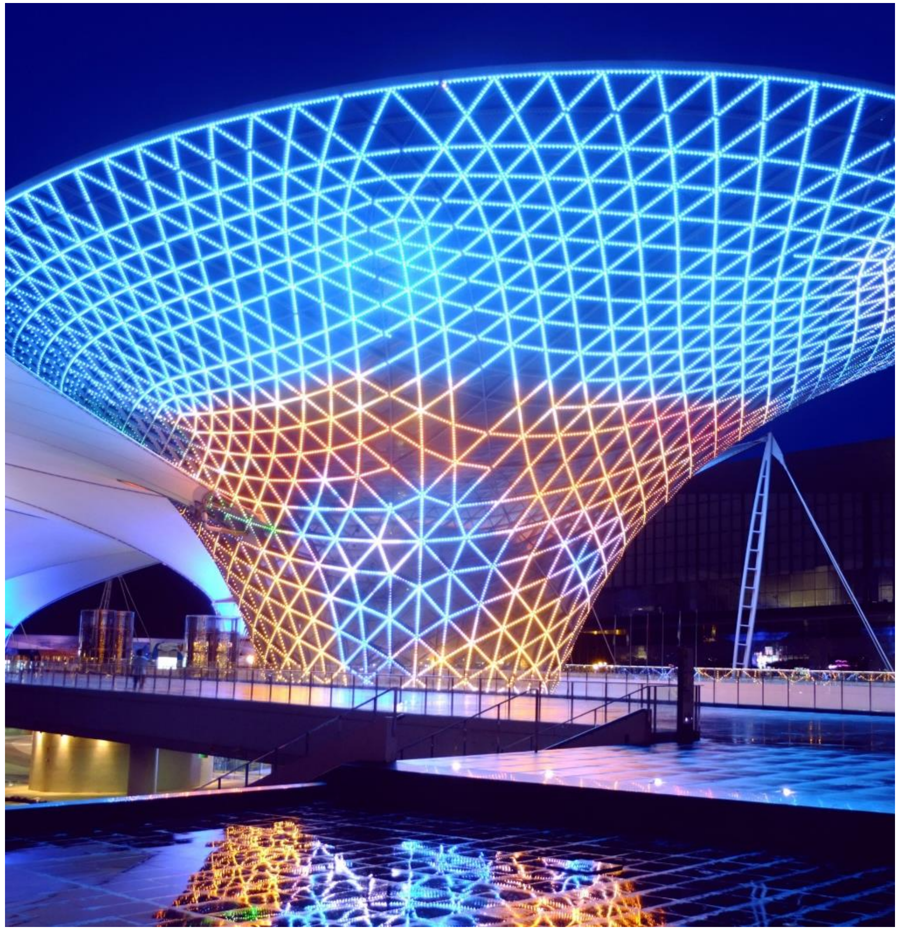
Machine Learning in Enterprise Computing

Objectives

- Become familiar with common tasks and architecture principles used in machine learning
- Understand how machine learning fits into enterprise application landscapes



Machine Learning in Enterprise Computing

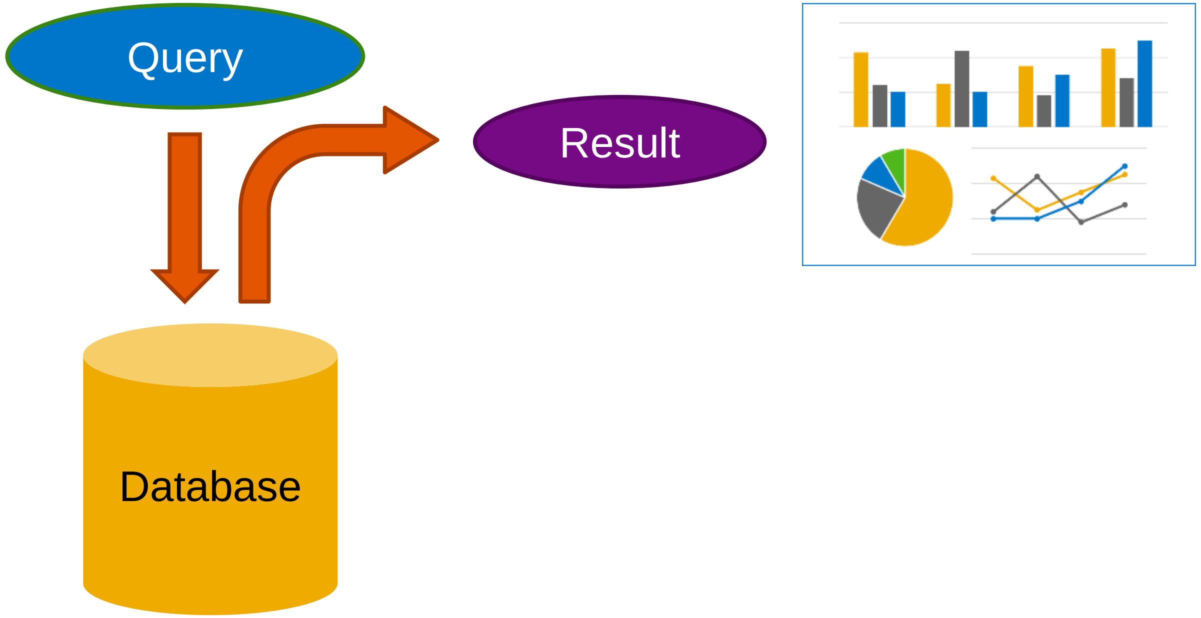
Goals and activities

- **Transform enterprise data into business value**
  - Higher revenue
  - Lower costs
  - Satisfied customers
  - Quality time at work
  - Etc.

Machine Learning in Enterprise Computing

Traditional business intelligence

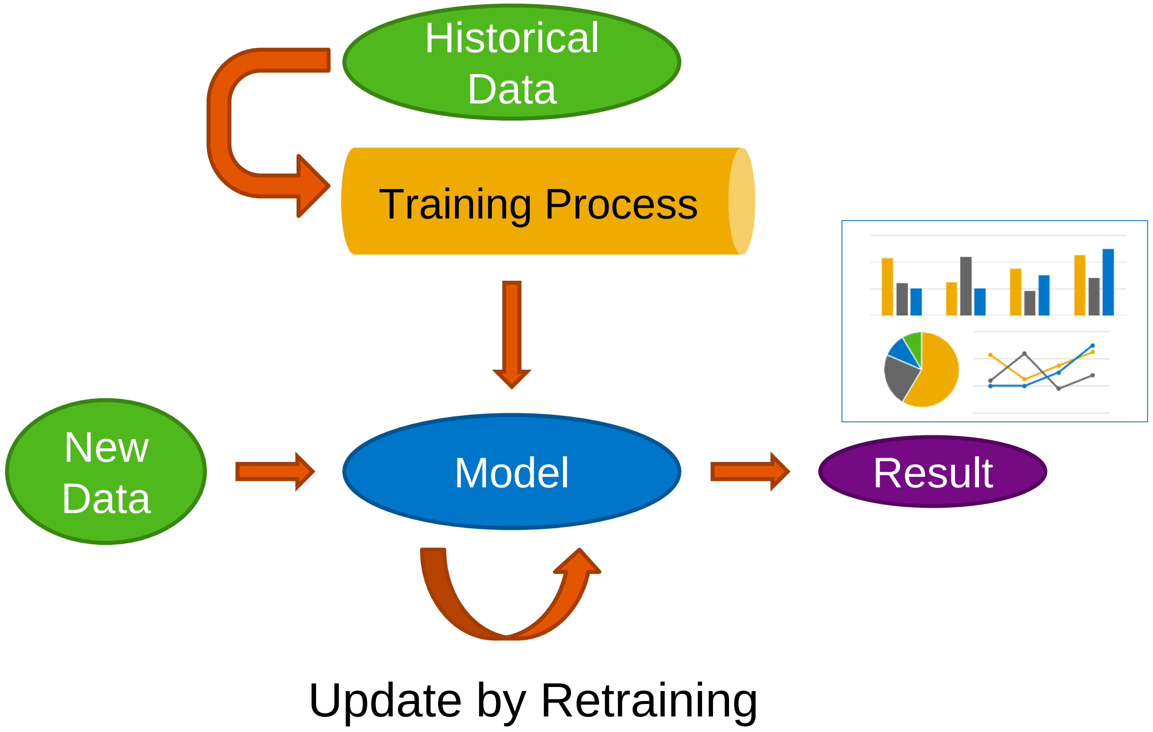
- Structured data in a database
- Human-defined queries or rules
- Focused on analysis of past data



Machine Learning in Enterprise Computing

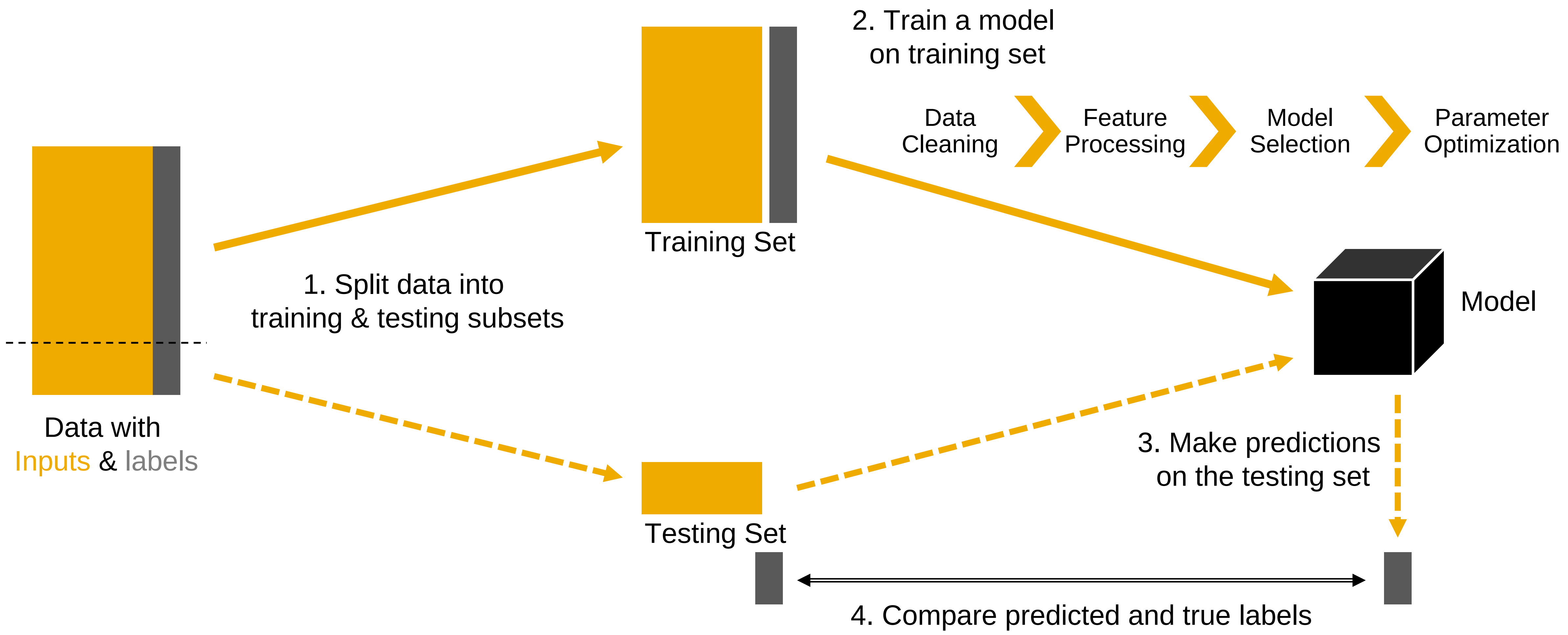
Machine learning

- Train machine-learning model on historical data
- Deploy the model to make predictions on new data
- Regularly retrain the model with new data
- Focus on making predictions about future data



Machine Learning in Enterprise Computing

Creating machine learning models

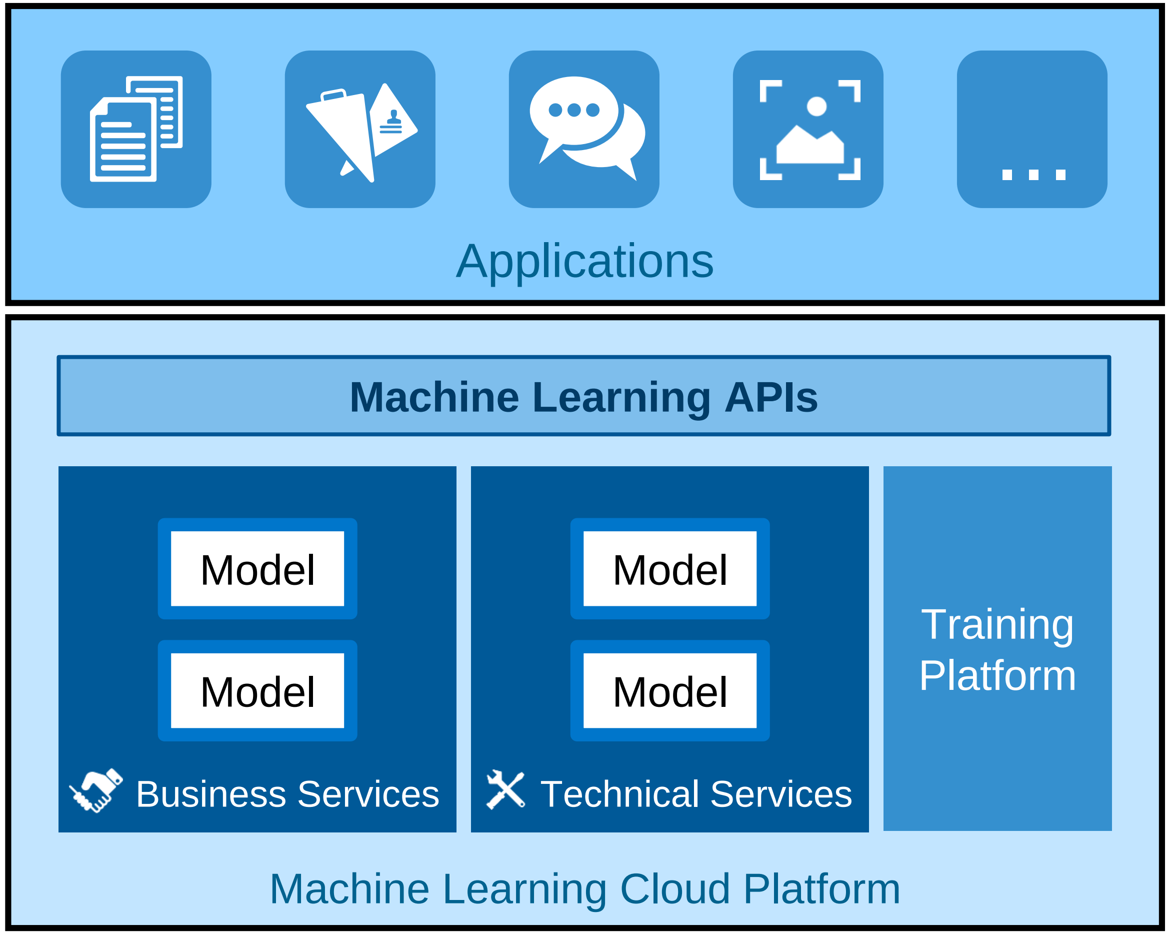


Machine Learning in Enterprise Computing

Deploying machine learning

Machine learning architecture

- Cloud platforms for handling large data volume and integrating data sources
- Machine learning models deployed as microservices
- Enterprise applications consume services through APIs
- Business services directly support enterprise applications
- Technical services are building blocks for new applications



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Week 1 Unit 5: **Application Example: Natural Language Processing**

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Application Example: Natural Language Processing

Objectives

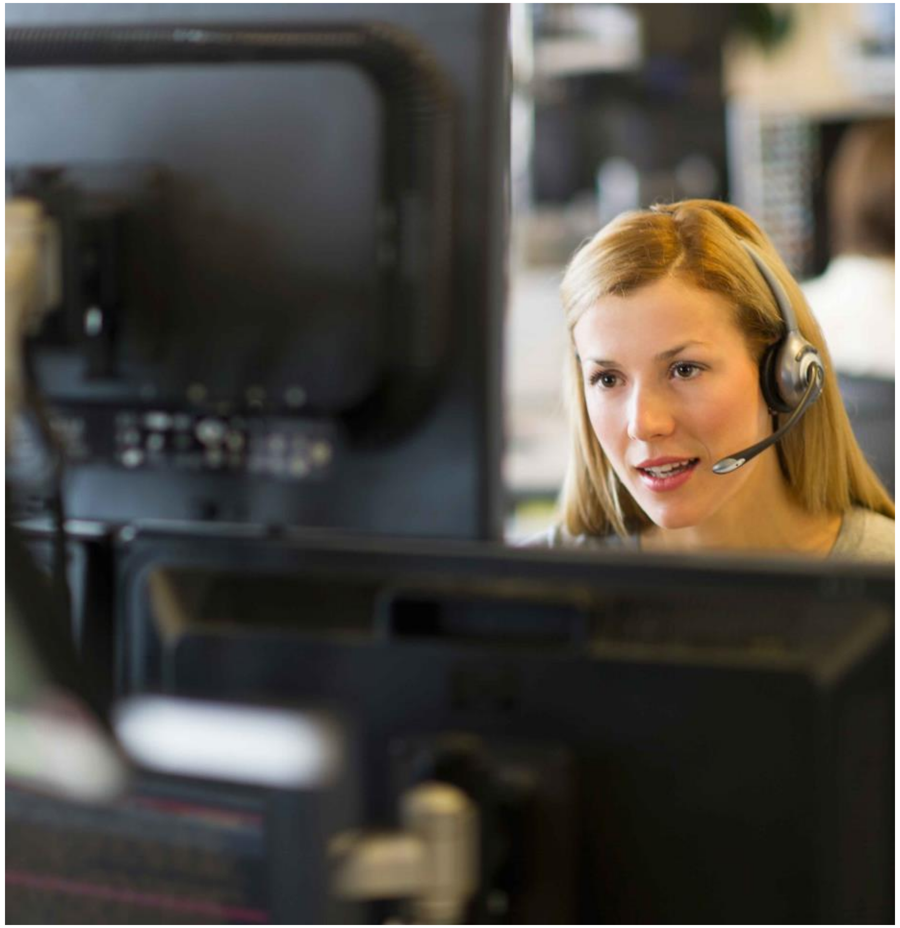
- Describe two end-to-end examples for applications involving natural language text
  - Support ticket classification
  - Recruiting – CV matching

Application Example: Natural Language Processing

Support ticket classification

Example: Classify support tickets into categories so that they can be routed to corresponding agents

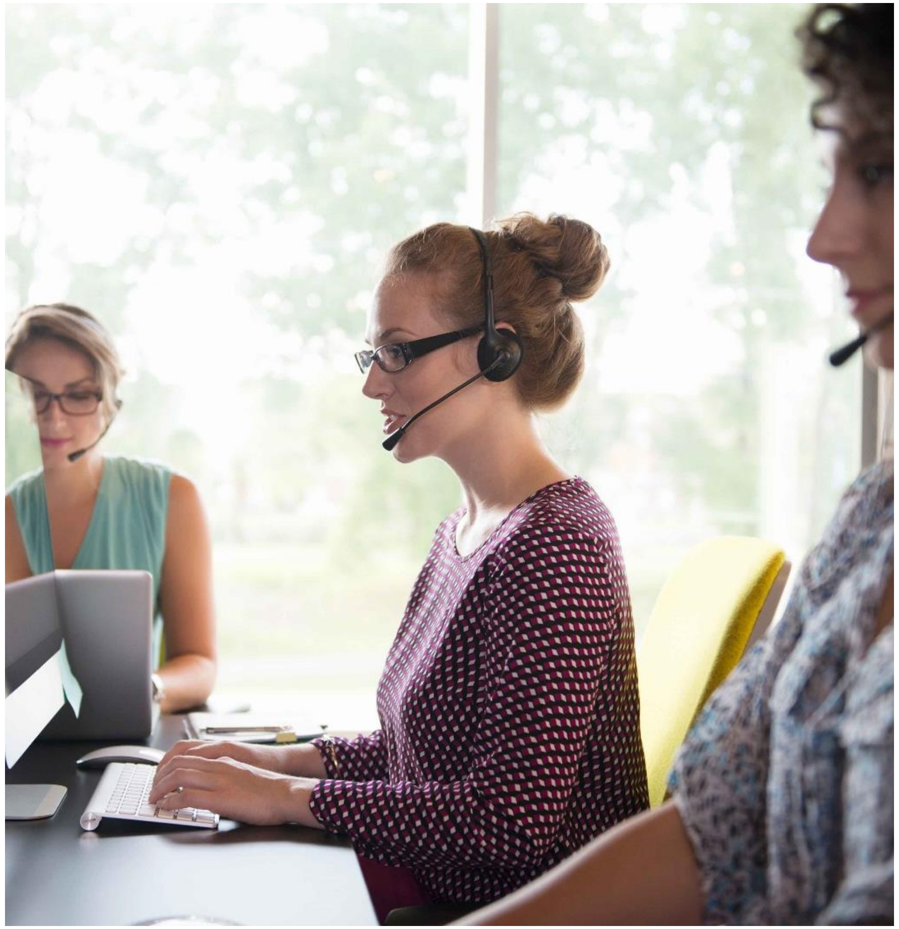
1. **Do you need machine learning?**
   - High volume of support tickets
   - Human language is complex and ambiguous
2. **Can you formulate your problem clearly?**
   - Given a customer support ticket, predict its service category
   - Input: customer support ticket; output: service category
3. **Do you have sufficient examples?**
   - Large volume of customer support tickets with respective service category from ticket support systems



Application Example: Natural Language Processing

Support ticket classification

4. **Does your problem have a regular pattern?**
   - Common customer issues will have many tickets
   - Issues will correlate with common keywords, e.g., *bill* or *payment* will appear more often in support tickets with category *payments*
5. **Can you find meaningful representations of your data?**
   - Represent customer support tickets as vector of word frequencies
   - Label is the service category of the customer support ticket
6. **How do you define success?**
   - Measure percentage of correctly predicted service categories

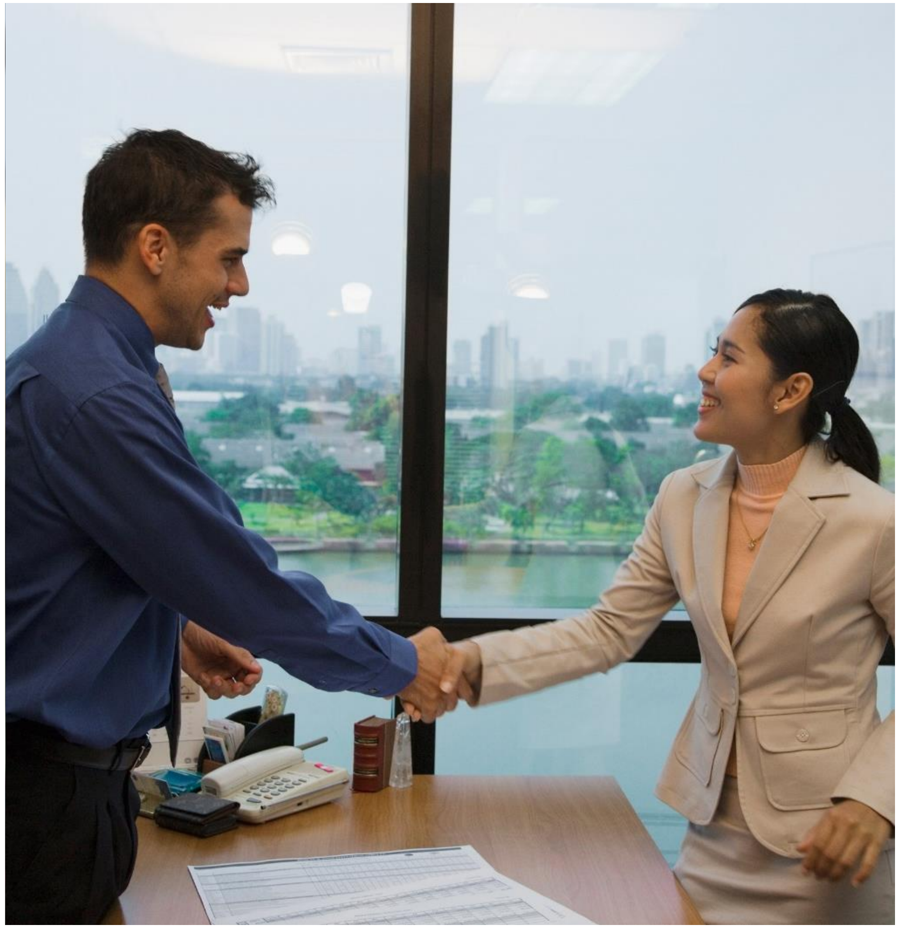


Application Example: Natural Language Processing

Recruiting – CV matching

Example: Shortlist candidates during recruiting

1. **Do you need machine learning?**
   - Hundreds of applications per job opening
   - Manual effort to read CVs and screen candidates
2. **Can you formulate your problem clearly?**
   - Given a candidate’s CV and a job description, predict suitability
   - Input: CV and job description; output: yes/no
3. **Do you have sufficient examples?**
   - Large volume of previous job applications, job descriptions, and whether candidate was invited for interview



Application Example: Natural Language Processing

Recruiting – CV matching

4. **Does your problem have a regular pattern?**
   - Required skills in job description should match experience in CV
   - Good CVs have no typos, are neither too long nor too short, etc.
5. **Can you find meaningful representations of your data?**
   - Represent CVs and job descriptions as vector of features that measure similarity and match
   - Label is whether the candidate was invited for interview
6. **How do you define success?**
   - Measure precision and recall of correct predictions

Thank you

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Week 1 Unit 6: **Application Example: Computer Vision**

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Application Example: Computer Vision
Objectives

- Describe end-to-end examples for applications involving computer vision
  - Retail shelf analytics
  - Fashion apparel color analysis

Application Example: Computer Vision

Retail shelf analytics

Example: Given a picture of a retail shelf, detect all products in the picture and compare with planned layout

1. **Do you need machine learning?**
   - High manual effort to monitor store shelves every day
   - Detecting products in images not possible with simple rules
2. **Can you formulate your problem clearly?**
   - Given a shelf image, first detect products and then compare their positions with the planned shelf layout
   - Input: photo; output: bounding boxes of products
3. **Do you have sufficient examples?**
   - Large volume of collected retail shelf pictures, manually labelled bounding boxes of products

Application Example: Computer Vision

Retail shelf analytics

4. **Does your problem have a regular pattern?**
   - Product packaging has regular shape, colors, and logos
5. **Can you find meaningful representations of your data?**
   - Represent photos as array of pixel values
   - Image patches with products are positive examples; random patches are negative examples
6. **How do you define success?**
   - Measure precision and recall of predicted bounding boxes and similarity of the detected layout to the true layout

Application Example: Computer Vision

Fashion apparel color analysis

Example: Analyze color trends in fashion apparel on social media to detect trends

1. **Do you need machine learning?**
   - High volume of photos on the Web and social media
   - Detecting fashion apparel in images not possible with simple rules
2. **Can you formulate your problem clearly?**
   - Given an image, first detect fashion apparel and then compute its color histogram
   - Input: photo; output: histogram of colors
3. **Do you have sufficient examples?**
   - Large volume of social media images including fashion apparel, manually labelled bounding boxes, and color histograms

Application Example: Computer Vision

Fashion apparel color analysis

4. **Does your problem have a regular pattern?**
   - Fashion apparel has regular, distinct shape
5. **Can you find meaningful representations of your data?**
   - Represent photos as array of pixel values
   - Image patches with fashion apparel are positive examples; random patches are negative examples
6. **How do you define success?**
   - Measure precision and recall of predicted bounding boxes and similarity of detected color histograms to ground truth

Thank you

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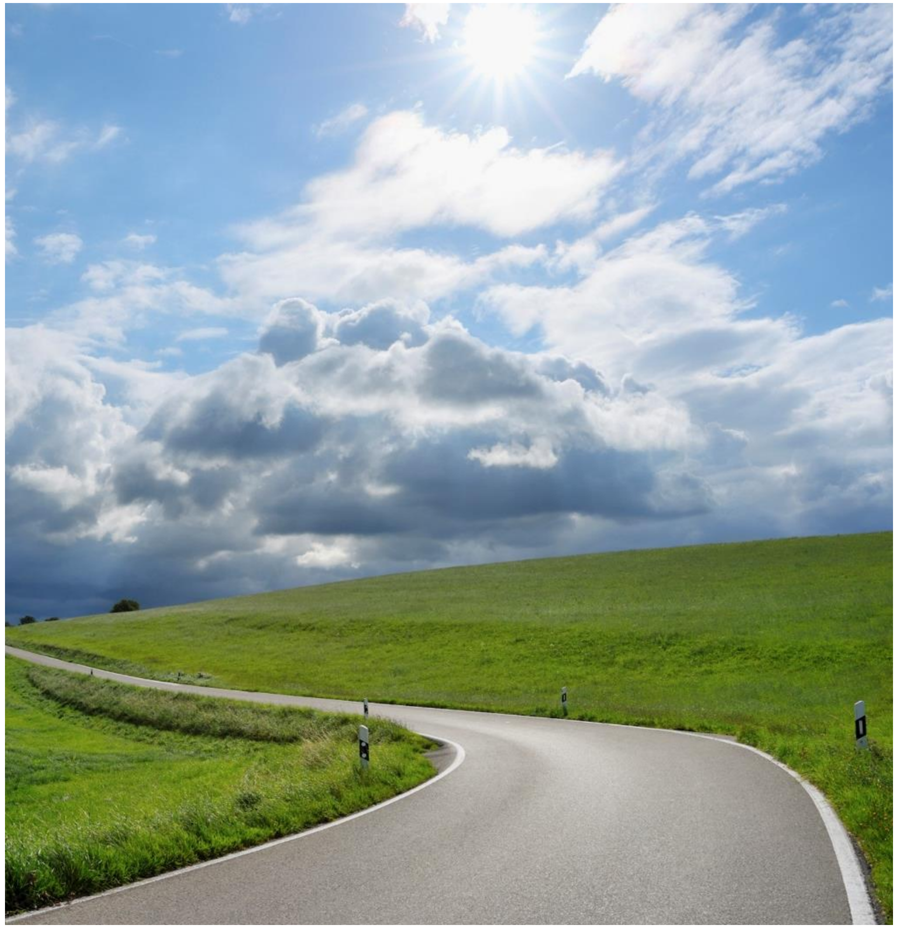
Week 1 Unit 7: **Key Takeaways**

Key Takeaways

Objectives

- Recap what we have learned
- Provide additional machine learning resources



Key Takeaways

Intelligent applications and machine learning

- **Machine learning enables computers to learn from data**
  - Computers approximate complex functions from historical data
  - Rules are not explicitly programmed but learned from data
- **Intelligent applications are expected to have a significant effect on the future of knowledge work and employment**
  - Large number of work activities can be automated with today's technology

Key Takeaways

From business use case to machine learning challenge

- **Identify if machine learning can solve your business problem**
  - High-volume, repetitive tasks on unstructured data are good candidates for ML
  - You cannot explicitly write the rules but you have examples
- **Machine learning comes with new architecture principles**
  - Machine learning requires separate training and prediction step
  - Microservices and APIs are a common architectural principle for ML services

Key Takeaways
Learning resources

- **Related openSAP courses**
  - Driving Business Results with Big Data
  - Big Data with SAP HANA Vora
  - Text Analytics with SAP HANA Platform
  - Data Science (coming soon)

- **Learning resources on the Web**
  - SAP ML microsite http://sap.com/ml
  - ML MOOCs (e.g. Andrew Ng at Coursera; Udacity ML Engineer Nanodegree)

Thank you

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