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Lab Session 1

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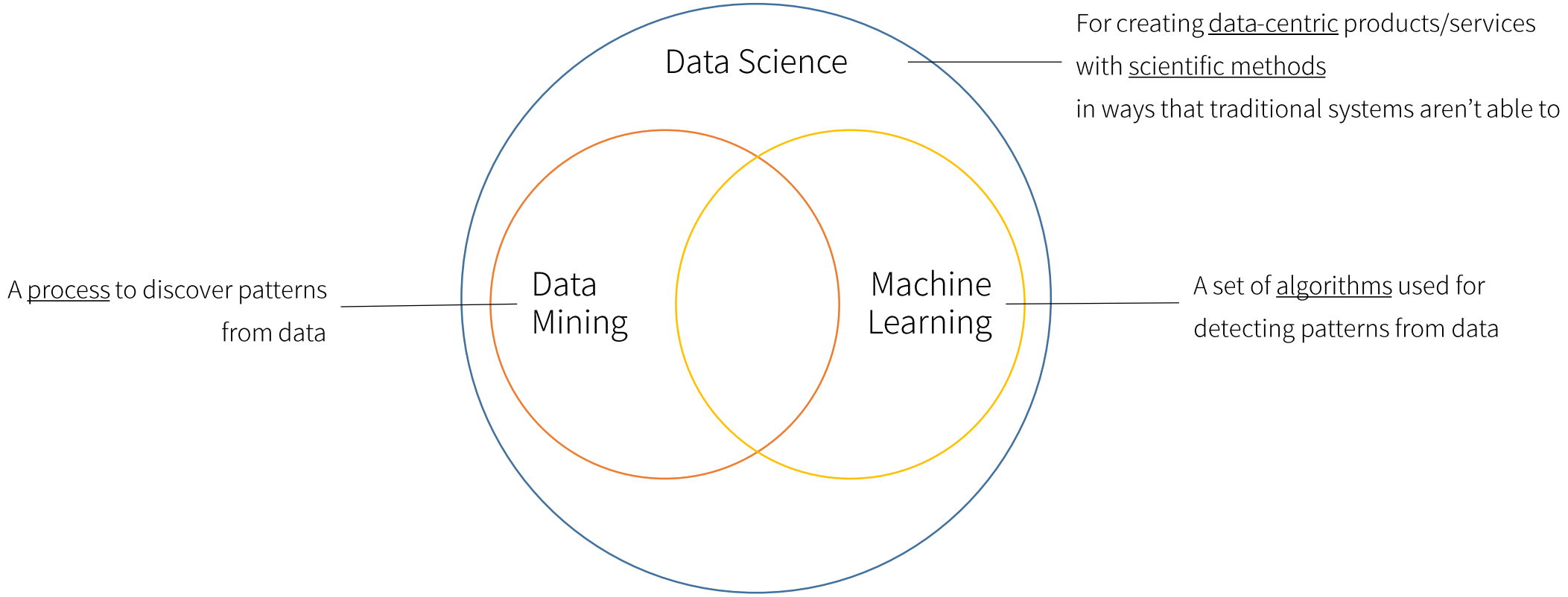
Glossary

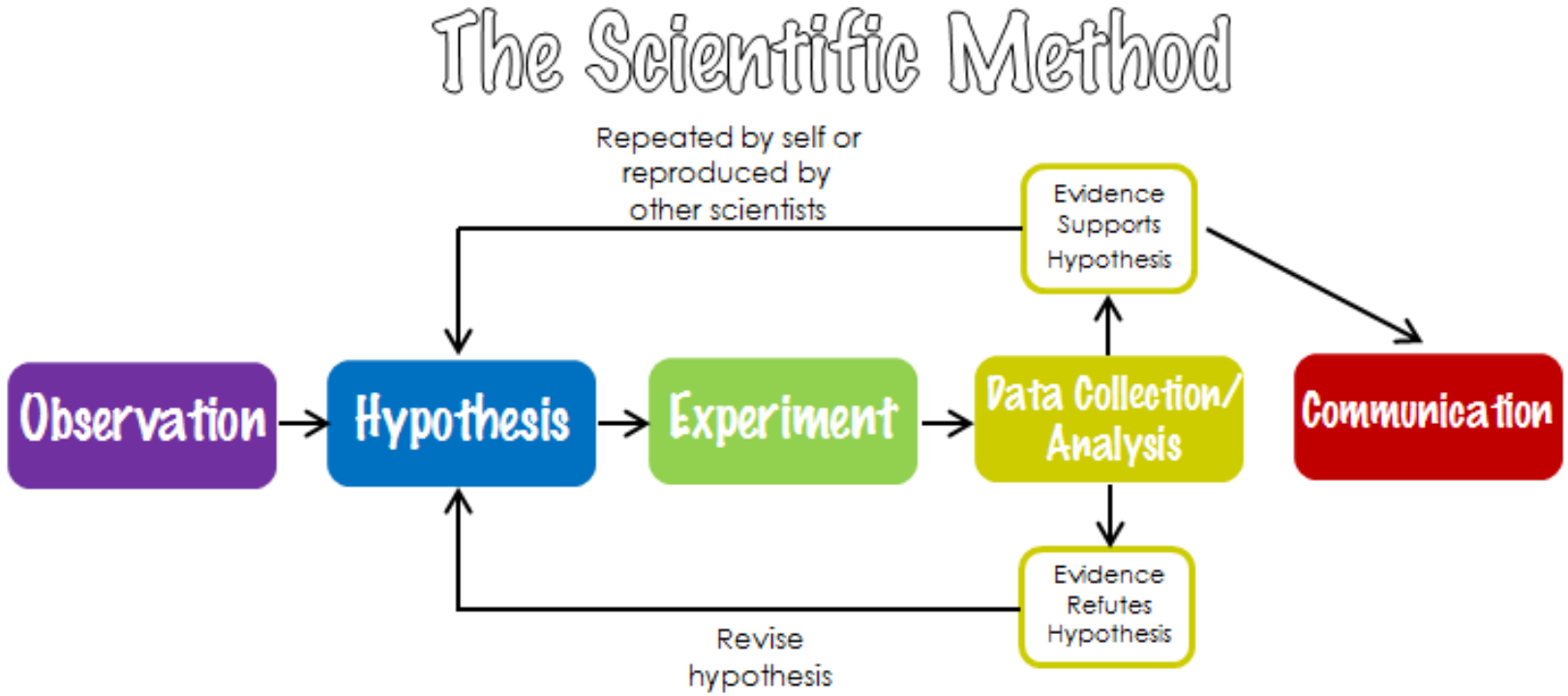
- Data science? Machine Learning? Data Mining?



Data scientists build a **data** products/services in **scientific** way using **machine learning algorithms** on the process called **data mining**.

Scientific Method

- It is data '**science**'; we need scientific method!
- You've already learned in a middle/high school...
- See wiki: https://en.wikipedia.org/wiki/Scientific_method#Process



Scientific Method

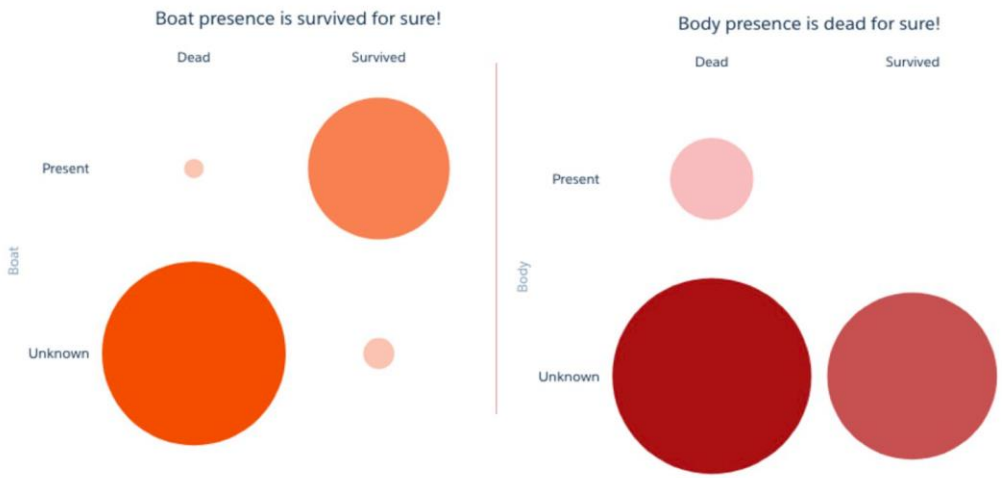
- Observation
  - Formulation of a question, collect and inspect data thoroughly.
  - ex) How can I predict house price?

    At first, I need house price data with its location, some demographics of residents, ...
- Hypothesis
  - Assumption based on knowledge obtained in observation stage
  - You can make a statistical assumption or plausible assumption based on domain-specific knowledge.
  - In data mining process, the hypothesis is represented as the combination of features.
  - ex) I think median income in a certain population group is a key factor to predict house price;

    People with high income may tend to buy an expensive house.
  - CAUTION: hindsight bias (사후 편향): Please be cautious if you have data leakage before modeling!

*Hindsight bias

- Knowing things you shouldn’t know
- Data leakage (or label leakage)
  - The accidental presence of information in the training data.
  - Model relies on information not available at scoring time.
  - In the original data of Titanic survival prediction, there exist ‘boat’ and ‘body’ features. (http://campus.lakeforest.edu/frank/FILES/MLFfiles/Bio150/Titanic/TitanicMETA.pdf)



Scientific Method

- Experiment
  - Determination of logical consequences of the hypothesis
    & investigation of whether the real world behaves as assumed by the hypothesis
  - ex) Train a machine learning algorithm to check whether the median income
    raises prediction accuracy of house price.
- Analysis
  - Determination of the next action based on the result of the experiment
  - Statistical analysis is frequently used for checking the strength of evidence
  - Reinforce/discard hypothesis to answer the question you made in the observation stage
  - ex) Test a machine learning algorithm with unseen data.

Data Mining Workflow

- Observation & Hypothesis (1: **Data Preparation**)
  - Collecting & Storing data (← nowadays a main role of a *data engineer*)
  - Exploratory data analysis (EDA)
  - Cleansing data (munging, imputation, removing duplicated values, feature scaling...)

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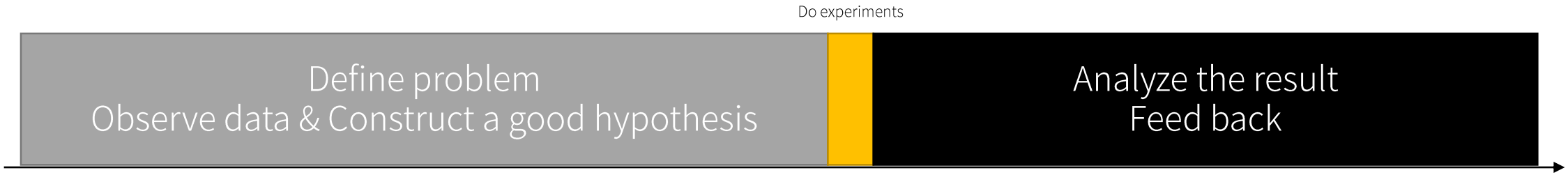
- Analysis (3: **Evaluation & Feedback**)
  - Testing models
  - Delivering the result to stakeholders
  - Deploying & monitoring services/systems or releasing products (← nowadays a main role of a *data engineer*)

Data Mining Workflow

- Overall summary



- It is **NOT** meaning that you don't have to know algorithms like you've learned in the class
- In fact, well-made algorithms are already ready for you.
- You SHOULD think about an appropriate algorithms for your problem.
  - In other words, you should know many algorithms as far as you can, so that can tackle various real-world problems!
  - And then, you may start to process your data in the form suitable for the model you select.
- If you know many, but still not being satisfied with them, then you CAN make your own algorithm! (→ ☎ Data Mining Lab. @ UNIST)

Observation: House Price Prediction

- Problem definition
  - Suppose we are now in 1990s, and you are the CEO of a construction company in California.
  - You are going to build an apartment complex somewhere in California, but where?
  - Where you can redeem a capital you invested.
  - If you build luxurious penthouses in Eonyang-eup, can you retrieve your investment...?
  - Thus, the important thing is to predict the future housing price accurately.
- Checking existing method
  - Existing method is to ask for consultation to experts in real-estate fields. (Delphi method)
  - But it is time-consuming, inaccurate, and expensive.
  - Then, it seems reasonable to use data mining approach in prediction of house price!
- Collect related data
  - Thankfully, suppose there already exists a good data; California Housing Prices dataset.
  - http://lib.stat.cmu.edu/datasets/houses.zip

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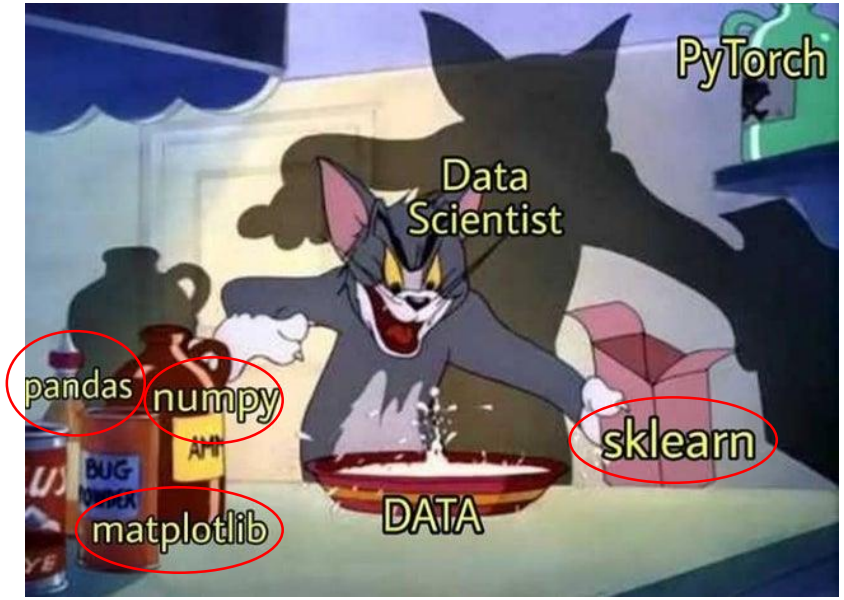
What if you just want to know the degree of expensiveness of house price?
(e.g. cheap / so-so / expensive)

Hypothesis: House Price Prediction

- Hypothesis
  - In collected data, suppose we already completed filtering out relevant predictors according to our hypothesis.
- Munging data
  - Load data
  - Handle columns and rows of data
  - Split training and test data
- Exploratory data analysis (EDA)
  - Data visualization
- Pre-process data
  - Data cleansing (handling missing values, handling categorical features, feature scaling)
- Let’s code!
  - Remember popular libraries
  - NumPy, Pandas, MatPlotLib, Scikit-Learn



Experiment: House Price Prediction

- Modeling on training data
  - Select algorithms
  - Fit algorithms on data
  - Evaluation of the trained model using cross-validation (internal validation)
  - Tune hyper-parameters of the model
- Test a generalization performance of the model
  - Check performance of the model using unseen test data

Analysis: House Price Prediction

- Analyze the result
  - Did predictors you provide as a means of verifying your hypothesis work well?
  - If it is, tidy up results, make a presentation file, and deliver the result to stakeholders!
  - If it is not, collect more data or change your hypothesis and problem definition.
  - In high probability, a machine learning model you choose has no fault.
    (Yes, it is developed by genius!)

Questions?

Thank You