INTRO TO MACHINE LEARNING

Types, Tasks, Terminology

https://econ.lange-analytics.com/aibook/

INTRODUCTION TO MACHINE LEARNING

WHAT IS WHAT?

- Artificial Intelligence (AI),
- Machine Learning,
- Deep Learning
- Big Data

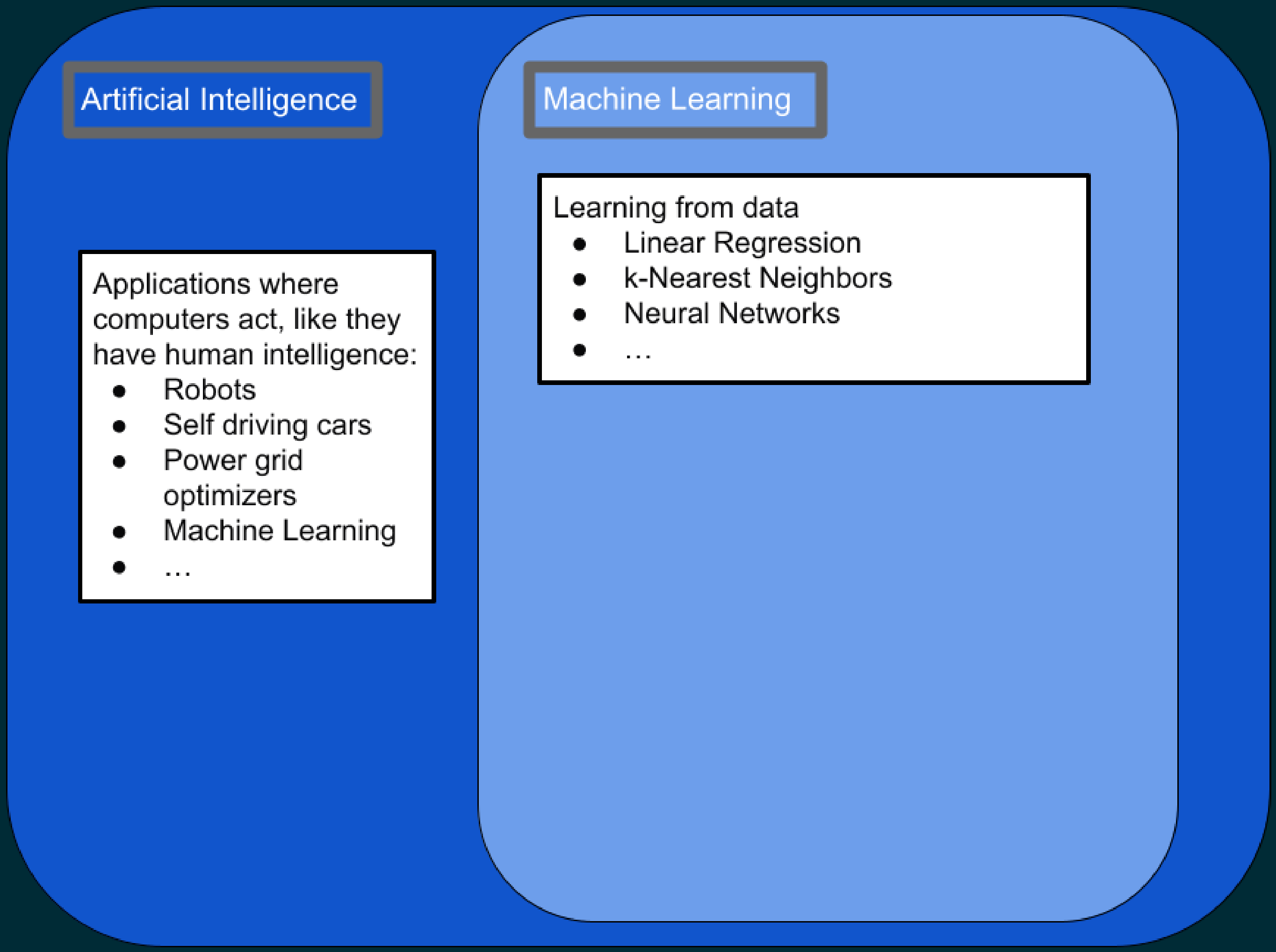
WHAT IS WHAT?

Artificial Intelligence

Applications where computers act, like they have human intelligence:

- Robots
- Self driving cars
- Power grid optimizers
- Machine Learning
- …

WHAT IS WHAT?



Categorizing AI, Machine Learning, and Deep Learning

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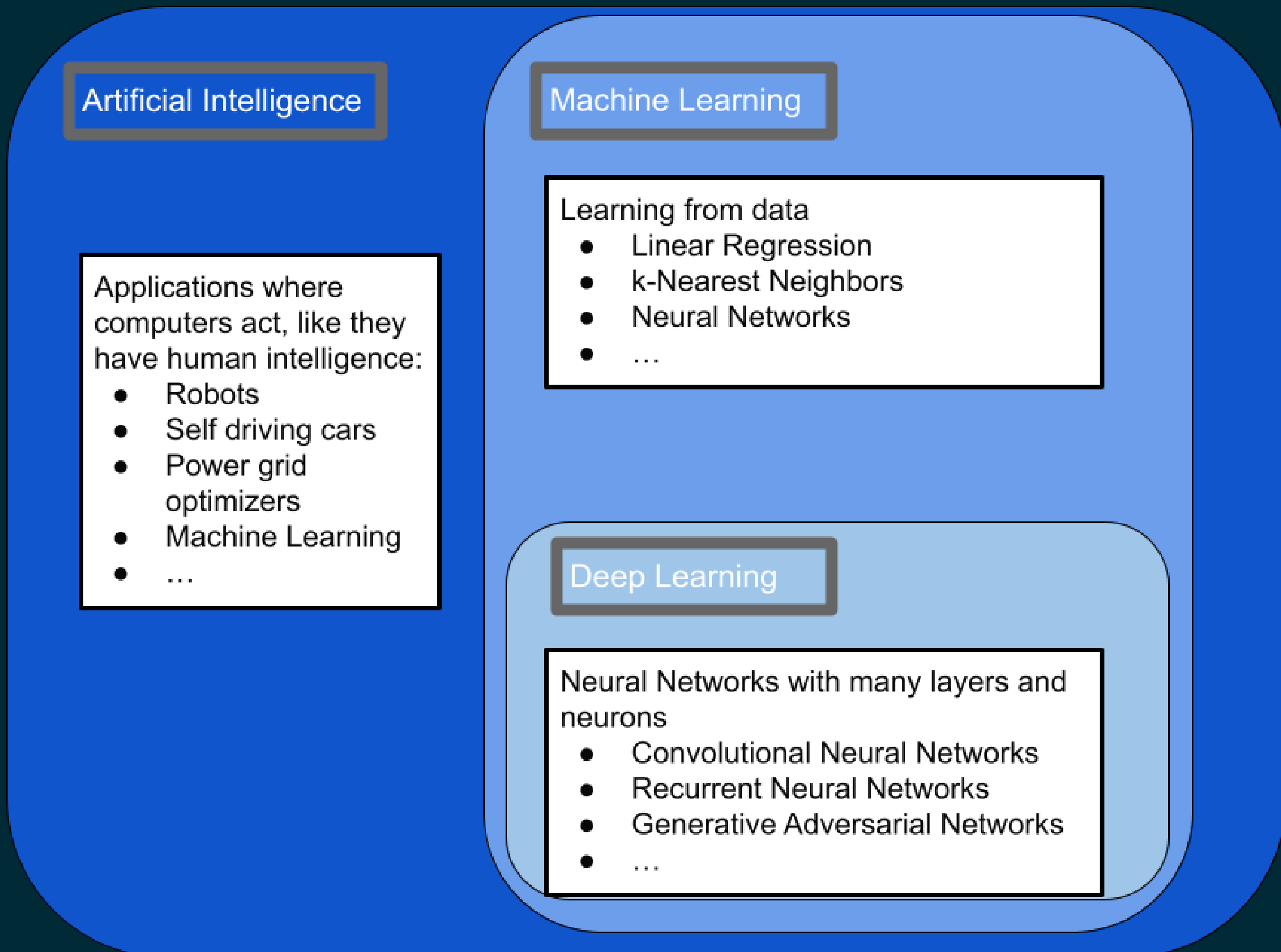

Categorizing AI, Machine Learning, and Deep Learning

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WHAT ABOUT BIG DATA

WHAT ABOUT BIG DATA

- Big Data is not a category of learning. It is a category of data!!!
- Two common definitions
  - Laymen: Many records (thousands?, millions?, billions?)
  - Experts: So many records that they do not fit in the memory of one computer.
    - At least billions of records.
    - Requires distributed computing.

THREE APPLICATIONS OF MACHINE LEARNING

- Regression
- Classification
- Cluster

THREE APPLICATIONS OF MACHINE LEARNING

- Regression
    - Outcome variable is continuous
    - We try to predict a numerical value
- Classification
- Cluster

THREE APPLICATIONS OF MACHINE LEARNING

- Regression
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THREE APPLICATIONS OF MACHINE LEARNING

- Regression
- Classification
  - Outcome variable is categorial
  - Most of the times 2 categories such as:
    - Yes/No
    - Red Wine/White Wine
    - True/False
    - often represented as dummies: 1/0
  - Sometimes more than two catogories (ordered or unordered):
    - good, fair, bad (ordered)
    - red, blue, green (unordered)
    - strongly agree, agree, disagree, strongly disagree (ordered)
- Cluster

THREE APPLICATIONS OF MACHINE LEARNING

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THREE APPLICATIONS OF MACHINE LEARNING

- Regression
- Classification
- Cluster
  - Sorting observations into a number of groups based on feature variables.
  - Groups are as homogenous inside as possible.
  - Groups are as diverse between groups (when comparing groups)

THREE APPLICATIONS OF MACHINE LEARNING

- Regression
- Classification
- Cluster

TERMINOLGY

First 3 Observations (records) of the Housing Dataset (to predict house prices)

▶ Code

```
   Price Sqft Bedrooms Waterfront
1 221900 1180        3         no
2 538000 2570        3         no
3 180000  770        2         no
```

Tidy data:

- Observations (synonym: records) are in the rows.
- Variables (synonym: features) are in the columns.
- Variable names (column names) are in the first row.
- Data are in individual cells (and they form vectors; column names can be interpreted as vector names).

TERMINOLGY

Main | Synonyms

First 3 Observations (records) of the Housing Dataset (predict house prices)

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```
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```

- **Outcome Variable**: The variables that is the outcome of the prediction ($Price$)
- **Predictor Variables**: The variables that **predict** an outcome ($Sqft$, $Bedrooms$, $Waterfront$)
- **Example linear regression:** $$Price=\beta_1 \cdot Sqft+ \beta_2 \cdot Bedrooms +\beta_3 \cdot Waterfront+\beta_4$$

PREDICTION

Predicting means that we use the values for one or more known variables to estimate an *outcome*. Predictions can be forecasts or for the same time period.

- Predict tomorrows weather based on todays barometric change of pressure.
- Predict the price of a house (today) based on it’s square footage (today).

Variables that are based on a prediction are marked with a *hat* (e.g., \(\widehat{Price_i}\)).

MODEL

A *model* is what we use for predicting an outcome variable based on values of predictor variables — given certain assumptions.

$$\widehat{Price_i}=\beta_1 Sqft_i + \beta_2$$

FITTED MODEL

Can we use the model from the previous slide to predict the price of a house, if we know the value for the house's predictor variable (e.g., $Sft=1000$)

Only if we know the values for the parameters (the $\beta's$)!

Suppose OLS based on data determines that $\beta_1=300$ andt $\beta_2=500,000$:

$$\widehat{Price_i}=300 Sqft_i + 500000$$

A model where the parameters (the $\beta's$) have been determined by a machine learning algorithm is called a **fitted model**.

A fitted model can be used for predictions. E.g., a house with a square footage of 1,000 sqft is predicted to cost $8000,000.

- In our case:

  $$\widehat{Price_i}=300 \cdot 1,000 + 500,000= 800,000$$

PARAMETERS

The \(\beta s\) of a model.

Machine learning can be (over)simplified to the following steps:

1. Determine the model including the \(\beta s\).
2. Use machine learning to determine the \(\beta s\) and therefore create a *fitted model*.
3. Use the itted model o predict based on *predictor variables*.

WHY USING R FOR MACHINE LEARNING?

Software

- R (free, advanced, timely delivery of new algorithms, easy to use with the `tidyverse` and `tidymodels` packages)
- Phython ((free, advanced, often first delivery of new algorithms, not as easy to use because it is a programming language rather then a statistical language)
- SAS (not free, somehow advanced, slow in delivering new algorithms, easy to use)
- Stata (not free, somehow advanced, slow in delivering new algorithms, easy to use)
- SPSS (not free, not advanced, slow in delivering new algorithms, optimized for survey procssing, extremly easy to use)