

# CS305 Machine Learning

## Course Information

*Instructor:* Brian Tjaden  
*Pronouns:* He, Him, His  
*Course Materials:* <http://cs.wellesley.edu/~cs305>

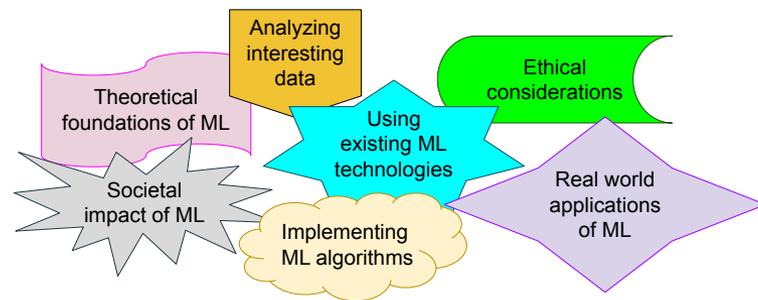
## Programming Environment

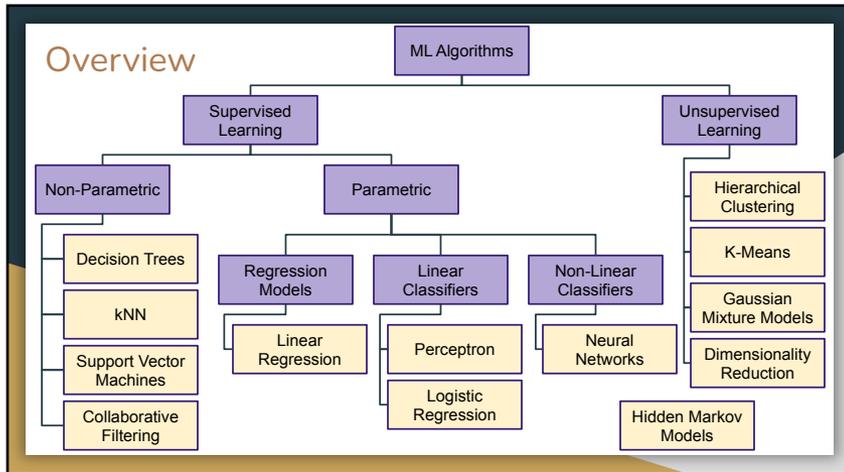
Check out  
Project 0!

- We will both implement our own machine learning algorithms and use existing machine learning algorithm implementations
- There are *many* software libraries for studying and programming machine learning applications
- In this course, we will use Python and its libraries `numpy`, `matplotlib`, and `sklearn`
- For development, we will use Anaconda together with Jupyter notebooks

## Aspects of the Course

Different machine learning (ML) courses emphasize different things





### What is Learning?

How old do you need to be in order to vote?

There is a line that passes through (1,4) and (5,1). Does (3,3) also lie along this line?

In machine learning, computers learn with experience. They solve a problem based on data or they get better at a task as they have more examples.

### Observe these photos of two people

**Z**

**TS**

### Quick!

Is this **Z** or **TS**?

How would you write a program to recognize a particular person in a picture?

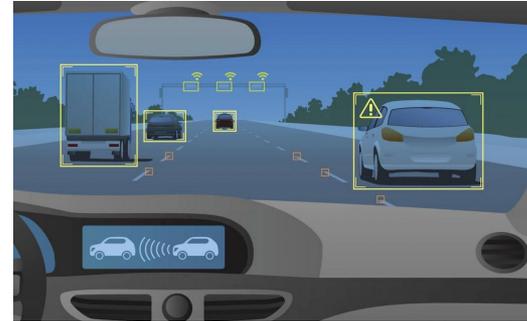
Could this program be adapted easily to recognize some other person?



Automatically learn from examples

Program should **observe patterns** in pictures of faces to recognize new ones

## ML Application



Is this how humans perform tasks?

- Do we pattern match from examples?
- Or do we have a deeper understanding / intuition for how to recognize faces, drive safely, and play chess?

## Flavors of Machine Learning

### 1. Supervised learning:

given **training examples with labels**, learn to automatically label (aka classify) a new example

Z



## Flavors of Machine Learning

2. Unsupervised learning:  
given **data without labels**, extract hidden structure

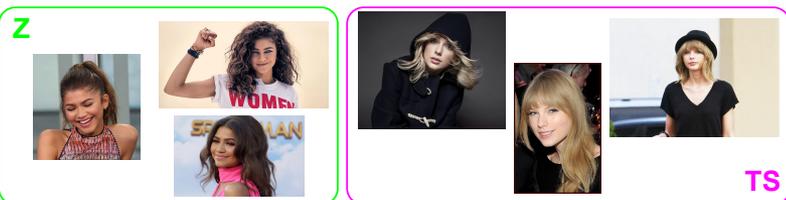
Handwritten characters in various scripts, illustrating unsupervised learning.

## Flavors of Machine Learning

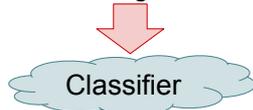
3. Reinforcement learning:  
learn how to take actions to maximize total reward



## Supervised Learning Phases: (1) Training



Training Data

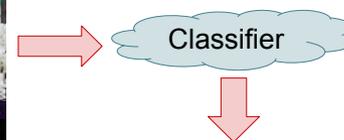


## Supervised Learning Phases: (2) Prediction + Evaluation

Testing Data



Z

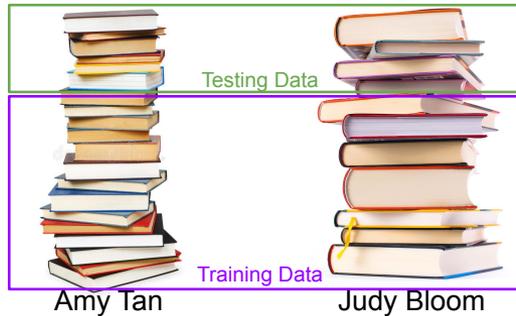


Are these equal?

Predicted Label



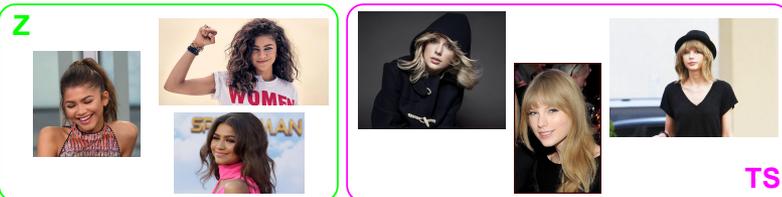
## Training and Testing ML Algorithms



## Data Representation with Features

- A **feature** is a **question** you ask of every example in your data (in training and testing)
- A **feature value** is the **answer to that question** for a particular example in the data
- Typically have LOTS of features
- Machine learning algorithms specify **how to use these features** to build classifiers

## Common Danger: Overfitting



- **TS's** shirt is black in all training examples
- Classifier may learn that "black shirt" is a good feature for recognizing her
- What happens if she is not wearing black clothing, or if someone else is wearing black clothing?

## This Course

- Algorithms for learning supervised classifiers
- Some unsupervised learning
- Social and ethical issues
- Designing good features for different domains
- How to evaluate your classifier
- How to overcome overfitting
- Processing large amounts of data