LECTURE 1 INTRODUCTION TO WEB MINING

LEK HSIANG HUI

OUTLINE

Introduction to Web Mining

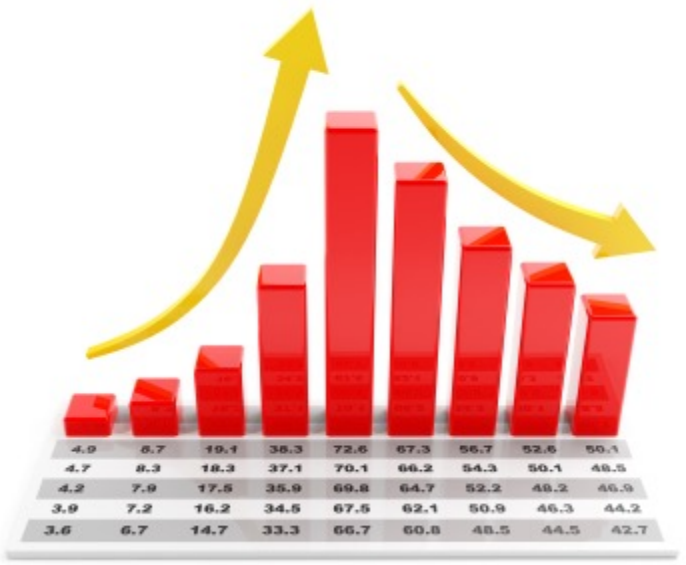
Supervised Learning

Unsupervised Learning

Web Scraping Demo

INTRODUCTION TO WEB MINING

DATA



Companies are generating a LOT of data
e.g. sales, transaction, customer data, etc

MORE DATA

Data is produced not only by the companies but also by others about the companies

DATA MINING

Since everything is computerized nowadays, data is now stored in digital form (e.g. databases)

From these databases, the purpose of data mining is to look for patterns so as to discover more insights to the raw data

- Raw Data ➡ Patterns ➡ Knowledge

This knowledge will be helpful for decision making

HOW TO MAKE DECISION MAKING?

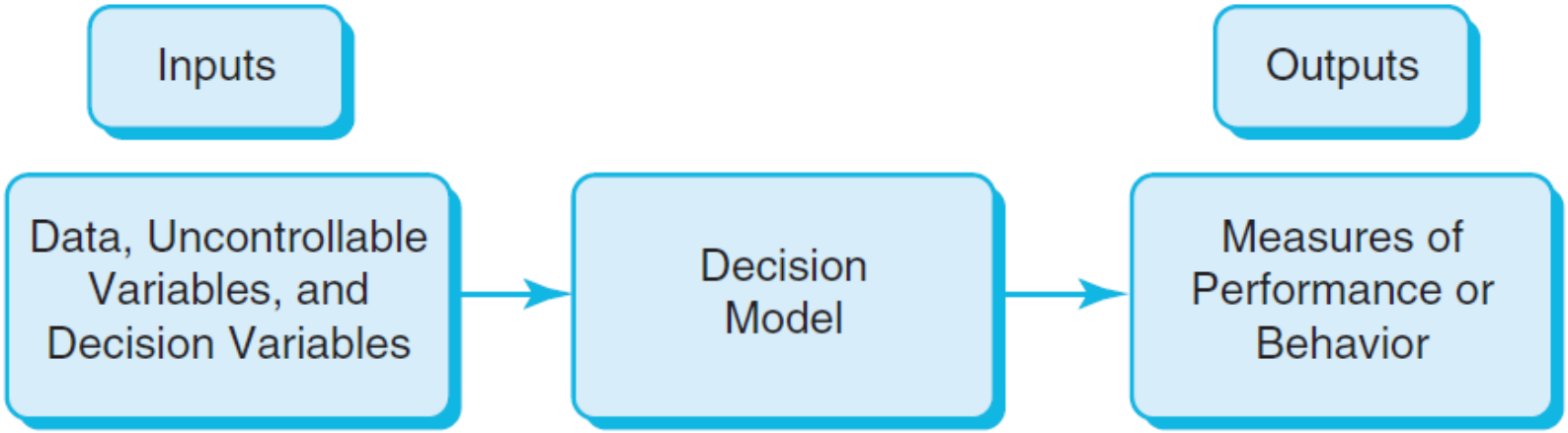
Decision Making

- Make **prediction** based on the data
  - E.g. Based on past experience (i.e. historical data) predict how many patients we are expecting today
- To do this, we build **decision models** using historical data
- The models can then allow us to make prediction of future data instances

WHAT IS A DECISION MODEL?

Decision Model is a model used to understand, analyze, or facilitate decision making

- Can be in the form of a mathematical formula or software



WEB MINING

Web mining is concerned with mining data from the web which can then be transformed into knowledge

2 main aspects we will be focus on

- Mining Web Content
- Data mining techniques for handling web content (regression, classification, clustering, recommender systems)

WHY THIS COURSE?

Most courses only focus on the predictive modeling aspect

- Assumes that all datasets can be downloaded (e.g. from Kaggle)

However:

- The datasets we need is usually not readily available
- Having the ability to mine your own data from the web is useful skill!

CLASSIC DECISION PROBLEMS

Regression (Supervised)

- Stock price prediction

Classification (Supervised)

- Weather forecast (sunny, rainy, cloudy, etc)

Clustering (Unsupervised)

- Group Weibo/Twitter users based on their interest

What's the difference between regression & classification?

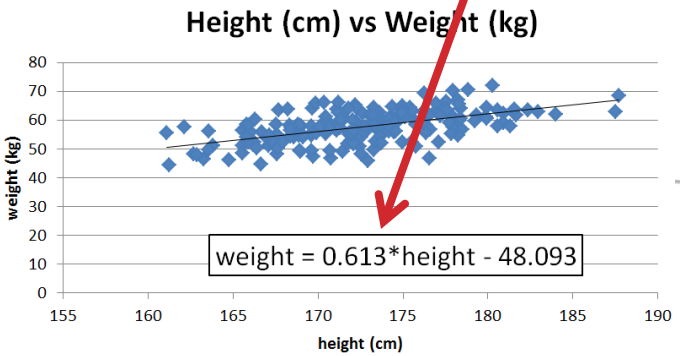
SUPERVISED LEARNING

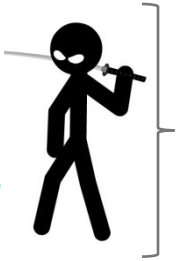
REGRESSION

Regression (Supervised)

- Using existing data instances to learn a **model** for predicting subsequent instances
- Example:
  - Assume we have a list of human height and weight

Height(cm)	Weight(kg)
167.0812	51.25136008
181.6608	61.91077208
176.276	69.41318376
173.2788	64.56428528
172.1866	65.4533256
174.498	55.9278936
177.292	64.17873208
177.8254	61.89716432
172.466	50.97013304
169.6212	54.73494664
168.8846	57.8103004
171.7548	51.77239088
173.482	56.97569112
170.4848	55.54687632
173.4312	52.65749528

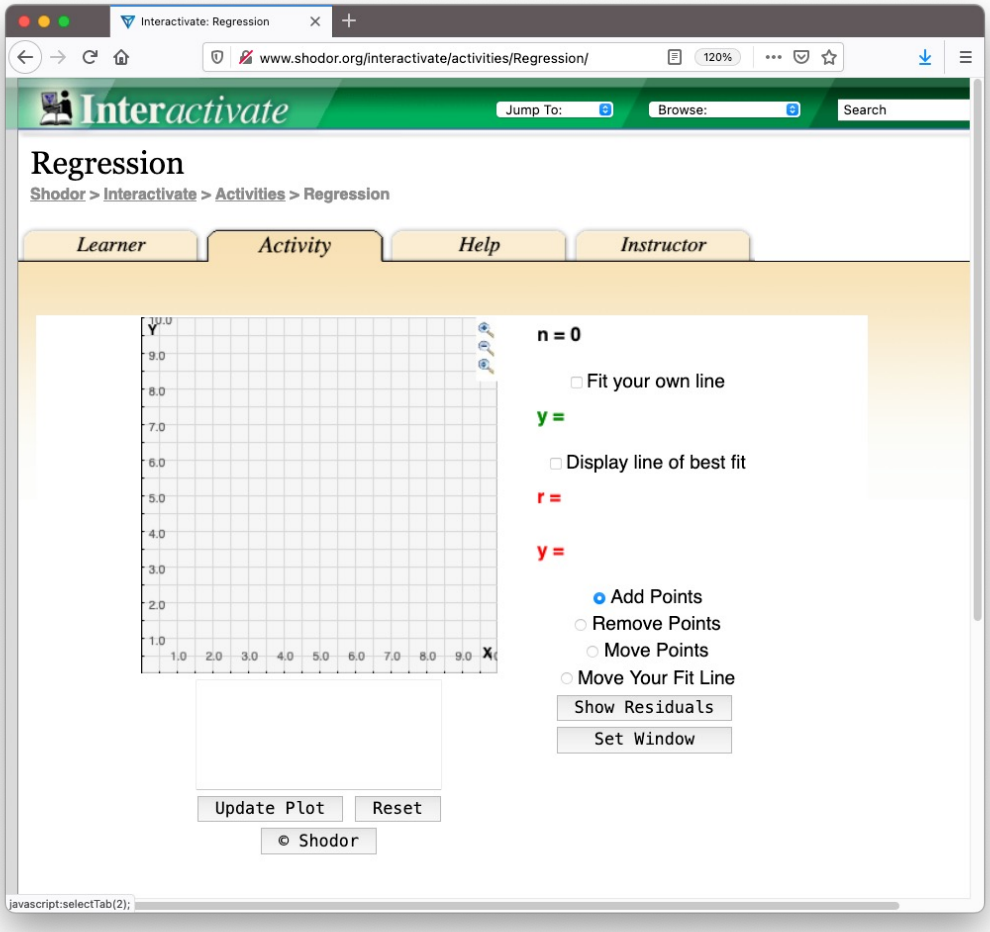




height = 170cm

weight = ?

REGRESSION DEMO



http://www.shodor.org/interactivate/activities/Regression/

REGRESSION EXAMPLE

Dataset:

- https://www.kaggle.com/mohansacharya/graduate-admissions
- Prediction of Graduate Admissions from an Indian perspective
- 500 instances
- Admission_Predict_Ver1.1.csv

GRADUATE ADMISSION

	A	B	C	D	E	F	G	H	I
1	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
2	1	337	118	4	4.5	4.5	9.65	1	0.92
3	2	324	107	4	4	4.5	8.87	1	0.76
4	3	316	104	3	3	3.5	8	1	0.72
5	4	322	110	3	3.5	2.5	8.67	1	0.8
6	5	314	103	2	2	3	8.21	0	0.65
7	6	330	115	5	4.5	3	9.34	1	0.9
8	7	321	109	3	3	4	8.2	1	0.75
9	8	308	101	2	3	4	7.9	0	0.68
10	9	302	102	1	2	1.5	8	0	0.5
11	10	323	108	3	3.5	3	8.6	0	0.45
12	11	325	106	3	3.5	4	8.4	1	0.52
13	12	327	111	4	4	4.5	9	1	0.84

Identifier (unique for all instance) → Not useful for modeling

Undergraduate GPA
(out of 10)

Research Experience
(0 or 1)

Chance of Admin
(0 to 1)

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GRE Scores
(out of 340)

TOEFL Score
(out of 120)

Uni. Rating
(out of 5)

Statement of Purpose (SOP) & Letter of Recommendation (LOR) Recommendation Strength
(out of 5)

TYPES OF DATA

Target/Response
Dependent Variable

	A	B	C	D	E	F	G	H	I
1	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
2	1	337	118	4	4.5	4.5	9.65	1	0.92
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10	9	302	102	1	2	1.5	8	0	0.5
11	10	323	108	3	3.5	3	8.6	0	0.45
12	11	325	106	3	3.5	4	8.4	1	0.52
13	12	327	111	4	4	4.5	9	1	0.84

Predictors
Independent Variables

TYPES OF DATA

Datasets with values for both predictors & response are also known as **labeled** data (also known as **training data**)

	A	B	C	D	E	F	G	H	I
1	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
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5	4	322	110	3	3.5	2.5	8.67	1	0.8
6	5	314	103	2	2	3	8.21	0	0.65
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8	7	321	109	3	3	4	8.2	1	0.75
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10	9	302	102	1	2	1.5	8	0	0.5
11	10	323	108	3	3.5	3	8.6	0	0.45
12	11	325	106	3	3.5	4	8.4	1	0.52
13	12	327	111	4	4	4.5	9	1	0.84

TYPES OF DATA

Datasets with only values for predictors are also known as **unlabeled** data (also known as **testing data**)

	A	B	C	D	E	F	G	H	I
1	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit
2	401	304	100	2	3.5	3	8.22	0	?
3	402	315	105	2	3	3	8.34	0	?
4	403	324	109	3	3.5	3	8.94	1	?
5	404	330	116	4	4	3.5	9.23	1	?
6	405	311	101	3	2	2.5	7.64	1	?
7	406	302	99	3	2.5	3	7.45	0	?
8	407	322	103	4	3	2.5	8.02	1	?
9	408	298	100	3	2.5	4	7.95	1	?
10	409	297	101	3	2	4	7.67	1	?
11	410	300	98	1	2	2.5	8.02	0	?

We want the generated model to predict the response values

SUPERVISED LEARNING

This also illustrates the idea of
Supervised Learning

- Teach the machine to do prediction with examples and the corresponding expected prediction

HANDS-ON: REGRESSION

HANDS-ON: REGRESSION

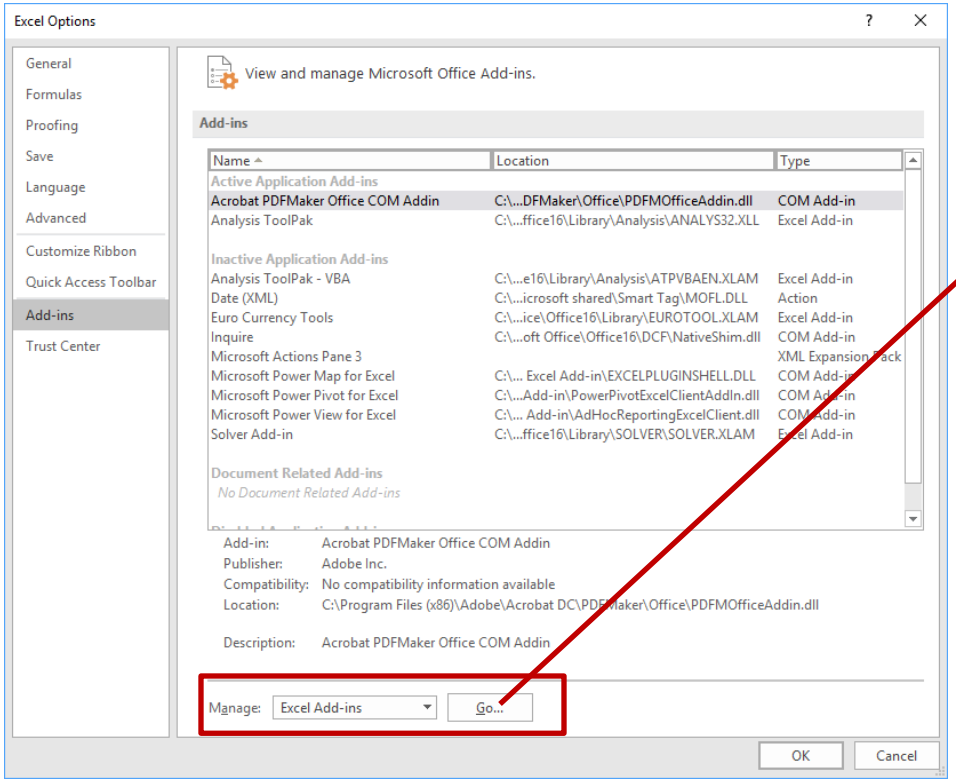
Dataset:

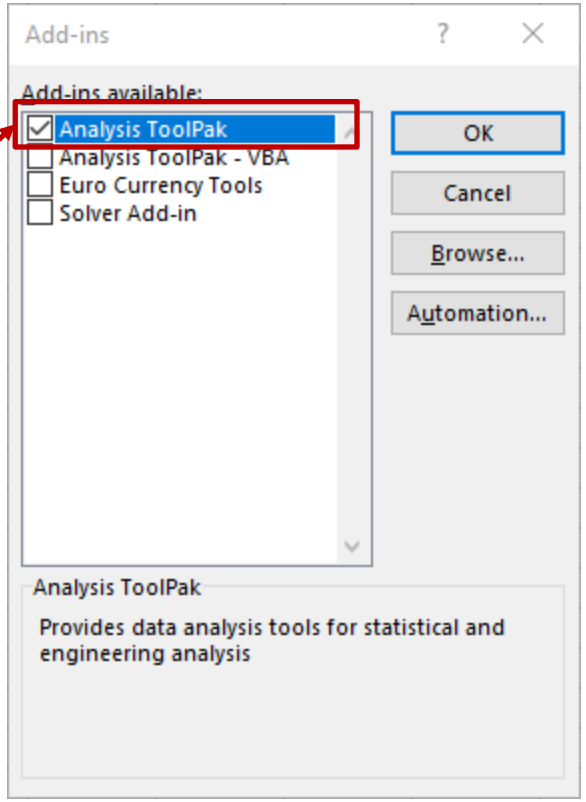
- https://www.kaggle.com/mohansacharya/graduate-admissions
- Prediction of Graduate Admissions from an Indian perspective
- 500 instances
- **Manually divided into:**
  - **400 instances training data (Admission_Predict_Ver1.1.train.csv)**
  - **100 instances testing data (Admission_Predict_Ver1.1.test.csv)**

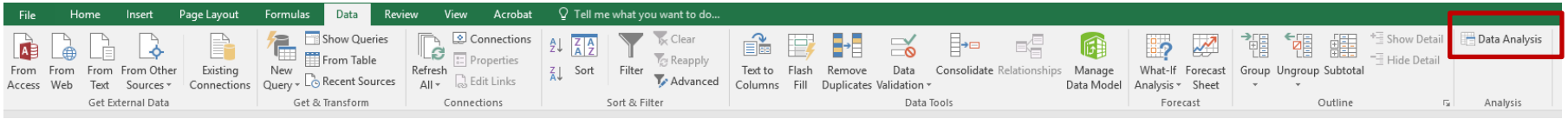
Software:

- Excel (with the **Analysis ToolPak**)

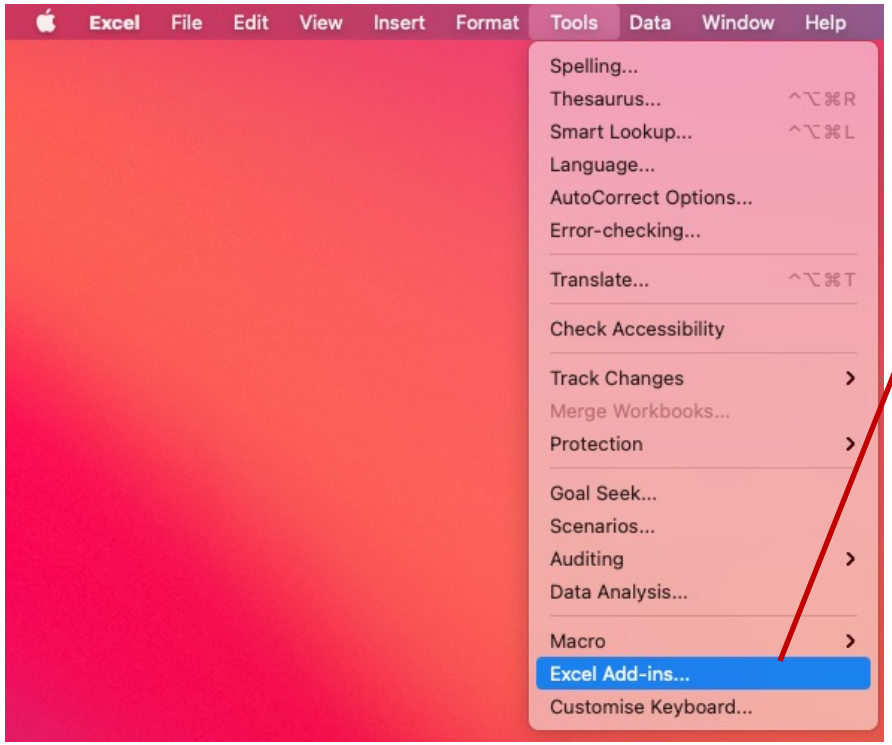
INSTALLING EXCEL ANALYSIS TOOLPAK (WIN)

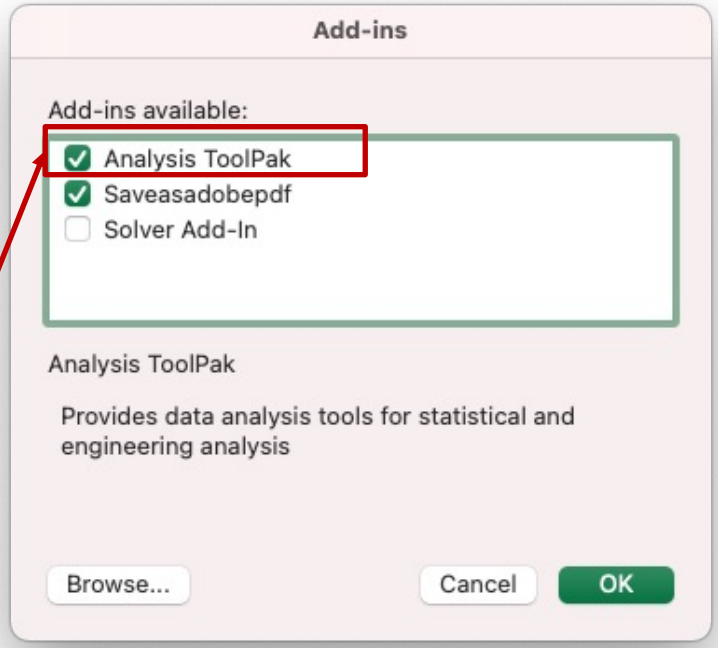


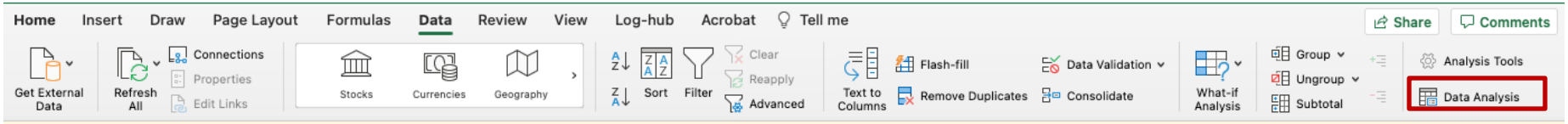




INSTALLING EXCEL ANALYSIS TOOLPAK (MAC)







GENERATING REGRESSION MODEL (EXCEL)

	A	B	C	D	E	F	G	H	I
1	Serial No.	GRE Score	TOEFL Score	University Ra	SOP	LOR	CGPA	Research	Chance of Admit
2	1	337	118	4	4.5	4.5	9.65	1	0.92
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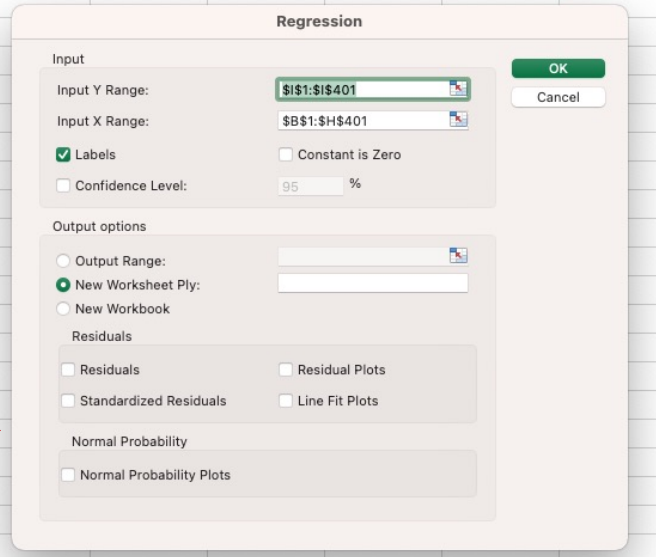
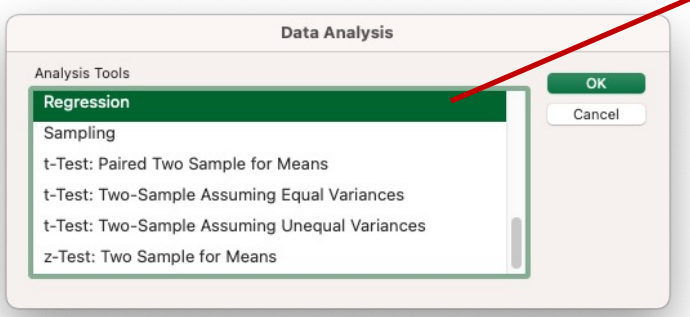
12	11	325	106	3	3.5	4	8.4	1	0.52
13	12	327	111	4	4	4.5	9	1	0.84
14	13	328	112	4	4	4.5	9.1	1	0.78
15	14	307	109	3	4	3	8	1	0.62
16	15	311	104	3	3.5	2	8.2	1	0.61
17	16	314	105	3	3.5	2.5	8.3	0	0.54
18	17	317	107	3	4	3	8.7	0	0.66
19	18	319	106	3	4	3	8	1	0.65
20	19	318	110	3	4	3	8.8	0	0.63





Admission_Predict_Ver1.1.train.csv

GENERATING REGRESSION MODEL (EXCEL)

		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
17	Intercept	-1.259432478	0.124730747	-10.097209	1.841E-21	-1.5046574	-1.0142076	-1.5046574	-1.0142076
18	GRE Score	0.001737412	0.000597897	2.9058702	0.0038701	0.0005619	0.0029129	0.0005619	0.0029129
19	TOEFL Score	0.002919577	0.001089532	2.6796622	0.0076802	0.0007775	0.0050616	0.0007775	0.0050616
20	University Rating	0.005716658	0.004770425	1.1983539	0.2315032	-0.0036622	0.0150955	-0.0036622	0.0150955
21	SOP	-0.003305169	0.005561643	-0.5942792	0.5526682	-0.0142395	0.0076292	-0.0142395	0.0076292
22	LOR	0.022353127	0.005541485	4.0337793	6.599E-05	0.0114584	0.0332479	0.0114584	0.0332479
23	CGPA	0.118939454	0.012219435	9.7336294	3.382E-20	0.0949156	0.1429633	0.0949156	0.1429633
24	Research	0.024525106	0.007959756	3.0811379	0.0022076	0.008876	0.0401743	0.008876	0.0401743

-1.259432478 + 0.001737412 * **GRE** + 0.002919577 * **TOEFL** + 0.005716658 * **Uni_Rating** - 0.003305169 * **SOP** + 0.022353127 * **LOR** + 0.118939454 * **CGPA** + 0.024525106 * **Research**

PREDICTING TESTING DATA (EXCEL)

Admission_Predict_Ver1.1.test.csv

-1.259432478 + 0.001737412 * **GRE** + 0.002919577 * **TOEFL** + 0.005716658 * **Uni_Rating** - 0.003305169 * **SOP** + 0.022353127 * **LOR** + 0.118939454 * **CGPA** + 0.024525106 * **Research**

	A	B	C	D	E	F	G	H	I	J
1	Serial No.	GRE Score	TOEFL Score	University Rating	SOP	LOR	CGPA	Research	Chance of Admit (Actual)	Chance of Admit (Predicted)
2	401	304	100	2	3.5	3	8.22	0	0.63	0.605305387
3	402	315	105	2	3	3	8.34	0	0.66	0.654940123
4	403	324	109	3	3.5	3	8.94	1	0.78	0.782207991
5	404	330	116	4	4	3.5	9.23	1	0.91	0.862802581
6	405	311	101	3	2	2.5	7.64	1	0.62	0.575424919
7	406	302	99	3	2.5	3	7.45	0	0.52	0.516349434

Predicted values

RECALL: TYPES OF DECISION PROBLEM (LEARNING PROBLEMS)

Regression (Supervised)

- Stock price prediction

Classification (Supervised)

- Weather forecast (sunny, rainy, cloudy, etc)

Clustering (Unsupervised)

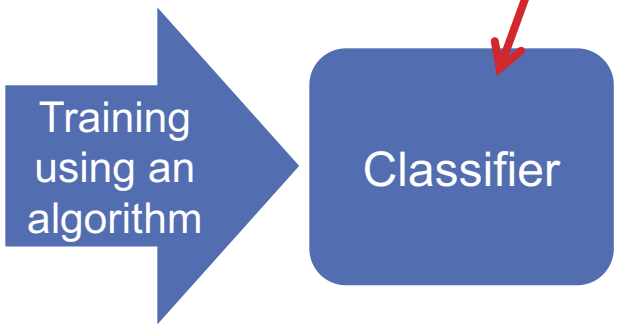
- Group Facebook users based on their interest

CLASSIFICATION

Classification (Supervised)

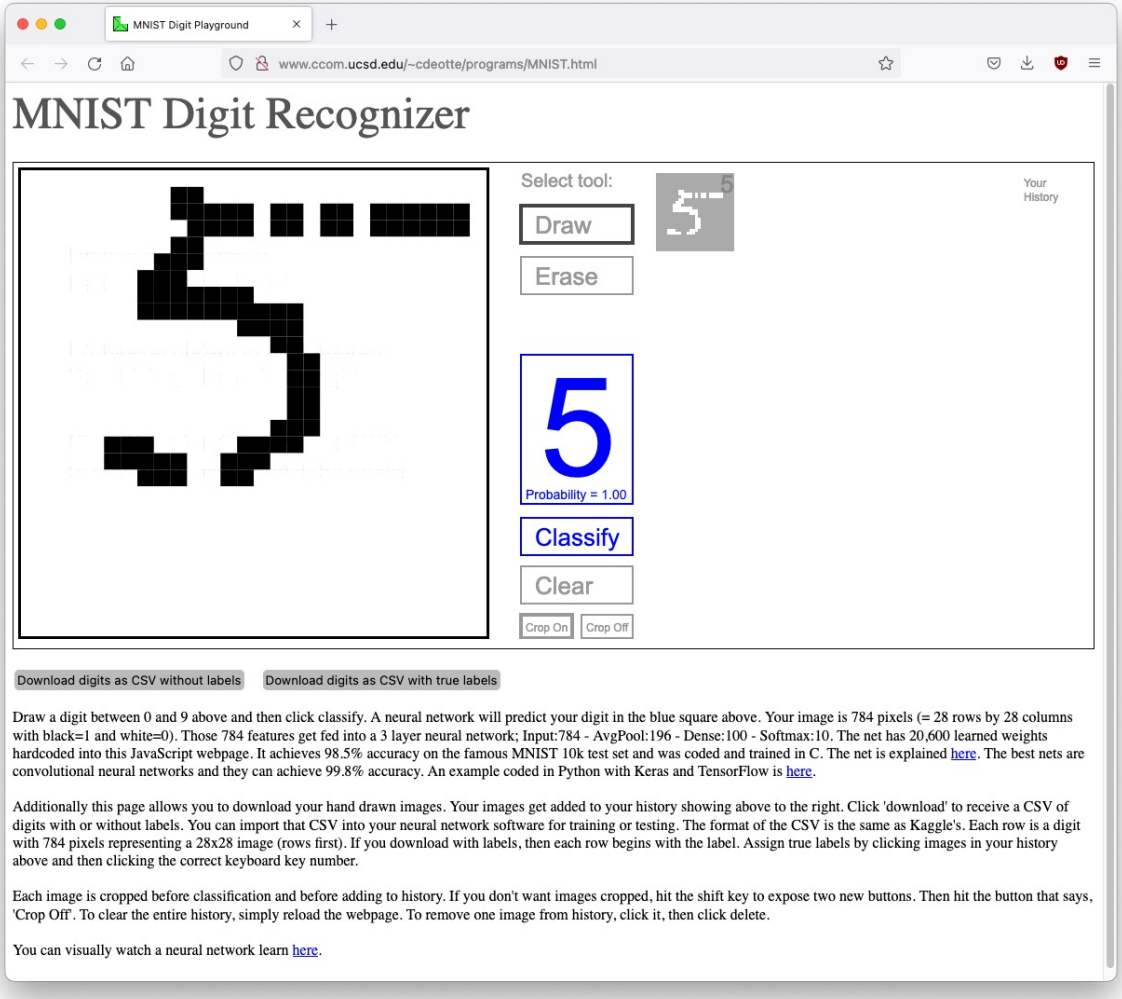
- Using existing data instances (labeled) to learn a model for predicting subsequent instances (unlabeled)
- Example:
  - Assume that you have some attributes of the current weather, and we need to decide whether to go out to play

No.	1: outlook Nominal	2: temperature Nominal	3: humidity Nominal	4: windy Nominal	5: **play** Nominal
1	sunny	hot	high	FALSE	no
2	sunny	hot	high	TRUE	no
3	overcast	hot	high	FALSE	yes
4	rainy	mild	high	FALSE	yes
5	rainy	cool	normal	FALSE	yes
6	rainy	cool	normal	TRUE	no
7	overcast	cool	normal	TRUE	yes
8	sunny	mild	high	FALSE	no
9	sunny	cool	normal	FALSE	yes
10	rainy	mild	normal	FALSE	yes
11	sunny	mild	normal	TRUE	yes
12	overcast	mild	high	TRUE	yes
13	overcast	hot	normal	FALSE	yes
14	rainy	mild	high	TRUE	no



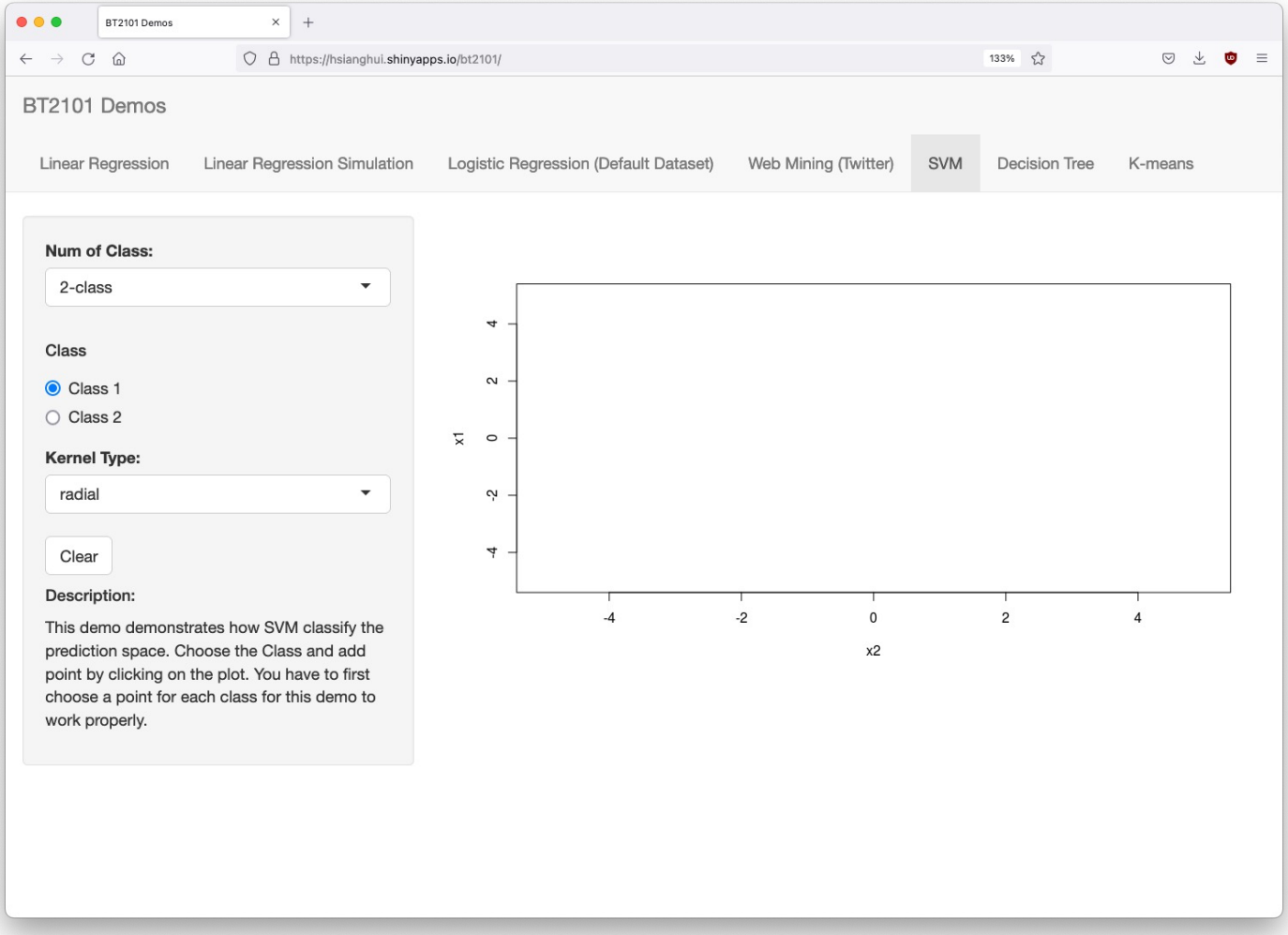
outlook: rainy
temperature: mild
humidity: high
windy: TRUE
play: ?

CLASSIFICATION DEMO



http://www.ccom.ucsd.edu/~cdeotte/programs/MNIST.html

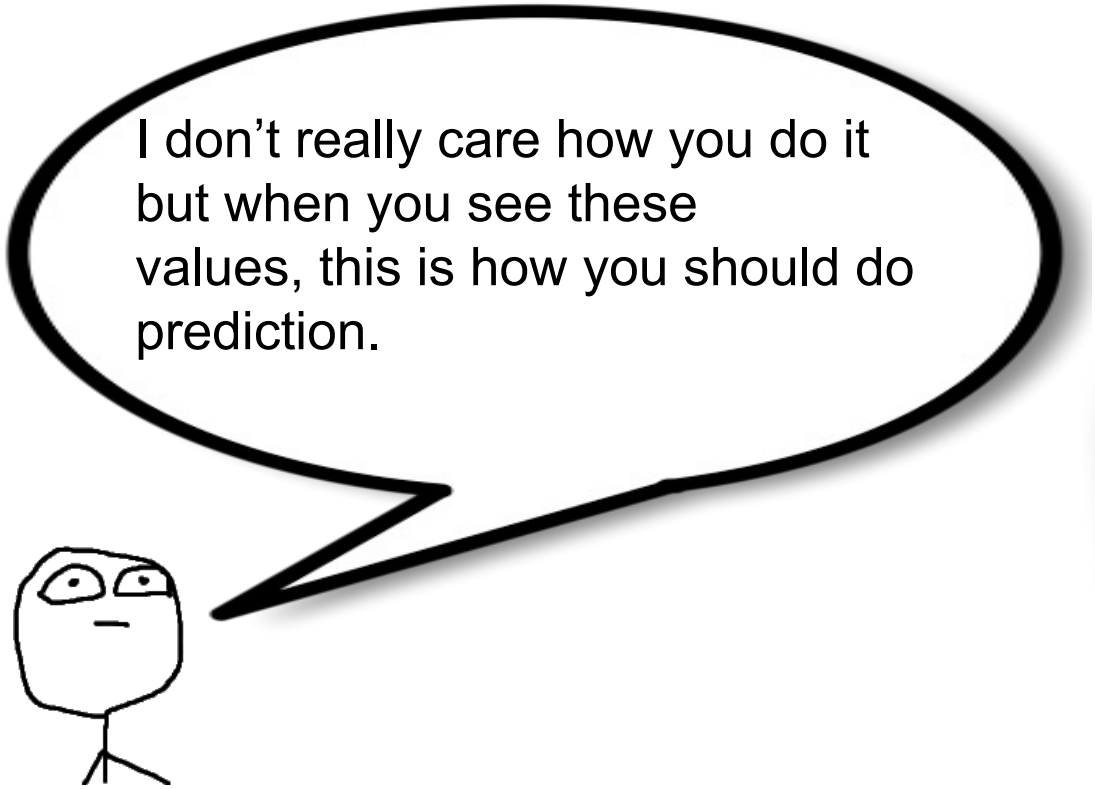
CLASSIFICATION DEMO



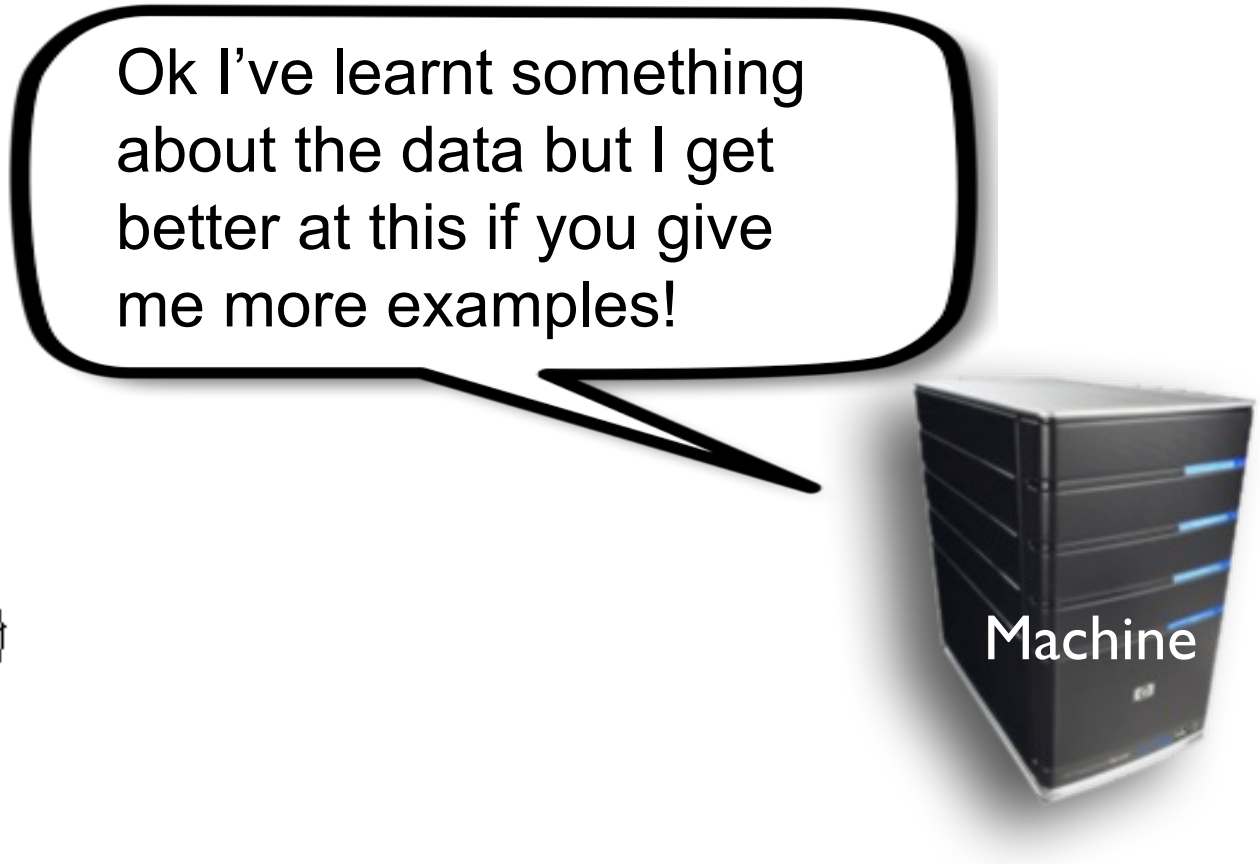
https://hsianghui.shinyapps.io/bt2101/

UNSUPERVISED LEARNING

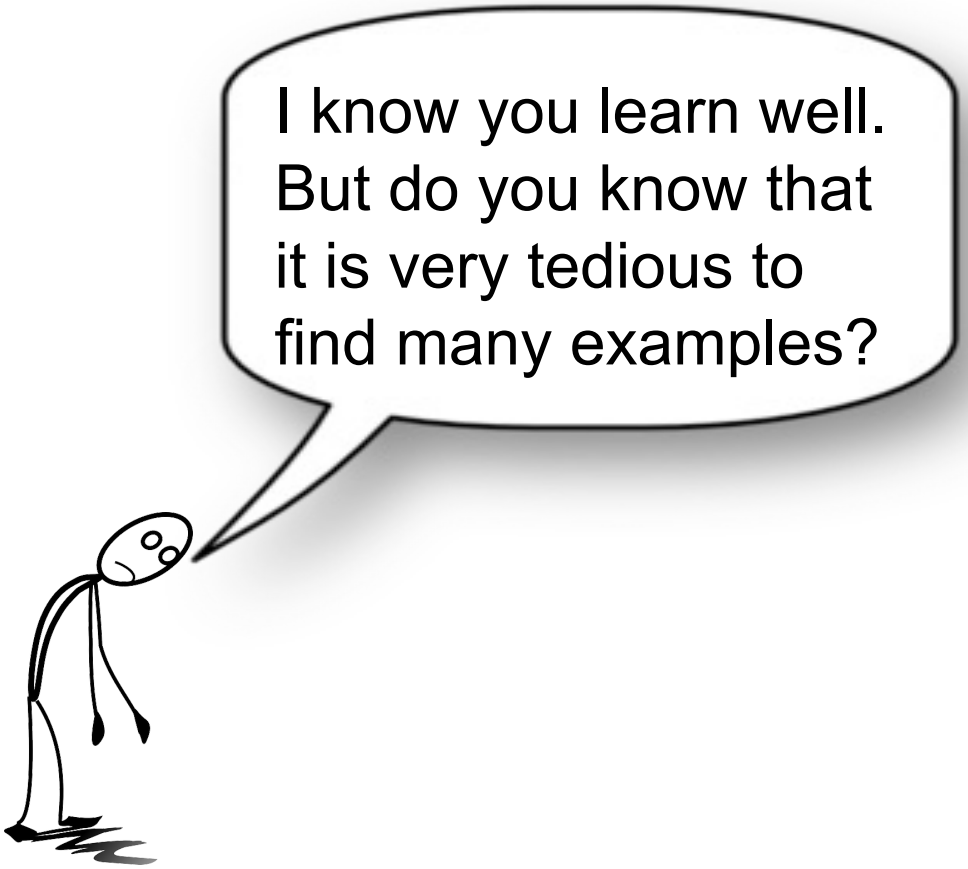
MACHINE LEARNING



MACHINE LEARNING



CHALLENGES OF SUPERVISED LEARNING



UNSUPERVISED LEARNING

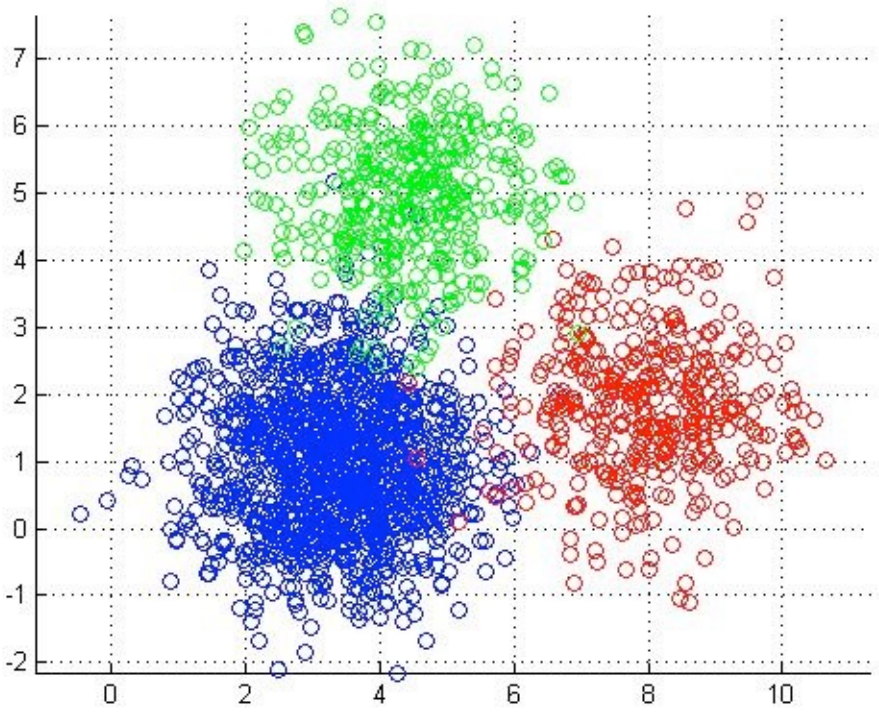
Unsupervised

- Assume we only have unlabeled data and we want to either:
  - label the data instances
  - or group up data instances into subsets sharing common characteristics
- One commonly application of unsupervised approach is clustering

- What do you think is the accuracy of unsupervised approaches compared to supervised?
- Why are unsupervised approaches important?

CLUSTERING EXAMPLE

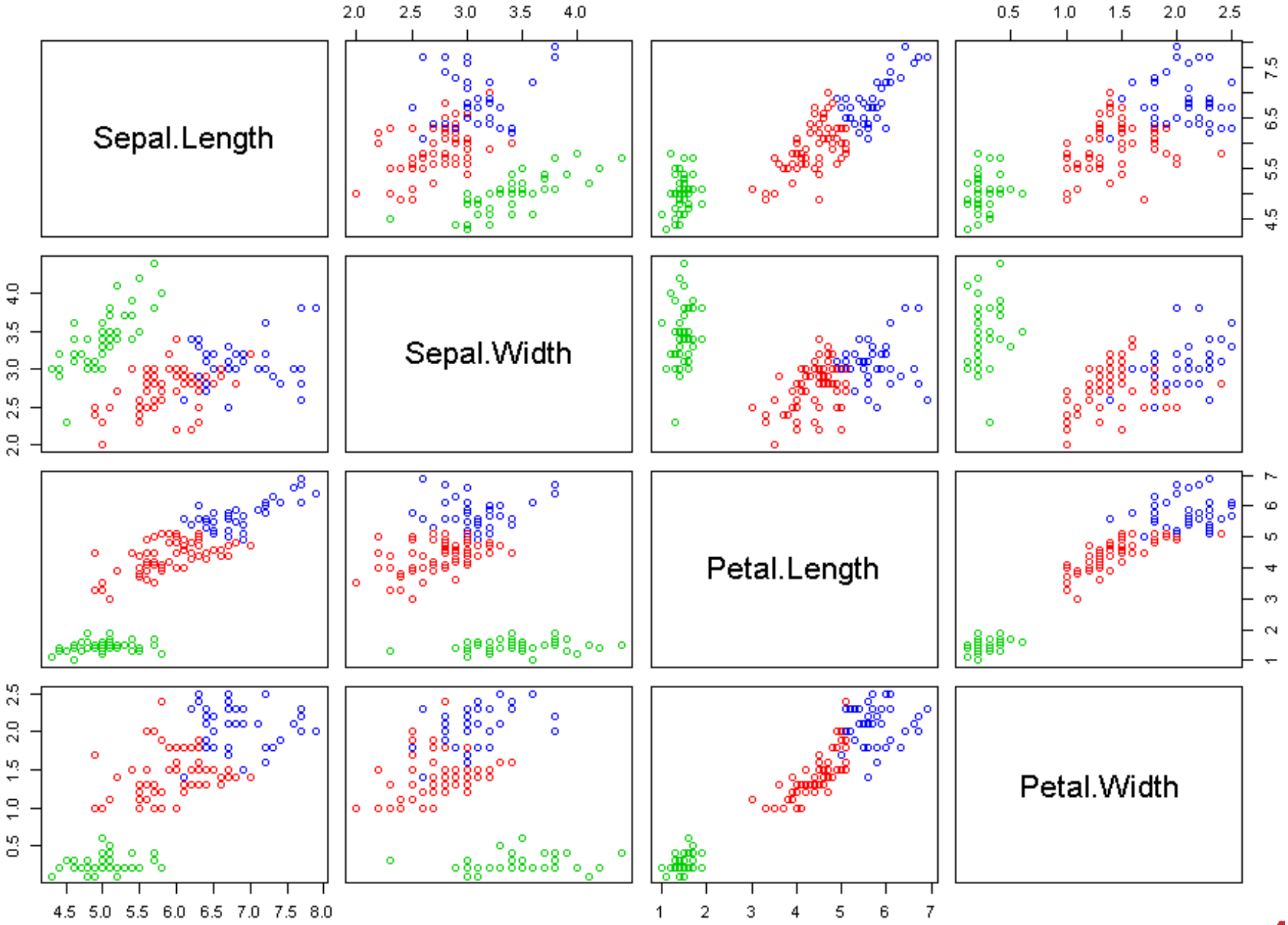
Points are clustered together because they are closer to each other



UNSUPERVISED

Clustering Example (Iris flower)

Sepal Length	Sepal Width	Petal Length	Petal Width	Species
5.1	3.5	1.4	0.2	setosa
4.9	3	1.4	0.2	setosa
4.7	3.2	1.3	0.2	setosa
4.6	3.1	1.5	0.2	setosa
6.2	2.2	4.5	1.5	versicolor
5.7	2.6	3.5	1	versicolor
5.5	2.4	3.8	1.1	versicolor
5.5	2.4	3.7	1	versicolor
7.2	3.6	6.1	2.5	virginica
6.5	3.2	5.1	2	virginica
6.4	2.7	5.3	1.9	virginica
6.8	3	5.5	2.1	virginica


Sepal.Length
Sepal.Width
Petal.Length
Petal.Width
2.0 2.5 3.0 3.5 4.0
0.5 1.0 1.5 2.0 2.5
4.5 5.5 6.5 7.5
2.0 2.5 3.0 3.5 4.0
1 2 3 4 5 6 7
0.5 1.0 1.5 2.0 2.5
4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0
1 2 3 4 5 6 7

OTHER TYPES OF DECISION PROBLEMS

Regression (Supervised)

- Stock price prediction

Classification (Supervised)

- Weather forecast (sunny, rainy, cloudy, etc)

Clustering (Unsupervised)

- Group Facebook users based on their interest

OTHER TYPES OF DECISION PROBLEMS

Data mining techniques:

- Regression
- Classification
- Clustering
- Association Rules
- Neural Networks
- Deep Learning
- etc

Already discussed briefly earlier

ASSOCIATION RULES

Association Rules

- Quite different from Regression and Classification
- Still using data but there is no clear-cut prediction that we can derive
- Also different from Clustering in that we are clear in our objectives
- We are interested in mining Association Rules which look like:
  - $X \rightarrow Y$ (X implies Y)
  - E.g. {diaper, milk} $\rightarrow$ {beer}

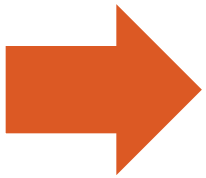
SUPERMARKET PROBLEM

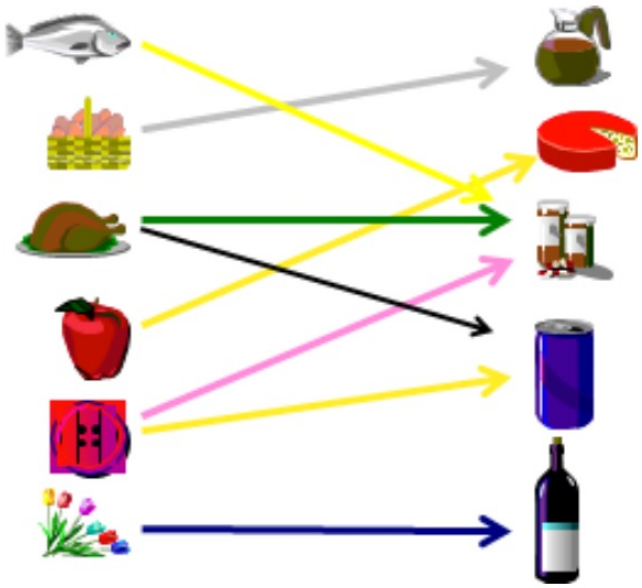
One of the key problems that a supermarket wants to tackle is how to place the products

Place similar category products together for better searching?

MARKET BASKET ANALYSIS

Market Basket Analysis (MBA) aims to find association between groups of items based on the transactions





98% of people who purchased items A and B also purchased C

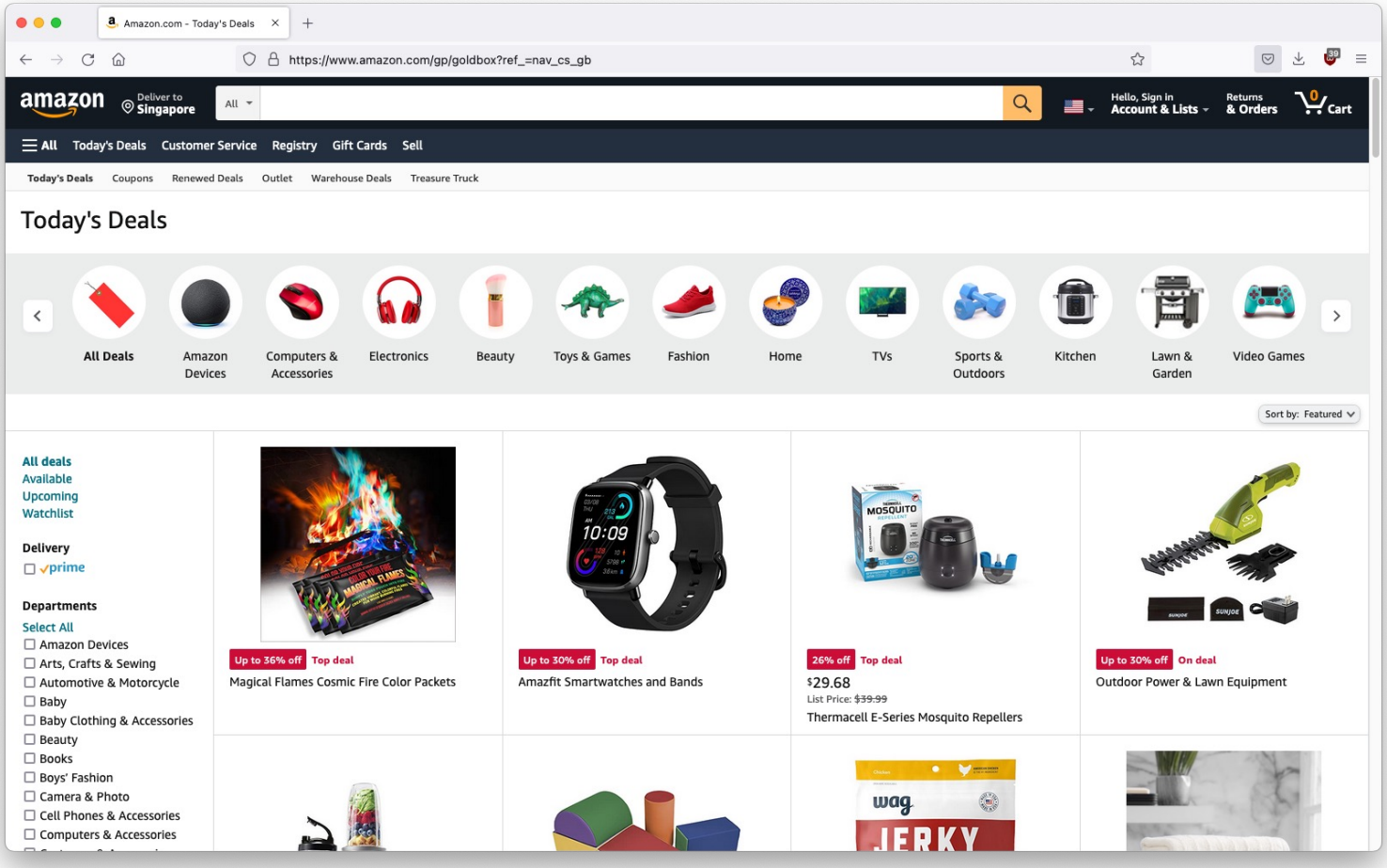
SUPERMARKET PROBLEM

Probably better to place products that users are likely to buy together in the same location

- Likely to generate more sales that way

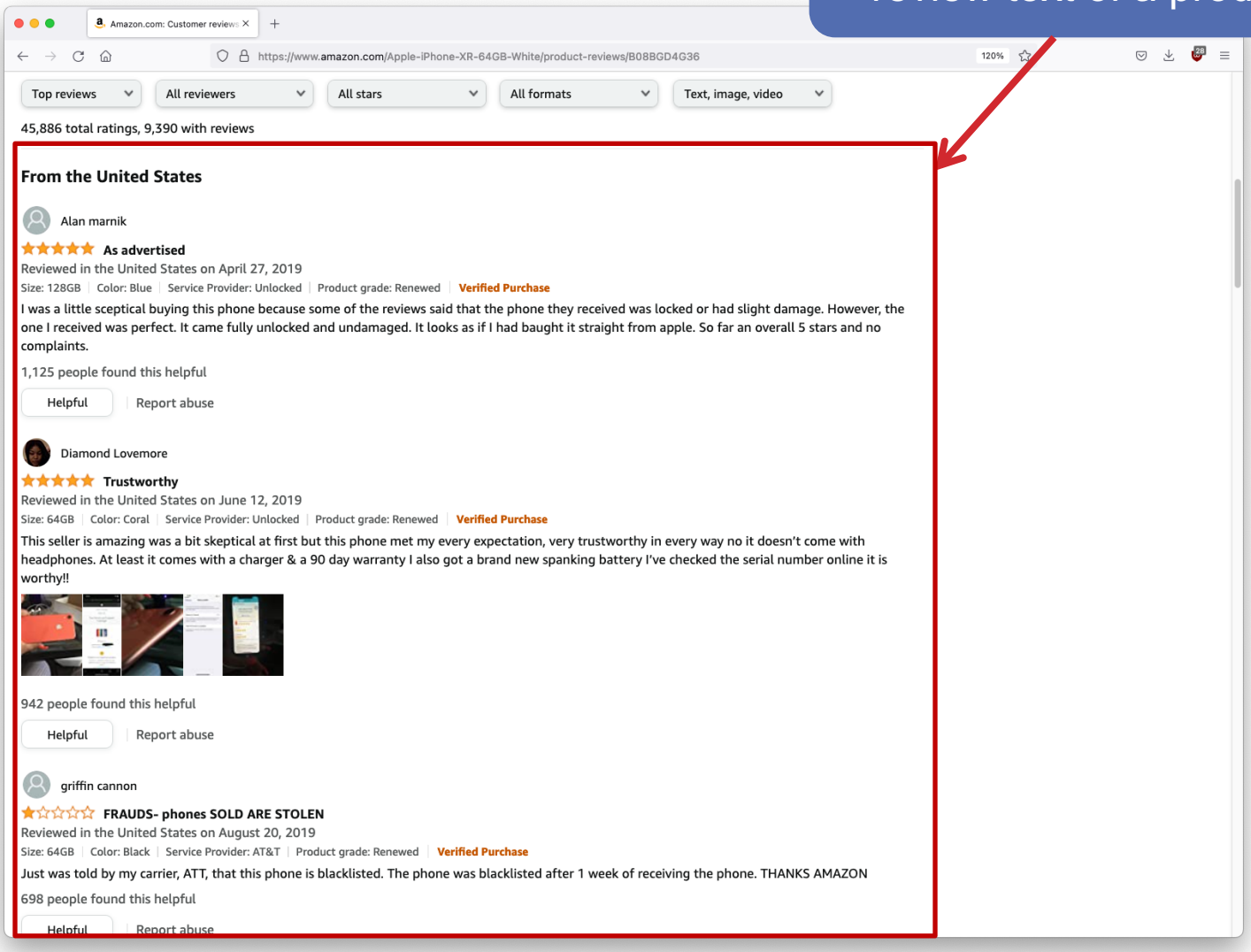
WEB SCRAPING DEMO

WEB SCRAPING DEMO: AMAZON.COM



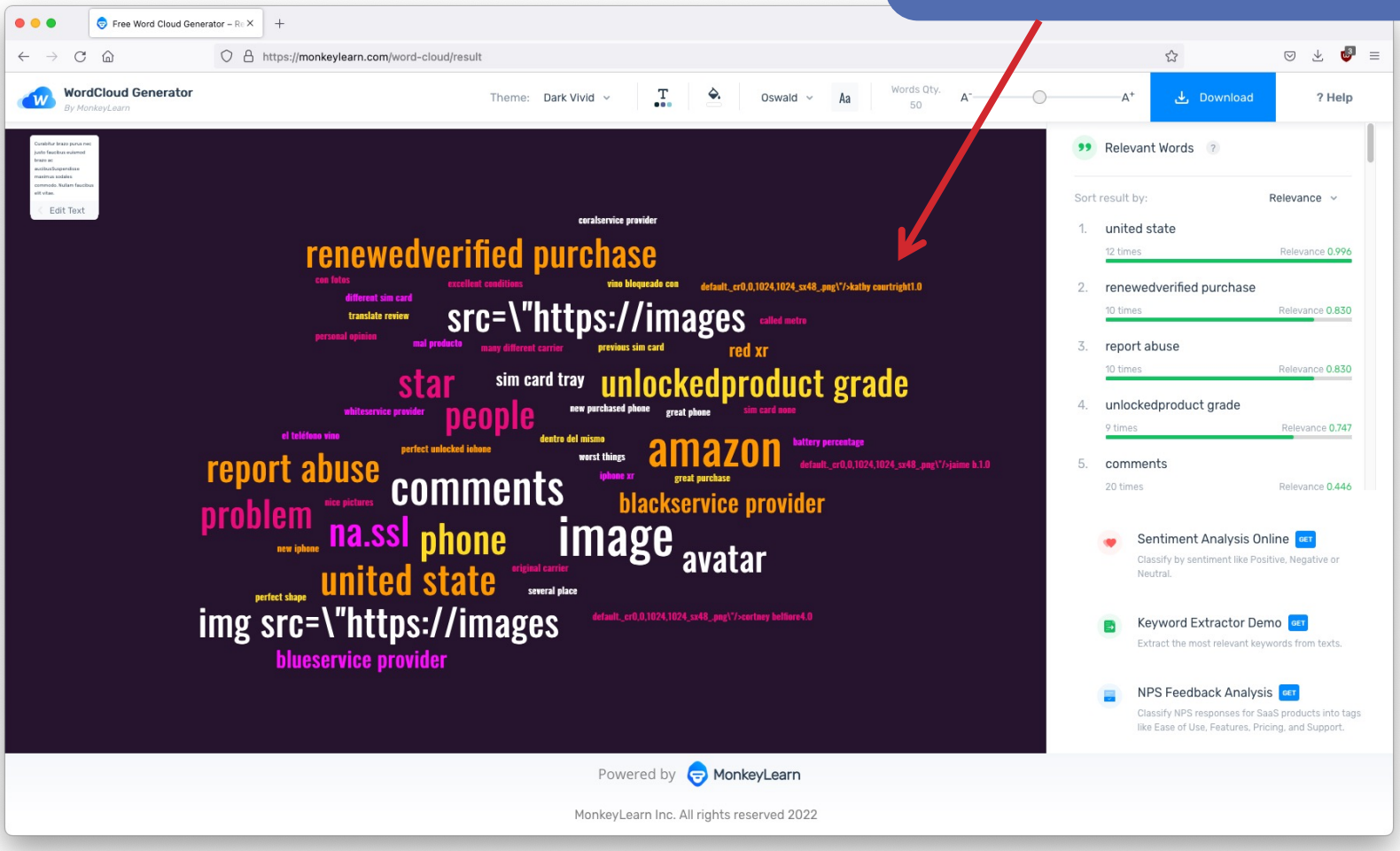
CHALLENGE

Are you able to get the review text of a product?



CHALLENGE

And use a word cloud generator to summarize the insights



https://monkeylearn.com/word-cloud

WHAT'S NEXT?

Cross-Industry Standard Process for Data Mining (CRISP-DM) & Predictive Analytics I