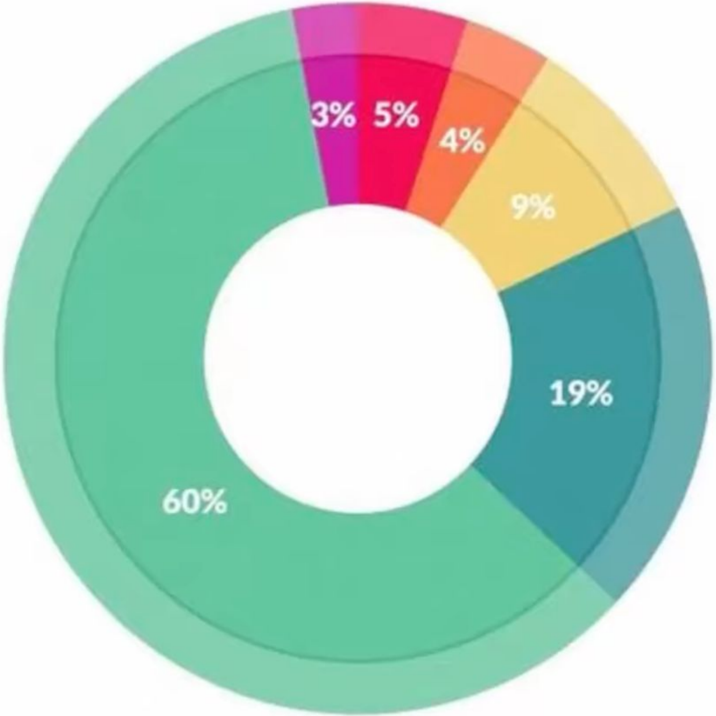
MIDS W207
Applied Machine Learning

Summer 2022

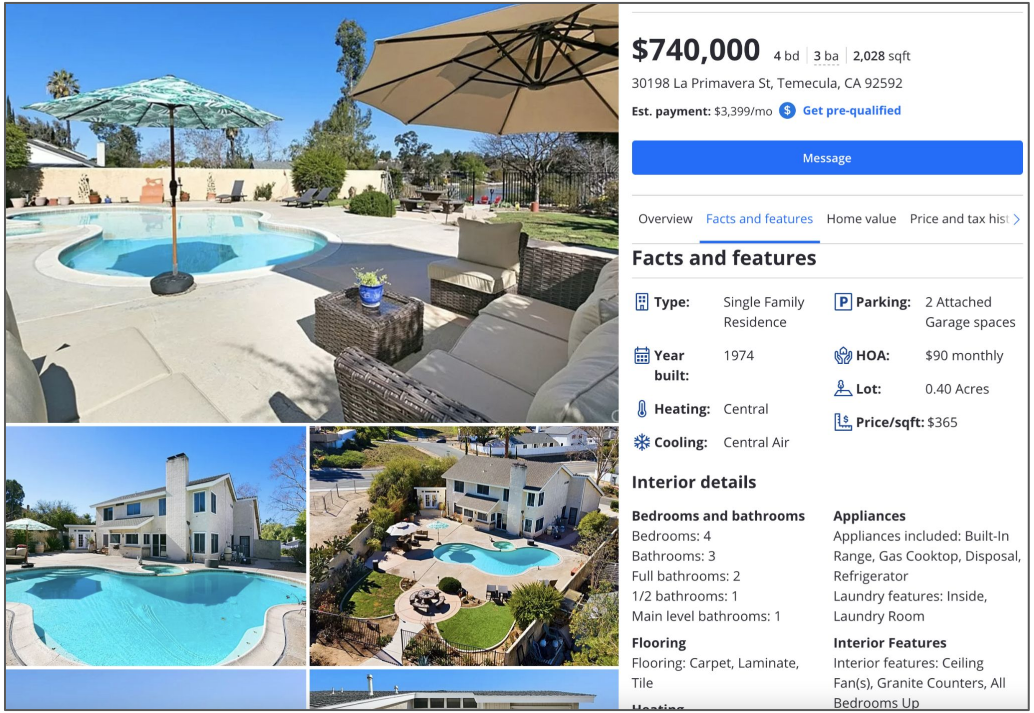
Week 3



What data scientists spend the most time doing

- *Building training sets: 3%*
- *Cleaning and organizing data: 60%*
- *Collecting data sets; 19%*
- *Mining data for patterns: 9%*
- *Refining algorithms: 4%*
- *Other: 5%*

Prediction



$740,000 4 bd | 3 ba | 2,028 sqft

30198 La Primavera St, Temecula, CA 92592

Est. payment: $3,399/mo **Get pre-qualified**

Facts and features

- **Type:** Single Family Residence
- **Year built:** 1974
- **Heating:** Central
- **Cooling:** Central Air
- **Parking:** 2 Attached Garage spaces
- **HOA:** $90 monthly
- **Lot:** 0.40 Acres
- **Price/sqft:** $365

Interior details

Bedrooms and bathrooms

Bedrooms: 4

Bathrooms: 3

Full bathrooms: 2

1/2 bathrooms: 1

Main level bathrooms: 1

Flooring

Flooring: Carpet, Laminate, Tile

Heating

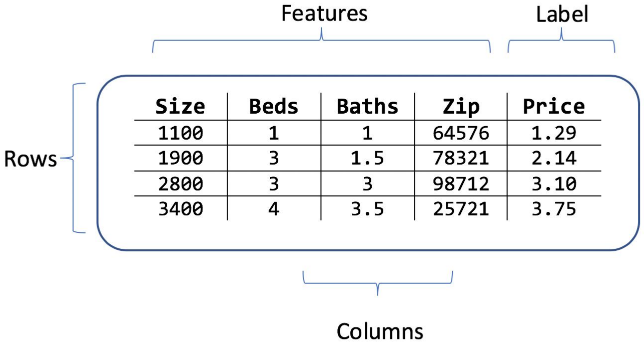
Appliances

Appliances included: Built-In Range, Gas Cooktop, Disposal, Refrigerator

Laundry features: Inside, Laundry Room

Interior Features

Interior features: Ceiling Fan(s), Granite Counters, All Bedrooms Up



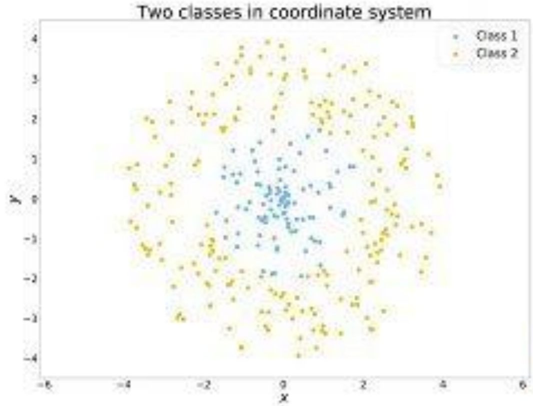
Features

Label

Rows

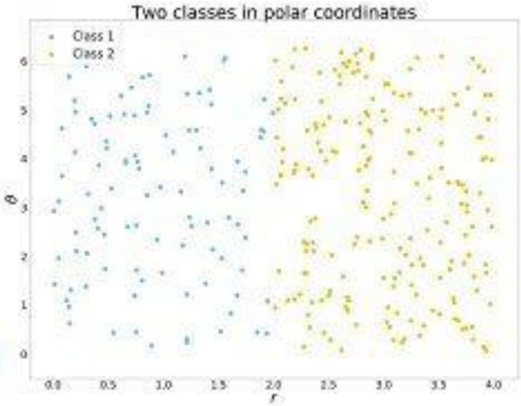
Size	Beds	Baths	Zip	Price
1100	1	1	64576	1.29
1900	3	1.5	78321	2.14
2800	3	3	98712	3.10
3400	4	3.5	25721	3.75

Columns

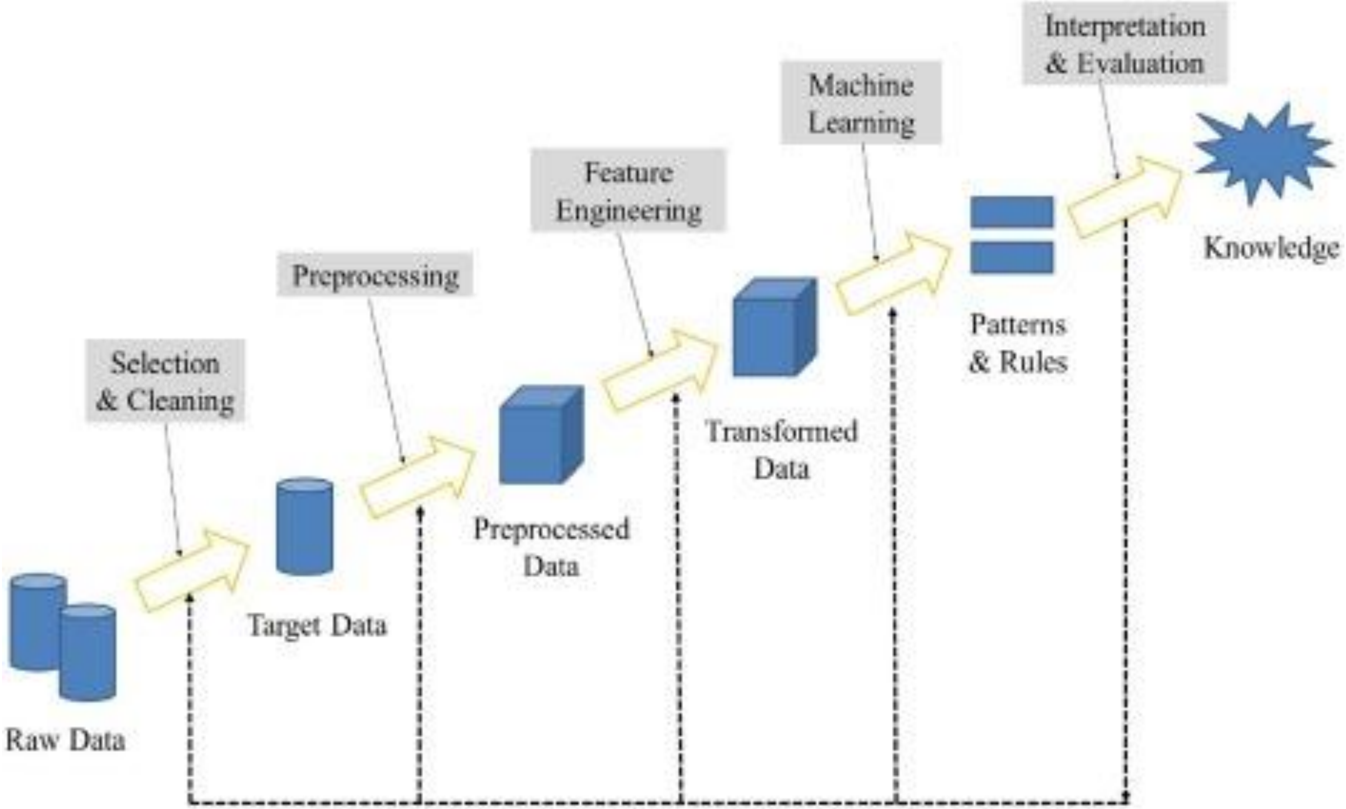


Tangled

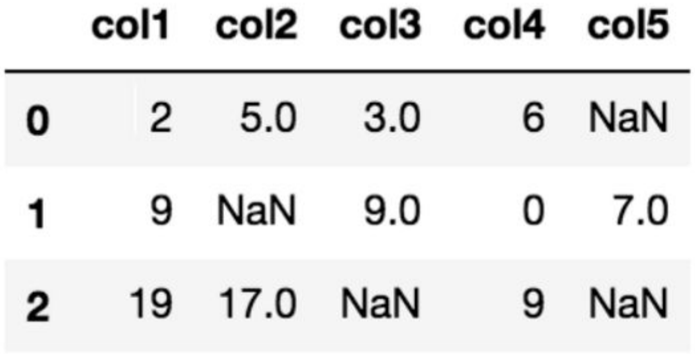
Feature engineering



Transparent

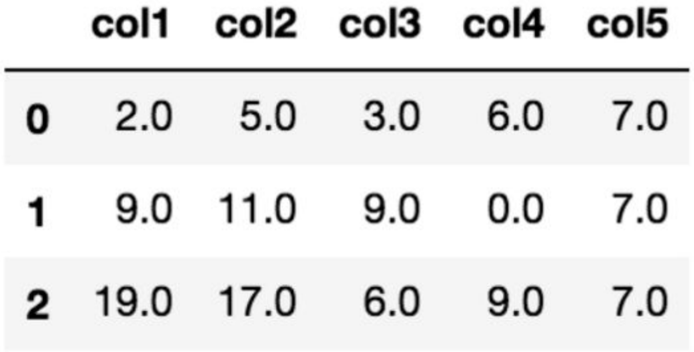

Interpretation & Evaluation
Machine Learning
Feature Engineering
Preprocessing
Selection & Cleaning
Knowledge
Patterns & Rules
Transformed Data
Preprocessed Data
Target Data
Raw Data

Missing Values



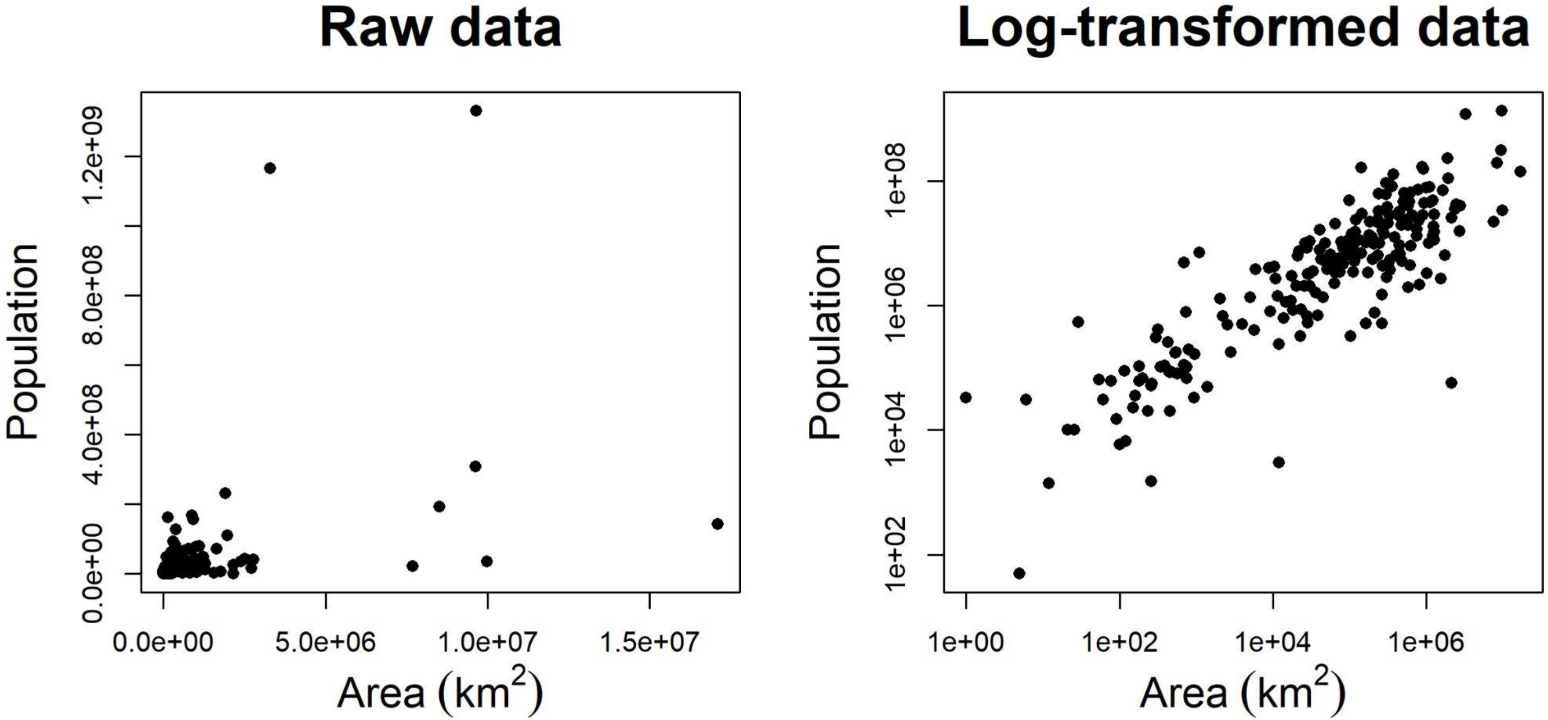
	col1	col2	col3	col4	col5
0	2	5.0	3.0	6	NaN
1	9	NaN	9.0	0	7.0
2	19	17.0	NaN	9	NaN

mean()

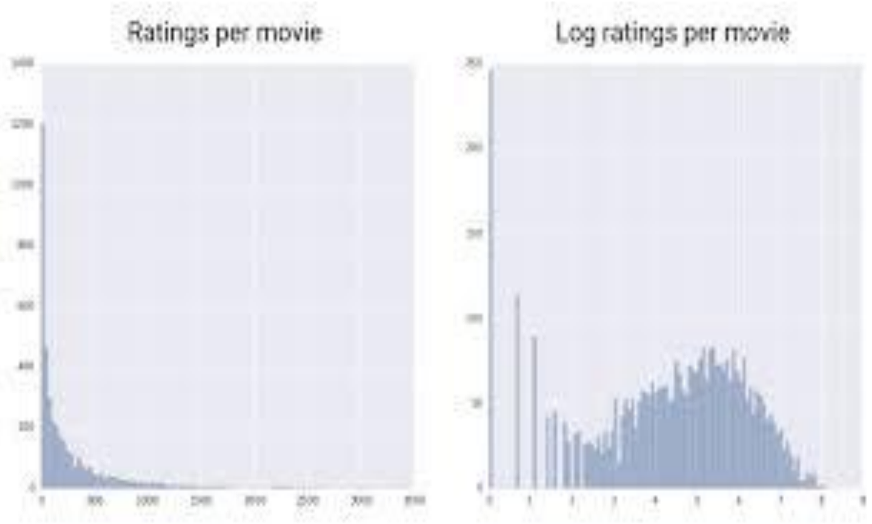


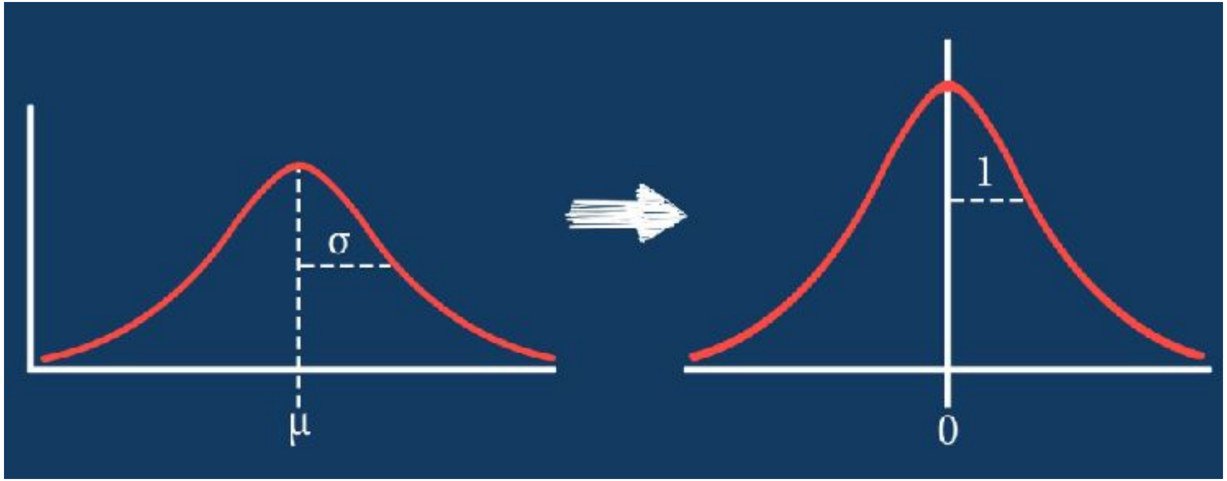
	col1	col2	col3	col4	col5
0	2.0	5.0	3.0	6.0	7.0
1	9.0	11.0	9.0	0.0	7.0
2	19.0	17.0	6.0	9.0	7.0

Transforming Features

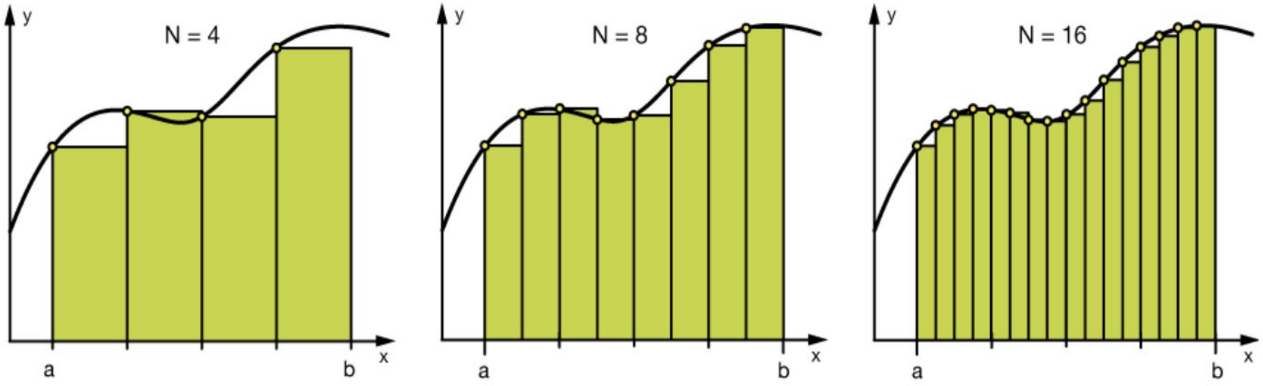


Scaling


Ratings per movie
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
3000
3500
Log ratings per movie
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
9


σ
μ
1
0

Bucketing



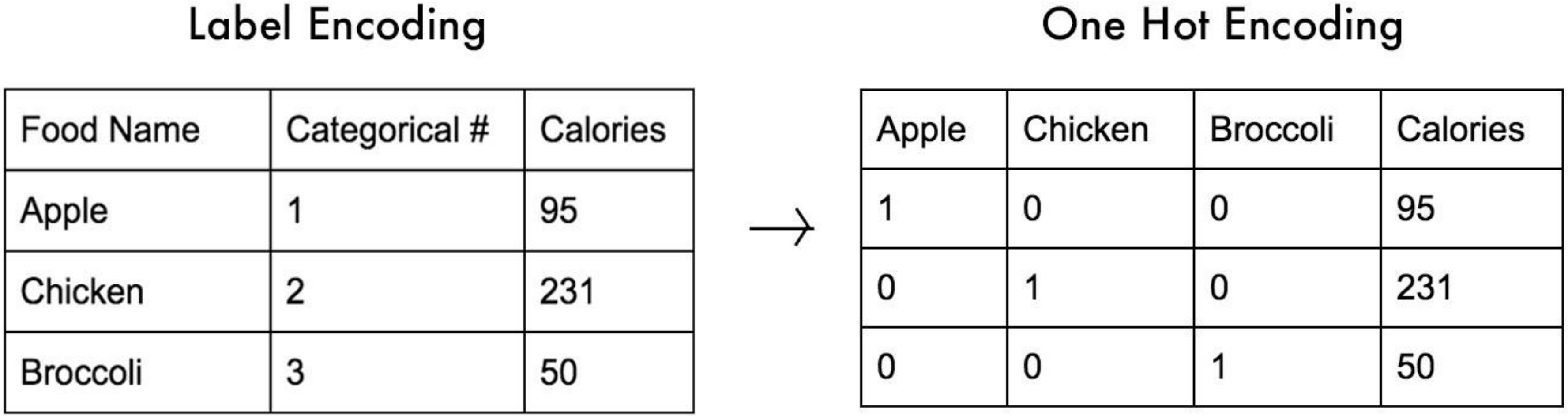
```
#Numerical Binning Example

Value       Bin
0-30    ->  Low
31-70   ->  Mid
71-100  ->  High

#Categorical Binning Example

Value       Bin
Spain   ->  Europe
Italy   ->  Europe
Chile   ->  South America
Brazil  ->  South America
```

Encoding



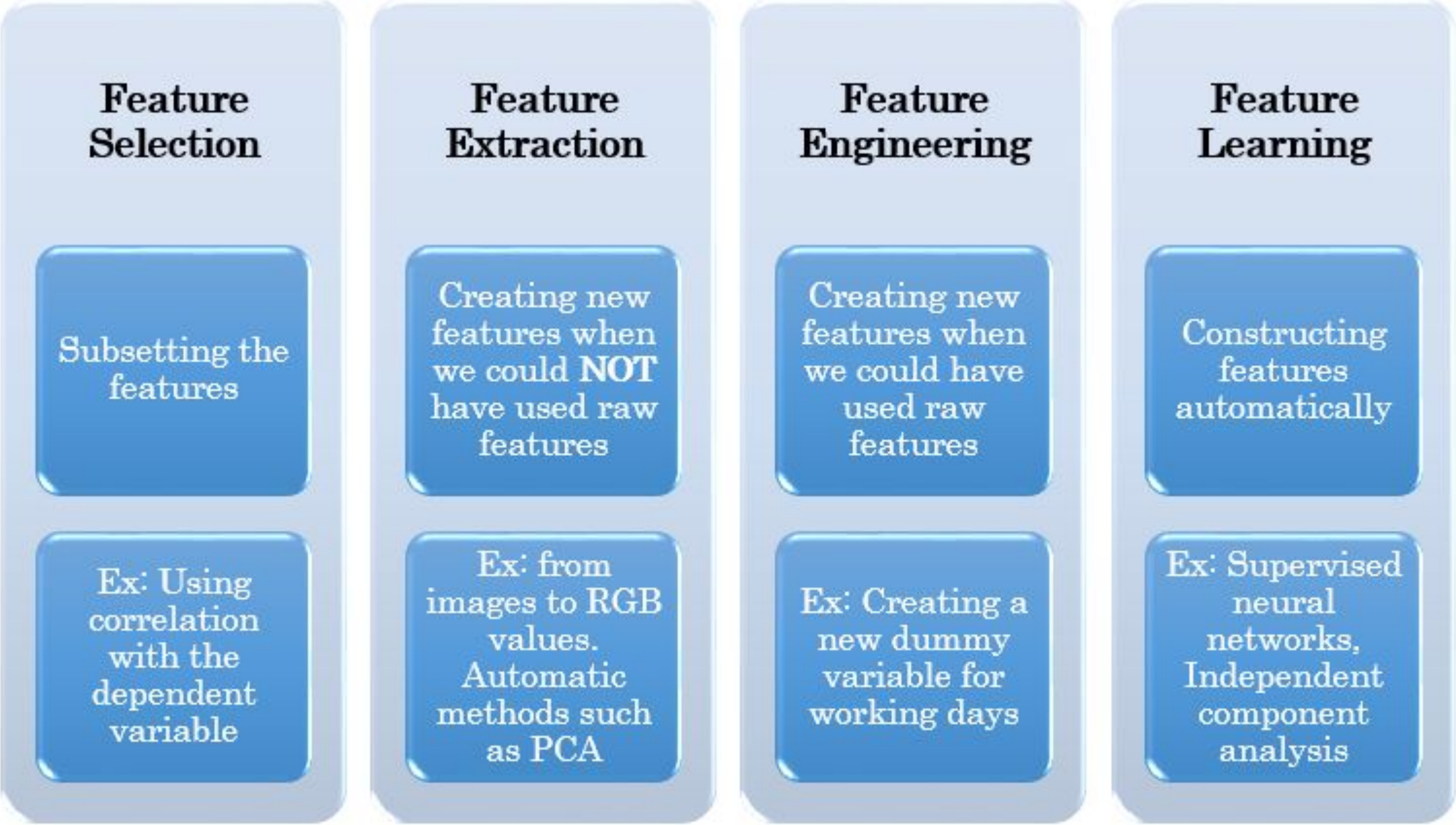
Label Encoding

Food Name	Categorical #	Calories
Apple	1	95
Chicken	2	231
Broccoli	3	50

→

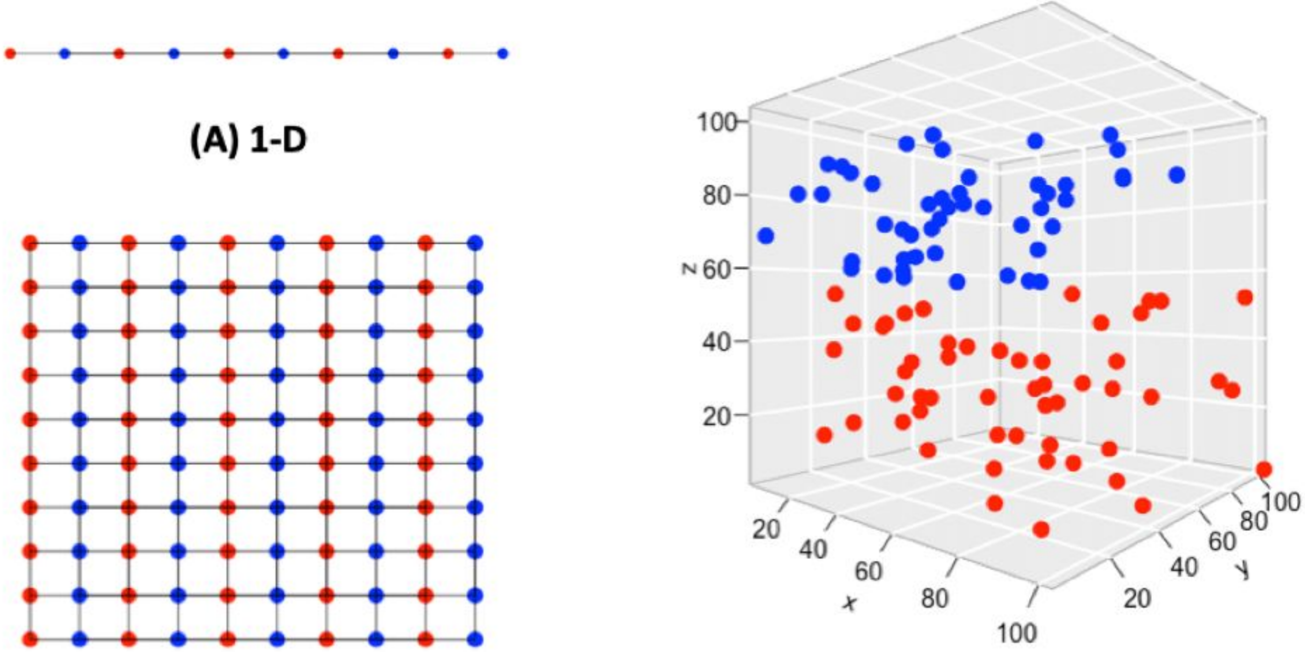
One Hot Encoding

Apple	Chicken	Broccoli	Calories
1	0	0	95
0	1	0	231
0	0	1	50



Feature Selection	Feature Extraction	Feature Engineering	Feature Learning
Subsetting the features	Creating new features when we could **NOT** have used raw features	Creating new features when we could have used raw features	Constructing features automatically
Ex: Using correlation with the dependent variable	Ex: from images to RGB values. Automatic methods such as PCA	Ex: Creating a new dummy variable for working days	Ex: Supervised neural networks, Independent component analysis

Curse of Dimensionality

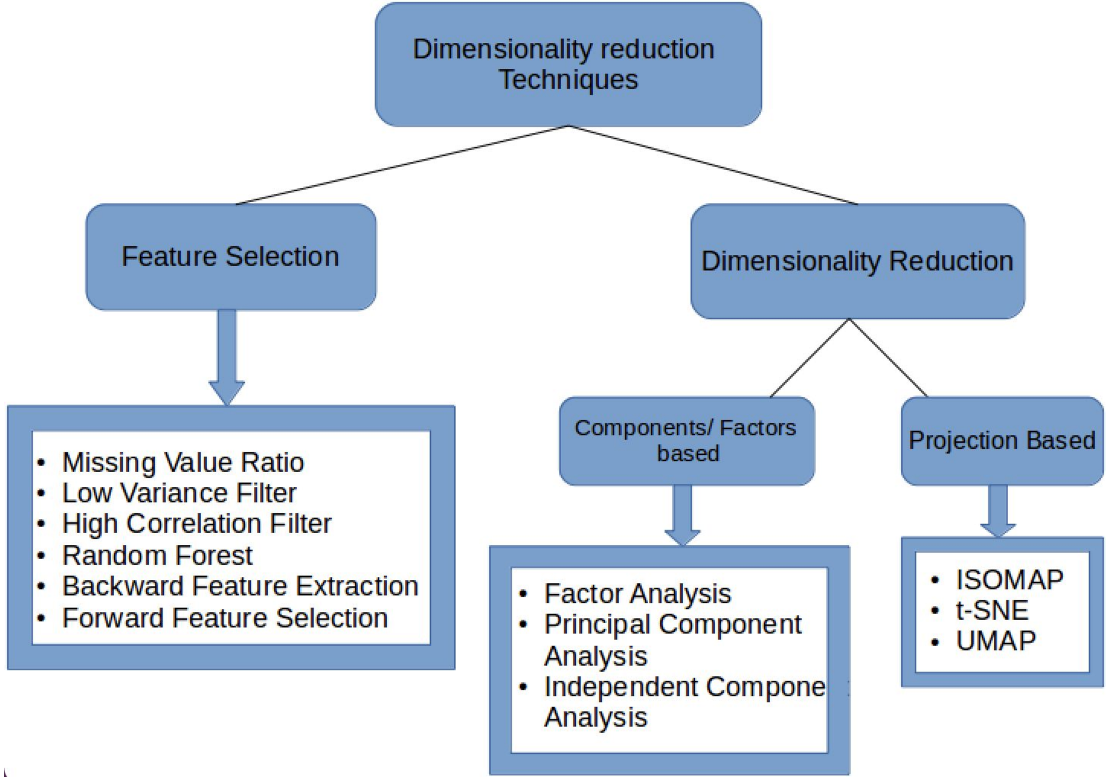


(A) 1-D

(B) 2-D

(C) 3-D

Dimensionality Reduction


Dimensionality reduction Techniques
Feature Selection
Dimensionality Reduction
Components/ Factors based
Projection Based

- Missing Value Ratio
- Low Variance Filter
- High Correlation Filter
- Random Forest
- Backward Feature Extraction
- Forward Feature Selection

- Factor Analysis
- Principal Component Analysis
- Independent Compone Analysis

- ISOMAP
- t-SNE
- UMAP

Numerical

- Standardization

$$Z = \frac{X - \mu}{\sigma}$$

- Normalization

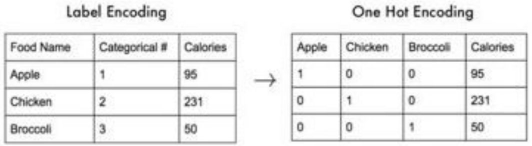
$$X_{\text{normalized}} = \frac{(x - x_{\text{minimum}})}{(x_{\text{minimum}} - x_{\text{minimum}})}$$

- Bucketing

Age<18	19<=Age<30	30<=Age<40	Age>=40

Categorical

- One-hot encoding



Label Encoding

Food Name	Categorical #	Calories
Apple	1	95
Chicken	2	231
Broccoli	3	50

→

One Hot Encoding

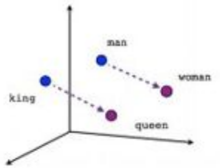
Apple	Chicken	Broccoli	Calories
1	0	0	95
0	1	0	231
0	0	1	50

- TF-IDF

$$w_{i,j} = tf_{i,j} \times \log\left(\frac{N}{df_i}\right)$$

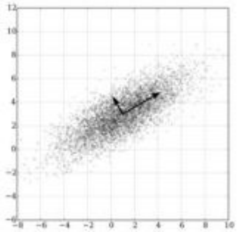
tf_{ij} = number of occurrences of i in j
df_i = number of documents containing i
N = total number of documents

- Word embeddings

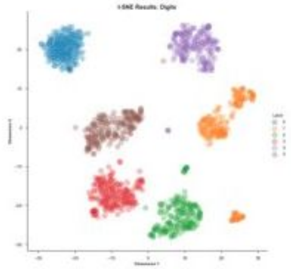


Dimensionality Reduction

- Principal component analysis (PCA)



- t-SNE


t-SNE Results: Digits