CIMVHR
Canadian Institute for Military and Veteran Health Research

ICRSMV
L'Institut canadien de recherche sur la santé des militaires et des vétérans

Machine Learning for Health Research

Sunday October 20th, 2019

9:00 am – 12:00 pm

Krieghoff room

DEMOS SESSION

Presented by :
Dr. Mohamed Sami Rakha

CIMVHR
Canadian Institute for Military and Veteran Health Research

ICRSMV
L'Institut canadien de recherche sur la santé des militaires et des vétérans

Assumption…

At this point we assume that you get your environment setup successfully. This means you have a Jupyter NoteBook instance running.

https://jupyter.org/try

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So First… What we need?

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So First… What we need?

Dataset

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We have two Datasets

Diabetes Dataset

442 Patients

Breast Cancer Dataset

569 Patients

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We have two Datasets

Diabetes Dataset

442 Patients

Breast Cancer Dataset

569 Patients

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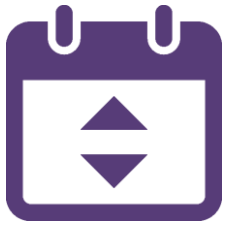
1# Diabetes Dataset

Number of Patients

442 Patients

10 Features



Age

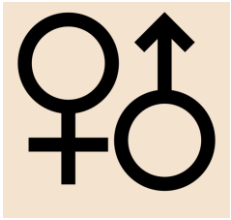
1# Diabetes Dataset

Number of Patients

442 Patients

10 Features

Age



Gender

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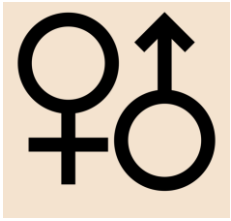
1# Diabetes Dataset

Number of Patients

442 Patients

10 Features

Age



Gender

BMI

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1# Diabetes Dataset

Number of Patients

442 Patients

10 Features

Age

Gender

BMI

Blood Pressure

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1# Diabetes Dataset

Number of Patients

442 Patients

10 Features

Age

Gender

BMI

Blood Pressure

S1 S2 S3 S4 S5 S6

Six Blood Serum Measurements

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1# Diabetes Dataset

Number of Patients

442 Patients

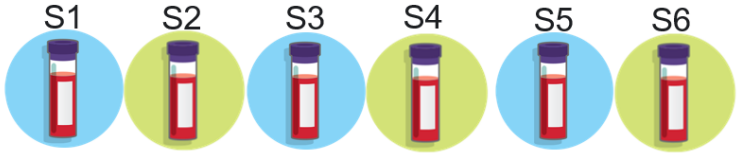
10 Features

Age

Gender

BMI

Blood Pressure



Six Blood Serum Measurements

11 Columns

Outcome

Quantitative Measure of the Disease

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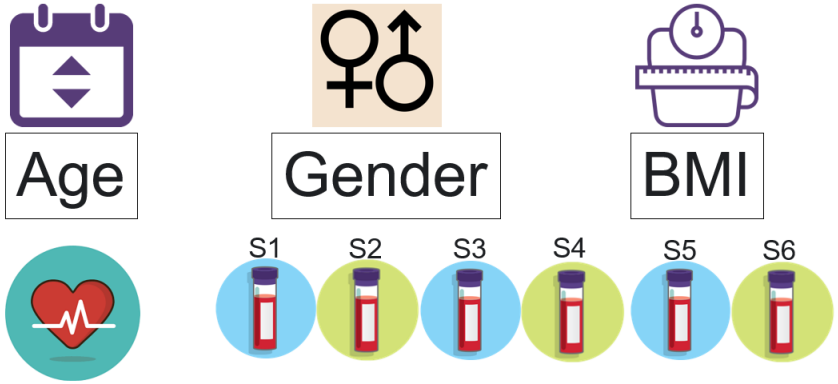
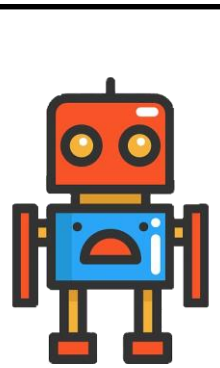
1# Diabetes Dataset

10 Features



Training



Machine Learning Model

Outcome

Regression Model

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We have two Datasets

Diabetes Dataset

442 Patients

Breast Cancer Dataset

569 Patients

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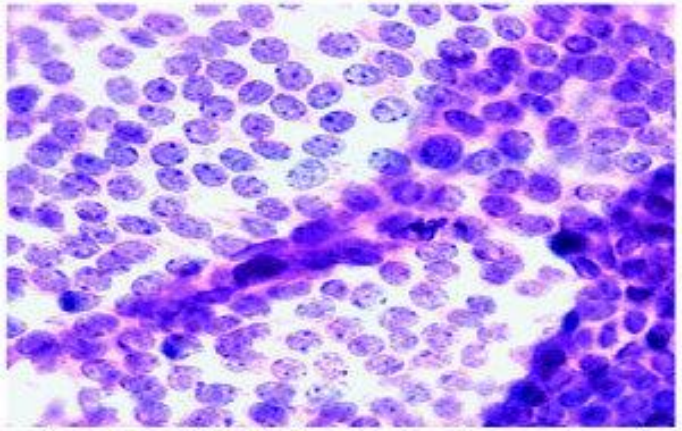
2# Breast Cancer Dataset

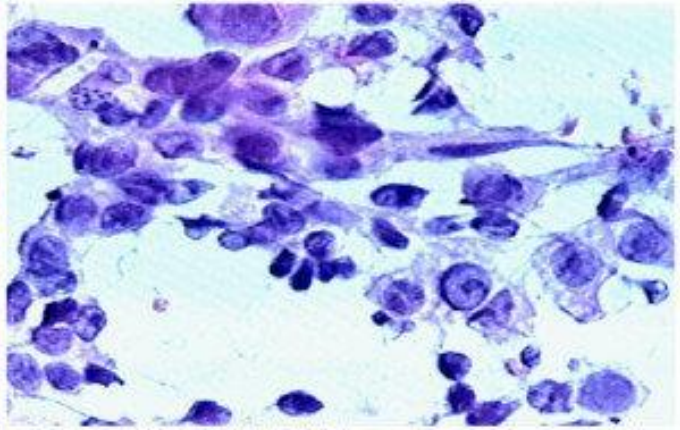
Number of Patients

569 Patients

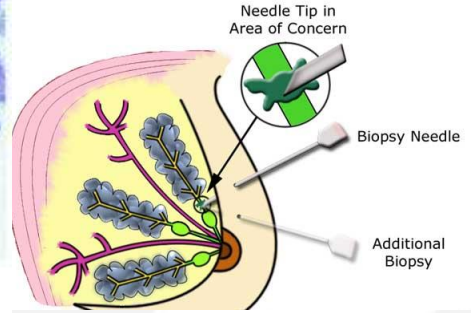
30 Features



Smear with BENIGN diagnosis – uniform nucleus of cells, symmetrical, homogeneous, with areas within normal size



Smear with MALIGNANT diagnosis – nucleus of cells without uniformity, asymmetrical, not homogeneous (multiple sizes) and with areas above normal size



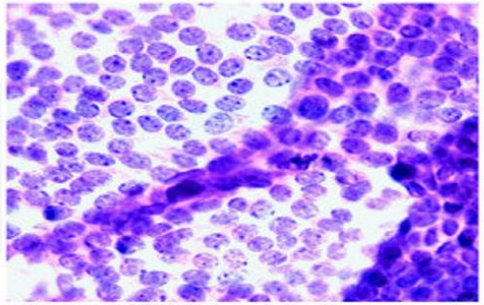
radius	compactness	radius	compactness	radius	compactness
texture	concavity	texture	concavity	texture	concavity
perimeter	concave points	perimeter	concave points	perimeter	concave points
area	symmetry	area	symmetry	area	symmetry
smoothness	fractal dimension	smoothness	fractal dimension	smoothness	fractal dimension

2# Breast Cancer Dataset

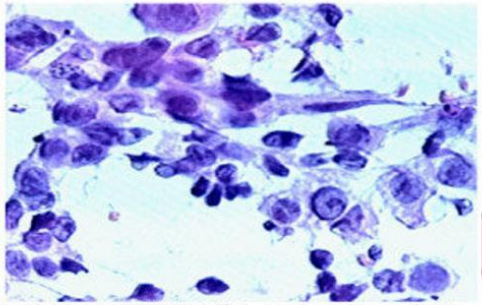
Number of Patients

569 Patients

30 Features



Smear with BENIGN diagnosis – uniform nucleus of cells, symmetrical, homogeneous, with areas within normal size



Smear with MALIGNANT diagnosis – nucleus of cells without uniformity, asymmetrical, not homogeneous (multiple sizes) and with areas above normal size

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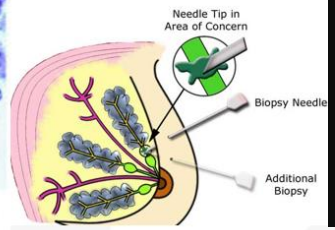
texture	concavity	texture	concavity	texture	concavity
perimeter	concave points	perimeter	concave points	perimeter	concave points
area	symmetry	area	symmetry	area	symmetry
smoothness	fractal dimension	smoothness	fractal dimension	smoothness	fractal dimension

Outcome



2 Classes:

- Malignant
- Benign

31 Columns

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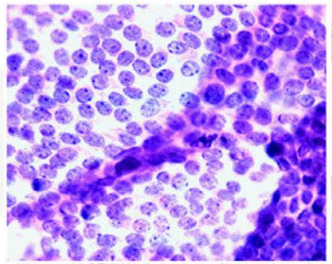
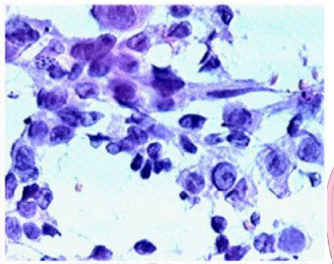
2# Breast Cancer Dataset

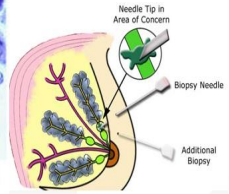
29 Features



Smear with BENIGN diagnosis – uniform nucleus of cells, symmetrical, homogeneous, with areas within normal size

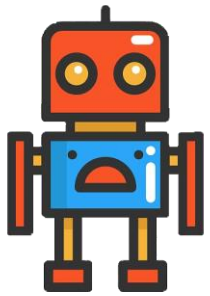


Smear with MALIGNANT diagnosis – nucleus of cells without uniformity, asymmetrical, not homogeneous (multiple sizes) and with areas above normal size



radius	compactness	radius	compactness	radius	compactness
texture	concavity	texture	concavity	texture	concavity
perimeter	concave points	perimeter	concave points	perimeter	concave points
area	symmetry	area	symmetry	area	symmetry
smoothness	fractal dimension	smoothness	fractal dimension	smoothness	fractal dimension

Training



Machine Learning Model

Outcome

Classification Model

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Supervised Learning Demos

Regression Demo

Classification Demo

Supervised Learning Demos

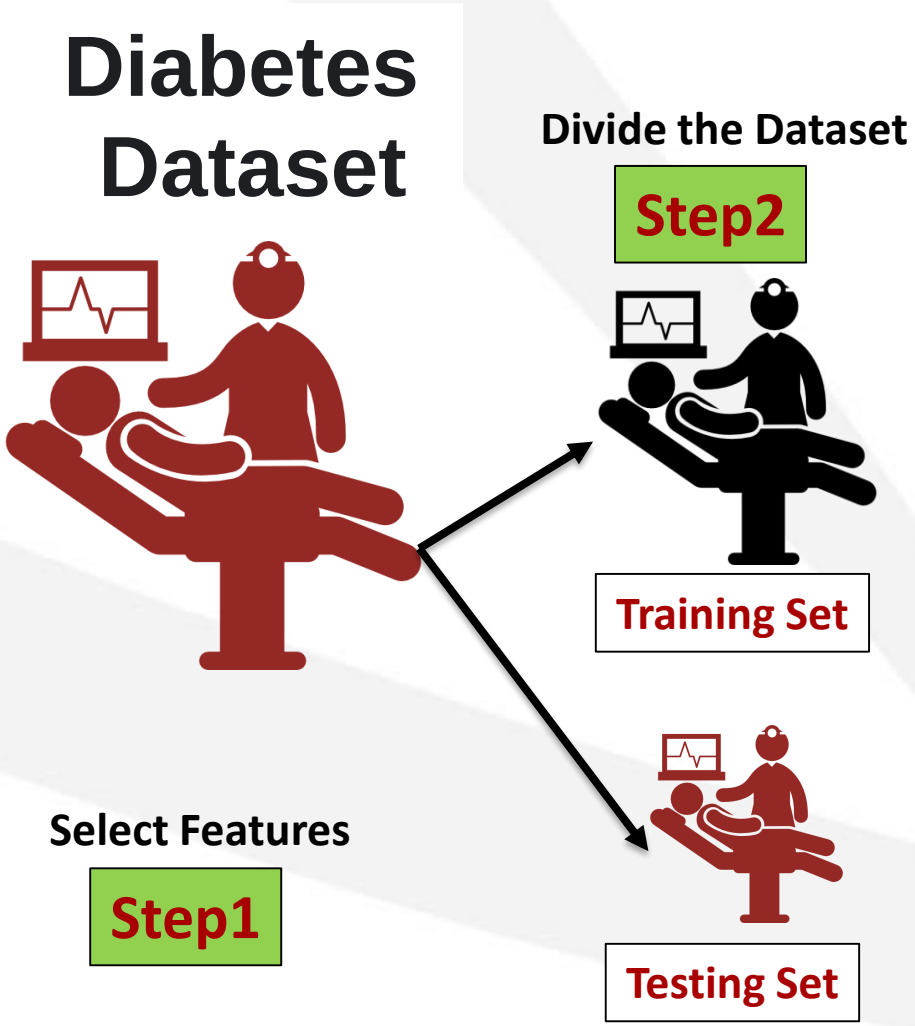
Regression Demo

Classification Demo

DEMO#1

Regression Modeling

Demo#1: Regression Modeling



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Demo#1: Regression Modeling

Diabetes Dataset

Select Features

Step1

Divide the Dataset

Step2

Training Set

Testing Set

The features and the Target are continuous values. We want to model a linear relation between the features and the target

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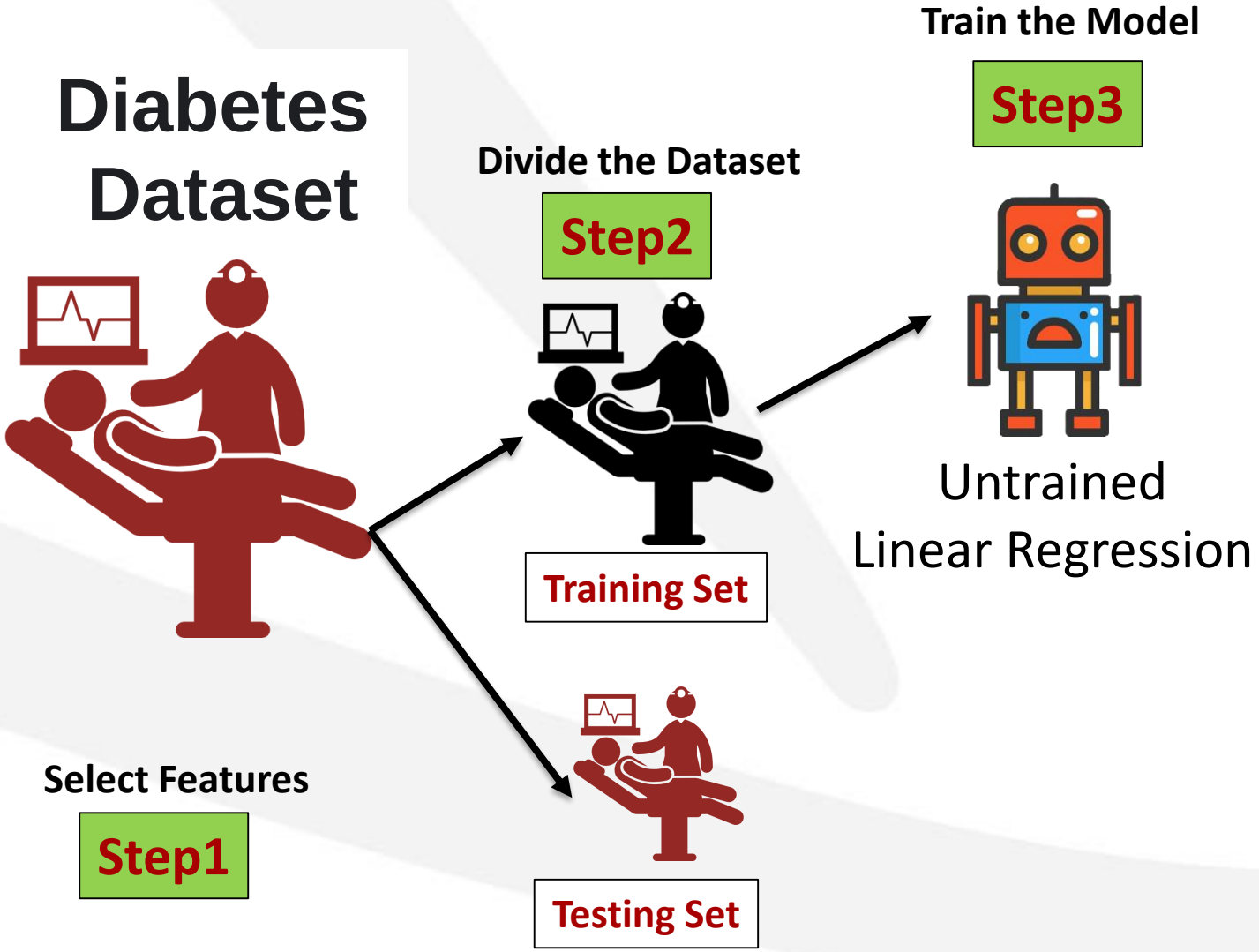
Demo#1: Regression Modeling



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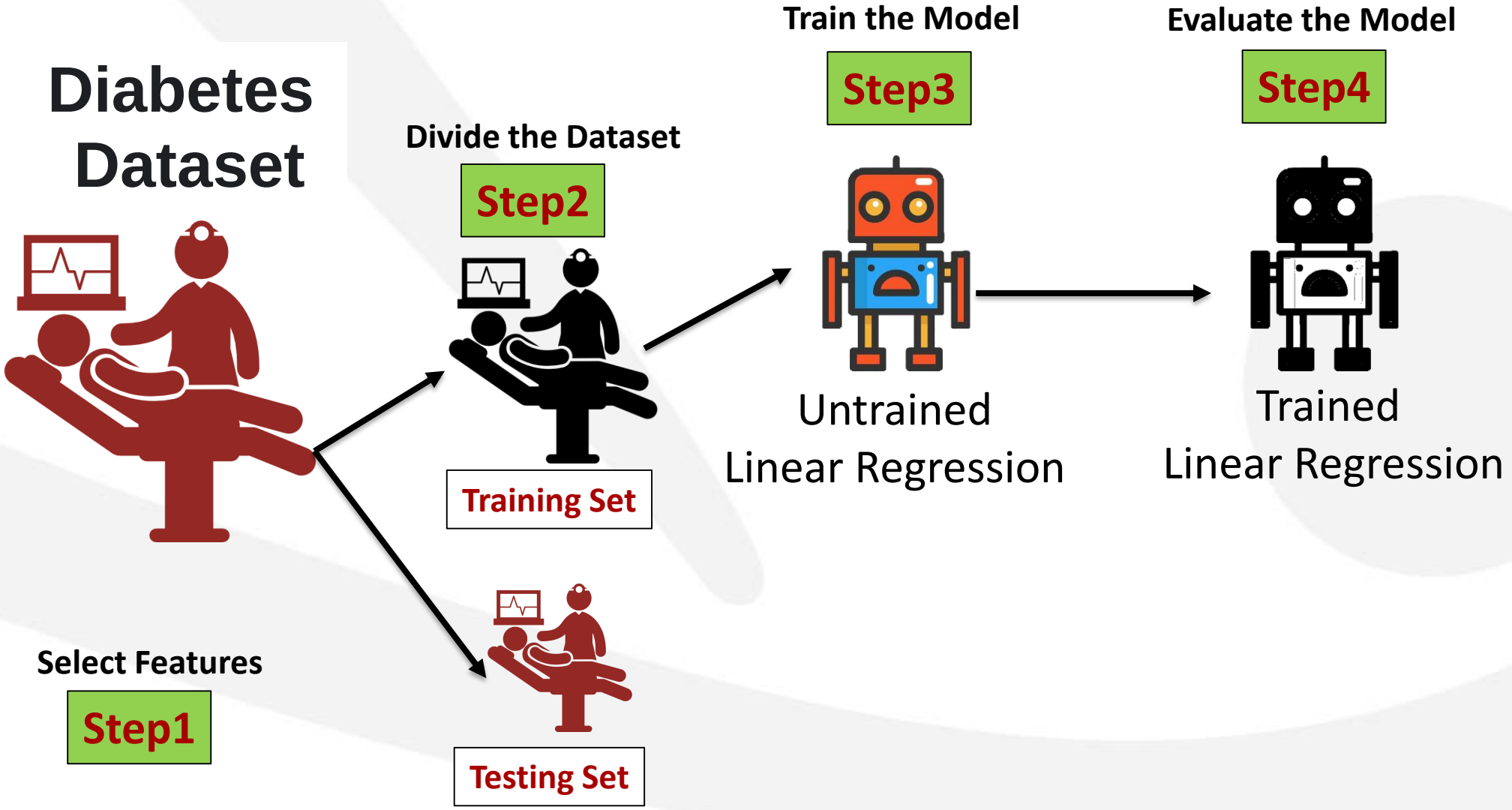
Demo#1: Regression Modeling



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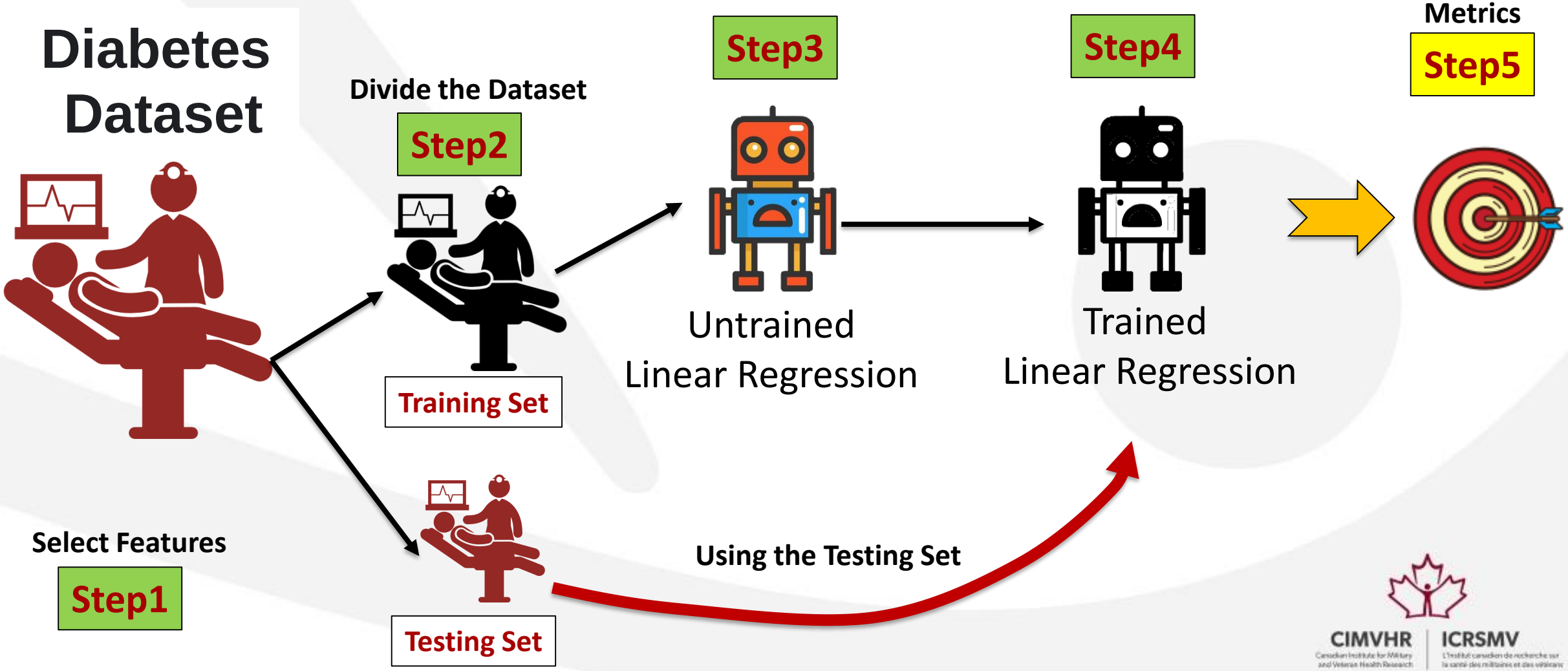
Demo#1: Regression Modeling



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Demo#1: Linear Regression

Lets Do Some Coding!

Supervised Learning Demos

Regression Demo

Classification Demo

DEMO#2

First Classification

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Demo#2: Classification

Breast Cancer Dataset

Select Features

Step1

radius	compactness	radius	compactness	radius	compactness
texture	concavity	texture	concavity	texture	concavity
perimeter	concave points	perimeter	concave points	perimeter	concave points
area	symmetry	area	symmetry	area	symmetry
smoothness	fractal dimension	smoothness	fractal dimension	smoothness	fractal dimension

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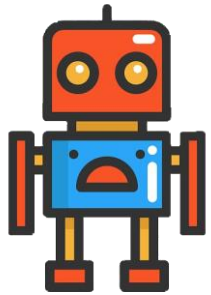
Demo#2: Classification

Breast Cancer Dataset

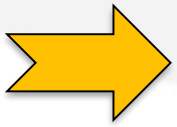


Untrained
Naïve Bayes

Our goal is train this model, so it predict future the class of future data

Select Features

Step1



radius	compactness	radius	compactness	radius	compactness
texture	concavity	texture	concavity	texture	concavity
perimeter	concave points	perimeter	concave points	perimeter	concave points
area	symmetry	area	symmetry	area	symmetry
smoothness	fractal dimension	smoothness	fractal dimension	smoothness	fractal dimension

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Demo#2: Classification

Breast Cancer Dataset

Select Features

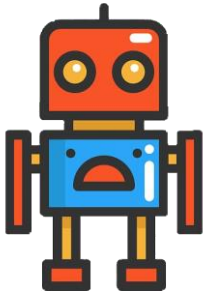
Step1

Divide the Dataset

Step2

Training Set

Testing Set



Untrained
Naïve Bayes

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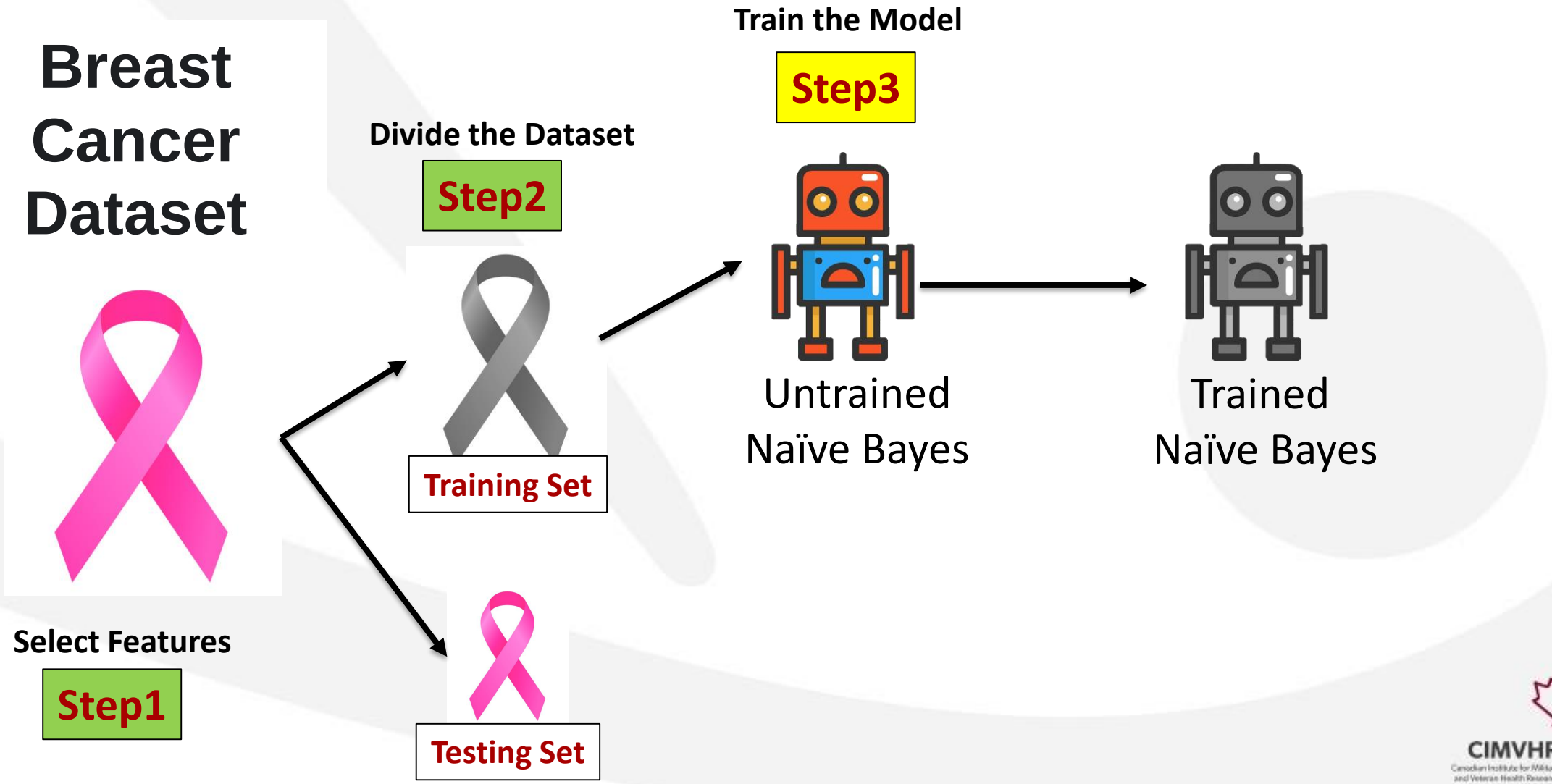
Demo#2: Classification



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Demo#2: Classification

Breast Cancer Dataset

Select Features

Step1

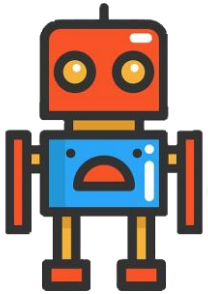
Divide the Dataset

Step2

Training Set

Train the Model

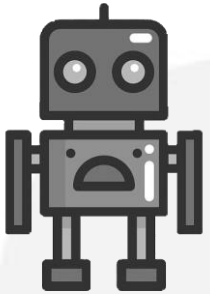
Step3



Untrained Naïve Bayes

Evaluate the Model

Step4



Trained Naïve Bayes

Testing Set

Using the Testing Set

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Demo#2: Classification

Breast Cancer Dataset

Select Features

Step1

Divide the Dataset

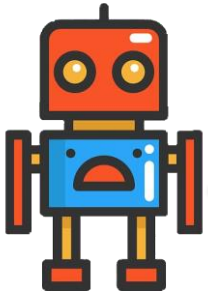
Step2

Training Set

Testing Set

Train the Model

Step3

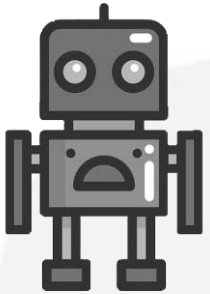


Untrained Naïve Bayes

Using the Testing Set

Evaluate the Model

Step4



Trained Naïve Bayes

Print Accuracy Metrics

Step5

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Demo#2: Classification

Lets Do Some Coding!

DEMO#3

Trying another Classifer

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Demo#3: Trying Another Classifier

Breast Cancer Dataset

Select Features

Step1

Divide the Dataset

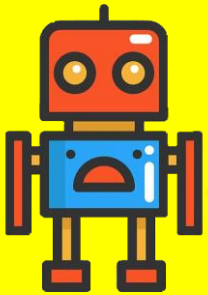
Step2

Training Set

Testing Set

Train the Model

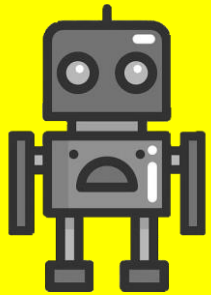
Step3



Untrained Naïve Bayes

Evaluate the Model

Step4

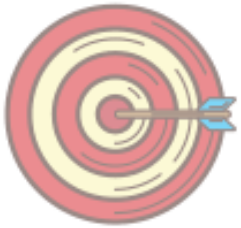


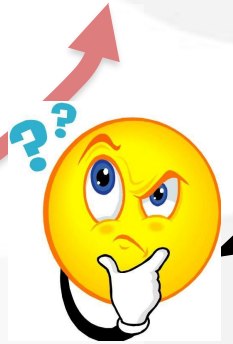
Trained Naïve Bayes

Using the Testing Set

Print Accuracy Metrics

Step5





Lets try another Learning Algorithm…. **Random Forest?**

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Demo#3: Trying Another Classifier

Breast Cancer Dataset

Select Features

Step1

Divide the Dataset

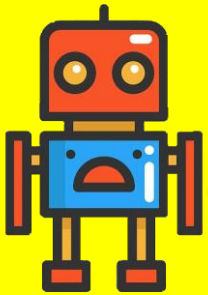
Step2

Training Set

Testing Set

Train the Model

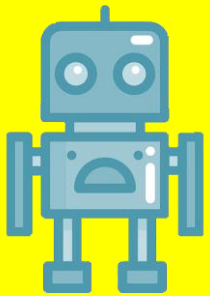
Step3



Untrained **RandomForest**

Evaluate the Model

Step4

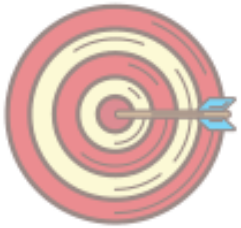


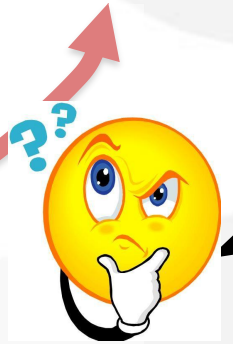
Trained **RandomForest**

Using the Testing Set

Print Accuracy Metrics

Step5





Lets try another Learning Algorithm…. **Random Forest?**

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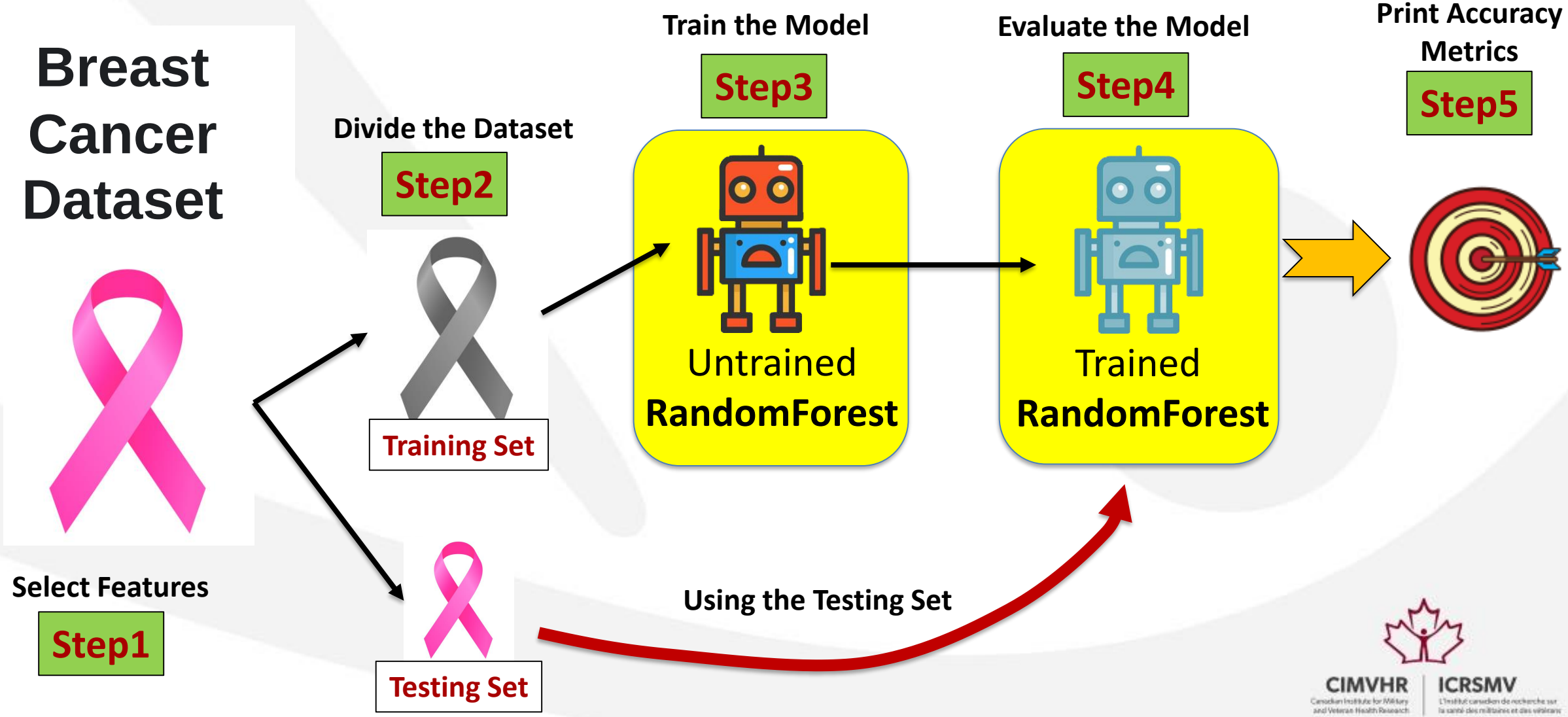
Demo#3: Trying Another Classifier



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Demo#3: Trying Another Classifier

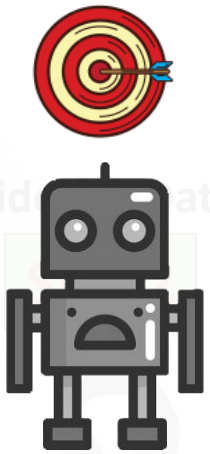
Lets Do Some Coding!

Demo#3: Trying Another Classifier

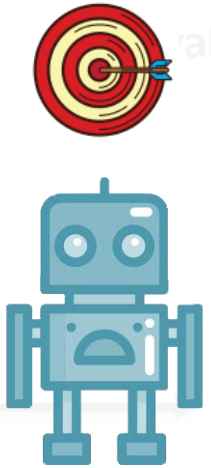
Naïve Bayes **RandomForest**

Based on the Accuracy Metrics.. Which Learning Algorithm is performing better?

Demo#3: Which one is better?



Naïve Bayes



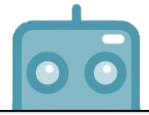
RandomForest

Based on the Accuracy Metrics.. Which Learning Algorithm is performing better?

What about trying Model Validation Techniques?Why?

Demo#3: Which one is better?

		precision	recall	f1-score	support
malignant	0	0.93	0.76	0.83	98
benign	1	0.88	0.97	0.92	187
accuracy				0.89	285
macro avg		0.90	0.86	0.88	285
weighted avg		0.90	0.89	0.89	285



		precision	recall	f1-score	support
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accuracy				0.90	285
macro avg		0.90	0.88	0.89	285
weighted avg		0.90	0.90	0.90	285

Based on the Accuracy Metrics.. Which Learning Algorithm is performing better?

What about trying Model Validation Techniques?Why?

Demo#3: Which one is better?

		precision	recall	f1-score	support
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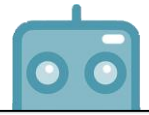
macro avg		0.90	0.86	0.88	285
weighted avg		0.90	0.89	0.89	285



		precision	recall	f1-score	support
malignant	0	0.89	0.82	0.85	98
benign	1	0.91	0.95	0.93	187
accuracy				0.90	285
macro avg		0.90	0.88	0.89	285
weighted avg		0.90	0.90	0.90	285

What else RandomForest does? Descriptive analysis

DEMO#4

Exploring Model Validation

Demo#4: Model Validation

Breast Cancer Dataset

Select Features

Step1

Divide the Dataset

Step2

Training Set

Testing Set

We change how data is splitted? And use K-fold validation

Demo#4: Model Validation

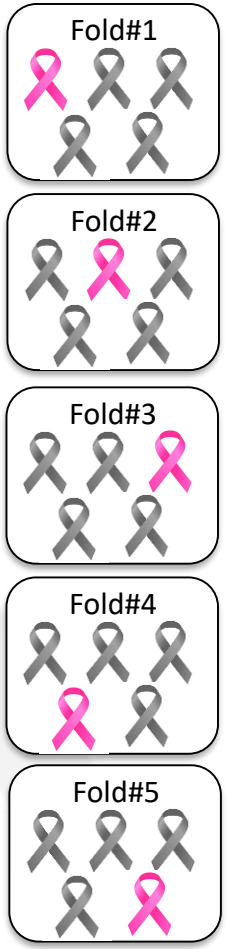
Breast Cancer Dataset

Select Features

Step1

Step2

5 folds cross-validation



Reduces the chances of overfitting.

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Demo#4: Model Validation

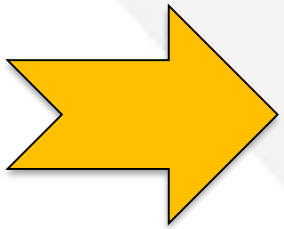
Breast Cancer Dataset

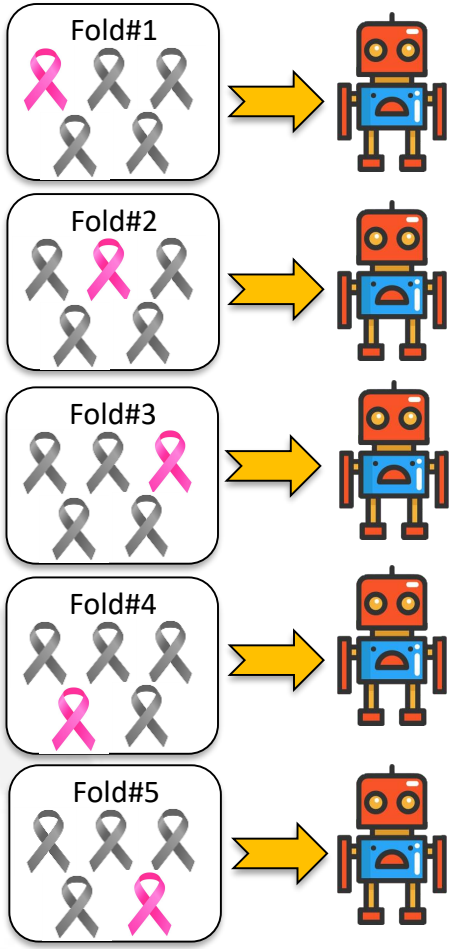
Select Features

Step1

Step2

5 folds cross-validation





Reduces the chances of overfitting.

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Demo#4: Model Validation

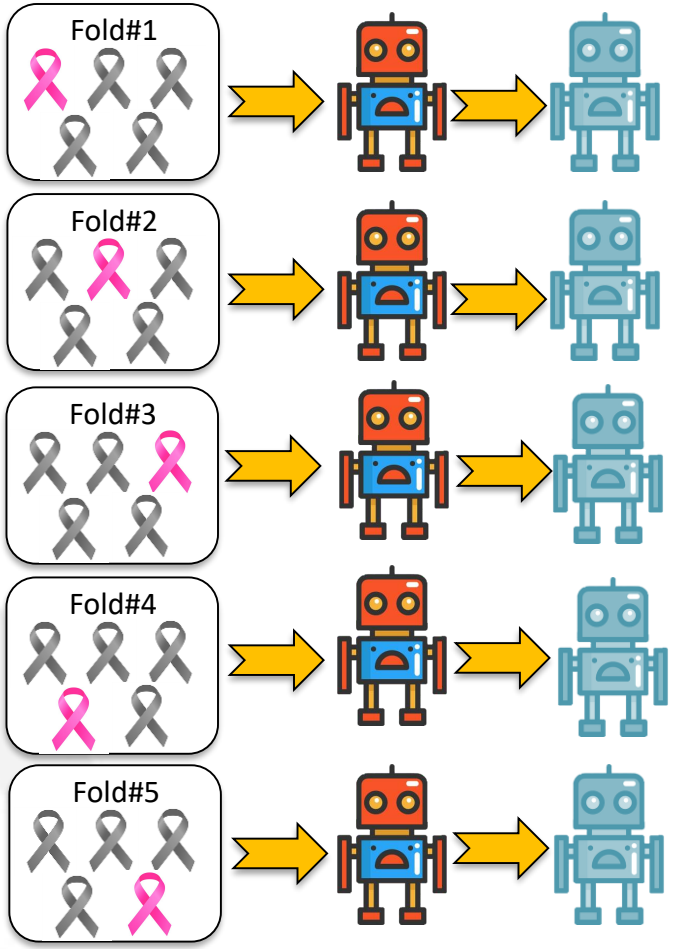
Breast Cancer Dataset

Select Features

Step1

Step2

5 folds cross-validation



Reduces the chances of overfitting.

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Demo#4: Model Validation

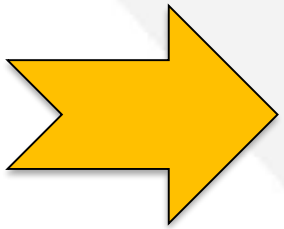
Breast Cancer Dataset

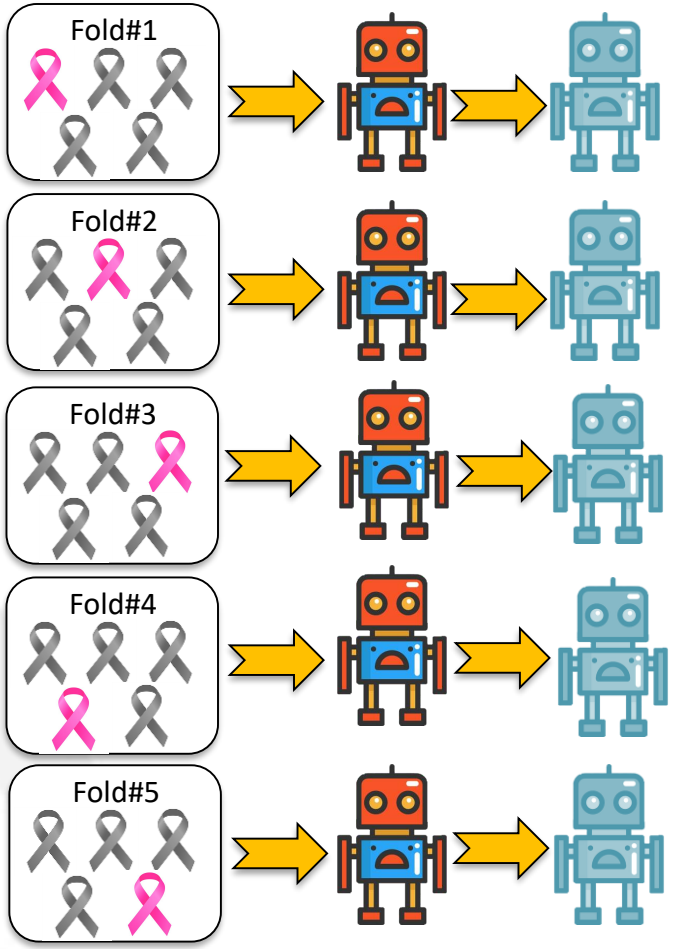
Select Features

Step1

Step2

5 folds cross-validation





Step3

Report Average Accuracy Metrics

Reduces the chances of overfitting.

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Demo#4: Model Validation

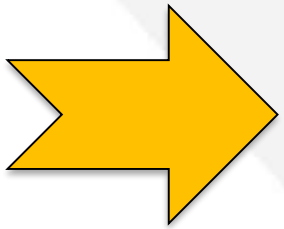
Breast Cancer Dataset

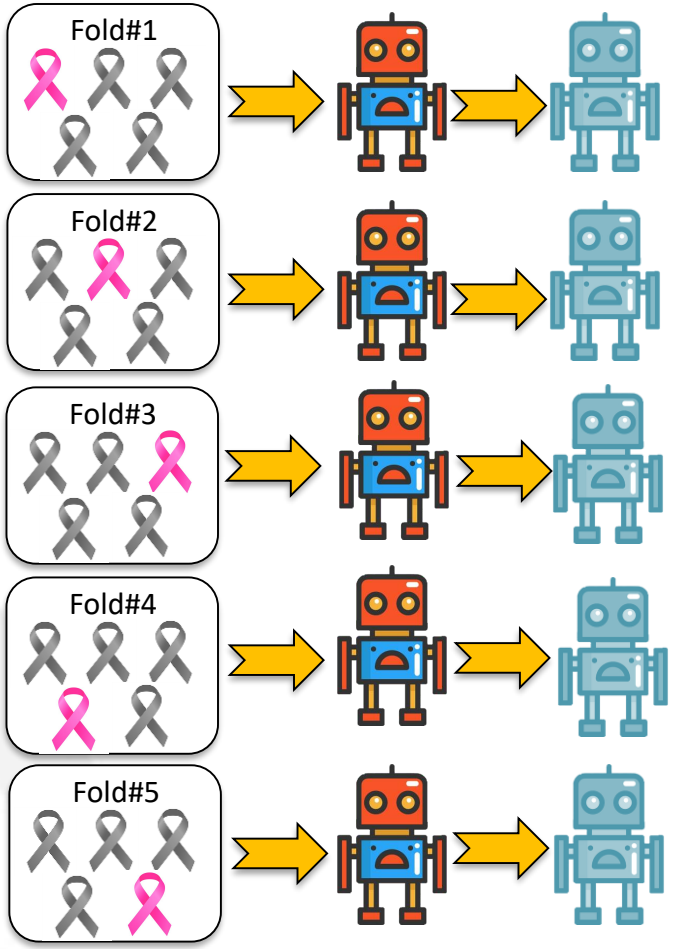
Select Features

Step1

Step2

5 folds cross-validation



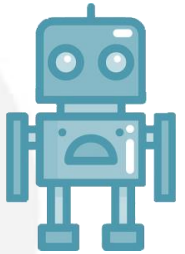


Step3

Report Average Accuracy Metrics

Step4

Pick best one out of the five



Reduces the chances of overfitting.

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Demo#4: Model Validation

Lets Do Some Coding!

UnSupervised Learning Demos

Clustering

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DEMO#5

Clustering with Kmeans

Demo#5: Clustering with K-means

Breast Cancer Dataset

Select Features

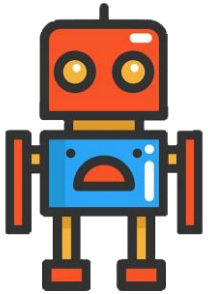
Step1

Step2

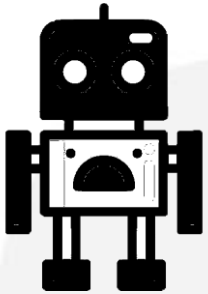
Send data to Kmeans after ignoring the labels

Start Clustering

Step3



Before Clustering Kmeans



Clustered Data Kmeans

Print Accuracy Metrics

Step4

Compare the labelled data and Clustered data

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Demo#5: Clustering with K-means

Lets Do Some Coding!

Selected Topics

Parameter Optimization

Automatic Feature Selection

Selected Topics

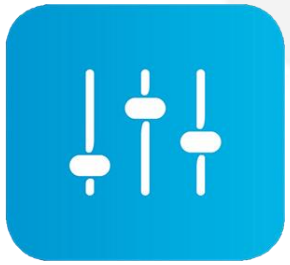
Parameter Optimization

Automatic Feature Selection

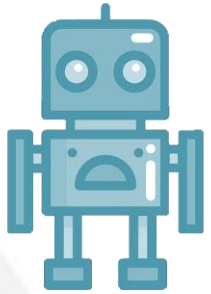
DEMO#6

Parameter Optimization

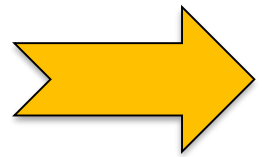
Demo#6: Parameter Optimization



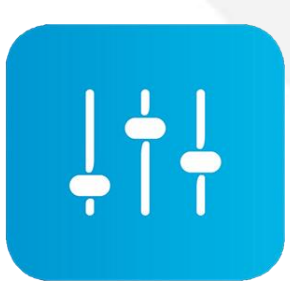
Parameter Optimization



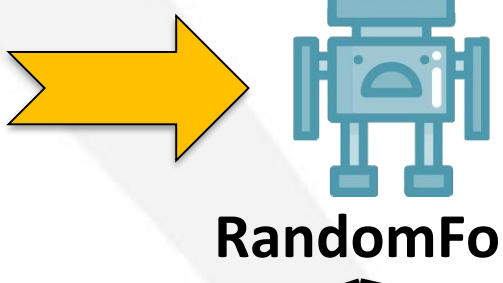
RandomForest



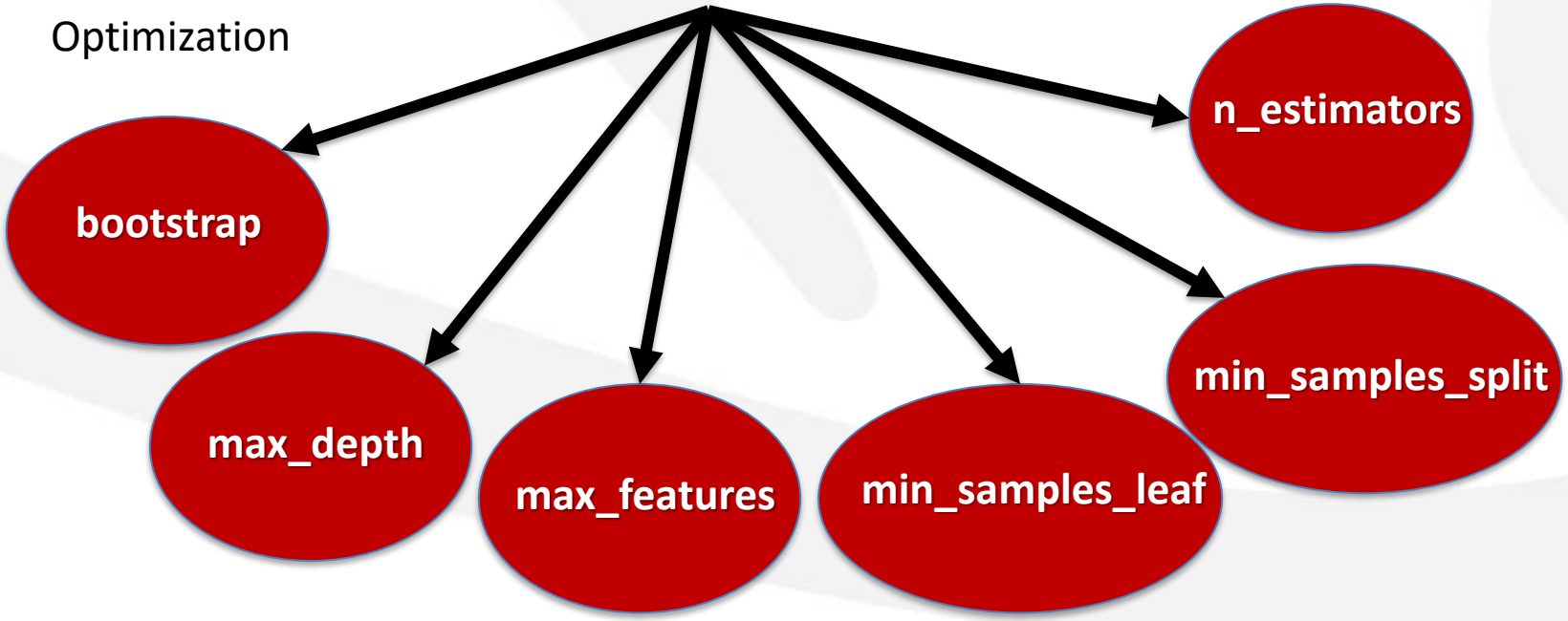
Demo#6: Parameter Optimization

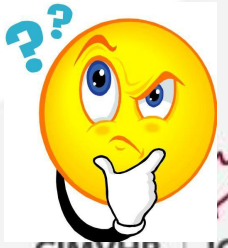


Parameter Optimization



RandomForest





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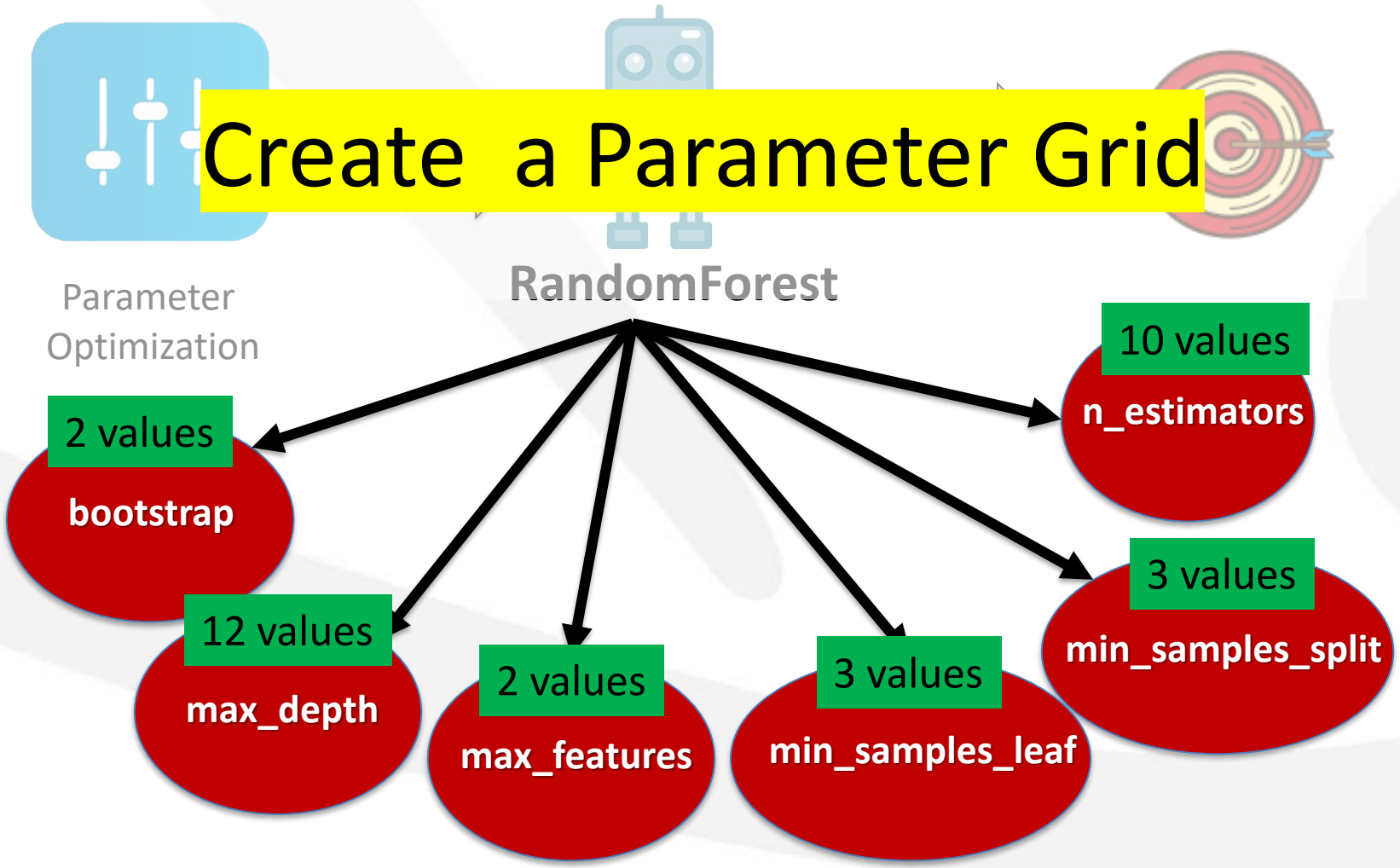
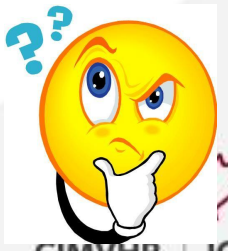
Demo#6: Parameter Optimization





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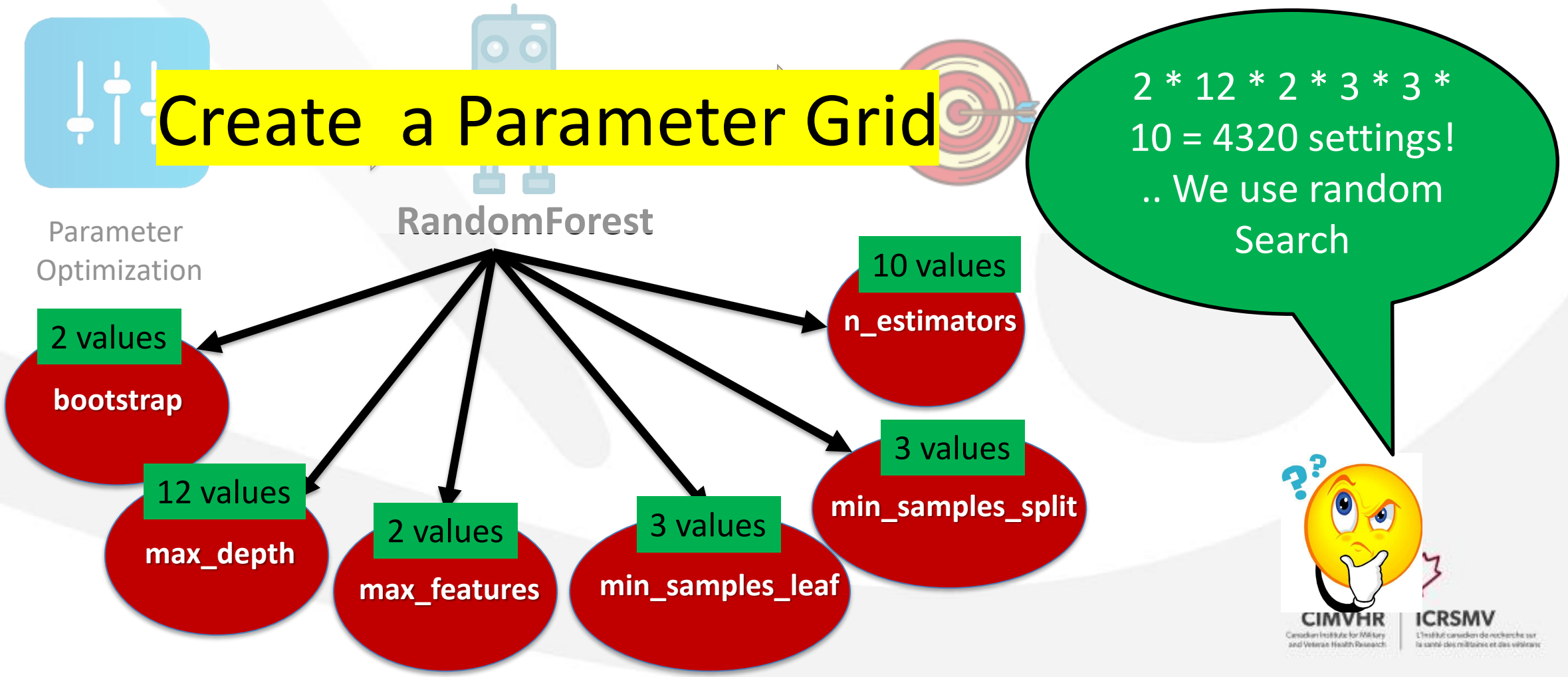
Demo#6: Parameter Optimization



Demo#7: Parameter Optimization

Lets Do Some Coding!

Selected Topics Demos

Parameter Optimization

Automatic Feature Selection

DEMO#7 [PART1]

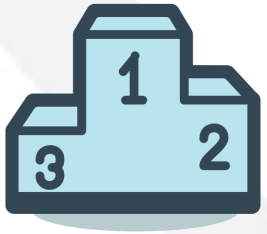
Automatic Feature Selection

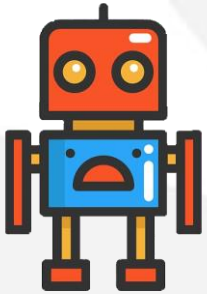
Demo#7: Automatic Feature Selection

Breast Cancer Dataset

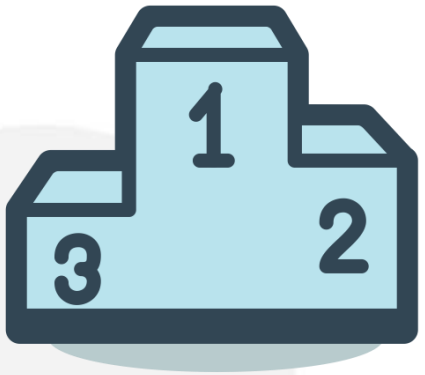
30 Features

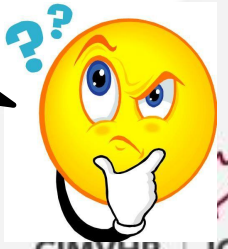
radius	compactness	radius	compactness	radius	compactness
texture	concavity	texture	concavity	texture	concavity
perimeter	concave points	perimeter	concave points	perimeter	concave points
area	symmetry	area	symmetry	area	symmetry
smoothness	fractal dimension	smoothness	fractal dimension	smoothness	fractal dimension





So many features… can automatically select the good features and ignore the noisy one





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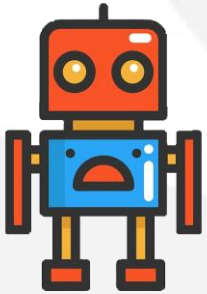
Demo#7: Automatic Feature Selection

Breast Cancer Dataset

30 Features

radius	compactness	radius	compactness	radius	compactness
texture	concavity	texture	concavity	texture	concavity
perimeter	concave points	perimeter	concave points	perimeter	concave points
area	symmetry	area	symmetry	area	symmetry
smoothness	fractal dimension	smoothness	fractal dimension	smoothness	fractal dimension

1. Univariate Selection



One solution is studying the statistical relationship between the Features and the Target Class

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Demo#7: Automatic Feature Selection

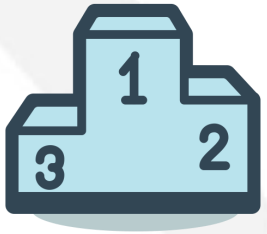
Breast Cancer Dataset

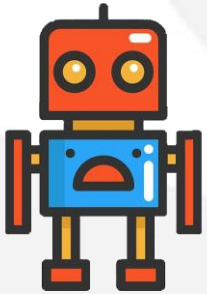
30 Features

radius	compactness	radius	compactness	radius	compactness
texture	concavity	texture	concavity	texture	concavity
perimeter	concave points	perimeter	concave points	perimeter	concave points
area	symmetry	area	symmetry	area	symmetry
smoothness	fractal dimension	smoothness	fractal dimension	smoothness	fractal dimension

1. Univariate Selection

2. Recursive Feature Selection





One solution is studying the statistical relationship between the Features and the Target Class

Another example is the **Recursive Feature Selection**

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Demo#7: Automatic Feature Selection

Lets Do Some Coding!

DEMO#7 [PART2]

Most Informative Features

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Demo#7: Most Informative Features