EVML3

FEATURE DATA EXPLORATION

HANDS-ON

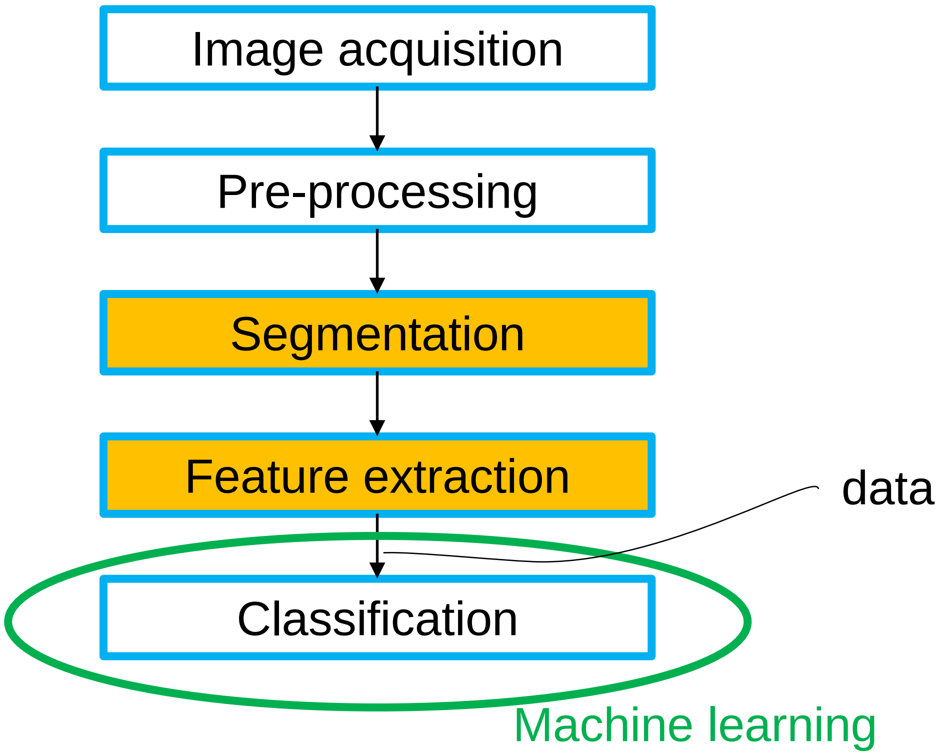
JEROEN VEEN

HAN_UNIVERSITY
OF APPLIED SCIENCES

CONTENTS

- Basic segmentation and feature extraction
- Splitting your data
- Exploratory data analysis
- Feature engineering
- Data preparation

A JUMP-START TO DATA 2



HAN_UNIVERSITY OF APPLIED SCIENCES

TRAINING DATA

Weight	Texture	Label
150 g	Bumpy	Orange
170g	Bumpy	Orange
140g	Smooth	Apple
130g	Smooth	Apple
…	…	…

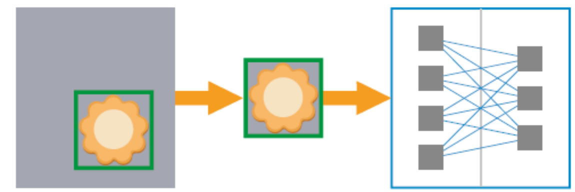
examples

features

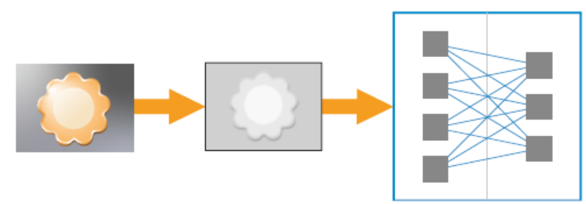
labels

HAN_UNIVERSITY OF APPLIED SCIENCES

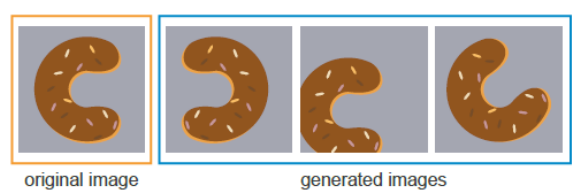
GENERAL TIPS ON DATA



- Reduction of the image size
- Minimize variance
  (If the avoidable differences to the inspected images are reduced, less image data is needed to train an algorithm
- Static ambient conditions such as stable lighting,
  a consistent monochrome background,
  fixed positioning of the inspected objects
  and unchanging orientation



- Increase in the number and variance of the training data, e.g. by generating additional training data, or so-called augmentation.



BASIC SEGMENTATION EXAMPLE

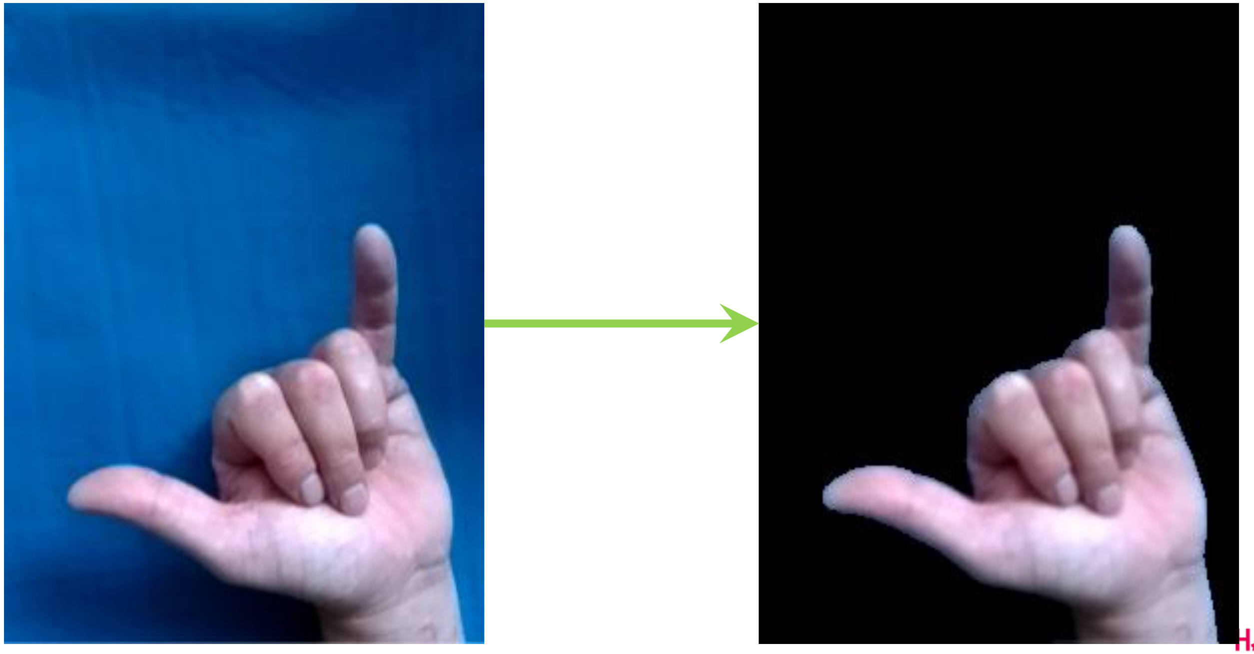
- segment.py
  create segmentation function in a module

```python
def maskBlueBG(img):
    """ Asssuming the background is blue, segment the image and return a
        BW image with foreground (white) and background (black)
    """
    # Change image color space
    img_hsv = cv.cvtColor(img, cv.COLOR_BGR2HSV)
    # Note that 0≤V≤1, 0≤S≤1, 0≤H≤360 and if H<0 then H←H+360
    # 8-bit images: V←255V,S←255S,H←H/2(to fit to 0 to 255)
    # see https://docs.opencv.org/4.5.3/de/d25/imgproc_color_conversions.html#color_convert_rgb_hsv

    # Define background color range in HSV space
    light_blue = (75,125,0)  # converted from HSV value obtained with colorpicker (150,50,0)
    dark_blue  = (140,255,255)  # converted from HSV value obtained with colorpicker (250,100,100)

    light_blue = (0,0,0)  # converted from HSV value obtained with colorpicker (150,50,0)
    dark_blue  = (255,50,255)  # converted from HSV value obtained with colorpicker (250,100,100)

    # Mark pixels outside background color range
    mask = ~cv.inRange(img_hsv, light_blue, dark_blue)
    return mask
```

BASIC SEGMENTATION EXAMPLE

- segment.py

```
# mask background
mask = maskBlueBG(img)
masked_img = cv.bitwise_and(img, img, mask=mask)
```



BASIC FEATURE EXTRACTION EXAMPLE

- extract.py or fetch_data.py

  import our segmentation function from module

```python
from segment import maskBlueBG
```

  segment the image and do a bit of denoising

```python
# mask background
img_BW = maskBlueBG(img)

# perform a series of erosions and dilations to remove any small regions of noise
img_BW = cv.erode(img_BW, None, iterations=2)
img_BW = cv.dilate(img_BW, None, iterations=2)
```

BASIC FEATURE EXTRACTION EXAMPLE

- extract.py or fetch_data.py

  get some features from contour

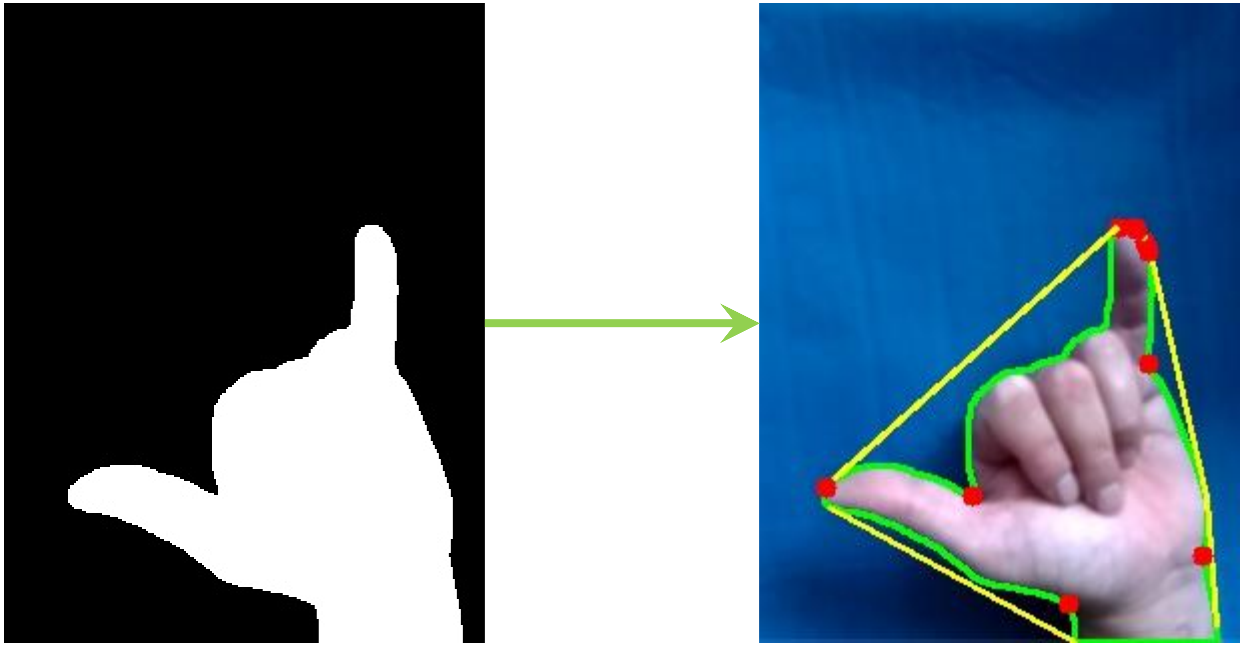
```
# find largest contour
contour = getLargestContour(img_BW)

# extract features
features, defects = getContourFeatures(contour)
print("[INFO] contour features: {}".format(features))
```

  using standard OpenCV functions to find perimeter, area, etc.

- You can do much better than this!!

BASIC FEATURE EXTRACTION EXAMPLE

- 03_extract.py or 04_fetch_data.py



HAN_UNIVERSITY OF APPLIED SCIENCES

BASIC FEATURE EXTRACTION EXAMPLE

- extract.py or fetch_data.py

```
>>> gestures.feature_names
['area', 'perimeter', 'aspect_ratio', 'extent']
```

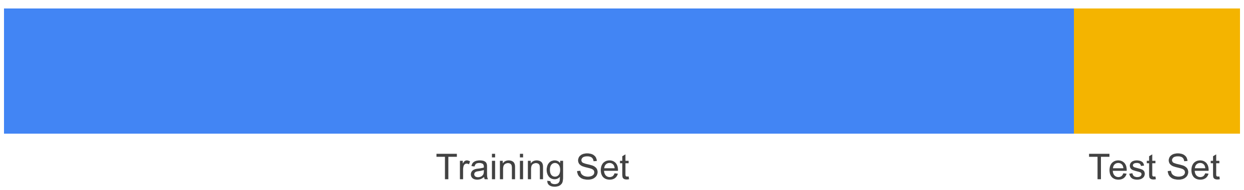
```
>>> gestures.data
array([[2.04375000e+04, 8.50541191e+02, 8.36206897e-01, 4.54085940e-01],
       [2.02550000e+04, 8.37068102e+02, 7.81115880e-01, 4.77644673e-01],
       [2.08760000e+04, 8.42582821e+02, 8.70370370e-01, 5.14085894e-01],
       ...,
```

```
>>> gestures.unique_targets
array(['hang_loose', 'ignore', 'paper', 'rock', 'scissors'], dtype='<U10')
```

```
>>> gestures.target
['hang_loose', 'hang_loose', 'hang_loose', 'hang_loose', 'hang_loose', 'hang_loose', 'hang_loose', 'hang_lo
_loose', 'hang_loose', 'hang_loose', 'hang_loose', 'hang_loose', 'hang_loose', 'hang_loose', 'hang_loose',
', 'hang_loose', 'hang_loose', 'hang_loose', 'hang_loose', 'hang_loose', 'hang_loose', 'hang_loose', 'hang
```

TRAINING AND TEST SETS: SPLITTING DATA

- **training set**—a subset to train a model.
- **test set**—a subset to test the trained model.
- You could imagine slicing the single data set as follows:

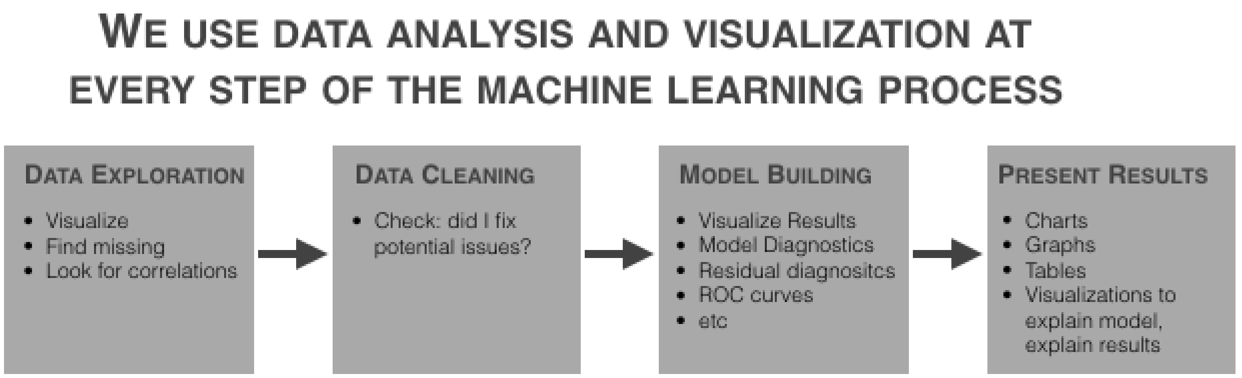


- Make sure that your test set meets the following two conditions:
  - Is large enough to yield statistically meaningful results.
  - Is representative of the data set as a whole. In other words, don't pick a test set with different characteristics than the training set.

https://developers.google.com/machine-learning/crash-course/training-and-test-sets/splitting-data

EXPLORATORY DATA ANALYSIS

- Initial investigations on data to discover patterns
- Spot anomalies, and to check assumptions
- Summary statistics and graphical representations.



Source: Stanford: Statistical reasoning MOOC

DATA EXPLORATION EXAMPLE

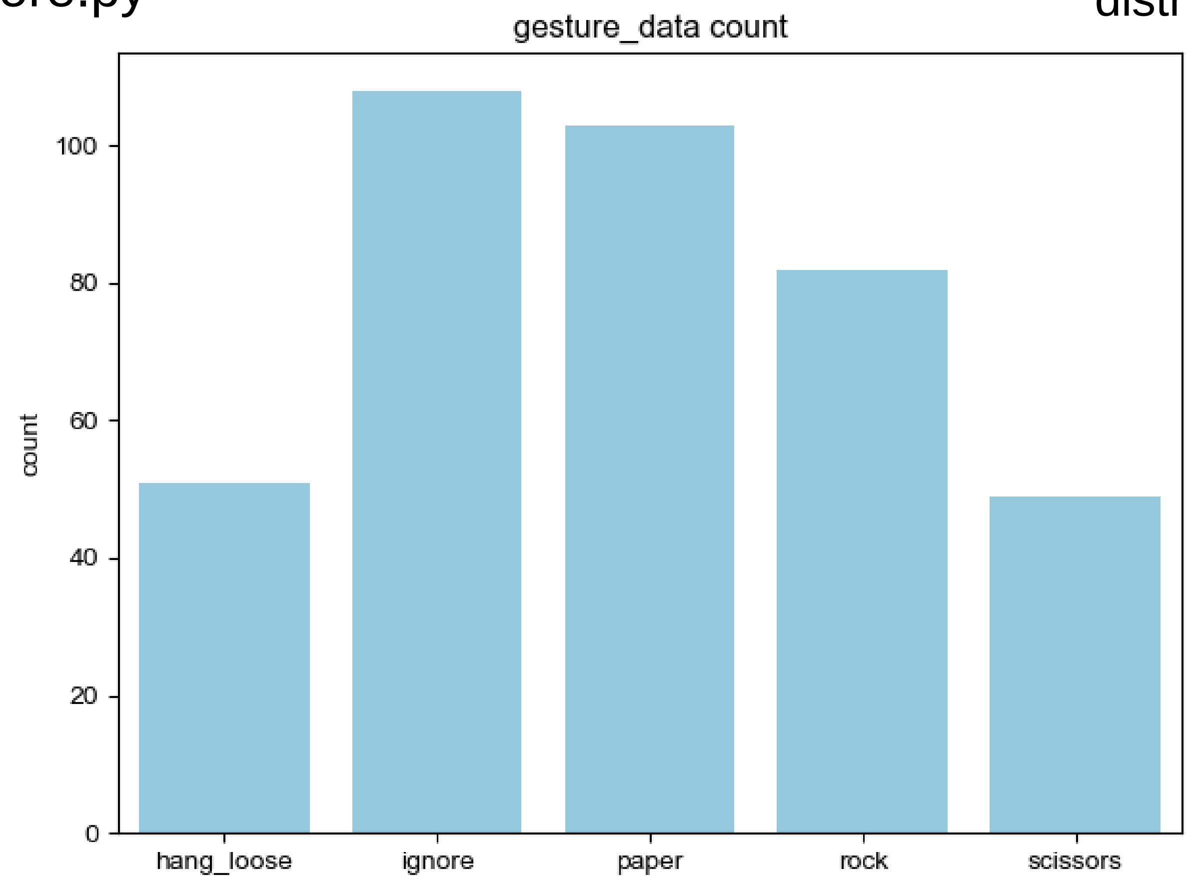
- explore.py

```python
import numpy as np
from fetch_data import fetch_data
from sklearn.preprocessing import LabelEncoder, StandardScaler
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt
import seaborn as sns


if __name__ == "__main__":
    """feature exploration"""
    data_path = r'G:\My Drive\data\gesture_data'

    # fetch the data
    gestures = fetch_data(data_path)

    # encode the categorical labels
    le = LabelEncoder()
    coded_labels = le.fit_transform(gestures.target)

    # partition the data into training and testing splits using 75% of
    # the data for training and the remaining 25% for testing
    (trainX, testX, trainY, testY) = train_test_split(gestures.data, coded_labels,
    test_size=0.25, stratify=gestures.target)#, random_state=42)

```

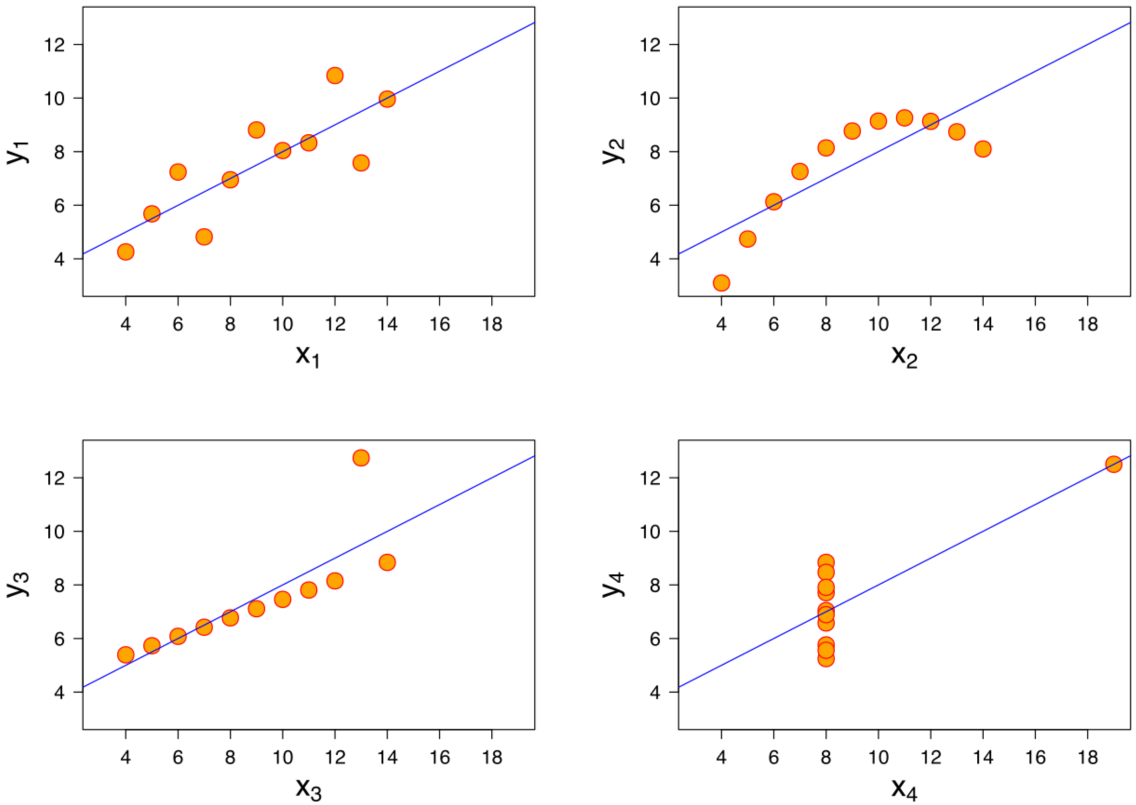
DATA EXPLORATION EXAMPLE

- explore.py

distribution of data



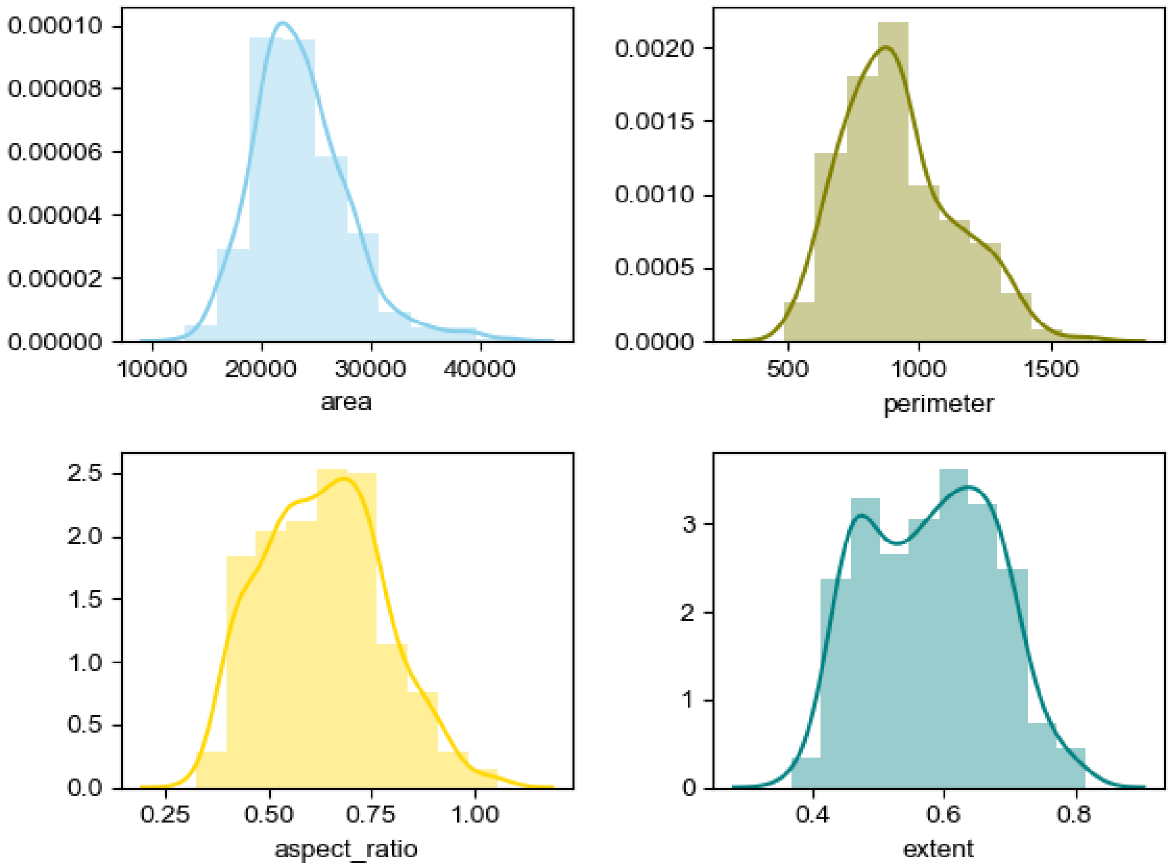
ANSCOMBE'S QUARTET



DATA EXPLORATION EXAMPLE

- explore.py

Total feature histograms

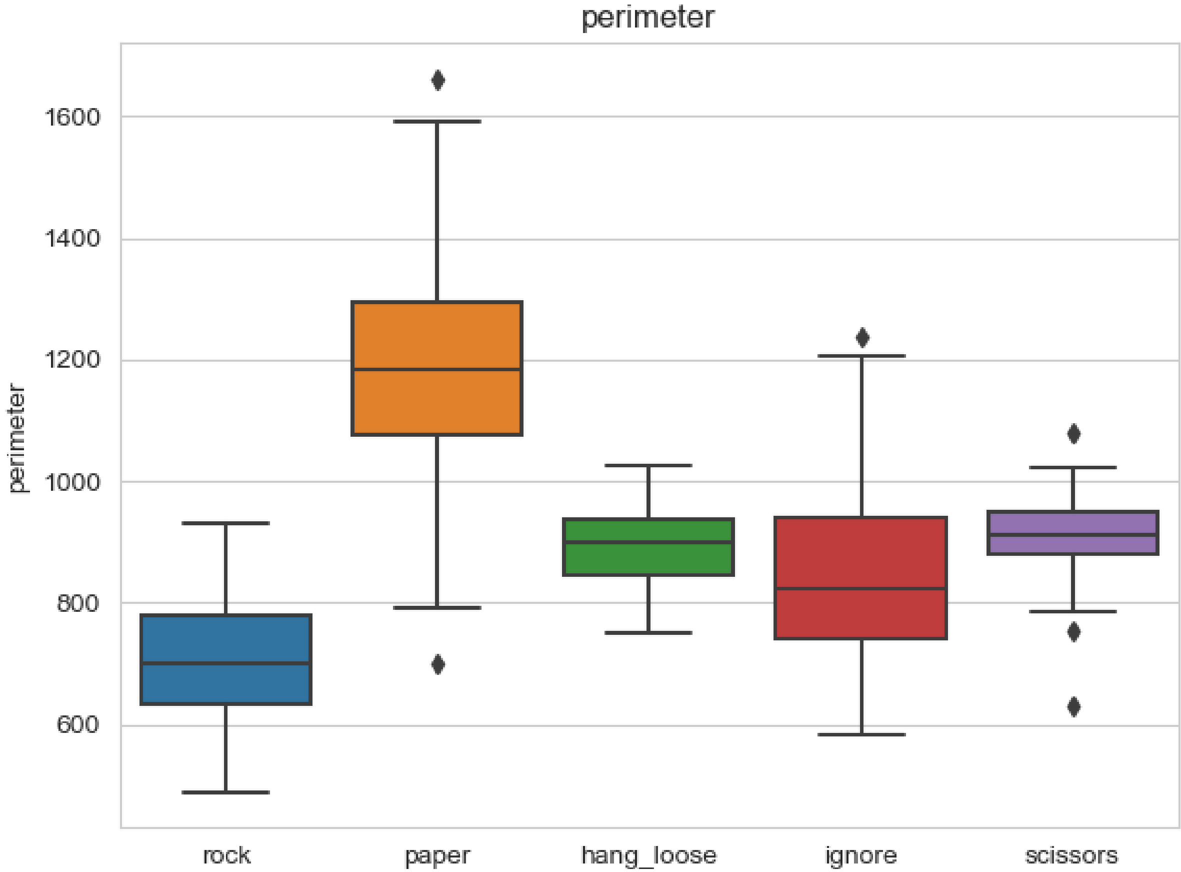


HAN_UNIVERSITY OF APPLIED SCIENCES

DATA EXPLORATION EXAMPLE

- explore.py

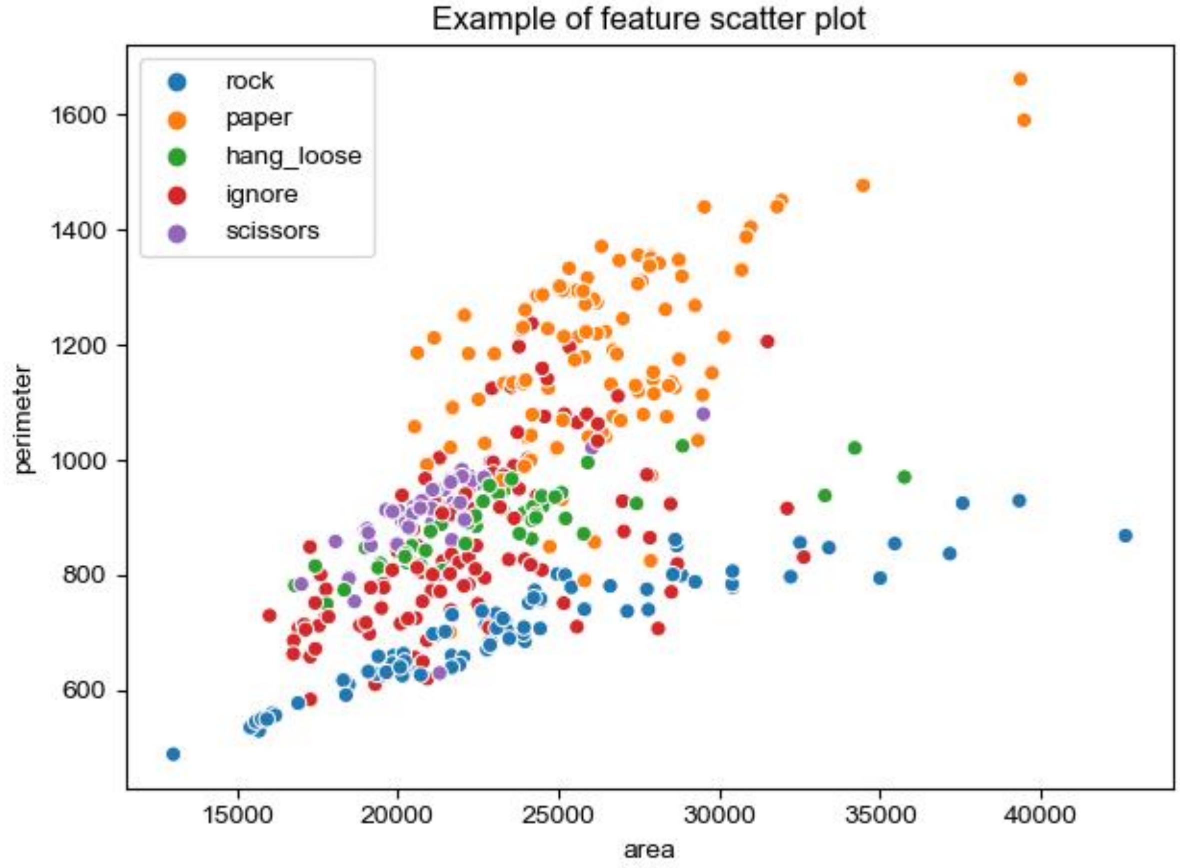
Boxplot of a single feature



DATA EXPLORATION EXAMPLE

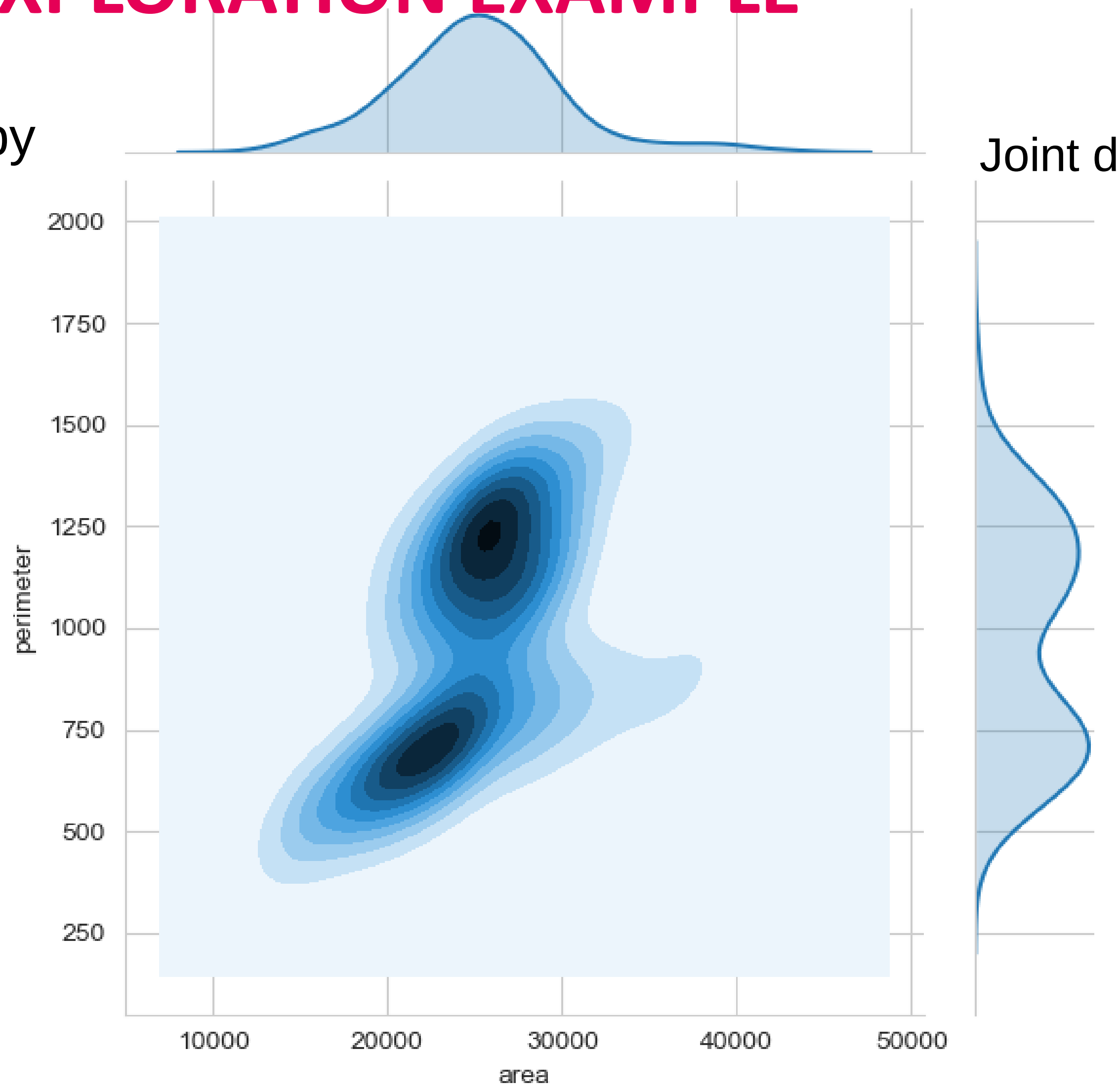
- explore.py

Scatterplot of 2 features



DATA EXPLORATION EXAMPLE

- explore.py



Joint distribution plot of 2 features for 2 classes

DATA EXPLORATION EXAMPLE

- explore.py

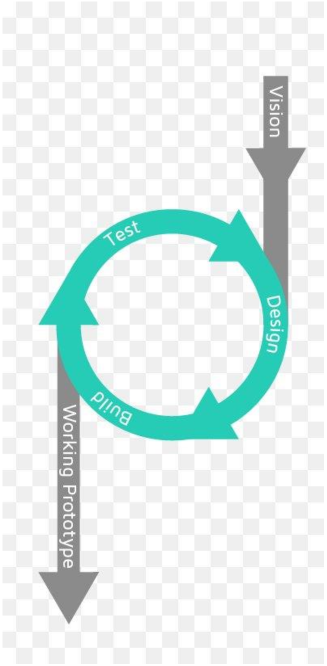
Feature correlation heatmap

See: https://www.statology.org/how-to-read-a-correlation-matrix/

HAN_UNIVERSITY OF APPLIED SCIENCES

FEATURE ENGINEERING

- Based on your explorations:
  - Select features
  - Decompose features (e.g. area -> length, width)
  - Extract features (e.g. aggregate, combinations)
  - Add promising transformations of features (e.g., log(x), sqrt(x), x^2, etc.).
- Propose new features?
- Adjust data acquisition?
- Remember that machine learning is an iterative process!



MORE ON FEATURE SELECTION

- Possible strategy
  - Create many, many features,
  - Use automated process to select best

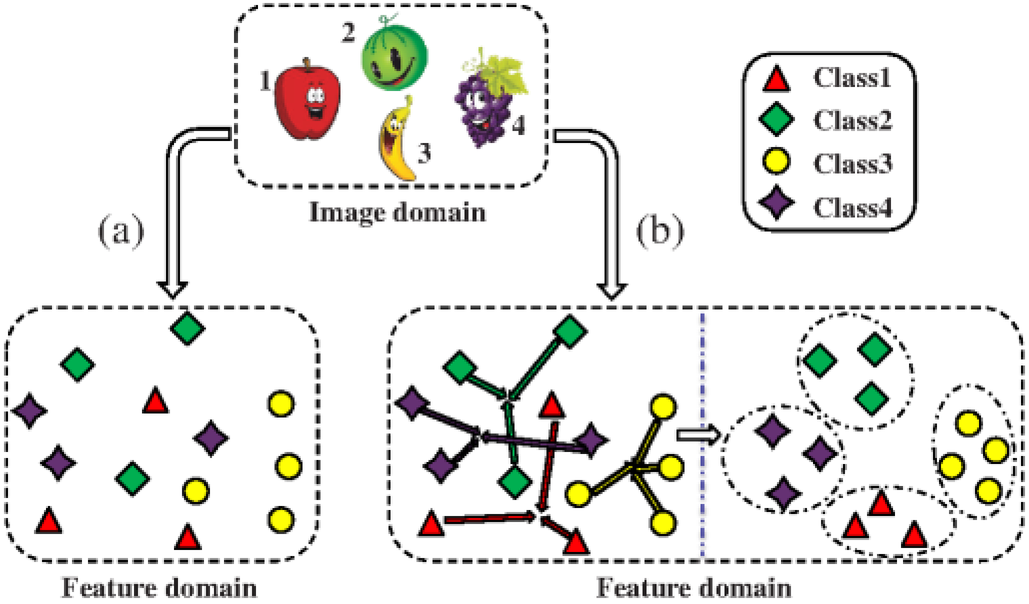
  - E.g. using scikit learn feature selection module

    https://scikit-learn.org/stable/modules/feature_selection.html

- Alternatively, use regularization techniques, we'll get to that in another lesson

QUALITIES OF GOOD FEATURES

- Informative
- Discriminating
- Independent
- Nearly unique



Source: https://www.spiedigitallibrary.org/ContentImages/Journals/JEIME5/26/1/013023

- NB feature scaling may be required

DATA PREPARATION

- Data cleaning:
  - Fix or remove outliers (optional)
  - Fill in missing values (e.g., with zero, mean, median…) or drop their rows (or columns).

- Feature computation:
  - Selection
  - Transformation

- Feature scaling:
  - Standardize or normalize features.

EXAMPLE OF FEATURE SCALING

- explore.py

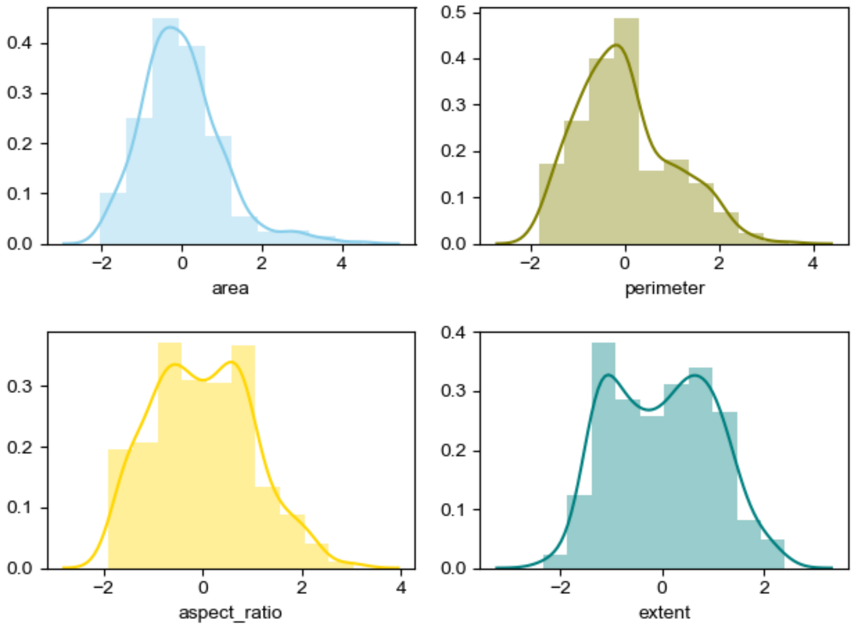
```
from fetch_data import fetch_data
from sklearn.preprocessing import LabelEncoder, StandardScaler
from sklearn.model_selection import train_test_split
```

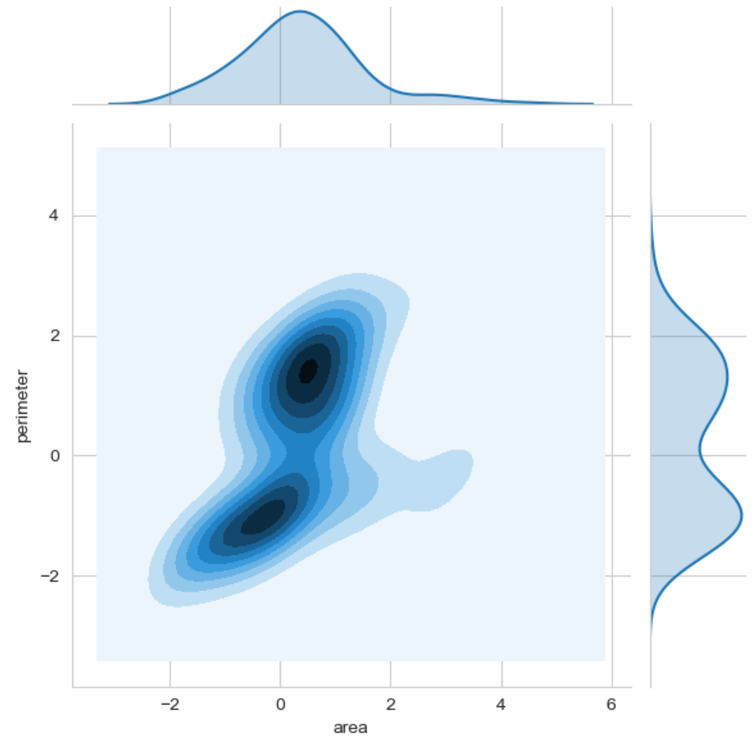
```
# Data preparation (note that a pipeline  would help here)
trainX = StandardScaler().fit_transform(trainX)
```

- See https://scikit-learn.org/stable/auto_examples/preprocessing/plot_all_scaling.html for more inspiration

EXAMPLE OF FEATURE SCALING

- explore.py





HAN_UNIVERSITY
OF APPLIED SCIENCES