AI Games course

Certificate 2, session 2
Classification of textual data.
Linguistic features.

AIgaming.com

Language Identification

- **Task**: given a phrase in an unknown Germanic language, identify the language
- Languages: Dutch, Norwegian, Swedish
- Example:

“gelukkige verjaardag”	→	Dutch
“Gratulerer med dagen”	→	Norwegian
“Grattis på födelsedagen”	→	Swedish

Step 1: Data instances

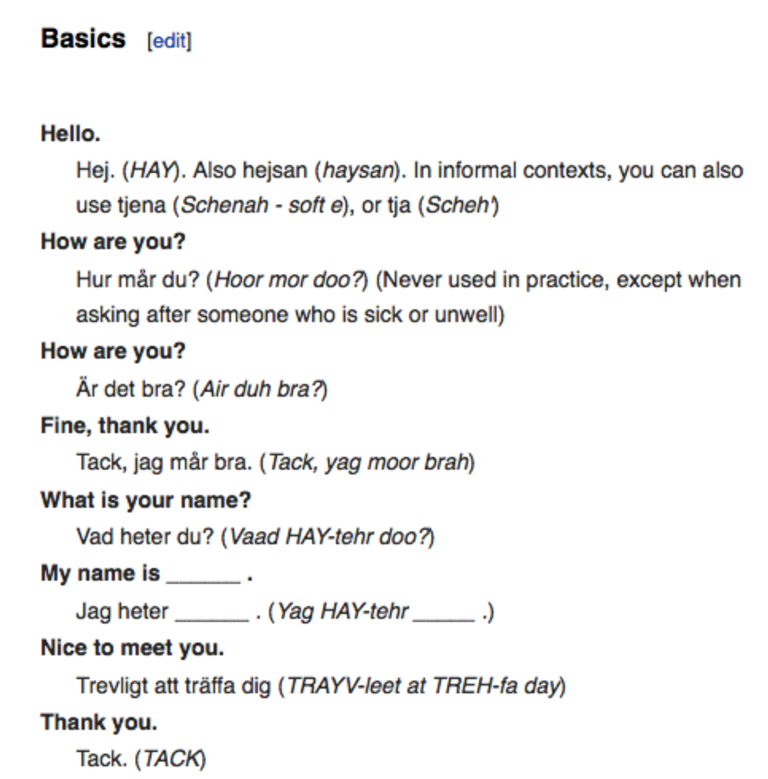
- we use Wikitravel phrasebooks: https://wikitravel.org/en/List_of_phrasebooks

- download *phrases.txt*

- file structure:

  % comment line with translation into English

  phrase in a foreign language ||| LANGUAGE_CODE



Basics [edit]

Hello.
Hej. (*HAY*). Also hejsan (*haysan*). In informal contexts, you can also use tjena (*Schenah - soft e*), or tja (*Scheh'*)

How are you?
Hur mår du? (*Hoor mor doo?*) (Never used in practice, except when asking after someone who is sick or unwell)

How are you?
Är det bra? (*Air duh bra?*)

Fine, thank you.
Tack, jag mår bra. (*Tack, yag moor brah*)

What is your name?
Vad heter du? (*Vaad HAY-tehr doo?*)

My name is ______ .
Jag heter ______ . (*Yag HAY-tehr ______* .)

Nice to meet you.
Trevligt att träffa dig (*TRAYV-leet at TREH-fa day*)

Thank you.
Tack. (*TACK*)

Languages: *SWE (Swedish), NOR (Norwegian), DUT (Dutch)*

Step 2: Linguistic features

- **language model** — probability distribution over sequences of words or other linguistic units

- **ngram** — a continuous sequence of *n* items from a text sample

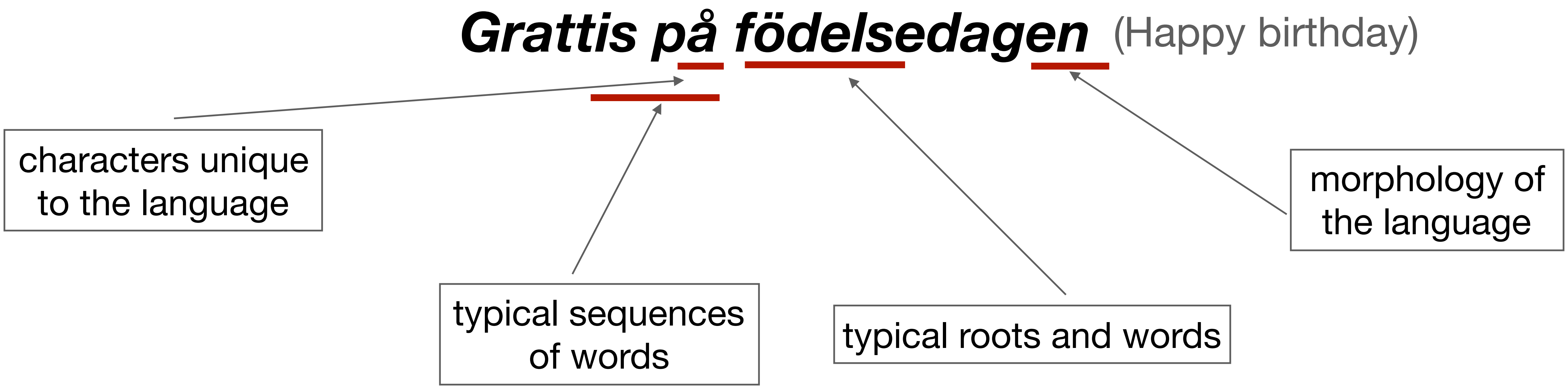
- **Example**: ‘*how to make an AI gaming bot’*
  - word trigrams:

    ‘*how to make’, ‘to make an’, ‘make an AI’, ‘an AI gaming’, ‘AI gaming bot’*
  - character trigrams

    ‘how’, ‘ow ‘, ‘w t’, ‘ to’, ‘to ’, ‘o m’, ‘ ma’, ‘mak’, ‘ake’, ‘ke ’, ‘e a’, ‘ an’, ‘an ’, ’n A’, ‘ AI’, ‘AI ’, ‘I g’, ‘ ga’, ‘gam’, ‘ami’, ‘min’, ‘ing’, ‘ng ’ etc.

Why ngrams work

Ngrams (up to length 5) are a surprisingly powerful and universal tool to model language. They can capture:



Grattis på födelsedagen (Happy birthday)

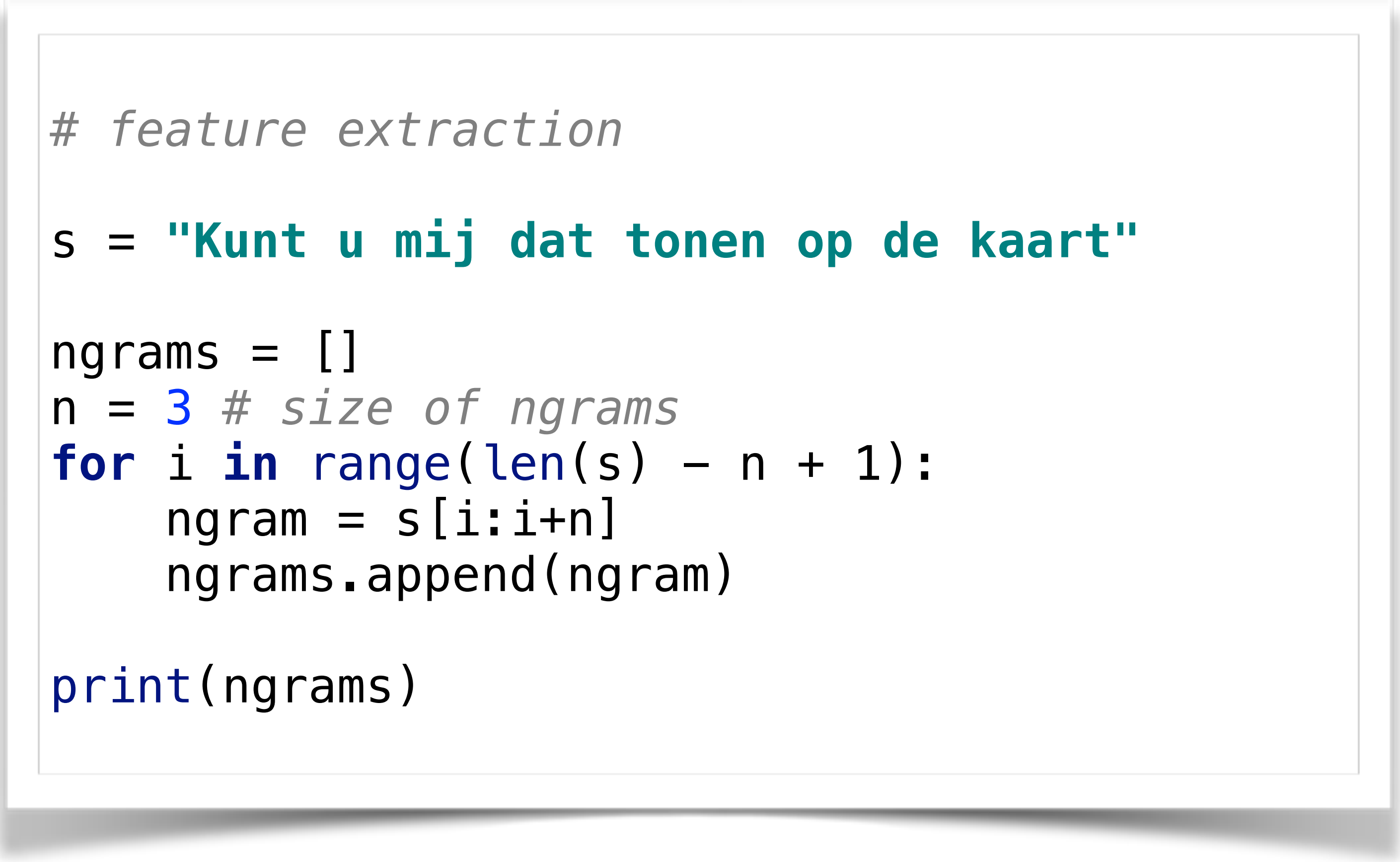
characters unique to the language

typical sequences of words

typical roots and words

morphology of the language

Extracting features



```python
# feature extraction

s = "Kunt u mij dat tonen op de kaart"

ngrams = []
n = 3 # size of ngrams
for i in range(len(s) - n + 1):
    ngram = s[i:i+n]
    ngrams.append(ngram)

print(ngrams)
```

Task 1: modify the code so that it generates ngrams of length *up to n*
Task 2: write code for extracting word ngrams

Extracting features

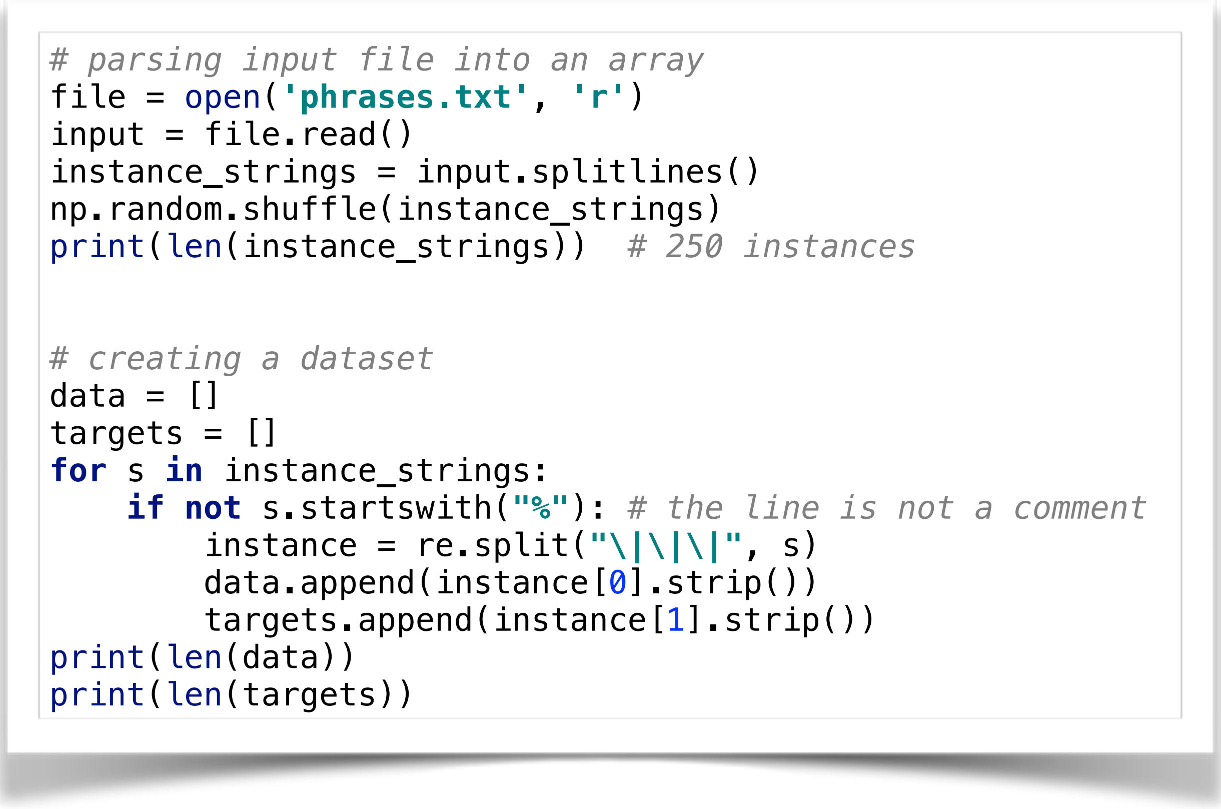
Things to think about:

- combine word and character ngrams
- vary ngram size (parameter *n*)
- upper-case and lower-case letters [*s.lower()*]
- extra spaces [*s.strip()*]
- punctuation signs [*s.replace(“,”, “”)*]

Preparing a dataset

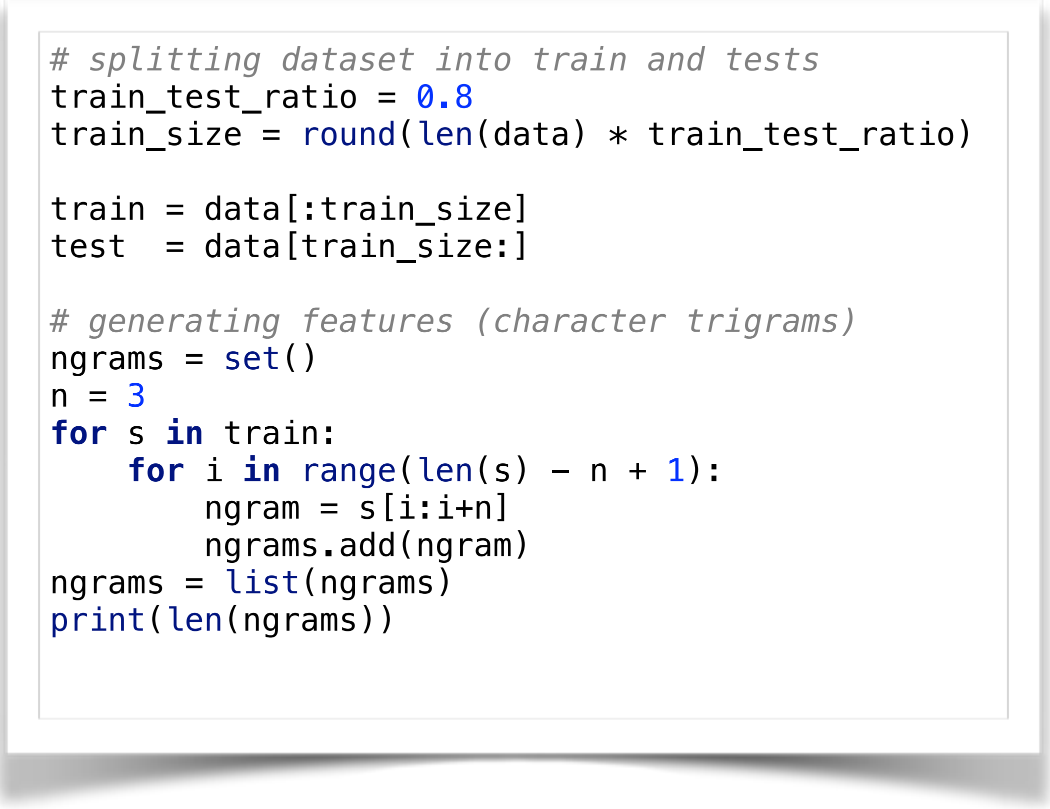
- once all features are collected, generate feature vectors for all data instances;
- NB! only use features from the train set!

1.



```
# parsing input file into an array
file = open('phrases.txt', 'r')
input = file.read()
instance_strings = input.splitlines()
np.random.shuffle(instance_strings)
print(len(instance_strings))  # 250 instances


# creating a dataset
data = []
targets = []
for s in instance_strings:
    if not s.startswith("%"): # the line is not a comment
        instance = re.split("\|\|\|", s)
        data.append(instance[0].strip())
        targets.append(instance[1].strip())
print(len(data))
print(len(targets))
```

2.

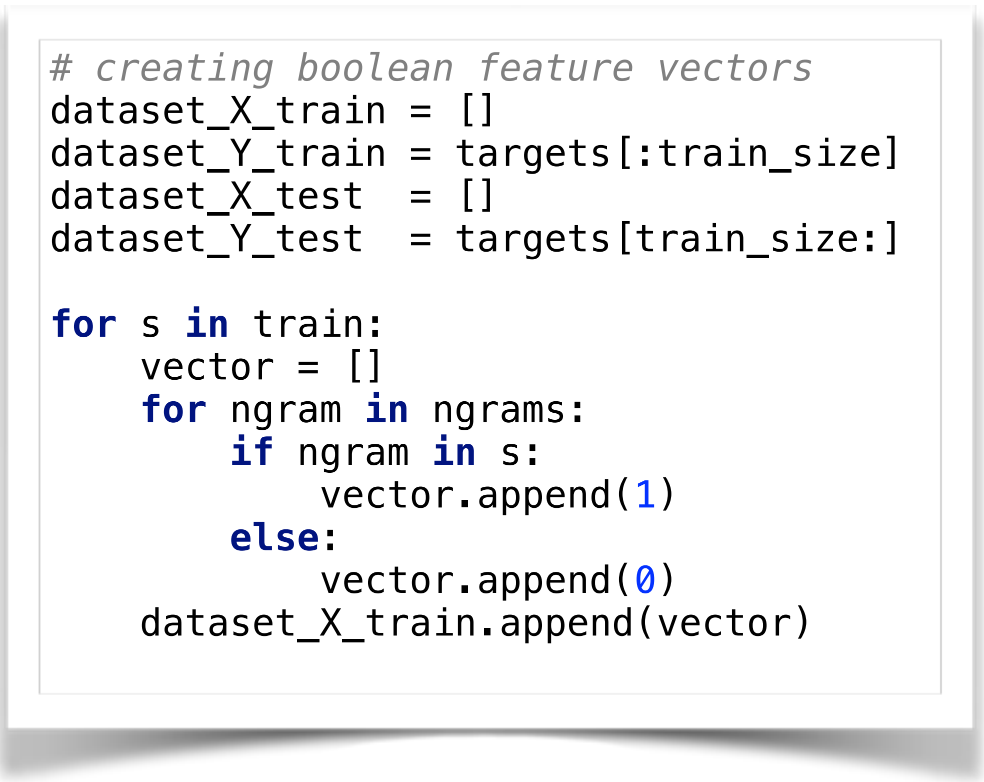


```
# splitting dataset into train and tests
train_test_ratio = 0.8
train_size = round(len(data) * train_test_ratio)

train = data[:train_size]
test  = data[train_size:]

# generating features (character trigrams)
ngrams = set()
n = 3
for s in train:
    for i in range(len(s) - n + 1):
        ngram = s[i:i+n]
        ngrams.add(ngram)
ngrams = list(ngrams)
print(len(ngrams))
```

Preparing a dataset

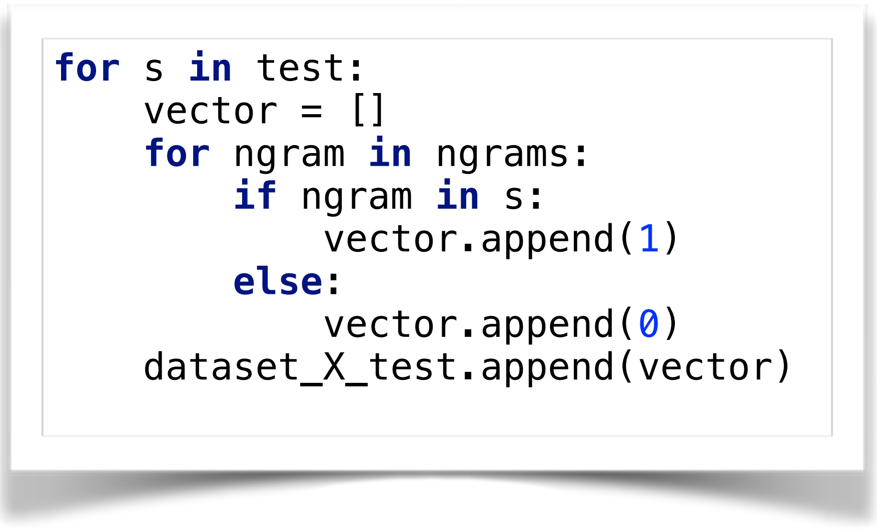
- once all features are collected, generate feature vectors for all data instances;
- NB! only use features from the train set!

3.



```
# creating boolean feature vectors
dataset_X_train = []
dataset_Y_train = targets[:train_size]
dataset_X_test  = []
dataset_Y_test  = targets[train_size:]

for s in train:
    vector = []
    for ngram in ngrams:
        if ngram in s:
            vector.append(1)
        else:
            vector.append(0)
    dataset_X_train.append(vector)
```

4.



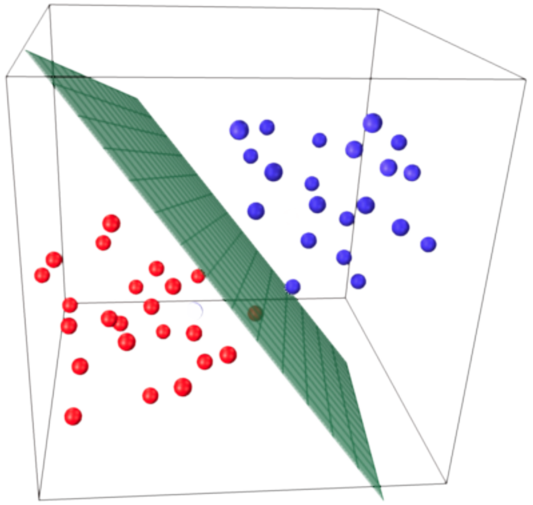
```
for s in test:
    vector = []
    for ngram in ngrams:
        if ngram in s:
            vector.append(1)
        else:
            vector.append(0)
    dataset_X_test.append(vector)
```

Step 3: Learning algorithm

- there are hundreds of different machine learning algorithms
    - for classification/regression/clustering
    - for supervised/unsupervised/reinforcement learning
    - for various types of data
- today, we are going to use *logistic regression*

Logistic Regression

- basic classification algorithm
- **Assumption**: the data is *linearly separable* (data points of different classes can be separated by line/plane/hyperplane)



- **Discriminant**: an n-dimensional polynomial, where *n* is the number of features

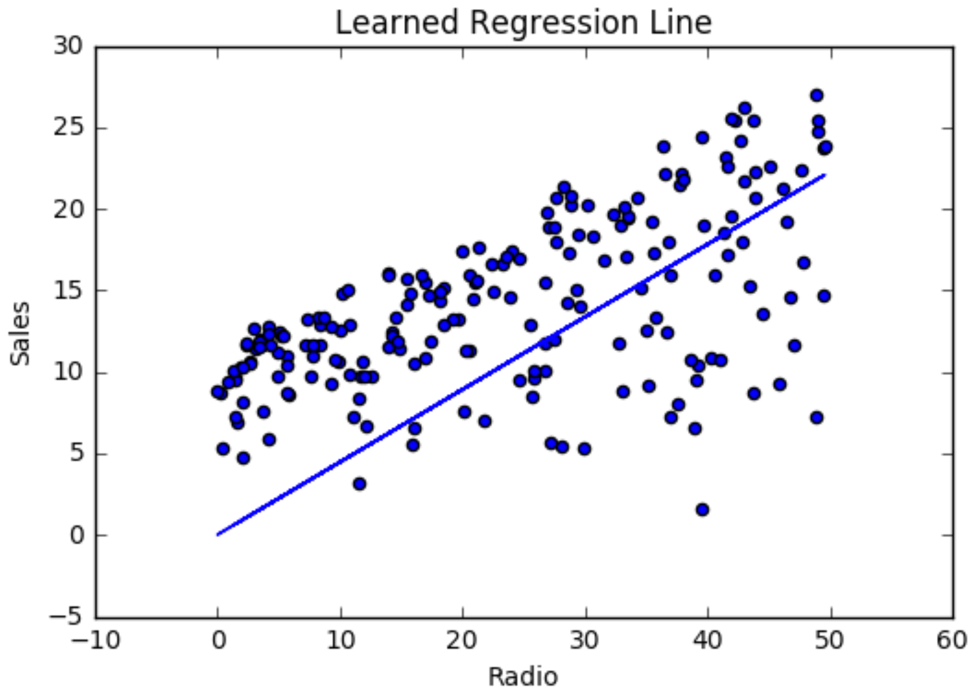
Studied	Slept	Passed
4.85	9.63	YES
8.62	3.23	NO
5.43	8.23	YES
9.21	6.34	NO

Passed_score = W_1*Studied + W_2*Slept + W_3

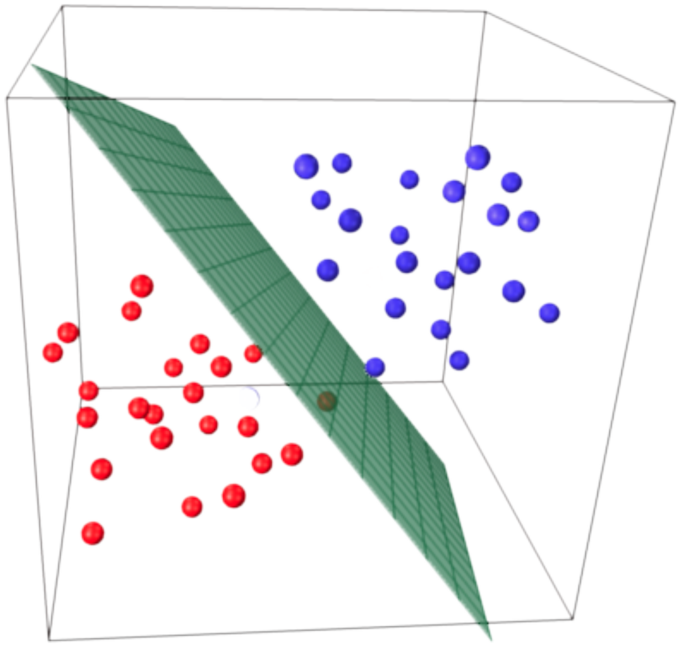
Logistic Regression

- basic classification algorithm

- it is called *regression*, because it stems from a regression algorithm (linear regression) that tries to *fit the data* with a polynomial function instead of differentiating it



vs



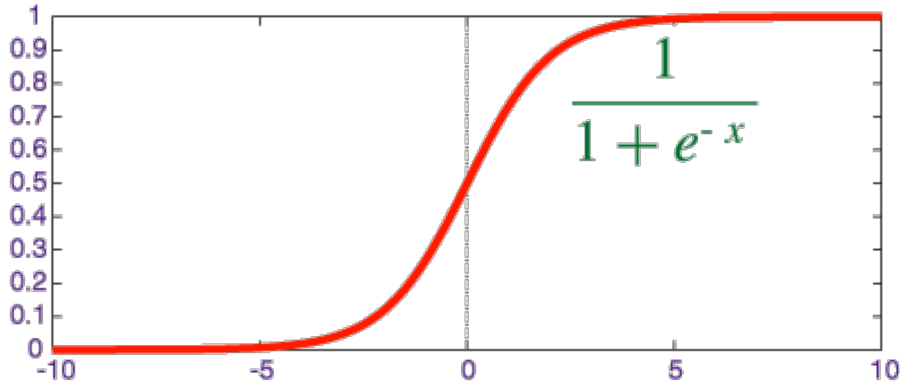
Logistic Regression

- When we know the discriminant formula, i.e., know the weights, then for a given input we can compute a prediction score ∈ (-∞, +∞).

- The score can be *squashed* into the [0,1] interval (e.g., with a sigmoid function) so that the score becomes a probability *P* of belonging to one class (and not the other one):

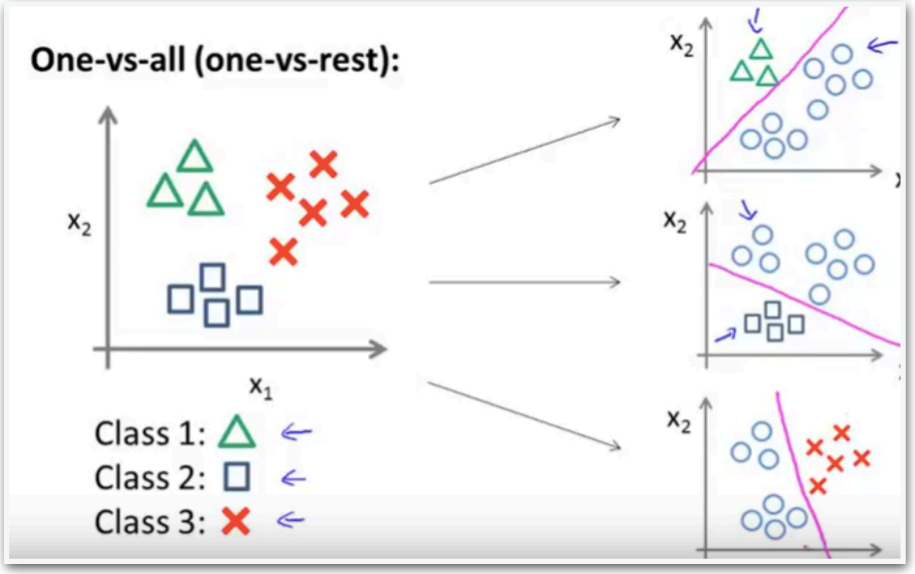
  - P > 0.5 ➡ class YES

  - P ≤ 0.5 ➡ class NO



Logistic Regression

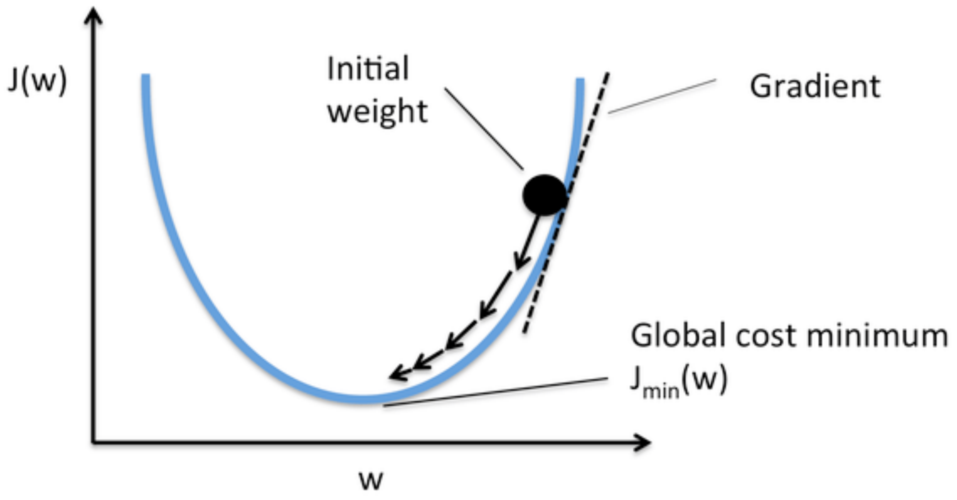
- What if we have *k > 2* classes?



- *Multiclass logistic regression*:
  - build *k* one-vs-all binary discriminants;
  - compute probabilities of instance *i* being in class *c* for all classes: $P(i,c_1)$, …, $P(i,c_k)$;
  - choose the class with the highest probability.

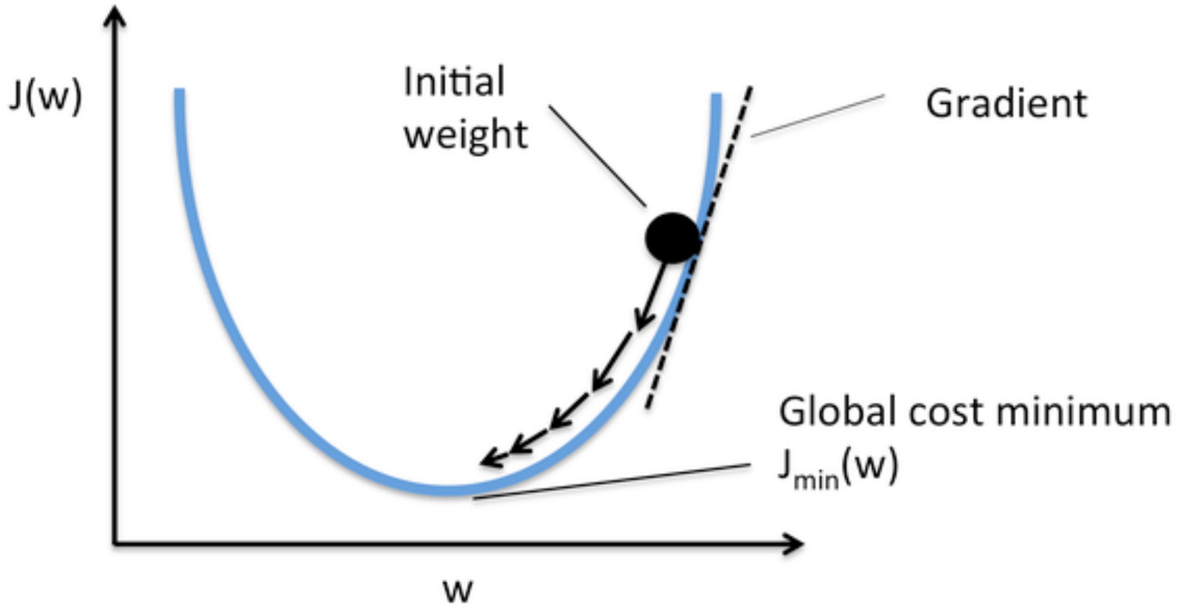
Learning the discriminant

- How to learn weights in the discriminant? Optimisation task.
  - define a *cost function* that estimates how good/bad are predictions compared to true class labels;
  - generate random weights;
  - iteratively update the weights so that the cost is minimised using the *gradient descent* method.



Learning the discriminant

- if we plot weight values against the respective cost of the discriminant, it is known that we get a continuous convex function;
- setting weights randomly will put us somewhere on the curve;
- our goal is to go in the direction of the minimum, i.e., to *descend* the sloe;
- one can conveniently figure out the direction of the descend by computing the *derivative* of the const function.



Cost function

- we know the shape of the discriminant:

$$\textbf{predicted\_score} = W_1 * \textbf{feature}_1 + W_2 * \textbf{feature}_2 + \ldots + W_k * \textbf{feature}_k + W_0$$

- we need to learn the weights;

- given some weights (e.g., randomly assigned), how can we estimate the quality of generated predictions?

- we will use *Log Loss* function, or *Cross Entropy* function.

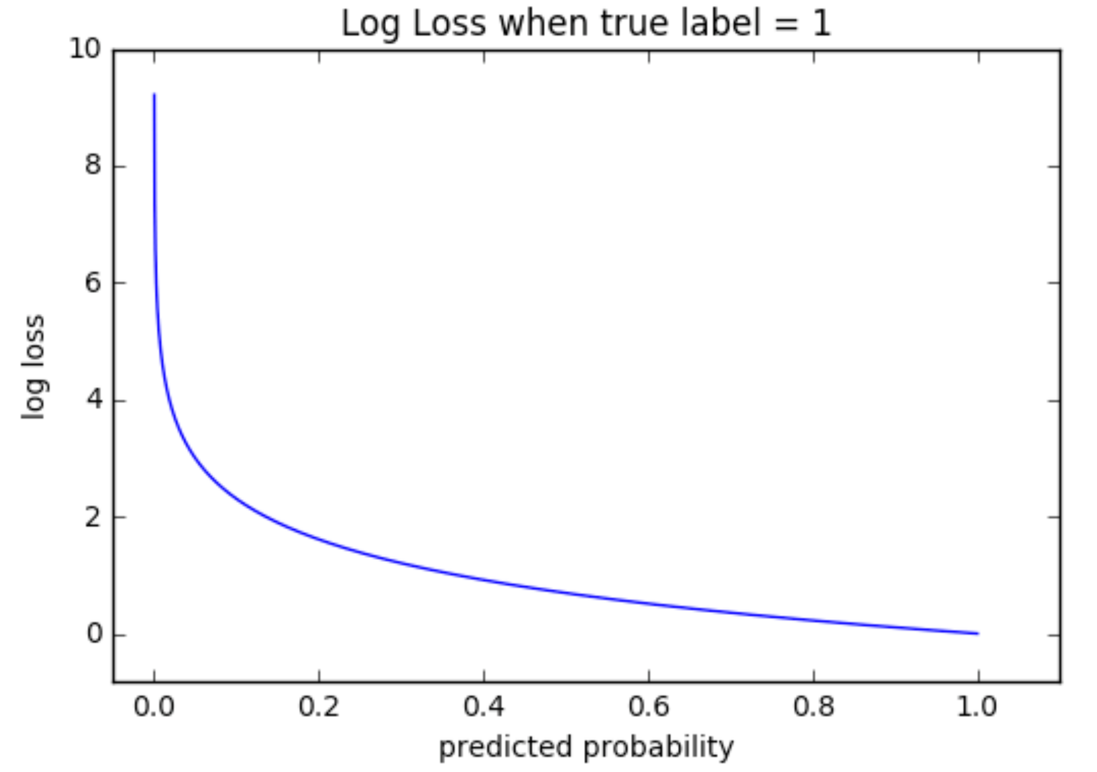
Log Loss function

- given a true label *y* and a prediction *p*, the cost for one data instance is:

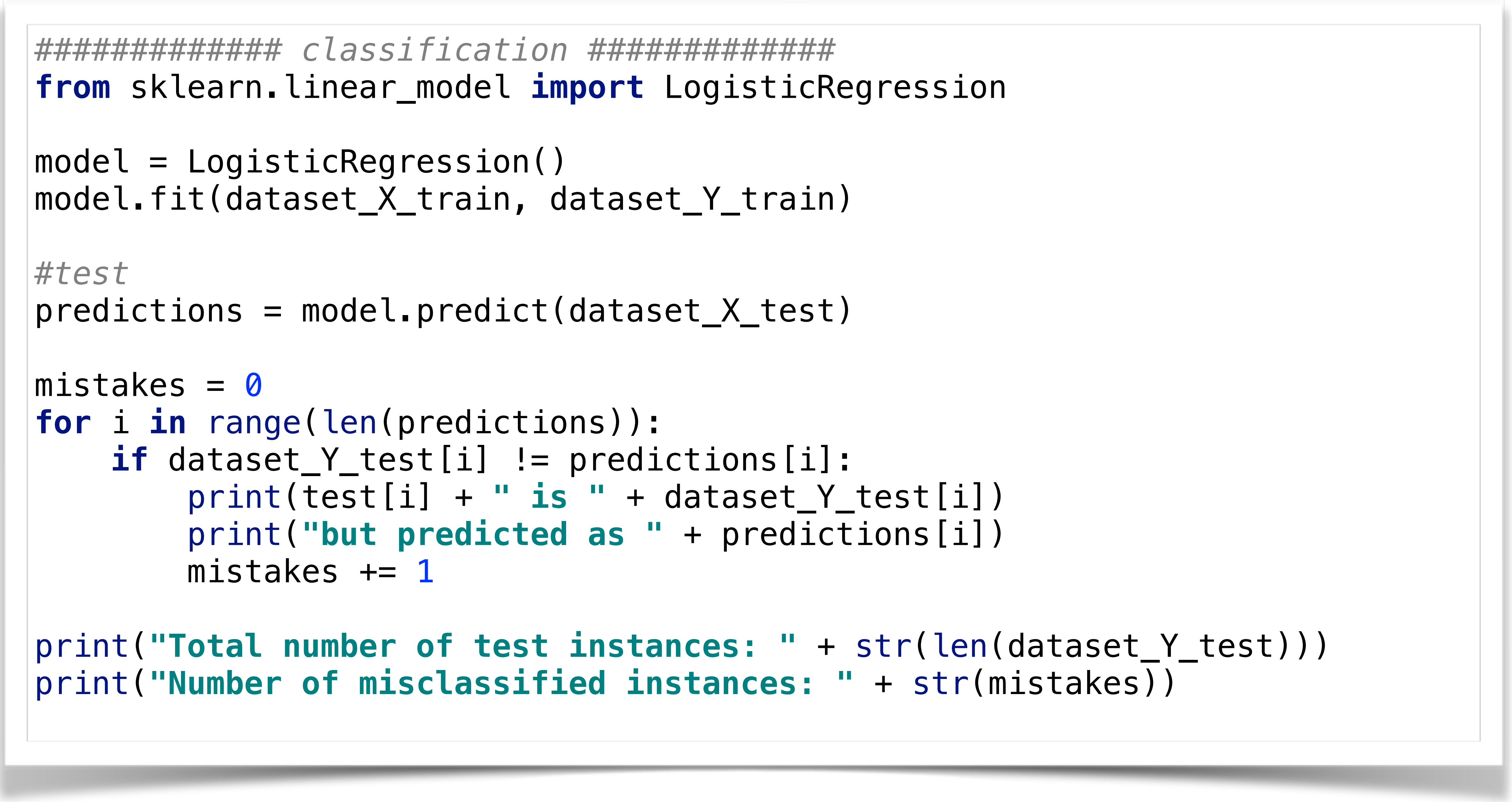
$$-(y*\log(p)+(1-y)*\log(1-p))$$

- to calculate the total cost, take an average over all instances;

- in case of multiple classes, sum the cost over all classes.

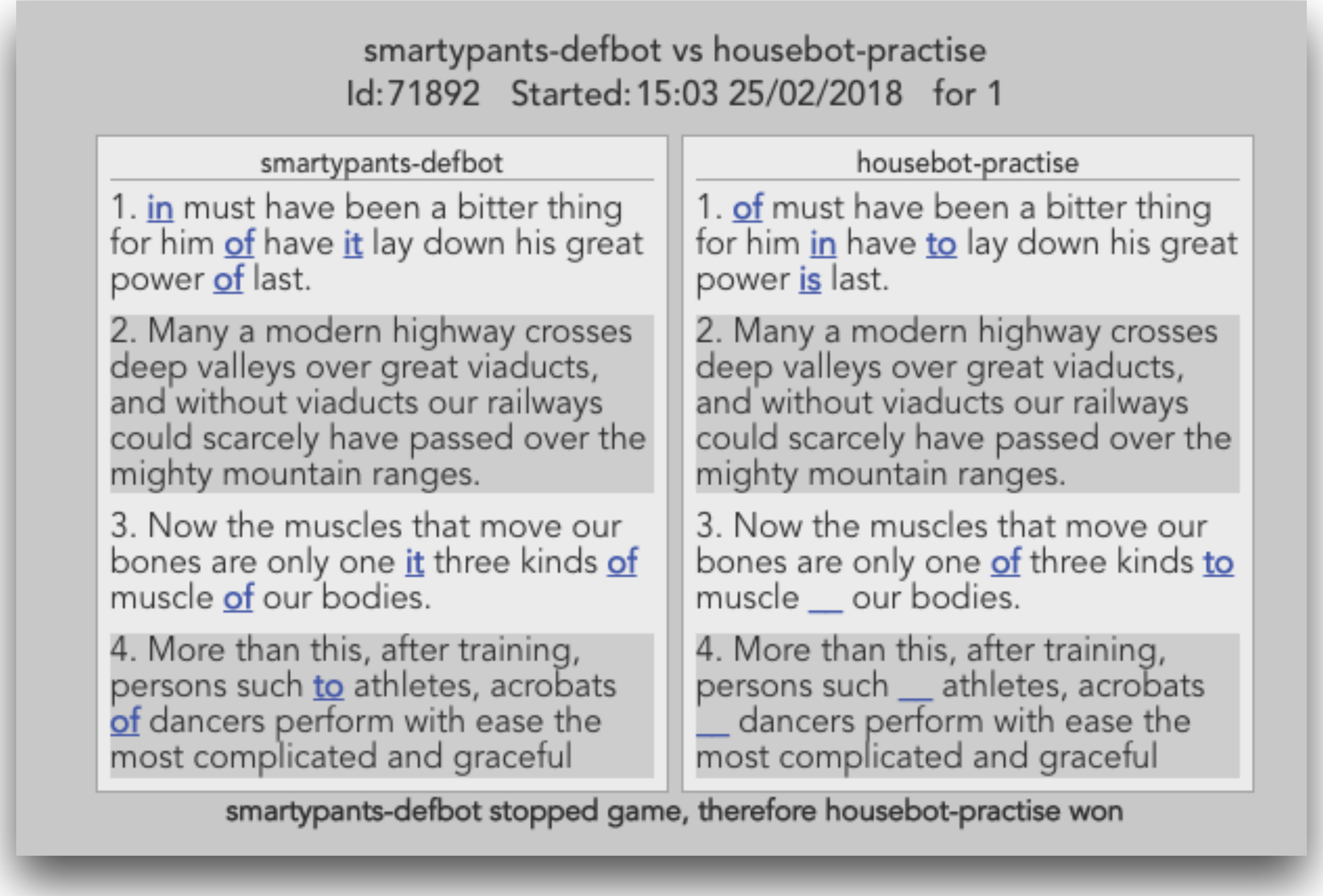


Classification with LogReg



```
############# classification #############
from sklearn.linear_model import LogisticRegression

model = LogisticRegression()
model.fit(dataset_X_train, dataset_Y_train)

#test
predictions = model.predict(dataset_X_test)

mistakes = 0
for i in range(len(predictions)):
    if dataset_Y_test[i] != predictions[i]:
        print(test[i] + " is " + dataset_Y_test[i])
        print("but predicted as " + predictions[i])
        mistakes += 1

print("Total number of test instances: " + str(len(dataset_Y_test)))
print("Number of misclassified instances: " + str(mistakes))
```

Predictive Text game



smartypants-defbot vs housebot-practise
Id:71892 Started:15:03 25/02/2018 for 1

smartypants-defbot	housebot-practise
1. in must have been a bitter thing for him of have it lay down his great power of last.	1. of must have been a bitter thing for him in have to lay down his great power is last.
2. Many a modern highway crosses deep valleys over great viaducts, and without viaducts our railways could scarcely have passed over the mighty mountain ranges.	2. Many a modern highway crosses deep valleys over great viaducts, and without viaducts our railways could scarcely have passed over the mighty mountain ranges.
3. Now the muscles that move our bones are only one it three kinds of muscle of our bodies.	3. Now the muscles that move our bones are only one of three kinds to muscle __ our bodies.
4. More than this, after training, persons such to athletes, acrobats of dancers perform with ease the most complicated and graceful	4. More than this, after training, persons such __ athletes, acrobats __ dancers perform with ease the most complicated and graceful

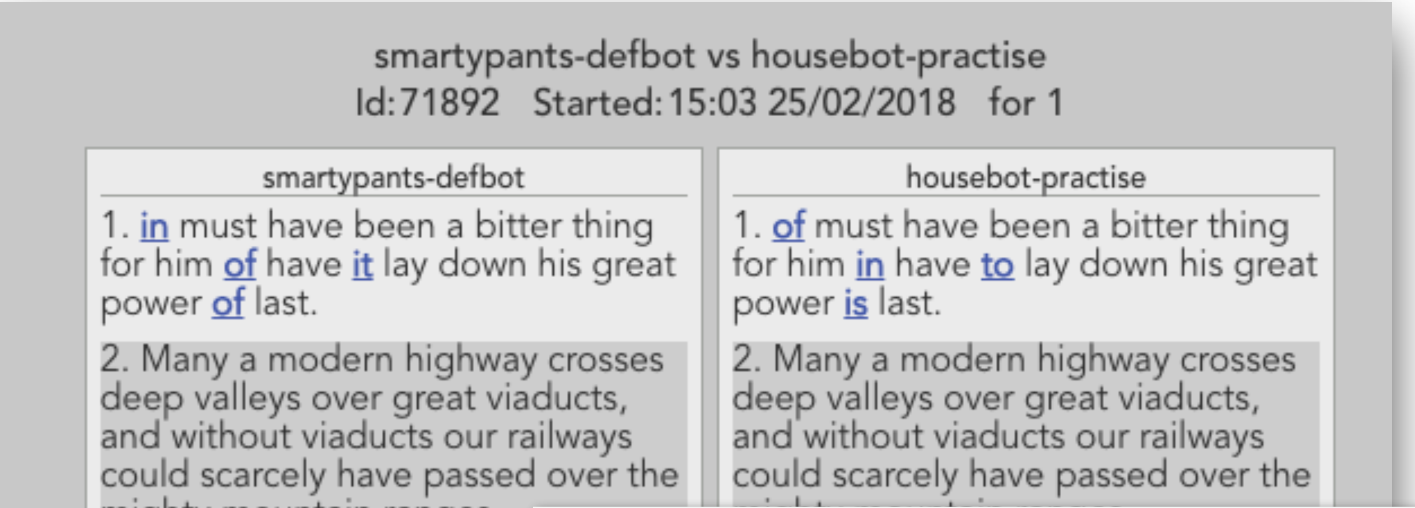
smartypants-defbot stopped game, therefore housebot-practise won

Given a text fragment in English with some of the words omitted, fill in the gaps using language modelling techniques.

Omitted words are: *of*, *to*, *in*, *it* and *is*.

➡ multi-class classification!

Predictive Text game



smartypants-defbot vs housebot-practise
Id:71892 Started:15:03 25/02/2018 for 1

smartypants-defbot

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