Algorithms&Complexity - In Class Assignments (Week 7)

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1. Implement a Markov chain working with whole words instead of letters. Leave the number of words in a sequence as an adjustable parameter, but due to memory limitations keep it at two. Example: k=2 “word1 word2” as one of the possible sequences. To test your implementation, you can use a smaller text. If you want, you can try to use something larger as an input text (a small book). Hint: Use a sparse dictionary from scipy.sparse.dok_matrix

Tips from Ilia def create_markov_chain(states, transition_matrix): """ Create a Markov chain.

```
Parameters:
- states: List of states in the Markov chain.
- transition_matrix: Dictionary representing transition
probabilities.

Returns:
- A function that simulates the Markov chain.
"""
```

In [1]:
```
import random
import nltk
nltk.download('punkt')
```

```
[nltk_data] Downloading package punkt to
[nltk_data]     /Users/mclevesluna/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
```

Out[1]:
```
True
```

In [2]:
```
from collections import defaultdict
from nltk.tokenize import word_tokenize
import random

def preprocess_text(text):

    #Preprocess the text by tokenizing and converting to lowercase
    tokens = word_tokenize(text.lower())
    return tokens

def create_markov_chain(states, text):

    transition_matrix = defaultdict(dict)

    for i in range(len(text) - 1):
        current_state = text[i]
        next_state = text[i + 1]

        if next_state not in transition_matrix[current_state]:
```

```
            transition_matrix[current_state][next_state] = 1
        else:
            transition_matrix[current_state][next_state] += 1

    # Normalize transition probabilities
    for state in transition_matrix:
        total_transitions = sum(transition_matrix[state].values())
        for next_state in transition_matrix[state]:
            transition_matrix[state][next_state] /= total_transitions

    return lambda num_words, seed_word: simulate_chain(num_words, seed_word, t

#Simulate the Markov chain and generate a sequence of words.
def simulate_chain(num_words, seed_word, transition_matrix):

    current_word = seed_word
    generated_sequence = [current_word]

    for _ in range(num_words - 1):
        if current_word in transition_matrix:
            next_word = random.choices(
                list(transition_matrix[current_word].keys()),
                weights=list(transition_matrix[current_word].values())
            )[0]
            generated_sequence.append(next_word)
            current_word = next_word
        else:
            break

    return generated_sequence

# Audre Lorde's poem
poem = """
Moon marked and touched by sun
my magic is unwritten
but when the sea turns back
it will leave my shape behind.
I seek no favor
untouched by blood
unrelenting as the curse of love
permanent as my errors
or my pride
I do not mix
love with pity
nor hate with scorn
and if you would know me
look into the entrails of Uranus
where the restless oceans pound.

I do not dwell
within my birth nor my divinities
who am ageless and half-grown
and still seeking
my sisters
witches in Dahomey
wear me inside their coiled cloths
as our mother did
mourning.

I have been woman
```

```
for a long time
beware my smile
I am treacherous with old magic
and the noon's new fury
with all your wide futures
promised
I am
woman
and not white.
"""

# Preprocess the text
preprocessed_text = preprocess_text(poem)

# Create the list of states
states = list(set(preprocessed_text))

# Create the Markov chain function
markov_chain = create_markov_chain(states, preprocessed_text)

# Simulate the Markov chain with a seed word and generate a sequence of words
generated_sequence = markov_chain(num_words=20, seed_word='woman')
print(generated_sequence)
```

```
['woman', 'for', 'a', 'long', 'time', 'beware', 'my', 'divinities', 'who', 'a
m', 'woman', 'for', 'a', 'long', 'time', 'beware', 'my', 'magic', 'and', 'if']
```

In [ ]:

Other code used in class (NOT for grading)

Regression demonstration

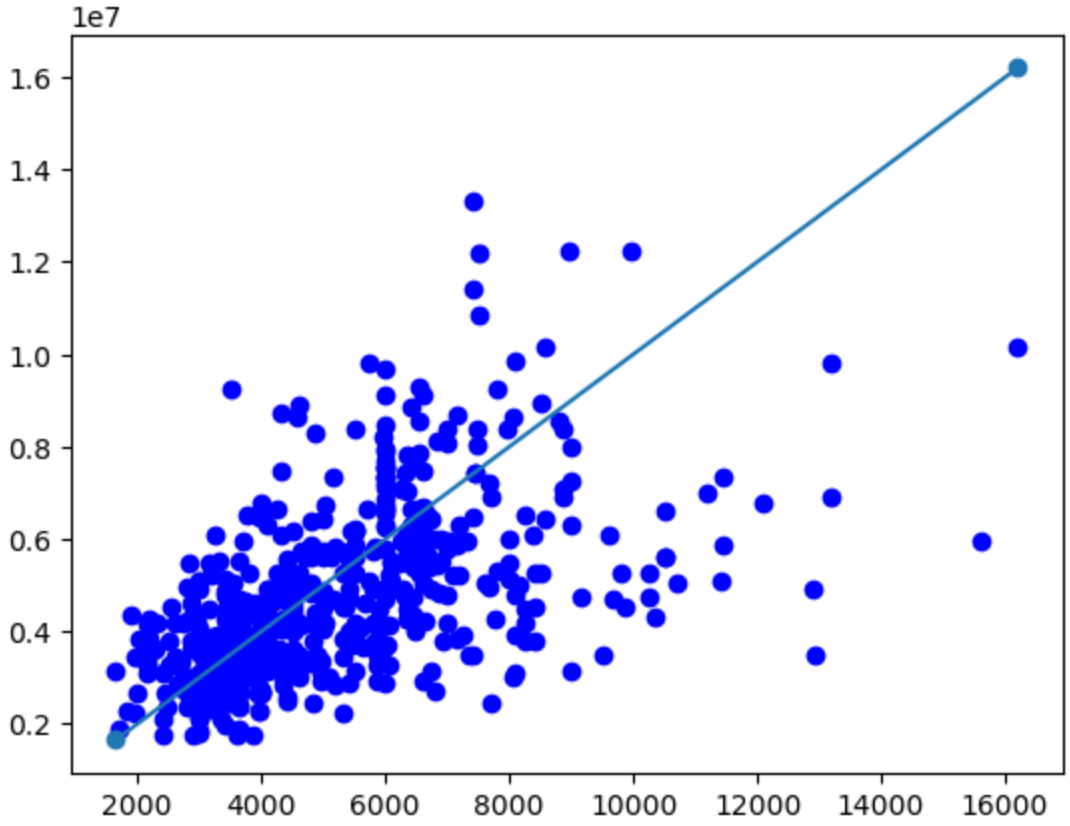
In [1]:
```
#import libraries

import csv
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import statsmodels.api as sm
import statsmodels.formula.api as smf
```

In [2]:
```
#import data

file_name = 'Documents/Algoritms&Complexity/Week 7/Housing.csv'
df = pd.read_csv(file_name, encoding='utf-8')
df.head()
```

Out[2]:

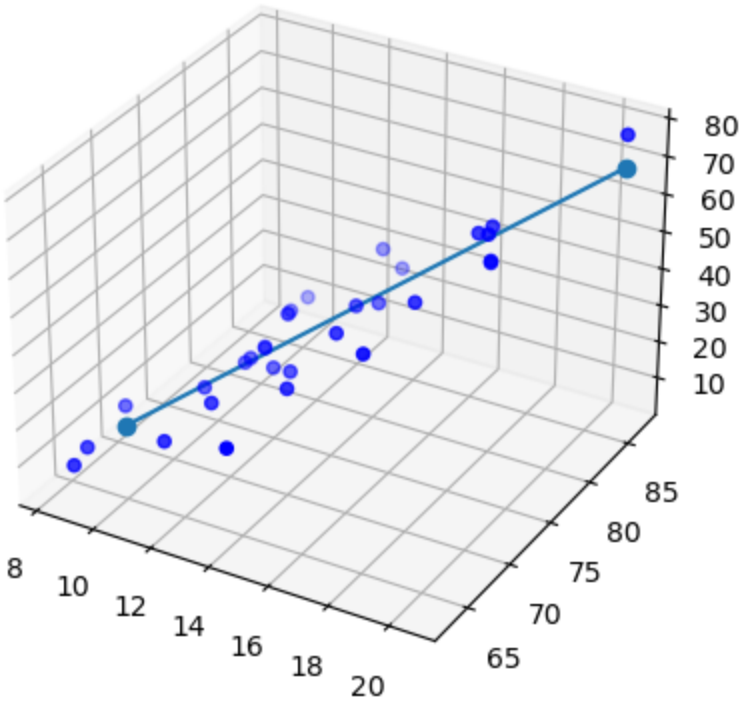
	price	area	bedrooms	bathrooms	stories	mainroad	guestroom	basement	hotwaterh
0	13300000	7420	4	2	3	yes	no	no	
1	12250000	8960	4	4	4	yes	no	no	
2	12250000	9960	3	2	2	yes	no	yes	
3	12215000	7500	4	2	2	yes	no	yes	
4	11410000	7420	4	1	2	yes	yes	yes	

In [3]:
```
# Plot the scatter plot in 2D

area = df['area'].to_numpy() #/ 1000
price = df['price'].to_numpy() #/ 1e6
def line(b1, b2, x):
    y = b1 + b2*x
    return y
fig, ax = plt.subplots()
ax.scatter(area, price, c ="blue")
x = np.array([min(area), max(area)])
y = line(0, 1000, x)
plt.plot([x[0], x[-1]], [y[0], y[-1]], marker = 'o')
plt.show()
```



In [4]:
```
# Plot the scatter plot in 3D

df = sm.datasets.get_rdataset('trees').data
df.head()
girth = df['Girth'].to_numpy()
height = df['Height'].to_numpy()
volume = df['Volume'].to_numpy()
X = np.stack([np.ones(31), girth, height], axis=1)
B = np.linalg.inv(np.dot(X.T,X))
B = np.dot(B,X.T)
B = np.dot(B,volume)
def line_3d(b, x):
    y = np.dot(x, b)
    return y
fig = plt.figure()
ax = fig.add_subplot(projection='3d')
ax.scatter(girth, height, volume, c ="blue")
y = line_3d(B, X)
```

```
plt.plot([girth[0], girth[-1]], [height[0], height[-1]], [y[0], y[-1]], marker
plt.show()
```



1. Molusc task

In [8]:
```
from ucimlrepo import fetch_ucirepo

# fetch dataset
abalone = fetch_ucirepo(id=1)  #id=186
abalone = abalone.data.features
```

In [9]:
```
#Show data
abalone
```

Out[9]:

	Sex	Length	Diameter	Height	Whole_weight	Shucked_weight	Viscera_weight	Shell_we
0	M	0.455	0.365	0.095	0.5140	0.2245	0.1010	0.1
1	M	0.350	0.265	0.090	0.2255	0.0995	0.0485	0.(
2	F	0.530	0.420	0.135	0.6770	0.2565	0.1415	0.1
3	M	0.440	0.365	0.125	0.5160	0.2155	0.1140	0.1
4	I	0.330	0.255	0.080	0.2050	0.0895	0.0395	0.(
...	...	...	...	...	...	...	...	
4172	F	0.565	0.450	0.165	0.8870	0.3700	0.2390	0.2
4173	M	0.590	0.440	0.135	0.9660	0.4390	0.2145	0.2
4174	M	0.600	0.475	0.205	1.1760	0.5255	0.2875	0.3
4175	F	0.625	0.485	0.150	1.0945	0.5310	0.2610	0.2
4176	M	0.710	0.555	0.195	1.9485	0.9455	0.3765	0.4

4177 rows × 8 columns

In [29]:
```
#Implement multivariate linear regression, find coefficient that will allow me
#Y = XB + E

#Define features and target
X=abalone[['Length','Diameter','Height']].to_numpy()
Y=abalone[['Whole_weight','Shucked_weight']].to_numpy()
#Find coefficient matrix (B)
#Using formular from ppt
```

In [30]:
```
X.shape
```

Out[30]:
```
(4177, 3)
```

In [31]:
```
#TransposeX
XT = np.transpose(X)  # or matrix.T
print(XT.shape)
```

```
(3, 4177)
```

In [27]:
```
XT.shape
```

Out[27]:
```
(3, 4177)
```

In [33]:
```
#Multiply XT by X

result_matrix = np.dot(XT, X)
result_matrix.shape
```

Out[33]:
```
(3, 3)
```

In [34]:
```
# Find the inverse of the matrix you calculated in the last step

inverse_XTX = np.linalg.inv(result_matrix)
```

In [38]:
```
result_matrix1 = np.dot(inverse_XTX, XT)
```

In [39]:
```
# Multiply XT by Y

coefficients = np.dot(result_matrix1, Y)
coefficients.shape
```

Out[39]:
```
(3, 2)
```

In [20]:
```
# Multiply the inverse matrix you found by the result_matrix1
# QUESTION FOR ILIA, BECAUSE THE MATRIX SIZE, THEY CAN'T NE MULTIPLIED!!!!!

coefficients= np.dot(result_matrix1,inverse_XTX)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
Cell In[20], line 3
      1 # Multiply the inverse matrix you found by the result_matrix1
----> 3 coefficients= np.dot(result_matrix1,inverse_XTX)

File <__array_function__ internals>:200, in dot(*args, **kwargs)

ValueError: shapes (3,2) and (3,3) not aligned: 2 (dim 1) != 3 (dim 0)
```

In [41]:
```
#Ask help for plotting

print(coefficientes)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[41], line 1
----> 1 print(coefficientes)

NameError: name 'coefficientes' is not defined
```

2. Markov Chain Task

In [13]:
```

```

```
[nltk_data] Downloading package punkt to
[nltk_data]     /Users/mclevesluna/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
```

Out[13]:
```
True
```

In [14]:
```

```

```
['woman', 'for', 'a', 'long', 'time', 'beware', 'my', 'sisters', 'witches', 'i
n', 'dahomey', 'wear', 'me', 'inside', 'their', 'coiled', 'cloths', 'as', 'm
y', 'magic']
```

In [ ]:
```

```