

LABORATORY REPORT #13

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Bioinformatics, 4th year 1st semester, 2025-2026

lab13_1.py

The screenshot shows the Spyder Python IDE interface. The left pane displays the code for lab13_1.py, which defines a function predict_steps that takes a matrix and a vector as input and returns a list of values. The right pane shows the Variable Explorer with the initial_matrix and initial_vector variables. The bottom pane shows the IPython console output, which includes the execution of the predict_steps function and the resulting values.

```
# -*- coding: utf-8 -*-  
"""  
Created on Thu Jan 15 14:01:58 2026  
  
@author: Antonio  
"""  
import numpy as np  
  
def predict_steps(matrix, vector):  
    A = np.array(matrix)  
    v = np.array(vector)  
    for i in range(5):  
        v = A @ v  
        print(f"Step {i + 1}: {v}")  
  
initial_matrix = [  
    [0.0, 0.1, 0.1],  
    [0.1, 0.6, 0.1],  
    [0.1, 0.1, 0.8]  
]  
  
initial_vector = [10.0, 5.0, 20.0]  
  
predict_steps(initial_matrix, initial_vector)
```

Variable Explorer:

Name	Type	Size	Value
initial_matrix	list	3	[[0.0, 0.1, 0.1], [0.1, 0.6, 0.1], [0.1, 0.1, 0.8]]
initial_vector	list	3	[10.0, 5.0, 20.0]

IPython Console:

```
Type "copyright", "credits" or "license()" for more information.  
IPython 8.30.0 -- An enhanced Interactive Python. Type '?' for help.  
  
In [1]: %runfile C:/Users/Antonio/Desktop/bioinfo/lab13/lab13_1.py --wdir  
Step 1: [11.5 6. 17.5]  
Step 2: [12.75 6.5 15.75]  
Step 3: [13.725 6.75 14.525]  
Step 4: [14.4575 6.875 13.6675]  
Step 5: [14.99525 6.9375 13.06725]  
  
In [2]:
```

lab13_2.py

The screenshot shows the Spyder Python IDE interface. The left pane displays the code for lab13_2.py, which defines a function predict_steps that takes a matrix and a vector as input and returns a list of values. The right pane shows the Variable Explorer with the initial_matrix and initial_vector variables. The bottom pane shows the IPython console output, which includes the execution of the predict_steps function and the resulting values.

```
# -*- coding: utf-8 -*-  
"""  
Created on Thu Jan 15 14:38:39 2026  
  
@author: Antonio  
"""  
import random  
import json  
  
nucleotides = ['A', 'C', 'G', 'T']  
sequence = ''.join(random.choices(nucleotides, k=50))  
  
counts = {n1: {n2: 0 for n2 in nucleotides} for n1 in nucleotides}  
  
for i in range(len(sequence) - 1):  
    current_char = sequence[i]  
    next_char = sequence[i + 1]  
    counts[current_char][next_char] += 1  
  
transition_matrix = {}  
for n1 in nucleotides:  
    total_transitions = sum(counts[n1].values())  
    transition_matrix[n1] = {}  
    for n2 in nucleotides:  
        if total_transitions > 0:  
            transition_matrix[n1][n2] = counts[n1][n2] / total_transitions  
        else:  
            transition_matrix[n1][n2] = 0.0  
  
with open('transition_matrix.json', 'w') as f:  
    json.dump(transition_matrix, f, indent=4)
```

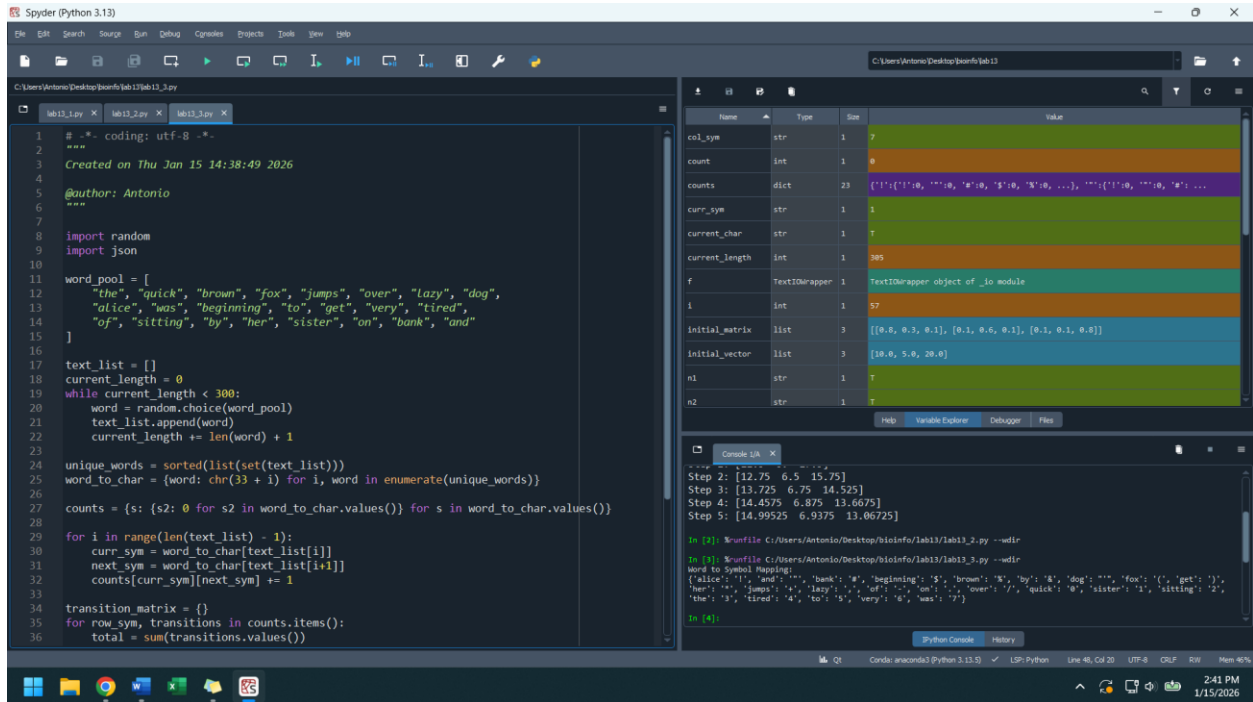
Variable Explorer:

Name	Type	Size	Value
cal_sys	str	1	2
count	int	1	0
counts	dict	23	{...}
curr_sys	str	1	1
current_char	str	1	T
current_length	int	1	385
f	TextWrapper	1	TextWrapper object of ...
i	int	1	57
initial_matrix	list	3	[[0.0, 0.2, 0.1], [0.1, 0.6, 0.1], [0.1, 0.1, 0.8]]
initial_vector	list	3	[10.0, 5.0, 20.0]
n1	str	1	T
n2	str	1	T

IPython Console:

```
Type "copyright", "credits" or "license()" for more information.  
IPython 8.30.0 -- An enhanced Interactive Python. Type '?' for help.  
  
In [1]: %runfile C:/Users/Antonio/Desktop/bioinfo/lab13/lab13_2.py --wdir  
Step 2: [12.75 6.5 15.75]  
Step 3: [13.725 6.75 14.525]  
Step 4: [14.4575 6.875 13.6675]  
Step 5: [14.99525 6.9375 13.06725]  
  
In [2]: %runfile C:/Users/Antonio/Desktop/bioinfo/lab13/lab13_2.py --wdir  
word to Symbol Mapping:  
[...]  
In [4]:
```

lab13_3.py



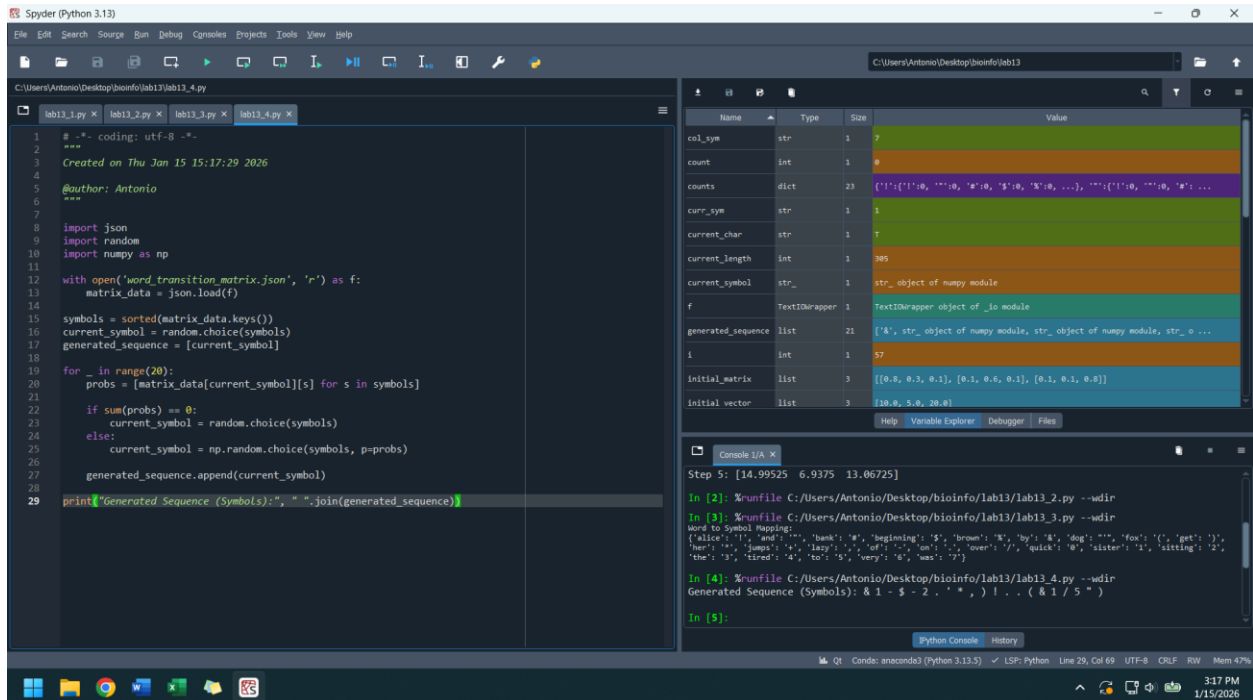
```
1 # -*- coding: utf-8 -*-
2 """
3 Created on Thu Jan 15 14:38:49 2026
4
5 @author: Antonio
6 """
7
8 import random
9 import json
10
11 word_pool = [
12     "the", "quick", "brown", "fox", "jumps", "over", "lazy", "dog",
13     "alice", "was", "beginning", "to", "get", "very", "tired",
14     "of", "sitting", "by", "her", "sister", "on", "bank", "and"
15 ]
16
17 text_list = []
18 current_length = 0
19 while current_length < 300:
20     word = random.choice(word_pool)
21     text_list.append(word)
22     current_length += len(word) + 1
23
24 unique_words = sorted(list(set(text_list)))
25 word_to_char = {word: chr(33 + i) for i, word in enumerate(unique_words)}
26
27 counts = {}
28 for s1 in range(len(text_list) - 1):
29     curr_sym = word_to_char[text_list[s1]]
30     next_sym = word_to_char[text_list[s1+1]]
31     counts[curr_sym][next_sym] += 1
32
33 transition_matrix = {}
34 for row_sym, transitions in counts.items():
35     total = sum(transitions.values())
36     transition_matrix[row_sym] = [transitions[s2] / total for s2 in unique_words]
```

Console I/O

```
Step 2: [12.75 6.5 15.75]
Step 3: [13.725 6.75 14.525]
Step 4: [14.4575 6.875 13.6675]
Step 5: [14.99525 6.9375 13.06725]

In [2]: %runfile C:/Users/Antonio/Desktop/bioinfo/lab13/lab13_3.py --wdir
Word to Symbol Mapping:
{'alice': '!', 'and': '!', 'bank': '!', 'beginning': '!', 'brown': '!', 'by': '!', 'dog': '!', 'fox': '!', 'get': '!',
 'her': '!', 'jumps': '!', 'lazy': '!', 'over': '!', 'quick': '!', 'sister': '!', 'sitting': '!',
 'the': '!', 'tired': '!', 'to': '!', 'very': '!', 'was': '!'}
```

lab13_4.py



```
1 # -*- coding: utf-8 -*-
2 """
3 Created on Thu Jan 15 15:17:29 2026
4
5 @author: Antonio
6 """
7
8 import json
9 import random
10 import numpy as np
11
12 with open('word_transition_matrix.json', 'r') as f:
13     matrix_data = json.load(f)
14
15 symbols = sorted(matrix_data.keys())
16 current_symbol = random.choice(symbols)
17 generated_sequence = [current_symbol]
18
19 for _ in range(20):
20     probs = [matrix_data[current_symbol][s] for s in symbols]
21     if sum(probs) == 0:
22         current_symbol = random.choice(symbols)
23     else:
24         current_symbol = np.random.choice(symbols, p=probs)
25     generated_sequence.append(current_symbol)
26
27 print("Generated Sequence (Symbols):", " ".join(generated_sequence))
```

Console I/O

```
Step 5: [14.99525 6.9375 13.06725]

In [2]: %runfile C:/Users/Antonio/Desktop/bioinfo/lab13/lab13_2.py --wdir

In [3]: %runfile C:/Users/Antonio/Desktop/bioinfo/lab13/lab13_3.py --wdir
Word to Symbol Mapping:
{'alice': '!', 'and': '!', 'bank': '!', 'beginning': '!', 'brown': '!', 'by': '!', 'dog': '!', 'fox': '!', 'get': '!',
 'her': '!', 'jumps': '!', 'lazy': '!', 'over': '!', 'quick': '!', 'sister': '!', 'sitting': '!',
 'the': '!', 'tired': '!', 'to': '!', 'very': '!', 'was': '!'}
```