PennState
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University of Puerto Rico
Puerto Rico - IDeA Networks of Biomedical Research Excellence

PRINBRE
IDeA Network of Biomedical Research Excellence

Python3 Part 1 – Crash Course in Python3 for Future STEM Coders

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June 7, 2023 at UPR-Ciencias Médicas

- The following material is the result of PR-INBRE research and curriculum development effort to provide a set of educational materials for research training and curriculum changes in biology programs across the island to support PR-INBRE efforts to establish a Community of Practice in Bioinformatics that offers a fruitful environment to increase computational and bioinformatics skills among traditional researchers and students (undergraduate and graduate) in the island. They have been developed as a part of the NIH funded project "**Puerto Rico IDeA Network Biomedical Research Excellence (PRINBRE)**" (Award Number 5P20GM103475).

- Most recent versions of these presentations can be found at **http://inbre.hpcf.upr.edu/**.

Competencies

June 5, 2023 - Record and write simple and common **Python scripts to deal with Bioinformatic needs for biological data analyses** using a Jupyter Notebook

Today – Exploit **datatypes that can record objects**, as well as, reason **logical statements**

Objectives

- Continue to use **Google Colab as an environment** to practice and learn common **Python** lines of code.
- Formulate logical statements through **Booleans** and **Conditions**
- Create and manage **Python lists** and **dictionaries**
- Analyze Python Lists and Dictionaries using **Python For Loops** and **While Loops**

Target Audience

- This training is addressed to beginners, highly motivated (eager to learn what is needed in order to be competitive without the tendency to self-limit when learning computational skills by saying that is difficult) wanting to become familiar with the **Python** programming language and become the Script Master of their bioinformatic analysis.

The importance of Python

- R is great however… eventually, you'll have to use Python language
- No matter your field, python will be a necessity (chemistry, biology, engineering, ecology, mathematics, etc)
- Knowing Python gives you an edge when job searching and navigating graduate research
- The majority bioinformatic tools are python-based and will lead you to understand under the hood code in order to successfully execute said program's purpose.

Lesson 2.0.0

Booleans and Conditions

Booleans

Booleans in Python return whether the statement is True or False

Operator	Definition	Statement Example
==	Equal-to	2 + 2 == 5
!=	Not equal-to	2 + 2 != 5
>	Greater-than	2 > 5
<	Less-than	2 < 5
>=	Greater or equal-to	2 >= 2 3 >= 2
<=	Lesser or equal-to	2 <= 2 1 <= 2

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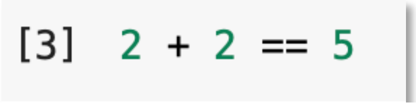

```
[3]  2 + 2 == 5
```

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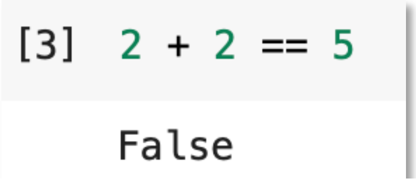

```
[3]  2 + 2 == 5

     False
```

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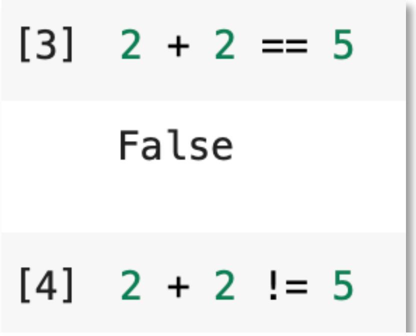

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[3]  2 + 2 == 5

     False

[4]  2 + 2 != 5
```

Booleans

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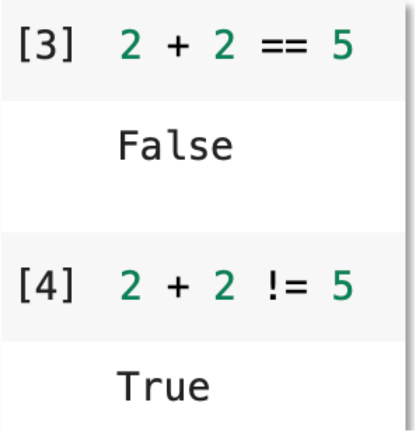

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[3]  2 + 2 == 5

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[4]  2 + 2 != 5

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```

Booleans

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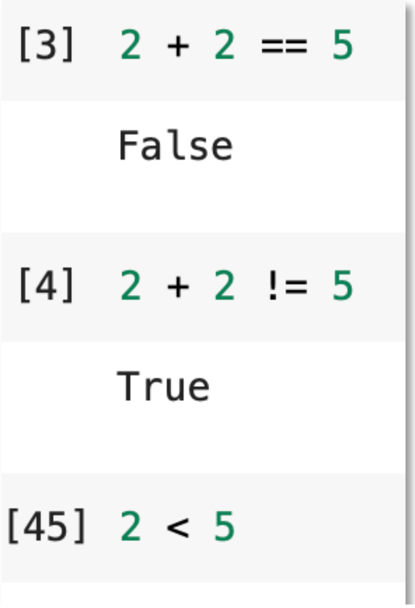

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[3]  2 + 2 == 5

     False

[4]  2 + 2 != 5

     True

[45] 2 < 5
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Booleans

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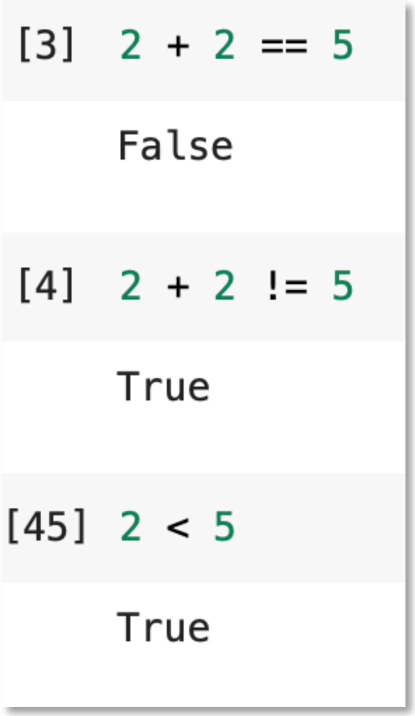


```
[3]  2 + 2 == 5

     False

[4]  2 + 2 != 5

     True

[45] 2 < 5

     True
```

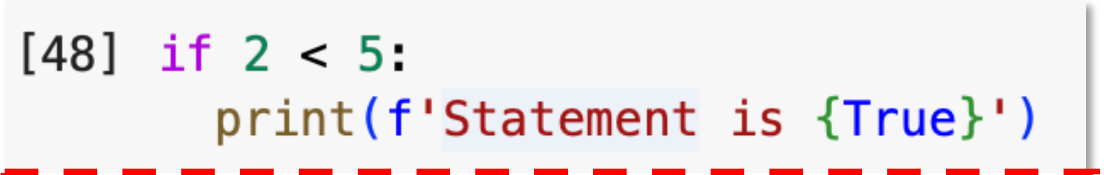
Conditions

Conditions in Python facilitate decision making in your code

Operator	Decision
if	When the condition is true
else	When the if condition is false
elif	When another option is true

Adding if conditions to Booleans

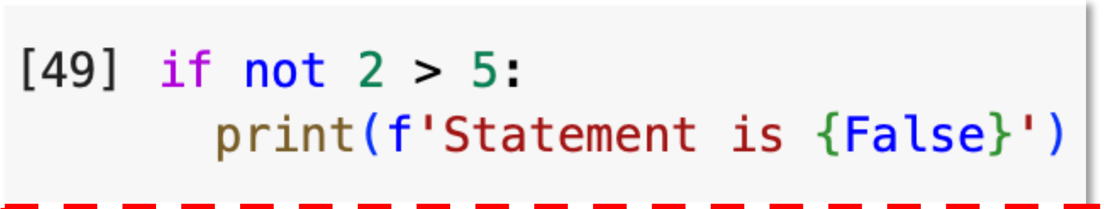
Using an if statement



```
[48] if 2 < 5:
       print(f'Statement is {True}')
```

Answer

Using an if not statement

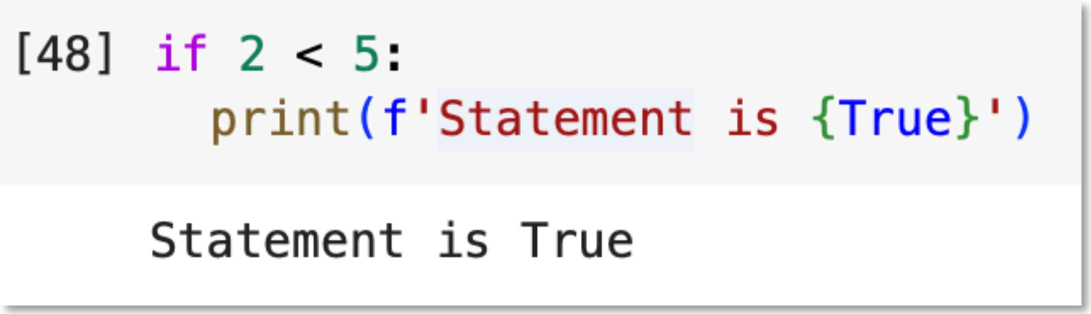


```
[49] if not 2 > 5:
       print(f'Statement is {False}')
```

Answer

Adding if conditions to Booleans

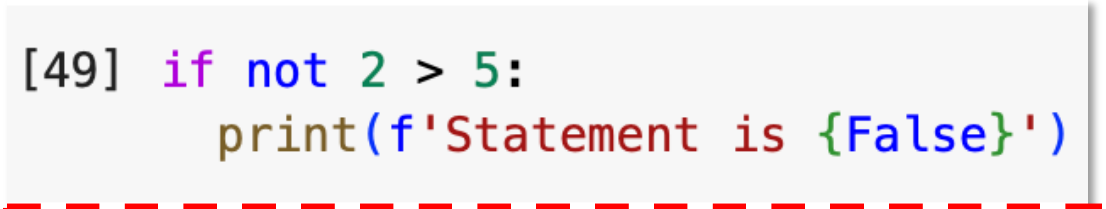
Using an if statement



```
[48] if 2 < 5:
       print(f'Statement is {True}')

     Statement is True
```

Using an if not statement



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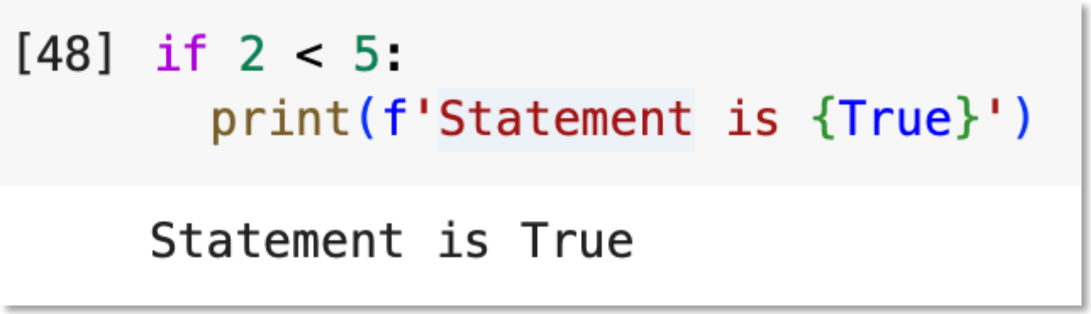
[49] if not 2 > 5:
       print(f'Statement is {False}')
```

Answer

Adding if conditions to Booleans

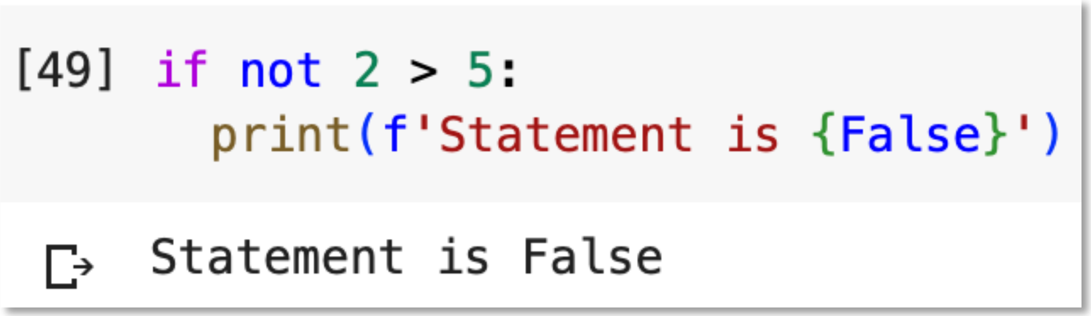
Using an if statement



```
[48] if 2 < 5:
       print(f'Statement is {True}')

     Statement is True
```

Using an if not statement

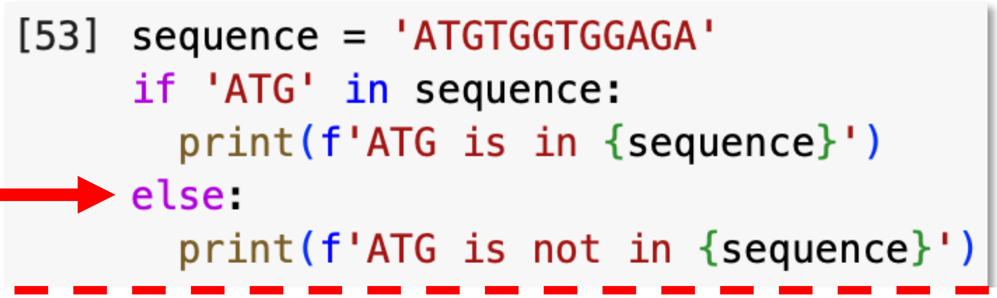


```
[49] if not 2 > 5:
       print(f'Statement is {False}')

     Statement is False
```

Adding if-else conditions to Booleans

Is ATG in the sequence?



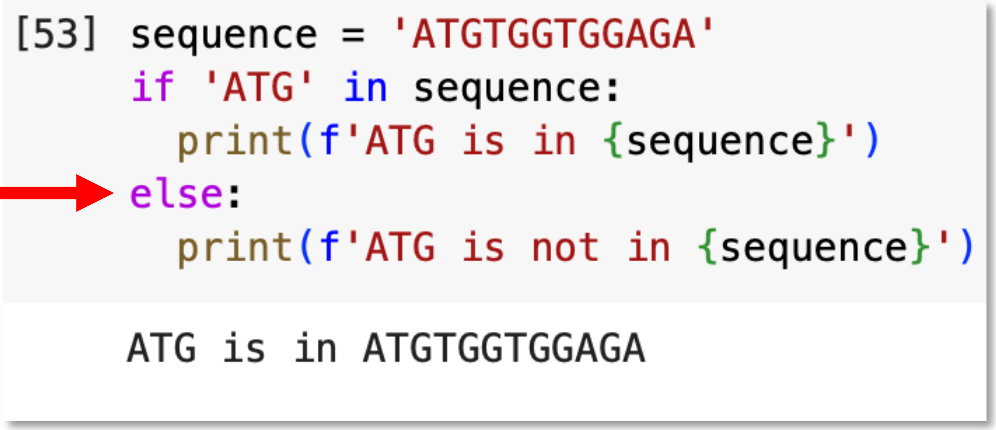
```
[53] sequence = 'ATGTGGTGGAGA'
     if 'ATG' in sequence:
       print(f'ATG is in {sequence}')
     else:
       print(f'ATG is not in {sequence}')
```

else can be used without a statement so when nothing there is no other option use else

Answer

Adding if-else conditions to Booleans

Is ATG in the sequence?



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[53] sequence = 'ATGTGGTGGAGA'
     if 'ATG' in sequence:
       print(f'ATG is in {sequence}')
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     ATG is in ATGTGGTGGAGA
```

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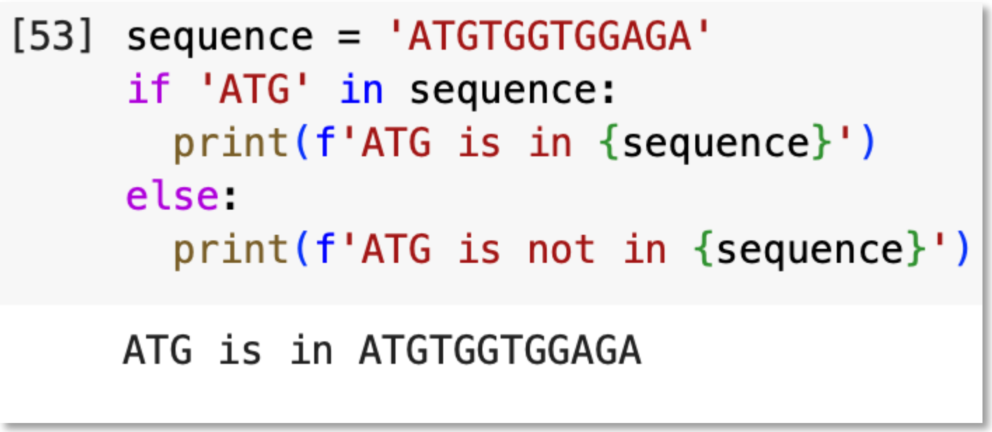
Adding if-else conditions to Booleans

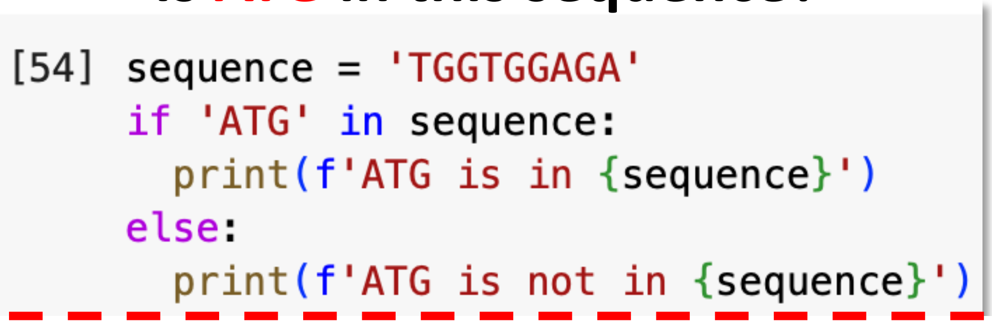
Is ATG in the sequence?



```
[53] sequence = 'ATGTGGTGGAGA'
     if 'ATG' in sequence:
       print(f'ATG is in {sequence}')
     else:
       print(f'ATG is not in {sequence}')

     ATG is in ATGTGGTGGAGA
```

Is ATG in this sequence?

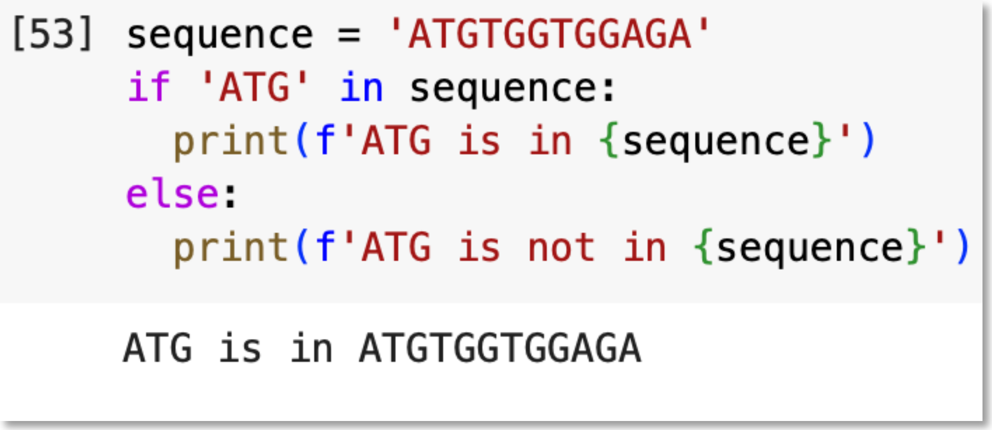


```
[54] sequence = 'TGGTGGAGA'
     if 'ATG' in sequence:
       print(f'ATG is in {sequence}')
     else:
       print(f'ATG is not in {sequence}')
```

Answer

Adding if-else conditions to Booleans

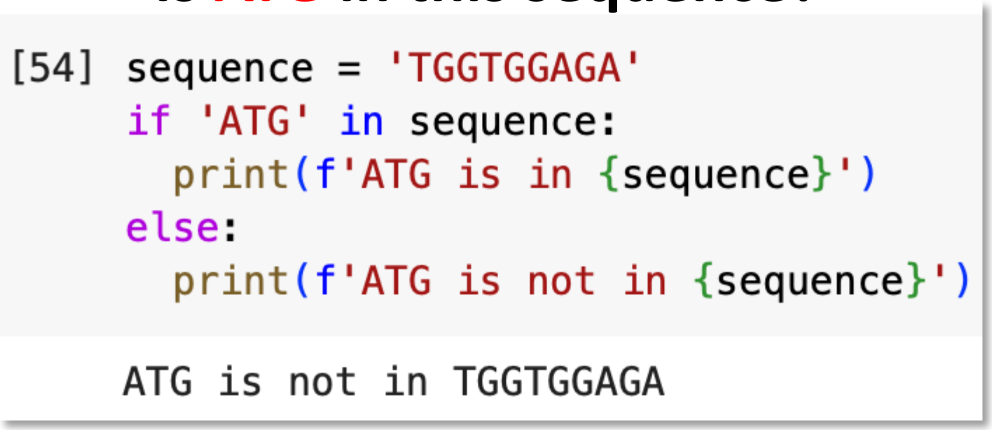
Is ATG in the sequence?



```
[53] sequence = 'ATGTGGTGGAGA'
     if 'ATG' in sequence:
       print(f'ATG is in {sequence}')
     else:
       print(f'ATG is not in {sequence}')
```

```
     ATG is in ATGTGGTGGAGA
```

Is ATG in this sequence?



```
[54] sequence = 'TGGTGGAGA'
     if 'ATG' in sequence:
       print(f'ATG is in {sequence}')
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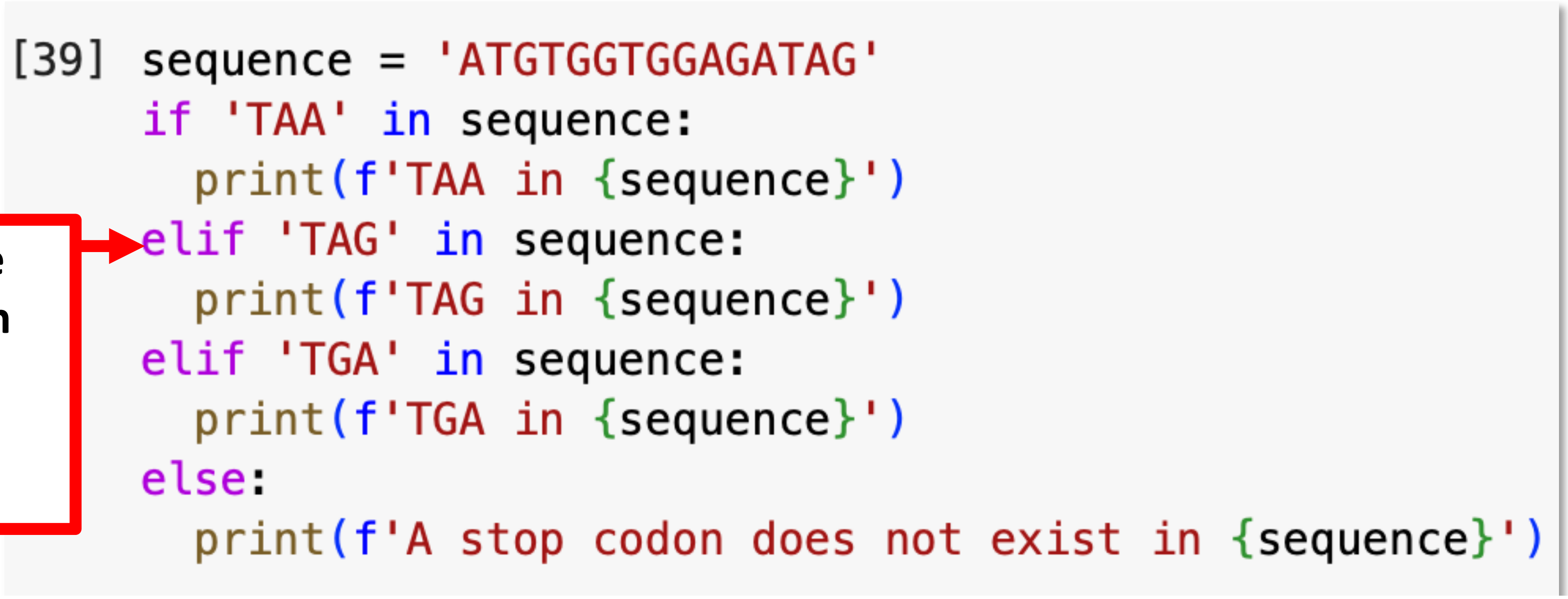
       print(f'ATG is not in {sequence}')
```

```
     ATG is not in TGGTGGAGA
```

Adding if-elif-else conditions to Booleans



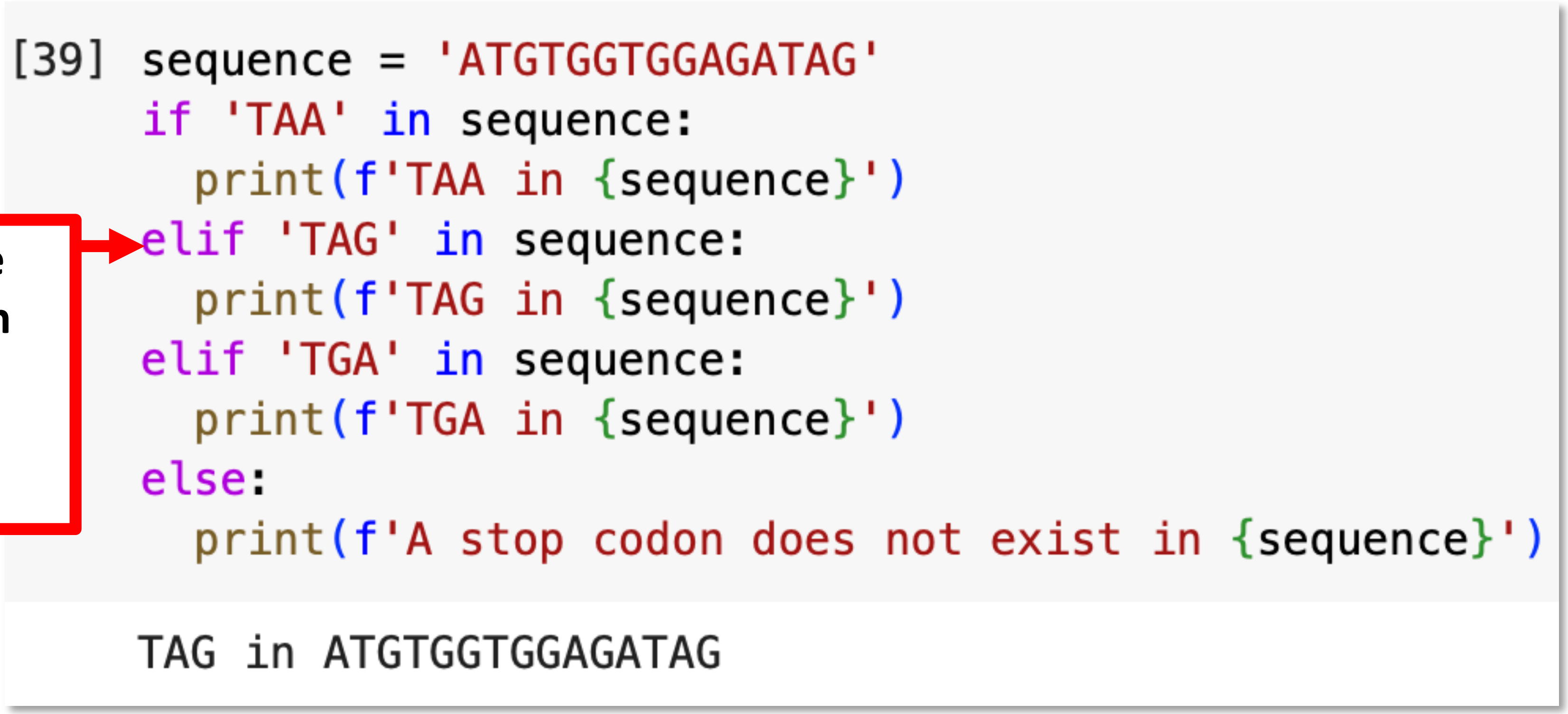
```
[39] sequence = 'ATGTGGTGGAGATAG'
     if 'TAA' in sequence:
       print(f'TAA in {sequence}')
     elif 'TAG' in sequence:
       print(f'TAG in {sequence}')
     elif 'TGA' in sequence:
       print(f'TGA in {sequence}')
     else:
       print(f'A stop codon does not exist in {sequence}')
```

elif can be used when there are multiple options

Answer

Adding if-elif-else conditions to Booleans

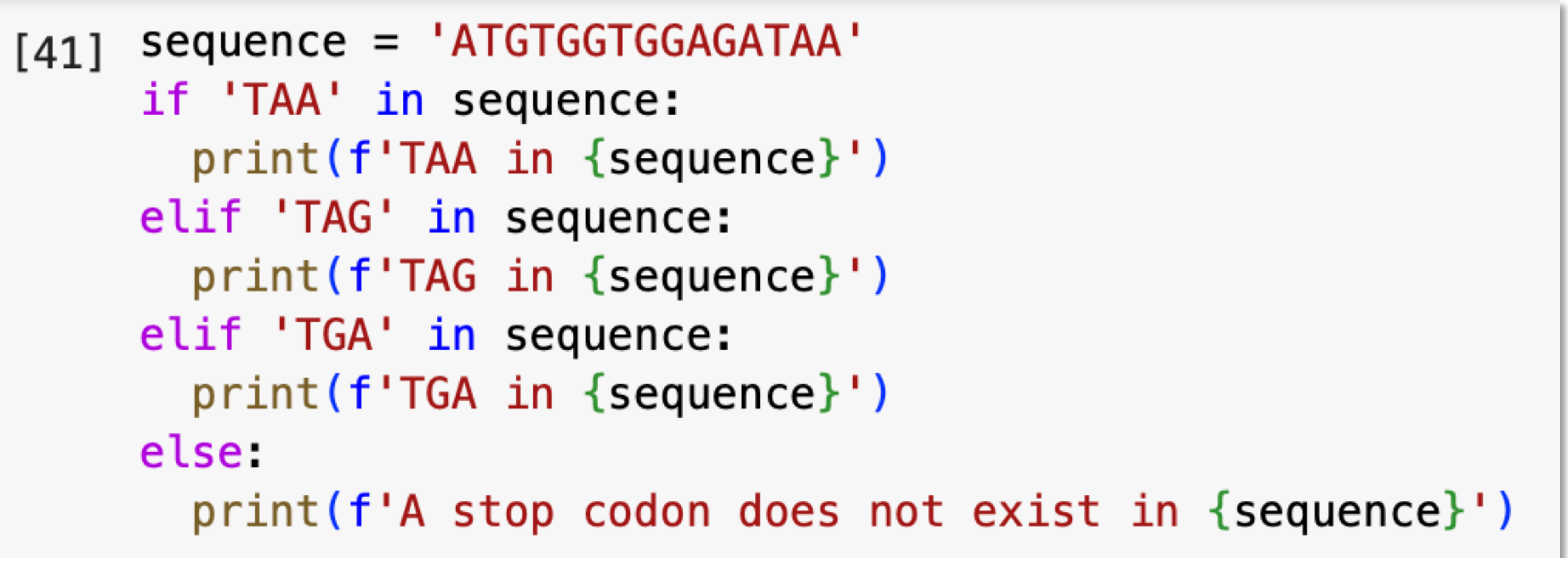
elif can be used when there are multiple options



```
[39] sequence = 'ATGTGGTGGAGATAG'
     if 'TAA' in sequence:
       print(f'TAA in {sequence}')
     elif 'TAG' in sequence:
       print(f'TAG in {sequence}')
     elif 'TGA' in sequence:
       print(f'TGA in {sequence}')
     else:
       print(f'A stop codon does not exist in {sequence}')
```

```
     TAG in ATGTGGTGGAGATAG
```

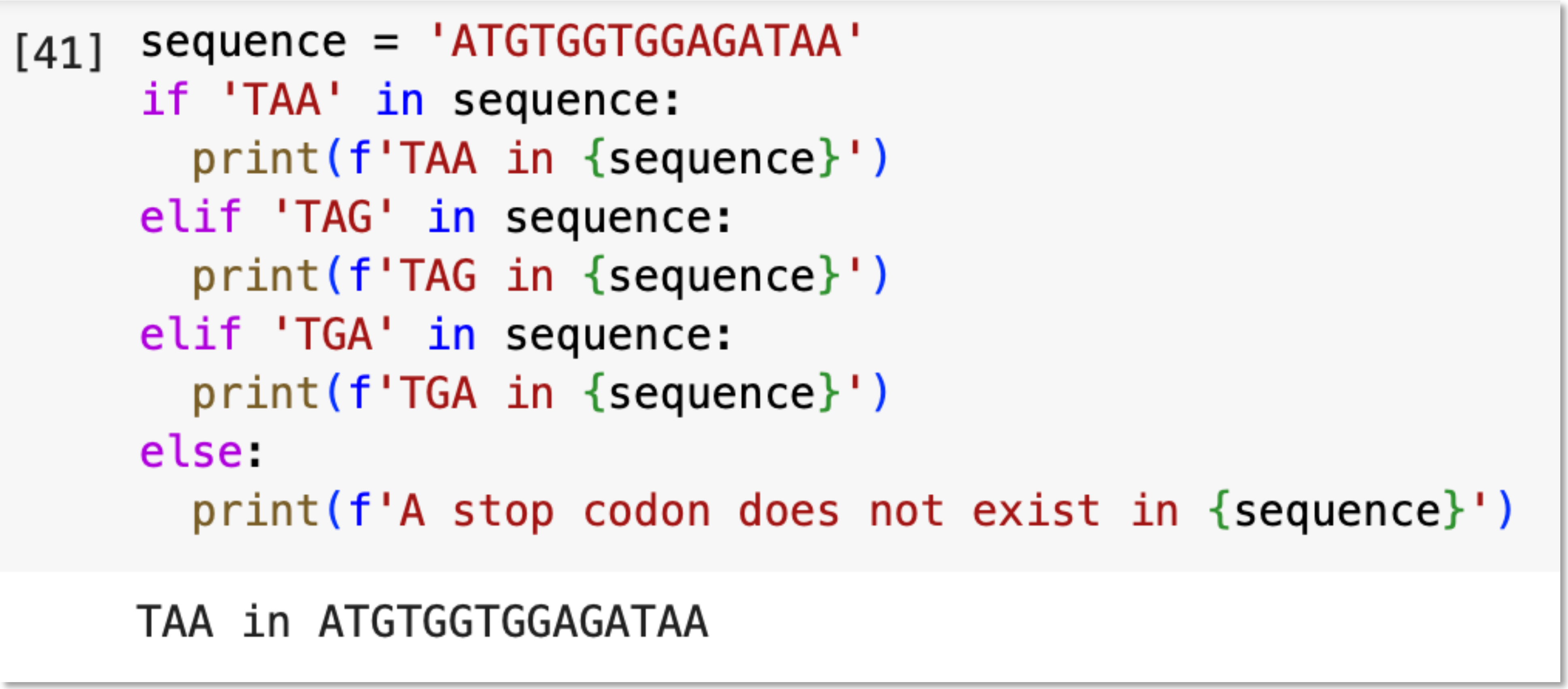
Adding if-elif-else conditions to Booleans



```
[41] sequence = 'ATGTGGTGGAGATAA'
     if 'TAA' in sequence:
       print(f'TAA in {sequence}')
     elif 'TAG' in sequence:
       print(f'TAG in {sequence}')
     elif 'TGA' in sequence:
       print(f'TGA in {sequence}')
     else:
       print(f'A stop codon does not exist in {sequence}')
```

Answer

Adding if-elif-else conditions to Booleans

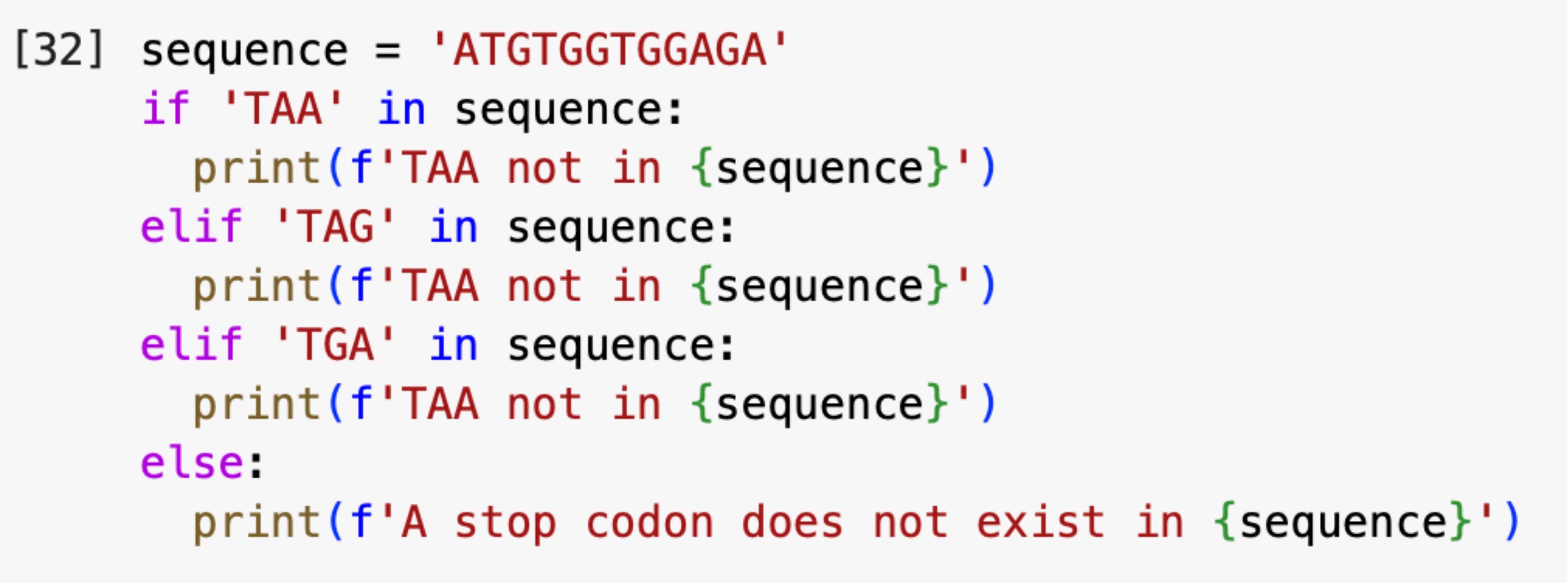


[41]

```
sequence = 'ATGTGGTGGAGATAA'
if 'TAA' in sequence:
  print(f'TAA in {sequence}')
elif 'TAG' in sequence:
  print(f'TAG in {sequence}')
elif 'TGA' in sequence:
  print(f'TGA in {sequence}')
else:
  print(f'A stop codon does not exist in {sequence}')
```

```
TAA in ATGTGGTGGAGATAA
```

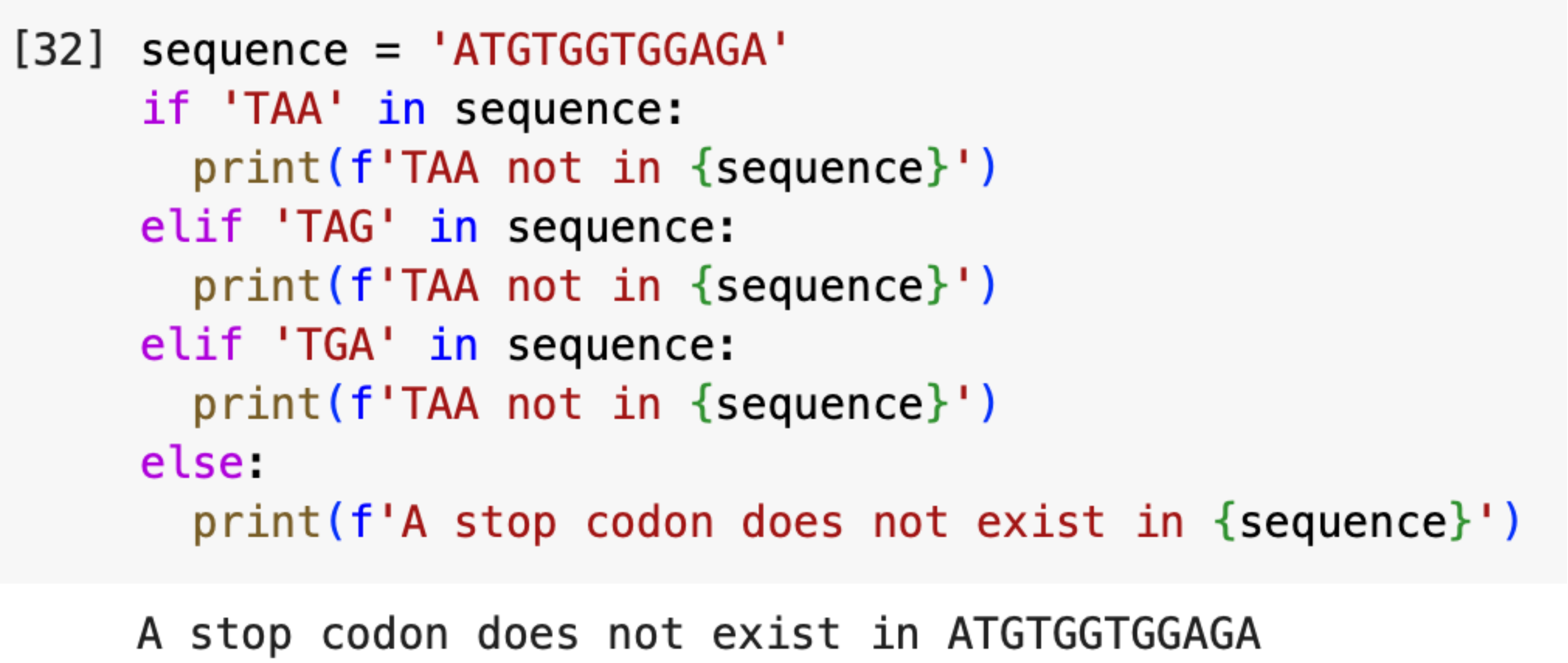
Adding if-elif-else conditions to Booleans



```
[32] sequence = 'ATGTGGTGGAGA'
     if 'TAA' in sequence:
       print(f'TAA not in {sequence}')
     elif 'TAG' in sequence:
       print(f'TAA not in {sequence}')
     elif 'TGA' in sequence:
       print(f'TAA not in {sequence}')
     else:
       print(f'A stop codon does not exist in {sequence}')
```

Answer

Adding if-elif-else conditions to Booleans



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[32] sequence = 'ATGTGGTGGAGA'
     if 'TAA' in sequence:
       print(f'TAA not in {sequence}')
     elif 'TAG' in sequence:
       print(f'TAA not in {sequence}')
     elif 'TGA' in sequence:
       print(f'TAA not in {sequence}')
     else:
       print(f'A stop codon does not exist in {sequence}')
```

```
A stop codon does not exist in ATGTGGTGGAGA
```

Lesson 2.1.0

More Python datatypes

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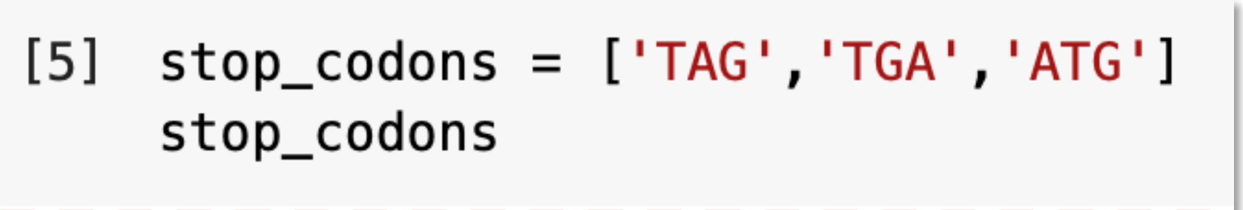
Lesson 2.1.1

Lists

Starting lists

Method 1: Create a list with items



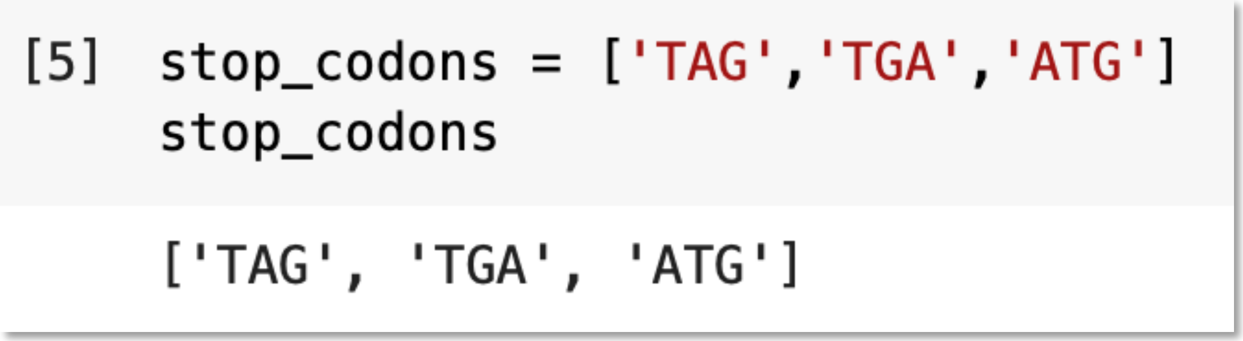
```
[5]  stop_codons = ['TAG','TGA','ATG']
     stop_codons
```

Answer

Store multiple items using brackets.

Starting lists

Method 1: Create a list with items



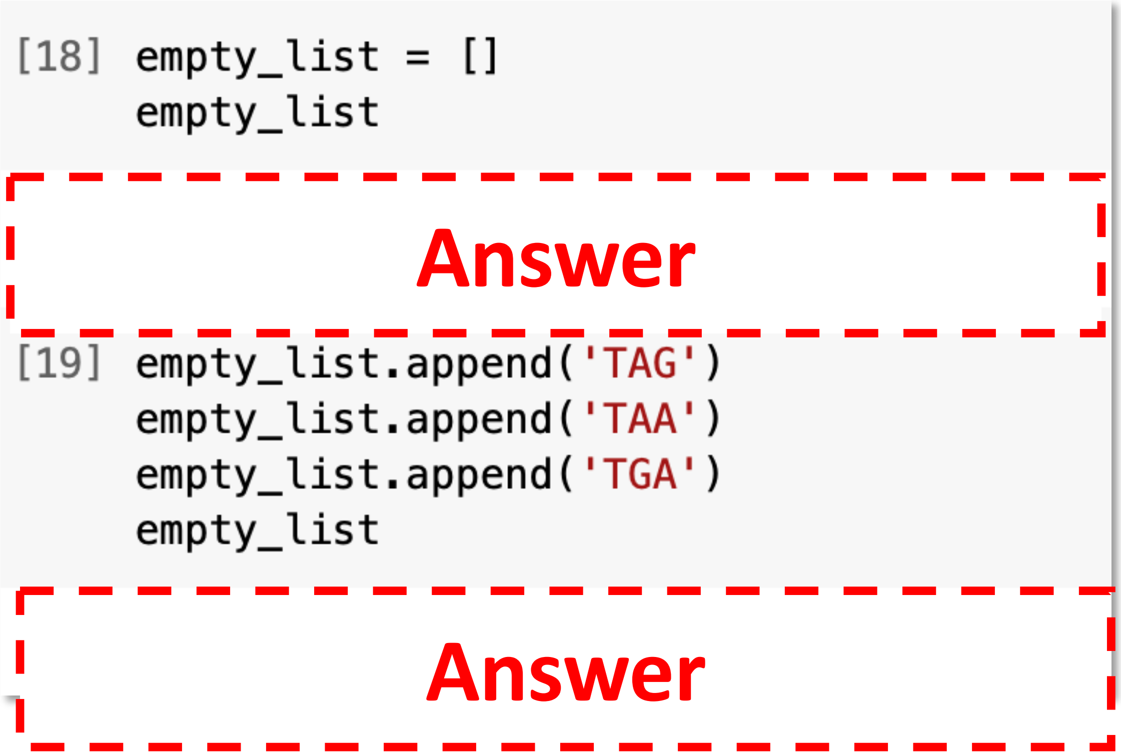
```
[5]  stop_codons = ['TAG','TGA','ATG']
     stop_codons

     ['TAG', 'TGA', 'ATG']
```

Store multiple items using brackets.

Starting lists

Method 2: Start an empty list



```
[18] empty_list = []
     empty_list
```

Answer

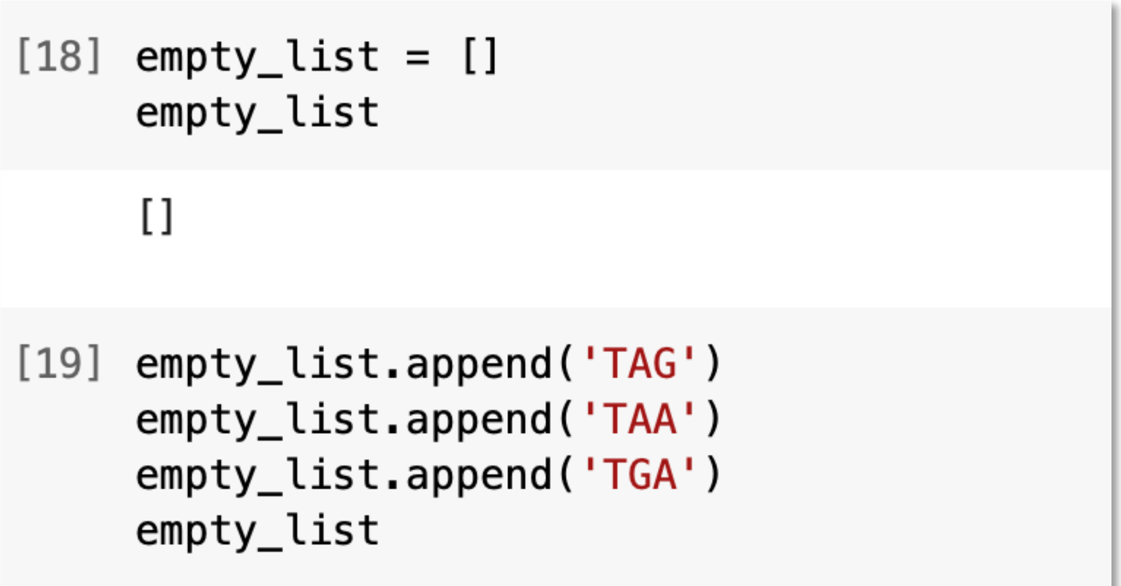
```
[19] empty_list.append('TAG')
     empty_list.append('TAA')
     empty_list.append('TGA')
     empty_list
```

Answer

The **append(*object*)** function will add new objects to an existing list.

Starting lists

Method 2: Start an empty list



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[18] empty_list = []
     empty_list

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```

```
[19] empty_list.append('TAG')
     empty_list.append('TAA')
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```

Answer

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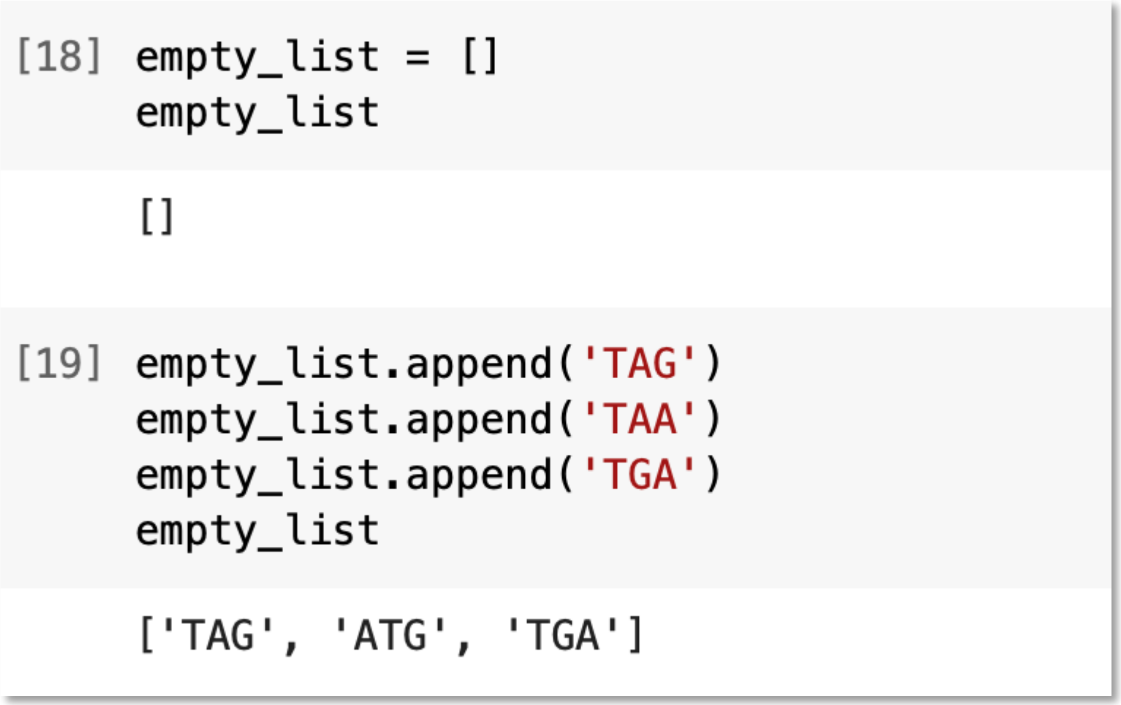
Starting lists

Method 2: Start an empty list



```
[18] empty_list = []
     empty_list

     []

[19] empty_list.append('TAG')
     empty_list.append('TAA')
     empty_list.append('TGA')
     empty_list

     ['TAG', 'ATG', 'TGA']
```

The append(*object*) function will add new objects to an existing list.

Functions you can use to evaluate and manipulate lists

len(*list*)

*list.*count("")

list.remove(*object*)

list.append(*object*)

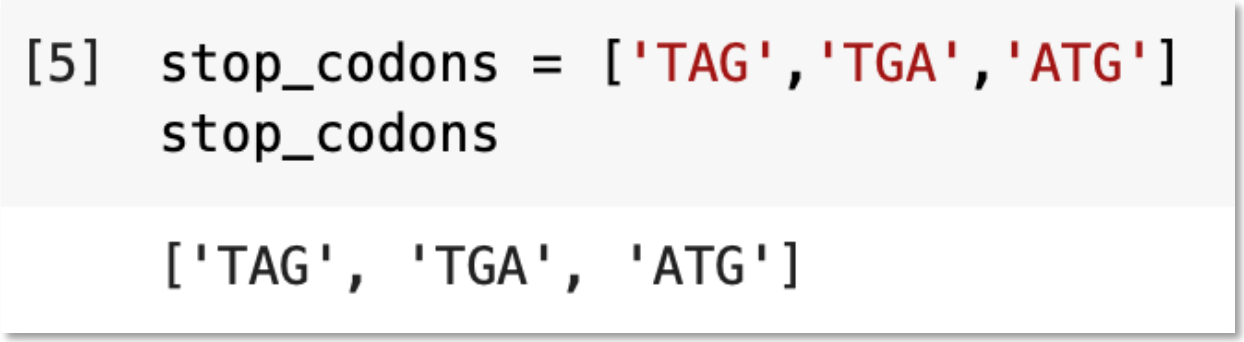
list.sort()

list.reverse()

Note: These **functions** are used similarly to **string** objects!

Let’s fix our stop_codons lists

What is wrong with the stop_codons list?



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[5]  stop_codons = ['TAG','TGA','ATG']
     stop_codons

     ['TAG', 'TGA', 'ATG']
```

Let’s fix our stop_codons lists

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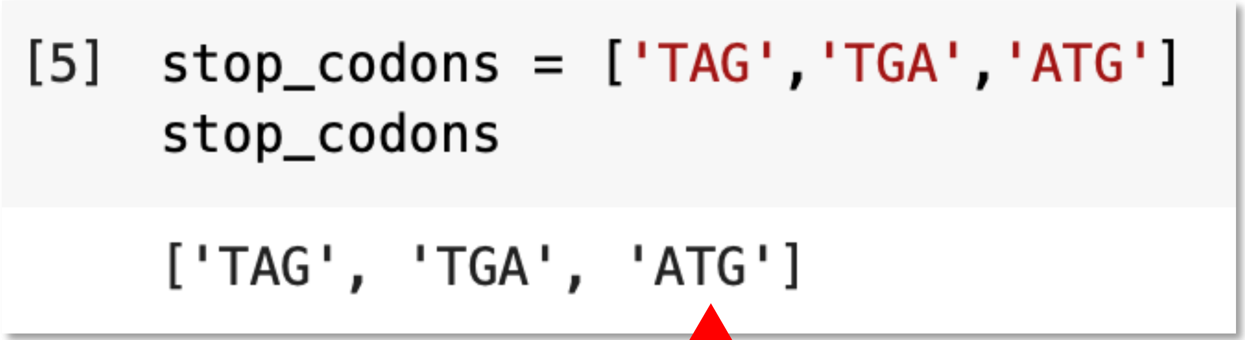


```
[5]  stop_codons = ['TAG','TGA','ATG']
     stop_codons
```

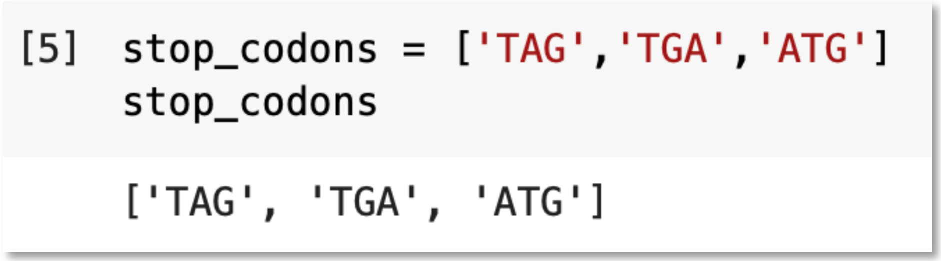
```
     ['TAG', 'TGA', 'ATG']
```

TAA ?

Not a stop codon

Let’s fix our stop_codons lists

How should we fix this?



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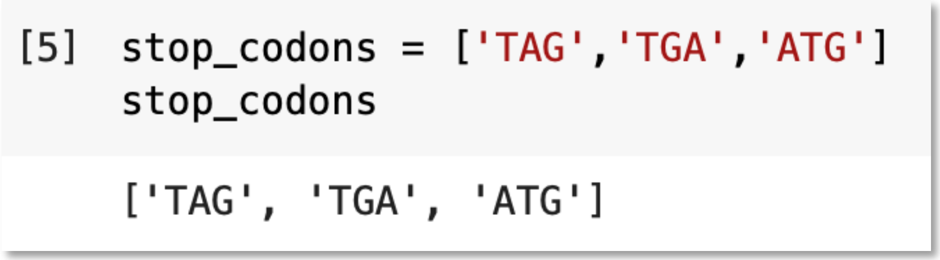
[5]  stop_codons = ['TAG','TGA','ATG']
     stop_codons

     ['TAG', 'TGA', 'ATG']
```

Answer

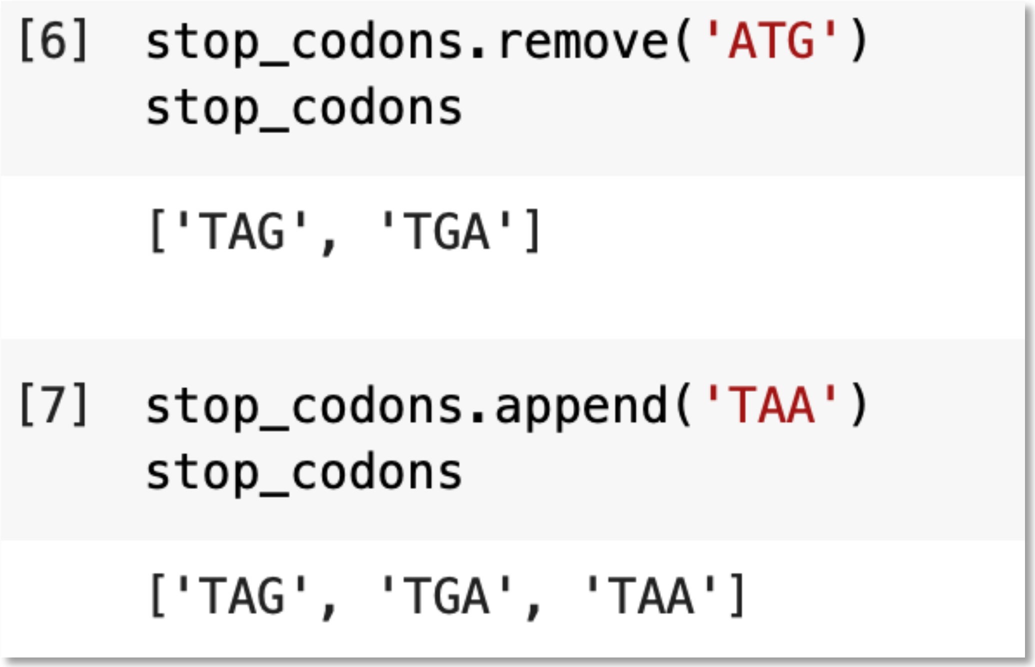
Let’s fix our stop_codons lists

How should we fix this?



```
[5]  stop_codons = ['TAG','TGA','ATG']
     stop_codons

     ['TAG', 'TGA', 'ATG']
```



```
[6]  stop_codons.remove('ATG')
     stop_codons

     ['TAG', 'TGA']

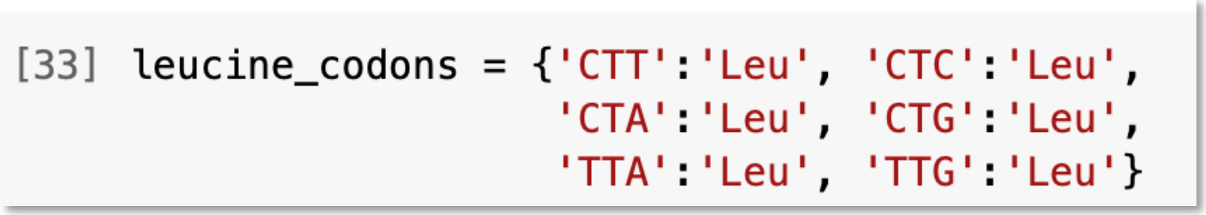
[7]  stop_codons.append('TAA')
     stop_codons

     ['TAG', 'TGA', 'TAA']
```

Lesson 2.1.2
Dictionaries

Starting a dictionary

Method 1: Create a dictionary with items

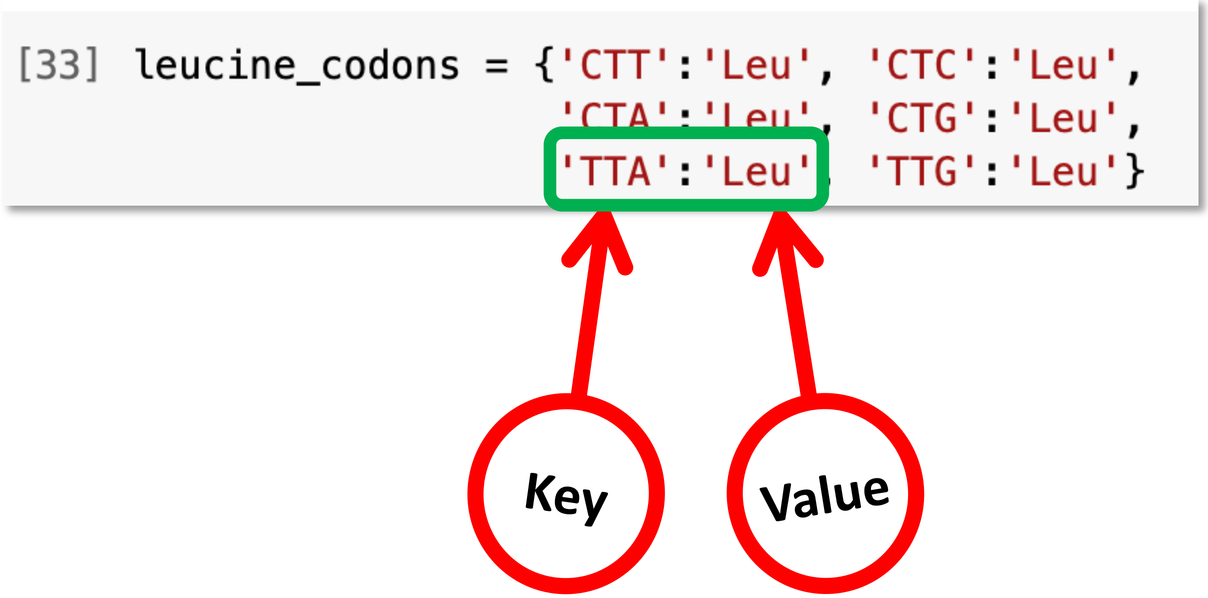


```
[33]  leucine_codons = {'CTT':'Leu', 'CTC':'Leu',
                        'CTA':'Leu', 'CTG':'Leu',
                        'TTA':'Leu', 'TTG':'Leu'}
```

An array of association that stores a key and its value and is represented by a colon

Starting a dictionary

Method 1: Create a dictionary with items



```
[33] leucine_codons = {'CTT':'Leu', 'CTC':'Leu',
                       'CTA':'Leu', 'CTG':'Leu',
                       'TTA':'Leu', 'TTG':'Leu'}
```

An array of association that stores a key and its value and is represented by a colon

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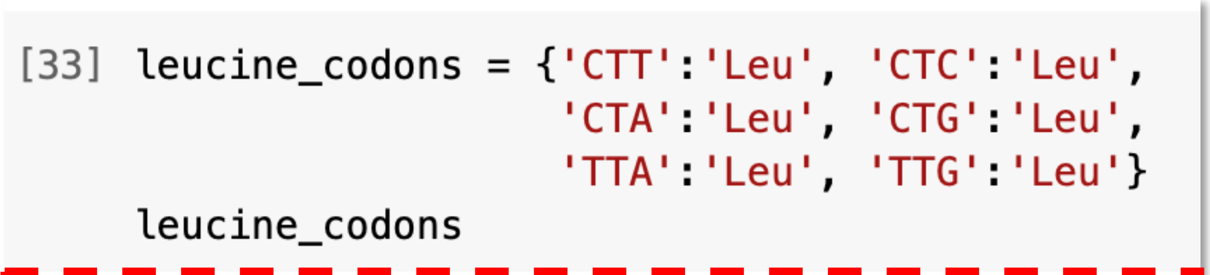


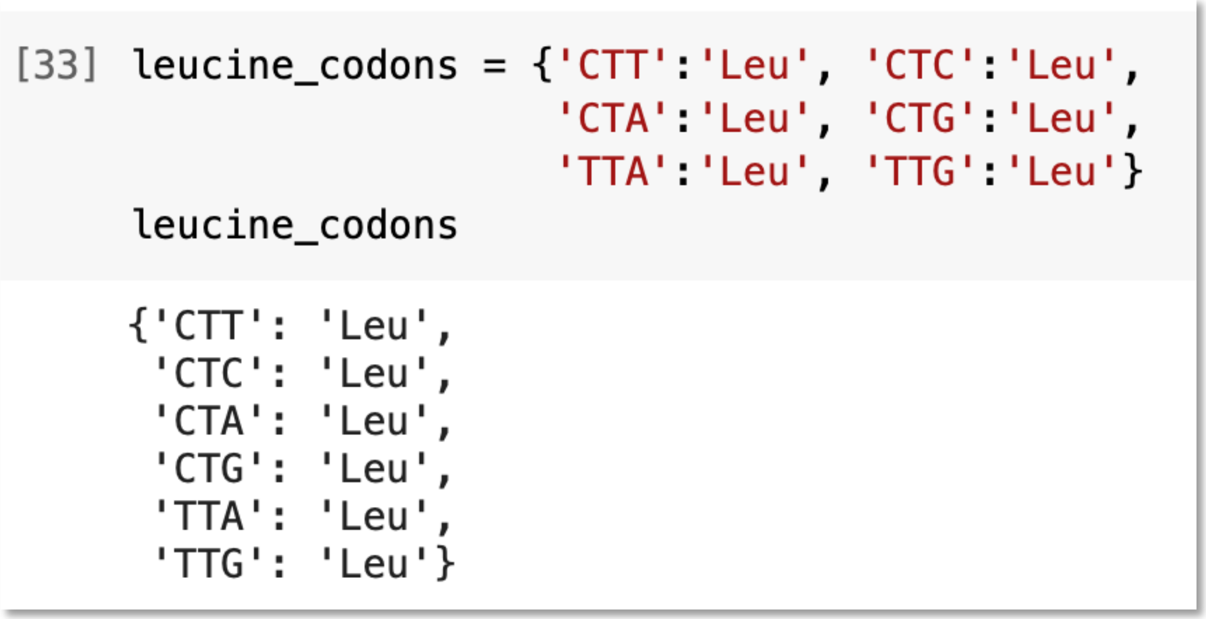
```
[33] leucine_codons = {'CTT':'Leu', 'CTC':'Leu',
                       'CTA':'Leu', 'CTG':'Leu',
                       'TTA':'Leu', 'TTG':'Leu'}
     leucine_codons
```

Answer

An array of association that stores a key and its value and is represented by a colon

Starting a dictionary

Method 1: Create a dictionary with items



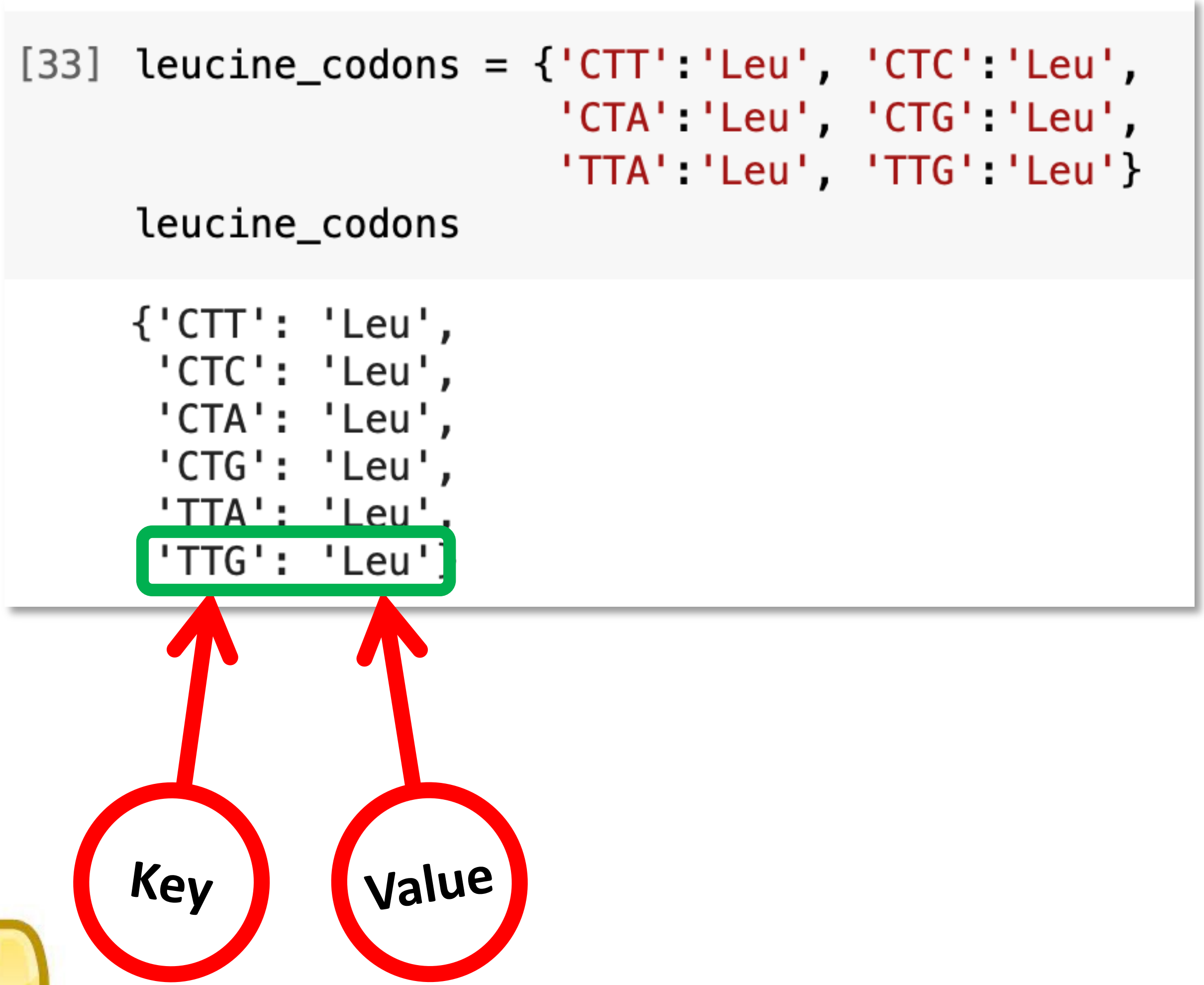
```
[33] leucine_codons = {'CTT':'Leu', 'CTC':'Leu',
                       'CTA':'Leu', 'CTG':'Leu',
                       'TTA':'Leu', 'TTG':'Leu'}
     leucine_codons
```

```
     {'CTT': 'Leu',
      'CTC': 'Leu',
      'CTA': 'Leu',
      'CTG': 'Leu',
      'TTA': 'Leu',
      'TTG': 'Leu'}
```

An array of association that stores a key and its value and is represented by a colon

Starting a dictionary

Method 1: Create a dictionary with items



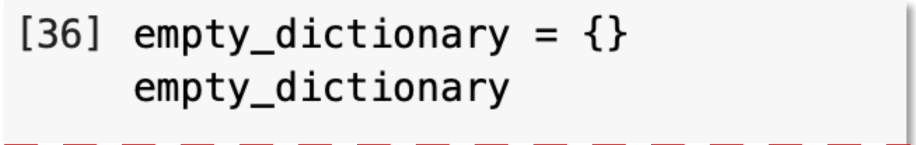
```
[33] leucine_codons = {'CTT':'Leu', 'CTC':'Leu',
                       'CTA':'Leu', 'CTG':'Leu',
                       'TTA':'Leu', 'TTG':'Leu'}
     leucine_codons

     {'CTT': 'Leu',
      'CTC': 'Leu',
      'CTA': 'Leu',
      'CTG': 'Leu',
      'TTA': 'Leu',
      'TTG': 'Leu'}
```

An array of association that stores a key and its value and is represented by a colon

Starting a dictionary

Method 2: Add elements to an empty/existing the dictionary

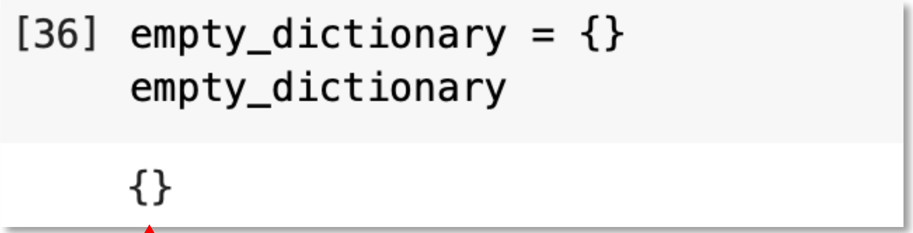


```
[36] empty_dictionary = {}
     empty_dictionary
```

Answer

Starting a dictionary

Method 2: Add elements to an empty/existing the dictionary



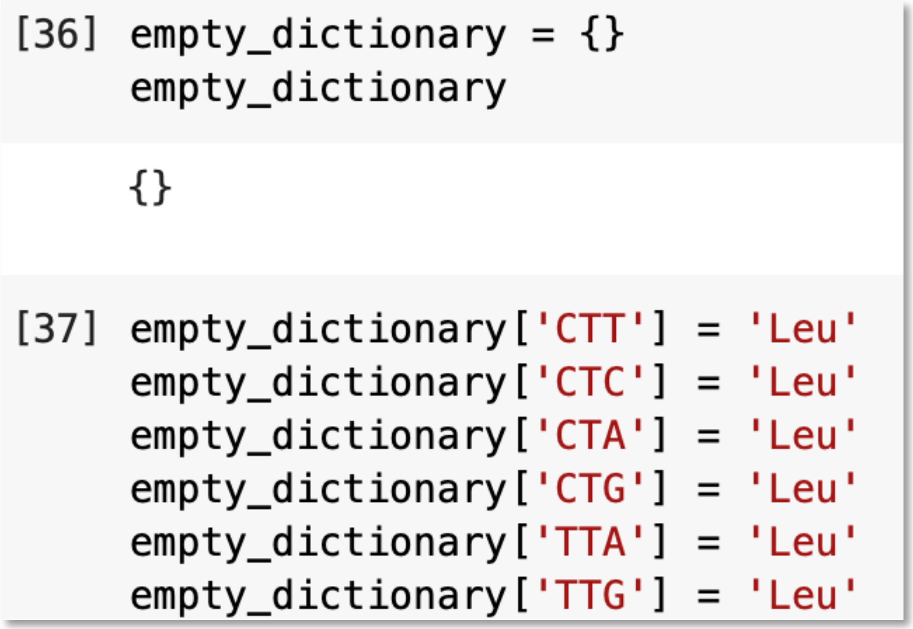
```
[36] empty_dictionary = {}
     empty_dictionary

     {}
```

Empty dictionary

Adding elements to a dictionary

Method 2: Add elements to an empty/existing the dictionary



```
[36] empty_dictionary = {}
     empty_dictionary

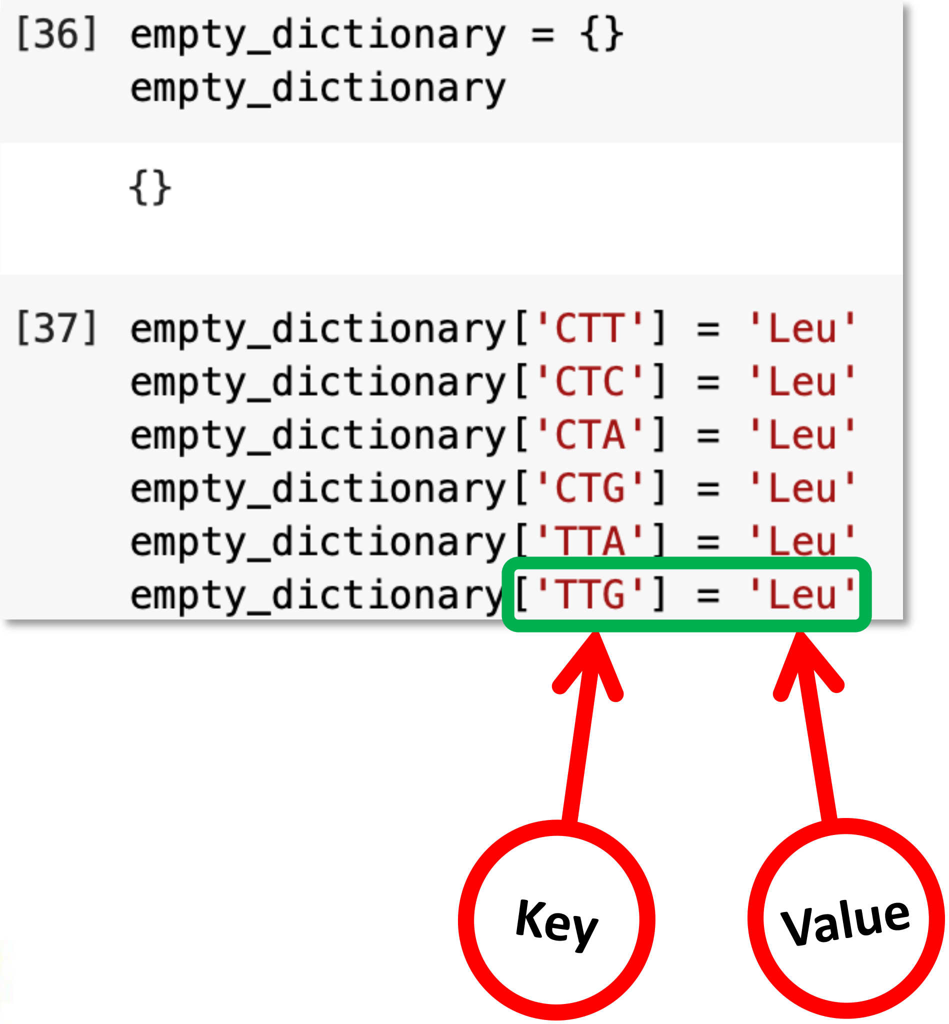
     {}

[37] empty_dictionary['CTT'] = 'Leu'
     empty_dictionary['CTC'] = 'Leu'
     empty_dictionary['CTA'] = 'Leu'
     empty_dictionary['CTG'] = 'Leu'
     empty_dictionary['TTA'] = 'Leu'
     empty_dictionary['TTG'] = 'Leu'
```

Note: the value of a key can be any data type which include strings, integers, floats, lists, or nested dictionaries

Adding elements to a dictionary

Method 2: Add elements to an empty/existing the dictionary



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[36] empty_dictionary = {}
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     {}

[37] empty_dictionary['CTT'] = 'Leu'
     empty_dictionary['CTC'] = 'Leu'
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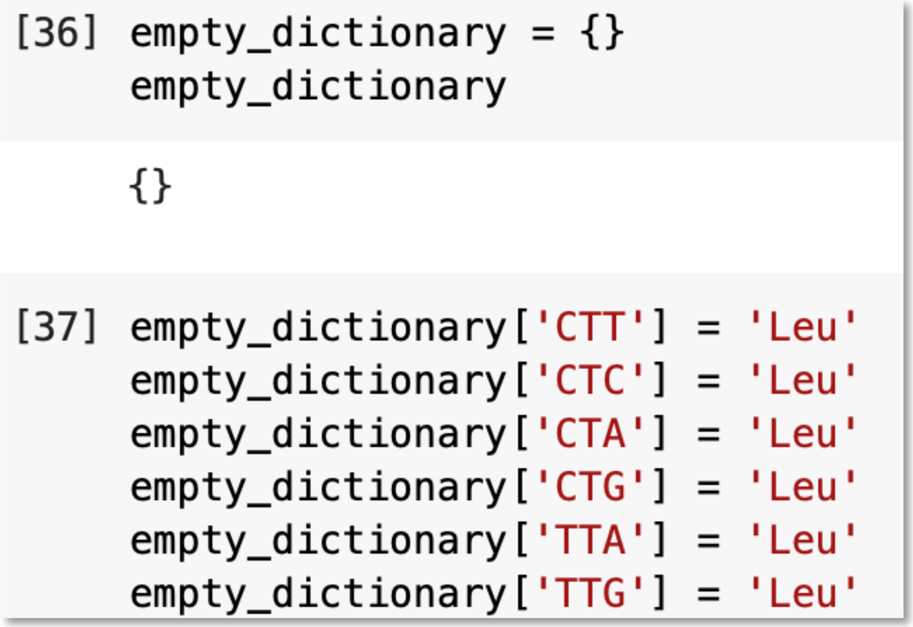
     empty_dictionary['TTG'] = 'Leu'
```

Note: the value of a key can be any data type which include strings, integers, floats, lists, or nested dictionaries

Adding elements to a dictionary

Method 2. Start an empty dictionary using curly brackets



```
[36] empty_dictionary = {}
     empty_dictionary

     {}

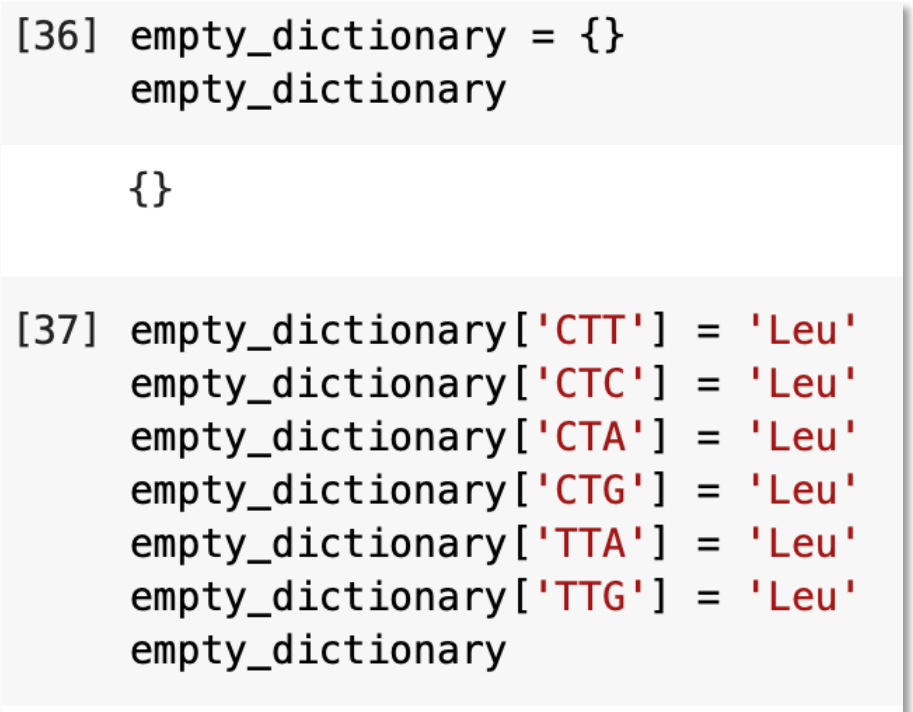
[37] empty_dictionary['CTT'] = 'Leu'
     empty_dictionary['CTC'] = 'Leu'
     empty_dictionary['CTA'] = 'Leu'
     empty_dictionary['CTG'] = 'Leu'
     empty_dictionary['TTA'] = 'Leu'
     empty_dictionary['TTG'] = 'Leu'
```

Note: the value of a key can be any data type which include strings, integers, floats, lists, or nested dictionaries

So what data type are these keys storing?

Adding elements to a dictionary

Method 2. Start an empty dictionary using curly brackets



```
[36] empty_dictionary = {}
     empty_dictionary

     {}

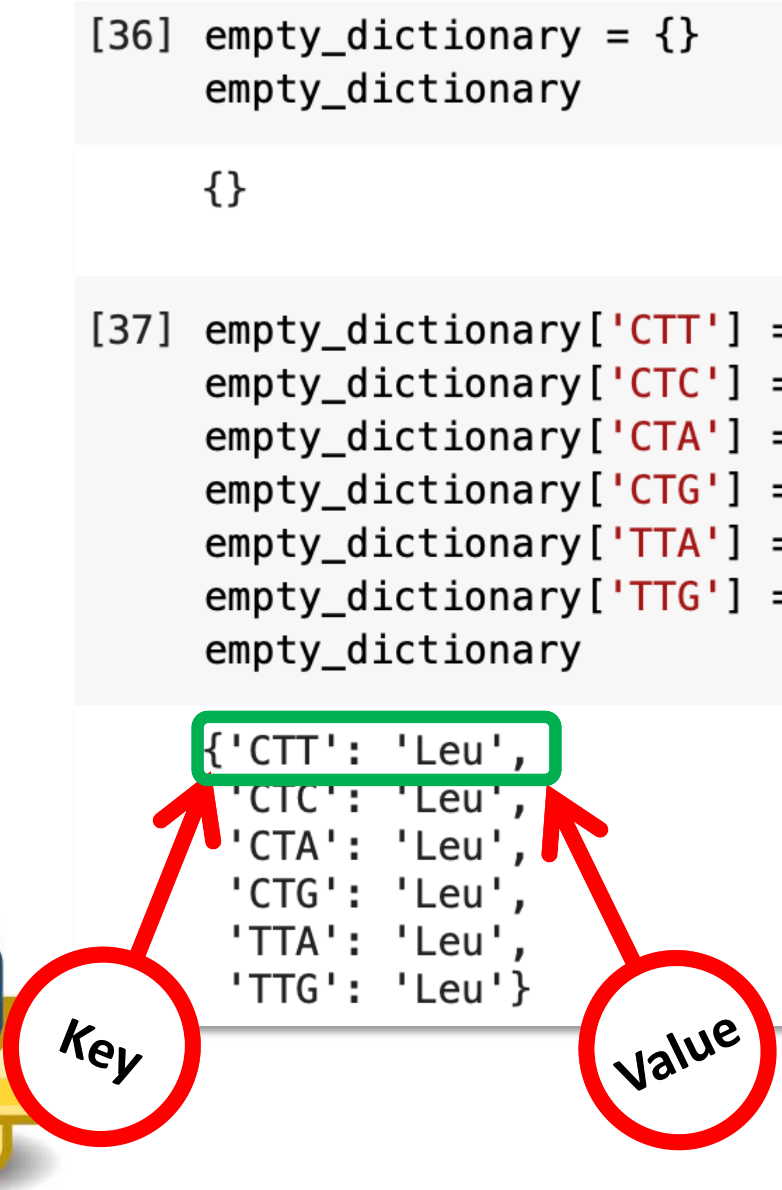
[37] empty_dictionary['CTT'] = 'Leu'
     empty_dictionary['CTC'] = 'Leu'
     empty_dictionary['CTA'] = 'Leu'
     empty_dictionary['CTG'] = 'Leu'
     empty_dictionary['TTA'] = 'Leu'
     empty_dictionary['TTG'] = 'Leu'
     empty_dictionary
```

Answer

Note: the value of a key can be any data type which include strings, integers, floats, lists, or nested dictionaries

Adding elements to a dictionary

Method 2. Start an empty dictionary using curly brackets



```
[36] empty_dictionary = {}
     empty_dictionary

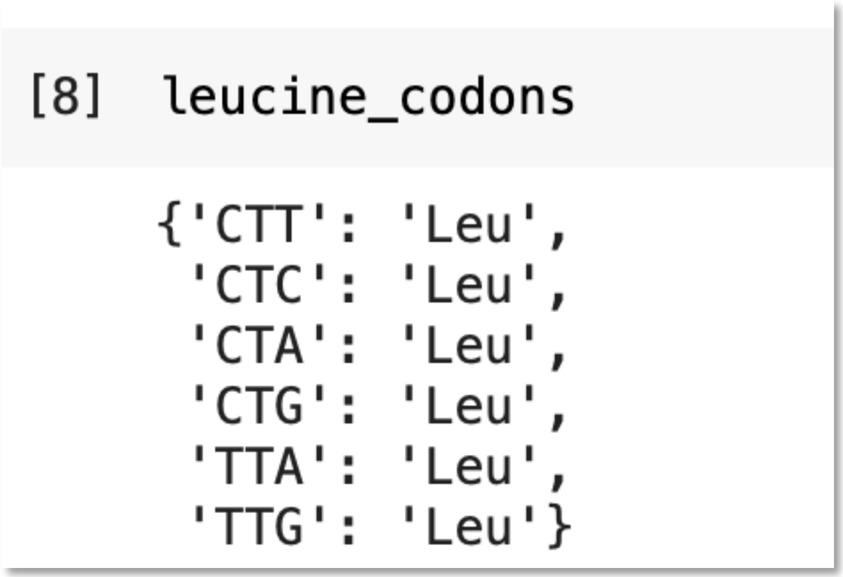
     {}
```

```
[37] empty_dictionary['CTT'] = 'Leu'
     empty_dictionary['CTC'] = 'Leu'
     empty_dictionary['CTA'] = 'Leu'
     empty_dictionary['CTG'] = 'Leu'
     empty_dictionary['TTA'] = 'Leu'
     empty_dictionary['TTG'] = 'Leu'
     empty_dictionary

     {'CTT': 'Leu',
      'CTC': 'Leu',
      'CTA': 'Leu',
      'CTG': 'Leu',
      'TTA': 'Leu',
      'TTG': 'Leu'}
```

Note: the value of a key can be any data type which include strings, integers, floats, lists, or nested dictionaries

How to use a dictionary

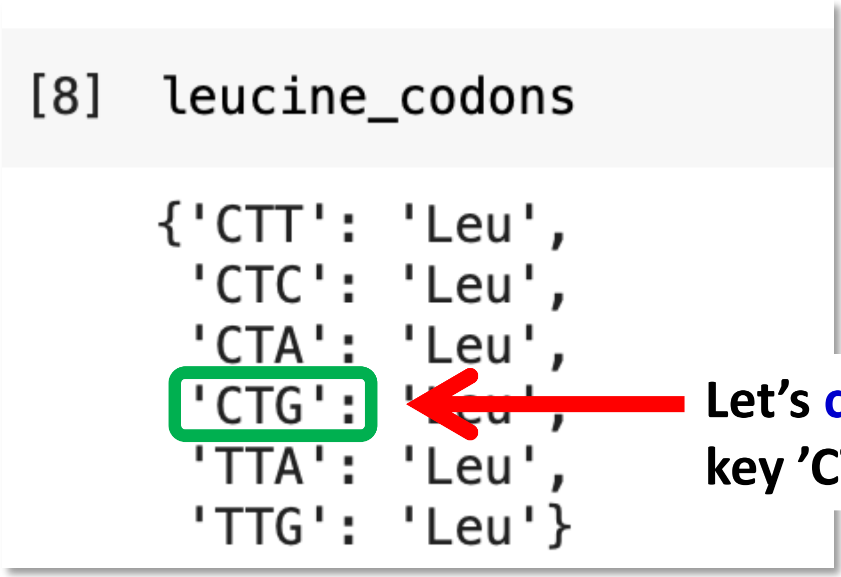


```
[8]  leucine_codons

     {'CTT': 'Leu',
      'CTC': 'Leu',
      'CTA': 'Leu',
      'CTG': 'Leu',
      'TTA': 'Leu',
      'TTG': 'Leu'}
```

Note: Calling a key returns its value

How to use a dictionary



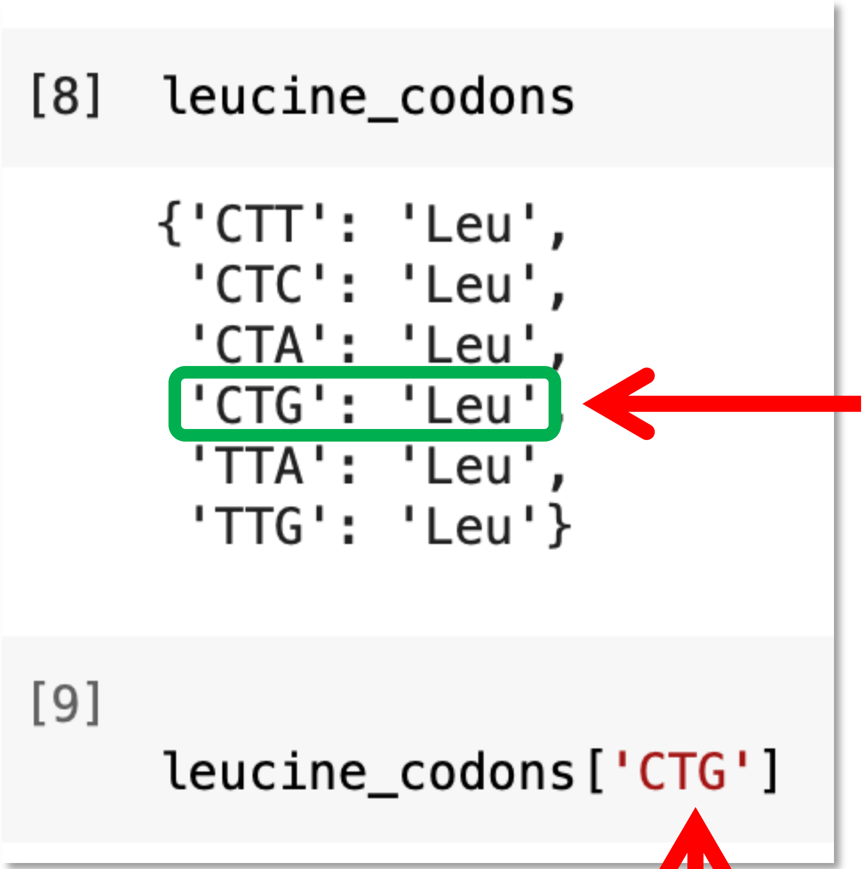
```
[8]  leucine_codons

     {'CTT': 'Leu',
      'CTC': 'Leu',
      'CTA': 'Leu',
      'CTG': 'Leu',
      'TTA': 'Leu',
      'TTG': 'Leu'}
```

Note: Calling a key returns its value

Let’s call (find/consult) the key ’CTG’

How to use a dictionary



```
[8]  leucine_codons
```

```
     {'CTT': 'Leu',
      'CTC': 'Leu',
      'CTA': 'Leu',
      'CTG': 'Leu',
      'TTA': 'Leu',
      'TTG': 'Leu'}
```

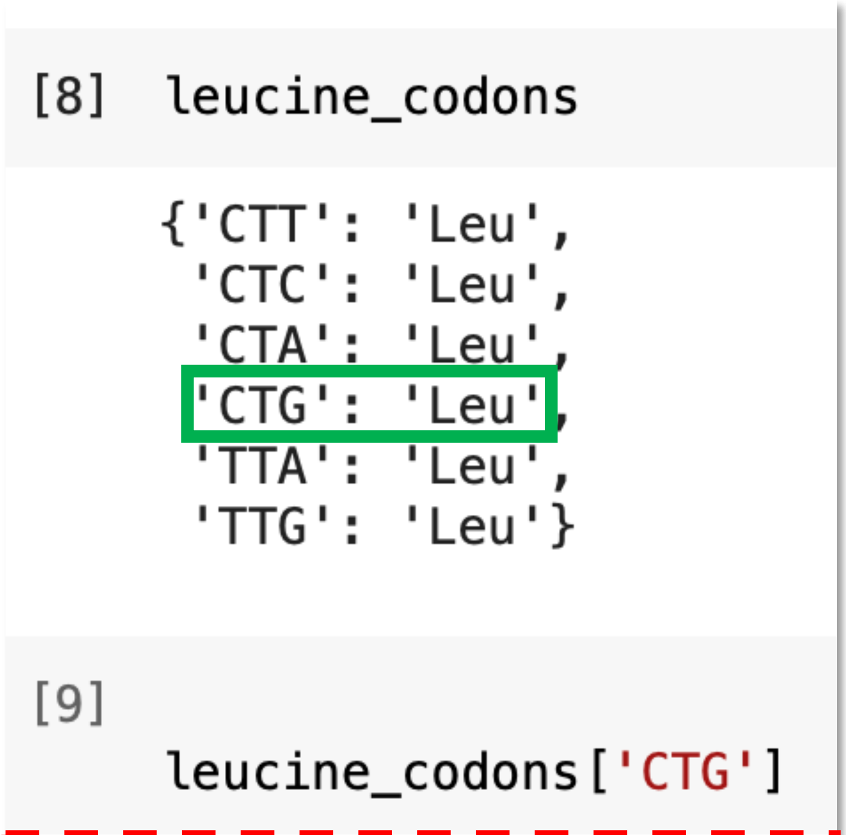
```
[9]
     leucine_codons['CTG']
```

Note: Calling a key returns its value

Let’s call (find/consult) the key ’CTG’

1

How to use a dictionary



```
[8]  leucine_codons

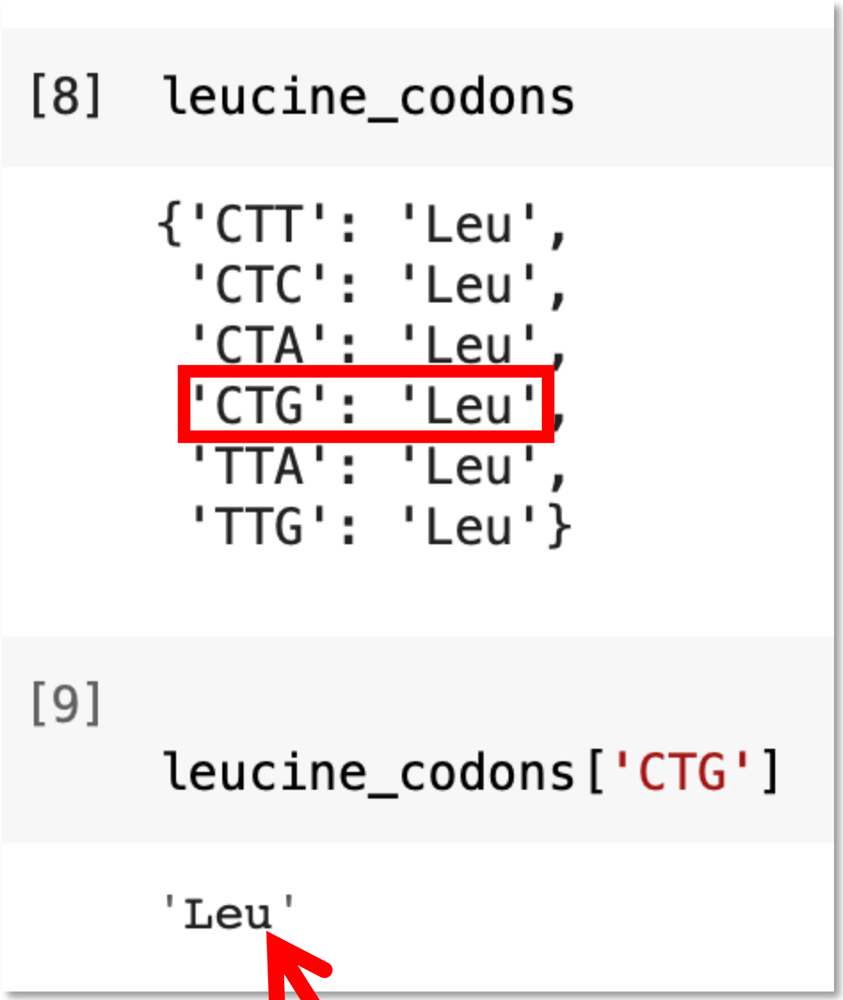
     {'CTT': 'Leu',
      'CTC': 'Leu',
      'CTA': 'Leu',
      'CTG': 'Leu',
      'TTA': 'Leu',
      'TTG': 'Leu'}

[9]
     leucine_codons['CTG']
```

Answer

Note: Calling a key returns (produces/result) its value

How to use a dictionary



```
[8]  leucine_codons

     {'CTT': 'Leu',
      'CTC': 'Leu',
      'CTA': 'Leu',
      'CTG': 'Leu',
      'TTA': 'Leu',
      'TTG': 'Leu'}

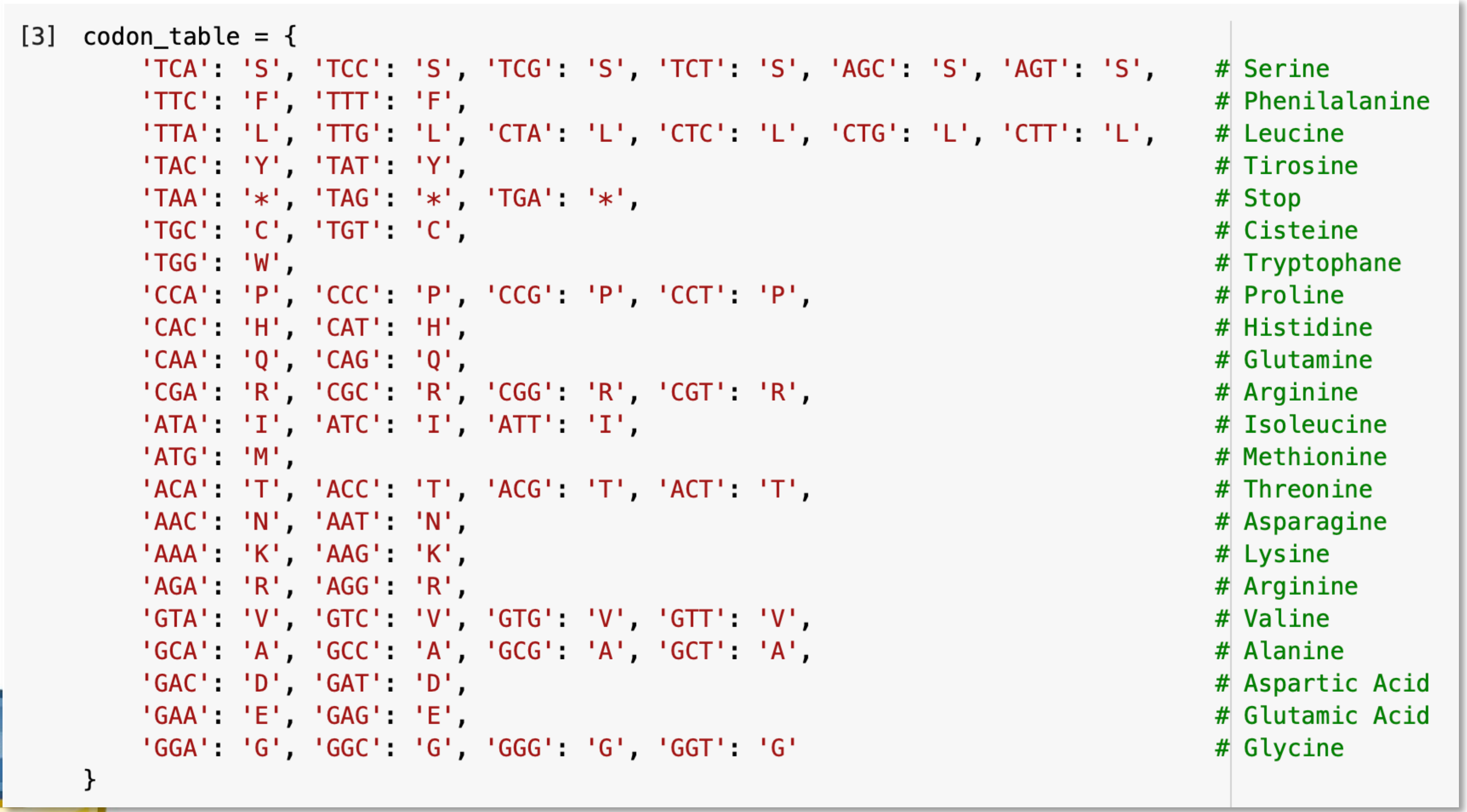
[9]
     leucine_codons['CTG']

     'Leu'
```

2

Note: Calling a key returns (produces/result) its value

A dictionary with all codons and their associated amino acid can be used to translate a protein-coding sequence



```
[3]  codon_table = {
         'TCA': 'S', 'TCC': 'S', 'TCG': 'S', 'TCT': 'S', 'AGC': 'S', 'AGT': 'S',    # Serine
         'TTC': 'F', 'TTT': 'F',                                                    # Phenilalanine
         'TTA': 'L', 'TTG': 'L', 'CTA': 'L', 'CTC': 'L', 'CTG': 'L', 'CTT': 'L',    # Leucine
         'TAC': 'Y', 'TAT': 'Y',                                                    # Tirosine
         'TAA': '*', 'TAG': '*', 'TGA': '*',                                        # Stop
         'TGC': 'C', 'TGT': 'C',                                                    # Cisteine
         'TGG': 'W',                                                                # Tryptophane
         'CCA': 'P', 'CCC': 'P', 'CCG': 'P', 'CCT': 'P',                            # Proline
         'CAC': 'H', 'CAT': 'H',                                                    # Histidine
         'CAA': 'Q', 'CAG': 'Q',                                                    # Glutamine
         'CGA': 'R', 'CGC': 'R', 'CGG': 'R', 'CGT': 'R',                            # Arginine
         'ATA': 'I', 'ATC': 'I', 'ATT': 'I',                                        # Isoleucine
         'ATG': 'M',                                                                # Methionine
         'ACA': 'T', 'ACC': 'T', 'ACG': 'T', 'ACT': 'T',                            # Threonine
         'AAC': 'N', 'AAT': 'N',                                                    # Asparagine
         'AAA': 'K', 'AAG': 'K',                                                    # Lysine
         'AGA': 'R', 'AGG': 'R',                                                    # Arginine
         'GTA': 'V', 'GTC': 'V', 'GTG': 'V', 'GTT': 'V',                            # Valine
         'GCA': 'A', 'GCC': 'A', 'GCG': 'A', 'GCT': 'A',                            # Alanine
         'GAC': 'D', 'GAT': 'D',                                                    # Aspartic Acid
         'GAA': 'E', 'GAG': 'E',                                                    # Glutamic Acid
         'GGA': 'G', 'GGC': 'G', 'GGG': 'G', 'GGT': 'G'                             # Glycine
     }
```

Lesson 2.2.0
Automating repetitive tasks using Python

Lesson 2.2.1a
For Loops

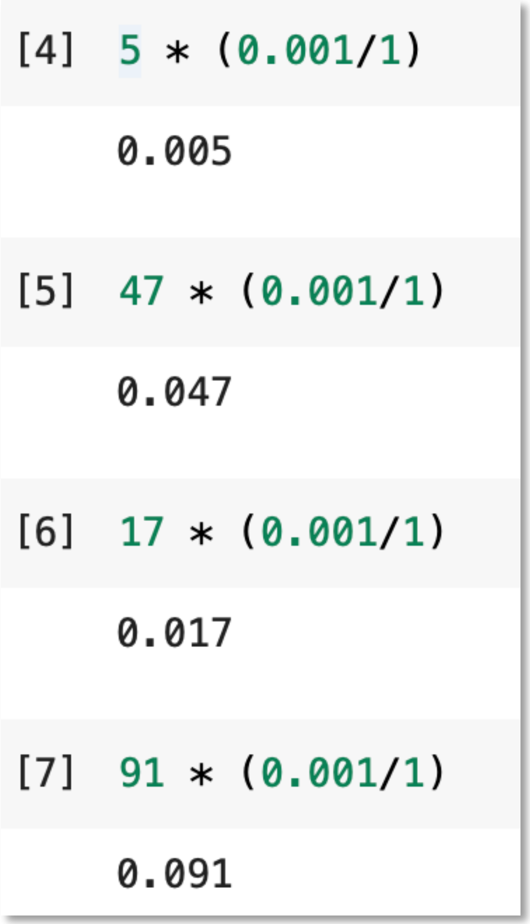
Let’s say I have a list of µL measurements that I want to convert to mL

measurement	µL	mL
0	5	?
1	47	?
2	17	?
3	91	?

Let’s say I have a list of μL measurements that I want to convert to mL

measurement	μL	mL
0	5	?
1	47	?
2	17	?
3	91	?

Solution option 1:



```
[4]  5 * (0.001/1)

     0.005

[5]  47 * (0.001/1)

     0.047

[6]  17 * (0.001/1)

     0.017

[7]  91 * (0.001/1)

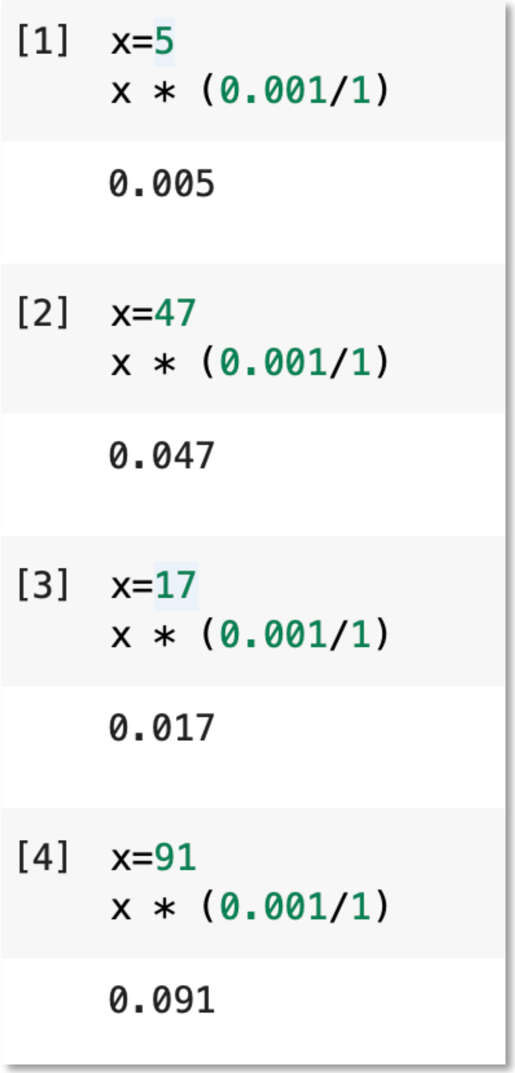
     0.091
```

Let’s say I have a list of µL measurements that I want to convert to mL

measurement	µL	mL
0	5	?
1	47	?
2	17	?
3	91	?

Solution option 2:

Create a variable x and substitute for each value



```
[1]  x=5
     x * (0.001/1)

     0.005

[2]  x=47
     x * (0.001/1)

     0.047

[3]  x=17
     x * (0.001/1)

     0.017

[4]  x=91
     x * (0.001/1)

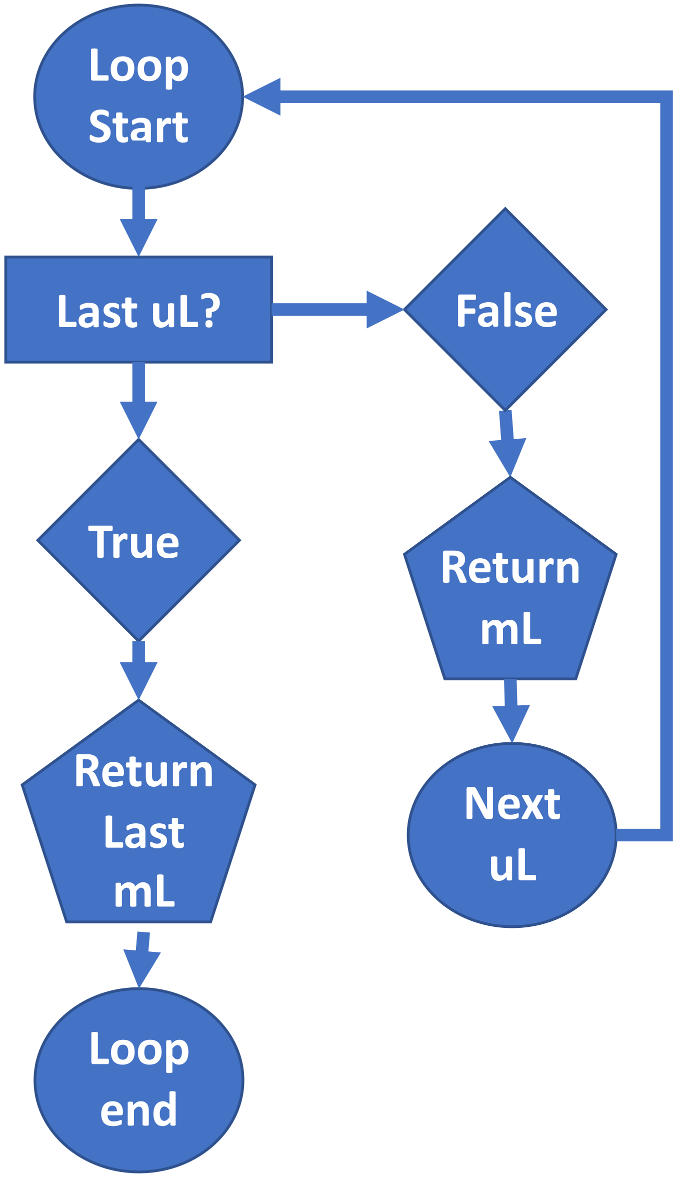
     0.091
```

What if we have a hundred μL measurements that we converted to mL?

measurement	μL	mL
0	5	?
1	47	?
2	17	?
3	91	?
.	.	?
.	.	?
.	.	?
99	77	?

What if we have a hundred μL measurements that we converted to mL?

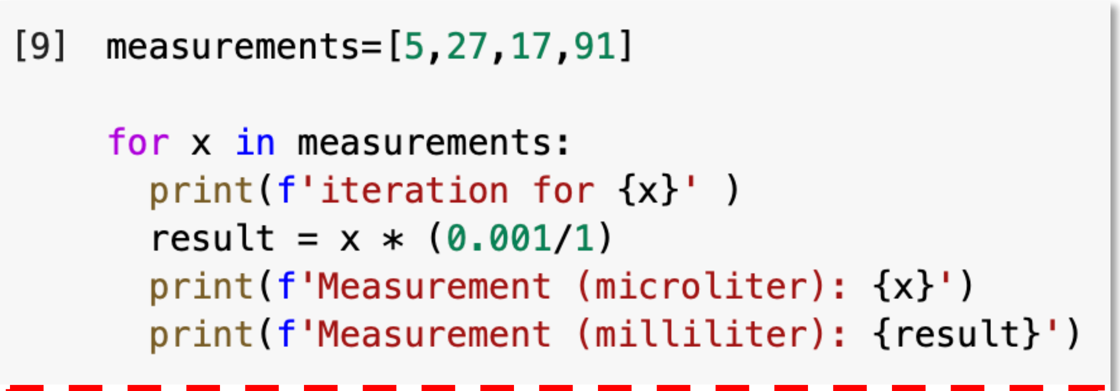
measurement	μL	mL
0	5	?
1	47	?
2	17	?
3	91	?
.	.	?
.	.	?
.	.	?
99	77	?



Let’s say I have a list of µL measurements that I want to convert to mL

measurement	µL	mL
0	5	?
1	47	?
2	17	?
3	91	?

Solution option 3:



```
[9]  measurements=[5,27,17,91]

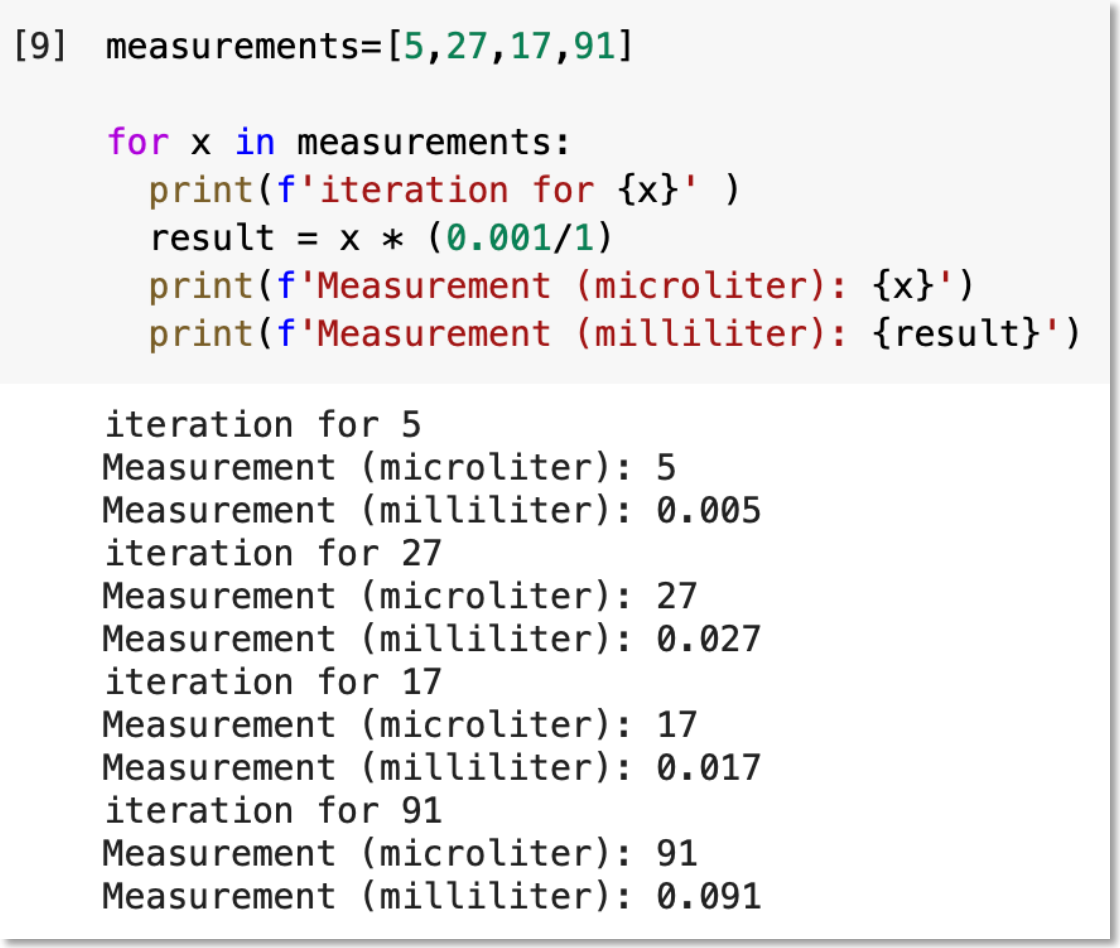
     for x in measurements:
       print(f'iteration for {x}' )
       result = x * (0.001/1)
       print(f'Measurement (microliter): {x}')
       print(f'Measurement (milliliter): {result}')
```

Answer

Let’s say I have a list of μL measurements that I want to convert to mL

measurement	μL	mL
0	5	?
1	47	?
2	17	?
3	91	?

Solution option 3:



```
[9]  measurements=[5,27,17,91]

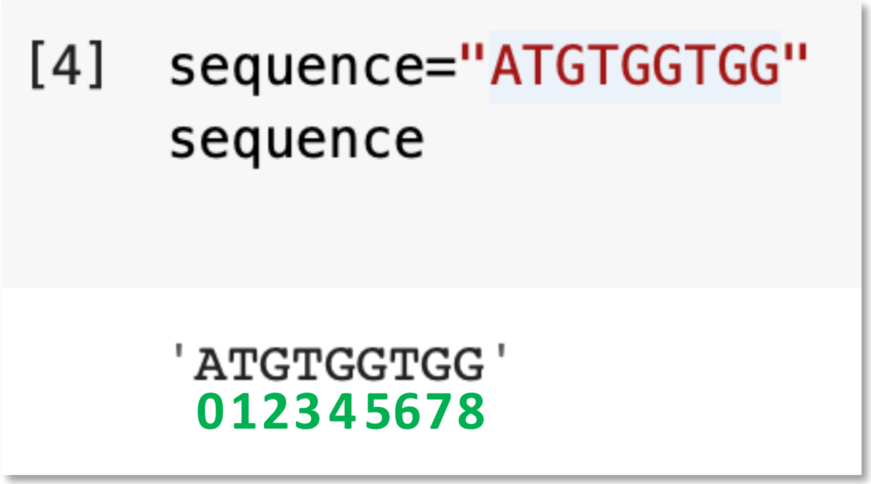
     for x in measurements:
       print(f'iteration for {x}' )
       result = x * (0.001/1)
       print(f'Measurement (microliter): {x}')
       print(f'Measurement (milliliter): {result}')
```

```
     iteration for 5
     Measurement (microliter): 5
     Measurement (milliliter): 0.005
     iteration for 27
     Measurement (microliter): 27
     Measurement (milliliter): 0.027
     iteration for 17
     Measurement (microliter): 17
     Measurement (milliliter): 0.017
     iteration for 91
     Measurement (microliter): 91
     Measurement (milliliter): 0.091
```

Lesson 2.2.1b

Exploit information from sequences using For loops

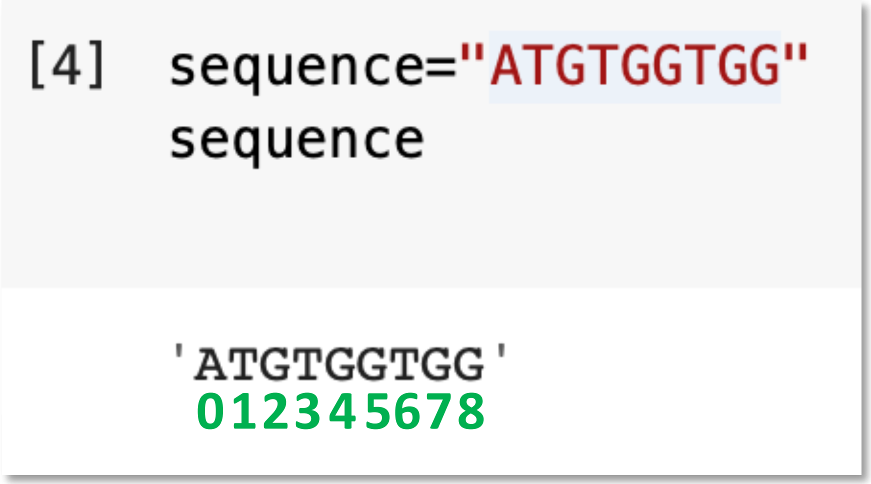
Can we For loop through a string that is a sequence?



```
[4]  sequence="ATGTGGTGG"
     sequence
```

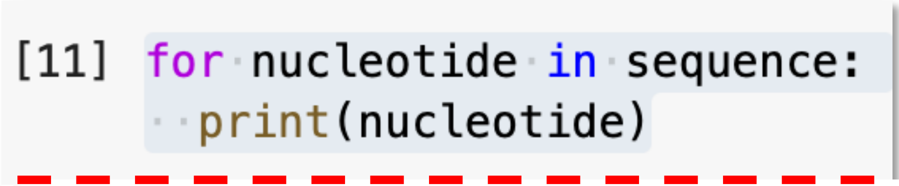
```
'ATGTGGTGG'
 012345678
```

Can we For loop through a string that is a sequence?



```
[4]  sequence="ATGTGGTGG"
     sequence

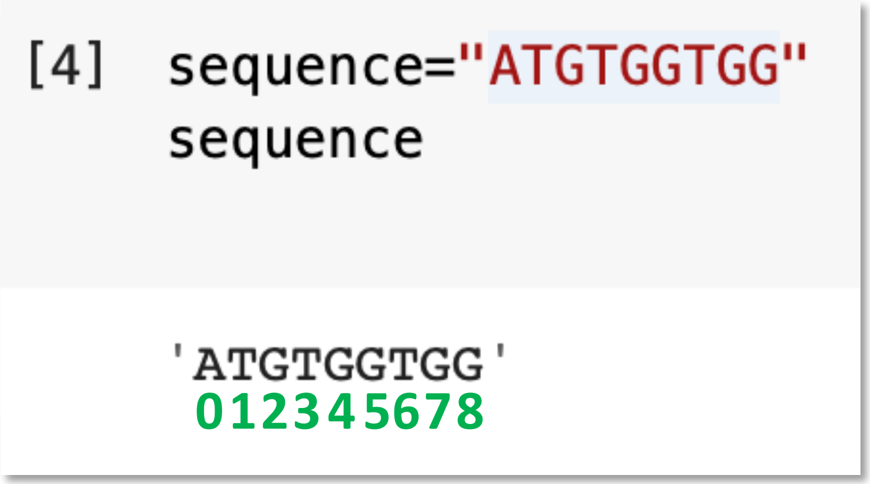
     'ATGTGGTGG'
      012345678
```



```
[11] for nucleotide in sequence:
       print(nucleotide)
```

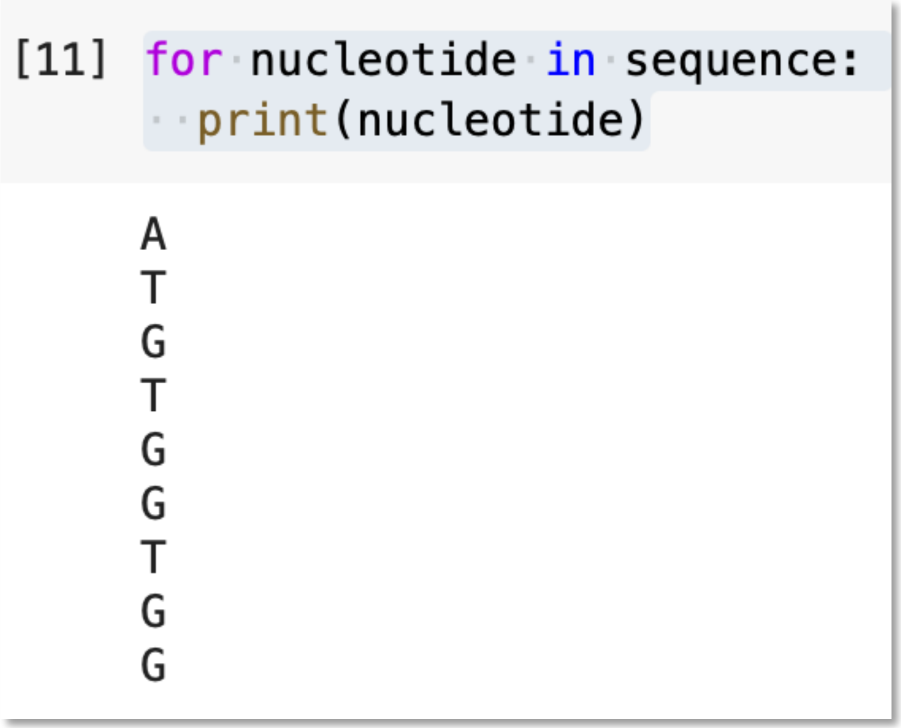
Answer

Can we For loop through a string that is a sequence?



```
[4]  sequence="ATGTGGTGG"
     sequence

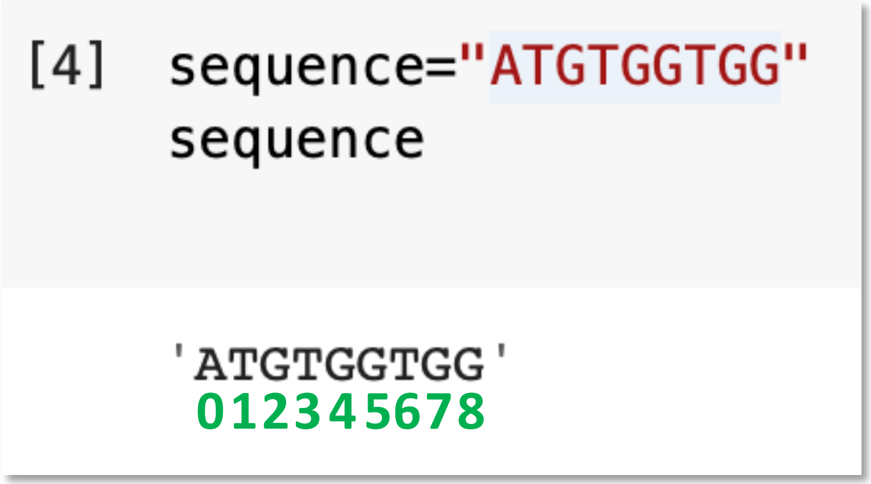
     'ATGTGGTGG'
      012345678
```



```
[11] for nucleotide in sequence:
       print(nucleotide)

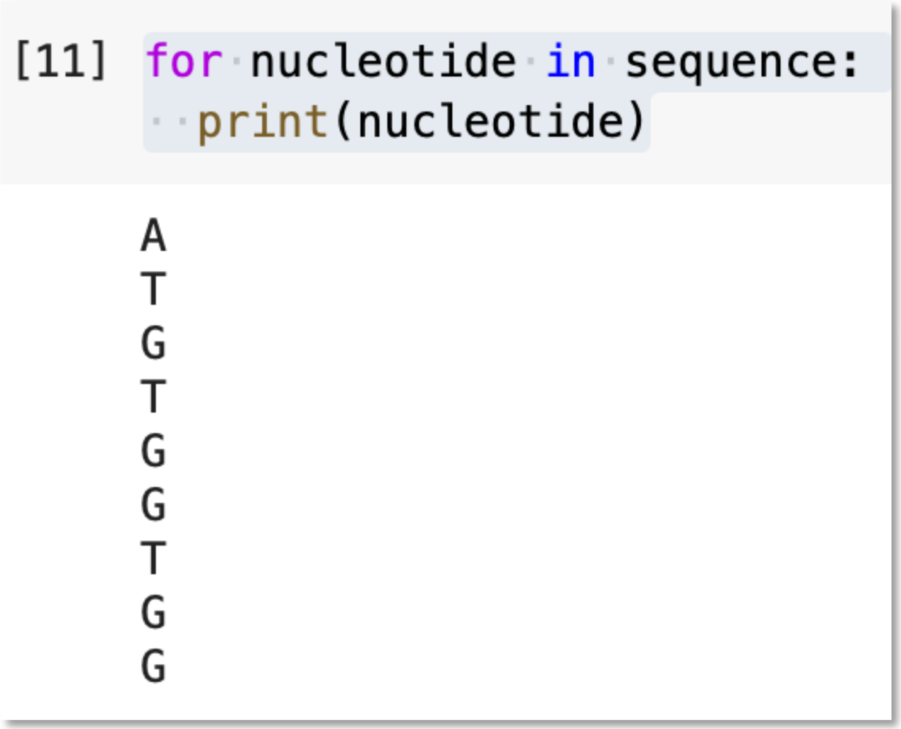
     A
     T
     G
     T
     G
     G
     T
     G
     G
```

For looping through a string that is a sequence?



```
[4]  sequence="ATGTGGTGG"
     sequence

     'ATGTGGTGG'
      012345678
```



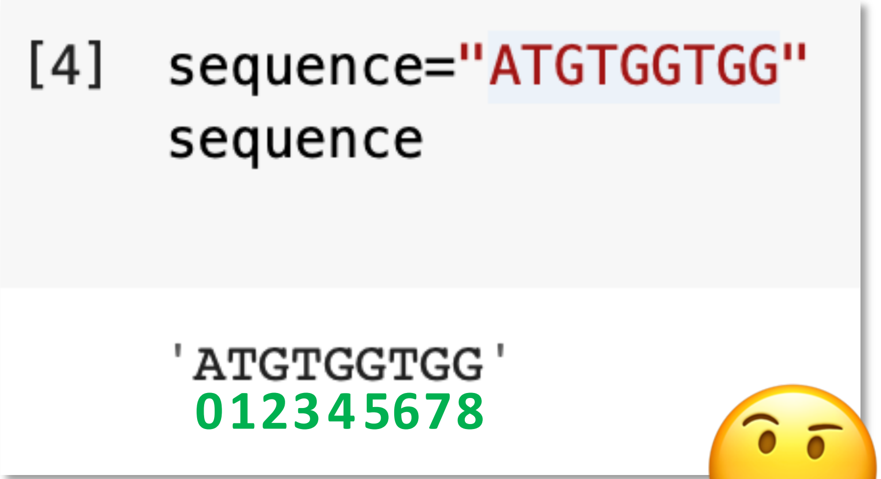
```
[11] for nucleotide in sequence:
       print(nucleotide)

     A
     T
     G
     T
     G
     G
     T
     G
     G
```

What if we need to use the indexes of this sequence?

For loop through the indexes of a string that is a sequence

How would you produce indexes?

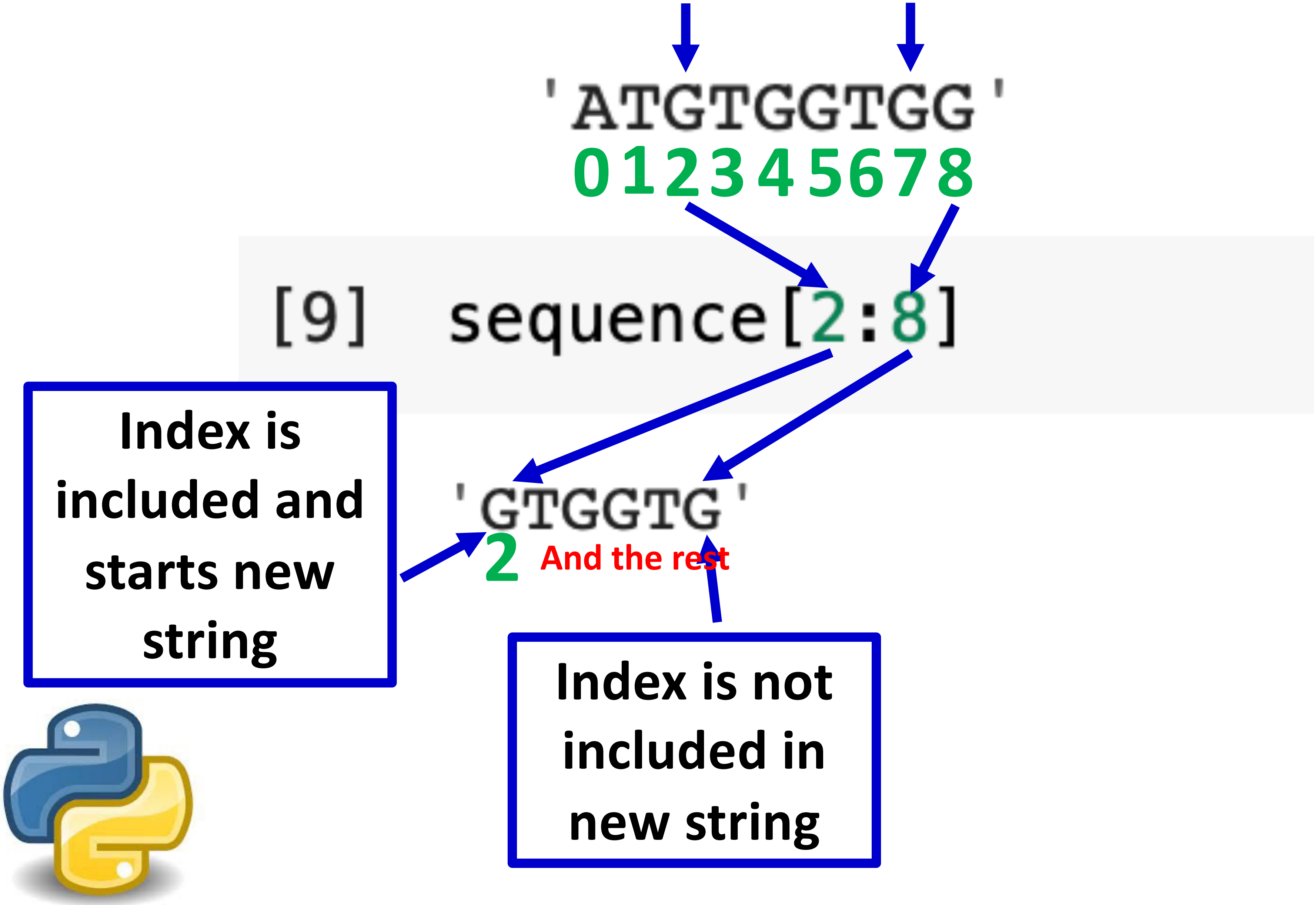


```
[4]  sequence="ATGTGGTGG"
     sequence
```

```
'ATGTGGTGG'
 012345678
```

Using indexes to slice a String

Index a range of the sequence



'ATGTGGTGG'

012345678

```
[9]  sequence[2:8]
```

'GTGGTG'

2 And the rest

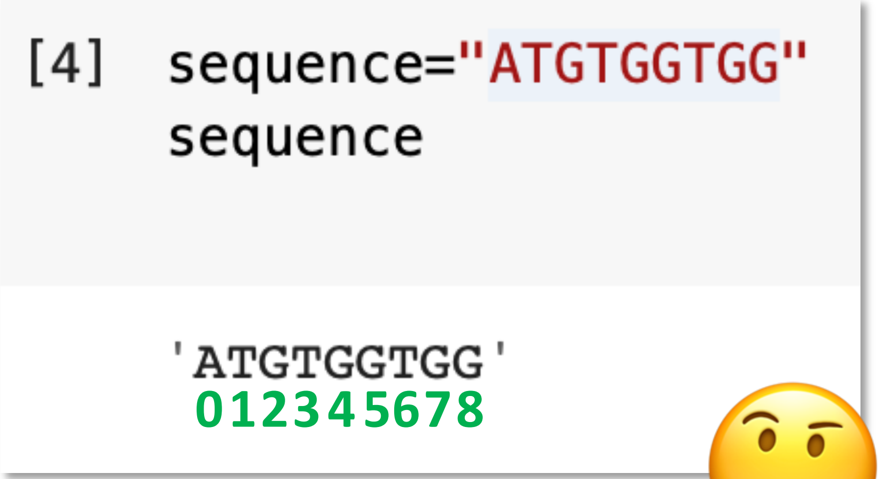
Index is included and starts new string

Index is not included in new string

For loop through the indexes of a string that is a sequence

How would you produce indexes?

Hint: a combination between range() and len()

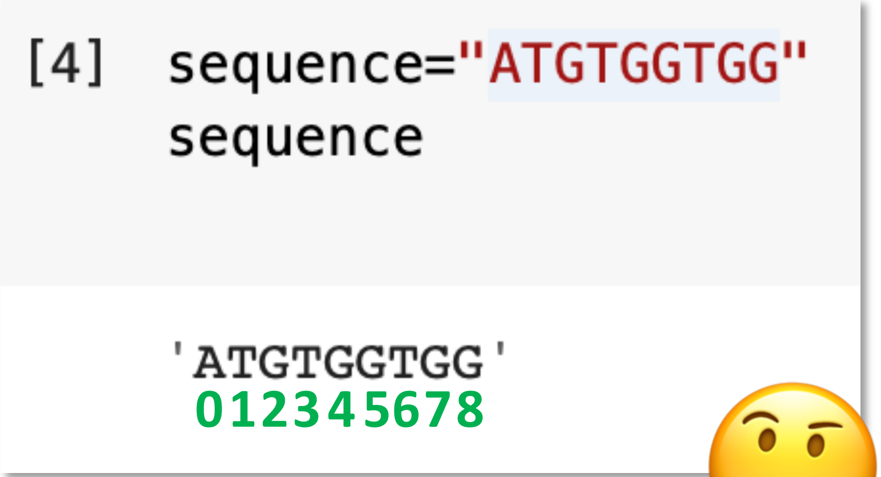


```
[4]  sequence="ATGTGGTGG"
     sequence

     'ATGTGGTGG'
      012345678
```

For loop through the indexes of a string that is a sequence

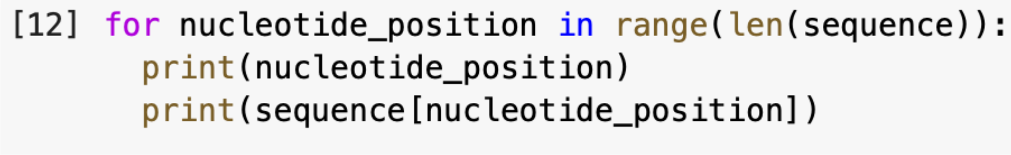
How would you produce indexes?



```
[4]  sequence="ATGTGGTGG"
     sequence

     'ATGTGGTGG'
      012345678
```

Hint: a combination between range() and len()

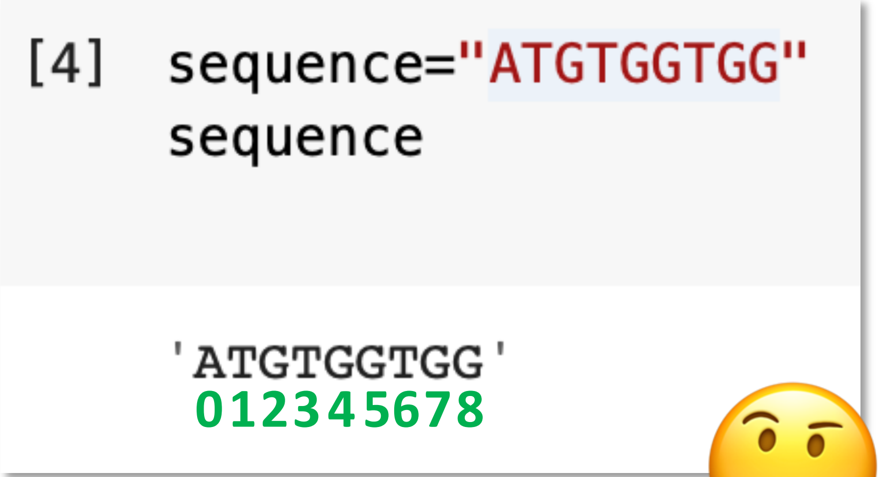


```
[12] for nucleotide_position in range(len(sequence)):
         print(nucleotide_position)
         print(sequence[nucleotide_position])
```

Answer

For loop through the indexes of a string that is a sequence

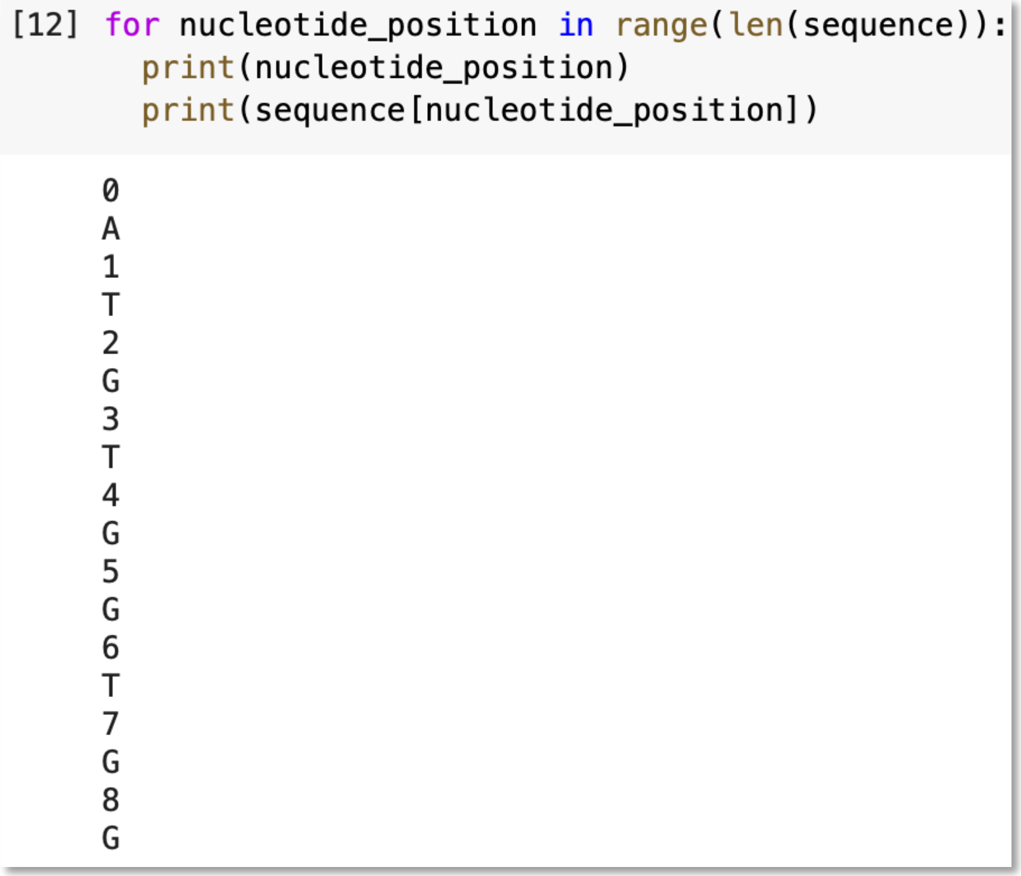
How would you produce indexes?



```
[4]  sequence="ATGTGGTGG"
     sequence
```

```
     'ATGTGGTGG'
      012345678
```

Hint: a combination between range() and len()



```
[12] for nucleotide_position in range(len(sequence)):
       print(nucleotide_position)
       print(sequence[nucleotide_position])
```

```
0
A
1
T
2
G
3
T
4
G
5
G
6
T
7
G
8
G
```

For loop through the indexes of a string that is a sequence

Do we remember how to index a range of a string?

🤔

For loop through the indexes of a string that is a sequence

How would you produce a coding sequence?

INPUT

'ATGTGGTGG'

012345678

→

OUTPUT

['AUG', 'UGG', 'UGG']

0 1 2

For loop through the indexes of a string that is a sequence

How would you produce a coding sequence?

INPUT

'ATGTGGTGG'

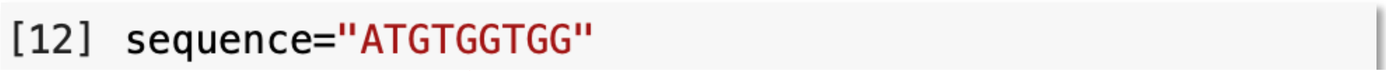
012345678

→

OUTPUT

['AUG', 'UGG', 'UGG']

0 1 2

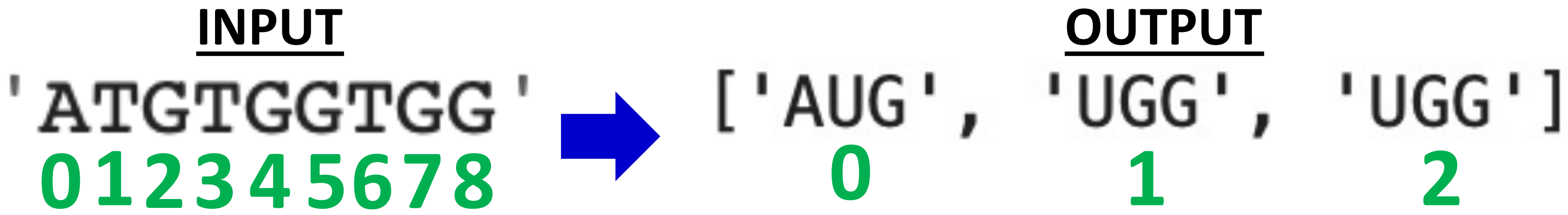


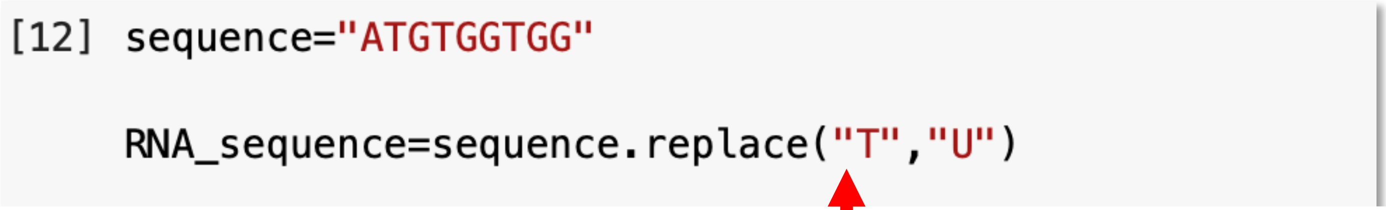
```
[12] sequence="ATGTGGTGG"
```

Identify your input sequence

For loop through the indexes of a string that is a sequence

How would you produce a coding sequence?





```
[12] sequence="ATGTGGTGG"

     RNA_sequence=sequence.replace("T","U")
```

Replace T for U in the sequence

For loop through the indexes of a string that is a sequence

How would you produce a coding sequence?

INPUT

'ATGTGGTGG'

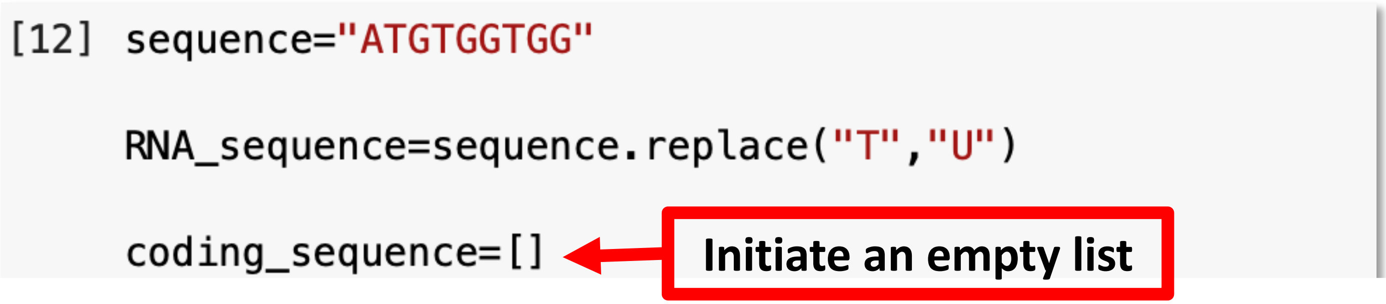
012345678

→

OUTPUT

['AUG', 'UGG', 'UGG']

0 1 2



```
[12] sequence="ATGTGGTGG"

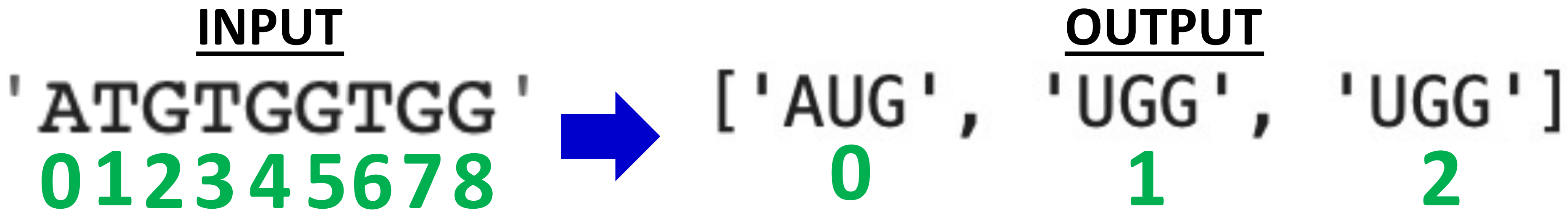
     RNA_sequence=sequence.replace("T","U")

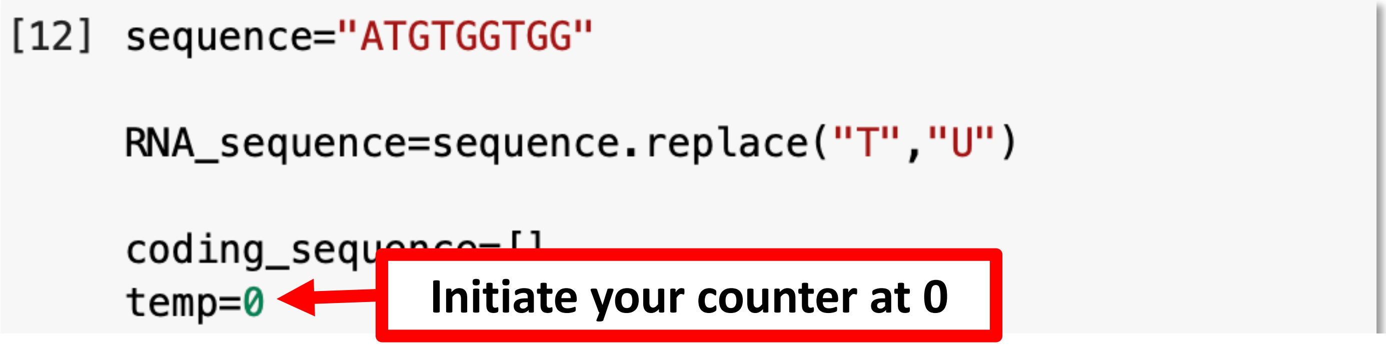
     coding_sequence=[]
```

Initiate an empty list

For loop through the indexes of a string that is a sequence

How would you produce a coding sequence?





```
[12] sequence="ATGTGGTGG"

     RNA_sequence=sequence.replace("T","U")

     coding_sequence=[]
     temp=0
```

Initiate your counter at 0

For loop through the indexes of a string that is a sequence

How would you produce a coding sequence?

INPUT

'ATGTGGTGG'

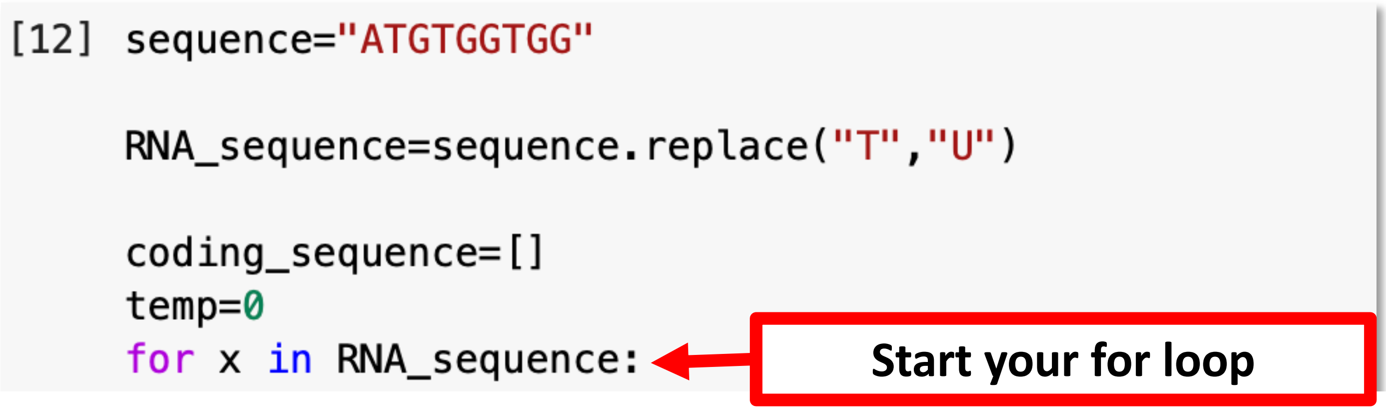
012345678

→

OUTPUT

['AUG', 'UGG', 'UGG']

0 1 2



```
[12]  sequence="ATGTGGTGG"

      RNA_sequence=sequence.replace("T","U")

      coding_sequence=[]
      temp=0
      for x in RNA_sequence:
```

Start your for loop

For loop through the indexes of a string that is a sequence

How would you produce a coding sequence?

INPUT

'ATGTGGTGG'

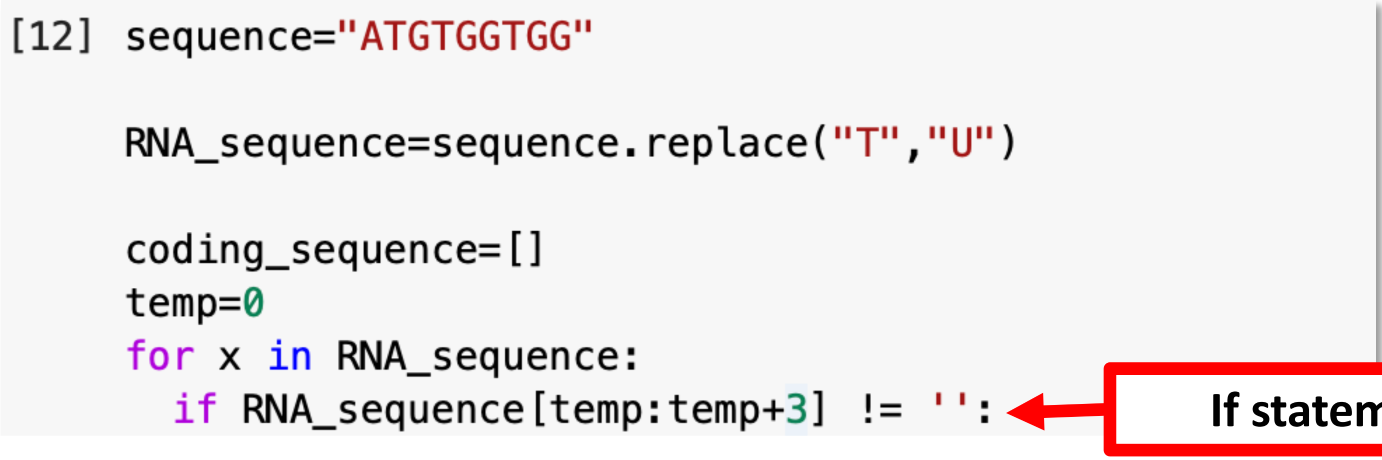
012345678

→

OUTPUT

['AUG', 'UGG', 'UGG']

0 1 2



```
[12] sequence="ATGTGGTGG"

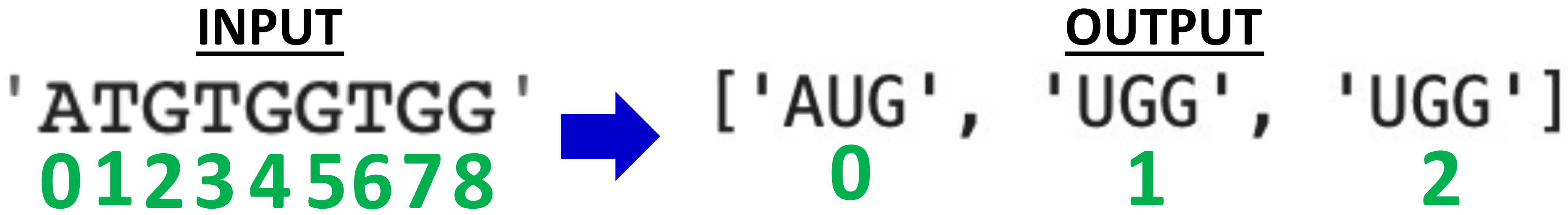
     RNA_sequence=sequence.replace("T","U")

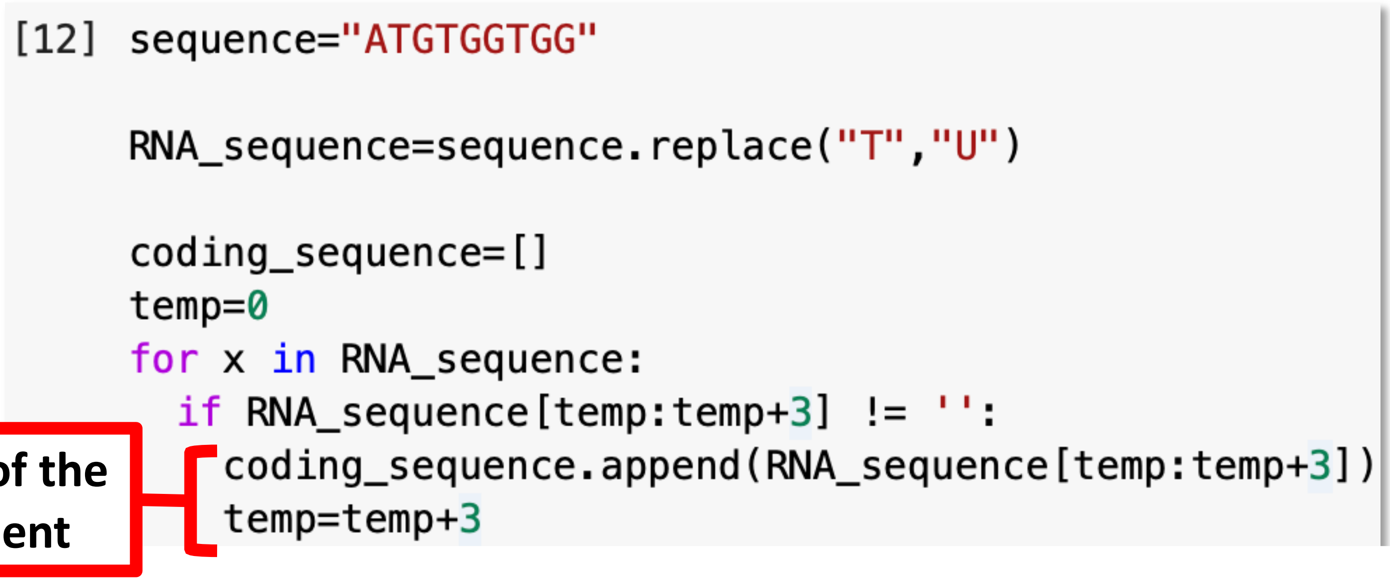
     coding_sequence=[]
     temp=0
     for x in RNA_sequence:
       if RNA_sequence[temp:temp+3] != '':
```

If statement

For loop through the indexes of a string that is a sequence

How would you produce a coding sequence?





```
[12] sequence="ATGTGGTGG"

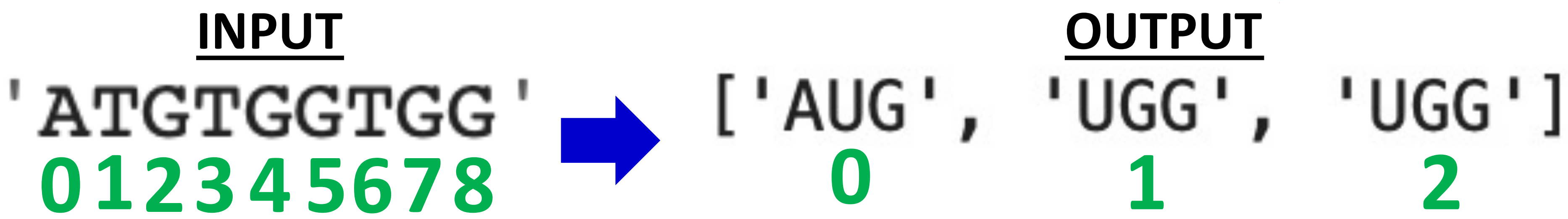
     RNA_sequence=sequence.replace("T","U")

     coding_sequence=[]
     temp=0
     for x in RNA_sequence:
       if RNA_sequence[temp:temp+3] != '':
         coding_sequence.append(RNA_sequence[temp:temp+3])
         temp=temp+3
```

The body of the If statement

For loop through the indexes of a string that is a sequence

How would you produce a coding sequence?



INPUT

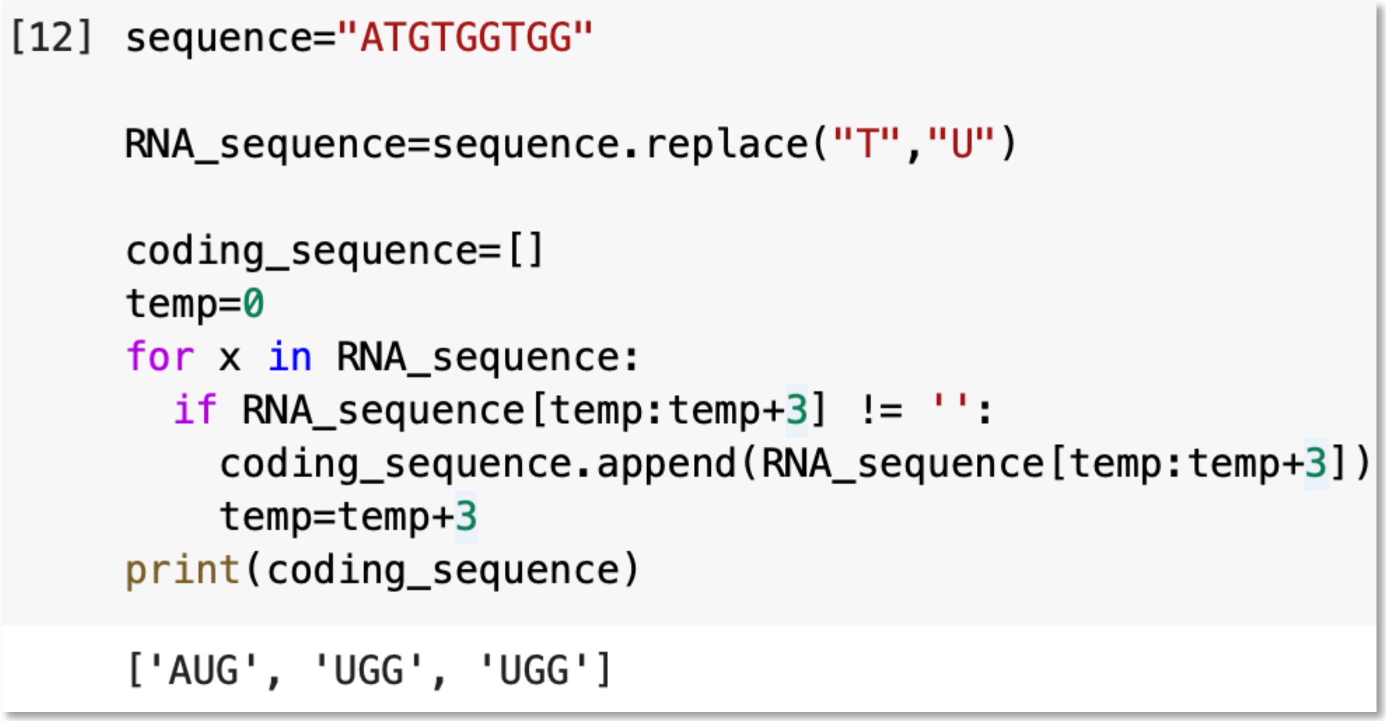
'ATGTGGTGG'

012345678

OUTPUT

['AUG', 'UGG', 'UGG']

0 1 2



```
[12] sequence="ATGTGGTGG"

     RNA_sequence=sequence.replace("T","U")

     coding_sequence=[]
     temp=0
     for x in RNA_sequence:
       if RNA_sequence[temp:temp+3] != '':
         coding_sequence.append(RNA_sequence[temp:temp+3])
         temp=temp+3
     print(coding_sequence)

     ['AUG', 'UGG', 'UGG']
```

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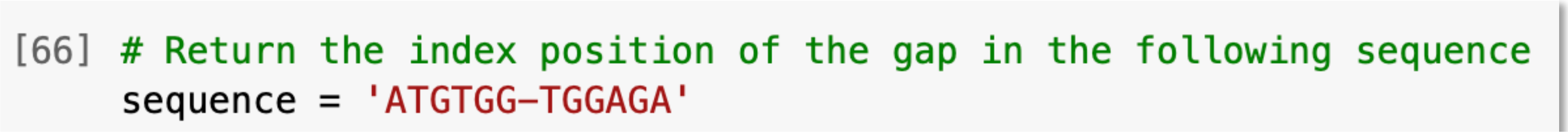
Lesson 2.2.2a

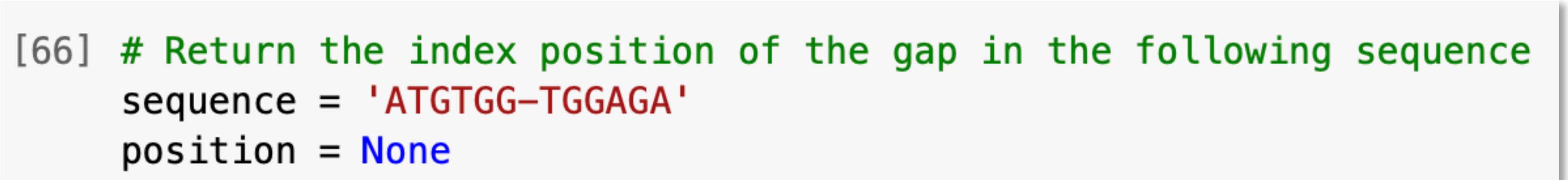
While Loops

Use a while loop to return the index of the first gap encountered in the sequence



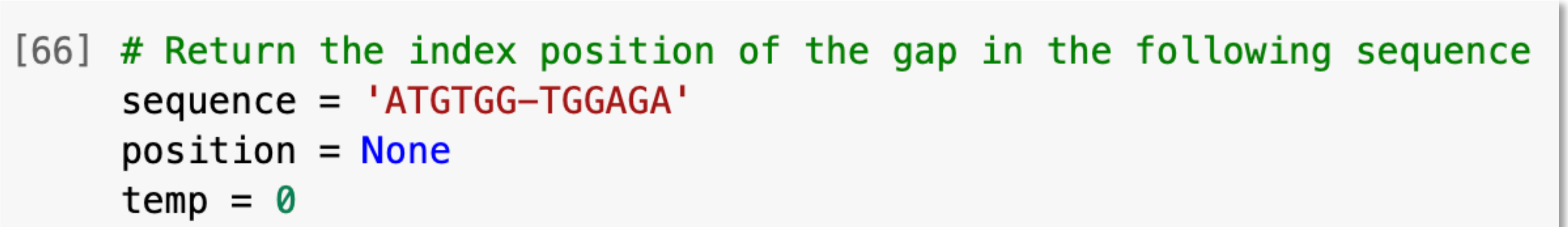
```
[66] # Return the index position of the gap in the following sequence
     sequence = 'ATGTGG-TGGAGA'
```

Use a while loop to return the index of the first gap encountered in the sequence



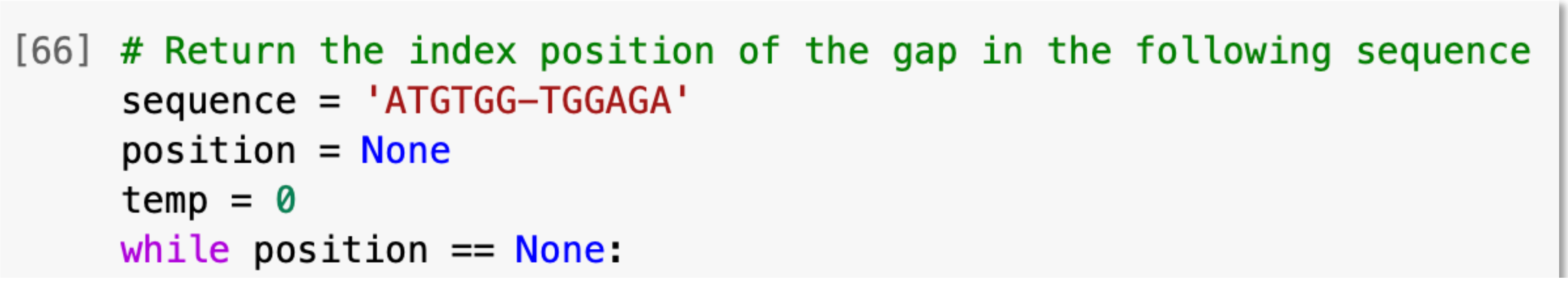
```
[66] # Return the index position of the gap in the following sequence
     sequence = 'ATGTGG-TGGAGA'
     position = None
```

Use a while loop to return the index of the first gap encountered in the sequence



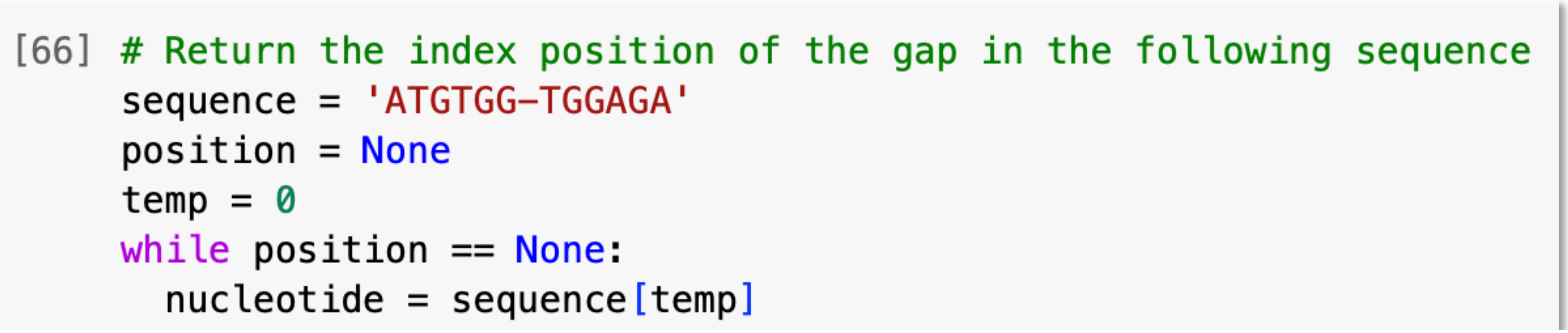
```
[66] # Return the index position of the gap in the following sequence
     sequence = 'ATGTGG-TGGAGA'
     position = None
     temp = 0
```

Use a while loop to return the index of the first gap encountered in the sequence



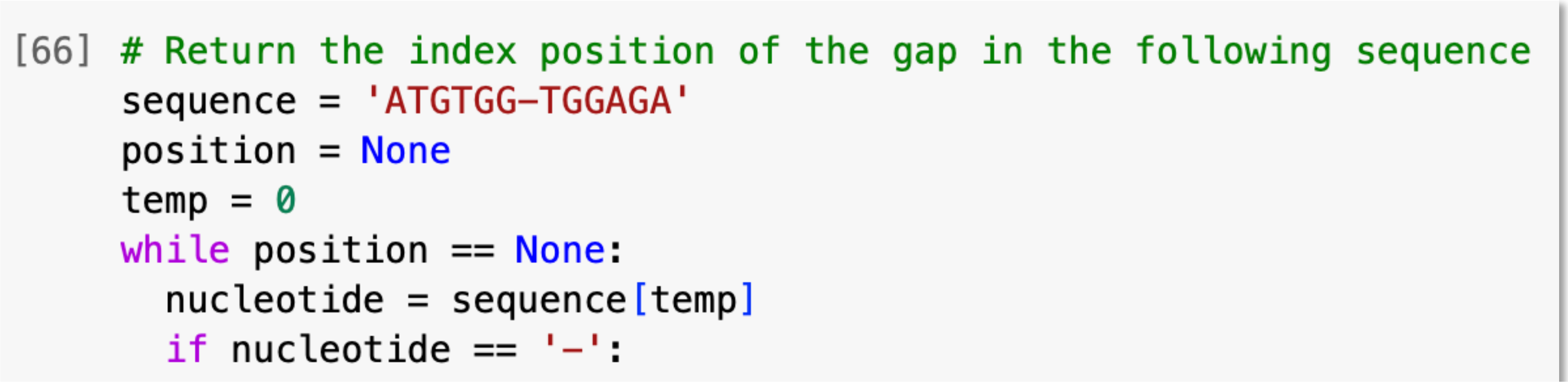
```
[66] # Return the index position of the gap in the following sequence
     sequence = 'ATGTGG-TGGAGA'
     position = None
     temp = 0
     while position == None:
```

Use a while loop to return the index of the first gap encountered in the sequence



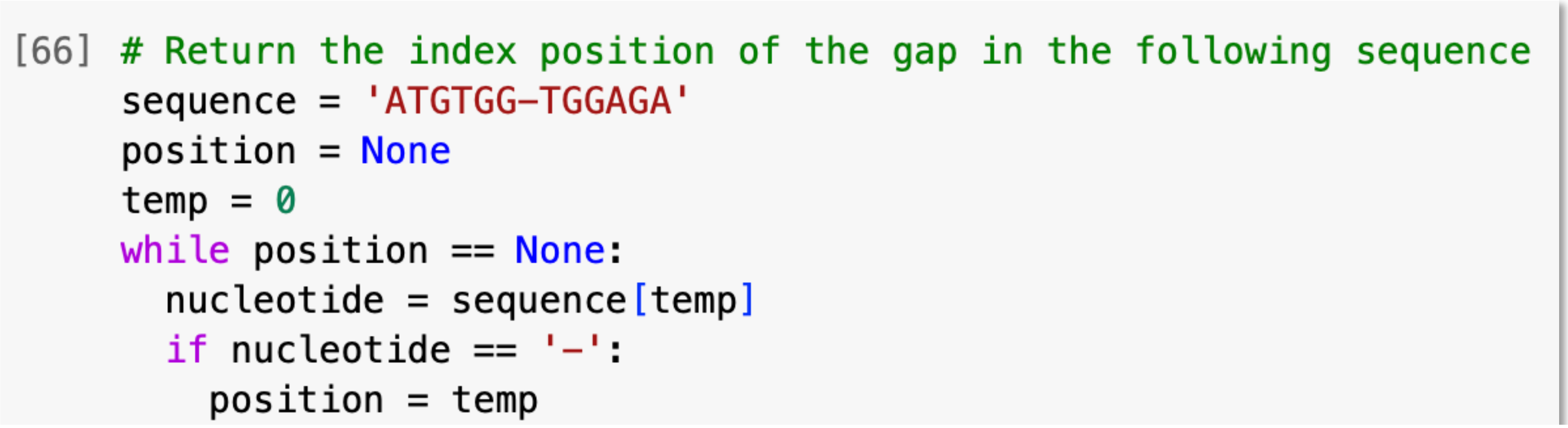
```
[66] # Return the index position of the gap in the following sequence
     sequence = 'ATGTGG-TGGAGA'
     position = None
     temp = 0
     while position == None:
       nucleotide = sequence[temp]
```

Use a while loop to return the index of the first gap encountered in the sequence



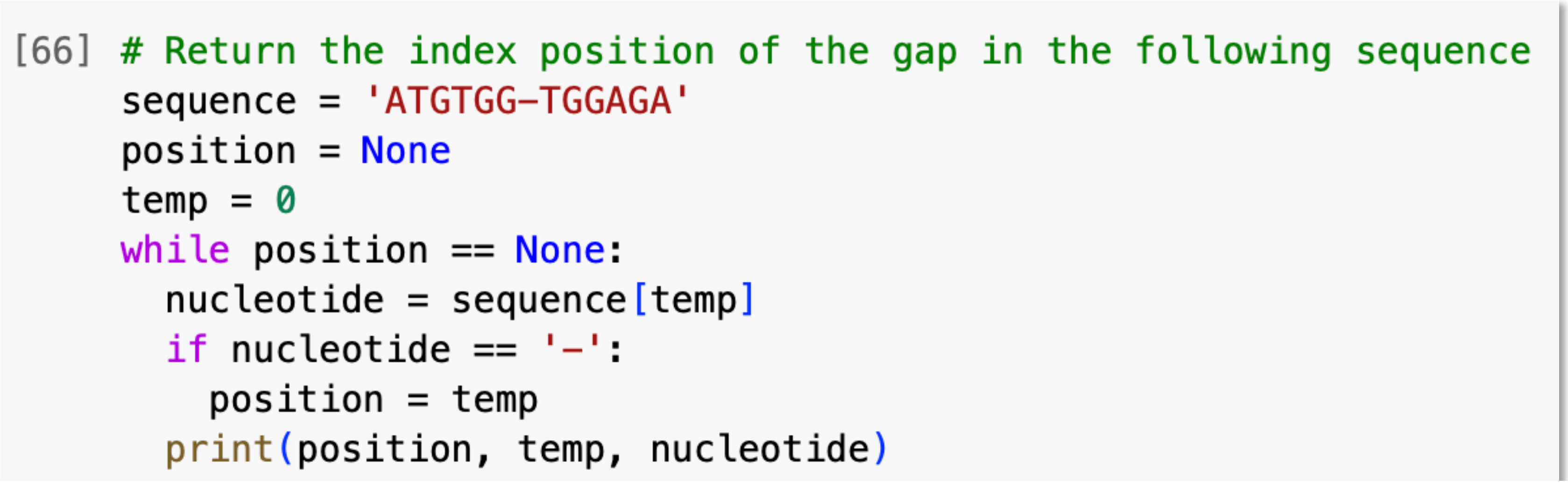
```
[66] # Return the index position of the gap in the following sequence
     sequence = 'ATGTGG-TGGAGA'
     position = None
     temp = 0
     while position == None:
       nucleotide = sequence[temp]
       if nucleotide == '-':
```

Use a while loop to return the index of the first gap encountered in the sequence



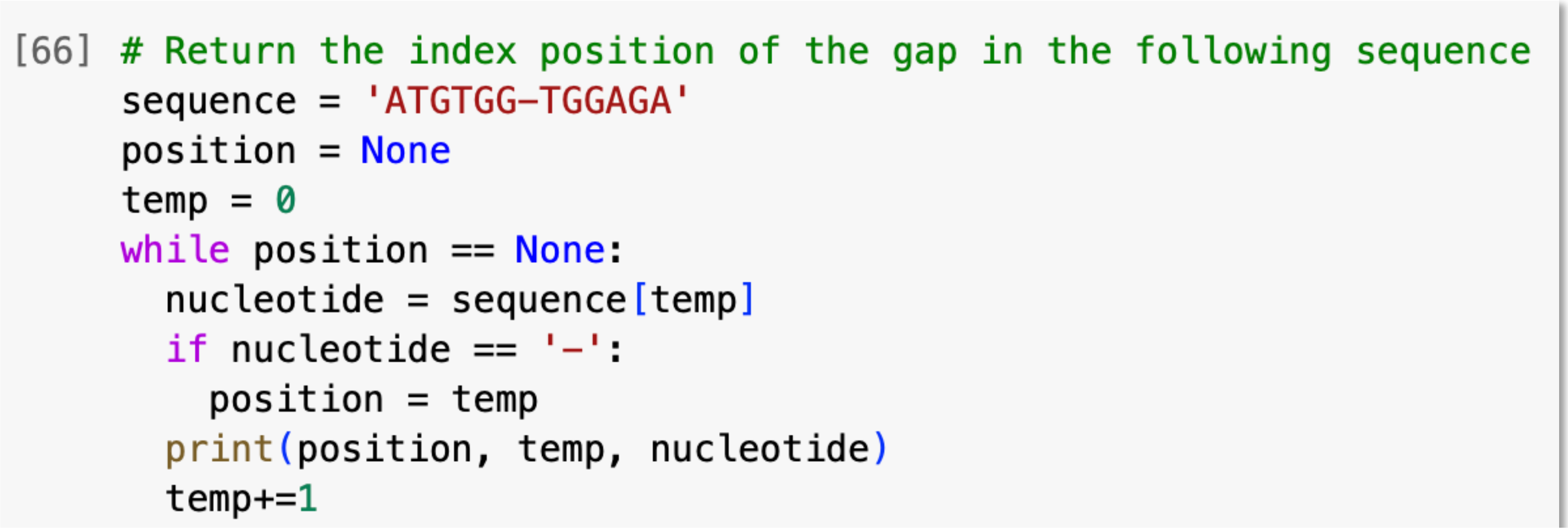
```
[66] # Return the index position of the gap in the following sequence
     sequence = 'ATGTGG-TGGAGA'
     position = None
     temp = 0
     while position == None:
       nucleotide = sequence[temp]
       if nucleotide == '-':
         position = temp
```

Use a while loop to return the index of the first gap encountered in the sequence



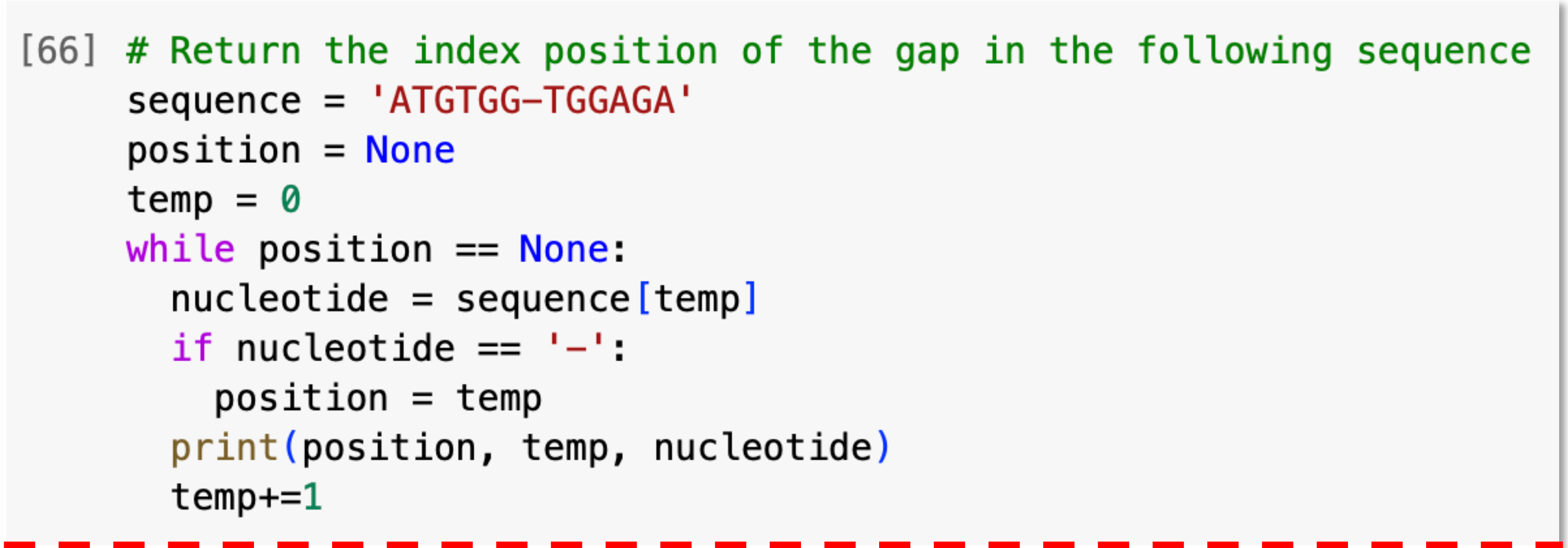
```
[66] # Return the index position of the gap in the following sequence
     sequence = 'ATGTGG-TGGAGA'
     position = None
     temp = 0
     while position == None:
       nucleotide = sequence[temp]
       if nucleotide == '-':
         position = temp
       print(position, temp, nucleotide)
```

Use a while loop to return the index of the first gap encountered in the sequence



```
[66] # Return the index position of the gap in the following sequence
     sequence = 'ATGTGG-TGGAGA'
     position = None
     temp = 0
     while position == None:
       nucleotide = sequence[temp]
       if nucleotide == '-':
         position = temp
       print(position, temp, nucleotide)
       temp+=1
```

Use a while loop to return the index of the first gap encountered in the sequence



```
[66] # Return the index position of the gap in the following sequence
     sequence = 'ATGTGG-TGGAGA'
     position = None
     temp = 0
     while position == None:
       nucleotide = sequence[temp]
       if nucleotide == '-':
         position = temp
       print(position, temp, nucleotide)
       temp+=1
```

Answer

Proficiency Assessment

Exercise 1: Return the total number of guanines Sequence A.

You can use the count() function in python to check your work! 😉

Start with a variable called counter equal to 0

For loop through each nucleotide of the sequence

Use a condition statement to identify a guanine in the sequence

Record by tallying the guanines found

Exercise 2: How many differences are between Sequence A and Sequence B

Refer to Exercise 1 for ideas

Exercise 3: You will be given a list of protein-coding sequences and other resources (i.e. dictionary). Find the following for each sequence:

Length of the DNA sequence

Transcript of the DNA sequence (RNA sequence)

Coding sequence as a list

Amino acid sequence

Bonus: add something yourself! ☺