

# Python Programming

## String methods, error and exceptions

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## Outline

Introduction

The standard library

String methods

Improving our script with comments and docstrings

Errors and exceptions

# Introduction

## Let's start with a simple GC calculator

seq\_toolbox.py

```
1 def calc_gc_percent(seq):
2     at_count, gc_count = 0, 0
3     for char in seq:
4         if char in ('A', 'T'):
5             at_count += 1
6         elif char in ('G', 'C'):
7             gc_count += 1
8
9     return gc_count * 100.0 / (gc_count + at_count)
10
11 print("The sequence 'CAGG' has a %GC of {:.2f}".format(
12     calc_gc_percent("CAGG")))
```

# Introduction

## Let's start with a simple GC calculator

seq\_toolbox.py

```
1 def calc_gc_percent(seq):
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7             gc_count += 1
8
9     return gc_count * 100.0 / (gc_count + at_count)
10
11 print("The sequence 'CAGG' has a %GC of {:.2f}".format(
12     calc_gc_percent("CAGG")))
```

Our script is nice and dandy, but we don't want to edit the source file everytime we calculate a sequence's GC.

## The standard library

- A collection of Python modules (or functions, for now) that comes packaged with a default Python installation.
- They're not part of the language per se, more like a batteries included thing.

## The standard library

### Our first standard library module: sys

- We'll start by using the simple sys module to make our script more flexible.
- Standard library (and other modules, as we'll see later) can be used via the import statement, for example:

IPython

```
In [1]: import sys
```

- Like other objects so far, we can peek into the documentation of these modules using help, or the IPython ? shortcut. For example:

IPython

```
In [2]: sys?
```

### The `sys.argv` list

- The `sys` module allows to capture command line arguments with its `argv` object.
- This is a list of arguments supplied when invoking the current Python session.
- Not really useful for an interpreter session, but very handy for scripts.

IPython

```
In [3]: sys.argv
```

```
Out[3]: ['/usr/local/bin/ipython']
```

### Improving our script with sys.argv

seq\_toolbox.py

```
1  import sys
2
3  def calc_gc_percent(seq):
4      at_count, gc_count = 0, 0
5      for char in seq:
6          if char in ('A', 'T'):
7              at_count += 1
8          elif char in ('G', 'C'):
9              gc_count += 1
10
11     return gc_count * 100.0 / (gc_count + at_count)
12
13 input_seq = sys.argv[1]
14 print("The sequence '{}' has a %GC of {:.2f}".format(
15     input_seq, calc_gc_percent(input_seq)))
```



## String methods

- Try running the script with 'cagg' as the input sequence. What happens?
- As we saw earlier, many objects, like those of type `list`, `dict`, or `str`, have useful methods defined on them.
- One way to squash this potential bug is by using Python's string method `upper`.
- Let's first check out some commonly used string functions.

IPython

```
In [4]: my_str = 'Hello again, ipython!'
```

```
In [5]: my_str.upper()
```

```
Out[5]: 'HELLO AGAIN, IPYTHON!'
```

```
In [6]: my_str.lower()
```

```
Out[6]: 'hello again, ipython!'
```

```
In [7]: my_str.title()
```

```
Out[7]: 'Hello Again, Ipython!'
```

## String methods

IPython

```
In [8]: my_str.startswith('H')
```

```
Out[8]: True
```

```
In [9]: my_str.startswith('h')
```

```
Out[9]: False
```

```
In [10]: my_str.split(',')
```

```
Out[10]: ['Hello again', ' ipython!']
```

```
In [11]: my_str.replace('ipython', 'lumc')
```

```
Out[11]: 'Hello again, lumc!'
```

```
In [12]: my_str.count('n')
```

```
Out[12]: 2
```

### Improving our script with upper()

seq\_toolbox.py

```
1  import sys
2
3  def calc_gc_percent(seq):
4      at_count, gc_count = 0, 0
5      for char in seq.upper():
6          if char in ('A', 'T'):
7              at_count += 1
8          elif char in ('G', 'C'):
9              gc_count += 1
10
11     return gc_count * 100.0 / (gc_count + at_count)
12
13 input_seq = sys.argv[1]
14 print("The sequence '{}' has a %GC of {:.2f}".format(
15     input_seq, calc_gc_percent(input_seq)))
```

## Improving our script with comments and docstrings

seq\_toolbox.py

```
1 import sys
2
3 def calc_gc_percent(seq):
4     """
5     Calculates the GC percentage of the given sequence.
6
7     Arguments:
8         - seq - the input sequence (string).
9
10    Returns:
11        - GC percentage (float).
12
13    The returned value is always <= 100.0
14    """
15    at_count, gc_count = 0, 0
16    # Change input to all caps to allow for non-capital
17    # input sequence.
18    for char in seq.upper():
19        if char in ('A', 'T'):
20            at_count += 1
21        elif char in ('G', 'C'):
22            gc_count += 1
23
24    return gc_count * 100.0 / (gc_count + at_count)
25
26 input_seq = sys.argv[1]
27 print("The sequence '{}' has a %GC of {:.2f}".format(
28     input_seq, calc_gc_percent(input_seq)))
```

- Try running the script with `'ACTG123'` as the argument.
  - What happens?
  - Is this acceptable behavior?
- Sometimes we want to put safeguards to handle invalid inputs. In this case we only accept ACTG, all other characters are invalid.
- Python provides a way to break out of the normal execution flow, by raising what's called as an `exception`.
- We can raise exceptions ourselves as well, by using the `raise` statement.

### The ValueError built-in exception

- Used on occasions where inappropriate argument values are used, for example when trying to convert the string A to an integer:

IPython

```
In [13]: int('A')
```

```
-----  
ValueError                                Traceback (most recent call last)  
<ipython-input-14-0da6d315d7ad> in <module>()  
----> 1 int('A')
```

```
ValueError: invalid literal for int() with base 10: 'A'
```

- ValueError is the appropriate exception to raise when your function is called with argument values it cannot handle.

## Improving our script by handling invalid inputs

seq\_toolbox.py

```
1 def calc_gc_percent(seq):
2     """
3     Calculates the GC percentage of the given sequence.
4
5     Arguments:
6     - seq - the input sequence (string).
7
8     Returns:
9     - GC percentage (float).
10
11     The returned value is always <= 100.0
12     """
13     at_count, gc_count = 0, 0
14     # Change input to all caps to allow for non-capital
15     # input sequence.
16     for char in seq.upper():
17         if char in ('A', 'T'):
18             at_count += 1
19         elif char in ('G', 'C'):
20             gc_count += 1
21         else:
22             raise ValueError('Unexpected character found: {}'.format(char))
23
24     return gc_count * 100.0 / (gc_count + at_count)
25
```

### Handling corner cases

- Try running the script with `' '` as the argument.
  - What happens?
  - Why? Is this a valid input?
- We don't always want to let exceptions stop program flow, sometimes we want to provide alternative flow.
- The `try ... except` block allows you to do this.



## Improving our script by handling corner cases

seq\_toolbox.py

```
1 def calc_gc_percent(seq):
2     """
3     Calculates the GC percentage of the given sequence.
4     ...
5     The returned value is always <= 100.0
6     """
7     at_count, gc_count = 0, 0
8     # Change input to all caps to allow for non-capital
9     # input sequence.
10    for char in seq.upper():
11        if char in ('A', 'T'):
12            at_count += 1
13        elif char in ('G', 'C'):
14            gc_count += 1
15        else:
16            raise ValueError('Unexpected character found: {}. Only '
17                              'ACTGs are allowed.'.format(char))
18
19    # Corner case handling: empty input sequence.
20    try:
21        return gc_count * 100.0 / (gc_count + at_count)
22    except ZeroDivisionError:
23        return 0.0
```

### Aim for a minimal try block

- We want to be able to pinpoint the statements that may raise the exceptions so we can tailor our handling.
- Example of code that violates this principle:

```
try:  
    my_function()  
    my_other_function()  
except ValueError:  
    my_fallback_function()
```

- A better way would be:

```
try:  
    my_function()  
except ValueError:  
    my_fallback_function()  
my_other_function()
```

### Be specific when handling exceptions

- The following code is syntactically valid, but never use it:

```
try:  
    my_function()  
except:  
    my_fallback_function()
```

- Always use the full exception name when to make for a much cleaner code:

```
try:  
    my_function()  
except ValueError:  
    my_fallback_function()  
except TypeError:  
    my_other_fallback_function()  
except IndexError:  
    my_final_function()
```

### Look Before You Leap (LBYL) vs Easier to Ask for Apology (EAFP)

- We could have written our last exception block like so:

```
if gc_count + at_count == 0:  
    return 0.0  
return gc_count * 100.0 / (gc_count + at_count)
```

- Both approaches are correct and have their own plus and minuses in general.

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