Getting Started With Python Programming: Part 3

- Named constants
- Documenting programs
- Prewritten python functions
- Common programming errors
- Programming style: layout and formatting of your program

Reminder: **Variables**

- By convention variable names are all lower case
- The exception is long (multi-word) names
- As the name implies their **contents can change** as a program runs e.g.,

```
income = 300000
income = income + interest
Income = income + bonuses
```

Named Constants

- They are similar to variables: a memory location that’s been given a name.
- Unlike variables their contents *shouldn’t* change.
  - This means changes should not occur because of style reasons rather than because Python prevents the change
- The naming conventions for choosing variable names generally apply to constants but the name of constants should be all UPPER CASE. (You can separate multiple words with an underscore).
- Example **PI** = 3.14
- They are capitalized so the reader of the program can distinguish them from variables.
  - For some programming languages the translator will enforce the unchanging nature of the constant.
  - For languages such as *Python it is up to the programmer* to recognize a named constant and not to change it.

Why Use **Named Constants**

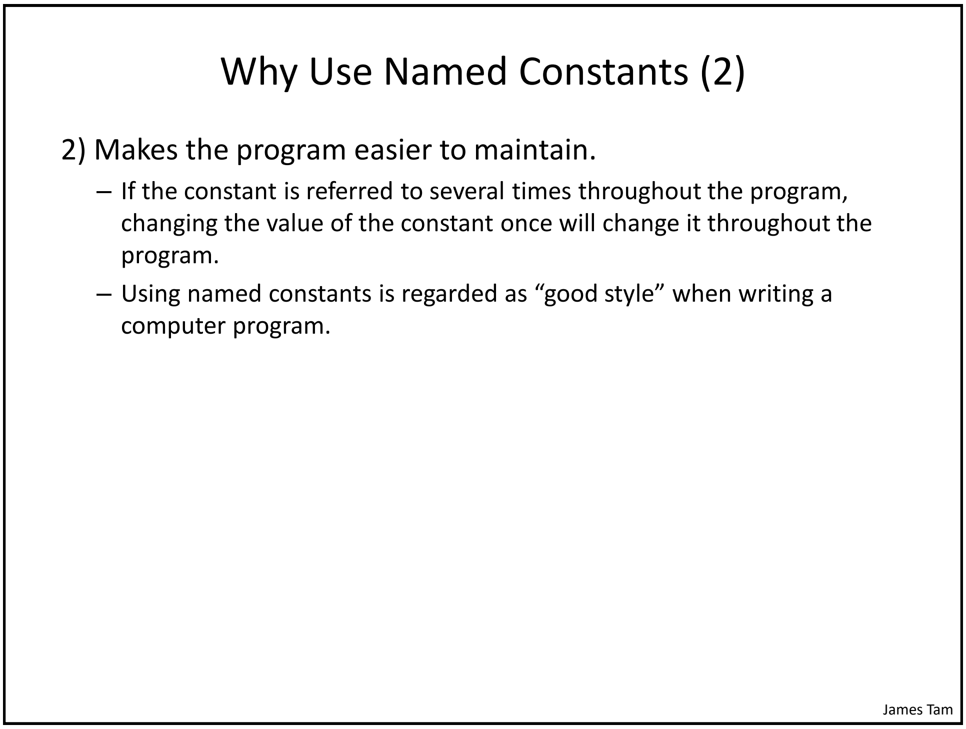
1. They make your program easier to read and understand

```
# NO
populationChange = (0.1758 – 0.1257) * currentPopulation
```

Avoid unnamed constants whenever possible!

Vs.

```
#YES
BIRTH_RATE = 17.58
MORTALITY_RATE = 0.1257
currentPopulation = 1000000
populationChange = (BIRTH_RATE - MORTALITY_RATE) *
   currentPopulation
```



Why Use Named Constants (2)

2) Makes the program easier to maintain.

- If the constant is referred to several times throughout the program, changing the value of the constant once will change it throughout the program.
- Using named constants is regarded as “good style” when writing a computer program.

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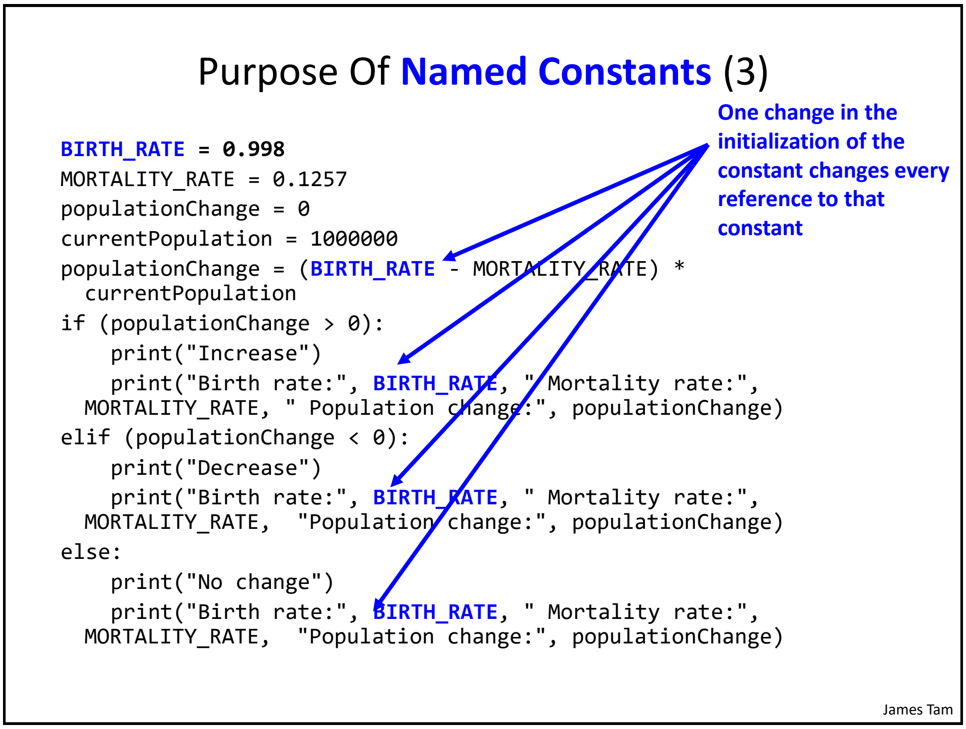

Purpose Of **Named Constants** (3)

```
BIRTH_RATE = 0.998
MORTALITY_RATE = 0.1257
populationChange = 0
currentPopulation = 1000000
populationChange = (BIRTH_RATE - MORTALITY_RATE) *
  currentPopulation
if (populationChange > 0):
    print("Increase")
    print("Birth rate:", BIRTH_RATE, " Mortality rate:",
  MORTALITY_RATE, " Population change:", populationChange)
elif (populationChange < 0):
    print("Decrease")
    print("Birth rate:", BIRTH_RATE, " Mortality rate:",
  MORTALITY_RATE,  "Population change:", populationChange)
else:
    print("No change")
    print("Birth rate:", BIRTH_RATE, " Mortality rate:",
  MORTALITY_RATE,  "Population change:", populationChange)
```

One change in the initialization of the constant changes every reference to that constant

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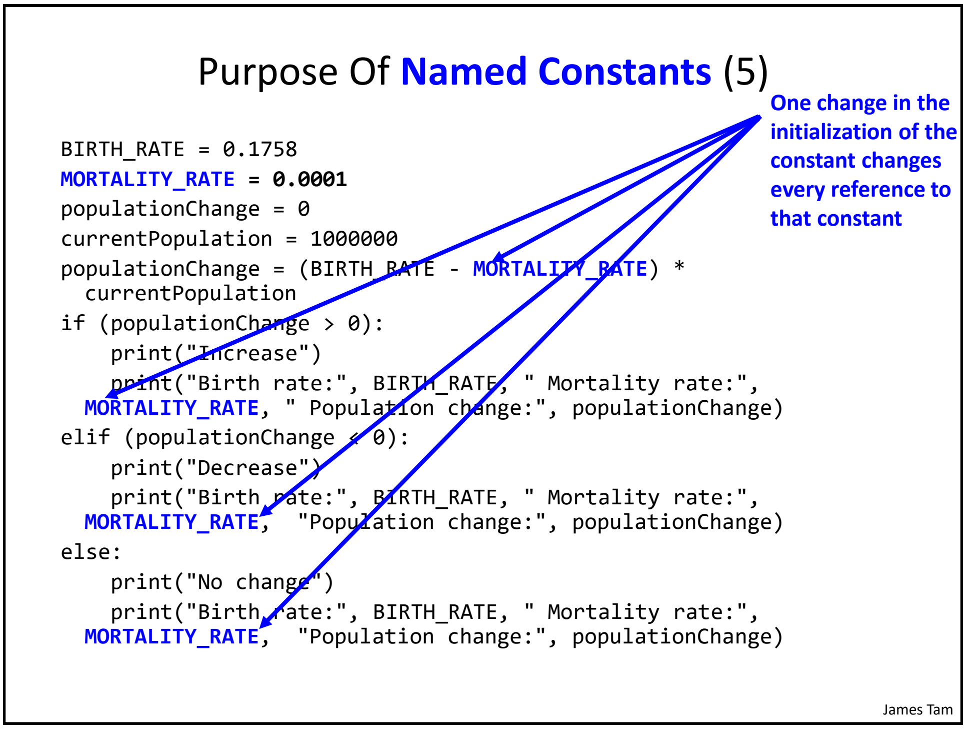

Purpose Of **Named Constants** (5)

```
BIRTH_RATE = 0.1758
MORTALITY_RATE = 0.0001
populationChange = 0
currentPopulation = 1000000
populationChange = (BIRTH_RATE - MORTALITY_RATE) *
  currentPopulation
if (populationChange > 0):
    print("Increase")
    print("Birth rate:", BIRTH_RATE, " Mortality rate:",
  MORTALITY_RATE, " Population change:", populationChange)
elif (populationChange < 0):
    print("Decrease")
    print("Birth rate:", BIRTH_RATE, " Mortality rate:",
  MORTALITY_RATE,  "Population change:", populationChange)
else:
    print("No change")
    print("Birth rate:", BIRTH_RATE, " Mortality rate:",
  MORTALITY_RATE,  "Population change:", populationChange)
```

One change in the initialization of the constant changes every reference to that constant

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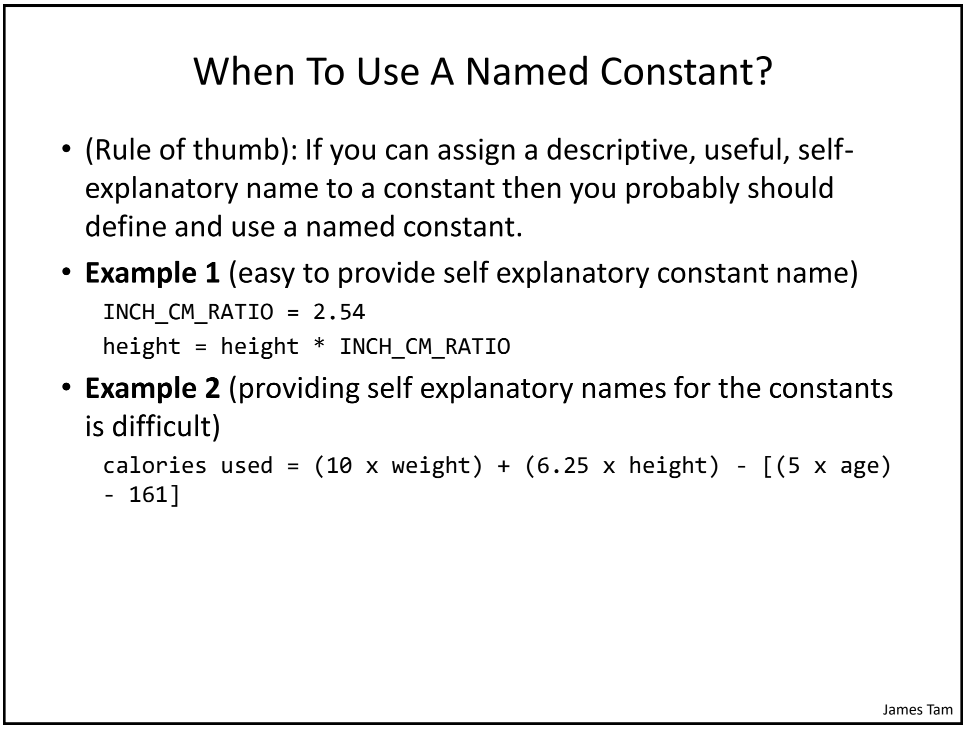

When To Use A Named Constant?

- (Rule of thumb): If you can assign a descriptive, useful, self-explanatory name to a constant then you probably should define and use a named constant.
- **Example 1** (easy to provide self explanatory constant name)

```
INCH_CM_RATIO = 2.54
height = height * INCH_CM_RATIO
```

- **Example 2** (providing self explanatory names for the constants is difficult)

```
calories used = (10 x weight) + (6.25 x height) - [(5 x age)
- 161]
```

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Named Constants: A Final Example

Correct/incorrect use of named constants can affect your assignment grade

- Which of the following programs is more self explanatory ("self documenting" code)?
  - (You will learn how the 'IF' works in the branching/decisions making lectures).
  - **Example #1:**

```
gameStatus = 1
silverLockPosition = 2
goldLockPosition = 0
if ((silverLockPosition == 1) and (goldLockPosition ==  0)):
    gameStatus = 2
```

  - **Approach #2:**

```
WON = 2
LEFT = 0
RIGHT = 1
CENTER = 2
If ((silverLockPosition == RIGHT) and (goldLockPosition ==  LEFT)):
    gameStatus = WON
```

Extra Practice

- Provide a formula where it would be appropriate to use named constants (should be easy).
- Provide a formula where unnamed constants (i.e., named constant used instead of named constants) may be acceptable (may be trickier).
- Search for formulas in science or engineering sites online if you can't think of any formulas.

Section Summary: Named Constants

- What is a named constant
  - How does it differ from a variable
  - How does it differ from an unnamed constant
  - What are some reasons for using named constants
- Naming conventions for named constants

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Program Documentation

- *Program documentation*: Used to provide information about a computer program to **another programmer** (writes or modifies the program).
- This is different from a *user manual* which is written for people who will **use the program**.
- Documentation is written inside the same file as the computer program (when you see the computer program you can see the documentation).
- The purpose is to help other programmers understand the program: what the different parts of the program do, what are some of it’s limitations etc.

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Program Documentation (2)

- Doesn’t contain instructions for the computer to execute.
- Not translated into machine language.
- Consists of information for the reader of the program:
  - **The author** of the program (or for a particular part of a program).
  - **What does** the program as a while do e.g., calculate taxes.
  - What are the **specific features** of the program e.g., it calculates personal or small business tax.
  - What are it’s **limitations** e.g., it only follows Canadian tax laws and cannot be used in the US. In Canada it doesn’t calculate taxes for organizations with yearly gross earnings over $1 billion.
  - What is the **version** of the program.
    - If you don’t use numbers for the different versions of your program then simply use dates (tie versions with program features – more on this in a moment “Program versioning and backups”).

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Program Documentation (3)

- **Format (single line documentation):**

```
# <Documentation>
```

The number sign ‘#” flags the translator that the remainder of the line is documentation.

- **Examples:**

```
# Tax-It v1.0: This program will electronically calculate
# your tax return. This program will only allow you to complete
# a Canadian tax return.
```

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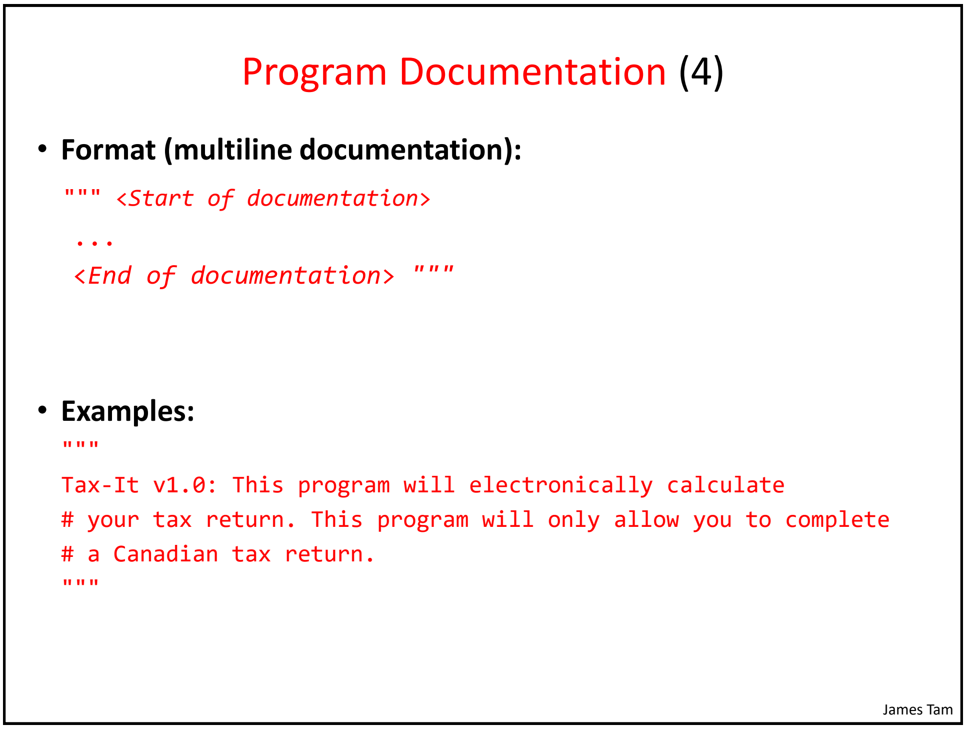

Program Documentation (4)

- **Format (multiline documentation):**

```
""" <Start of documentation>
 ...
 <End of documentation> """
```

- **Examples:**

```
"""
Tax-It v1.0: This program will electronically calculate
# your tax return. This program will only allow you to complete
# a Canadian tax return.
"""
```

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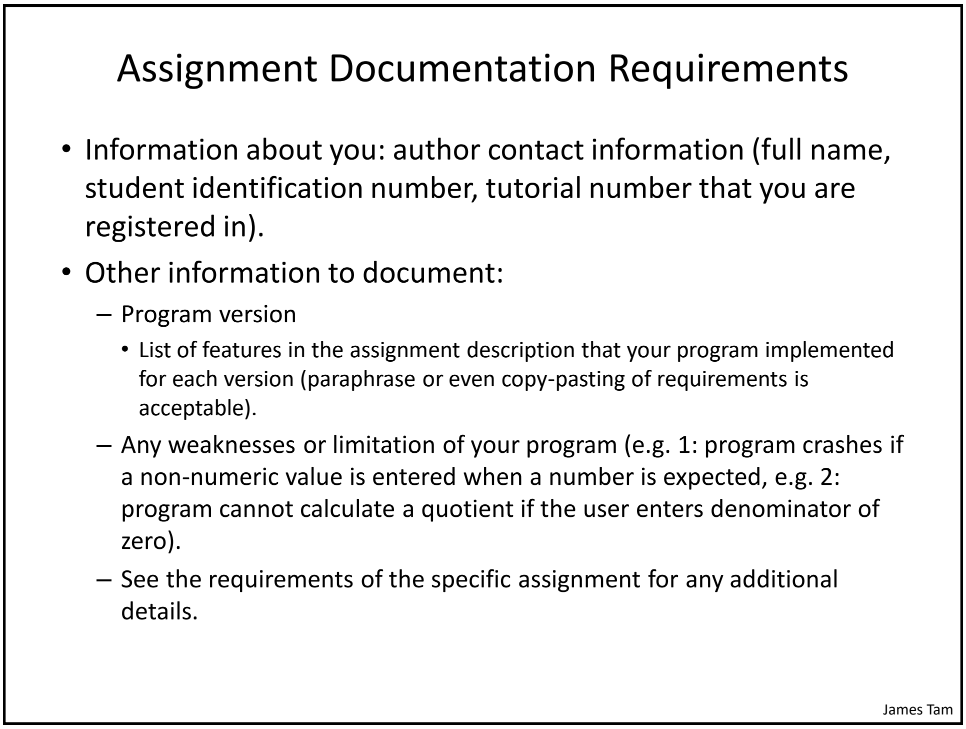

Assignment Documentation Requirements

- Information about you: author contact information (full name, student identification number, tutorial number that you are registered in).
- Other information to document:
  - Program version
    - List of features in the assignment description that your program implemented for each version (paraphrase or even copy-pasting of requirements is acceptable).
  - Any weaknesses or limitation of your program (e.g. 1: program crashes if a non-numeric value is entered when a number is expected, e.g. 2: program cannot calculate a quotient if the user enters denominator of zero).
  - See the requirements of the specific assignment for any additional details.

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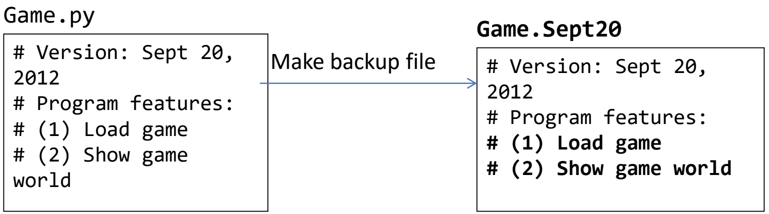
Program Versioning And Back Ups

- As significant program features have been completed (tested and the errors removed/debugged) a new version should be saved in a separate file.



Game.py

```
# Version: Sept 20,
2012
# Program features:
# (1) Load game
# (2) Show game
world
```

Make backup file

Game.Sept20

```
# Version: Sept 20,
2012
# Program features:
# (1) Load game
# (2) Show game world
```

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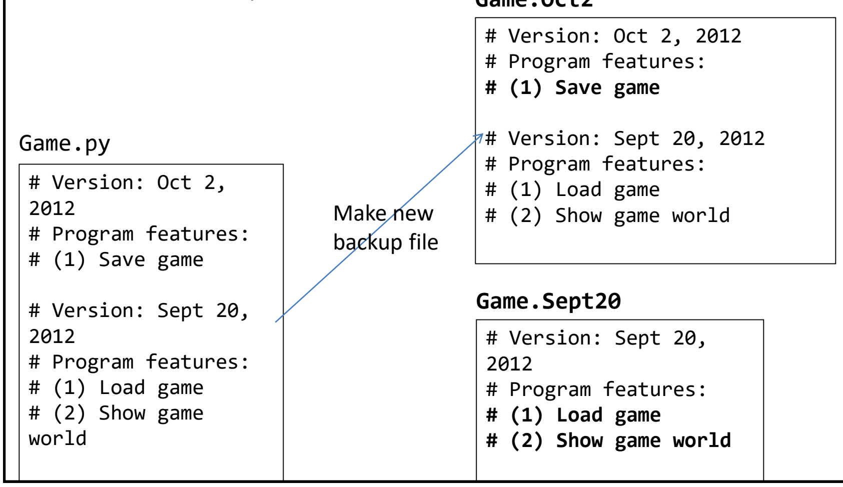
Program Versioning And Back Ups

- As significant program features have been completed (tested and the errors removed/debugged) a new version should be saved in a separate file.



Game.Oct2

```
# Version: Oct 2, 2012
# Program features:
# (1) Save game

# Version: Sept 20, 2012
# Program features:
# (1) Load game
# (2) Show game world
```

Game.py

```
# Version: Oct 2,
2012
# Program features:
# (1) Save game

# Version: Sept 20,
2012
# Program features:
# (1) Load game
# (2) Show game
world
```

Make new backup file

Game.Sept20

```
# Version: Sept 20,
2012
# Program features:
# (1) Load game
# (2) Show game world
```

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Backing Up Your Work

- Do this every time that you have completed a significant milestone in your program.
  - What is ‘significant’ will vary between people but make sure you do this periodically.
- Ideally the backup file should be stored in a separate directory/folder (better yet on a separate device and/or using an online method such as an email attachment or ‘cloud’ storage).
- Common student reason for not making copies: “Backing up files takes time!”
- Compare:
  - Time to copy a file: ~10 seconds (generous in some cases).
  - Time to re-write your program to implement the feature again: 10 minutes (might be overly conservative in some cases).
- **Failing to backup your work is not a sufficient reason for receiving an extension**.

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Over-Documenting A Program

- Except for very small programs documentation should be included
- However, it is *possible* to over-document a program
- (Stating the obvious)

```
num = num + 1  #Variable num increased by one
```

- (Documentation of the last row in a list may be a good reminder)

```
lastRow = SIZE – 1  #Row numbering begins at zero
```

Example: there are 3 rows in a list (SIZE = 3)

- First row = 0
- Second row = 1
- Third (and last) row = 2 (equals 3-1 = 2)

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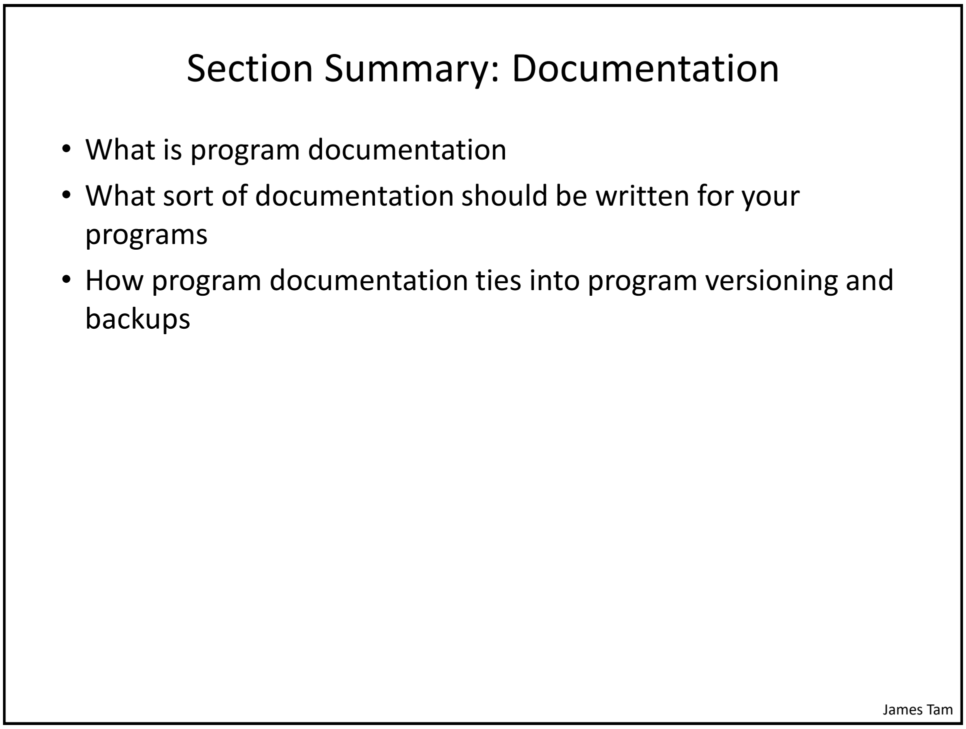

Section Summary: Documentation

- What is program documentation
- What sort of documentation should be written for your programs
- How program documentation ties into program versioning and backups

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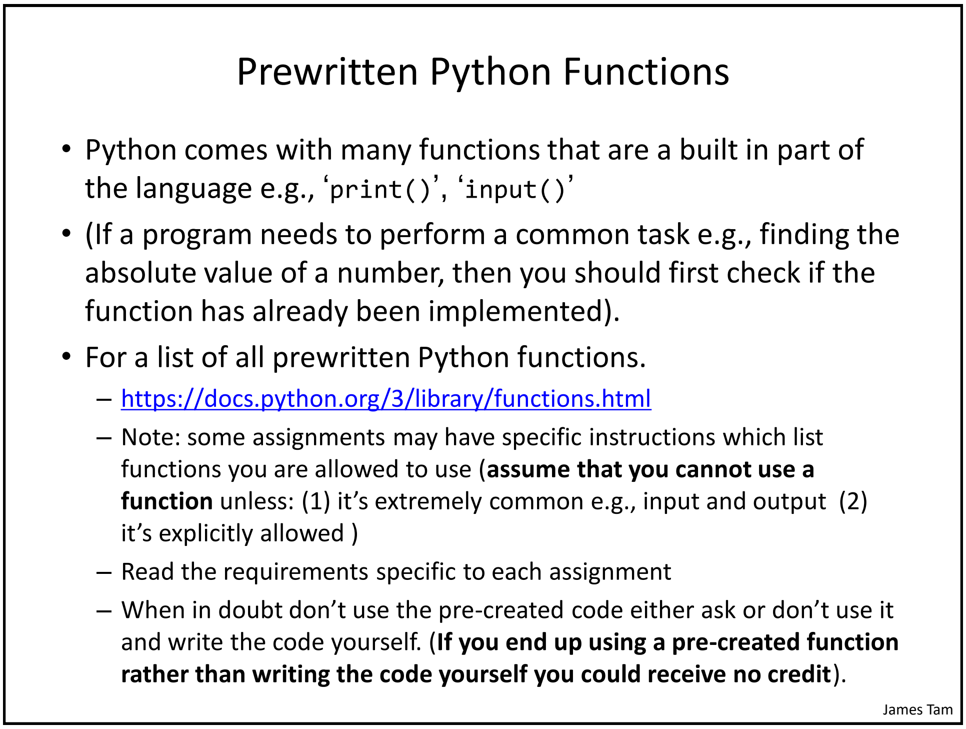

Prewritten Python Functions

- Python comes with many functions that are a built in part of the language e.g., ‘`print()`’, ‘`input()`’
- (If a program needs to perform a common task e.g., finding the absolute value of a number, then you should first check if the function has already been implemented).
- For a list of all prewritten Python functions.
  - https://docs.python.org/3/library/functions.html
  - Note: some assignments may have specific instructions which list functions you are allowed to use (**assume that you cannot use a function** unless: (1) it’s extremely common e.g., input and output (2) it’s explicitly allowed)
  - Read the requirements specific to each assignment
  - When in doubt don’t use the pre-created code either ask or don’t use it and write the code yourself. (**If you end up using a pre-created function rather than writing the code yourself you could receive no credit**).

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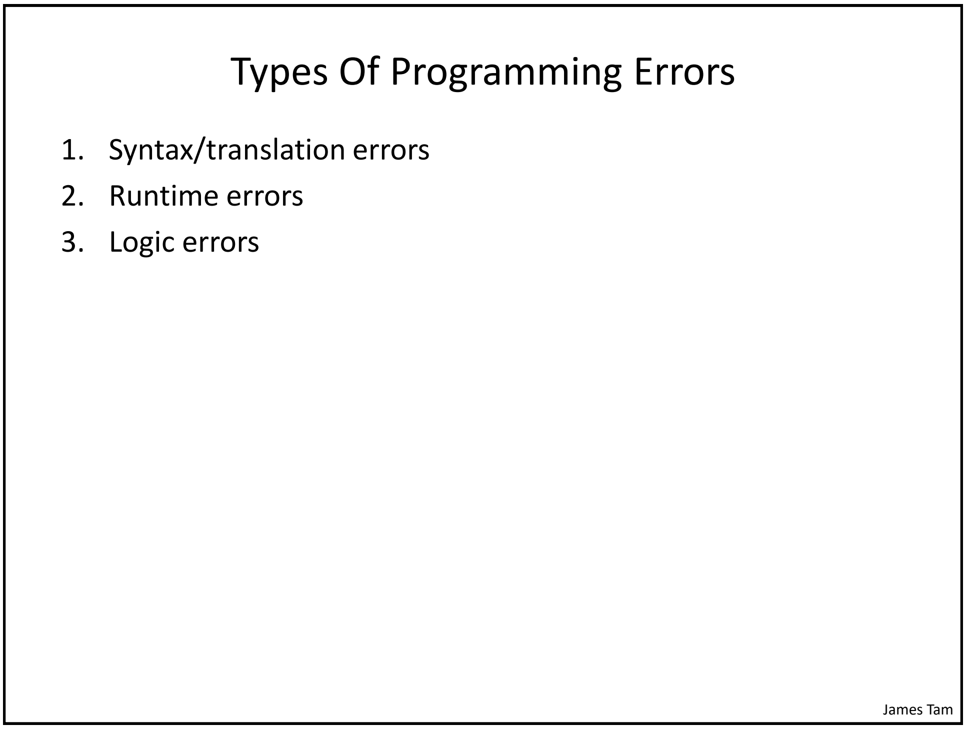

Types Of Programming Errors

1. Syntax/translation errors
2. Runtime errors
3. Logic errors

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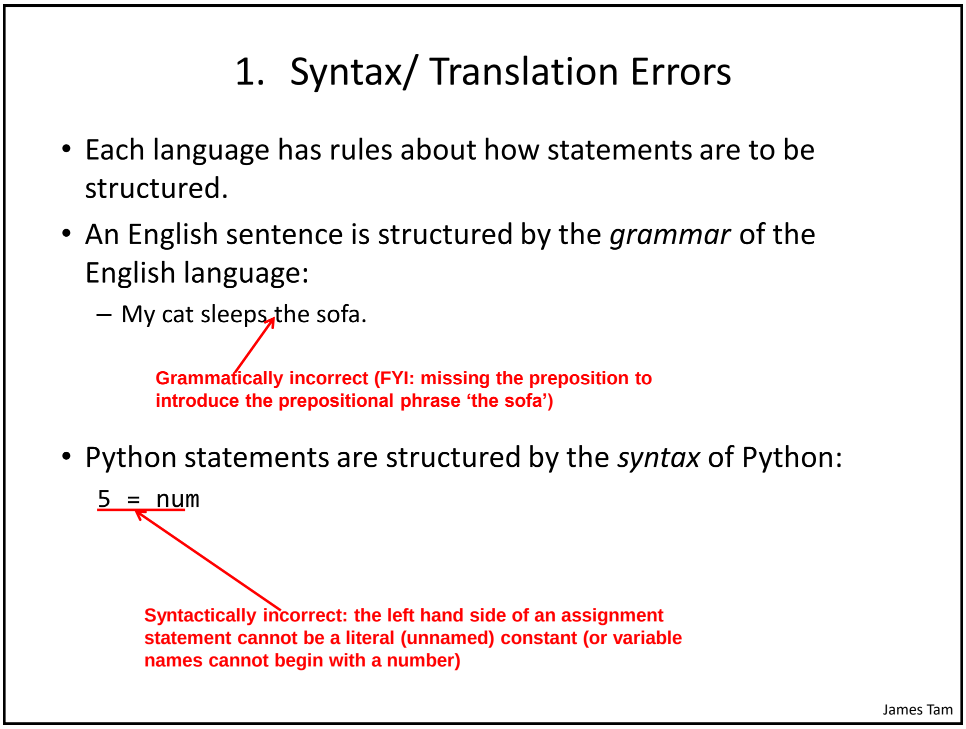

1. Syntax/ Translation Errors

- Each language has rules about how statements are to be structured.
- An English sentence is structured by the *grammar* of the English language:
  - My cat sleeps the sofa.

Grammatically incorrect (FYI: missing the preposition to introduce the prepositional phrase 'the sofa')

- Python statements are structured by the *syntax* of Python:

```
5 = num
```

Syntactically incorrect: the left hand side of an assignment statement cannot be a literal (unnamed) constant (or variable names cannot begin with a number)

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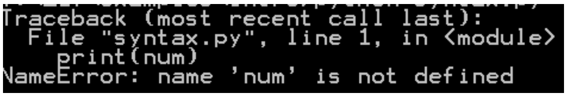
1. Syntax/ Translation Errors (2)

- The translator checks for these errors when a computer program is translated to machine language.

1. Some Common **Syntax Errors**

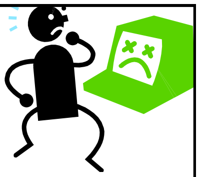
- Miss-spelling names of keywords
  - e.g., ‘**`primt()`**’ instead of ‘`print()`’
- Forgetting to match closing quotes or brackets to opening quotes or brackets e.g., **print("hello)**
- Using variables before they’ve been named (allocated in memory).
- **Name of the full example**: `17error_syntax.py`

```
print(num)
num = 123
```



```
Traceback (most recent call last):
  File "syntax.py", line 1, in <module>
    print(num)
NameError: name 'num' is not defined
```

2. Runtime Errors



- Occur as a program is executing (running).
- The syntax of the language has *not* been violated (each statement follows the rules/syntax).
- During execution a serious error is encountered that causes the execution (running) of the program to cease.
- With a language like Python where translation occurs just before execution (interpreted) the timing of when runtime errors appear won’t seem different from a syntax error.
- But for languages where translation occurs well before execution (compiled) the difference will be quite noticeable.
- A common example of a runtime error is a division by zero error.
  - We will talk about other run time errors later.

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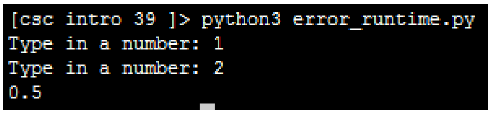
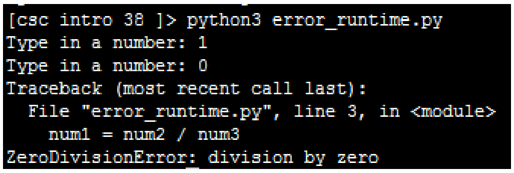
2. Runtime Error[1]: An Example

- **Name of the full example**: `18error_runtime.py`

```
num2 = int(input("Type in a number: "))
num3 = int(input("Type in a number: "))
num1 = num2 / num3 # When zero is entered
print(num1)
```



```
[csc intro 39 ]> python3 error_runtime.py
Type in a number: 1
Type in a number: 2
0.5
```



```
[csc intro 38 ]> python3 error_runtime.py
Type in a number: 1
Type in a number: 0
Traceback (most recent call last):
  File "error_runtime.py", line 3, in <module>
    num1 = num2 / num3
ZeroDivisionError: division by zero
```

[1] When ‘num3’ contains zero

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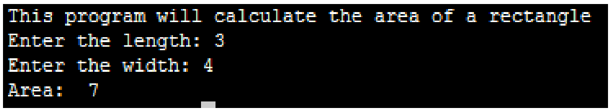
3. Logic Errors

- The program has no *syntax errors*.
- The program runs from beginning to end with *no runtime errors*.
- But the logic of the program is incorrect (it doesn't do what it's supposed to and may produce an incorrect result).
- **Name of the full example**: `19error_logic.py`

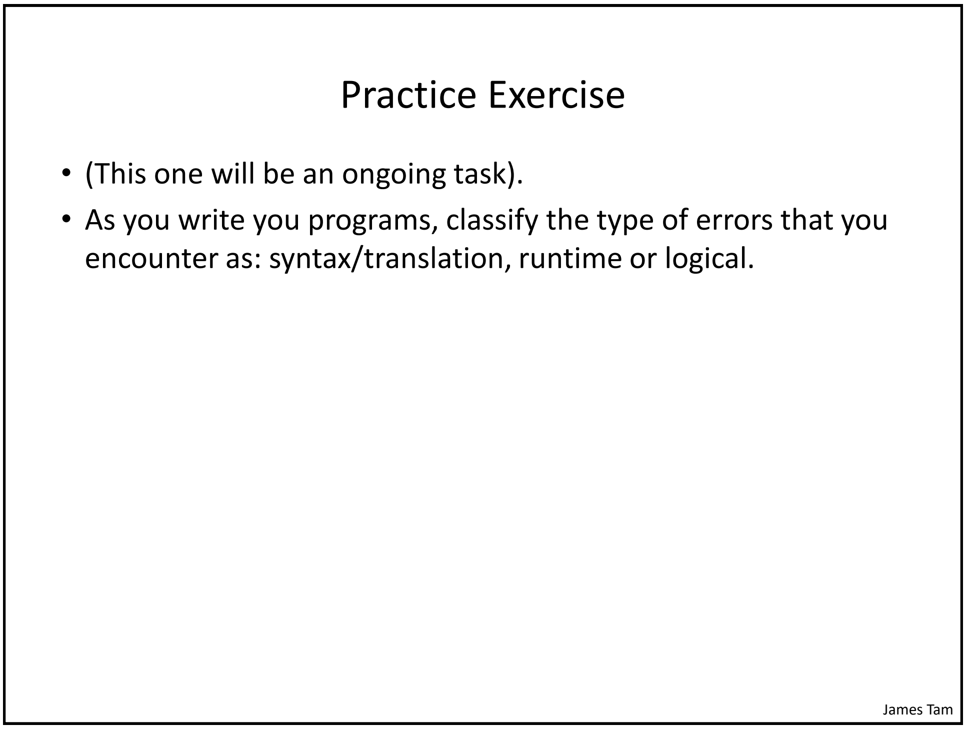
```
print ("This program will calculate the area of a rectangle")
length = int(input("Enter the length: "))
width = int(input("Enter the width: "))
area = length + width
print("Area: ", area)
```



```
This program will calculate the area of a rectangle
Enter the length: 3
Enter the width: 4
Area:  7
```

Some Additional Examples Of Errors

- All external links (not produced by your instructor):
  - http://level1wiki.wikidot.com/syntax-error
  - http://www.cs.bu.edu/courses/cs108/guides/debug.html
  - http://cscircles.cemc.uwaterloo.ca/1e-errors/
  - http://www.greenteapress.com/thinkpython/thinkCSpy/html/app01.html



Practice Exercise

- (This one will be an ongoing task).
- As you write you programs, classify the type of errors that you encounter as: syntax/translation, runtime or logical.

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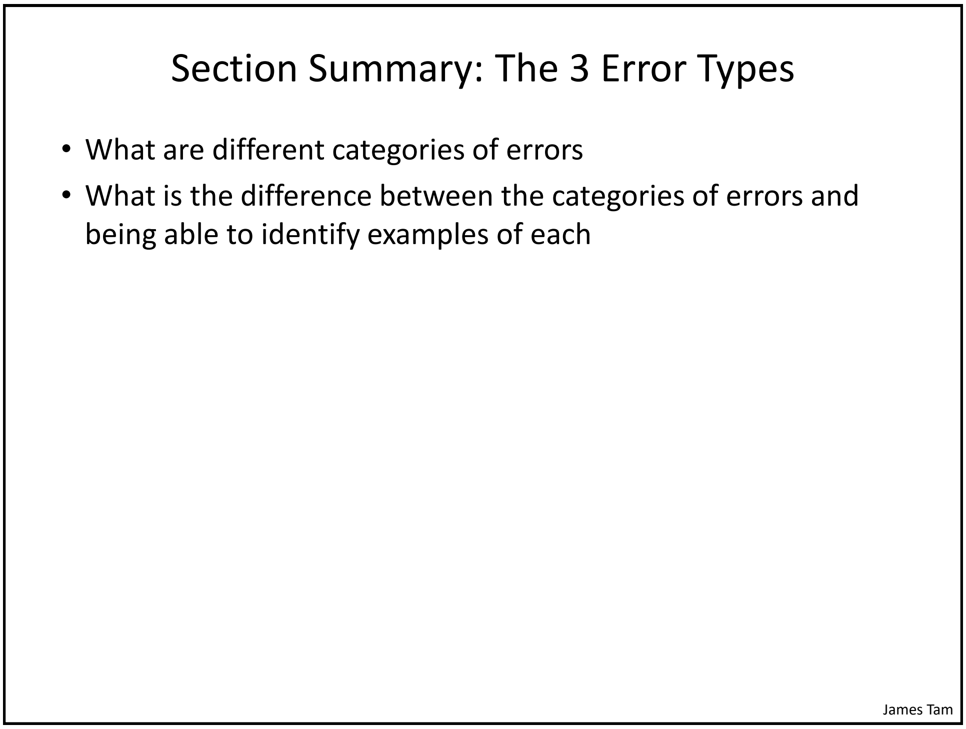

Section Summary: The 3 Error Types

- What are different categories of errors
- What is the difference between the categories of errors and being able to identify examples of each

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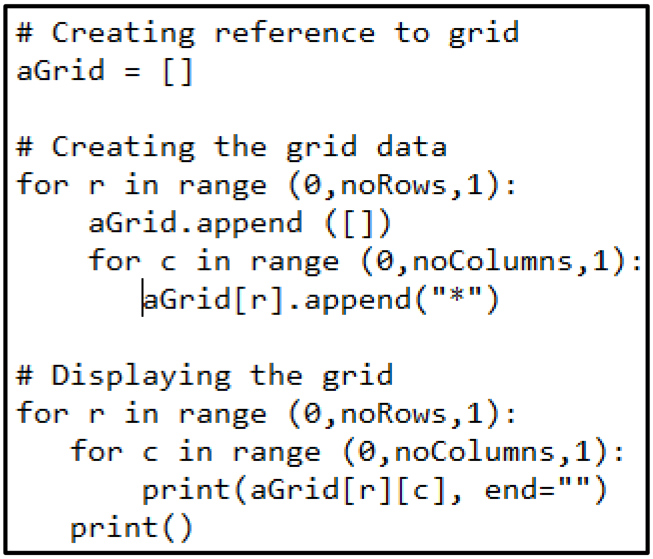
Layout And Formatting

- Similar to written text: all computer programs (except for the smallest ones) should use white space to group related instructions and to separate different groups.

```
# These are output statements to prompt for user information
Instruction1
Instruction2
Instruction3
Instruction4


# These are instructions to perform calculations on the user
# input and display the results
Instruction5
Instruction6
```

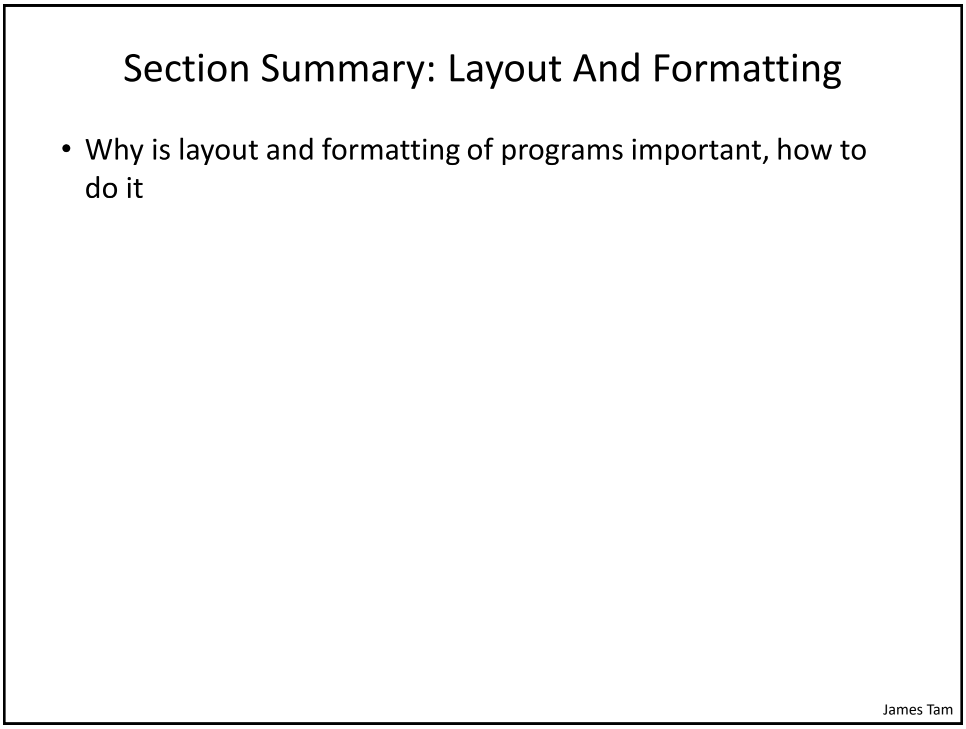
Layout And Formatting: Example



```
# Creating reference to grid
aGrid = []

# Creating the grid data
for r in range (0,noRows,1):
    aGrid.append ([])
    for c in range (0,noColumns,1):
       aGrid[r].append("*")

# Displaying the grid
for r in range (0,noRows,1):
   for c in range (0,noColumns,1):
       print(aGrid[r][c], end="")
   print()
```



Section Summary: Layout And Formatting

- Why is layout and formatting of programs important, how to do it

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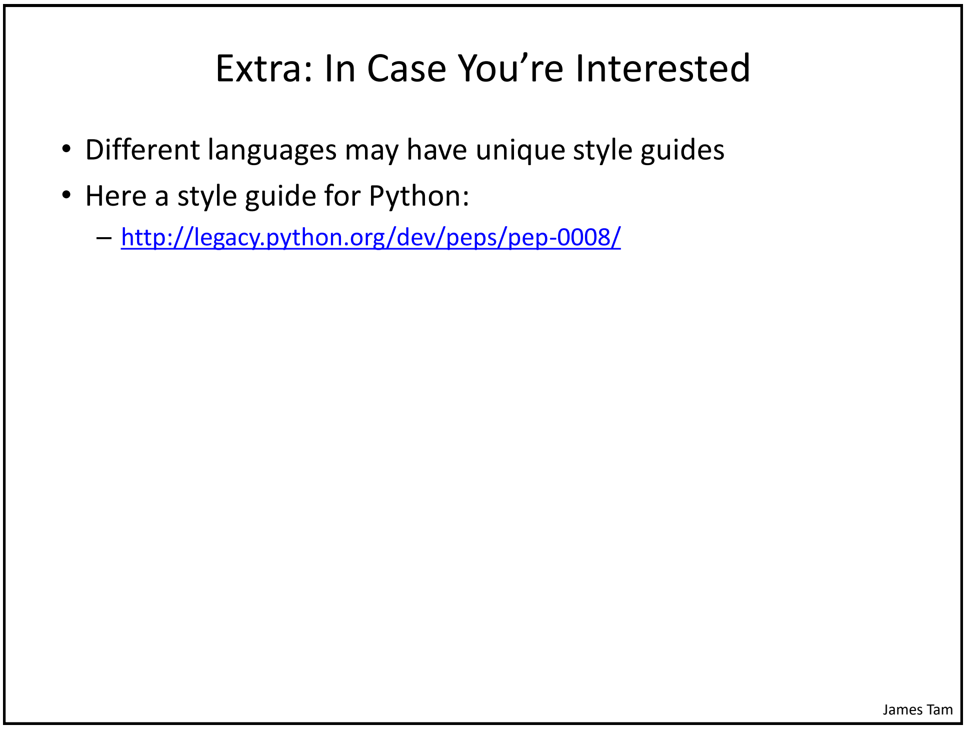

Extra: In Case You're Interested

- Different languages may have unique style guides
- Here a style guide for Python:
  - http://legacy.python.org/dev/peps/pep-0008/

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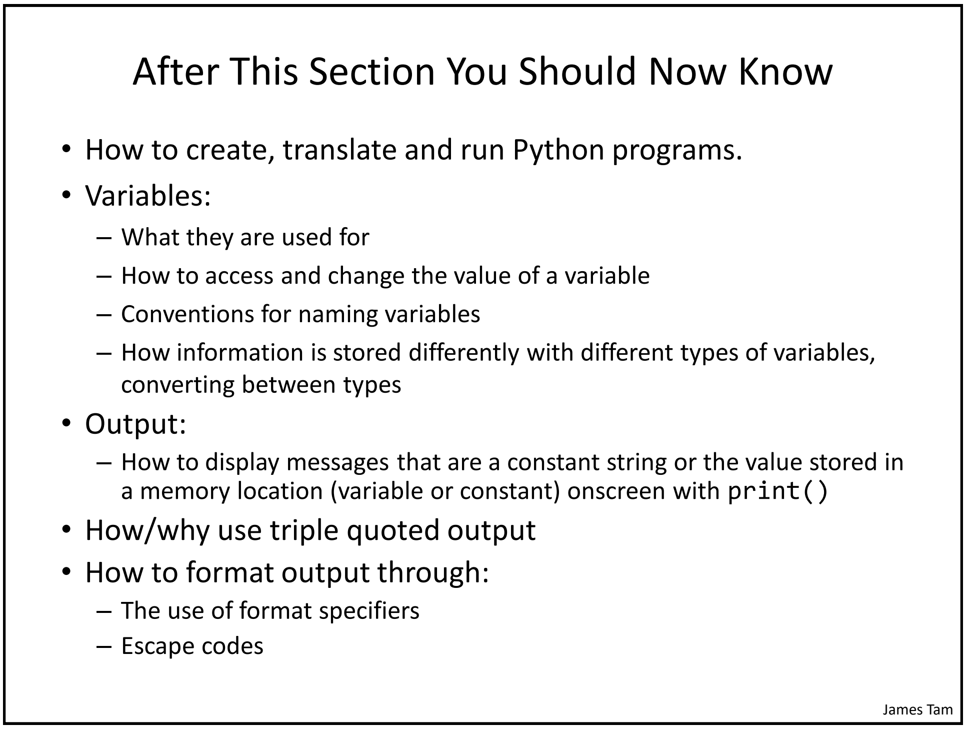

After This Section You Should Now Know

- How to create, translate and run Python programs.
- Variables:
  - What they are used for
  - How to access and change the value of a variable
  - Conventions for naming variables
  - How information is stored differently with different types of variables, converting between types
- Output:
  - How to display messages that are a constant string or the value stored in a memory location (variable or constant) onscreen with `print()`
- How/why use triple quoted output
- How to format output through:
  - The use of format specifiers
  - Escape codes

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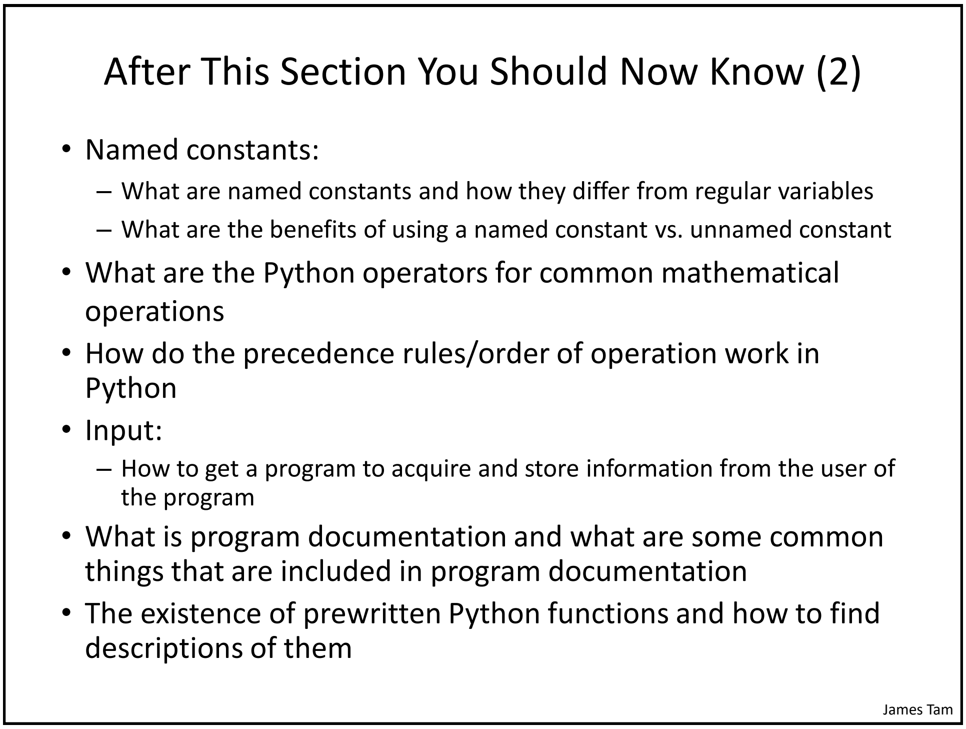

After This Section You Should Now Know (2)

- Named constants:
  - What are named constants and how they differ from regular variables
  - What are the benefits of using a named constant vs. unnamed constant
- What are the Python operators for common mathematical operations
- How do the precedence rules/order of operation work in Python
- Input:
  - How to get a program to acquire and store information from the user of the program
- What is program documentation and what are some common things that are included in program documentation
- The existence of prewritten Python functions and how to find descriptions of them

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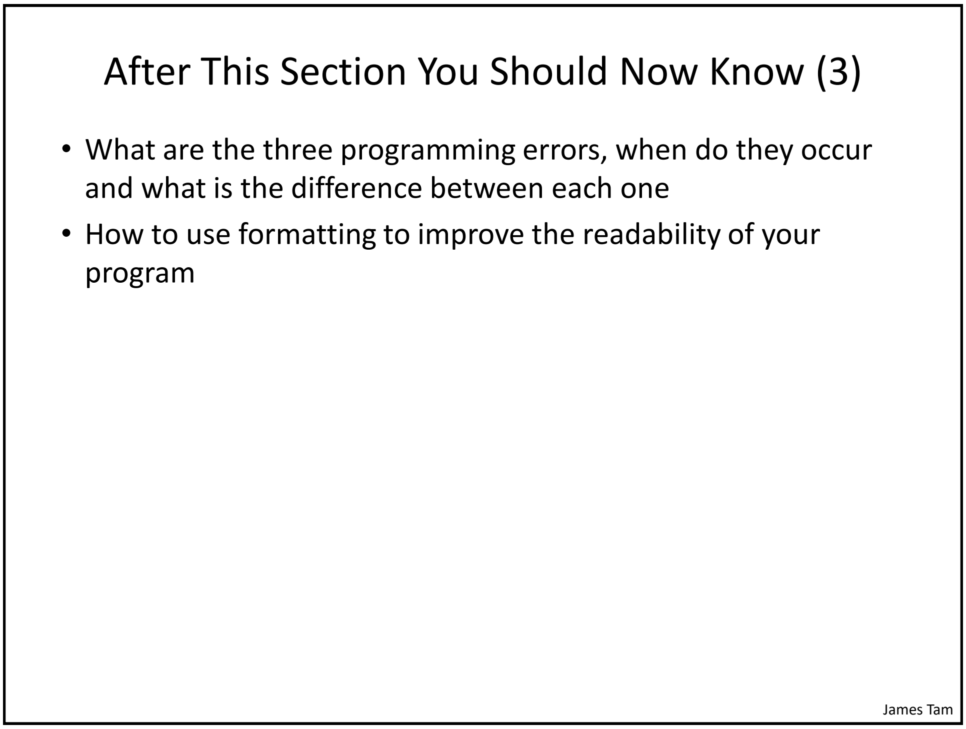

After This Section You Should Now Know (3)

- What are the three programming errors, when do they occur and what is the difference between each one
- How to use formatting to improve the readability of your program

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