



Debugging Principles and Techniques

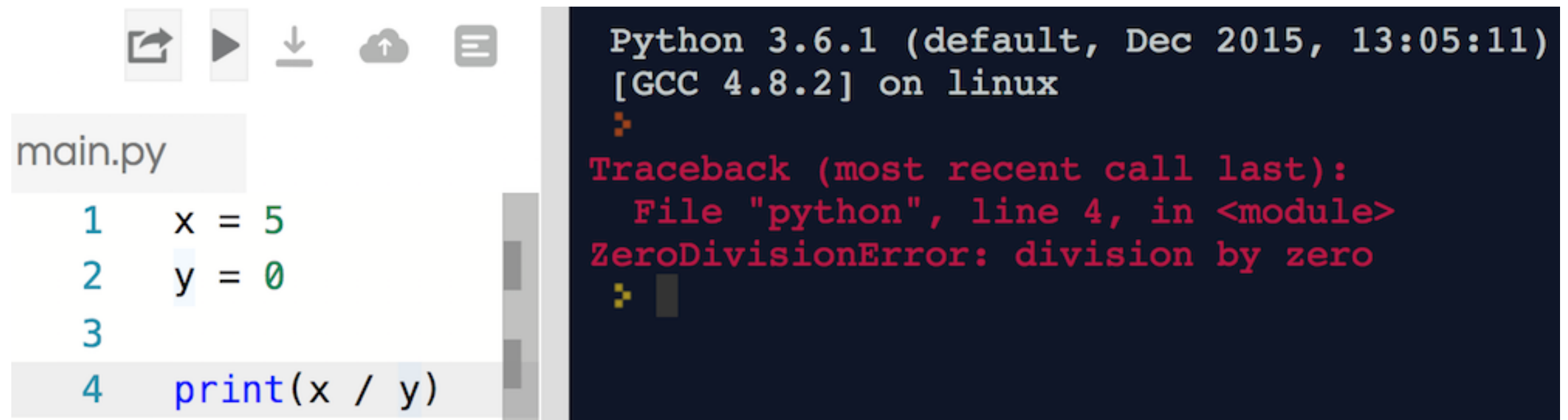
Lesson Objectives

After this lesson, you will be able to...

- Troubleshoot common types of errors.
- Implement basic exception mitigation.
- Troubleshoot logic errors.

Discussion: Error Messages

Have you found a shiny red error message before? What do you think has happened here?



The image shows a code editor interface. On the left, a file named 'main.py' is open, containing four lines of Python code: `1 x = 5`, `2 y = 0`, `3`, and `4 print(x / y)`. The code is displayed with syntax highlighting. Above the code editor is a toolbar with icons for running, saving, and other functions. On the right, a terminal window shows the output of running the script. It displays the Python version and GCC version, followed by a red traceback message: `Traceback (most recent call last):`, `File "python", line 4, in <module>`, and `ZeroDivisionError: division by zero`. The error message is highlighted in red, and a cursor is visible at the end of the last line.

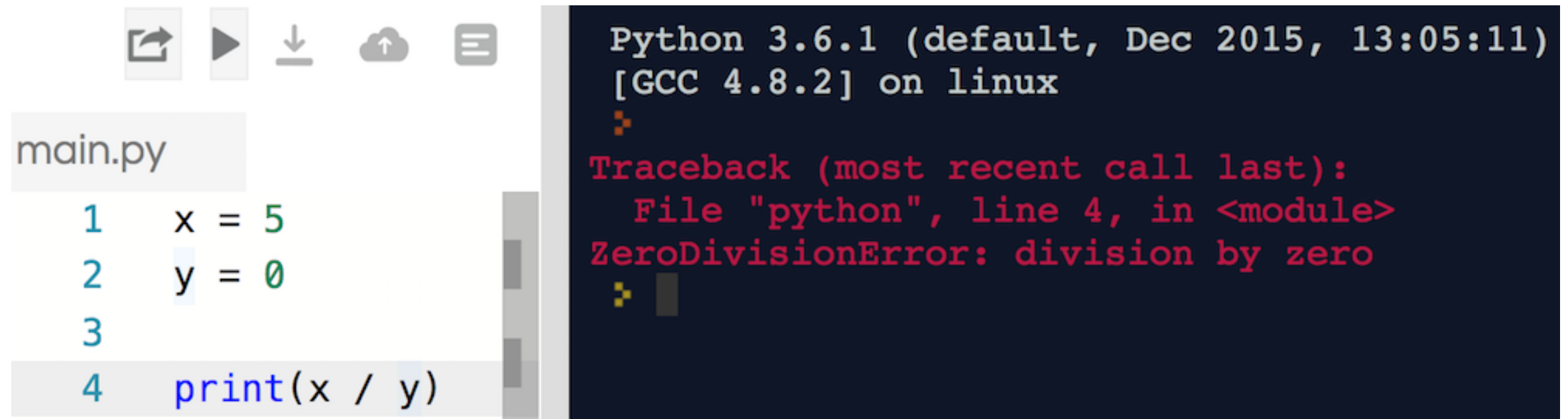
```
Python 3.6.1 (default, Dec 2015, 13:05:11)
[GCC 4.8.2] on linux
Traceback (most recent call last):
  File "python", line 4, in <module>
ZeroDivisionError: division by zero
```

Making Errors Into Friends

On the surface, errors are frustrating! However, we'll walk through some common ones. You'll see:

- Errors sometimes say exactly what's wrong.
- Some errors have very common causes.
- Errors may say exactly how to fix the issue.
- Python errors are very helpful and have clear messages.

With that in mind - what's the problem with this code?



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```
Python 3.6.1 (default, Dec 2015, 13:05:11)
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>
Traceback (most recent call last):
  File "python", line 4, in <module>
ZeroDivisionError: division by zero
>
```

We Do: IndexError

Let's debug this code together.

run ▶ open in repl.it

main.py history

```
1 race_runners = ["Yuna", "Bill", "Hyun"]
2
3 first_place = race_runners[1]
4 second_place = race_runners[2]
5 third_place = race_runners[3]
6
7 print("The winners are:", first_place, second_place, third_place)
```

Python 3.6.1 (default, Dec 2015, 13:05:11)
[GCC 4.8.2] on linux
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Protip: Index errors typically happen when you attempt to access a list index that doesn't exist.

You Do: Fix a NameError

Directions: Fix it!

Hints: - Run the code to get the error. - What kind of error is it? What is the error message?

run ▶

open in 

main.py history

```
1 # Get a number between 2 and 8.
2 my_nums = 5
3
4 # Print the number
5 print(my_num)
```

Python 3.6.1 (default, Dec 2015, 13:05:11)
[GCC 4.8.2] on linux
✖ █


KeyError

Accessing a key in a dictionary that doesn't exist.

Commonly caused by: - A misspelling. - Mixing uppercase and lowercase.

The error message tells you exactly what key is missing!

run ▶

open in 

main.py history

```
1 my_favorites = {
2     "Food": "Lobster Rolls",
3     "Song": "Bohemian Rhapsody",
4     "Flower": "Iris",
5     "Band": "Tom Petty & the Heartbreakers",
6     "Color": "Green",
7     "Movie": "The Princess Bride",
8     "Programming Language": "Python"
9 }
10
```

Python 3.6.1 (default, Dec 2015, 13:05:11)


[GCC 4.8.2] on linux


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AttributeError

- More general than `KeyError`, but the same idea.
- Accessing an attribute (e.g., function or property) that doesn't exist

run ▶

open in 

main.py  history


```
1 class Dog():
2     def __init__(self, name):
3         self.name = name
4
5     def bark(self):
6         print("Bark!")
7
8 # Declare a new dog instance
9 my_dog = Dog("Fido")
10
```


Python 3.6.1 (default, Dec 2015, 13:05:11)
[GCC 4.8.2] on linux
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Discussion: SyntaxError

Let's run the code together. What happens? How can we fix it?

run ▶

open in 

main.py  history

```
1 my_age = 13
2
3 if my_age = 18:
4     print("I may vote.")
5 else:
6     print("I may not vote.")
```

Python 3.6.1 (default, Dec 2015, 13:05:11)
[GCC 4.8.2] on linux
✖ █

Discussion: TypeError

`TypeError` and its message tell us:

```
my_num = 5 + "10"  
  
print(my_num)  
  
# TypeError: unsupported operand type(s) for +: 'int' and 'str'
```

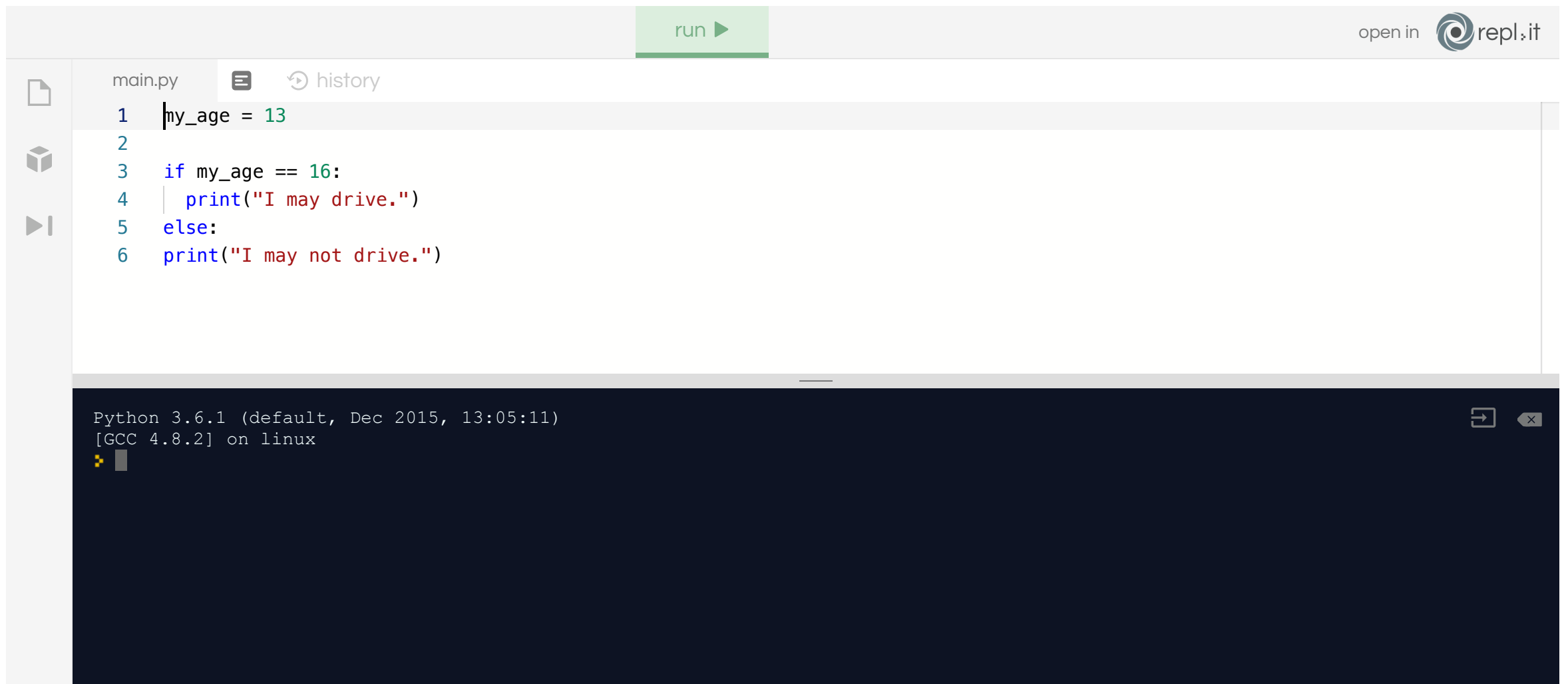
What do we learn from this error message? Have you learned a way to fix this?

Fun Fact: Some languages, like JavaScript, let this code run (breaking something!).

IndentationError

May be caused by:

- Not enough indentation
- Mismatched indentation
- Mixing tabs and spaces!



The screenshot shows a Repl.it Python environment. At the top, there is a 'run' button and a link to 'open in repl.it'. Below this is a code editor with a file named 'main.py'. The code in the editor is as follows:

```
1 my_age = 13
2
3 if my_age == 16:
4     print("I may drive.")
5 else:
6     print("I may not drive.")
```

The code is syntactically correct, but it would cause an IndentationError if run as-is because the indentation of the code inside the if and else blocks is not consistent (it uses a mix of spaces and tabs, though in this specific image it appears to be spaces). The bottom of the screenshot shows a terminal window with the following text:

```
Python 3.6.1 (default, Dec 2015, 13:05:11)
[GCC 4.8.2] on linux
>
```

ValueError

Most commonly caused by trying to convert a bad string into a number.

```
# This is okay!  
my_num = int("10")  
  
# This throws a ValueError  
my_num = int("Moose")
```

RuntimeError

The worst error to see!

- When no other error type fits.
- You need to rely on the error message content.
- May be used for custom errors.

Example: `RuntimeError` is like if I said to you:

```
Please eat the piano
```

You can understand what's being asked, but can't actually do that!

Quick Review

There are many types of errors in Python!

Usually, the error has a name or description that says exactly what's wrong.

Think about `IndentationError` or `IndexError` - what went wrong?

Sometimes, you'll see `RuntimeError`. Python throws us this if something is broken but it can't say specifically what - like `Please eat the piano`. Revisit your code and see what might have happened.

Next Up: A list of common errors, then ways to prevent errors.

List of Common Errors

This chart's for you to refer to later - don't memorize it now!

Error Type	Most Common Cause
AttributeError	Attempting to access a non-existent attribute
KeyError	Attempting to access a non-existent key in a dict
ImportError	A module you tried to import doesn't exist
IndexError	You attempted to access a list element that doesn't exist
IndentationError	Indenting code in an invalid way
IOError	Accessing a file that doesn't exist
NameError	Attempting to use a module you haven't imported/installed
OverflowError	You made a number larger than the maximum size
RuntimeError	The error doesn't fit into any other category
SyntaxError	A typo, such as forgetting a colon
TypeError	Using two different types in an incompatible way
ValueError	When you are trying to convert bad keyboard input to a number
ZeroDivisionError	Dividing By Zero

Discussion: Throwing Errors

Sometimes, we might have code that we expect to throw an error.

```
# The user might not give us a number!  
my_num = int(input("Please give me a number:"))
```

What if the user types a string like “Moose”?

- This causes a `ValueError` - we'll be trying to make an int out of a string “Moose”.
- We can anticipate and prepare for it!


Try-Except

A `Try-Except` block is the way we can catch errors in Python. We can catch:

- One error (`except ValueError:`)
- Multiple errors (`except (ValueError, KeyError):`)
- Any/every error (`except:`)

Always try to specify the error, if possible!

run ▶

open in 

main.py history

```
1 my_num = None
2
3 while my_num is None:
4     try:
5         my_num = int(input("Please give me a number:"))
6     except ValueError:
7         print("That was not good input, please try again!")
8
9 print("Thanks for typing the number", my_num)
```

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[GCC 4.8.2] on linux

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Discussion: Switching Gears

Not every programming error is caught by an error message!

- Can anyone say what is wrong with this code?
- What might happen if you run it?

Do not try to run the below code.

```
my_num = 1

while my_num < 10:
    print(my_num)
    my_num + 1
```

Discussion: Another Infinite Loop

It's easy to accidentally make an infinite loop. What's the problem here?

```
am_hungry = True
fridge_has_food = True

while am_hungry or fridge_has_food:
    print("Opening the fridge!")
    am_hungry = False
```

Infinite Infinite Loops!

Most common infinite loops are a result of:

- A `while` loop's condition never becomes `False`.
- Forgetting to increment a counter variable.
- Logic inside the loop that restarts the loop.
- Bad logic in a `while` loop's condition (e.g., putting `or` instead of `and`)

Be careful to check your end conditions!

If you find your program running endlessly, hit `control-c` in the terminal window to stop it!

Discussion: Logic Error

Here, we want to find the average of 8 and 10. The answer should be 9, because $8 + 10 == 18$, then $18 / 2 == 9$

What happened and why?

run ▶

open in repl.it

main.py

history

```
1 x = 8
2 y = 10
3 average = x + y / 2
4 print(average)
```

Python 3.6.1 (default, Dec 2015, 13:05:11)

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Quick Review: Common Errors

- If you expect an error, use a try/except block:

```
my_num = None

while my_num is None:
    try:
        my_num = int(input("Please give me a number:"))
    except ValueError as err:
        print("That was not good input, please try again!")
        print("Error was", err)

print("Thanks for typing the number", my_num)
```

- Logic problems are common but won't throw a helpful error. Always check end conditions on your `while` loops!

Print Statements for Sanity Checks

Pro Tip: If something is wonky and you don't know why, starting `printing`.

- Use `print` statements on each line to peek at the values.
- Remember to remove debugging statements once the problem is solved!


```
x = 8
y = 10
get_average = x + y / 2
print("get_average is", get_average) # Print out what this equals (it's wrong)
testing_sum = x + y # To figure out why, break it down.
print("testing_sum is", testing_sum) # Print out each step.
testing_average = testing_sum / 2
print("testing_average is", testing_average) # The individual math test works
# We know there must be a problem with the logic in "average"
```

When your programs become very complex, adding `print` statements will be a great help.

You Do: Wrapping it Up

Can you fix the code below?

run ▶

open in 

main.py history

```
1 new_phone = Phone(5214)
2
3 class Phone:
4     def __init__(self, phone_number):
5         self.number = phone_number
6
7     def call(self, other_number):
8         print("Calling from" self.number, "to", other_number)
9
10    def text(self, other number, msg):
```

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Summary and Q&A

- Python has many common built-in errors.
- Use `try-except` syntax to catch an expected error.
- Logic issues don't throw errors, so be careful!
- Use `print` statements to walk through your code line-by-line.

Additional Resources

- [List of Built-In Errors](#)
- [Error Flowchart PDF](#)
- [Try-Except Documentation](#)
- [A deep dive into try/except clauses](#)
- To get advanced, add [logging](#) to your code.
- To get very advanced, include [unit tests](#); the [pytest module](#) is great.