

Exceptions & Decorators

Class outline:

- Exceptions
- Decorators

Exceptions

Handling errors

Sometimes, computer programs behave in non-standard ways.

- A function receives an argument value of an improper type
- Some resource (such as a file) is not available
- A network connection is lost in the middle of data transmission



Moth found in a Mark II Computer (Grace Hopper's Notebook, 1947)

Exceptions

An **exception** is a built-in mechanism in a programming language to declare and respond to "exceptional" conditions.

A program raises an exception when an error occurs.

If the exception is not handled, the program will stop running entirely.

But if a programmer can anticipate when exceptions might happen, they can include code for **handling the exception**, so that the program continues running.

Many languages include exception handling: C++, Java, Python, JavaScript, etc.

Exceptions in Python

Python raises an exception whenever a runtime error occurs.

How an unhandled exception is reported:

```
>>> 10/0
Traceback (most recent call last):
  File "<stdin>", line 1, in
ZeroDivisionError: division by zero
```

If an exception is not handled, the program stops executing immediately.

Types of exceptions

A few exception types and examples of buggy code:

Exception	Example
<code>OverflowError</code>	<code>pow(2.12, 1000)</code>
<code>TypeError</code>	<code>'hello'[1] = 'j'</code>
<code>IndexError</code>	<code>'hello'[7]</code>
<code>NameError</code>	<code>x += 5</code>
<code>FileNotFoundError</code>	<code>open('dsfdfd.txt')</code>

See full list in the [exceptions docs](#).

The try statement

To handle an exception (keep the program running), use a `try` statement.

```
try:
    <try suite>
except <exception class> as <name>:
    <except suite>
...
```

The `<try suite>` is executed first. If, during the course of executing the `<try suite>`, an exception is raised that is not handled otherwise, and if the class of the exception inherits from `<exception class>`, then the `<except suite>` is executed, with `<name>` bound to the exception.

Try statement example

```
try:  
    quot = 10/0  
except ZeroDivisionError as e:  
    print('handling a', type(e))  
    quot = 0
```



Try in PythonTutor

Try inside a function

```
def div_numbers(dividend, divisor):  
    try:  
        quotient = dividend/divisor  
    except ZeroDivisionError:  
        print("Function was called with 0 as divisor")  
        quotient = 0  
    return quotient
```

```
div_numbers(10, 2)  
div_numbers(10, 0)  
div_numbers(10, -1)
```



Try in PythonTutor

What would Python Do?

```
def invert(x):  
    inverse = 1/x # Raises a ZeroDivisionError if x is 0  
    print('Never printed if x is 0')  
    return inverse  
  
def invert_safe(x):  
    try:  
        return invert(x)  
    except ZeroDivisionError as e:  
        print('Handled', e)  
        return 0
```

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```
invert_safe(1/0)
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        print('Handled', e)  
        return 0
```

```
invert_safe(1/0)
```

```
try:  
    invert_safe(0)  
except ZeroDivisionError as e:  
    print('Handled!')
```

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```
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```

```
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    invert_safe(0)  
except ZeroDivisionError as e:  
    print('Handled!')
```

```
inverrrrt_safe(1/0)
```

Raising exceptions

Assert statements

Assert statements raise an exception of type `AssertionError`:

```
assert <expression>, <string>
```

Assertions are designed to be used liberally. They can be ignored to increase efficiency by running Python with the "-O" flag; "O" stands for optimized.

```
python3 -O
```


Raise statements

Any type of exception can be raised with a `raise` statement

```
raise <expression>
```

`<expression>` must evaluate to a subclass of `BaseException` or an instance of one

Exceptions are constructed like any other object. E.g., `TypeError('Bad argument!')`

Decorators

A tracing function

Let's make a higher-order tracing function.

```
def trace1(f):  
    """Return a function that takes a single argument, x, prints it,  
    computes and prints F(x), and returns the computed value.  
>>> square = lambda x: x * x  
>>> trace1(square)(3)  
-> 3  
<- 9  
9  
"""
```

A tracing function

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```
def trace1(f):  
    """Return a function that takes a single argument, x, prints it,  
    computes and prints F(x), and returns the computed value.  
    >>> square = lambda x: x * x  
    >>> trace1(square)(3)  
    -> 3  
    <- 9  
    9  
    """  
    def traced(x):  
        print("->", x)  
        r = f(x)  
        print("<-", r)  
        return r  
    return traced
```

A tracing decorator

What if we always wanted a function to be traced?

```
@trace1  
def square(x):  
    return x * x
```

That's equivalent to..

```
def square(x):  
    return x * x  
square = trace1(square)
```

General decorator syntax

The notation:

```
@ATTR  
def aFunc(...):  
    ...
```

is essentially equivalent to:

```
def aFunc(...):  
    ...  
aFunc = ATTR(aFunc)
```

ATTR can be any expression, not just a single function name.