Exceptions
Announcements
Exceptions
Today's Topic: Handling Errors
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Sometimes, computer programs behave in non-standard ways
Today's Topic: Handling Errors

Sometimes, computer programs behave in non-standard ways
  • A function receives an argument value of an improper type
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- A function receives an argument value of an improper type
- Some resource (such as a file) is not available
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- A function receives an argument value of an improper type
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- A network connection is lost in the middle of data transmission
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Grace Hopper's Notebook, 1947, Moth found in a Mark II Computer
Exceptions
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A built-in mechanism in a programming language to declare and respond to exceptional conditions
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Python raises an exception whenever an error occurs
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Mastering exceptions:
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**Mastering exceptions:**

Exceptions are objects! They have classes with constructors.
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They enable non-local continuation of control
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They enable non-local continuation of control

If \( f \) calls \( g \) and \( g \) calls \( h \), exceptions can shift control from \( h \) to \( f \) without waiting for \( g \) to return.
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They enable non-local continuation of control

If \( f \) calls \( g \) and \( g \) calls \( h \), exceptions can shift control from \( h \) to \( f \) without waiting for \( g \) to return.

(Exception handling tends to be slow.)
Raising Exceptions
Assert Statements

Assert statements raise an exception of type AssertionError
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assert <expression>, <string>
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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
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Whether assertions are enabled is governed by a bool __debug__
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(Demo)
Raise Statements
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Exceptions are raised with a raise statement
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<expression> must evaluate to a subclass of BaseException or an instance of one
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 Exceptions are constructed like any other object. E.g., `TypeError('Bad argument!')`
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**TypeError** — A function was passed the wrong number/type of argument
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\[ \textit{raise} \ <\text{expression}> \]

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Exceptions are constructed like any other object. E.g., \texttt{TypeError('Bad argument!')} \n
**TypeError** -- A function was passed the wrong number/type of argument

**NameError** -- A name wasn't found
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- **TypeError** -- A function was passed the wrong number/type of argument
- **NameError** -- A name wasn't found
- **KeyError** -- A key wasn't found in a dictionary
Raise Statements

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- **NameError** -- A name wasn't found
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- **RecursionError** -- Too many recursive calls
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(Demo)
Try Statements
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Try statements handle exceptions
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```python
try:
    <try suite>
except <exception class> as <name>:
    <except suite>
...
```
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Execution rule:
Try Statements

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Execution rule:

The `<try suite>` is executed first.
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    <try suite>
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If, during the course of executing the <try suite>, an exception is raised that is not handled otherwise, and
Try Statements

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If the class of the exception inherits from `<exception class>`, then
Try Statements

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try:
    <try suite>
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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
Handling Exceptions
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Exception handling can prevent a program from terminating
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```python
>>> try:
```
Handling Exceptions

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```python
>>> try:
    x = 1/0
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Handling Exceptions

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```python
>>> try:
    x = 1/0
  except ZeroDivisionError as e:
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Handling Exceptions

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```python
>>> try:
    x = 1/0
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        print('handling a', type(e))
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    x = 1/0
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Handling Exceptions

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>>> try:
    x = 1/0
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handling a <class 'ZeroDivisionError'>
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handling a <class 'ZeroDivisionError'>
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Handling Exceptions

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handling a <class 'ZeroDivisionError'>
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```

**Multiple try statements:** Control jumps to the except suite of the most recent try statement that handles that type of exception
Handling Exceptions

Exception handling can prevent a program from terminating

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>>> try:
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handling a <class 'ZeroDivisionError'>
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**Multiple try statements:** Control jumps to the except suite of the most recent try statement that handles that type of exception
WWPD: What Would Python Display?

How will the Python interpreter respond?
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How will the Python interpreter respond?

```python
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:
        return str(e)
```

**WWPD: What Would Python Display?**

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>>> invert_safe(1/0)
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```console
>>> invert_safe(1/0)
>>> try:
```

```python
```
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>>> invert_safe(1/0)
>>> try:
    ...
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    except ZeroDivisionError as e:
    ...
    print('Hello!')
```

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**WWPD: What Would Python Display?**

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Example: Reduce
Reducing a Sequence to a Value
Reducing a Sequence to a Value

```python
def reduce(f, s, initial):
    """Combine elements of s pairwise using f, starting with initial.

    E.g., reduce(mul, [2, 4, 8], 1) is equivalent to mul(mul(mul(1, 2), 4), 8).
    
    >>> reduce(mul, [2, 4, 8], 1)
    64
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reduce(pow, [1, 2, 3, 4], 2)
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(Demo)
Environment Diagrams Review
def oski(bear):
    def cal(berk):
        nonlocal bear
        if bear(berk) == 0:
            return [berk+1, berk-1]
        bear = lambda ley: berk-ley
        return [berk, cal(berk)]
    return cal(2)
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```

```
Global frame
  oski

f1: oski [parent=G]
  bear
  cal
  Return Value

f2: cal [parent=f1]
  berk 2
  Return Value

f3: cal [parent=f1]
  berk 2
  Return Value

f4: λ [parent=f2]
  ley 2
  Return Value 0

list
  0 3 1
```

```
func oski(bear)[parent=G]
func λ(ley) [parent=f2]
func cal(berk) [parent=f1]
```
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