Basic Programming

Lesson 04

Functions

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Defining Functions

```
>>> def square(x):
...     return x * x
...
>>> square(5)
25
>>> def launch_missiles():
...     print("Missiles launched!")
...
>>> launch_missiles()
Missiles launched!
>>>
```

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Early Return

```
>>> def even_or_odd(n):
...     if n % 2 == 0:
...         print("even")
...         return
...     print("odd")
...
>>> w = even_or_odd(31)
odd
>>> w is None
True
>>>
```

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Naming Special Functions

__feature__

Hard to prounounce!

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dunder

Our way of pronouncing special names

A portmanteau of "double underscore"

Instead of "underscore underscore name underscore underscore" we'll say "dunder name"

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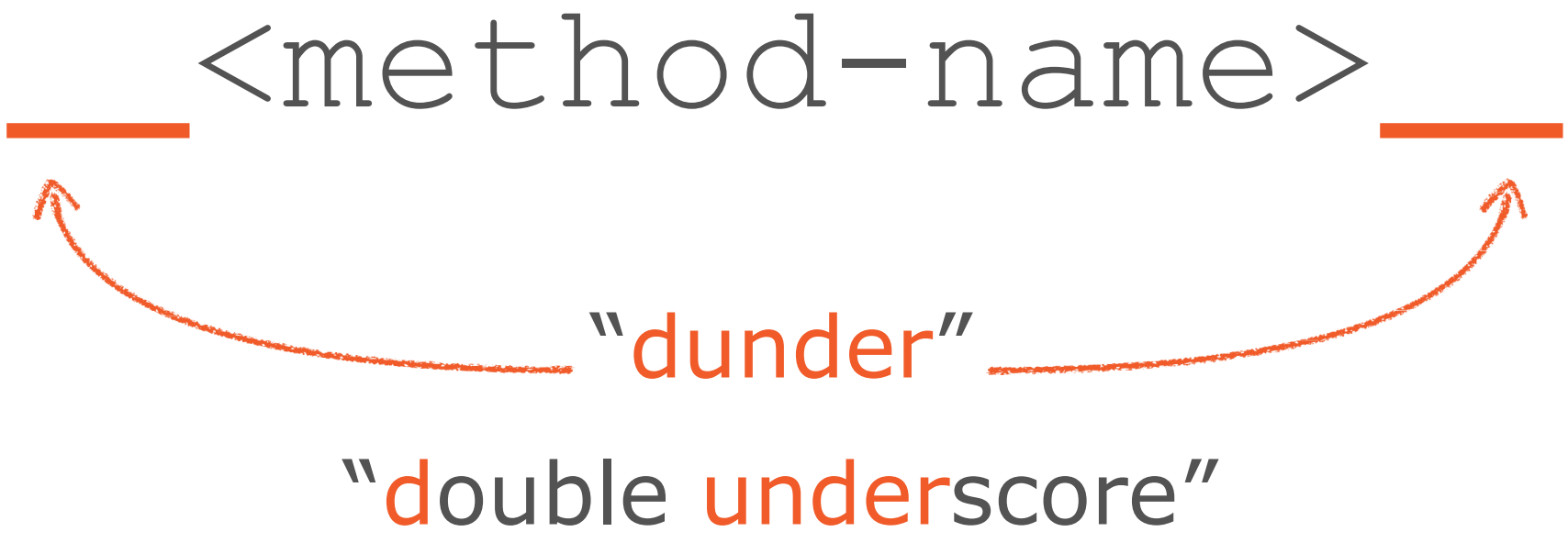
Terminology for Python Special Methods



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Terminology for Python Special Methods

`__len__`

"dunder len"

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Import or Execute

```
from urllib.request import urlopen

def fetch_words():
  story = urlopen('http://sixty-north.com/c/t.txt')
  story_words = []
  for line in story:
      line_words = line.decode('utf8').split()
      for word in line_words:
          story_words.append(word)
  story.close()

  for word in story_words:
      print(word)

if __name__ == '__main__':
    fetch_words()
```

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Docstrings

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docstrings

Literal strings which document functions, modules, and classes.

They must be the first statement in the blocks for these constructs.

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Docstrings

```
>>> from words import *
>>> help(fetch_words)
Help on function fetch_words in module words:

fetch_words(url)
    Fetch a list of words from a URL.

    Args:
        url: The URL of a UTF-8 text document.

    Returns:
        A list of strings containing the words from
        the document.
(END)
```

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Docstrings

```
Help on module words:

NAME
    words - Retrieve and print words from a URL.

DESCRIPTION
    Usage:

       python3 words.py <URL>

FUNCTIONS
    fetch_words(url)
        Fetch a list of words from a URL.

        Args:
            url: The URL of a UTF-8 text document.

        Returns:
            A list of strings containing the words from
            the document.

    main(url)
        Print each word from a text document from at a URL.
:
```

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Comments

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Comments

Code is ideally clear enough without ancillary explanation

Sometimes you need to explain why your code is written as it is

Comments in Python start with # and extend to the end of the line

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Passing arguments and returning values

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Argument Passing

```
>>> m = [9, 15, 24]
>>> def modify(k):
...         k.append(39)
...         print("k =", k)
...
>>> modify(m)
k = [9, 15, 24, 39]
>>> m
[9, 15, 24, 39]
>>>
```

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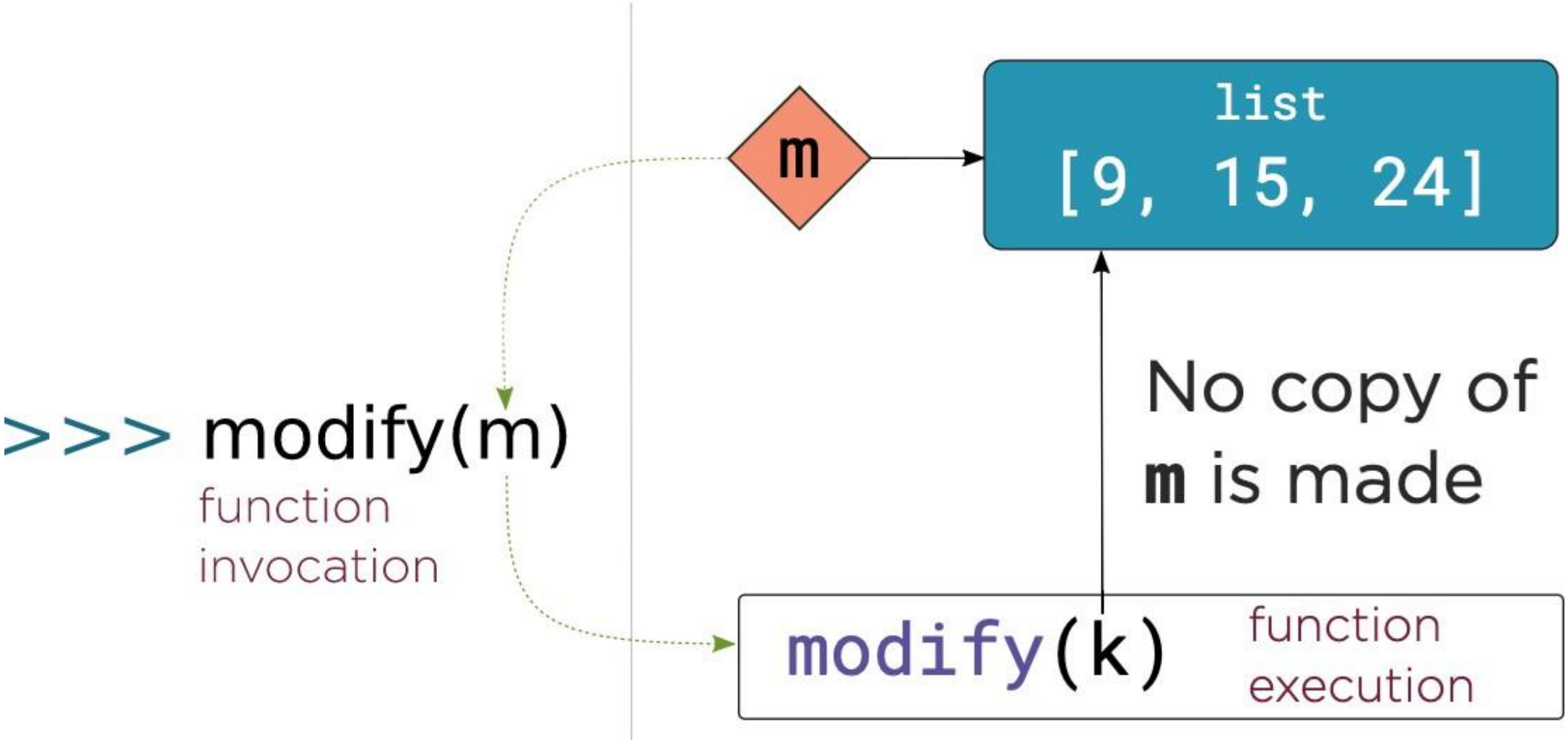
Argument Passing Semantics



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Replacing Argument Value

```
>>> f = [14, 23, 37]
>>> def replace(g):
...         g = [17, 28, 45]
...         print("g =", g)
...
>>> replace(f)
g = [17, 28, 45]
>>> f
[14, 23, 37]
>>>
```

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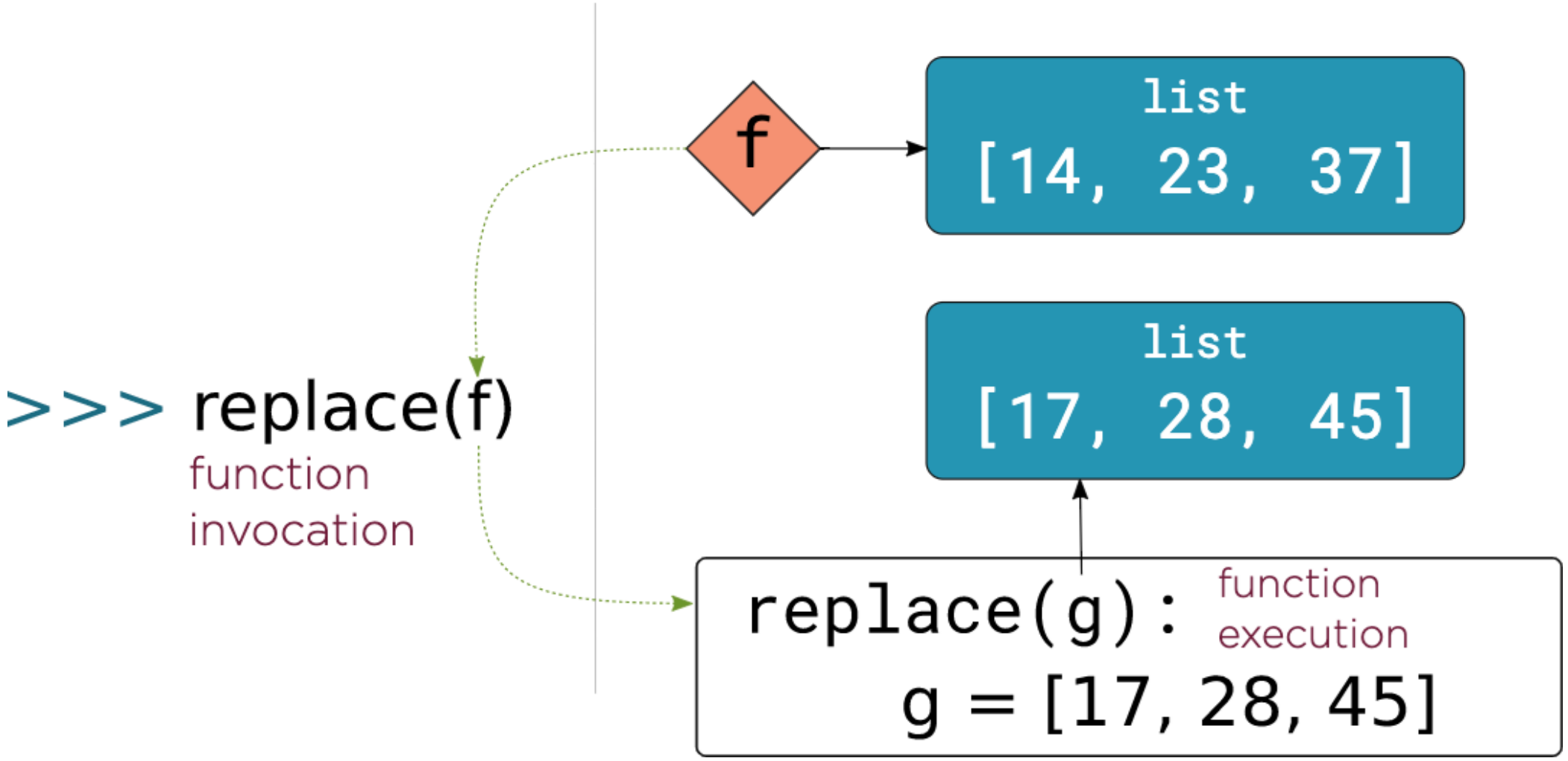
Replacing Argument Value



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Return Semantics

```
>>> def f(d):
...     return d
...
>>> c = [6, 10, 16]
>>> e = f(c)
>>> c is e
True
>>>
```

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Function Arguments

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Default Argument Values

```
>>> def banner(message, border='-'):
...     line = border * len(message)
...     print(line)
...     print(message)
...     print(line)
...
>>> banner("Norwegian Blue")
--------------
Norwegian Blue
--------------
>>> banner("Sun, Moon and Stars", "*")
******************
Sun, Moon and Stars
******************
>>> banner("Sun, Moon and Stars", border="*")
******************
Sun, Moon and Stars
******************
>>> banner(border=".", message="Hello from Earth")
................
Hello from Earth
................
>>>
```

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Arguments with default values must come after those without default values.

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When are default values evaluated?

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Default Value Evaluation

```
>>> import time
>>> time.ctime()
'Sun Nov 24 19:43:48 2019'
>>> def show_default(arg=time.ctime()):
...     print(arg)
...
>>> show_default()
Sun Nov 24 19:43:49 2019
>>> show_default()
Sun Nov 24 19:43:49 2019
>>> show_default()
Sun Nov 24 19:43:49 2019
>>>
```

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Default Value Evaluation

Remember that `def` is a statement executed at runtime.

Default arguments are evaluated when `def` is executed.

Immutable default values don't cause problems.

Mutable default values can cause confusing effects.

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Always use immutable objects for default values.

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Handle Exceptions

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Exception handling

Mechanism for interrupting normal program flow and continuing in surrounding context

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Exceptions: Key Concepts

1. Raising an exception
2. Handling an exception
3. Unhandled exceptions
4. Exception objects

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Handle Exceptions

Cleanup Actions

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try...finally

```
try:
    # try-block
finally:
    # executed no matter how the
    # try-block terminates
```

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Not Exception-safe

```
import os


def make_at(path, dir_name):
    original_path = os.getcwd()
    os.chdir(path)
    os.mkdir(dir_name)
    os.chdir(original_path)
```

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Handle Exception and Cleanup

```
import os
import sys

def make_at(path, dir_name):
    original_path = os.getcwd()
    os.chdir(path)
    try:
        os.mkdir(dir_name)
    except OSError as e:
        print(e, file=sys.stderr)
        raise
    finally:
        os.chdir(original_path)
```

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Moment of Zen

Errors should never pass silently, unless explicitly silenced

Errors are like bells
And if we make them silent
They are of no use

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Handle Exceptions

Exceptions and Control flow

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```
DIGIT_MAP = {
    'zero':  '0',
    'one':   '1',
    'two':   '2',
    'three': '3',
    'four':  '4',
    'five':  '5',
    'six':   '6',
    'seven': '7',
    'eight': '8',
    'nine':  '9',
}

def convert(s):
    number = ''
    for token in s:
        number += DIGIT_MAP[token]
    x = int(number)
    return x
```

◀ Filename: exceptional.py

◀ Define a function

◀ Convert string to integer
◀ Return the integer

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```
>>> from exceptional import convert
>>> convert("one three three seven".split())
1337
>>> convert("around two grillion".split())
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "/Users/sixty-north/corepy/slide_spec/use-convert-v1/exceptional.py", lin
e 18, in convert
    number += DIGIT_MAP[token]
KeyError: 'around'
>>>
```

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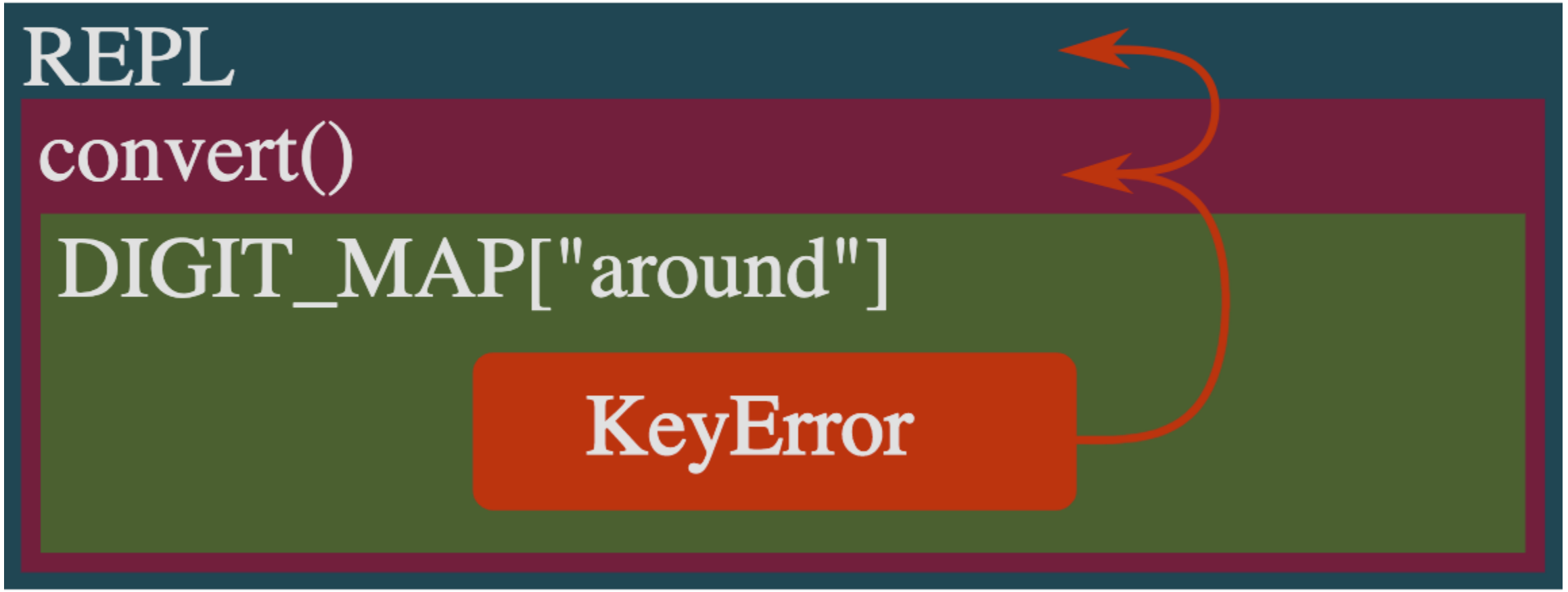
Exception Propagation



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```python
def convert(s):
    try:
        number = ''
        for token in s:
            number += DIGIT_MAP[token]
        x = int(number)
    except KeyError:
        x = -1
    return x
```

- try-block
- Raise exceptions

- except-block
- Handle exceptions

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```python
def convert(s):
    try:
        number = ''
        for token in s:
            number += DIGIT_MAP[token]
        x = int(number)
        print(f"Conversion succeeded! x = {x}")
    except KeyError:
        print("Conversion failed!")
        x = -1
    return x
```

◀ Print on success

◀ Print on failure

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```
>>> from exceptional import convert
>>> convert("three four".split())
Conversion succeeded! x = 34
34
>>> convert("eleventeen".split())
Conversion failed!
-1
>>> convert(512)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "/Users/sixty-north/corepy/slide_spec/use-convert-v3/exceptional.py", lin
e 18, in convert
    for token in s:
TypeError: 'int' object is not iterable
>>>
```

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```python
def convert(s):
    try:
        number = ''
        for token in s:
            number += DIGIT_MAP[token]
        x = int(number)
        print(f"Conversion succeeded! x = {x}")
    except KeyError:
        print("Conversion failed!")
        x = -1
    return x
```

◀ Not executed

◀ Executed

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```python
def convert(s):
    """Convert a string to an integer."""
    try:
        number = ''
        for token in s:
            number += DIGIT_MAP[token]
        x = int(number)
        print(f"Conversion succeeded! x = {x}")
    except KeyError:
        print("Conversion failed!")
        x = -1
    except TypeError:
        print("Conversion failed!")
        x = -1
    return x
```

- Duplication

- Add `TypeError` handler
- Duplication

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```
>>> from exceptional import convert
>>> convert(512)
Conversion failed!
-1
>>>
```

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```python
def convert(s):
    """Convert a string to an integer."""
    x = -1
    try:
        number = ''
        for token in s:
            number += DIGIT_MAP[token]
        x = int(number)
        print(f"Conversion succeeded! x = {x}")
    except KeyError:
        print("Conversion failed!")
    except TypeError:
        print("Conversion failed!")
    return x
```

◀ Assignment

◀ Duplication

◀ Duplication

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```python
def convert(s):
    """Convert a string to an integer."""
    x = -1
    try:
        number = ''
        for token in s:
            number += DIGIT_MAP[token]
        x = int(number)
        print(f"Conversion succeeded! x = {x}")
    except (KeyError, TypeError):
        print("Conversion failed!")
    return x
```

◀ Merge except blocks

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```
>>> from exceptional import convert
>>> convert("two nine".split())
Conversion succeeded! x = 29
29
>>> convert("elephant".split())
Conversion failed!
-1
>>> convert(451)
Conversion failed!
-1
>>>
```

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Exceptions resulting from programmer errors:

```
IndentationError

SyntaxError

NameError
```

These should almost never be caught.

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Handle Exceptions

Accessing Exception Objects

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```python
import sys

DIGIT_MAP =  . . .

def convert(s):
    try:
        number = ''
        for token in s:
            number += DIGIT_MAP[token]
        return int(number)
    except (KeyError, TypeError) as e:
        print(f"Conversion error: {e!r}",
              file=sys.stderr)
        return -1
```

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```
>>> from exceptional import convert
>>> convert("fail".split())
Conversion error: KeyError('fail')
-1
>>>
```

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Exceptions Can Not Be Ignored

Error codes are easy to ignore

Checks are always required

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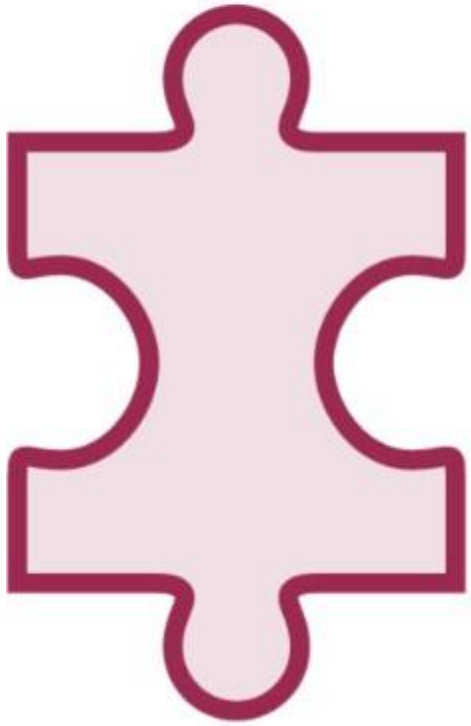
Exceptions and Protocols



Sequences should raise `IndexError` for out-of-bounds indexing.

Exceptions must be implemented and documented correctly.

Existing built-in exceptions are often the right ones to use.

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IndexError

An integer index is out of range

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```
>>> z = [1, 4, 2]
>>> z[4]
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
IndexError: list index out of range
>>>
```

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ValueError

An object is of the correct type but has an inappropriate value

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```
>>> int("jim")
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: invalid literal for int() with base 10: 'jim'
>>>
```

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KeyError

A lookup in a mapping failed

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```
>>> codes = dict(gb=44, us=1, no=47, fr=33, es=34)
>>> codes['de']
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
KeyError: 'de'
>>>
```

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Handle Exceptions

Avoid explicit type checks

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```
def convert(s):
    if not isinstance(s, list):
        raise TypeError(
            "Argument must be a list")

    try:
        number = ''
        for token in s:
            number += DIGIT_MAP[token]
        return int(number)
    except (KeyError, TypeError) as e:
        print(f"Conversion error: {e!r}",
              file=sys.stderr)
        raise
```

- Check argument type
- Raise TypeError

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```python
def convert(s):
    # if not isinstance(s, list):
    #     raise TypeError(
    #         "Argument must be a list")

    try:
        number = ''
        for token in s:
            number += DIGIT_MAP[token]
        return int(number)
    except (KeyError, TypeError) as e:
        print(f"Conversion error: {e!r}",
              file=sys.stderr)
        raise
```

- Catch TypeError
- Re-raise it

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