Recursion (Guttag 6)

and importing (Guttag 7)

Goals

Learn terms related to importing in python (Chapter 7)

Learn terms related to recursion (Chapter 6)

Practice three recursive algorithms (Chapter 6)

Importing

Guttag 7

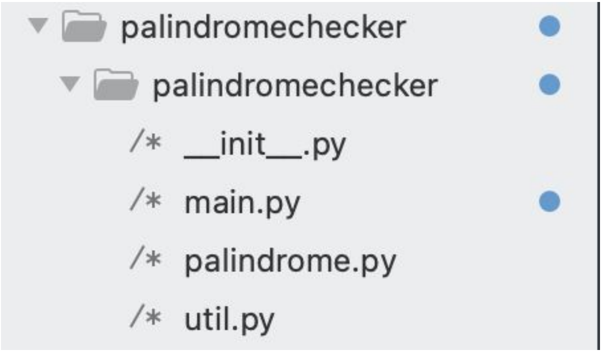
Terms: Module

Definition

- a module in python is a file that ends in .py

Examples from palindromes lab

- main.py
- util.py
- palidrome.py



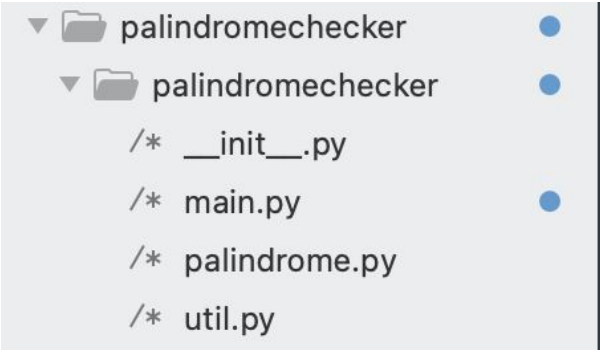
Terms: Package

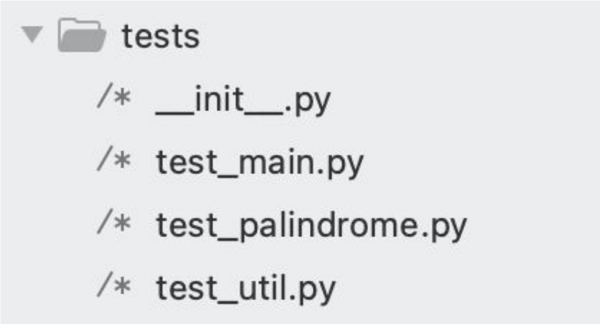
Definition

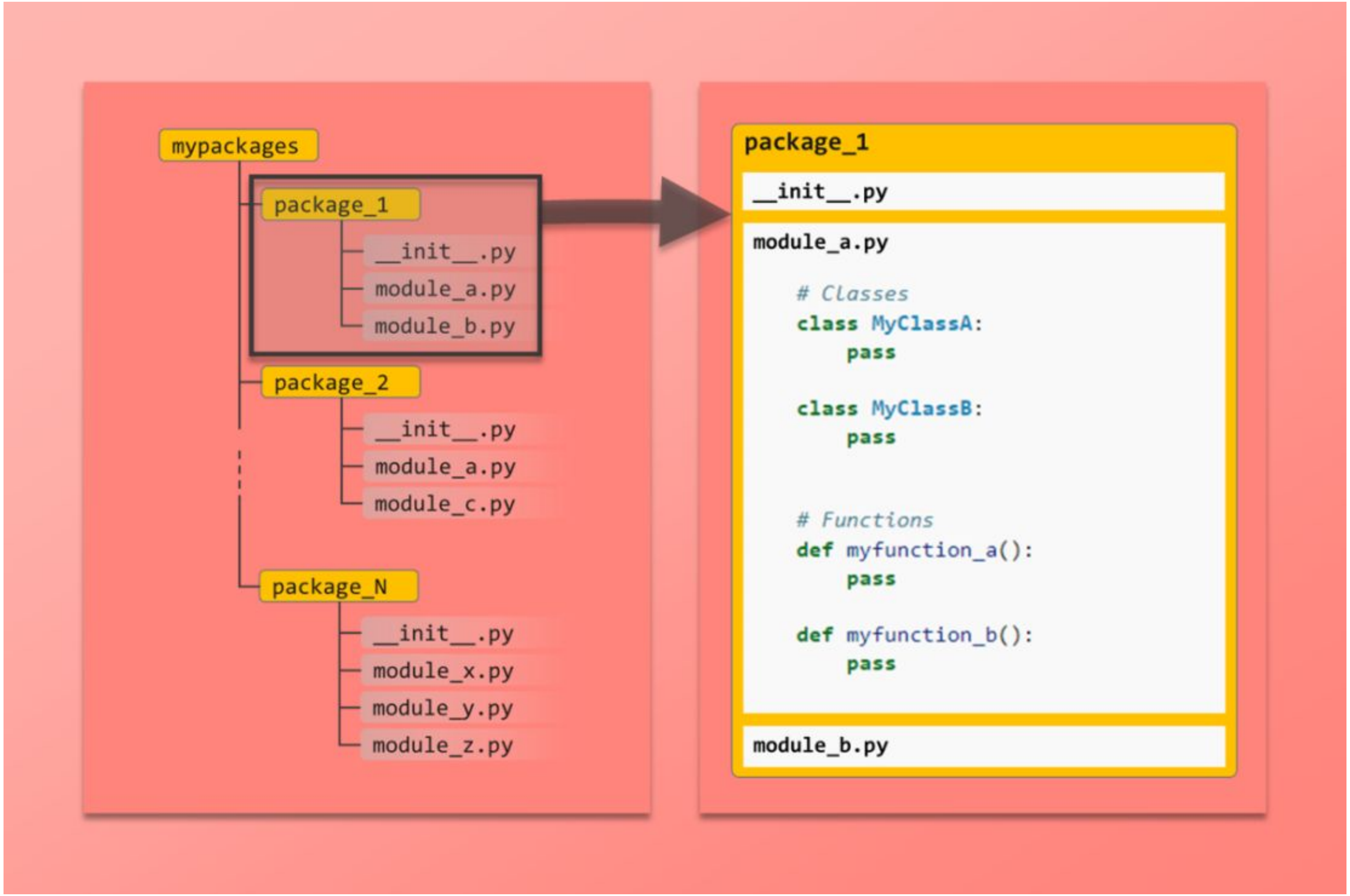
- a folder containing modules and an __init__ module

Examples from palindromes lab

- innermost palindromechecker directory
- tests directory






mypackages
package_1
__init__.py
module_a.py
module_b.py
package_2
__init__.py
module_a.py
module_c.py
package_N
__init__.py
module_x.py
module_y.py
module_z.py
package_1
__init__.py
module_a.py
# Classes
class MyClassA:
pass
class MyClassB:
pass
# Functions
def myfunction_a():
pass
def myfunction_b():
pass
module_b.py

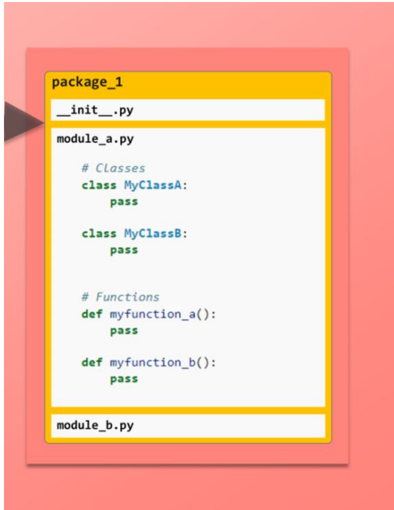
Terms: Symbol

Definition

- Anything defined within a module!
- recall, defined **variables** appear on the left-hand side of =
- recall, defined **functions** appear after keyword **def**
- we will also soon learn about **classes** appearing after keyword **class**

Examples

- **a** = 10
- **cli** = typer.Typer()
- def **is_prime**(n: int) -> bool:
- class **PalindromeCheckingApproach**(str, Enum):
- class **MyClassA**:
- class **MyClassB**:



Terms: Namespace & Fully-Qualified Name

Definition

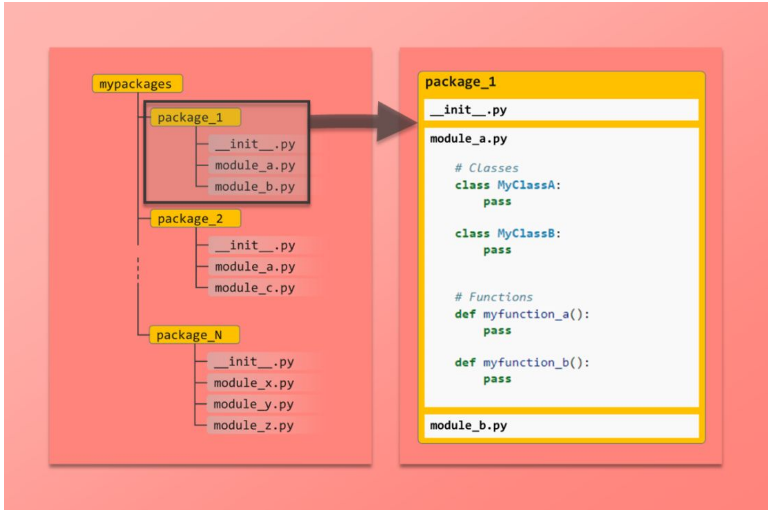
- Namespace refers to the module name
- Fully-Qualified Name specifies the Namespace and the symbol with dot notation

Examples

- module_a.MyClassA
- module_a.MyClassB

Further info

- Sometimes package names are included
- package_1.module_a.MyClassA



Terms: Import

Definition

- the python syntax used to "make available" symbols defined in different modules or packages.

Example

- import typing
- import random
- import typer

Further info

- The direct imports as shown above work for libraries, including the standard python libraries (included libraries)

Import Syntax

import LIBRARY

- import typing

from LIBRARY import MODULE

- from typing import List

import MODULE as ALIAS

- import numpy as np

Import Syntax Continued

from PACKAGE import MODULE

- from palindromechecker import util

from PACKAGE.MODULE import SYMBOL

- from palindromechecker.util import human_readable_boolean

Import Syntax Continued

from PACKAGE import MODULE

- from palindromechecker import util ← **util.human_readable_boolean ****

from PACKAGE.MODULE import SYMBOL

- from palindromechecker.util import human_readable_boolean

Recursion

Guttag 6

Definition

Applying the **same** logic repeatedly to solve a problem

- The problem **progresses** on each repetition

Problem-solving process stops when **base-case** is reached

Example: Factorial

informally:

5! = 5*4*3*2*1

formally:

1! = 1

n! = n * (n - 1)!

Iterative Algorithm	Recursive Algorithm

def factorial_iter(n: int) -> int:
    result = 1
    for i in range(1,n+1,1):
        result *= i
    return result
	def factorial(n: int) -> int:
	    if n == 1:
	        return 1
	    else:
	        return n * factorial(n - 1)

Factorial: Recursive Approach, details

```
def factorial(n: int) -> int:
    if n == 1:
        return 1

    else:
        return n * factorial(n - 1)
```

base case (recursion stops)

recursive call with progression of the input

- `factorial` is the call
- `n-1` is progression of the input

Critical Thinking

What happens if:

- base case is missing?
    - infinite loop
- there is no progression of the input?
    - infinite loop
- progression is the wrong direction?
    - infinite loop

Example: Palindrome

informally:

any string with any characters that is same forward and backward

Reverse Algorithm	Recursive Algorithm

def pal_rev(w: str) -> bool:
    w_rev = w[::-1]
    if w_rev == w:
        return True
    else:
        return False
	def pal_rec(w: str) -> bool:
	    if len(w) <= 1:
	        return True
	    elif w[0] == w[-1]:
	        return pal_rec(w[1:-1])
	    else:
	        return False

Palindrome: Recursive Approach, details

```
def pal_rec(w: str) -> bool:
    if len(w) <= 1:
        return True

    elif w[0] == w[-1]:
        return pal_rec(w[1:-1])
    else:
        return False
```

base case (recursion stops)

recursive call with progression of the input

- `pal_rec` is the call
- `w[1:-1]` is progression of the input

another base case (recursion stops)

Critical Thinking

Why does it matter:

- if len(w) <= 1
  - all strings that are one character or zero characters are palindromes!
- w[0] == w[-1]
  - the first and last character must be the same in a palindrome
- progression is done using w[1:-1]
  - slicing creates a shallow copied string starting at python 1st index and ending at -1 index (not inclusive!)
  - we already checked that the first character == last characters, thus we have to remove them to continue checking.

Example: Fibonacci Number

informally:

sum of previous two numbers in a sequence starting with 0 and 1

Iterative Algorithm	Recursive Algorithm

def fib(nth: int) -> int:
    zeroith = 0
    first = 1
    return zeroith is if nth == 0
    return first if nth == 1
    for i in range(n):
        next = zeroith + first
        zeroith = first
        first = next
    return next
	def fib(nth: int) -> int:
	    if n == 0 or n == 1:
	        return n
	    else:
	        return fib(n-1) + fib(n-2)

Fibonacci: Recursive Approach, details

```
def fib(nth: int) -> int:
    if n == 0 or n == 1:
        return n

    else:
        return fib(n-1) + fib(n-2)
```

base cases (recursion stops)

two recursive calls with progression of the input

- `fib` is the call
- `n-1` is progression of the input
- `n-2` is progression of the input