UNIVERSITY of WASHINGTON

Software Design for Data Science

Modules, Packages, and Imports

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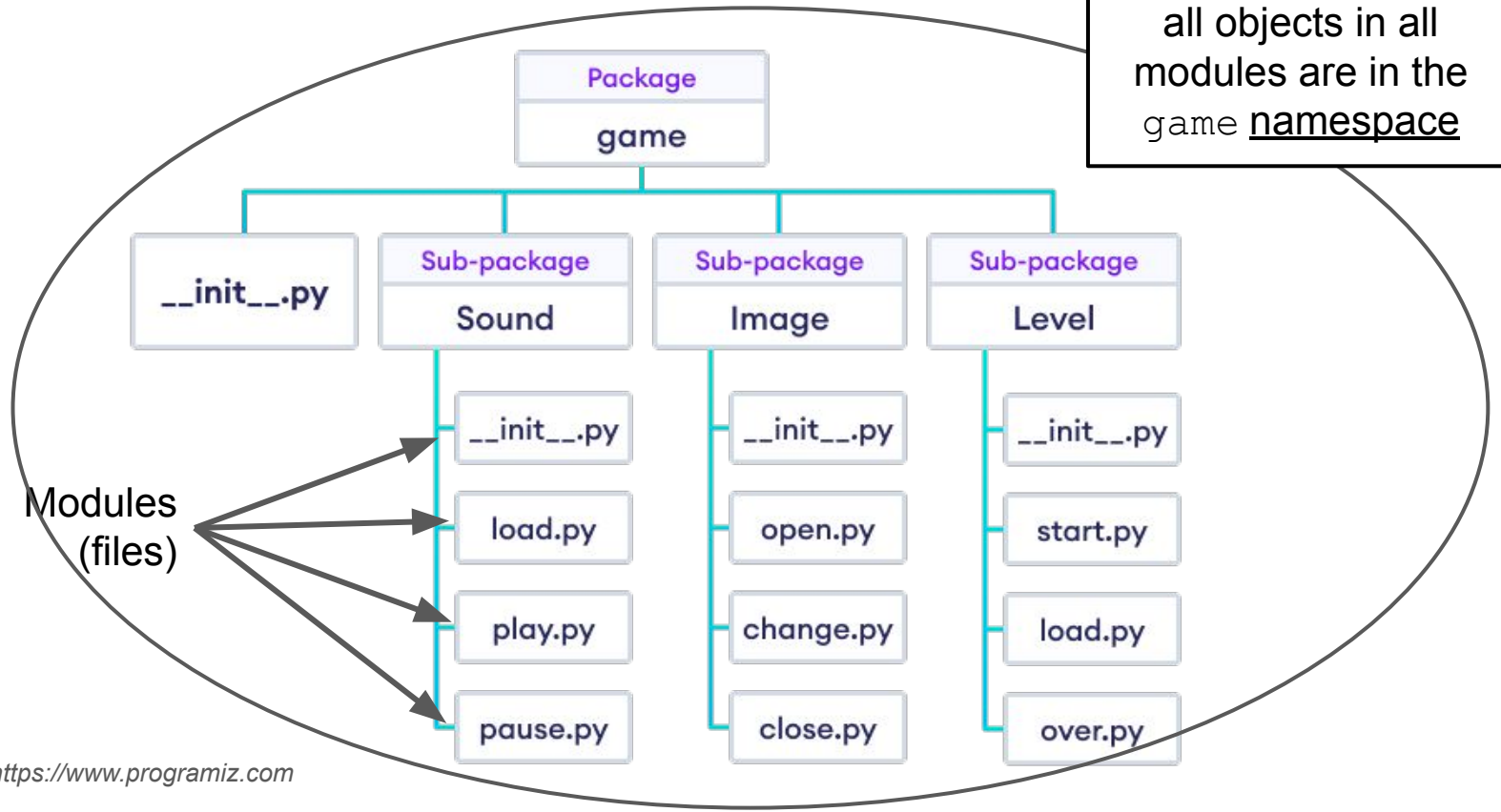
Definitions

- **Object**: Most things in Python, e.g. function, variable, class.
- **Module**: A *.py script; carries the name as the file.
- **Namespace**: A mapping of unique names to objects.
- **Package**: A directory-like concept that can hold multiple Python objects, modules, or subpackages under same namespace.

Definitions: Example

when running
`import game`
all objects in all modules are in the `game` namespace



Example from https://www.programiz.com

Imports

Imports

There are 4 different syntaxes for writing import statements.

1. `import <package>`
   a. Brings `<package>` into the current namespace
2. `import <module>`
   a. Brings `<module>` into the current namespace
3. `from <package> import <module or subpackage or object>`
   a. Brings `<module or subpackage or object>` into the current namespace
4. `from <module> import <object>`
   a. Brings `<object>` into the current namespace

Using imports

Let `X` be whatever name comes after import.

- If `X` is the name of a module or package, then to use objects defined in `X`, you have to write `X.object`

```
# for these cases
import <package>
import <module>
from <package> import <module or subpackage>
```

- If `X` is a variable name, then it can be used directly.
- If `X` is a function name, then it can be invoked with `X()`

```
from <package> import <object>
from <module> import <object>
```

Multiple imports

```
from <module> import <object1>, <object2>, <object3>
```

OR

```
from <module> import (
    <object1>,
    <object2>,
    <object3>,
)
```

Import as

Optionally, `as Y` can be added after any `import X` statement:

```
import X as Y

from X import (
    foo as Y,
    bar as Z,
)
```

Import order of search

How does Python find modules/packages to import?

1. Python Standard Library packages/modules (eg `math`, `sys`)
2. Packages/modules in `sys.path`:
    a. If run with the Python interpreter (ie just `python`)
        i. `sys.path[0]` is the empty string `''`, which means the current working directory
    b. If run with `python <module.py>`:
        i. `sys.path[0]` is the path to `<module>.py`
    c. Directories in `PYTHONPATH` environment variable
    d. Default `sys.path` locations - dependent on Python installation

Absolute vs relative imports

Absolute Imports (works in Python 2 and 3):

Import from the top-level Python package. e.g., `import <package>`

Relative Imports:

Import based on your `sys.path` location.

Explicit Relative Imports (works in Python 2 and 3):

Import using . (current directory) and .. (parent directory) notation

Implicit Relative Imports (only Python 2):

Discontinued

Wildcard imports

Bringing EVERYTHING from a package or module into the current namespace

```
from <package> import *
```

BAD BAD BAD! Why?

- Conflicts between names defined locally and the ones imported
- Reduces code readability - where did a name come from?
- Clutters the local namespace, which makes debugging more difficult

Example in the materials for today

Directory Structure

Basic codebase in a git repository

```
myproject/
    README.md
    LICENSE
    myproject/
        __init__.py
        core.py
        subpackage/
            __init__.py
            subpackage.py
        submodule/
            submodule.py
        tests/
            __init__.py
            test_core.py
```

Basic codebase in a git repository

`myproject/` ← This is your git repository, usually matching the name on Github

Basic codebase in a git repository

```
myproject/
    README.md
```

Markdown-formatted or plain text file describing the package

Basic codebase in a git repository

```
myproject/
    README.md
    LICENSE
```


Software license specifying how others may use your code

Basic codebase in a git repository

```
myproject/
    README.md
    LICENSE
    myproject/
```

The Python package, helpful for `import myproject` into separate namespaces.

Basic codebase in a git repository

```
myproject/
    README.md
    LICENSE
    myproject/
        __init__.py
```

This module marks the directory as a Python package and is run upon import

Basic codebase in a git repository

```
myproject/
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    myproject/
        __init__.py
        core.py
```

Other modules in the package containing importable code.

Basic codebase in a git repository

```
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        __init__.py
        core.py
        subpackage/
            __init__.py
            subpackage.py
```

Packages can have subpackages (and sub-subpackages, etc.) to any depth. They contain their own `__init__.py` files.

Basic codebase in a git repository

```
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        __init__.py
        core.py
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            __init__.py
            subpackage.py
        submodule/
            submodule.py
```

Packages can also have modules to any depth - ie without the `__init__.py`, this directory is just a collection of modules.

Basic codebase in a git repository

```
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            __init__.py
            subpackage.py
        submodule/
            submodule.py
        tests/
            __init__.py
            test_core.py
```

Unit tests go into their own subpackage

Basic codebase in a git repository

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            submodule.py
        tests/
            __init__.py
            test_core.py
```

But wait - what actually goes in `__init__.py`?

1. `__init__.py` is empty

Example: urllib

- Pros
  - Simple
- Cons
  - You don't get a *namespace*
  - You have to specify a specific submodule to import
  - Importing just the package is useless
  - Important to have good module names

Eg:

```
import urllib.parse
urllib.parse.urlparse("https://google.com")
```

Not

```
import urllib
urllib.urlparse("https://google.com")
```

2. `__init__.py` imports from subpackages/modules

Import from subpackages and submodules

Determine order of import (where that's important)

Example: tomllib (library that parses TOML files)

- Pros
  - Can create a helpful namespace
  - Interface of your package is more clear
- Cons
  - Interface of package is not super clear

3. `__init__.py` defines the interface for the package

Define the interface for the package

Importing/piecing together submodules

Example: json

- Pros
  - Great for someone reading your package to know where to start
  - Functionality is clear
- Cons
  - What goes in __init__.py vs submodule?

4. `__init__.py` defines everything

Example: collections

- Pros
  - One single file
  - Can work well for small packages
- Cons
  - Can be unwieldy if package is big

Exercise: Make it work

1. Go to the course website.
2. Curl the linked file (code from Week 3), make it executable with `chmod +x`
3. Update the imports so that you can run both main.py and run/runner.py

Hint: there are multiple ways to run python code. We've seen

```
python path/to/file.py
```

But you can also run a module with:

```
python -m path.to.module
```

What's the difference? The -m version keeps the path as the current directory! Try it out and print `sys.path`

Recommendation: Imports

- Use the root of the package as the source of truth
  - Import all local modules/packages relative to the root of your overall package
  - Run all Python commands from that same directory
  - Use `python -m path.to.module` to run specific modules, but always from the root directory

```
myproject/
    myproject/
        __init__.py
        core.py
        subpackage/
            __init__.py
            subpackage.py
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            __init__.py
            test_core.py
```