Modules 101

How to avoid spaghetti, big balls of mud and houses of straw!

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Planet Innovation

Agenda

- Principles of well structured code
- Benefits of using modules and packages
- Working with modules
- Working with packages
- Some advanced topics we won't cover today
- Where to find more information

“Building” software

- A flawed but useful metaphor
  - We have software architects
  - We build software
  - With build tools
  - With frameworks, structures, foundations

- Different buildings require different skills and levels of planning & design
  - Software is the same

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Getting design right is critical

- Easy to fix bugs?
- Easy to add new features?
- Easy to understand?
  - Today?
  - In two years?
  - By someone else?
- Easy to test?
- Easy to optimise?

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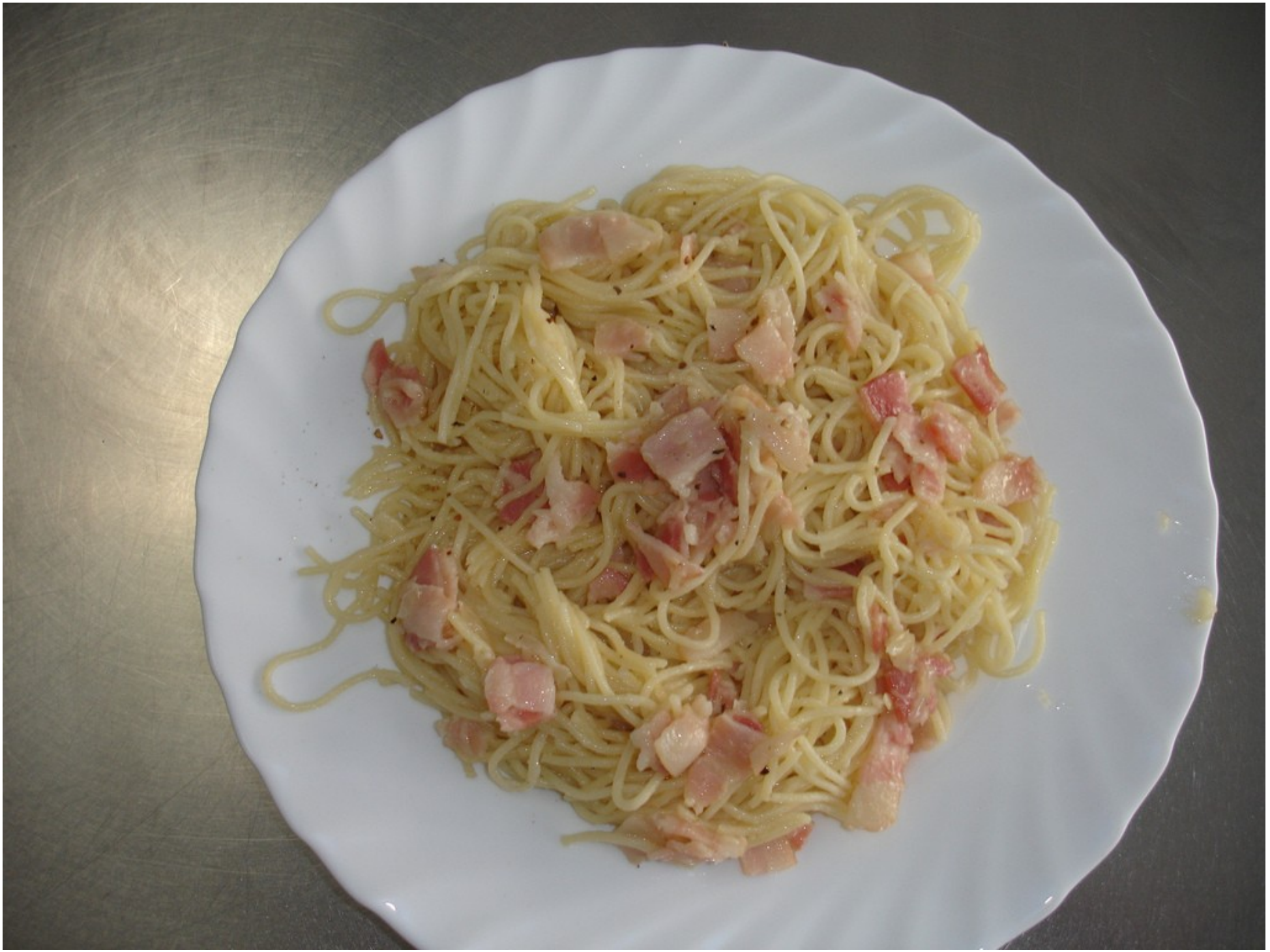
Some basic design principles

- Separation of concerns
- Abstraction
  - DRY: Don't Repeat Yourself
- Composition & the Law of Demeter
  - Loose coupling between components
- Functional programming
  - Idempotent functions
  - Minimise/eliminate state

What we want to avoid

- The Big Ball of Mud:
  - “Haphazardly structured, sprawling, sloppy, DuctTape and bailing wire, SpaghettiCode jungle”
  - “A casually, even haphazardly, structured system. Its organization, if one can call it that, is dictated more by expediency than design.”
- http://www.laputan.org/mud/mud.html



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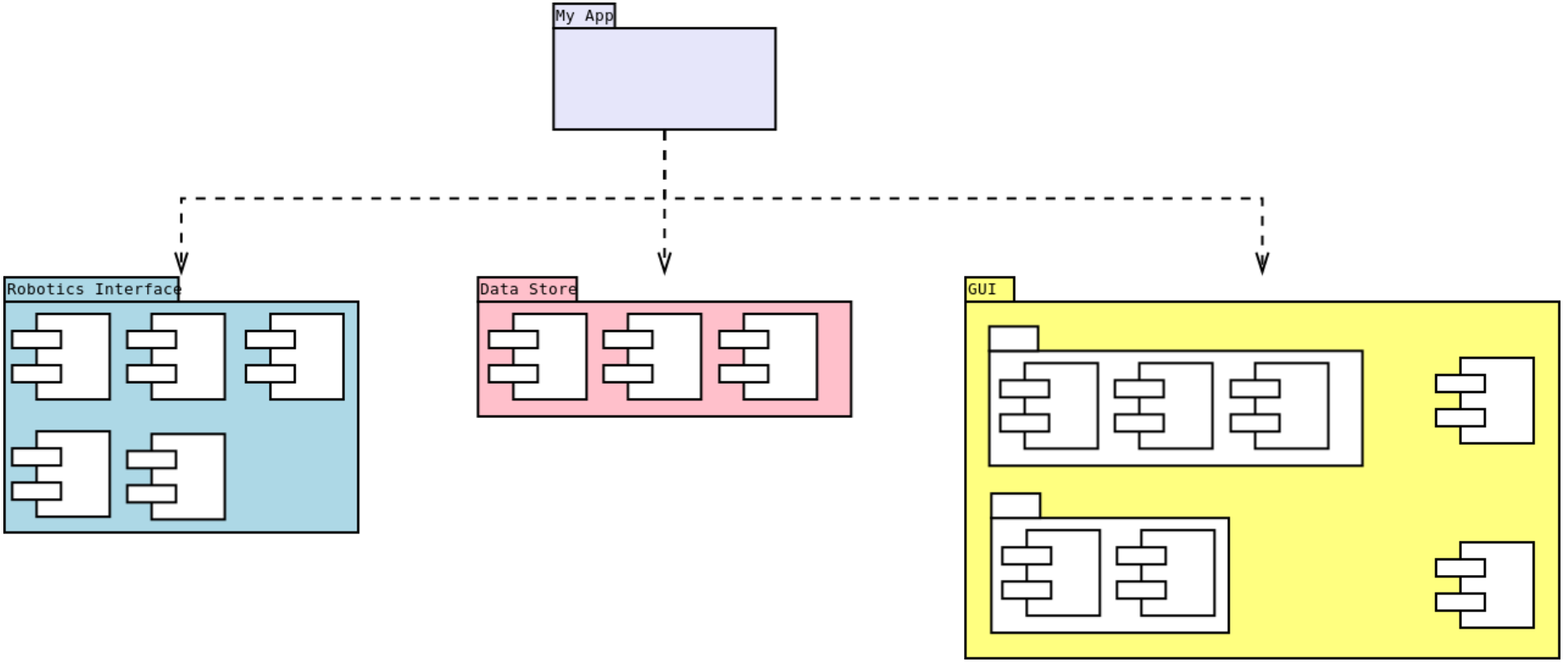
Why use modules and packages?

- Python heavily utilises modules & packages
- Smaller pieces, logical groups, less complexity
  - Designed for reuse
  - Can control the interfaces
  - Easier to understand
  - Easier to refactor and debug
- Easier to document and test
  - Modules can contain their own tests
  - Modules can contain their own documentation

Far nicer than spaghetti!



What is a module?

- A Python file that contains:
  - Definitions (functions, classes, etc.)
  - Executable code: executed once at import
- Has its own namespace (or symbol table)
  - Avoids clashes with other modules
- Fundamental library building block
- Has a .py extension (normally)
- Module name is the filename's basename :
  - `os.py` → module name is “`os`”

Module search paths

- How does Python find a module?
- It scans through a set of directories until it finds the module.
- The search order is important!
  1. Program's working directory
  2. $PYTHONPATH directories
  3. Python standard library directories
  4. (and any `.pth` path files)
- `sys.path` in Python is created from these

Namespaces

- You “import” a module
- This creates a module object
- The module objects have attributes
  - Functions, classes, variables, doc strings, ...
- These namespaces are dictionaries

import

- `import`
  - The way to access a module or package
  - Gives access to attributes in another Python file
  - Classes, functions, global variables, etc.
- Modules are imported at run-time
  - Located, byte-compiled, executed
  - This is not the same as C's `#include`
  - Specify the module's basename, not extension
  - `import math` (not `import math.py`)

as

- Is your module name so long it annoys you?
- The “as” keyword creates an alias:

```
import myverylongmodulename as shorty
x = shorty.random()
```

from

- `from`
  - An extension of `import`, but copies the module names into the current scope
  - `from` makes a copy = lots of surprises!
- To import all names from a module:

```
from module import *
```

- _ prefixed names are not imported with:

```
from *
```

What is in that module?

- Use `dir()` and `help()`:

```
>>> import math
>>> dir()
>>> dir(math)
>>> help(math)
```

- Alternatively, import the **see** module:

```
$ pip install see
$ python
>>> from see import see
>>> import math
>>> see(math)
```

Avoid clutter and clashes

- Don't use:

```
>>> from mymodule import *
>>> from mymodule import year
>>> year = 1967
```

- Instead:

```
>>> import mymodule
>>> mymodule.year = 1967
```

- It's too easy to:
  - Pollute your namespaces (see **badimport.py**)
  - Confuse your reader and your tools

reload

- `reload`
  - Re-imports and re-executes a module
  - Works on an existing module object (not file)
  - Is a function (unlike `import` and `from`)
  - Very useful in lots of circumstances, but...
  - Has numerous caveats, so use wisely!
- In Python 3.x, `reload` is not a built-in:

```
>>> import imp
>>> imp.reload(modulename)
```

Warnings!

- Do not use module names that:
  - Are the same as standard library module names
  - Are the same as Python keywords
- Use `from` sparingly
- Be very careful using `reload()`
- (As always) avoid global variables
- Don't change variables in other modules

Executing modules

- `if __name__ == '__main__'`
  - Module is being executed as a script
  - `Examples:`

```
$ python -m calendar
$ python mymodule
```

- Very useful
  - Create a command line tool, or
  - Automatically run unit tests from command line

Documenting modules

- Modules are documented the same way as functions and classes
- Very useful for providing an overview
- Have a look at examples in the standard library, some are beautiful CS lectures:

```
$ python -c "import heapq; print heapq.__about__"
```

Packages

- Module = file → Python namespace
- Package = directory → Python namespace
- Perfect for organising module hierarchies
- To import a module from a package:
  - Module location is mypath/mymodule.py

    ```
    >>> import mypath.mymodule
    ```

  - For this to work, the `mypath` directory must be in the Python search path

Defining packages: __init__.py

- A package is defined as a directory that contains a file named `__init__.py`
  - `__init__.py` can be empty, it simply has to be exist
  - Any code in `__init__.py` is executed when the package is first imported
- If you are using Python 2, packages must have a `__init__.py` file
- If you are using Python 3.3, they are optional

Subpackages

- You can have hierarchies of packages
- For example, the `frogger/ui/sprites/` directory can be imported as a package:

```
>>> import frogger.ui.sprites
```

- The `as` keyword is useful for large hierarchies:

```
>>> import frogger.ui.sprites.cars as cars
```

Why packages?

- Simplify your search path
- Reduce/eliminate module name clashes
- Organise modules logically in a project
- Organise modules across multiple projects
  - In a company
  - In projects with shared dependencies

Fun & interesting modules

```
>>> import antigravity
>>> import this
>>> from __future__ import braces


>>> import heapq
>>> print heapq.__about__
```

Executable modules

- Lots of modules are command line tools
- See http://www.curiousvenn.com/?p=353

Advanced topics to explore next

- Package import control with `__all__`
- Absolute versus relative imports
- zip packages
- `from __future__`
- Installing packages (PyPI, pip, virtualenv)
- How modules are compiled (.pyc and .pyo files)
- Creating packages for distribution (e.g. on PyPI)
- Import hooks – for creating your own import functions (e.g. plugins, decryption)
- Writing extension modules (in C)

For more information

Online documentation:

- The standard Python documentation
- The Hitchhiker's Guide to Python
- Learn Python the hard way

Books:

- “Learning Python”, Mark Lutz (O'Reilly)
- “Hello Python!”, Anthony Briggs (Manning)
- “Beautiful Code”, Andy Oram & Greg Wilson (O'Reilly)

These notes

These notes will be available:

- On Slideshare: http://www.slideshare.net/
- On my blog: http://curiousvenn.com/