Modularity

Class outline:

- Modules
- Packages
- Modularity
- Modular design

Modules

Python modules

A Python module is a file typically containing function or class definitions.

link.py:

```
class Link:
    empty = ()

    def __init__(self, first, rest=empty):
        assert rest is Link.empty or isinstance(rest, Link)
        self.first = first
        self.rest = rest

    def __repr__(self):
        if self.rest:
            rest_repr = ', ' + repr(self.rest)
        else:
            rest_repr = ''
        return 'Link(' + repr(self.first) + rest_repr + ')'

    def __str__(self):
        string = '<'
        while self.rest is not Link.empty:
            string += str(self.first) + ' '
            self = self.rest
        return string + str(self.first) + '>'
```

Importing

Importing a whole module:

```
import link

ll = link.Link(3, link.Link(4, link.Link(5)))
```

Importing specific names:

```
from link import Link

ll = Link(3, Link(4, Link(5)))
```

Importing all names:

```
from link import *

ll = Link(3, Link(4, Link(5)))
```

Importing with alias

I don't recommend aliasing a class or function name:

```
from link import Link as LL

ll = LL(3, LL(4, LL(5)))
```

But aliasing a whole module is sometimes okay (and is common in data science):

```
import numpy as np

b = np.array([(1.5, 2, 3), (4, 5, 6)])
```

Running a module

This command runs a module:

```
python module.py
```

When run like that, Python sets a global variable `__name__` to "main". That means you often see code at the bottom of modules like this:

```
if __name__ == "__main__":
    # use the code in the module somehow
```

The code inside that condition will be executed as well, but only when the module is run directly.

Packages

Python packages

A Python package is a way of bundling multiple related modules together. Popular packages are NumPy and Pillow.

Example package structure:

```
sound/                          Top-level package
    __init__.py                 Initialize the sound package
    formats/                    Subpackage for file format conversions
            __init__.py
            wavread.py
            wavwrite.py
            aiffread.py
            aiffwrite.py
            auread.py
            auwrite.py
            ...
    effects/                    Subpackage for sound effects
            __init__.py
            echo.py
            surround.py
            reverse.py
            ...
    filters/                    Subpackage for filters
            __init__.py
            equalizer.py
            vocoder.py
            karaoke.py
            ...
```

Importing from a package

Importing a whole path:

```
import sound.effects.echo

sound.effects.echo.echofilter(input, output, delay=0.
```

Importing a module from the path:

```
from sound.effects import echo

echo.echofilter(input, output, delay=0.7, atten=4)
```

Installing packages

The Python Package Index is a repository of packages for the Python language.

Once you find a package you like, `pip` is the standard way to install:

```
pip install nltk
```

You may need to use `pip3` if your system defaults to Python 2.

Modularity

Modular design

A design principle: Isolate different parts of a program that address different concerns.

A modular component can be developed and tested independently.

Ways to isolate in Python:

Modular design

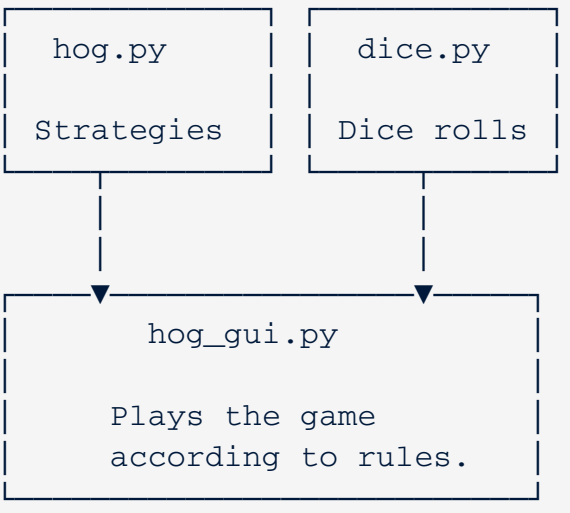
A design principle: Isolate different parts of a program that address different concerns.

A modular component can be developed and tested independently.

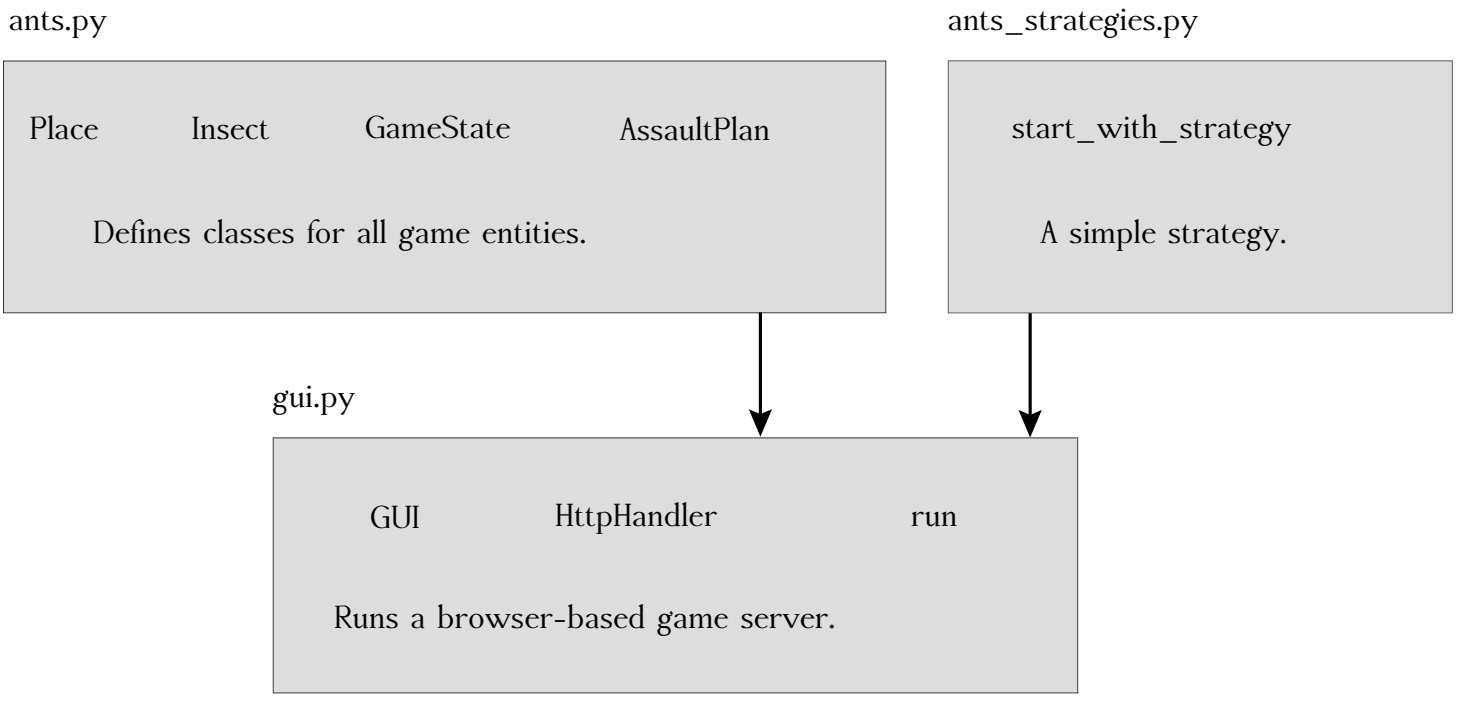
Ways to isolate in Python:

- Functions
- Classes
- Modules
- Packages

Hog design


hog.py
Strategies
dice.py
Dice rolls
hog_gui.py
Plays the game
according to rules.

Ants design



See also: Ants class diagram

Scheme design

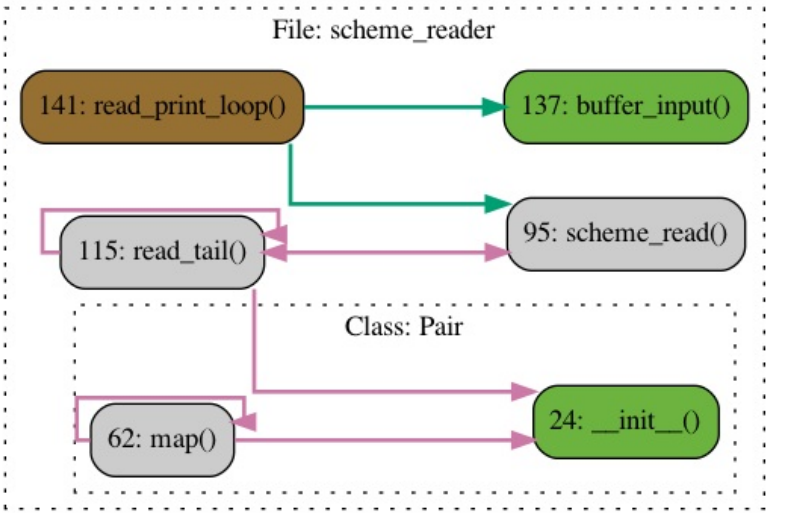
High-level overview

- `scheme_reader.py`: the reader for Scheme input
- `pair.py`: defines the `Pair` class and the `nil` object
- `buffer.py`: defines the `Buffer` class and related classes
- `scheme.py`: the interpreter REPL
- `scheme_eval_apply.py`: the recursive evaluator for Scheme expressions
- `scheme_forms.py`: evaluation for special forms
- `scheme_classes.py`: classes that describe Scheme expressions
- `scheme_builtins.py`: built-in Scheme procedures
- `scheme_tokens.py`: the tokenizer for Scheme input
- `scheme_utils.py`: functions for inspecting Scheme expressions

scheme_reader.py functions

✏ This is a file you edited in Lab 11!

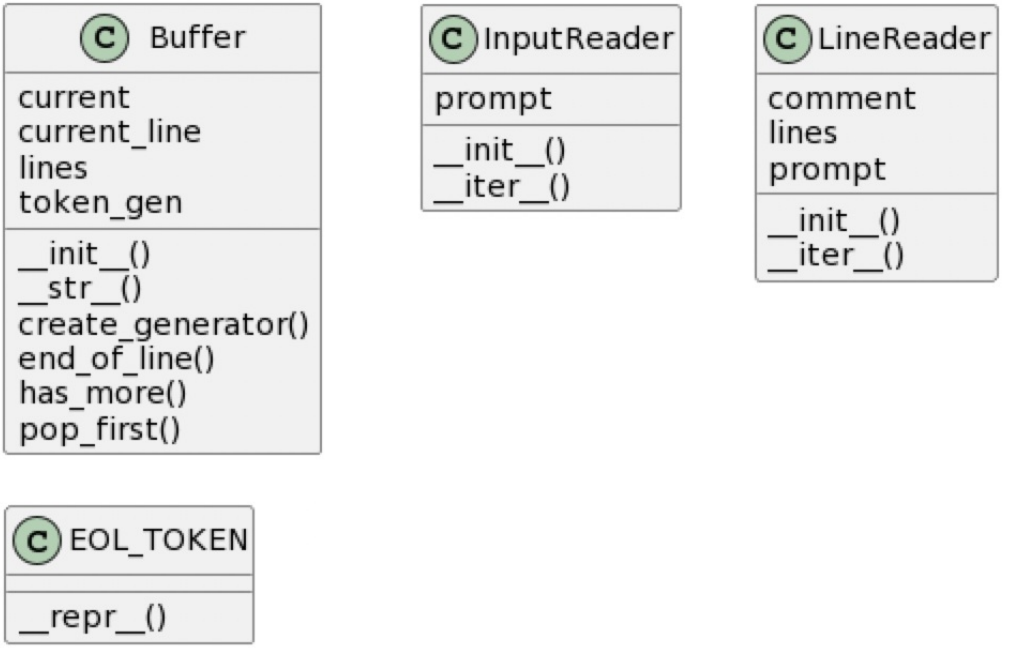
- `scheme_read(src)`
- `read_tail(src)`
- `buffer_input()`
- `buffer_lines()`
- `read_line()`
- `read_print_loop()`



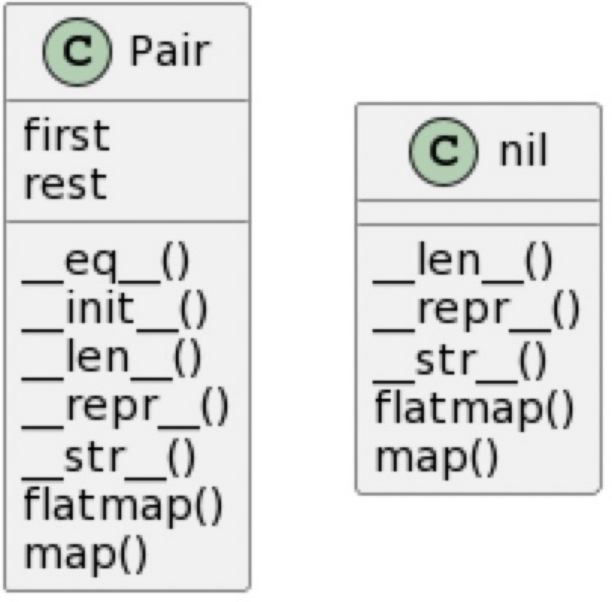
Code2flow Legend	
Regular function	
Trunk function (nothing calls this)	
Leaf function (this calls nothing else)	
Function call	→

buffer.py classes

✏ This is a file you edited in Lab 11!


Buffer
current
current_line
lines
token_gen
__init__()
__str__()
create_generator()
end_of_line()
has_more()
pop_first()
InputReader
prompt
__init__()
__iter__()
LineReader
comment
lines
prompt
__init__()
__iter__()
EOL_TOKEN
__repr__()

pair.py classes



scheme.py functions

- `read_eval_print_loop(next_line, env)`
- `add_builtins(frame, funcs_and_names)`
- `create_global_frame()`
- `run(*argv)`

scheme_eval_apply.py functions

✏ This is a file you'll be editing!

- `scheme_eval(expr, env)`
- `scheme_apply(procedure, args, env`
- `eval_all(expressions, env`

Also contains a class and some functions for the EC, tail call optimization.

- `Unevaluated` class
- `complete_apply(procedure, args, env)`
- `optimize_tail_calls(unoptimized_scheme_eval)`

scheme_builtins.py functions

- `scheme_equalp`
- `scheme_eqp`
- `scheme_pairp`
- `scheme_length`
- `scheme_cons`
- `scheme_car`
- `scheme_cdr`
- `scheme_list`
- `scheme_append`
- `scheme_add`
- `scheme_sub`
- `scheme_mul`
- `scheme_div`
- etc..

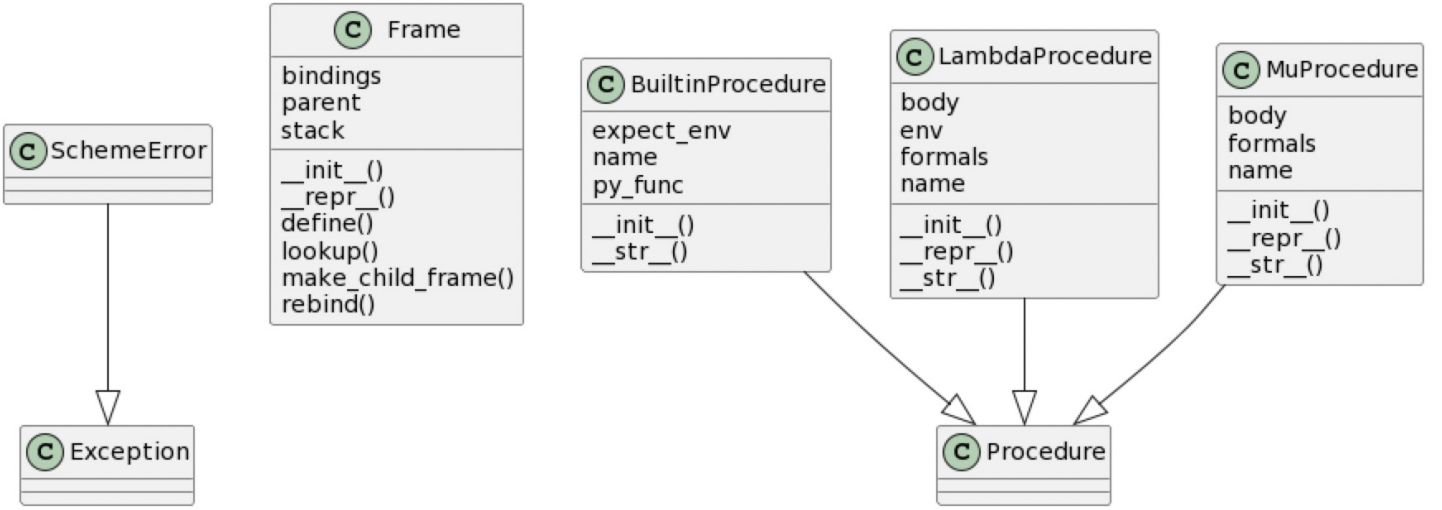
scheme_forms.py functions

✏ This is a file you'll be editing!

- `do_define_form`
- `do_quote_form`
- `do_begin_form`
- `do_lambda_form`
- `do_if_form`
- `do_and_form`
- `do_or_form`
- `do_cond_form`
- `do_let_form`
- `make_let_frame`
- `do_unquote_form`
- `do_mu_form`
- etc.

scheme_classes.py classes

✏ This is a file you'll be editing!



Appendix: Visualization tools

If you'd like to visualize the organization of your projects, try these tools:

- Code2Flow: Visualize the flow of functions (what calls what) in a file.
- PynSource: Generate UML diagrams of Python classes/subclasses.
- PyDeps: Visualize the dependencies (imports) between Python modules.

  More tools are mentioned in this blog post.