Command line arguments, packages & data hiding

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Course: Scientific Programming / Wissenchaftliches Programmieren (Python)

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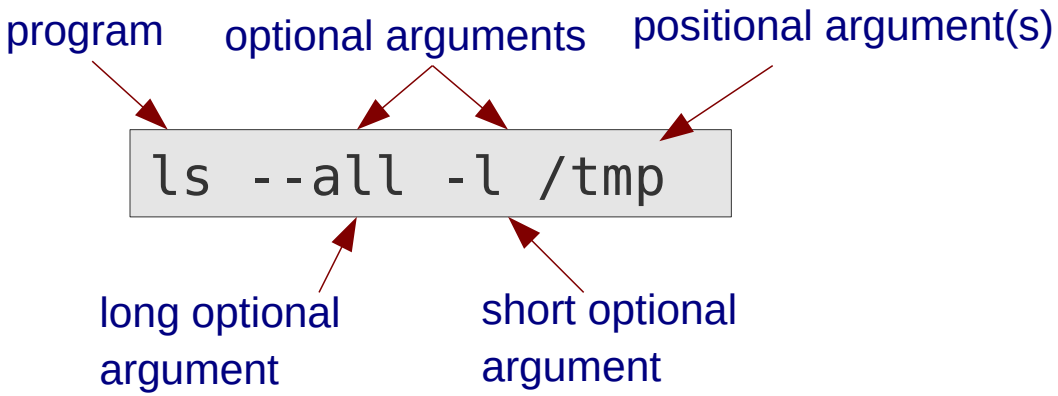
Outline

- Command line argument parsing
- Modularization via packages
- Data hiding via private entities

Command line argument parsing

Command line arguments

- Unix command line programs usually accept various arguments which control their behaviour



Positional arguments (“what should the program act on”)

- Last arguments on the command line
- Order may matter
- Number of required positional arguments may be fixed (0, 1, 2) or arbitrary

Optional arguments (“how should the program behave”)

- Start with singe dash (short form) or double dash (long form)
- Always optional (program must work without any optional arguments)

Simple argparse example

- The command line arguments can be parsed in Pyhon with the **ArgumentParser**

test.py

```
#!/usr/bin/env python3
import argparse

_DESCRIPTION = 'Test script demonstrating argparse'

parser = argparse.ArgumentParser(description=_DESCRIPTION)
msg = 'Directory  (default: .)'
parser.add_argument('-d', '--directory', default='.',  help=msg)
msg = 'Arbitrary integer number'
parser.add_argument('number', type=int, metavar='NUM', help=msg)
args = parser.parse_args()
print("Directory: {}".format(args.directory))
print("Number: {:d}".format(args.number))
```

Use “python” on Windows
and “python3” on Linux

Testing the example

- On Linux/macOS: Make the Python-script executable: `chmod +x test.py`
- Passing the **-h** option shows a help page with detailed information about the script

```
./test.py -h
usage: test.py [-h] [-d DIRECTORY] NUM

Test script demonstrating argparse

positional arguments:
  NUM                   Arbitrary integer number

optional arguments:
  -h, --help            show this help message and exit
  -d DIRECTORY, --directory DIRECTORY      Directory (default: .)
```

Testing the example

- One positional argument only

```
./test.py 2
Directory: .
Number: 2
```

- One optional argument (in short form) and one positional argument

```
./test.py -d /tmp 2
Directory: /tmp
Number: 2
```

- One optional argument (in long form) and one positional one

```
./test.py --directory /tmp 2
Directory: /tmp
Number: 2
```

Testing the example

- Invoking without the required positional argument

```
./test.py
usage: test.py [-h] [-d DIRECTORY] NUM
test.py: error: the following arguments are required: NUM
```

- Invoking without a required positional argument of the wrong type

```
./test.py 3.2
usage: test.py [-h] [-d DIRECTORY] NUM
test.py: error: argument NUM: invalid int value: '3.2'
```

- Invoking with an invalid optional argument

```
./test.py -a 2
usage: test.py [-h] [-d DIRECTORY] NUM
test.py: error: unrecognized arguments: -a
```

Building an argument parser step by step

```
parser = argparse.ArgumentParser(description=_DESCRIPTION)
```

- Creates an argument parser
- An optional description has been provided, which will be used as the general description in the help.

```
msg = 'Directory  (default: .)'
parser.add_argument('-d', '--directory', default='.', help=msg)
```

- Adds an optional argument with short form (**-d**) and long form (**--directory**) to the parser.
- As argument type is not explicitely defined, it assumes a string by default.
- If the optional argument has not been specified at the command line, the given default value (**.**) will be used
- The option description is provided with the **help=** argument

Building an argument parser step by step

```
msg = 'Arbitrary integer number'
parser.add_argument('number', type=int, metavar='NUM', help=msg)
```

- Adds a mandatory positional argument, named **number**
- Argument type should be an **integer**
- In the help **NUM** should be used as argument meta variable (shown in the help)
- Help message for the argument is provided

Parsing the command line

```
args = parser.parse_args()
```

- Parse the command line arguments
- Returns the result as a **Namespace** object, which can be queried

```
print("Directory: {}".format(args.directory))
print("Number: {:d}".format(args.number))
```

- The parsed values can be accessed in the returned Namespace object using the dot notation.
- The name after the dot is the long name of the argument

See the Argparse Tutorial for more examples and further details

Packages

Packages

- Generic module names in different projects can easily collide (e.g. solver, io)
- Packages enable a fine grained structuring of modules via name-spacing
- Modules within a package can be accessed with the dot-notation:

```
import PACKAGENAME.MODULENAME
```

- Many built-in modules and popular 3rd party modules use packages

```
import os.path
...
fname = os.path.join(directory, filename)
```

```
import numpy.linalg as linalg

xx = linalg.solve(aa, bb)
```

Custom packages

- Packages are directories in the file system
- In order to indicate that a directory is a package, it must contain an (evtl. empty) file **__init__.py**

```
linsolve
linsolver/
    __init__.py
    io.py
    solver.py
```

Empty file

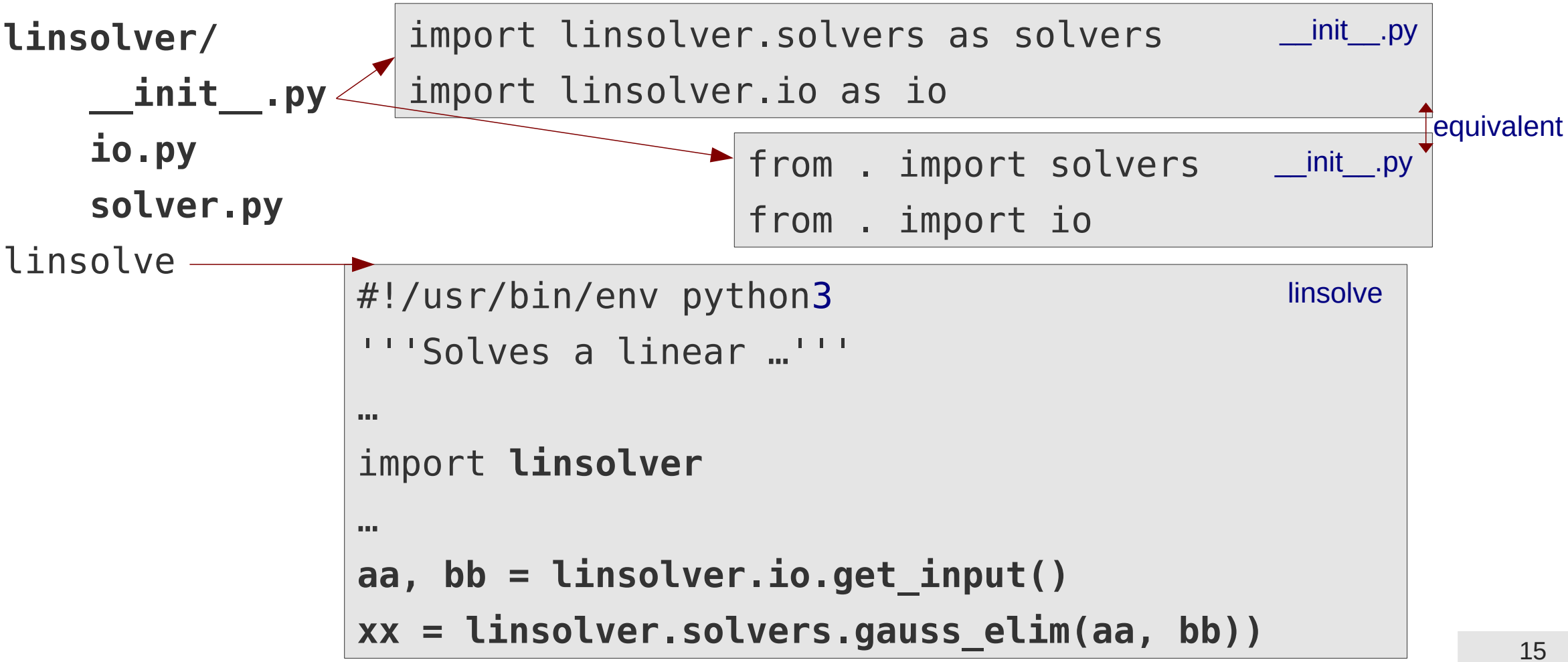
Modules in the package

linsolve

```
#!/usr/bin/env python3
'''Solves a linear …'''
…
import linsolver.solvers
import linsolver.io
…
aa, bb = linsolver.io.get_input()
xx = linsolver.solvers.gauss_elim(aa, bb))
```

Custom package initialization

- The **__init__.py** file may also contain Python code (package initialization)
- The content of **__init__.py** is imported if the package is imported as a whole
- It is often used to import the modules of the package with one statement



Finding modules / packages

- When Python encounters a module / package name, it looks for it at various places:
  - Current working directory
  - Directories specified in the **PYTHONPATH** environment variable
  - Directories of the Python standard installation

- The PYTHONPATH environment variable can be set up / adjusted in the shell by the user to let Python find packages at non-standard locations:

```
export PYTHONPATH=/home/aradi/.local/lib/python3.6/site-packages:...
```

- The directories, where Python should look up modules/packages should be separated by colon (:)
- The order of the directories corresponds to the search order
- The current value of the environment variable can be printed in the shell:

```
echo $PYTHONPATH
/home/aradi/.local/lib/python3.6/site-packages:/home/...
```

Private / public entities

Hiding module internals

- A module should only export functions / objects which should be invoked from outside
- Implementational details (e.g. helper routines, internal constants, etc.) should remain hidden.

```
_TOLERANCE = 1e-12                  Internally used constant

def gaussian_eliminate(aa, bb):             Public routine
    ...
    _eliminate(aa, pp)
    _make_back_subsitute(pp, bb)

def _eliminate(aa, pp):                  Internal helper routine
    ...

def _subsitute_back(pp, bb):             Internal helper routine
    ...
```

Public / private entities

- Whether an entity should be accessed from outside is **indicated** by its **name**.
- If its name **starts with** a letter **[a-zA-Z]**, the entity is considered to be a **public** entity
- If its name **starts with** a **single underscore** (_), the entity is considered to be a **private** entity.
- Private entities should only be accessed from within the scope (module, object) where they are defined.

Note

- The public / private naming rule above is **only** a **convention** and is not enforced by the language.
- Theoretically, one can also access “private” entities from outside.

Always stick to the public / private naming convention!

Make sure, you mark only the necessary entities in your module public and make everything else private (hiding implementation details)

Public entities should be always documented via their doc-strings

Have fun!