Programming for Today’s Physicists and Engineers

ISOTDAQ 2016 - Rehovot

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Opening words

Disclaimer: This is more a collection of pointers* than a tutorial, it’s a starting point…

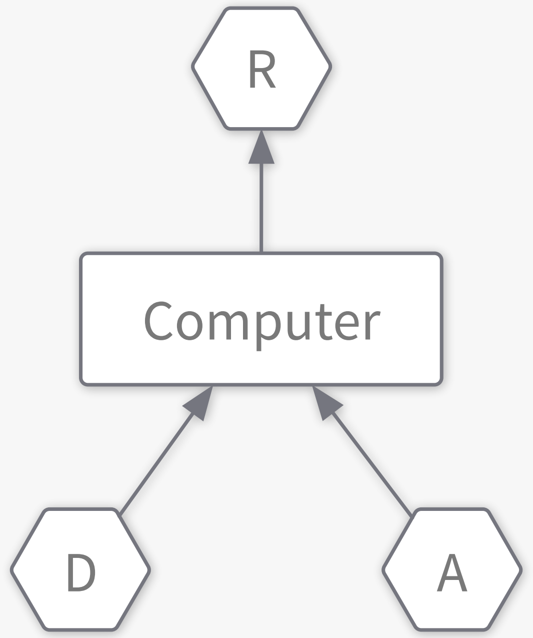
(Almost) no code but a bias towards C++ and Python

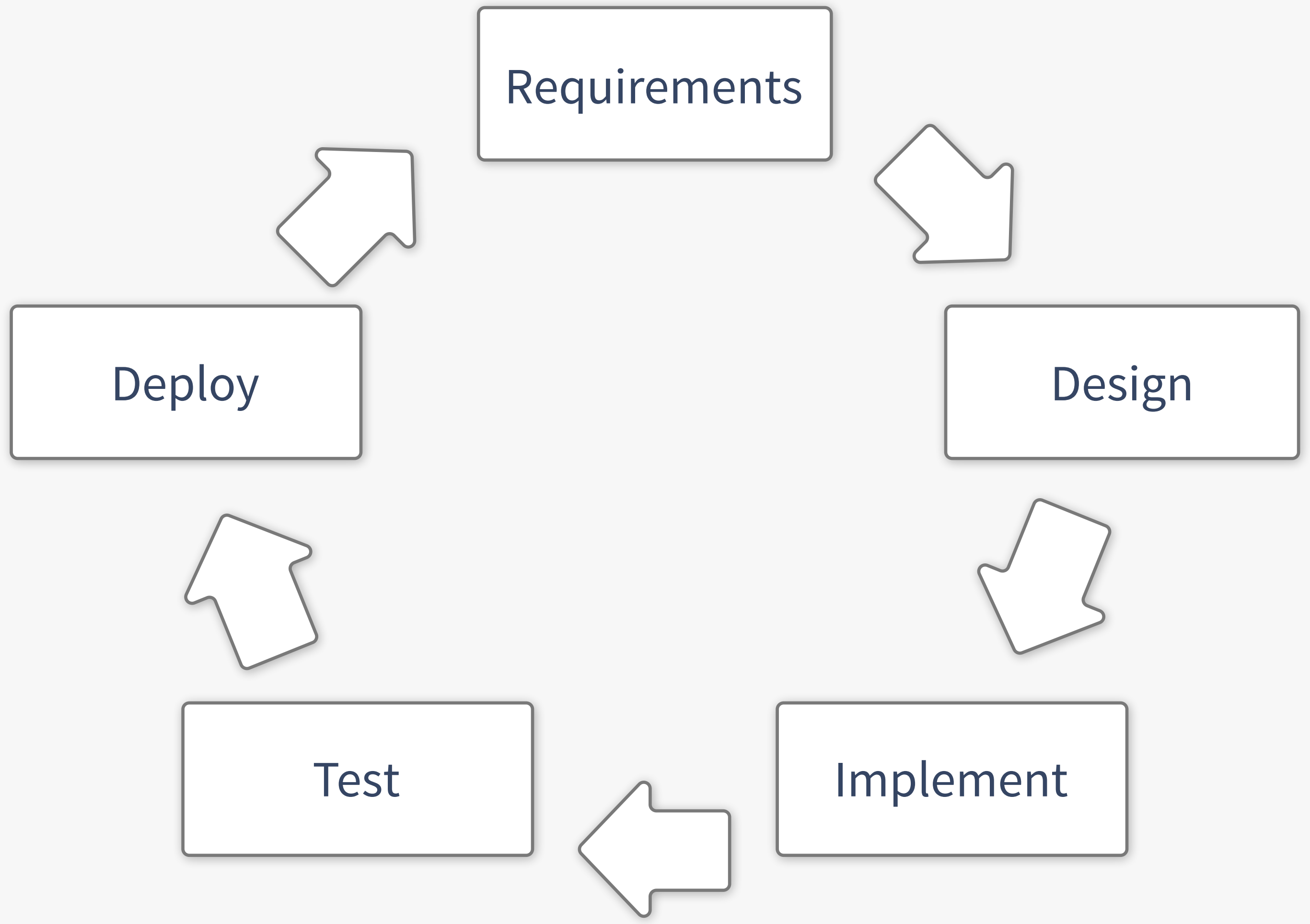
Acknowledgment: Slides are based on previous lectures by Erkcan Ozcan, see final slide for link

*further reading and tips in these boxes

What is programming?

- Understand & define what you want to solve
- Define the requirements for your software
- Formulate a possible solution
- Implement that solution
  - Which language?
  - Documentation
  - Debugging
  - Implement tests
- Make sure it works
  - Verification
- Deliver the code
  - Collect feedback
  - Portability to different platforms?
- And back to the start





Development Cycles

Developing software efficiently:

- Avoid duplication of work
- Avoid feature bloating
- Ensure code quality
- Deliver code timely

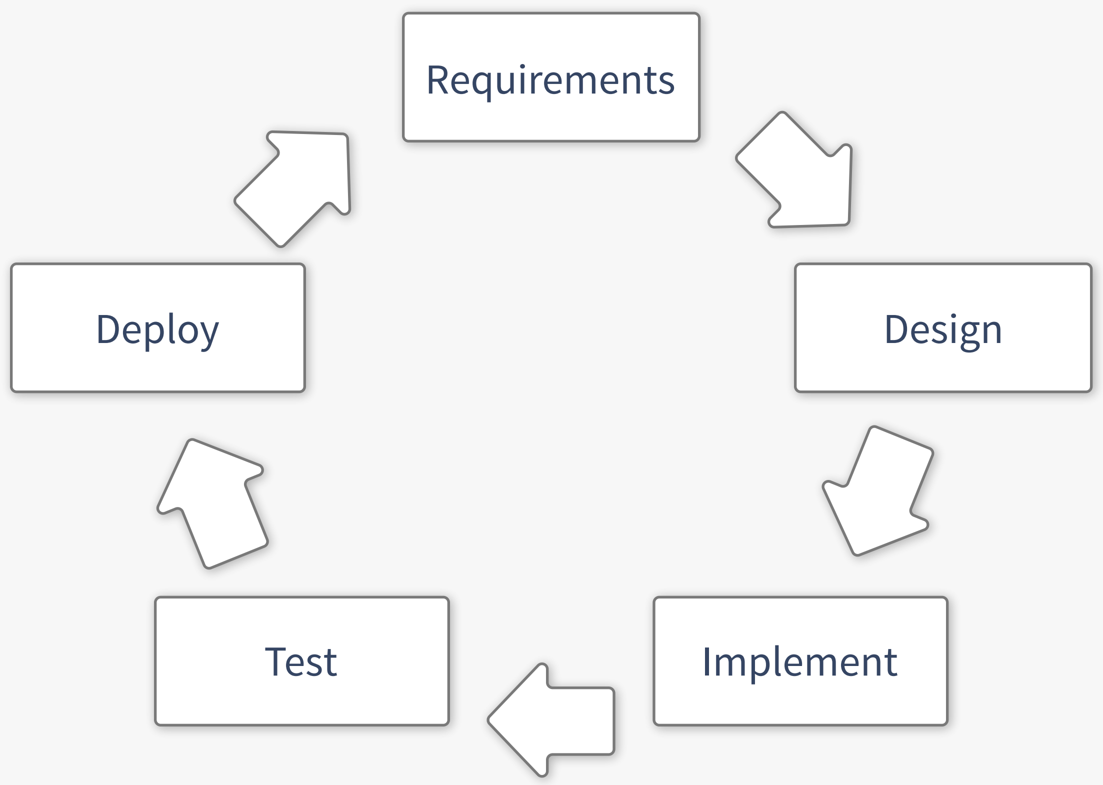
Many approaches to accomplish this, examples:

- Iterative and Test-Driven Development

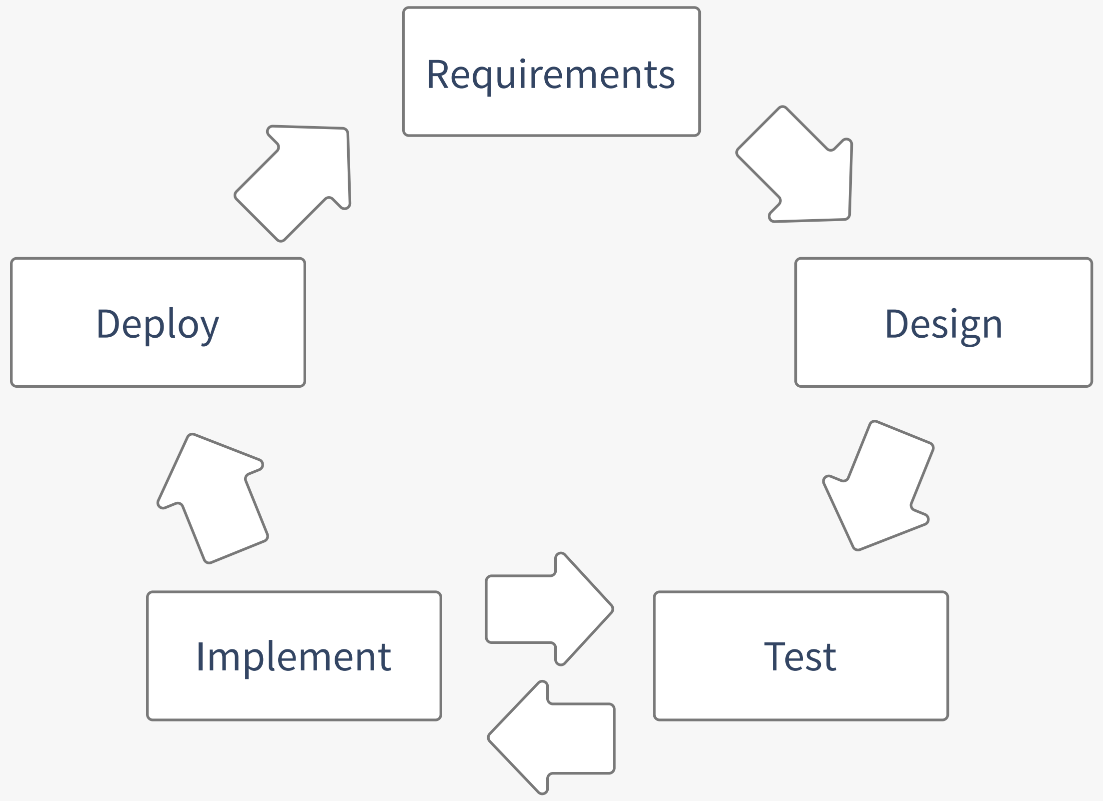
Most approaches have similar principles, different focus

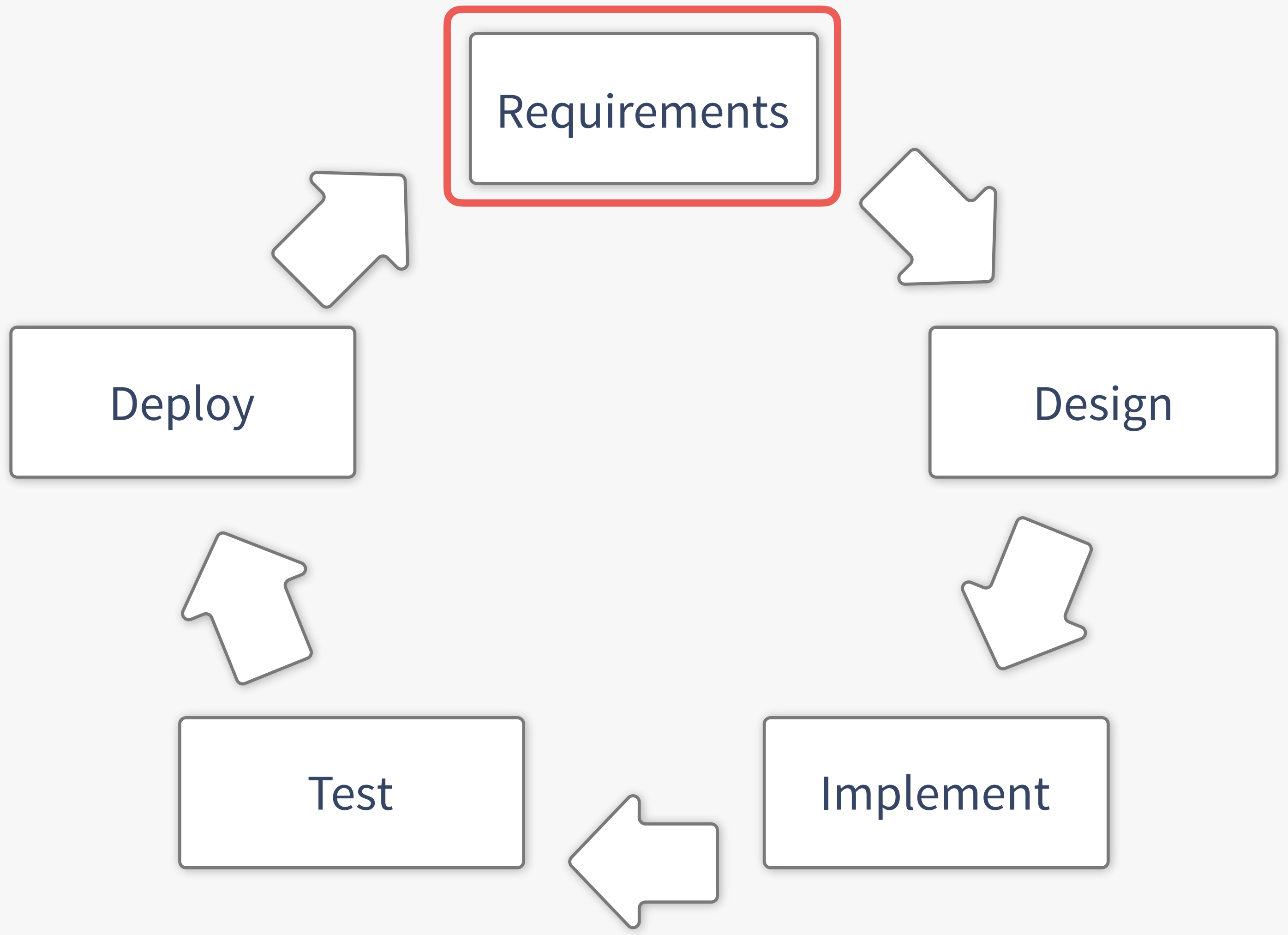
- on team management (agile development)
- on actual programming style (lean development / TDD)
- broad guidelines to deliver (iterative development)

Iterative Development



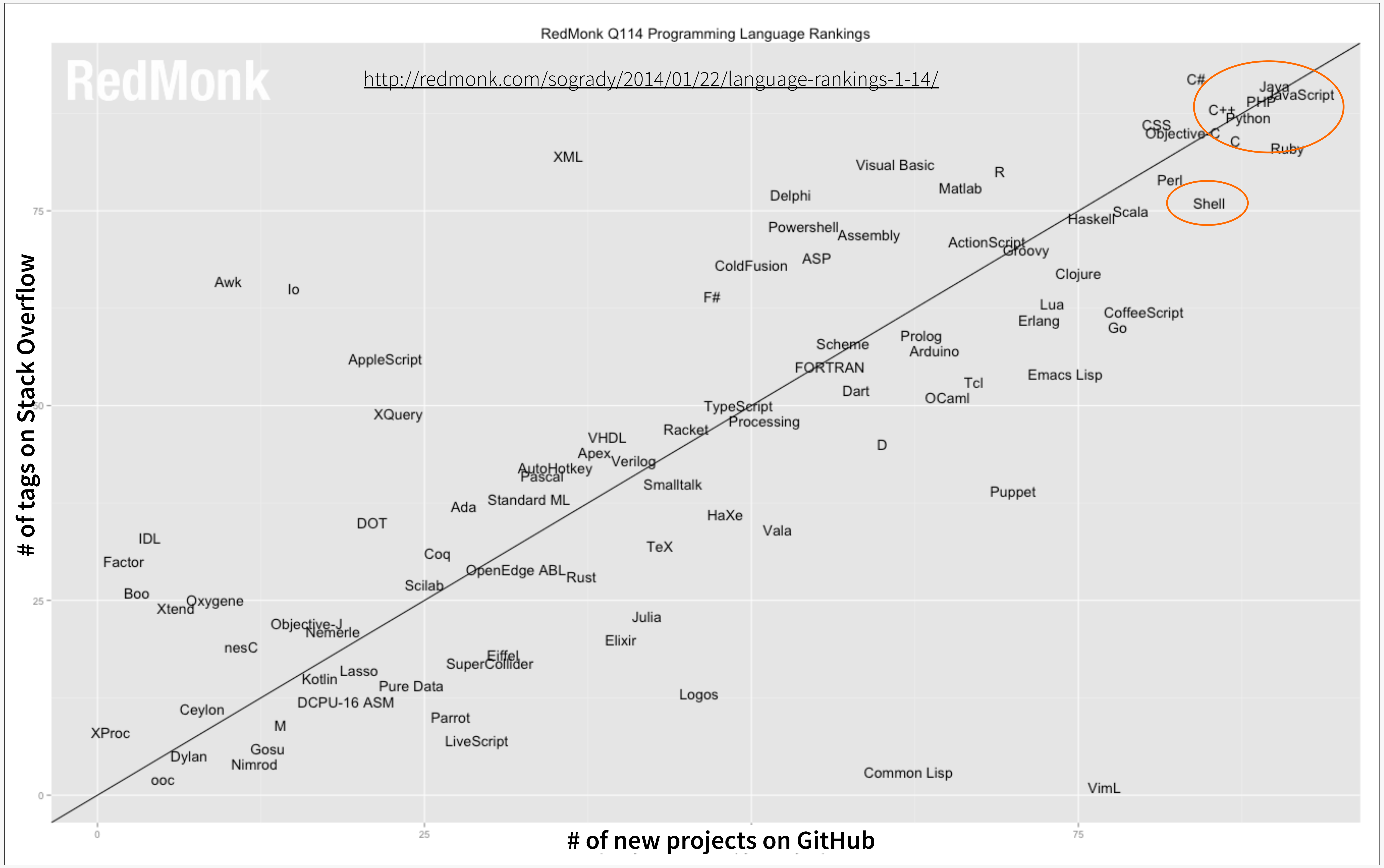
Test-Driven Development





Requirements

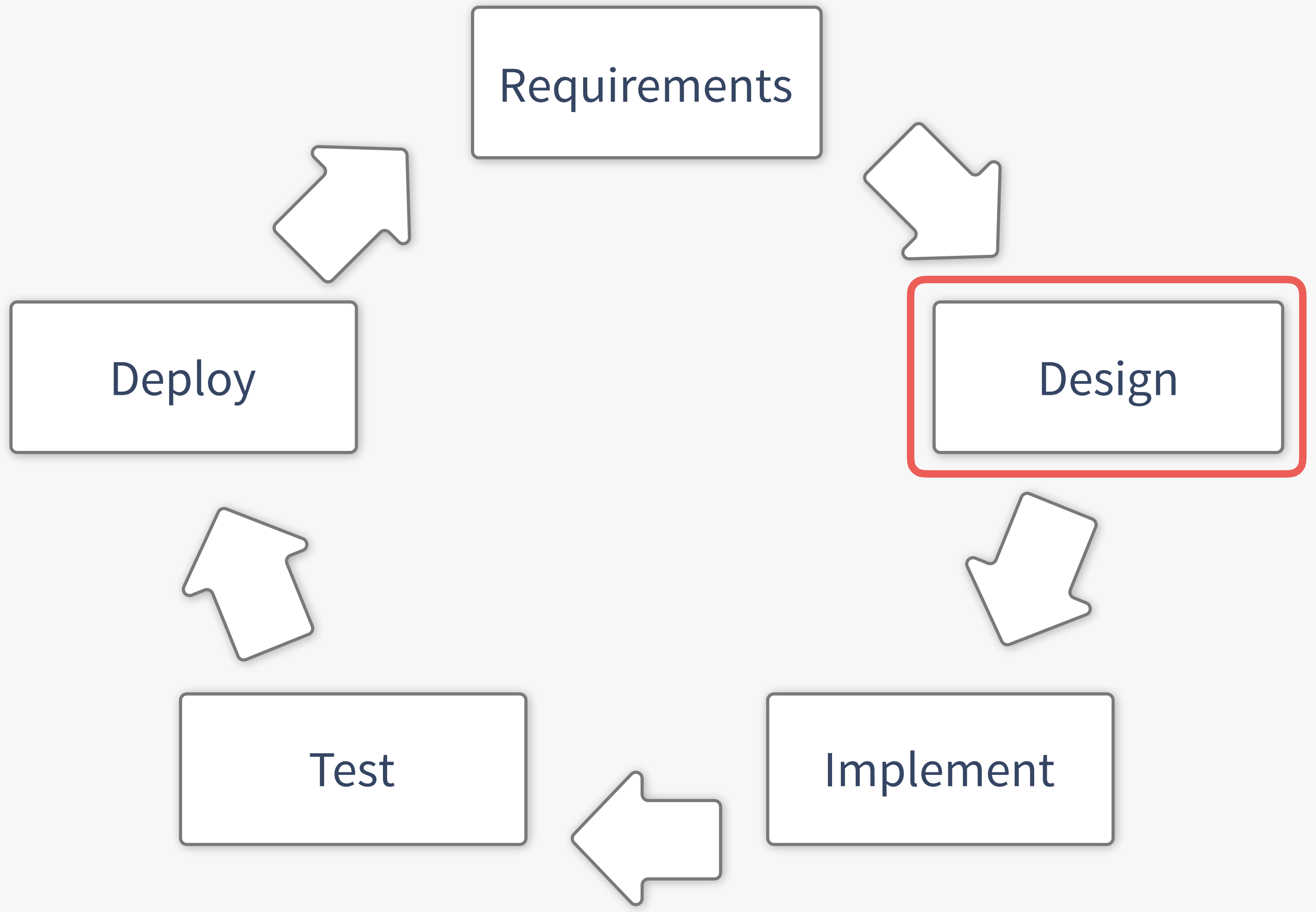
Choosing the programming language



The answer depends:

- Analysis?
- DAQ / Trigger?
- *External conditions?*
    - *Can you choose?*

Do you have to program?



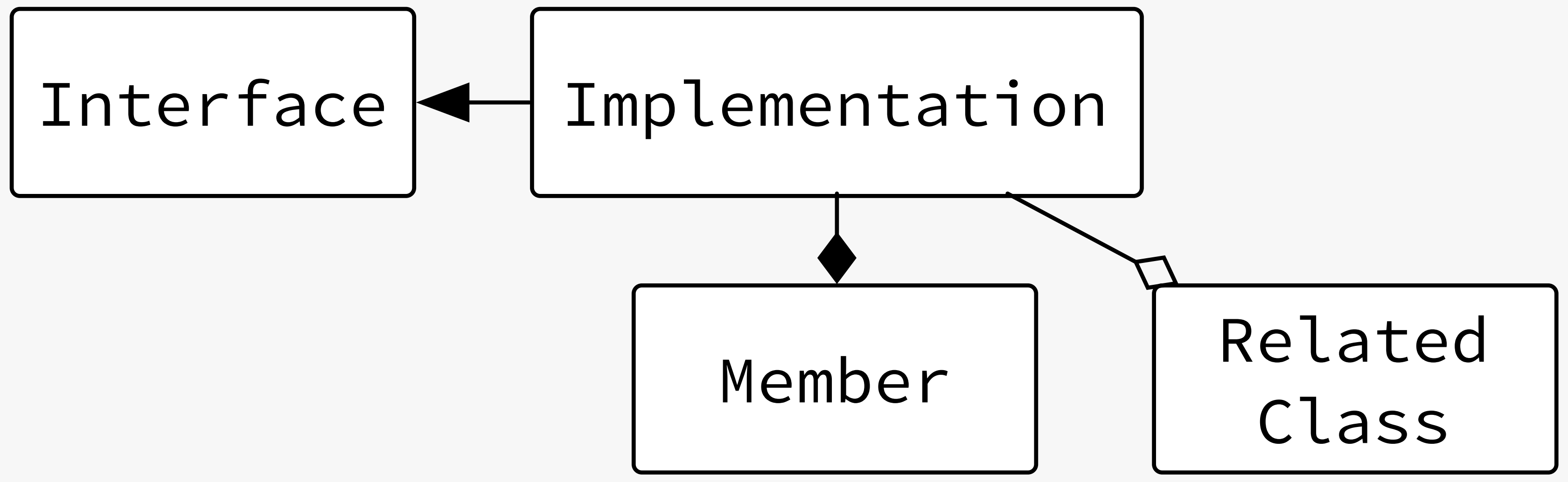
Design

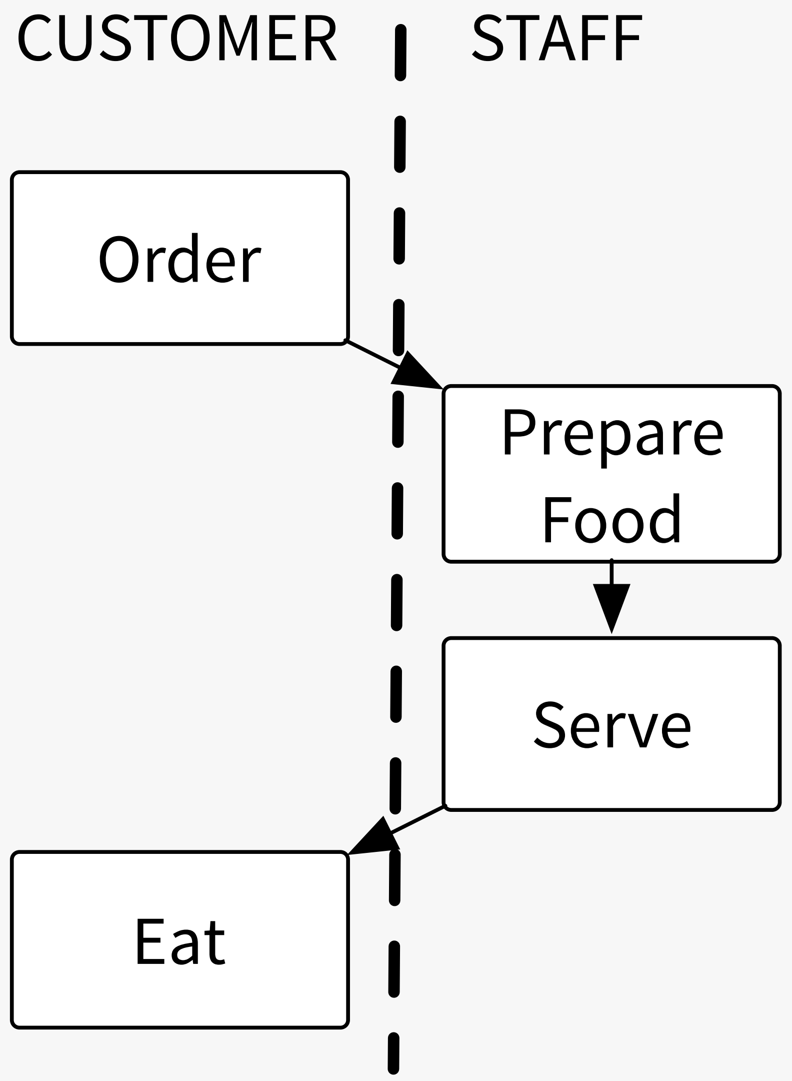
UML Diagrams

Unified Modelling Language can be useful to sketch a design

- Probably everyone has seen structure diagrams
  - Which classes (or larger components) have which relationship
- Behaviour diagrams
  - What does the user do and what should be the result?
- Interaction diagrams
  - How does data and control flow?

Forces you to be concrete!





Things to keep in mind when designing

Maintainability

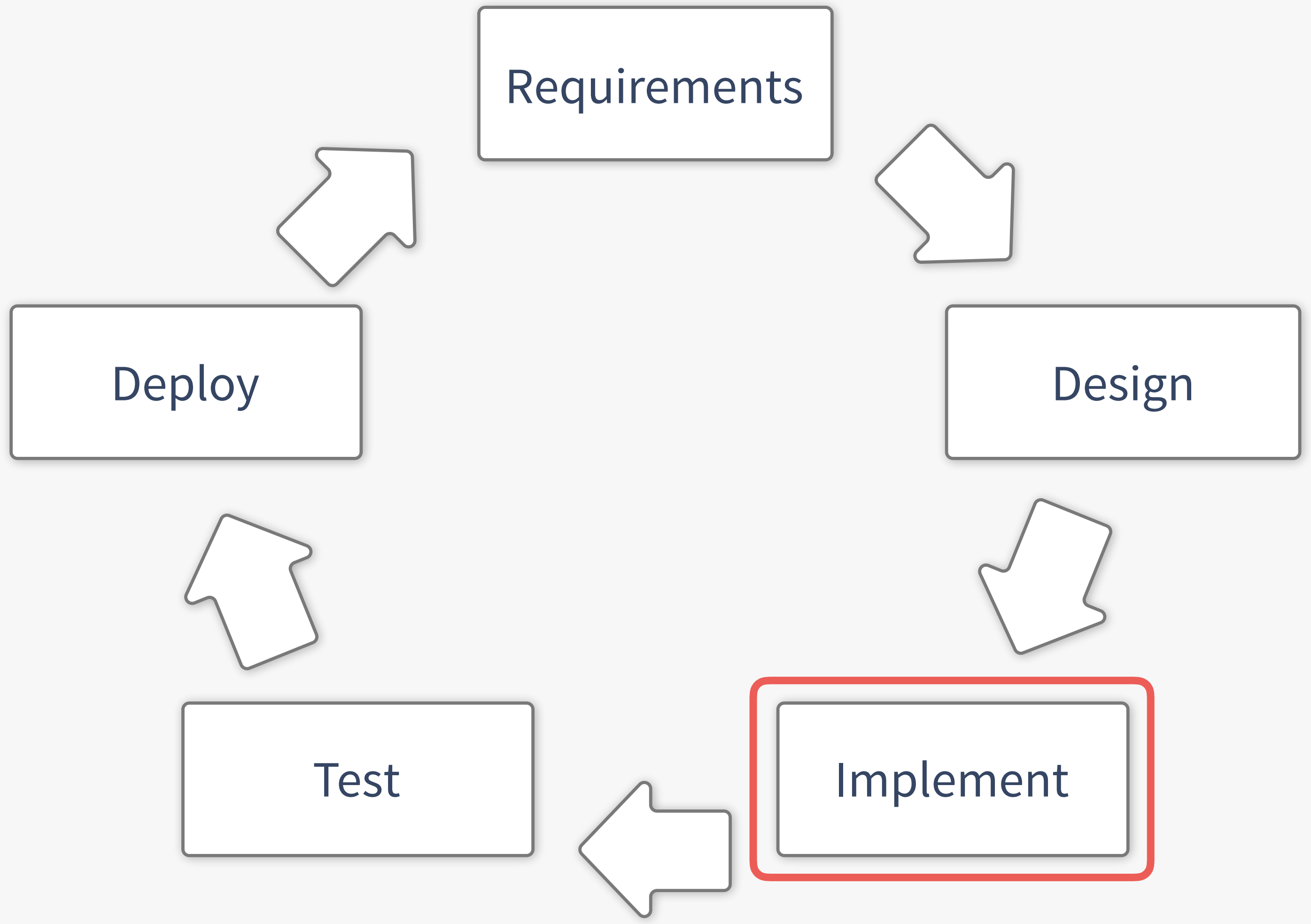
- Is it easy to adapt to changed environment?
- Can you cope with (slightly) changed requirements?

Scalability

- Large data volumes
  - Think about data-flow and data layout
  - Try to avoid complicated data structures

Re-usability

- Identify parts of the design that could be used elsewhere
- Could these be extracted in a dedicated library?



Implementation

Avoid feature bloating

If you try to do everything at once:

- You’ll probably end up doing nothing right
- Generalising a problem before solving it: Probably not a good idea
  - Only do it when you have a use case
- Write dedicated tools / libraries

Define features by writing a test that needs to be passed

- Do not implement more than you need to pass that test.

Be pragmatic

  - Only do the abstract cases when it is likely that they will be used
  - Try to make everything as concise as possible (maintain readability)
  - Keep it simple!

Check for existing solutions

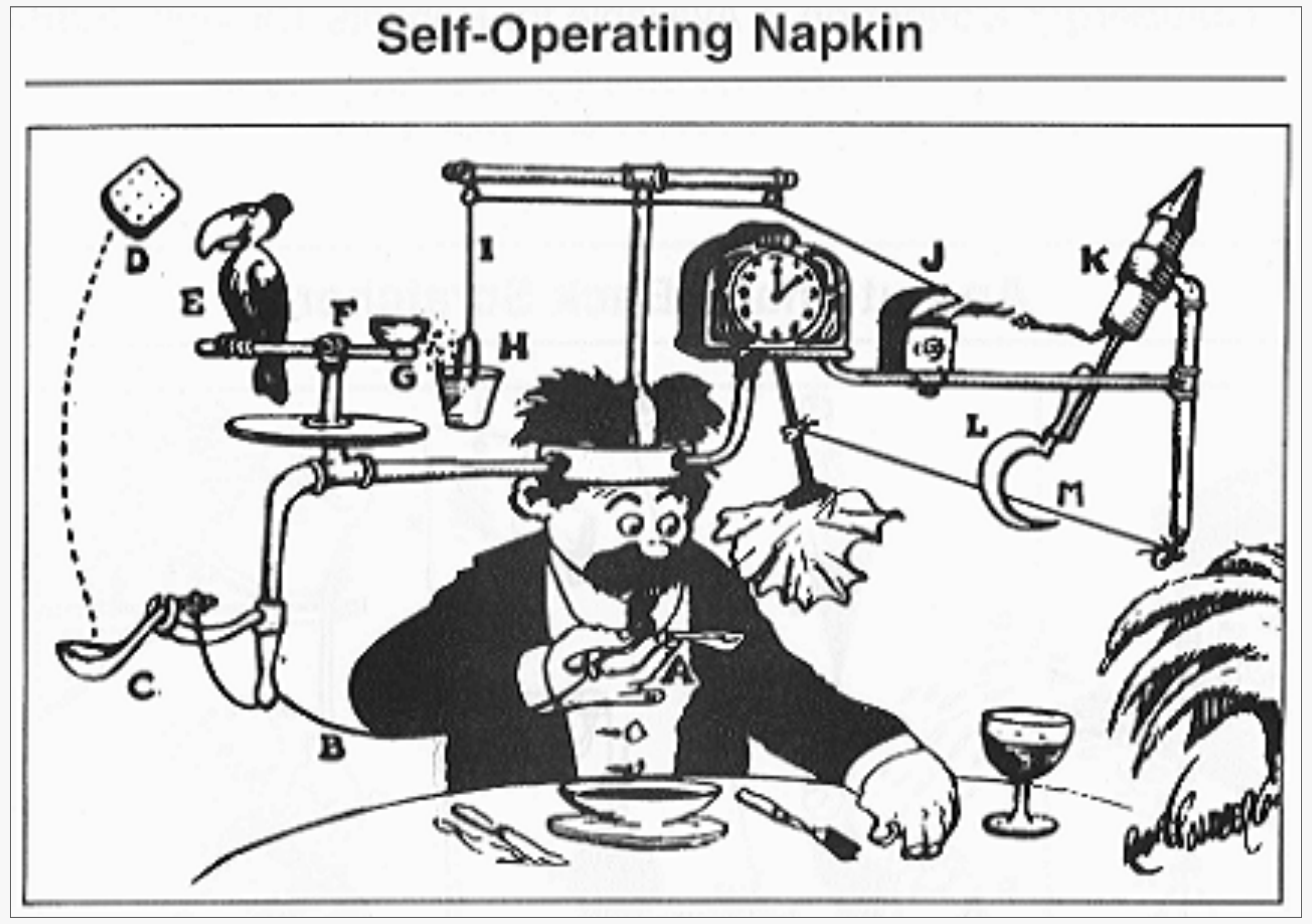
Do not reinvent the wheel

- Many problems have already been solved
- (Sometimes necessary — avoid dependencies)
  - Do not reject a library because of too many features

- When using external libraries, look out for:
  - Active community? Well maintained?
  - Tested?
  - Look for: Last commit a few days ago, most over a year old

Getting to know new frameworks:

- Before asking for advice: try the simple tools
  - Read the docs
    - Investing time in the beginning will pay off
  - Are there wikis? Has it been asked on StackOverflow?
  - python packages: try the ipython "help"



"Prof. Lucifer Butts and his Self-Operating Napkin",
by Rube Goldberg

- Start with a simple test (work your way from the existing examples)
  - Does the code do what you expect?

before looking at external libraries:
Look at the STL / python standard library

Don’t reinvent the wheel

Tools of the Trade: Editor, Terminal and IDEs

Whatever you do, you’ll end up using (at least)

- Editor
  - Know* at least one “always” present editor: nano, vi(m), emacs, etc.
  - More modern solutions: May have some benefits
  - Depending on the language / platform: IDEs are a better choice (Java, Python(?))
- Terminal
  - Learn about shortcuts (tab, ctrl+r, ctrl+e, ctrl+a . . . have a look)
  - Knowing about some basic command line-tools can come in handy

* at least know how to save and exit :)
for the more daring: try **ed**

A few words on editors: Choose what suits you and be effective

The choice of editor is yours…

- Do you want “a great operating system, lacking only a decent editor”
- Or one with two modes: “beep constantly” and “break everything” *

vs

Both are versatile and learning them is worthwhile

However: Alternatives exist that have a less steep learning-curve

- Most of them have been commercial solutions (TextMate, Sublime Text)
- Open alternatives: github’s Atom, https://atom.io/ & Microsoft’s Visual Studio Code
  - Integrated git diffs, active communities, many plugins…

Once you decided which one is best for you:

- Spend some time learning about it’s features and keybindings
- Many things that might require dozens of keystrokes can be done with 2 (5 in emacs ;))
- Learn about: Linters, extensibility — look at existing plugins

Atom on MacOS: Don’t forget to Install Shell Commands (after moving to final dest)

* from http://en.wikipedia.org/wiki/Editor_war

The Terminal - Get used to it

At the beginning might think: Quicker with GUI, don't need terminal

- After learning about some command line tools. . . probably not
- What if you don't have a GUI?

Searching for files / something in files: grep, find.. example:

```
$ find . -name "*.cc" -exec grep -A 3 "foo" {} +
```

- Displays all matches of "foo" (+3 lines below) in all .cc files from the current work dir

Once you learn about some of the small wheels you can build big machines:

- `sed`, `head`, `tail`, `sort`. . . `awk` (a turing-complete interpreted language)
- At the beginning: note down often used commands. . .
- After a tutorial dump your history* (increase cache size for max usage)

Shell-scripting:

- Anything you do with the shell can just be dumped in a script
- Alternative: Can solve most things more conveniently with an interpreted language
  - Con: interpreters might not always be available

* dump the last 100 steps:

```
$ history | tail -n 100 > steps.txt
```

log the terminal "responses":

```
$ script # press ctrl+d to stop
```

tune your bashrc / bash-profile
see additional material

Interlude: Working on the go — SSH

SSH — might be more versatile than you think:

- Tunneling
  - Secure connections to other machines
  - Use with VNC to avoid man-in-the-middle vulnerability
- Generate keys for authentication
- Working through X-forwarding can be annoying if you have bad latency / shaky connection
  - Always use screen or similar
  - Alternative: mosh (https://mosh.mit.edu/)
    - allows intermittent connectivity, roaming and more…

SSHFS and AFS

- Work locally but have files live in remote host

SSH tunnel for VNC connection:

```
ssh -L 5902:<VNCServerIP>5902
<user>@<remote> vncserver :<session> -
geometry <width>x<height> -localhost -
nolisten tcp
```

SSH authentication via kerberos token. In ~/.ssh/config:

```
GSSAPIAuthentication yes
GSSAPIDelegateCredentials yes
HOST lxplus*
    GSSAPITrustDns yes
```

Lots of things possible with the ssh-config:

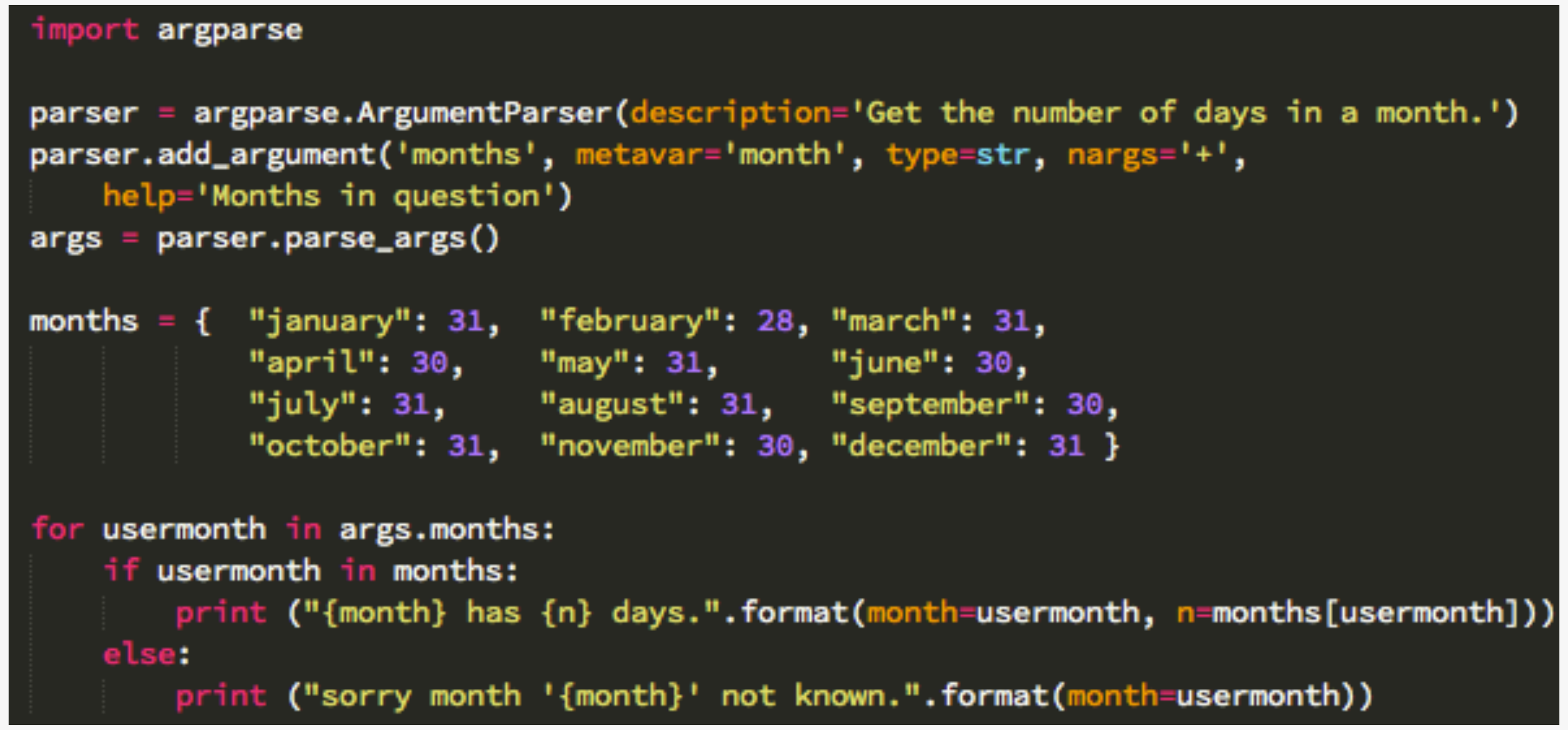
```
HOST <host>
    USER <remote-user>
    ProxyCommand ssh <tunnel> nc <host>
<port>
```

more on (auto-)tunnelling:
https://security.web.cern.ch/security/recommendations/en/ssh_tunneling.shtml

The right tool for many jobs - interpreted languages

Make your code as short as possible while maintaining readability

- For some solutions that means to use the right language
- Often quicker and nicer to use interpreted languages: python, perl, ruby, tcl, lua
- Often used as binding languages: Performance critical code in C/C++ modules instantiated within python (e.g. in CMS offline Software) — best of both worlds
- Personal choice: Python has a large standard library and is very expressive!



```python
import argparse

parser = argparse.ArgumentParser(description='Get the number of days in a month.')
parser.add_argument('months', metavar='month', type=str, nargs='+',
    help='Months in question')
args = parser.parse_args()

months = {  "january": 31,  "february": 28, "march": 31,
            "april": 30,    "may": 31,       "june": 30,
            "july": 31,     "august": 31,    "september": 30,
            "october": 31,  "november": 30, "december": 31 }

for usermonth in args.months:
    if usermonth in months:
        print ("{month} has {n} days.".format(month=usermonth, n=months[usermonth]))
    else:
        print ("sorry month '{month}' not known.".format(month=usermonth))
```

Easy to read Code

Easier to maintain; Easy to re-use

Interlude: iPython

```
> ipython
 In [1]: import array
 In [2]: help (array)
```

Interlude: iPython

```
ArrayType = class array(__builtin__.object)
 |  array(typecode [, initializer]) -> array
 |
 |  Return a new array whose items are restricted by typecode, and
 |  initialized from the optional initializer value, which must be a list,
 |  string or iterable over elements of the appropriate type.
 |
 |  Arrays represent basic values and behave very much like lists, except
 |  the type of objects stored in them is constrained.
 |
 |  Methods:
 |
 |  append() -- append a new item to the end of the array
 |  buffer_info() -- return information giving the current memory info
 |  byteswap() -- byteswap all the items of the array
 |  count() -- return number of occurrences of an object
 |  extend() -- extend array by appending multiple elements from an iterable
 |  fromfile() -- read items from a file object
 |  fromlist() -- append items from the list
```

Interlude: iPython

```
> ipython
 In [1]: import array
 In [2]: help (array)
 In [3]: import ROOT
 In [4]: help (ROOT.TH1D)
```

Interlude: iPython

```
class TH1D(TH1, TArrayD)
 |  Method resolution order:
 |      TH1D
 |      TH1
 |      TNamed
 |      TObject
 |      TAttLine
 |      TAttFill
 |      TAttMarker
 |      TArrayD
 |      TArray
 |      ObjectProxy
 |      __builtin__.object
 |
 |  Methods defined here:
 |
 |  AddBinContent(self, *args)
 |      void TH1D::AddBinContent(int bin)
 |      void TH1D::AddBinContent(int bin, double w)
```

Interlude: iPython

```
> ipython
 In [1]: import array
 In [2]: help (array)
 In [3]: import ROOT
 In [4]: help (ROOT.TH1D)
 In [4]: run myscript.py
```

Documentation: Do it while it’s fresh

Generally two sides of the same coin: Internal and external documentation

- Both are necessary to make your programs easy to use
- They have different purpose!

Internal documentation:

- Explain interfaces, i.e. function signatures
- Make note of possible future problems (better: prevent them)
- Sometimes might be good to document your reasoning
- Do not “over-comment”

External documentation:

- Again: Explain your interfaces (can be derived from internal, e.g. doxygen.org)
- For large projects: The big picture
  - Wiki pages with use-cases and examples
  - Consider using UML (unified modelling language)

```
class TheClass(object):
    """ Documentation of this class. """
    def __init__(self, var):
        self.var_ = var
    ## @var var_
    # my member variable

    ## Documentation of this function.
    # More on what this function does.
    ## @param arg1 an integer argument
    ## @param arg2 a string argument
    ## @returns a list of ...
    def some_function(self, arg1, arg2):
        pass
```

```
if a > b: # when a is greater than b, do...
```

Documentation: Do it while it’s fresh

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Internal documentation:

- Explain interfaces, i.e. function signatures
- Make note of possible future problems (better: prevent them)
- Sometimes might be good to document your reasoning
- Do not “over-comment”
- Clean code: You write it once and you read it many times

External documentation:

- Again: Explain your interfaces (can be derived from internal, e.g. doxygen.org)
- For large projects: The big picture
  - Wiki pages with use-cases and examples
  - Consider using UML (unified modelling language)

```
class TheClass(object):
    """ Documentation of this class. """
    def __init__(self, var):
        self.var_ = var
    ## @var var_
    # my member variable

    ## Documentation of this function.
    # More on what this function does.
    ## @param arg1 an integer argument
    ## @param arg2 a string argument
    ## @returns a list of ...
    def some_function(self, arg1, arg2):
        pass
```

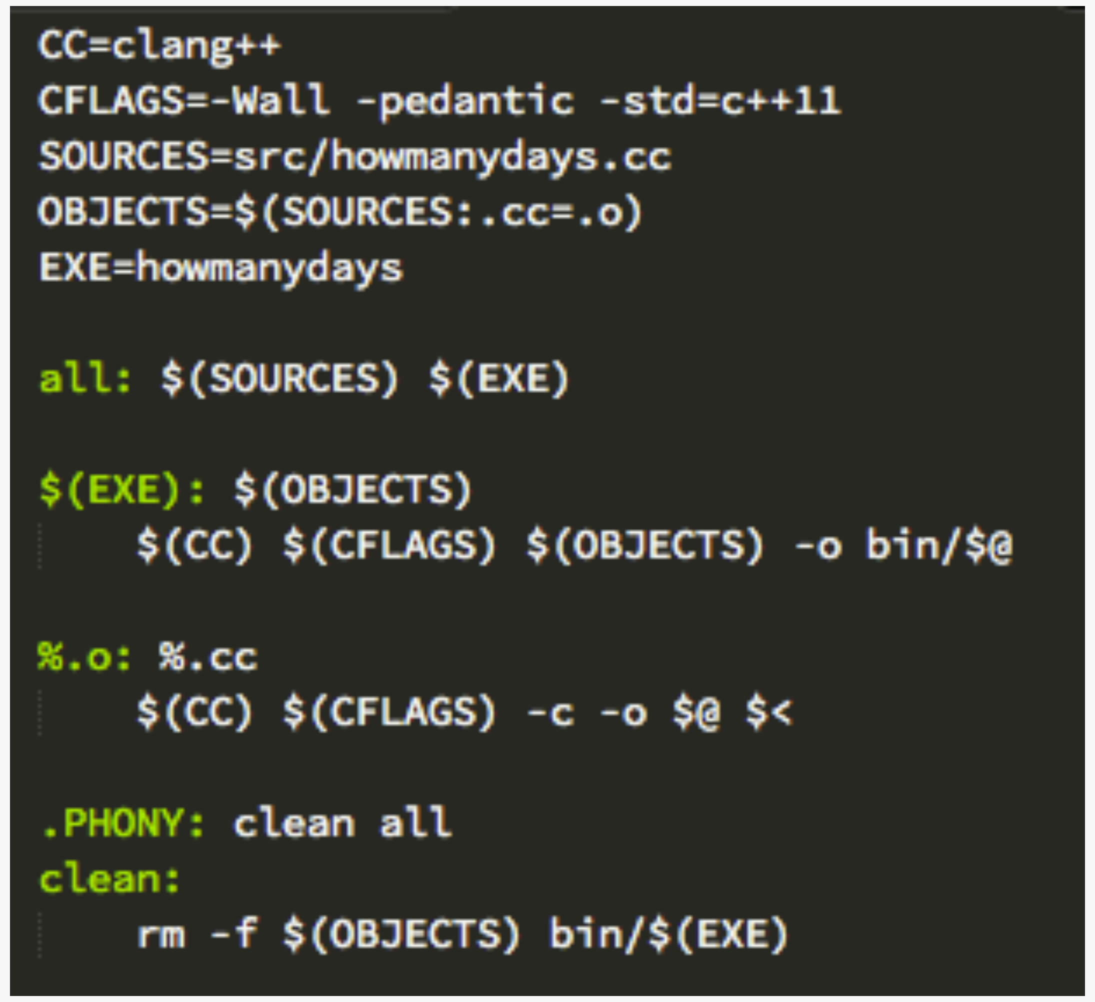
if a > b: # ~~when a is greater than b, do...~~

Document while coding

Write build scripts to ease your life

Makefiles — makes compilation easier

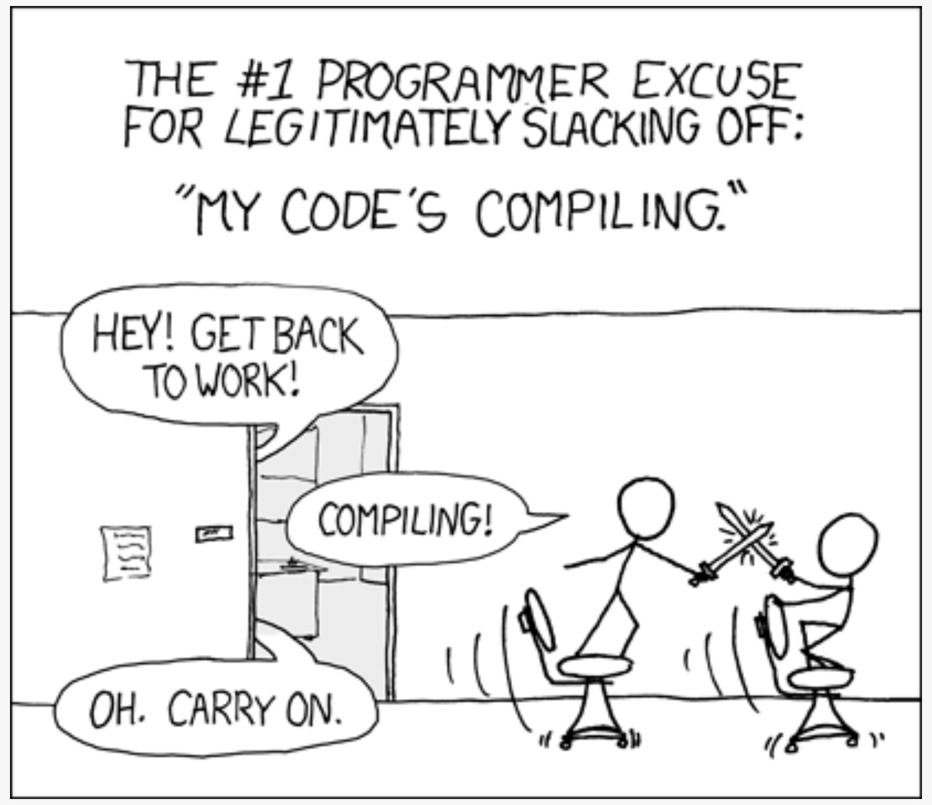
- Makefiles might look complex
- More than one source file: Useful!
  - Again: Think about compiling it in 2 years
- Write your own for a small project
- Automatically allows parallel compilation (option -j)



```
CC=clang++
CFLAGS=-Wall -pedantic -std=c++11
SOURCES=src/howmanydays.cc
OBJECTS=$(SOURCES:.cc=.o)
EXE=howmanydays

all: $(SOURCES) $(EXE)

$(EXE): $(OBJECTS)
    $(CC) $(CFLAGS) $(OBJECTS) -o bin/$@

%.o: %.cc
    $(CC) $(CFLAGS) -c -o $@ $<

.PHONY: clean all
clean:
    rm -f $(OBJECTS) bin/$(EXE)
```

Alternatives and improvements to makefiles: CMake and others

- Might look like overkill; Makes things easier in the long run
- CMake is easier to read and better documented
- Improved portability
- At least you should learn how to compile with it



"Compiling" by Randall Munroe
xkcd.com

Debugging with the right tools

While running your code:

- printing to console: only suitable for small code base
- Sooner or later have to use a debugger: gdb (GNU debugger) — get a stack-trace
  - basic commands: run, bt, info <*>, help
- Python: pdb — import pdb; pdb.set_trace() #set a breakpoint

General hint for debugging

- Most segmentation violations due to memory management
  - Life-time vs. scope
  - Only use raw pointers when you have to!

    (I.e. when you know what you’re doing and you need the performance)
  - Look at smart pointers (part of C++11/14 standards, alternative: boost)
- Even if you don’t have crashes: Memory Leaks. Try valgrind (valgrind.org)

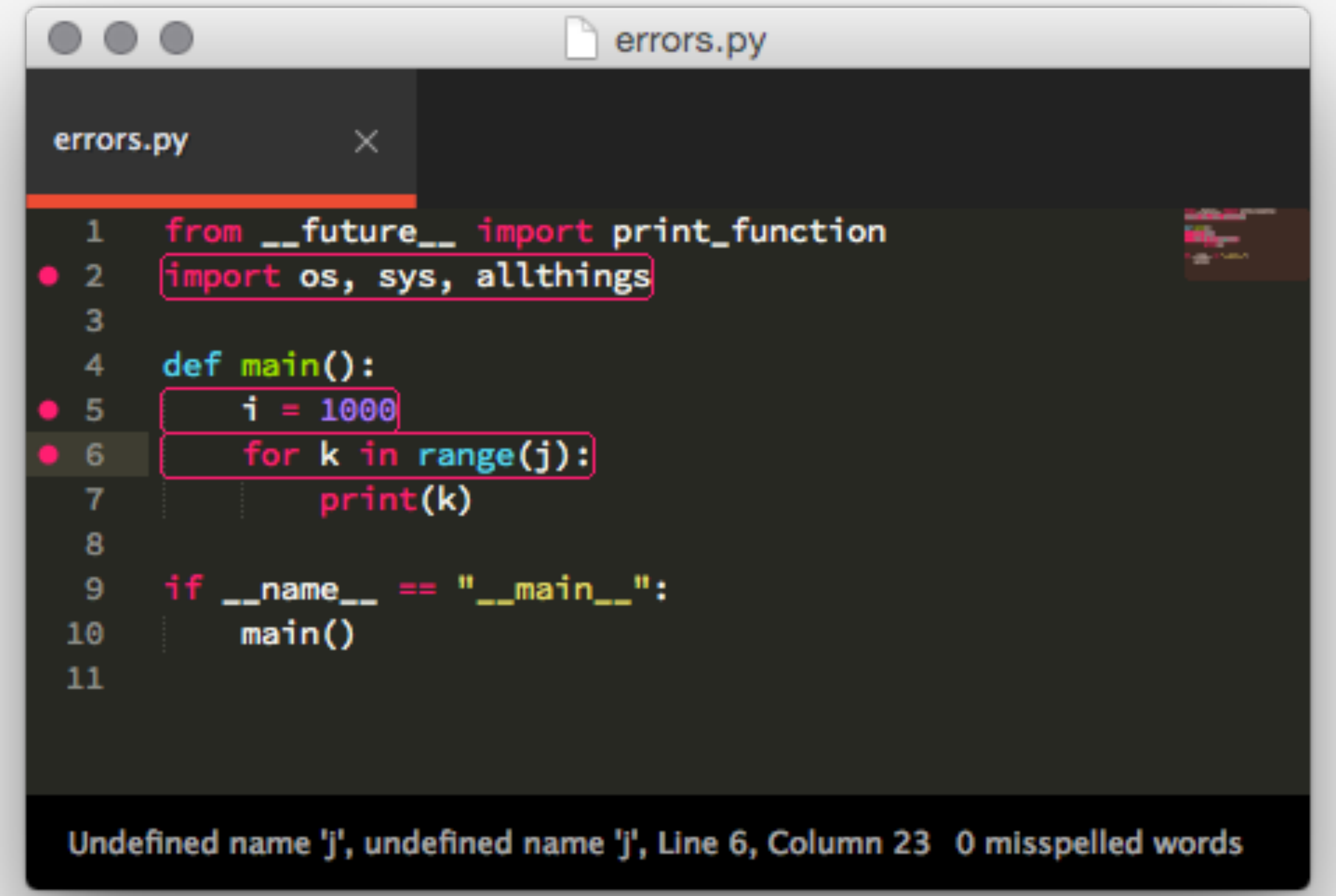
Static Code Checking

While writing your code:

- There are static code analysis tools that can help you
- Try out a linter for your preferred editor (e.g. atom: https://atom.io/packages/linter)
  - Highlights potentially problematic code— your code will be more reliable

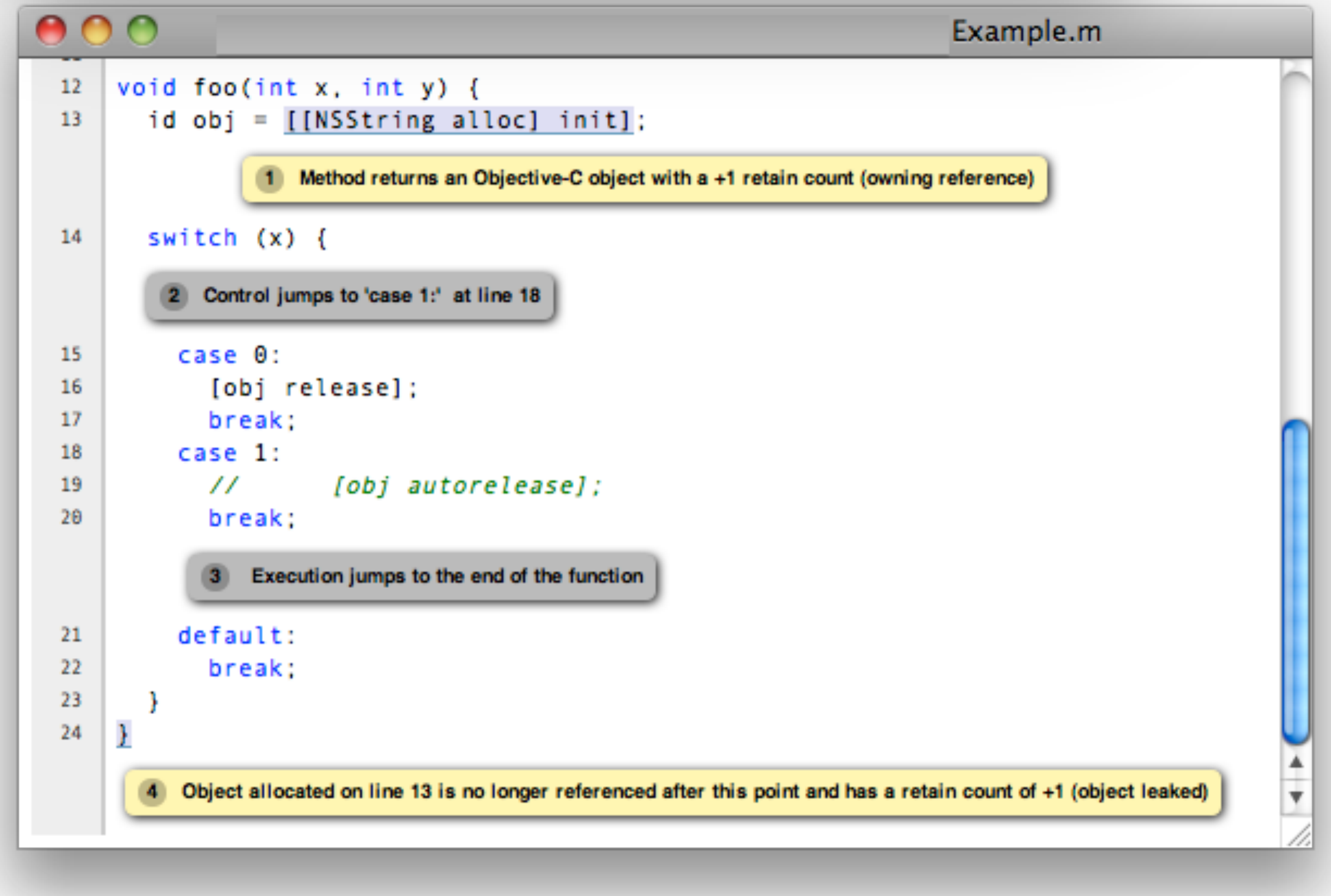
Static checking at compile time:

- Clang has a nice suite of static checks implemented http://clang-analyzer.llvm.org
  - Can also enforce coding styles
- Takes longer than compiling; gives HTML reports with possible bugs
- Might flag some false-positives

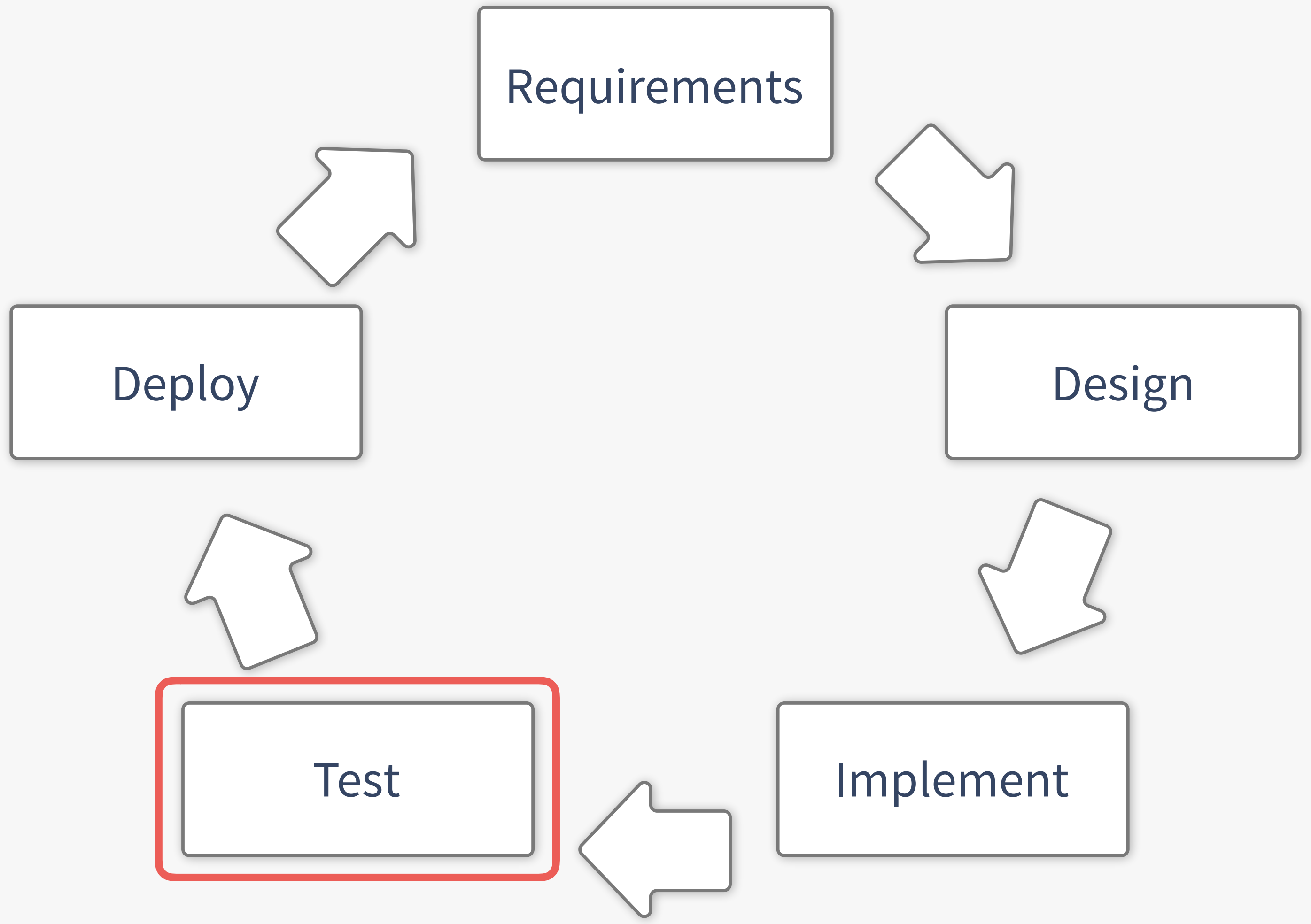


```
 1  from __future__ import print_function
 2  import os, sys, allthings
 3
 4  def main():
 5      i = 1000
 6      for k in range(j):
 7          print(k)
 8
 9  if __name__ == "__main__":
10      main()
11
```

Undefined name 'j', undefined name 'j', Line 6, Column 23   0 misspelled words



```
12  void foo(int x, int y) {
13    id obj = [[NSString alloc] init];

        1  Method returns an Objective-C object with a +1 retain count (owning reference)

14    switch (x) {

      2  Control jumps to 'case 1:'  at line 18

15      case 0:
16        [obj release];
17        break;
18      case 1:
19        //      [obj autorelease];
20        break;

       3  Execution jumps to the end of the function

21      default:
22        break;
23    }
24  }

    4  Object allocated on line 13 is no longer referenced after this point and has a retain count of +1 (object leaked)
```



Testing

What do we mean with tests?

Different tests, different purposes:

- Unit test
  - Testing a part of an algorithm, e.g. a class
  - Given a defined input, will that part produce expected output?
- Integration test
  - Testing a larger part of your software
  - For example running an example and checking output

Do not mix it up with verification!

Writing good tests is hard

How to come up with tests?

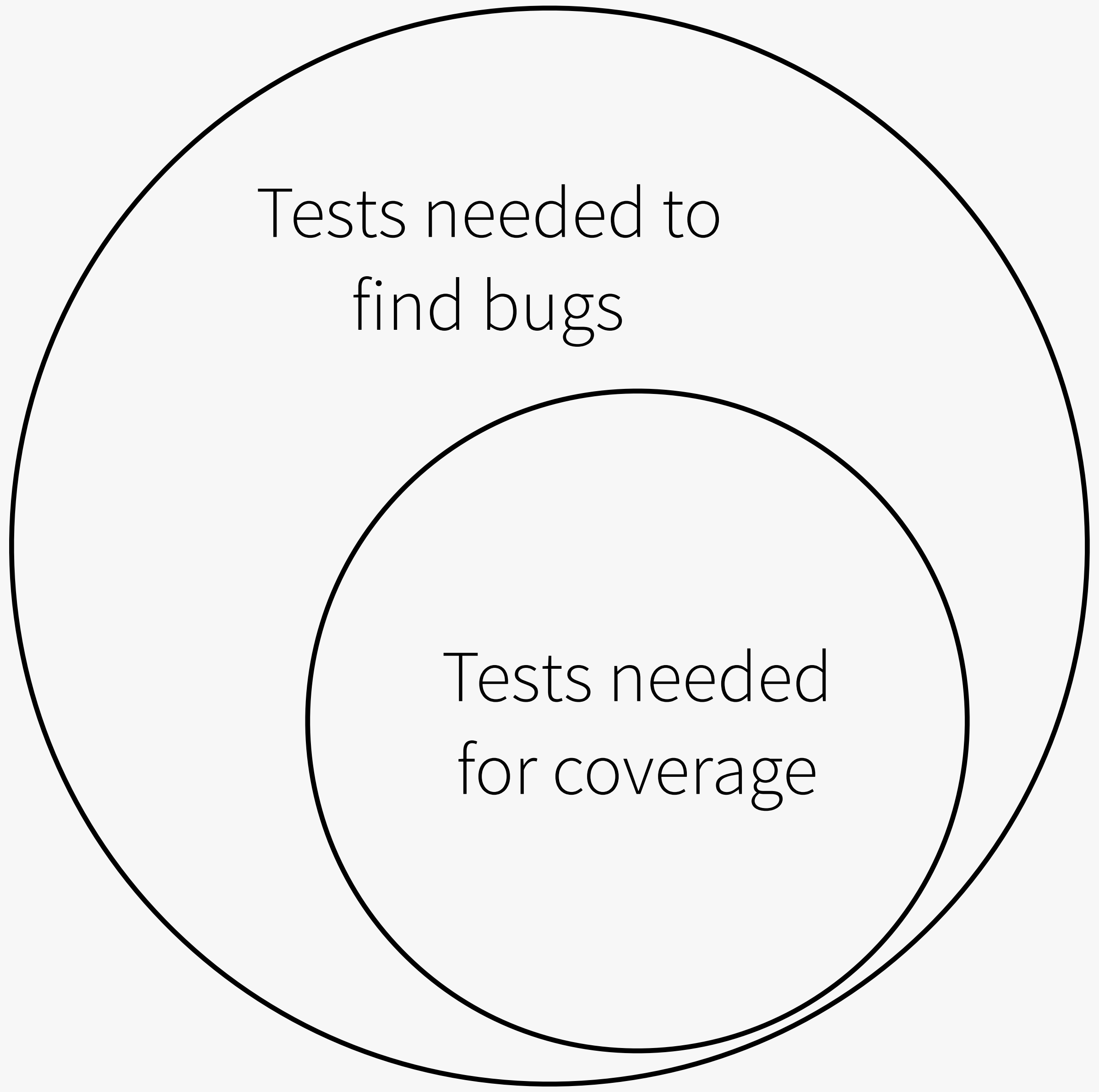
- What should the algorithm do?
  - Check if well defined input produces result
- How should the algorithm fail?
  - Check if wrong input fails in the way you want it to

You'll probably miss corner cases:

- Once you discover them, implement a test!
  - Only let an error hit you once
- Have beta-testers / users help you - use bug reports

Look at existing solutions for integrating tests

- Python: doctest and unittest packages
- C++: ctest integrated with cmake



Interlude: doctest

```
> python testfib.py
```

```python
def fib(n):
    """ Returns the fibonacci series at n
    >>> [fib(n) for n in range(6)]
    [0, 1, 1, 2, 3, 5]
    >>> fib(-1)
    Traceback (most recent call last):
      ...
    ValueError: n should be >= 0
    """
    if n < 0:   raise ValueError("n should be >= 0")
    if n == 0:  return 0
    a, b = 1, 1
    for i in range(n-1):
        a, b = b, a+b
    return a

import doctest
doctest.testmod()
```

Interlude: doctest

```
> python testfib.py
>
```

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def fib(n):
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Interlude: doctest

```
> python testfib.py -v
```

```python
def fib(n):
    """ Returns the fibonacci series at n
    >>> [fib(n) for n in range(6)]
    [0, 1, 1, 2, 3, 5]
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    Traceback (most recent call last):
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    """
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    a, b = 1, 1
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        a, b = b, a+b
    return a

import doctest
doctest.testmod()
```

Interlude: doctest

```
> python testfib.py -v
> Trying:
>     [fib(n) for n in range(6)]
> Expecting:
>     [0, 1, 1, 2, 3, 5]
> ok
> Trying:
>     fib(-1)
> Expecting:
>     Traceback (most recent call last):
>       ...
>     ValueError: n should be >= 0
> ok
```

```python
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    return a

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```
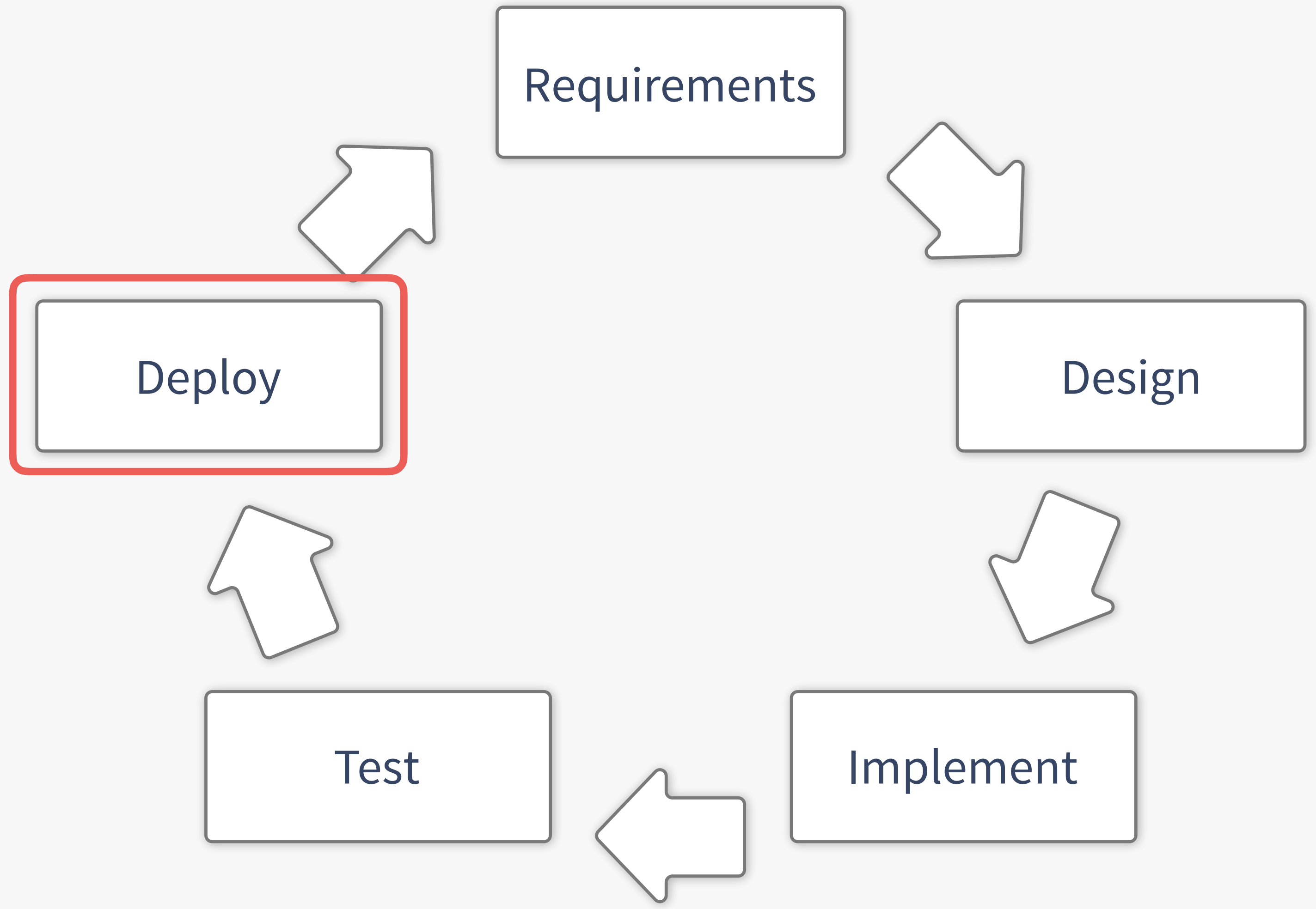

Test your software

and not only in production!



Deploying your software

Releasing the Software

When you release your package / library:

- Tag the repository
  - Ensure everyone has the same code
- Test in the target environment
  - Fresh virtual machine
- Accompanying documentation
  - Produce Doxygen pages
  - Update wikis (new version)
  - Make sure all examples work

Ideal case: All this is done every single night!

Continuous integration

Working in groups on software can be hard:

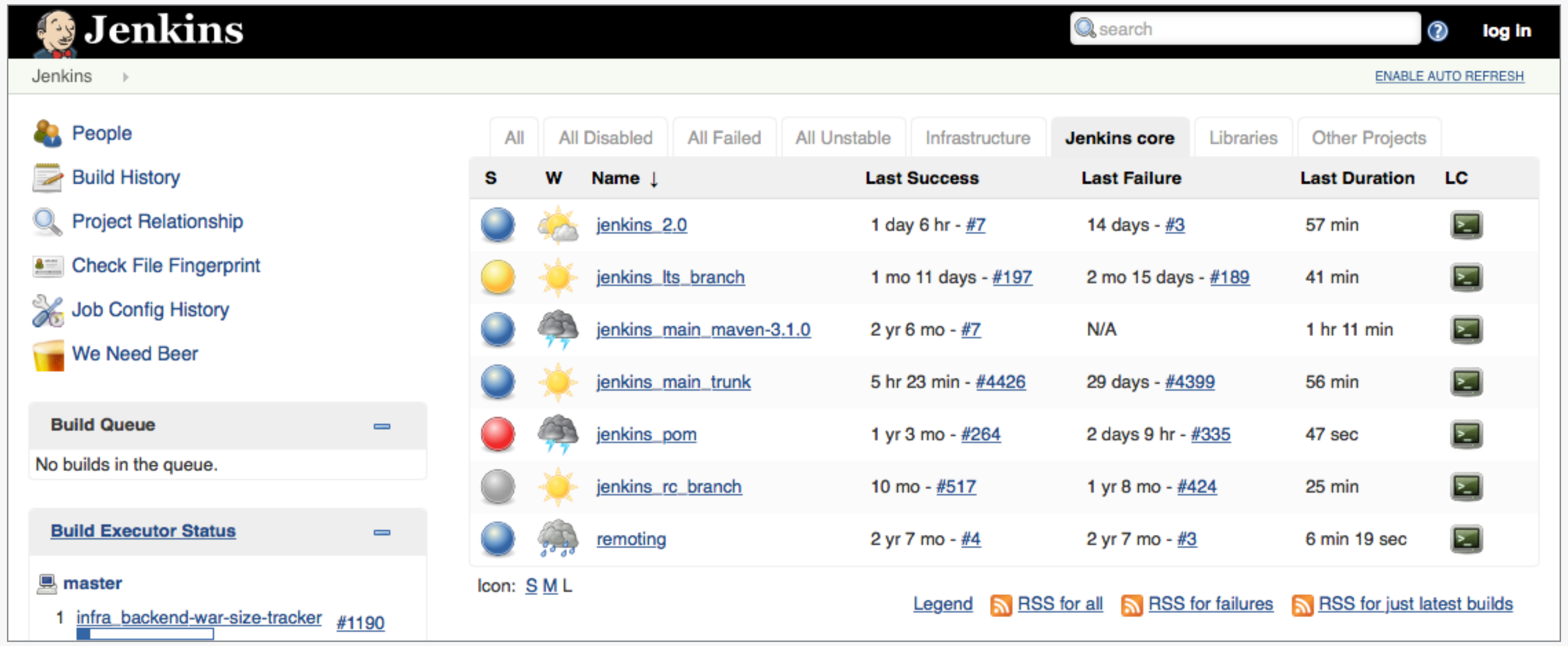
- Somebody changes something: Everything else's code breaks
- This is avoidable!

Whenever somebody contributes to the code base:

- Check everything works
  - Can do this by hand.. Tedious
  - Better: Automate it.

Many solutions exist that periodically test things:

- Check compilation
- Check all defined test cases
- Write nice summaries



S	W	Name ↓	Last Success	Last Failure	Last Duration	LC
●	⛅	jenkins_2.0	1 day 6 hr - #7	14 days - #3	57 min	▣
●	☀	jenkins_lts_branch	1 mo 11 days - #197	2 mo 15 days - #189	41 min	▣
●	⛈	jenkins_main_maven-3.1.0	2 yr 6 mo - #7	N/A	1 hr 11 min	▣
●	☀	jenkins_main_trunk	5 hr 23 min - #4426	29 days - #4399	56 min	▣
●	⛈	jenkins_pom	1 yr 3 mo - #264	2 days 9 hr - #335	47 sec	▣
●	☀	jenkins_rc_branch	10 mo - #517	1 yr 8 mo - #424	25 min	▣
●	🌧	remoting	2 yr 7 mo - #4	2 yr 7 mo - #3	6 min 19 sec	▣

Icon: S M L

Legend RSS for all RSS for failures RSS for just latest builds

Build Queue

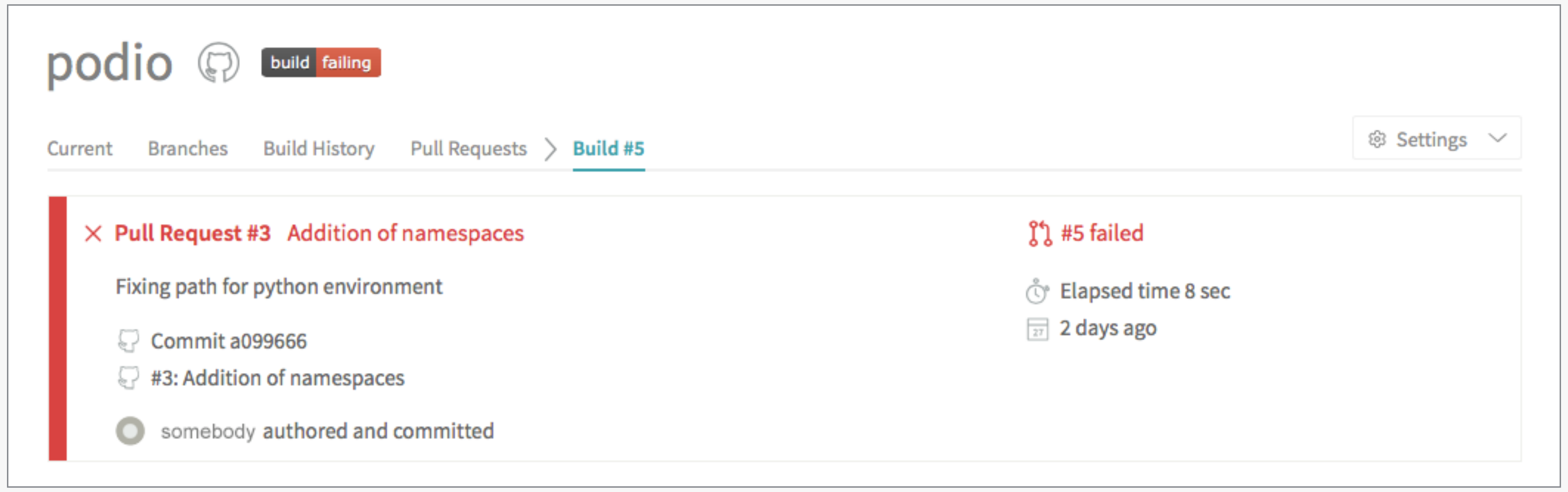
No builds in the queue.

Build Executor Status

master

1 infra_backend-war-size-tracker #1190

Jenkins CI - https://jenkins-ci.org



× Pull Request #3 Addition of namespaces

Fixing path for python environment

Commit a099666

#3: Addition of namespaces

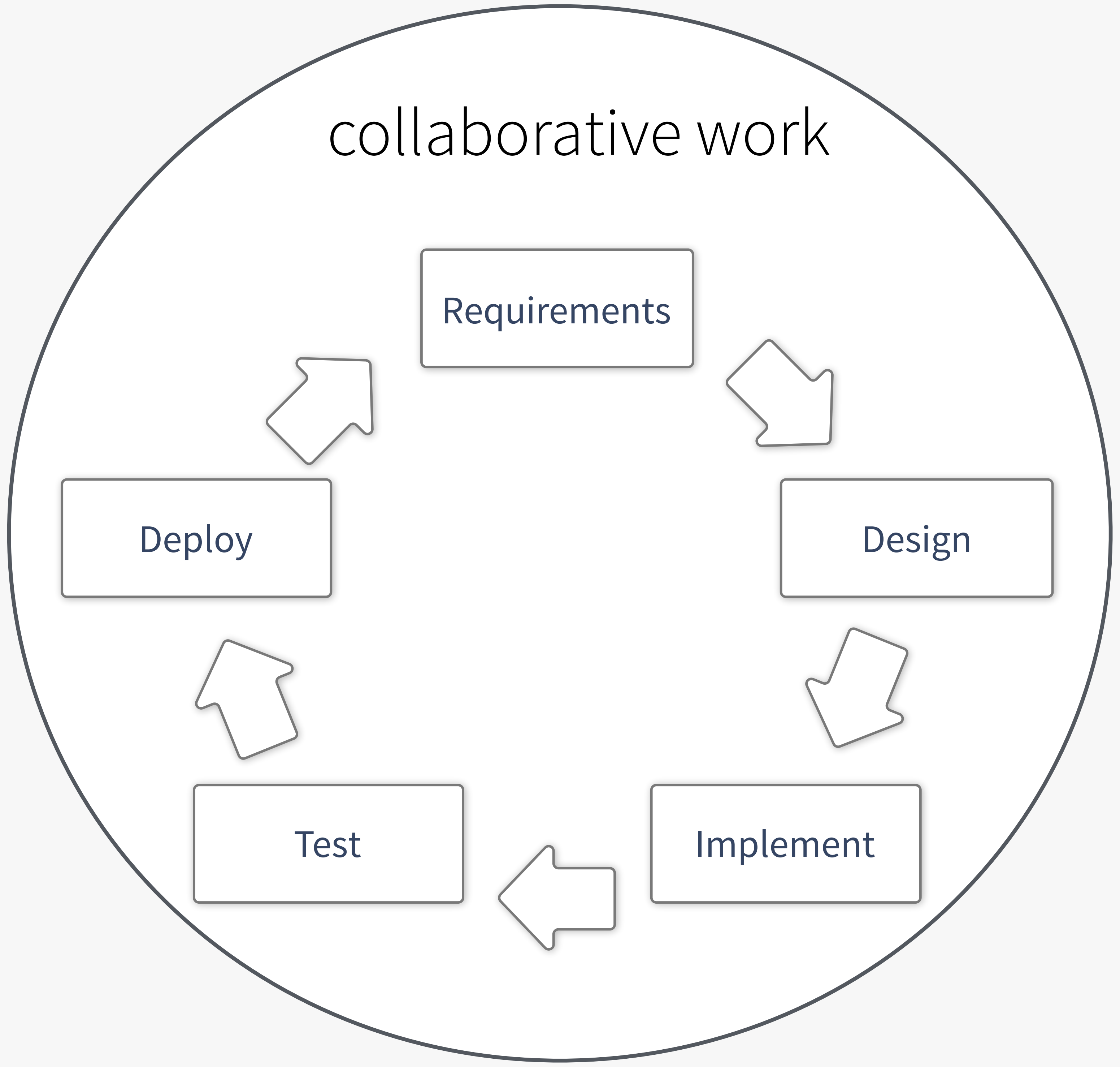
somebody authored and committed

#5 failed

Elapsed time 8 sec

2 days ago

Travis CI - https://travis-ci.org



Collaborative working

Revision control software

Revision control: Important for you, important for colleagues

Basic: CVS and Subversion (“CVS done right”*)

Distributed revision control: Great for personal use (for working on the go)

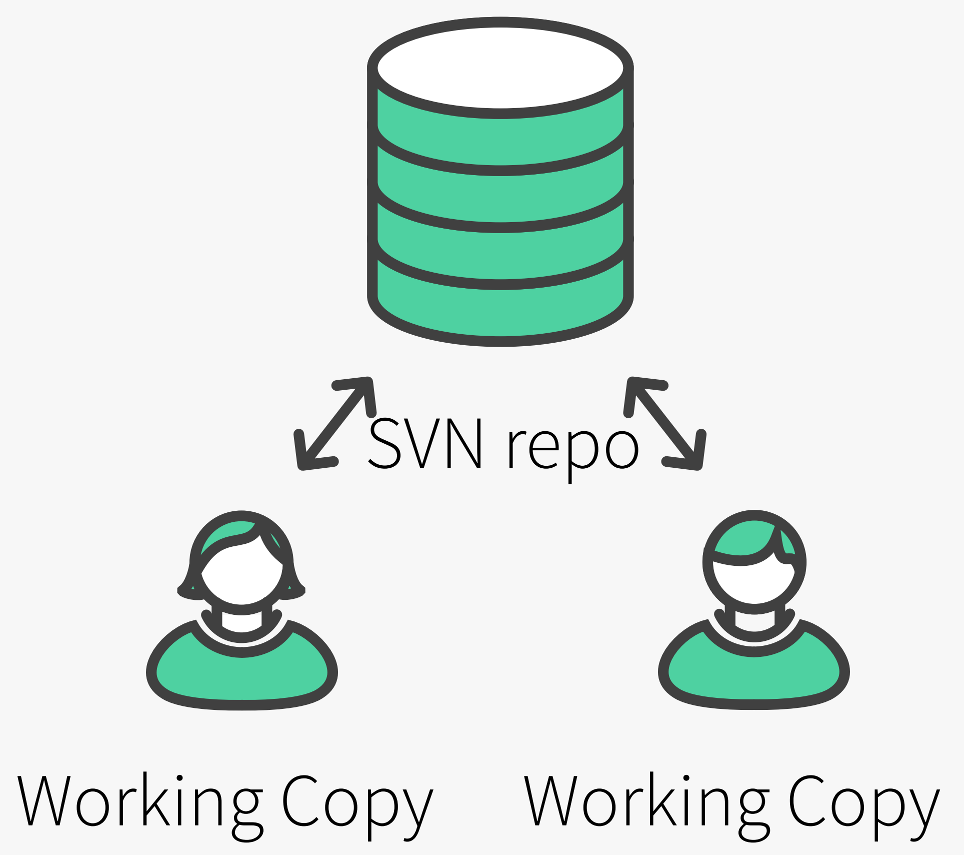
- Your local copy has everything (including history)

Gaining ever more popularity “git”: git-scm.com

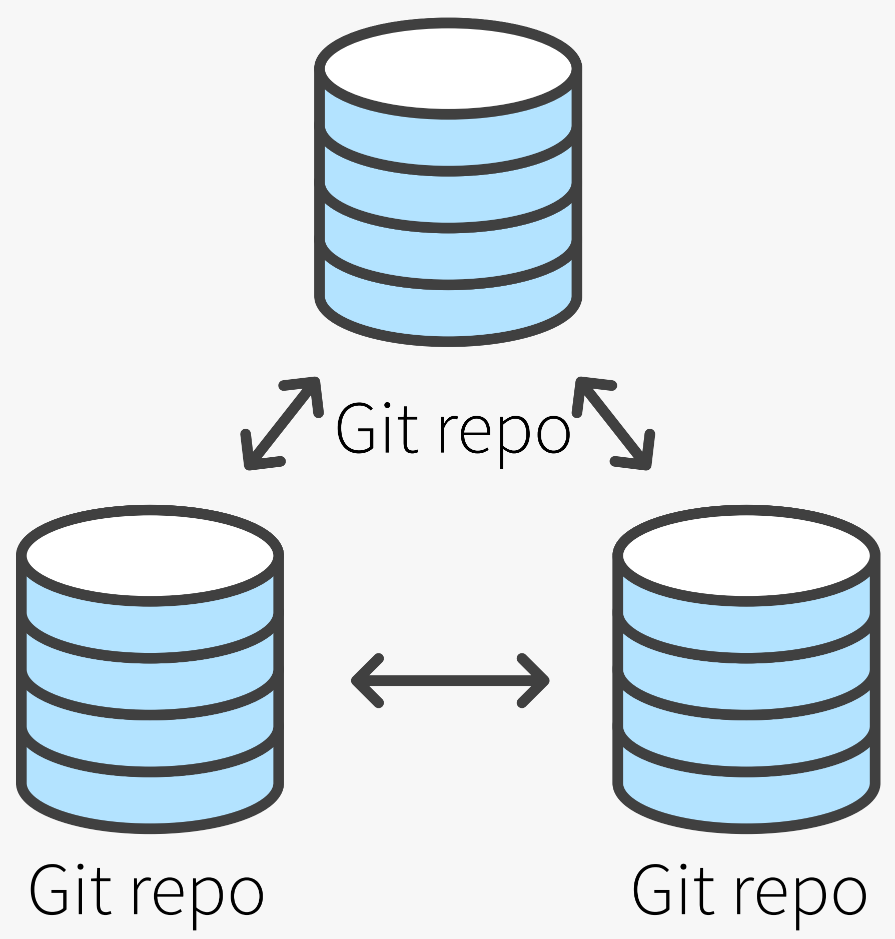
(“there is no way to do CVS right”*)

- Other solutions are: Mercurial, bazaar and more
- Easy to learn…

Central-To-Working-Copy Collaboration



Repo-To-Repo Collaboration



Pictures from: https://www.atlassian.com/git/tutorials/
http://git-scm.com/book/en/v2/Getting-Started-About-Version-Control
http://pcottle.github.io/learnGitBranching/

* paraphrasing Linus Torvalds

Interlude: git basics

```
> git init
 Initialized empty Git repository in /TestDirectory/.git/
```

Interlude: git basics

```
> git init
 Initialized empty Git repository in /TestDirectory/.git/
> vim README.md
 skipping this part.
```

Interlude: git basics

```
> git init
 Initialized empty Git repository in /TestDirectory/.git/
> vim README.md
 skipping this part.
> git add README.md
```

Interlude: git basics

```
> git init
 Initialized empty Git repository in /TestDirectory/.git/
> vim README.md
 skipping this part.
> git add README.md
> git commit -m “Initial commit of readme.”
```

Random github commit messages:
http://whatthecommit.com/

The git ecosystem

Easy to host & share your projects:

- Setting up a shared repo can be done via any cloud service, e.g. dropbox
- many open-source hosting sites, biggest: github.com
- Not open to public but CERN users: GitLab.cern.ch
  - Both include fairly usable bug-tracking
- The beauty of pull-requests:
  - do builds on pull-requests
  - review contributed code on pull-requests

Git is widely used — de-facto community standard

- Exception: Python uses Mercurial

The more you learn the more you'll like it!

General Tips & Pointers

Learning about software development

Udacity — courses from industry (Google, Intel, Autodesk)

- https://www.udacity.com/courses#!/all
  - course material is free (videos + exercises), tutoring for monthly fees
- Growing catalogue beginner to advanced — mostly web-centric
  - JavaScript + HTML5 + AJAX courses etc
  - But also: Intro to git, data analysis with R, parallel programming …

Coursera — courses by universities (Caltech, Johns Hopkins, Stanford and more)

- https://www.coursera.org/courses
- Large variety of courses
  - Not only technology / programming
  - Also physics, biology, economics… and more
  - Also in different languages

University Homepages — have a gander… many courses available through YouTube etc.

- i.e.: https://www.youtube.com/watch?v=Ps8jOj7diA0&feature=PlayList&p=9D558D49CA734A02&index=0

http://ureddit.com/ — University of Reddit

Closing Advice

Before you write trigger / DAQ software, you should know the ins and outs:

- What is: compiler, interpreter, linker, terminal, object, class, pointer, reference
- If these concepts are not clear: Excellent material on the web (previous slide)

Before (and while) implementing: Think

- Smart solutions can take significant amount of time… put it on the back-burner if you have other things to work on

Read! Ask! Write! The internet is full of information… Blogs, tutorials, StackOverflow, also Wikipedia can be very useful to get a grasp of new concepts

Conclusion

These slides was full of starting points: You have to follow up to get something out of it.

- Most of it are tools to make your life easier
  - Bonus: If you know them you'll have an easier time to follow nerd-talk
- Nothing is free
  - You'll have to invest some effort to learn
  - If you do that this week: We'll be here to help!

Homework:

- Install git, start a repository. Try branching on the web
- Run screen, kill the connection, reconnect and see if you can continue where you left off
- Tune your .bashrc / .bash_profile to get a more useful prompt
- Try out vim / emacs / atom and learn what suits you best — download a shortcut summary… Learn how to block-select, indent multiple lines, rename occurrences of text

Learn by writing code

Random Things

6 Stages of Debugging:

1. That can’t happen.
2. That doesn’t happen on my machine.
3. That shouldn’t happen.
4. Why does that happen?
5. Oh, I see.
6. How did that ever work?

– http://plasmasturm.org/log/6debug/

Guru of the Week: Regular C++ programming problems with solutions by Herb Sutter
http://www.gotw.ca/gotw/

> “Debugging is like being the detective in a crime novel where you are also the murderer.”
> – @fortes

Want to try your programming skills?
Google code jam (registration 08.03.16):
https://code.google.com/codejam
Also you can just practice
by solving nice problems.

Go-language: Designed with threading in mind
http://tour.golang.org/welcome/1

About JavaScript:
https://www.destroyallsoftware.com/talks/the-birth-and-death-of-javascript
https://www.destroyallsoftware.com/talks/wat

like the fonts in the presentation?
https://github.com/adobe-fonts/source-code-pro
https://github.com/adobe-fonts/source-sans-pro

2014 lecture has complementary stuff:
http://indico.cern.ch/event/274473/session/21/material/0/0.pdf

More useful open software

In HEP probably no way around ROOT / RooFit

- Maintained at CERN, used in LHC experiments

GNU R — www.r-project.org

- Used widely among statisticians (including finance and others)
- Interpreted language + software for analysis and graphical representation

SciPy — http://www.scipy.org/

- Collection of python libraries for numerical computations, graphical representation and containing additional data structures

Sci-kitlearn: — http://scikit-learn.org/stable/

- Python library for machine learning

Data visualisation:

Matplotlib (part of SciPy)

- histograms, power spectra, scatterplots and more.. extensive library for 2D/3D plotting

ROOT

- Again, probably no way around it… Sometimes a little unintuitive

Other:

JaxoDraw — http://jaxodraw.sourceforge.net/

- Feynman graphs through “axodraw” latex package

tex2im — http://www.nought.de/tex2im.php

- Need formulas in your favourite WYSIWG presentation tool?

GraphViz — http://www.graphviz.org/ or MacOS: http://www.pixelglow.com/graphviz/

- Diagrams / Flowcharts with auto-layout

SAGE — www.sagemath.org

- Open source alternative to Matlab, Maple and Mathematica

GNUPlot — http://www.gnuplot.info/

- Quick graphing and data visualisation

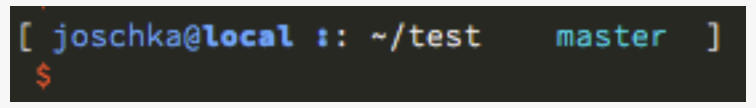
Wolfram Alpha — http://www.wolframalpha.com/

- Wolfram = Makers of Mathematica.. A. . . ask me anything?:
  - http://www.wolframalpha.com/input/?i=how+much+does+a+goat+weigh
  - Answer: Assuming “goat” is a species specification. Result: 61 kg

```
# tune your prompt:
if [ "$PS1" ]; then
          PS1="[\[\033[1;29m\]\[\033[0;34m\] \u\[\033[0;34m\]@\[\033[1;34m\]\h :\[\033[0m\]: \w   \
[\033[0;36m\] \$(git branch 2>/dev/null | grep '^*' | colrm 1 2) \[\033[0m\] ] \n \[\033[0;31m\]\$\
[\033[0m\] "
fi

# do not put duplicate lines into history:
export HISTCONTROL=“ignoredups”

# default to human readable filesizes
alias df=‘df -h’
alias du=‘du -h’

# get some color
alias grep=‘grep --color'

# more file listing:
alias l=‘ls’
alias ll=‘ls -lt -h -G -c -r’

# fool proof cp - asks for each file, use fcp if you’re sure
alias fcp='cp'
alias cp='cp -i -v'

# never remember those..
alias untgz='tar -xvzf'
alias tgz='tar -pczf'

#never install root:
source /path/to/your/working/root/bin/thisroot.sh
alias root=‘root -l’

# Mac OS stuff
alias wget=‘curl -O’
```

resulting prompt

```
[ user@host :: pwd   current git-branch  ]
```



```
[ joschka@local :: ~/test    master  ]
 $
```