Spack and SpackDev Build System

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LArSoft Tools and Technology Workshop 2017

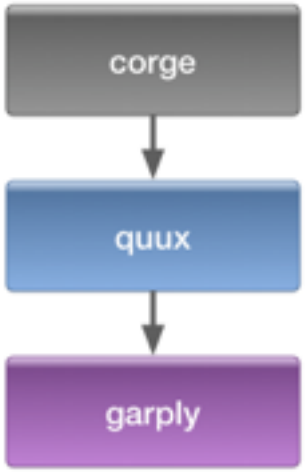
2017-06-20

What are you doing and why?

- Background
  - Spack and SpackDev are not one-for-one replacements for existing tools
- Spack
- SpackDev
- Status/issues
- Tutorial

Background from the world outside of Fermilab

- Consider a set of toy packages with dependencies



- corge package
  - provides *corgegator* executable
    - uses *libcorge*
    - uses *libquux* (from quux package)
      - uses *libgarply* (from garply package)

System packages

- Install as a system package (Scientific Linux [Ubuntu])
- Standard tools: distribution specific: rpm [dkpg], yum [apt]
- packages: corge, quux and garply (rpm, [dpkg])
- dependency management + package retrieval: yum [apt]
  - *yum install corge* (also installs quux and garply)
- user environment:
  - *corgegator* in /usr/bin (in default PATH)
  - libraries in /usr/lib (in default system library path)
  - nothing more to do; just type *corgegator*

Install multiple versions, variants, etc.

- Linux distributions do not have tools for this, in general
- Standard tools: trained monkeys
- staging: download *corge* source package (trained monkey)
- dependency management: determine dependencies and install (recursive trained monkey)
- configuration: point *corge* at dependencies
  - e.g., *cmake* or *./configure* (trained monkey)
- compile
- install in non-system directory
- user environment:
  - need to add *corge* executable directory to PATH
  - need to add *corge* library directory to LD_LIBRARY_PATH
  - likewise for dependencies (trained monkey should get started…)

Monkey hate package management

- In case you haven't figured it out, you are the monkey in this scenario

Fermilab alternative to trained monkeys

- pullProducts + ups + cetbuildtools + mrb
- package retrieval: pullProducts
- packaging + dependency management + user environment: ups
- configuration + build: cetbuildtools
  - cetbuildtools depends on ups
- staging: mrb

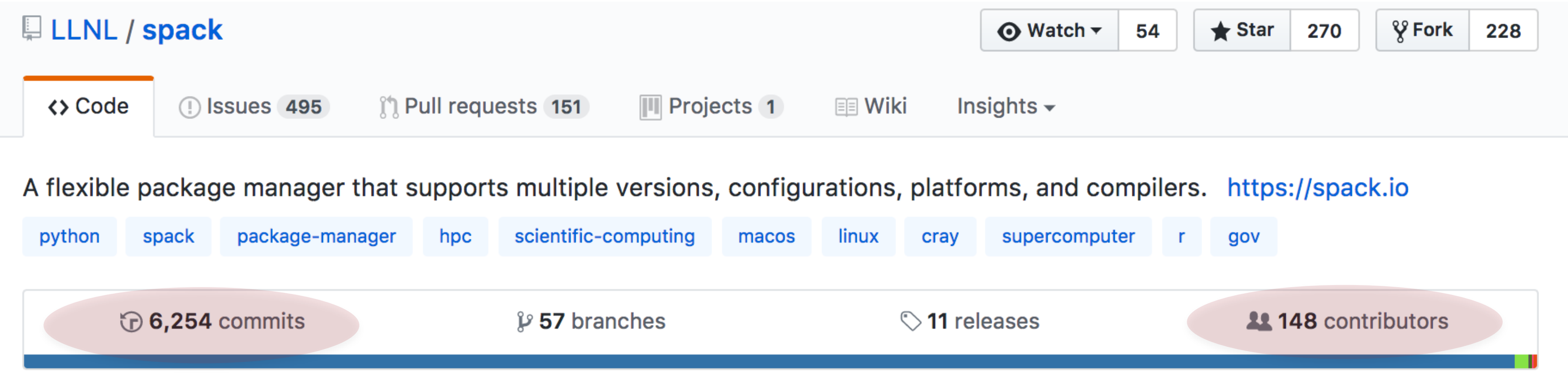
- This is only a rough picture of the roles played by various tools

Why change?

- Many complaints about the build system
  - We won’t get into that here
- Some other issues
  - pullProducts
    - very centralized (users cannot easily set up new distributions)
  - ups
    - Fermilab specific
    - Hard to google (curse you, United Parcel Service)
    - Fermilab has to maintain it
    - Few packages available
    - Non-trivial to create new packages
    - Difficult user interface
      - familiar, though
        - Stockholm syndrome?
    - Leads to very complicated user environment
    - OSX no longer fully supports "LD_LIBRARY_PATH" (i.e., DYLD_LIBRARY_PATH)
    - RPATH is an alternative to "LD_LIBRARY_PATH”
      - eliminates dependency on user environment
        - simplification cannot be overestimated

Spack

- Spack is a package manager designed to handle multiple versions and variants
  - https://spack.io/
  - https://github.com/LLNL/spack
- Spack has an active community of mostly non-HEP, but mostly scientific, developers



LLNL / spack

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Code | Issues 495 | Pull requests 151 | Projects 1 | Wiki | Insights

A flexible package manager that supports multiple versions, configurations, platforms, and compilers. https://spack.io

python | spack | package-manager | hpc | scientific-computing | macos | linux | cray | supercomputer | r | gov

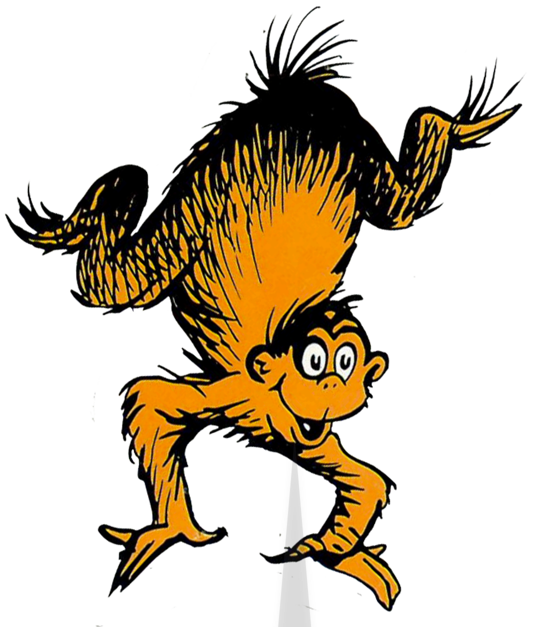
6,254 commits | 57 branches | 11 releases | 148 contributors

now 6,403

now 154

Spack, cont.

- Spack is well documented
  - http://spack.readthedocs.io/en/latest/
  - Spack is now on Slack
- Spack already contains many packages
  - `spack list | wc`
    ```
    1470     1470    13938 (now: 1550)
    ```
- Spack has a friendly user interface
  - `spack --help`
  - `spack list --help`
- Spack packages are easy to create and understand
  - try
    ```
    spack edit eigen
    ```
- Spack gives us RPATH for "free"



The Spack Slack is a shack where you can talk smack about a stack of Spack snacks!

Spack features

- Spack has a rigorous model for multiple versions, compilers and variants
  - Values consistency over reuse
  - More on this later
- Spack allows the user to specify which system (or other) packages to use instead of Spack-compiled versions
  - Details go in ~/.spack/*<platform>*/packages.yaml
    - Can also specify preferences for, e.g., compilers

```
packages:
    all:
       compiler: [clang@8.1.0-apple, gcc@7.1.0]
    cmake:
       paths:
             cmake@3.8.2: /usr/local/bin/cmake
       buildable: False
```

More Spack features

- Environment handling is configurable
  - Default is “environment modules”
    - old, Tcl-based
  - Lmod
    - newer, more rigorous, Lua-based
  - Adding ups is an option
- Spack internally uses compiler wrappers to add automatic support for RPATH
- Environment handling is *much simpler* because of the extensive use of RPATH

Local Spack features

- `spack buildcache`
  - Fetches and installs pre-compiled binaries
  - Performs relocations utilizing patchelf (Linux) or install_name_tools (OSX)
  - Contributions from Benedikt Hegner, Patrick Gartung, JFA
- SpackDev support
  - Minor behind-the-scenes additions
    - Mostly to export information
- Automatic system package discovery for packages.yaml
  - *Not yet implemented*
- A stable Spack branch
  - Our needs for stability differ from others in the community
  - No long-term divergence

Spack versions and configurations

```
# Install a particular version by appending @
$ spack install mpileaks@1.1.2

# Specify a compiler (and its version), with %
$ spack install mpileaks@1.1.2 %gcc@4.7.3

# Add special compile-time options by name
$ spack install mpileaks@1.1.2 %gcc@4.7.3 debug=True

# Add special boolean compile-time options with +
$ spack install mpileaks@1.1.2 %gcc@4.7.3 +debug

# Add compiler flags using the conventional names
$ spack install mpileaks@1.1.2 %gcc@4.7.3 cppflags="-O3 -floop-block"

# Cross-compile for a different architecture with arch=
$ spack install mpileaks@1.1.2 arch=bgqos_0
```

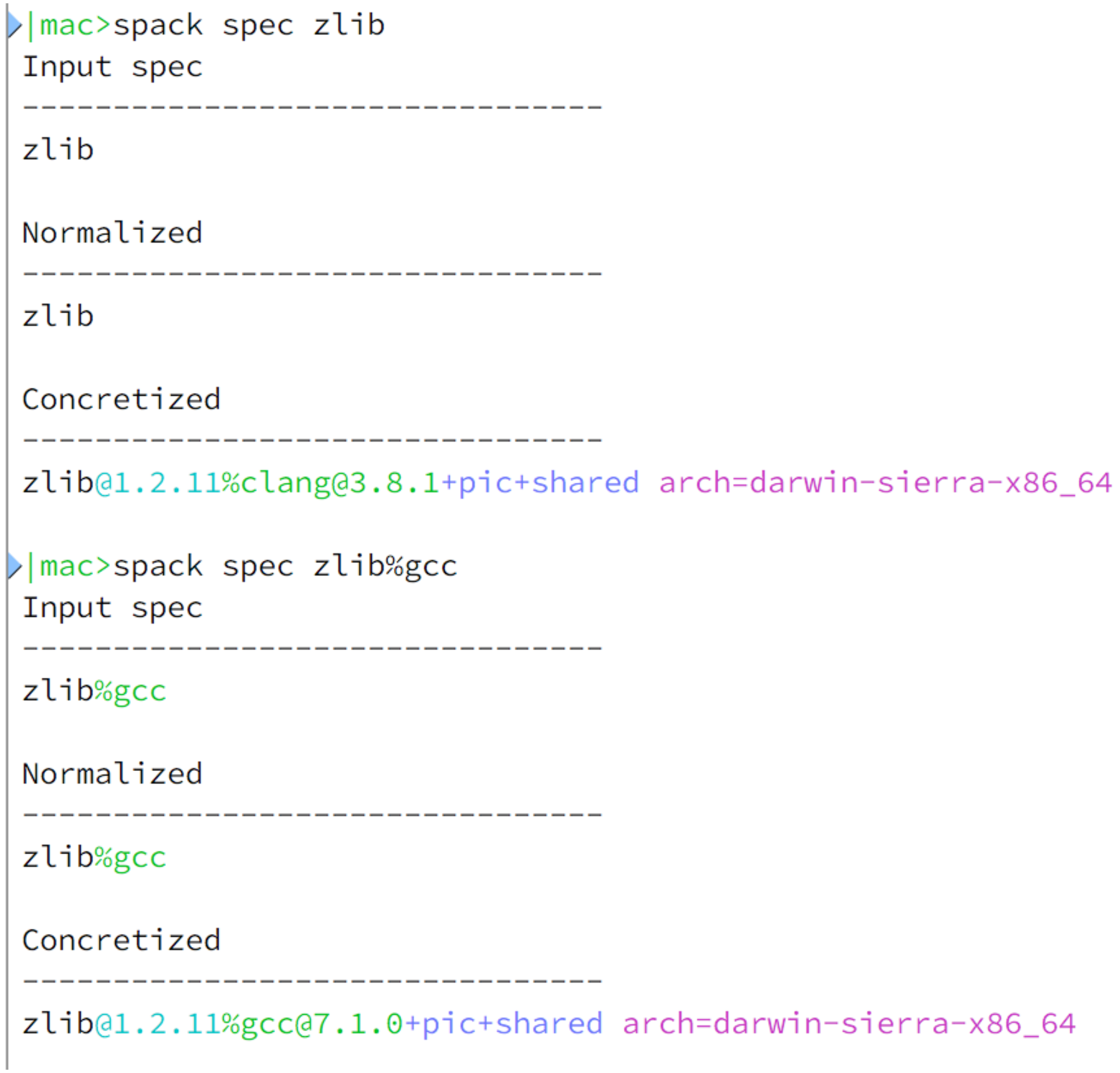
Dependencies can be customized

```
# Install mpileaks and link it with specific versions of libelf and libdwarf
$ spack install mpileaks@1.1.2 %gcc@4.7.3 +debug ^libelf@0.8.12 ^libdwarf@20130729+debug
```

Fermilab

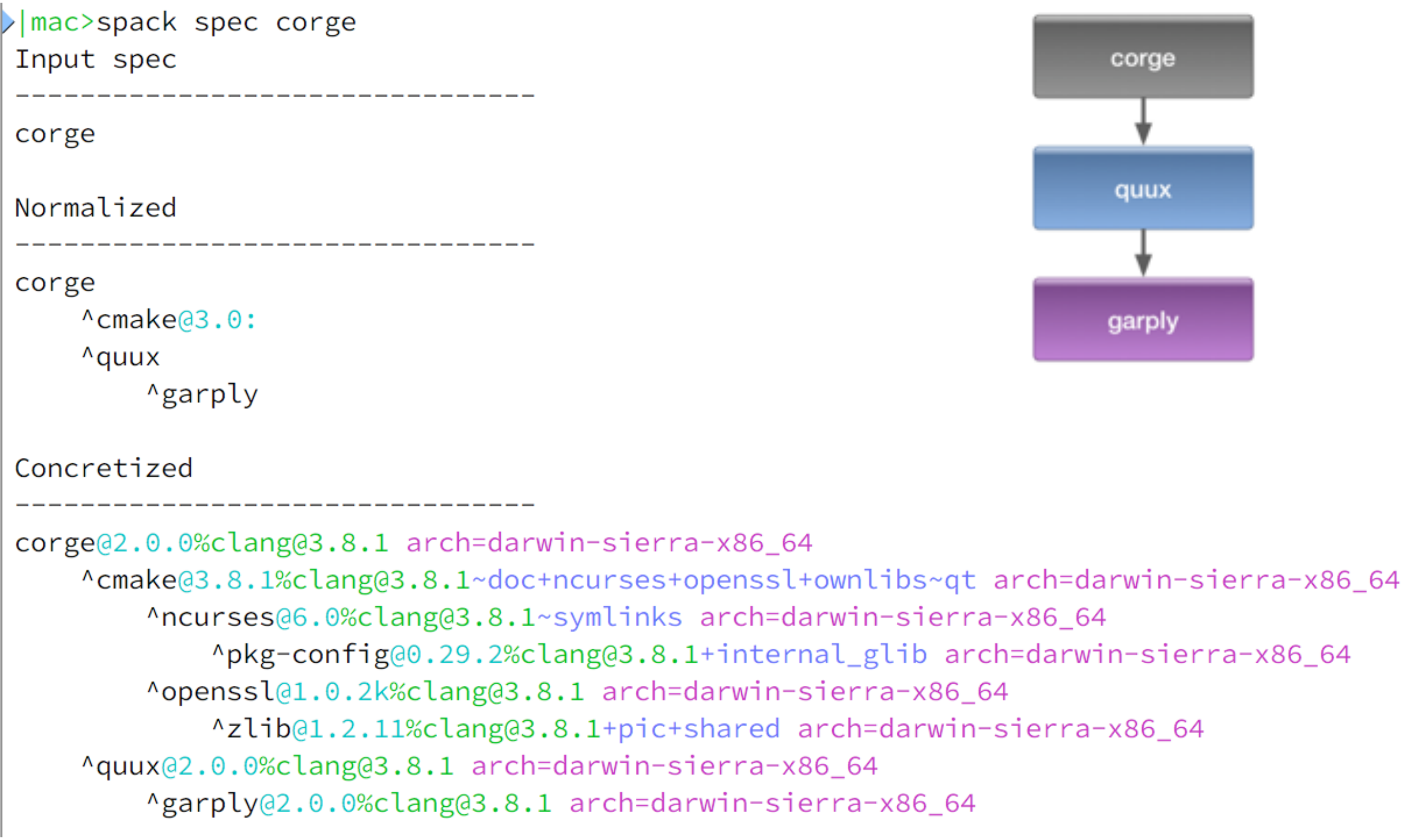
Spack dependencies

- `spack spec`

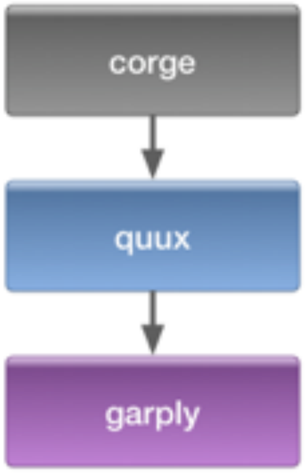


```
|mac>spack spec zlib
Input spec
--------------------------------
zlib

Normalized
--------------------------------
zlib

Concretized
--------------------------------
zlib@1.2.11%clang@3.8.1+pic+shared arch=darwin-sierra-x86_64

|mac>spack spec zlib%gcc
Input spec
--------------------------------
zlib%gcc

Normalized
--------------------------------
zlib%gcc

Concretized
--------------------------------
zlib@1.2.11%gcc@7.1.0+pic+shared arch=darwin-sierra-x86_64
```

Spack spec with dependencies



```
|mac>spack spec corge
Input spec
--------------------------------
corge

Normalized
--------------------------------
corge
    ^cmake@3.0:
    ^quux
        ^garply

Concretized
--------------------------------
corge@2.0.0%clang@3.8.1 arch=darwin-sierra-x86_64
    ^cmake@3.8.1%clang@3.8.1~doc+ncurses+openssl+ownlibs~qt arch=darwin-sierra-x86_64
        ^ncurses@6.0%clang@3.8.1~symlinks arch=darwin-sierra-x86_64
            ^pkg-config@0.29.2%clang@3.8.1+internal_glib arch=darwin-sierra-x86_64
        ^openssl@1.0.2k%clang@3.8.1 arch=darwin-sierra-x86_64
            ^zlib@1.2.11%clang@3.8.1+pic+shared arch=darwin-sierra-x86_64
    ^quux@2.0.0%clang@3.8.1 arch=darwin-sierra-x86_64
        ^garply@2.0.0%clang@3.8.1 arch=darwin-sierra-x86_64
```

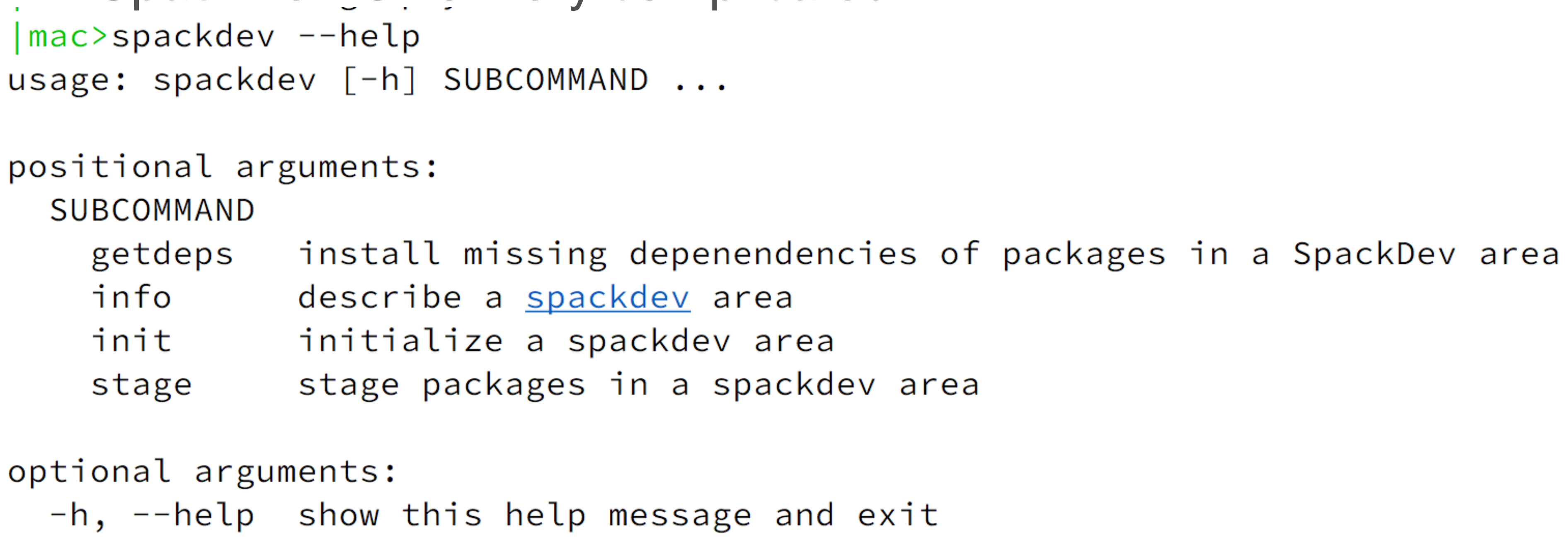


SpackDev

- Spack handles packaging, dependency management, package retrieval and package installation
  - It has hooks to user environment tools
- SpackDev handles developing packages with dependencies
  - Uses Spack for packaging and dependency management
  - Builds packages just like Spack does
    - configuration
    - RPATH handling
  - SpackDev sets up a build area, then gets out of the way
    - Build with *make* and/or *ninja*
    - No environment variables (no ”setup”)
    - Transparent
      - Spack functionality provided by readable shell scripts

SpackDev, cont.

- SpackDev is not very complicated

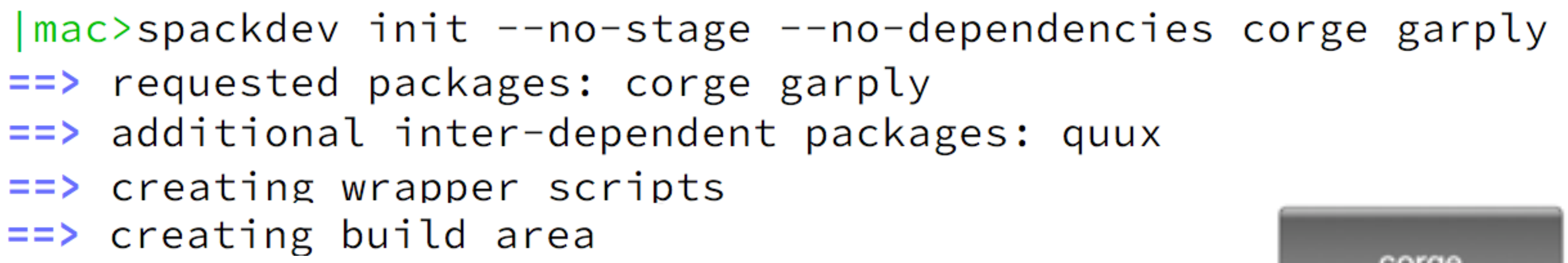


```
|mac>spackdev --help
usage: spackdev [-h] SUBCOMMAND ...

positional arguments:
  SUBCOMMAND
    getdeps   install missing dependendencies of packages in a SpackDev area
    info      describe a spackdev area
    init      initialize a spackdev area
    stage     stage packages in a spackdev area

optional arguments:
  -h, --help  show this help message and exit
```

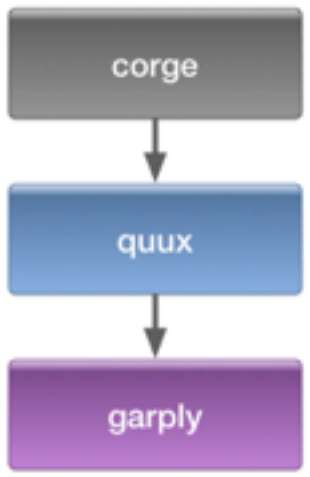
- SpackDev handles dependency installation, staging, configuration and build area creation
  – not quite in that order

SpackDev, still cont.

- SpackDev will build intermediate dependencies



```
|mac>spackdev init --no-stage --no-dependencies corge garply
==> requested packages: corge garply
==> additional inter-dependent packages: quux
==> creating wrapper scripts
==> creating build area
```



Status

- SpackDev is behind schedule
  - Planned to give a full demo here
  - Only going to explore spack functionality
- Delays are because of me

Learn from our mistakes

- Project managers
  - Do not rely on your department head to accomplish a long-term project
- Department heads
  - Do not commit yourself to a long-term development project
- Restructuring SpackDev development to remove me as a stumbling block

What needs to be done

- Binary package distribution (buildcache) is in place, but needs refinement
  - Cannot query what is available
  - Likely to get wrong variant -> binary package not found
- Automated support for system packages is necessary
  - We have a plan, but not an implementation
  - Without it “spack install lmod” will install 36 dependent packages, including perl, tar (!) and git.
- Full support for building art and LArSoft stacks without UPS is underway
  - Needs completion and testing
- Need to refine the user experience

Spackdev-bootstrap

- https://github.com/amundson/spackdev-bootstrap

```
git clone https://github.com/amundson/spackdev-bootstrap.git
cd spackdev-bootstrap
./bootstrap-spackdev
```

- Checks out Spack
- Checks out SpackDev
- Creates setup script
  - Adds spack to path
  - Adds spack shell function
    - optional for spack
  - Adds spackdev to path

Exploring Spack

- Spack commands are like git commands
  - `spack` *`command [arguments]`*
- Everything accepts a help argument
  - `spack –help`
  - `spack list –help`
- Some spack commands (try with –help first)
  - `spack find`
  - `spack list`
  - `spack compiler list`
  - `spack edit <package>`
- The Spack documentation site contains a full tutorial
  - http://spack.readthedocs.io/en/latest/tutorial.html

Things to try

- spack list
- spack find
- spack install zlib
- spack find (after installing zlib)
- mkdir foo; cd foo; spackdev init –no-deps garply
- mkdir bar; cd bar; spackdev init –no-deps –no-stage garply corge
- spack install corge
  - Will build cmake and dependents – expect to wait over 10 minutes