17 – Package Management, for real this time

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Package Management

Package Management Overview

- If I had to give *only one reason* why Unix systems are superior to Windows: Package Management.
- Can install almost anything with ease of from your terminal.
- Update to the latest version with one command.
    - No more download the latest installer nonsense!
- Various tools can be installed by installing a *package*.
    - A package contains the files and other instructions to setup a piece of software.
    - Many packages depend on each other.
    - High-level package managers download packages, figure out the dependencies for you, and deal with groups of packages.
    - Low-level managers unpack individual packages, run scripts, and get the software installed correctly.

Many different philosophies

- Monolithic binary packages: one big "app" with everything bundled together
  - docker containers, most windows programs
- Small binary packages: separate common code into independently-installed "libraries"
  - MSI files, Ubuntu, most of linux
- Source-based packages: no installers at all! Compile all your programs
  - language-based package managers, brew, portage
- Benefits to all approaches
  - monolithic binary: fastish install, very independent programs
  - small binary: very fast install, less wasted space
  - source-based: fastest code, smallest install, easy to use open-source

Package Managers in the Wild

- GNU/Linux:
    - Low-level: two general families of *binary packages* exist: `deb`, and `rpm`.
    - High-level package managers you are likely to encounter:
        - Debian/Ubuntu: `apt-get`, `apt`, `aptitude`.
        - SUSE/OpenSUSE: `zypper`.
        - Fedora: `dnf` (Fedora 22+) / `yum`.
        - RHEL/CentOS: `yum` (until they adopt `dnf`).
        - Arch: `pacman`
        - Gentoo: `Portage`, `emerge` (my favorite)

- Mac OSX:
    - Others exist, but the only one you should ever use is `brew`.
    - Don't user others (e.g. `port`), they are outdated / EOSL.

Using Package Managers

- Though the syntax for each package manager is different, the concepts are all the same.
    - This lecture will focus on `apt`, `dnf`, `emerge`, and `brew`.
    - The `dnf` commands are almost entirely interchangeable with `yum`, by design.
    - Note that `brew` is a "special snowflake", more on this later.

- What does your package manager give you? The ability to
    - `install` new packages you do not have.
    - `remove` packages you have installed.
    - `update` installed packages.
    - update the lists to search for files / updates from.
    - view `dependencies` of a given package.
    - a whole lot more!!!

A Note on **update**

- These "subcommands" are by category, not name: `update` is not always called `update`
- The `update` command has importantly different meanings in different package managers.
- Most do **not** default to system (read linux kernel) updates.
    - Fedora does; most others do not.
- It depends on your operating system, and package manager.
    - Know your operating system, and look up what the default behavior is.
- If your program needs a specific version of the linux kernel, you need to be very careful!
    - very, **very** few programs care about your kernel version.

A Note on Names and their Meanings

- Package names sometimes specify architecture:
    - [3456x]86{.bash} (e.g. .i386 or .i686 or x86): - These are th
      bit'
      packages.
    - x86_64 or amd64: these are the 64-bit packages.
    - noarch: these are independent of the architecture.
- Ubuntu / fedora often splits packages into smaller pieces:
    - The header files are usually called something like:
        - deb: usually <package>-dev
        - rpm: usually <package>-devel
    - The library you will need to link against:
        - If applicable, lib<package> or something similar.
    - The binaries (executables), often provided by just <package>.
    - Most relevant for C and C++, but also Python and others.
    - Use the search functionality of your package manager.

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Example Development Tool Installation

- If I needed to compile and link against **Xrandr** (X.Org X11 libXrandr runtime library) on ubuntu, I would have to install
    - **libxrandr2**: the library.
    - **libxrandr-dev**: the header files.
    - Usually don't explicitly include the architecture (e.g. **.x86_64**), it's inferred
    - If you're getting link errors, try installing explicit 32/64-bit version.
        - just google your error

- Splitting devel files more common for *binary* package managers, less for source-based ones.

System Specific Package Managers

Debian / Ubuntu Package Management (**apt-get**)

- Installing and uninstalling:
  - Install a package:
    apt-get install <pkg1> <pkg2> ... <pkgN>
  - Remove a package:
    apt-get remove <pkg1> <pkg2> ... <pkgN>
  - Only one **pkg** required, but can specify many.
  - "Group" packages are available, but still the same command.
- Updating components:
  - Update lists of packages available: apt-get update.
    - No arguments, it updates the whole list (even if you give args).
  - Updating currently installed packages: apt-get upgrade.
    - Specify a **package** name to only update / upgrade that package.
  - Update core (incl. kernel): apt-get dist-upgrade.
- Searching for packages:
  - Different command: apt-cache search <pkg>

RHEL / Fedora Package Managers (**yum** and **dnf**)

- Installing and uninstalling:
    - Install a package:
      dnf install <pkg1> <pkg2> ... <pkgN>
    - Remove a package:
      dnf remove <pkg1> <pkg2> ... <pkgN>
    - Only one **pkg** required, but can specify many.
    - "Group" packages are available, but different command:
        - dnf groupinstall 'Package Group Name'
- Updating components:
    - Update EVERYTHING: dnf upgrade.
    - update exists, but is essentially upgrade.
        - Specify a **package** name to only upgrade that package.
    - Updating repository lists: dnf check-update
- Searching for packages:
    - Same command: dnf search <pkg>
- yum and dnf (Dandified Yum) nearly interchangeable: [3].

dnf: Cautionary Tales

- WARNING: if you install package X, which installs X as a dependency, and later `remove Y`
    - By default, X will be removed!
    - Refer to [2] for workarounds.
    - Generally, won't know you needed to `mark` until it is too late.

- Solution?
    - Basically, pay attention to your package manager.
    - It gets removed because nothing *explicitly* depends on it.
    - So one day you may realize "OH NO! I'm missing package X"...
    - ...so just `dnf install X`.
        - So while `mark` is available, personally I don't use it.
    - Sad face, I know. Just the way of the world.

OSX Package Management: Install **brew** on your own

- Sitting in class right now with a Mac?
- **DON'T DO THIS IN CLASS**. You will want to make sure you do not have to interrupt the process.
    - Make sure you have the "Command Line Tools" installed.
        - Instructions are on the First Things First Config Page
    - Visit `http://brew.sh/`
    - Copy-paste the given instructions in the terminal *as a regular user (not **root**.).*

- **VERY IMPORTANT**: READ WHAT THE OUTPUT IS!!!! It will tell you to do things, and you *have* to do them. Specifically
  ```
  You should run 'brew doctor' BEFORE you install anything.
  ```

OSX Package Management (**brew**)

- Installing and uninstalling:
    - Install a *formula*:
      brew install <fmla1> <fmla2> ... <fmla2>
    - Remove a formula:
      brew uninstall <fmla1> <fmla2> ... <fmlaN>
    - Only one **fmla** required, but can specify many.
    - "Group" packages have no meaning in **brew**.
- Updating components:
    - Update **brew**, all *taps*, and installed formulae listings. This does not update the actual software you have installed with **brew**, just the definitions: brew update.
    - Update just installed formulae: brew upgrade.
        - Specify a **formula** name to only upgrade that formula.
- Searching for packages:
    - Same command: brew search <formula>

OSX: One of These Kids is Not Like the Others (Part I)

- Safe: confines itself (by default) in `/usr/local/Cellar`:
  - No `sudo`, plays nicely with OSX (e.g. Applications, `python3`).
  - Non-linking by default. If a conflict is detected, it will tell you.
  - Really important to read what **brew** tells you!!!
- `brew` is modular. Additional repositories ("*taps*") available:
  - Essentially what a `.rpm` or `.deb` would give you in linux.
  - These are 3rd party repos, not officially sanctioned by **brew**.
- Common taps people use:
  - `brew tap homebrew/science`
    - Various "scientific computing" tools, e.g. `opencv`.
  - `brew tap caskroom/cask`
    - Install `.app` applications! Safe: installs in the "Cellar", symlinks to `~/Applications`, but *now these update with brew all on their own* when you `brew update`!
    - E.g. `brew cask install vlc`

OSX: One of These Kids is Not Like the Others (Part II)

- **brew** installs *formulas*.
    - A **ruby** script that provides rules for where to download something from / how to compile it.
- Sometimes the packager creates a "Bottle":
    - If a bottle for your version of OSX exists, you don't have to compile locally.
    - The bottle just gets *downloaded* and then "*poured*".
- Otherwise, **brew** downloads the source and compiles locally.
- Though more time consuming, can be quite convenient!
    - `brew options opencv`
    - `brew install --with-cuda --c++11 opencv`
    - It really really really is magical. No need to understand the **opencv** build flags, because the authors of the **brew** formula are kind and wonderful people.
    - `brew reinstall --with-missed-option formula`

- Reiteration: **pay attention to brew and what it says**. Seriously.
- Example: after installing **opencv**, it tells me:

```
==> Caveats
Python modules have been installed and Homebrews site-packages
is not in your Python sys.path, so you will not be able to
import the modules this formula installed. If you plan to
develop with these modules, please run:

mkdir -p /Users/sven/.local/lib/python2.7/site-packages
echo 'import site; site.addsitedir(                        \
    "/usr/local/lib/python2.7/site-packages")' >> \
    /Users/sven/.local/lib/python2.7/site-packages/homebrew.pth
```

- **brew** gives copy-paste format, above is just so you can read.
- I want to use **opencv** in **Python**, so I do what **brew** tells me.

Less Common Package Management Operations

- Sometimes when dependencies are installed behind the scenes, and you no longer need them, you will want to get rid of them.
    - `apt-get autoremove`
    - `dnf autoremove`
    - `brew doctor`
- View the list of repositories being checked:
    - `apt-cache policy` (well, sort of…`apt` doesn't have it)
    - `dnf repolist [enabled|disabled|all]`
        - Some repositories for **dnf** are *disabled* by default (with good reason). Usually you want to just
          `dnf --enablerepo=<name> install <thing>`
          e.g. if you have **rawhide** (development branch for fedora).
    - `brew tap`

Other Managers

Like What?

- There are so many package managers out there for different things, too many to list them all!
- Ruby: `gem`
- Anaconda Python: `conda`
- Python: `pip`
- Python: `easy_install` (but really, just use `pip`)
- Python3: `pip3`
- LaTeX: `tlmgr` (uses the CTAN database)
    - Must install TeX from source to get `tlmgr`
- Perl: `cpan`
- Sublime Text: `Package Control`
- Many many others...

Like How?

- Some notes and warnings about Python package management.
- Notes:
    - If you want X in Python 2 **and** 3:
        - `pip install X` *and* `pip3 install X`
    - OSX Specifically: advise only using **brew** or Anaconda Python. The system Python can get really damaged if you modify it, you are better off leaving it alone.
    - So even if you want to use **python2** on Mac, I strongly encourage you to install it with **brew**.
- Warnings:
    - Don't mix **easy_install** and **pip**. Choose one, stick with it.
        - But the internet told me if I want **pip** on Mac, I should `easy_install pip`
        - NO! Because this **pip** will modify your **system** python, USE BREW.
    - Don't mix **pip** with **conda**. If you have Anaconda python, just stick to using **conda**.

References

[1] Stephen McDowell, Bruno Abrahao, Hussam Abu-Libdeh, Nicolas Savva, David Slater, and others over the years. "Previous Cornell CS 2043 Course Slides".

[2] Reddit.com. *DNF Remove Package, keep dependencies??* 2016. URL: https://www.reddit.com/r/Fedora/comments/3pqrv9/dnf_remove_package_keep_dependencies/.

[3] Jack Wallen. *What You Need to Know About Fedora's Switch From Yum to DNF.* 2015. URL: https://www.linux.com/learn/tutorials/838176-what-you-need-to-know-about-fedoras-switch-from-yum-to-dnf.