Conduite de Projet
Cours 2 — Version Control

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URL https://upsilon.cc/zack/teaching/1920/cproj/

Sommaire

Outline

Change

During the life time of a software project, *everything* changes:

- bugs are discovered and have to be fixed (code)
- system requirements change and need to be implemented
- external dependencies change
  - e.g. new version of hardware and software you depend upon
- competitors might catch up

Most software systems can be thought of as a set of evolving versions

- potentially, each of them has to be maintained concurrently with the others

Configuration management

Definition (Configuration Management)

Configuration Management (CM) is concerned with the policies, processes, and tools for managing changing software systems.

(Sommerville)

Why?

- it is easy to lose track of which changes have been incorporated in each version
  - things get even messier with versions which have to be maintained in parallel
- minimize risks of working on the wrong version
- useful for *solo* projects ⇒ backup on steroids + it's easy to forgot which change has been made and why
- useful for team project ⇒ help in praising(, blaming), know who to ask

Configuration management activities

Change management keep track of request for changes (from both customers and developers), evaluate costs/risks/benefits, making committment to change

Version management (or *version control*, revision control, etc.) keeping track of multiple version of (software) components and ensure unrelated changes do not interfere

System building assembling program components, data, and libraries into executable systems

Release management preparing software for external release and keep track of which version is in use at which customer site

Configuration management activities

Version management (or *version control*, revision control, etc.)
keeping track of multiple version of (software) components and ensure unrelated changes do not interfere

Outline

Before version control: diff & patch

The Swiss army knife of change management: diff & patch

diff compute the difference D among a file A and a file B

- can be applied recursively to directories

patch apply a difference D (usually computed using diff) to a file A (possibly producing a new file B)

Demo

diff & patch — discussion

- patches are (were) usually conveyed via email messages to the main software maintainer
- best practices
  - add to emails clear and concise explanations of the purpose of the attached patch
  - do the same in the source code added by the patch
    - nothing new: usual good coding practice; it becomes more important only because the number of software authors grows...)
  - `http://tldp.org/HOWTO/Software-Release-Practice-HOWTO/patching.html`

Poor man's version control

Projects by a license student often look like this:

```
lucien> ls
a.out
projet.ml
projet-save.ml
projet-hier.ml
projet-marche-vraiement.ml
projet-dernier.ml
```

- what are the differences among the 5 source files?
- what are the *relationships* among them?
- hard to answer without specific utilities

Poor men's version control (plural)

Project by *a group* of license students:

```
lucien> ls ~joel/projet
a.out
module.ml
module-de-julien-qui-marche.ml
projet.ml
projet-save.ml
projet-hier.ml
projet-marche-vraiement.ml
projet-dernier.ml
```

```
lucien> ls ~julien/projet
a.out
module.ml
projet.ml
projet-recu-de-joel.ml
module-envoye-a-joel.ml
```

What is the right combination of projet.ml and module.ml to obtain a good grade at the exam?

diff & patch to the rescue

To exchange projet.ml and module.ml a group of students can rely on emails, diff, and patch (a huge improvement!)

Julien

```
lucien> diff -Nurp projet-hier.ml projet.ml > mescorrections
lucien> mail -s "Voici mes modifs" joel@lucien < mescorrection
```

Joel

```
lucien> mail
Mail version 8.1.2 01/15/2001. Type ? for help.
> 1  julien@home Fri Sep 13 20:06   96/4309 voici mes modifs
& s 1 /tmp/changes
& x
lucien> patch < /tmp/changes
```

Julien's changes between projet-hier.ml and projet.ml are now integrated in Joel's copy of projet.ml (hoping no conflicting changes have been made by Joel...)

diff & patch: except that...

Nonetheless, on exam day nothing works, although it worked just the day before. *Panicking*, you'll try to understand:

- what has changed
- who did the change
  - probably you don't care about why, but still...
- when it has been done
- which state, not including that change, works properly
- how to get back to that state

⇒ you (badly) need a *real* Version Control System

Outline

Version Control System (VCS)

A version control system

- manage specific artifacts which form your source code
  - files, directories, their attributes, etc.
- is able to store changes to those artifacts (a VCS implements the notion of version for source code)
  - who has done a change
  - wrt which state
  - why
  - when
- can show the differences among different (stored) states
- can go back in time and restore a previous state
- can manage concurrent work among developers, distributing the changes among them

Basic VCS concepts

A few basic concepts are shared across VCSs: [1]

revision (or version) a specific state, or point in time, of the content tracked by the VCS

- granularity and scope vary

history a set of revisions, (partially) ordered

1. although the actual naming changes from system to system; we'll stick to the naming presented here

Basic VCS concepts (cont.)

A few basic concepts are shared across VCSs: [1]

repository (or depot) where the tracked content and all its history, as known to the VCS, is stored
- might be local or remote

working copy a local copy of a revision, which might be acted upon
- where the "real" work happens

checkout (or clone) the action of creating a working copy from a repository

1. although the actual naming changes from system to system; we'll stick to the naming presented here

Basic VCS concepts (cont.)

A few basic concepts are shared across VCSs: [1]

change (or **delta**) a specific modification to (or *with respect to*) the content tracked by the VCS

- granularity vary

commit (as a verb) the act of writing a change performed in the working copy back to the repository

- = adding a new revision to the history

commit (as a substantive) same as change, for changes that have been committed

diff the act of (or the result of) inspecting the differences among two revisions, or among a revision and the working copy

- inspection format is usually diff

1. although the actual naming changes from system to system; we'll stick to the naming presented here

Branching and merging

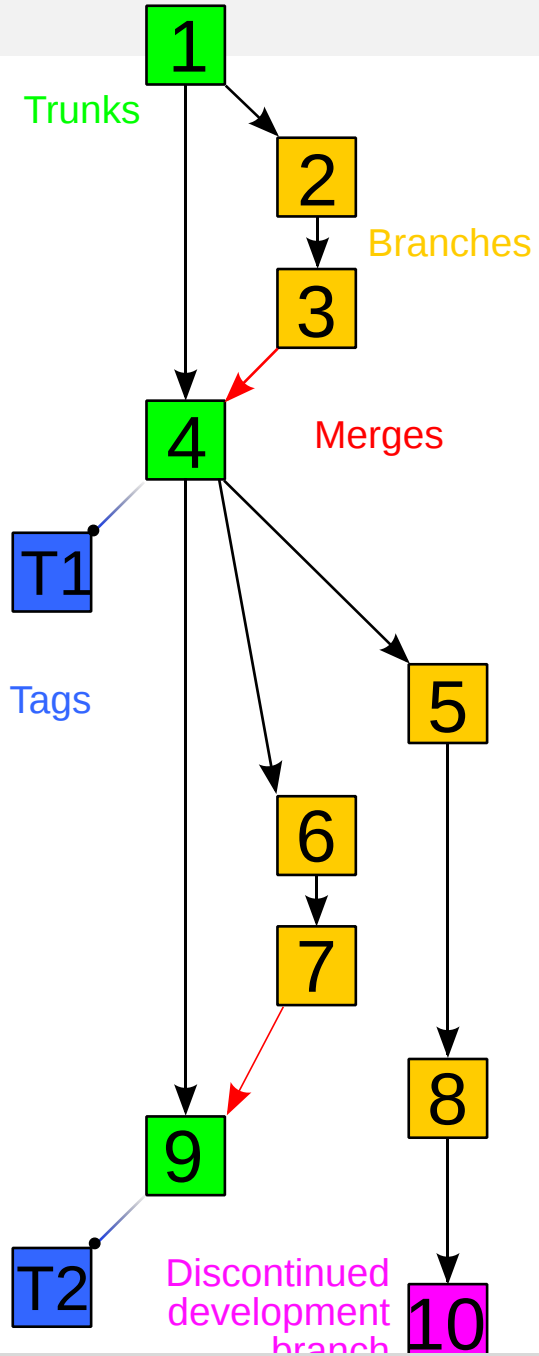
branch (verb) the act of duplicating (or "forking") a specific revision in history, to open up a new line of development

- branches are usually named

branch (substantive) subset of history rooted at a fork point and extending until the next merge point

merge (verb) the act of joining together multiple lines of development, reconciling all their changes together

merge (substantive) the point in history where the merge happens



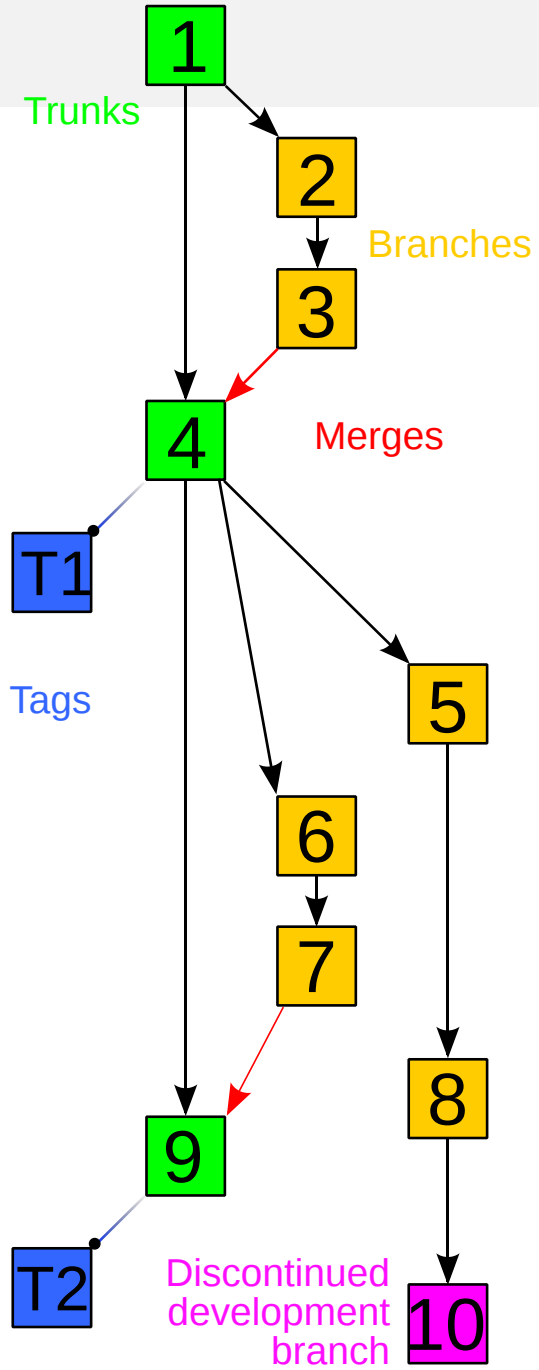
http://en.wikipedia.org/wiki/File:

Branching and merging (cont.)

- assuming an idealized purely functional model, content history can then be depicted as a direct acyclic graph
- parallel changes may or may not be compatible...

conflict the situation occurring when, upon a merge attempt, changes from involved branches cannot be reconciled

solving a conflict means applying extra changes to combine non (automatically) reconcilable changes or choose a subset of them



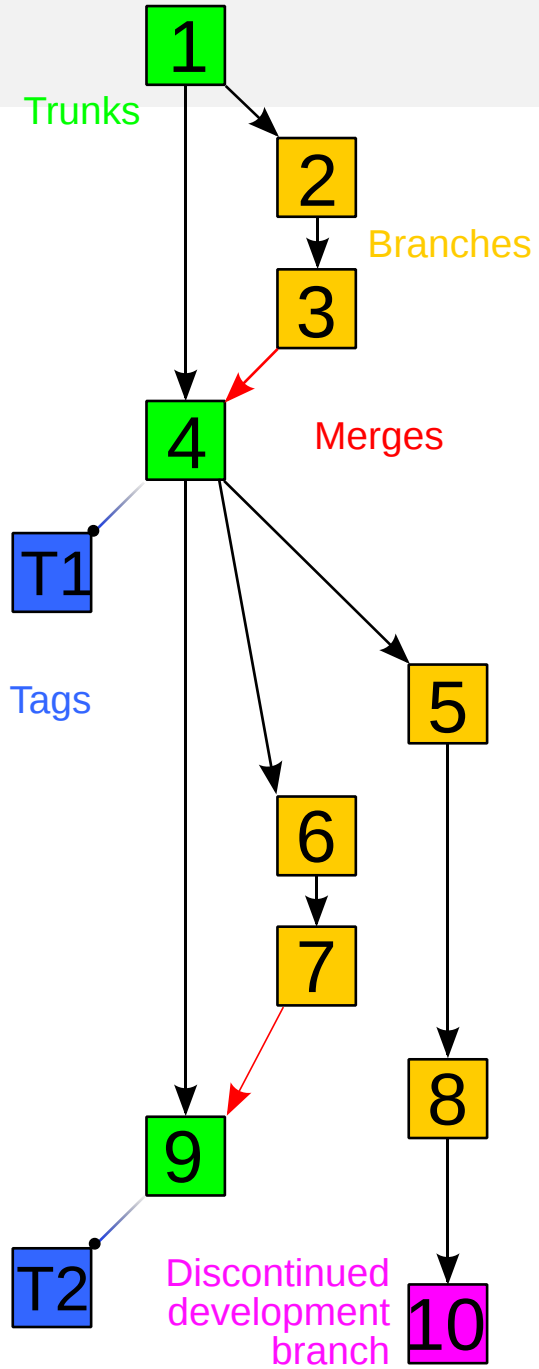
Branching and merging (cont.)

tag (or label) a symbolic name attached to a particular revision in history

head (or tip) the (moving) tag always associated to the most recent commit; might be limited to a specific "special" branch, such as:

trunk (or master) the unique line of development which is not a branch

- peculiar: treating a specific branch as special is not necessary for the idealized model to work



Brief history of VCSs

- 1972 SCCS (Source Code Control System), commercial (AT&T) UNIX-es, part of the Single UNIX Specification; scope: file; modern clone (for compatibility only): `cssc`
- 1982 RCS (Revision Control System) GNU-based UNIX-es; scope: file; Free-er and generally considered more evolved than SCCS, currently maintained by the GNU Project
- 1990 CVS (Concurrent Version System), client-server paradigm; scope: set of files
- late 1990's TeamWare, BitKeeper; early attempt at distributed version control system; proprietary
- 2000 Subversion (SVN); client-server, addressing many defects of CVS
- 2001– Distributed VCS (DVCS) golden age: GNU arch (2001), Darcs (2002), SVK (2003), Monotone (2003), Git (2005), Mercurial (2005), Bazaar (2005) more on this later...

Outline

Revision Control System (RCS)

- one of the oldest system (1982)
- typical of the commercial UNIX era
- scope: single file
  - although the repositories for several files can be stored in the same “shared” place
- repository
  - `file,v` where `file` is the original name of the checked in file
  - changes are stored as incremental reverse diffs
  - minimization of secondary storage: delta compression is triggered by deletion of intermediate revisions
- concurrency model:
  - pessimistic approach: one have to acquire explicit locks before making modification; by default working copies are read-only
  - as the working copy is shared among users, this enforced a rather heavy mutual exclusion discipline

RCS — basic operations

commit	ci FILE	(without lock)
	ci -l FILE	(with lock)
checkout	co FILE	(without lock)
	co -l FILE	(with lock)
diff	rcsdiff -rVERSION1 -rVERSION2 FILE	
history	rlog FILE	
acquire lock	rcs -l FILE	

RCS — basic operations

Demo

RCS — branching and merging

Versions in RCS are trees, where branches are reflected in the syntax of versions. “Minor” version numbers are increased automatically by RCS upon commit; “major” numbers can be specified explicitly by the user upon commit.

- history with single branch

```
(1.1) -> (1.2) -> (1.3) -> (1.4) -> (2.1) -> (2.2)
```

- history with multiple branches

```
(1.1) -> (1.2) -> (1.3) -> (1.4) -> (2.1) -> (2.2)
                     \
                      ----> (1.3.1.1)
```

RCS — branching and merging operations

branch ci -rVERSION FILE
example: ci -r2 foo.ml

branch checkout co -rVERSION FILE

merge rcsmerge -p -rVERSION1 -rVERSION2 FILE > RESULT

- preforms a 3-way diff (a-la `diff3`) among old (common) VERSION1, and the two new versions: VERSION2 and the current state of FILE

Example

```
rcsmerge -p -r1 -r3 foo.ml > foo.ml.new
```

merges the differences among branch 1 and 3 of foo.ml, with differences among branch 1 and the current version of foo.ml; save the result to foo.ml.new

RCS — branching and merging operations

Demo

Outline

Concurrent Versions System (CVS)

- a significant (r)evolution in the history of VCS
- designed to address the (too) constraining mutual exclusion discipline enforced by RCS (hence the emphasis on *concurrent*)
- client-server model
  - enforce decoupling of repository and working copy
  - several working copies exist—generally one for each developer—and can be acted upon independently
  - commands and processes to:
    - "push" local changes from working copies to the repository
    - "pull" changes (made by others) from the repository and merge it with the local (uncommitted) changes
    - deal with conflicts and try to avoid they hit the repository
  - note: the repository is used as the orchestrator and as the sole data storage
    - "local commits" are not possible
    - disconnected operations are heavily limited

CVS — some details

- scope: a project (i.e., a tree of file and directories)
- built as a set of scripts on top of RCS
  - each file has its own ,v file stored in the repository
  - each file has its own set of RCS versions (1.1, 2.3, 1.1.2.4, etc.)
  - a very cool hack, but still a hack
- the repository can be either local (i.e., on the same machine of the working copy) or remote (accessible through the network; common scenario)
- concurrency model:
  - optimistic approach: working copies can be acted upon by default; given that working copies are independent from each other, work is concurrent by default
  - conflicts are noticed upon commit and must be solved locally (i.e., commits prior to merges are forbidden)
  - explicit locks are permitted via dedicated actions
- curiosity: one of the first popular UNIX commands relying on sub-commands

CVS — basic operations

repository setup	export CVSROOT=SOME/DIR cvs init
create a project	cd PROJECT-DIR cvs import -d NAME VENDOR-NAME RELEASE-NAME example: cvs import -d coolhack zack initial
checkout	cvs checkout NAME
status	get information about the status of the working copy with respect to (the last contact with) the repository
commit	cvs commit [FILE...] example: cvs commit -m 'fix segmentation fault' foo.c
update	(merge changes from the repository in the local copy) cvs update -d

CVS — basic operations (cont.)

history	cvs log	
diff	cvs diff [FILE...]	(among working copy and last update)
diff	cvs diff -rVERSION1 -rVERSION2 [FILE...]	
remove file	cvs rm FILE	(*schedule* removal; needs commit)
add file	cvs add FILE	(*schedule* addition; needs commit)

CVS — basic operations

Demo

CVS — branching and merging operations

tag

```
cvs tag TAG-NAME
```

branch

```
cvs tag -b BRANCH-NAME
# work on trunk continues
cvs update -r BRANCH-NAME
# work on branch ...
cvs update -A
# go back working on trunk
```

merge

```
cvs update -j BRANCH-NAME     # merge changes (wc)
cvs commit
```

CVS — branching and merging operations

Demo

CVS — discussion

revolutionary for its time
affected by severe limitations nonetheless:

- revisions are per file, i.e., there is no knowledge of repository-wide revisions (they can be emulated by tags, but. . .)
- no knowledge of several common file-system features (e.g., attributes, symlink, file move)
- files are considered textual by default; ad-hoc and limited support for binary content
- branch operations are expensive (underlying assumption: most of the work happens in trunk)
- commits are not atomic operations
- very little support for disconnected operations (e.g., painful when you're hacking on a plane)

Outline

Subversion (SVN) — context

Started in 2000 to overcome CVS limitations.

Historical context:

> *In the world of open source software, the Concurrent Version System (CVS) has long been the tool of choice for version control. And rightly so. CVS itself is free software, and its non-restrictive modus operandi and support for networked operation—which allow dozens of geographically dispersed programmers to share their work—fits the collaborative nature of the open-source world very well. CVS and its semi-chaotic development model have become cornerstones of open-source.*
>
> — *Collins-Sussman*

Subversion (SVN)

- same paradigm of CVS: client-server + independent working copies
- features (i.e., “bug fixes” w.r.t. CVS):
  - atomic commits
  - tracking (in the history!) of file-system level operations (copy, move, remove, etc.)
  - global versioning (rather than per-file versioning)
  - support for symlinks and (some) file-system level metadata
  - cheap (server-side) branches
  - some (but not much) support for disconnected operations (most notably: diff among working copy and HEAD)

SVN — basic operations

To increase adoption chances within CVS circles, SVN command line interface has been designed to be as compatible as possible to CVS interface. The strategy has worked very well! Most commands work as in CVS.

basic operations svn checkout, svn status, svn add, svn remove, svn commit, svn diff, svn log, svn update, ...

repository setup svnadmin create REPO-PATH

create a project (actually: create a directory in a repository)

```
svn checkout REPO-PATH
svn mkdir DIR
svn commit
```

SVN — basic operations

Demo

SVN — branching and merging

- branches in SVN are part of the versioned tree
- to create a branch, one makes a copy of an existing directory to a new path
  - development can then proceed independently in the original and new directory
  - branches are cheap (“shallow copies”) on the repository side (but not on the client side)
  - partial checkouts are possible, to avoid forcing clients to keep all branches at once
- tags work in the same way; the only difference is that a tag doesn’t (i.e., shouldn’t) be committed to
- specific path conventions are suggested. . .

SVN — path conventions

```
project/
    trunk/
        main.ml
        module-foo.ml
        quux/
        ...
    branches/
        feature1/
            main.ml
            module-foo.ml
            quux/
            ...
        feature2/
            main.ml
            module-foo.ml
            quux/
            ...
    tags/
        1.0-rc1/
            main.ml
            module-foo.ml
            quux/
            ...
        1.0/
            main.ml
            module-foo.ml
            quux/
            ...
        1.1/
            main.ml
            module-foo.ml
            quux/
            ...
```

Recommended path conventions.

No strict requirement (but still recommended for uniformity across projects).

SVN — branching and merging example

- branching off trunk

```
$ svn cp -m "Creating branch for feature A" \
  /trunk/component1  /branches/zack-component1-featureA
$ svn log -v /branches/zack-component1-featureA
# prints revision number, say 123
```

- updating the branch

```
$ svn merge -r 123:HEAD /trunk/component1 .
# test new code from master
$ svn commit -m'sync with master'
# Revision 256.
```

- merging into trunk

```
$ cd /trunk/component1
$ svn merge -r 123:HEAD /branches/zack-component1-featureA
$ svn commit -m'integrate feature A by Zack'
$
```

SVN — branching and merging example (better)

```
$ cd /trunk/component1
$ svn merge --reintegrate REPO-PATH/branches/zack-componen
$ svn commit -m'integrate feature A by Zack'
$
```

- keep track of merged revisions via `svn:mergeinfo` property

Demo

Outline

A Git tutorial

We will follow the excellent tutorial:

Git 101
Scott Chacon
GitHub
`https://www.slideshare.net/chacon/git-101-presentation`

References

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Apress, 2005. http://progit.org/book/