Source Control

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Outline

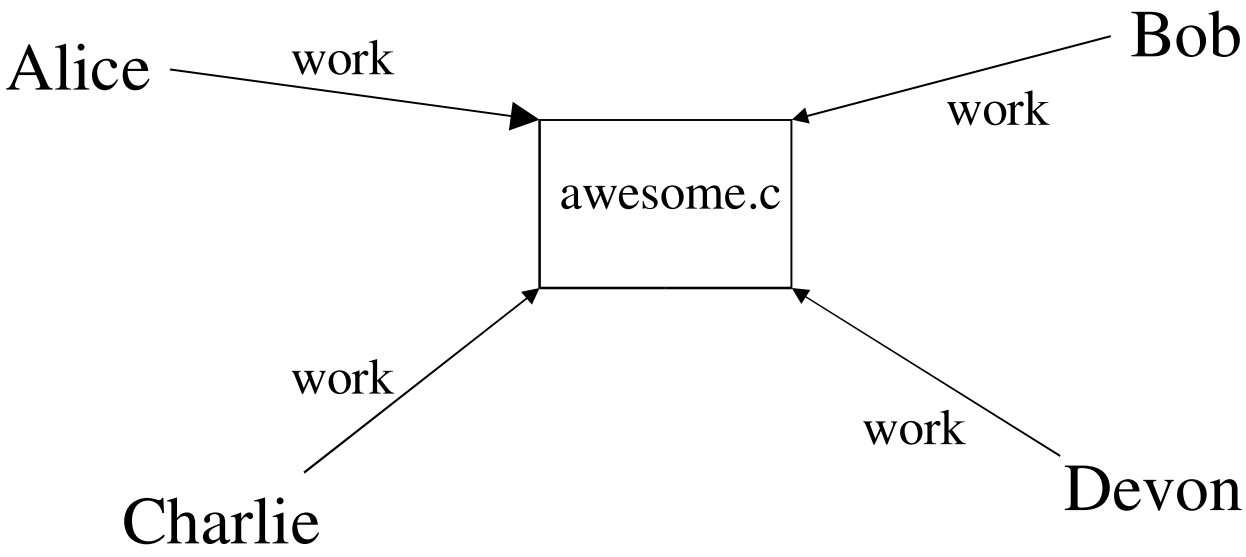
- Motivation
- Repository vs. Working Directory
- Conflicts and Merging
- Branching
- PRCS – Project Revision Control System

Goals

- Working together should be easy
- Time travel
  - Useful for challenging patents
  - ***Very*** useful for reverting from a sleepless hack session
- Parallel universes
  - Experimental universes
  - Product-support universes

Goal: Shared Workspace

- Reduce development latency via parallelism
  - [But: Brooks, Mythical Man-Month]



Goal: Time Travel

- Retrieving old versions should be easy.

Once Upon A Time…

Alice: What happened to the code? It doesn't work.
Charlie: Oh, I made some changes. My code is 1337!
Alice: Rawr! I want the code from last Tuesday!

Goal: Parallel Universes

- Safe process for implementing new features.
  - Develop bell in one universe
  - Develop whistle in another
  - Don't inflict B's core dumps on W
  - Eventually produce bell-and-whistle release

How?

- *Keep a global repository for the project.*

The Repository

- Version
  - Contents of some files at a particular point in time
  - AKA “Snapshot”
- Project
  - A “sequence” of versions
    - (not really)
- Repository
  - Directory where projects are stored

The Repository

- Stored in group-accessible location
  - Old way: file system
  - Modern way: “repository server”
- Versions ***in repository*** visible to whole group
- “Commit access” often a separate privilege

How?

- Keep a global repository for the project.
- *Each user keeps a working directory.*

The Working Directory

- Many names (“sandbox”)
- Where revisions happen
- Typically belongs to ***one*** user
- Versions are ***checked out*** to here
- New versions are ***checked in*** from here

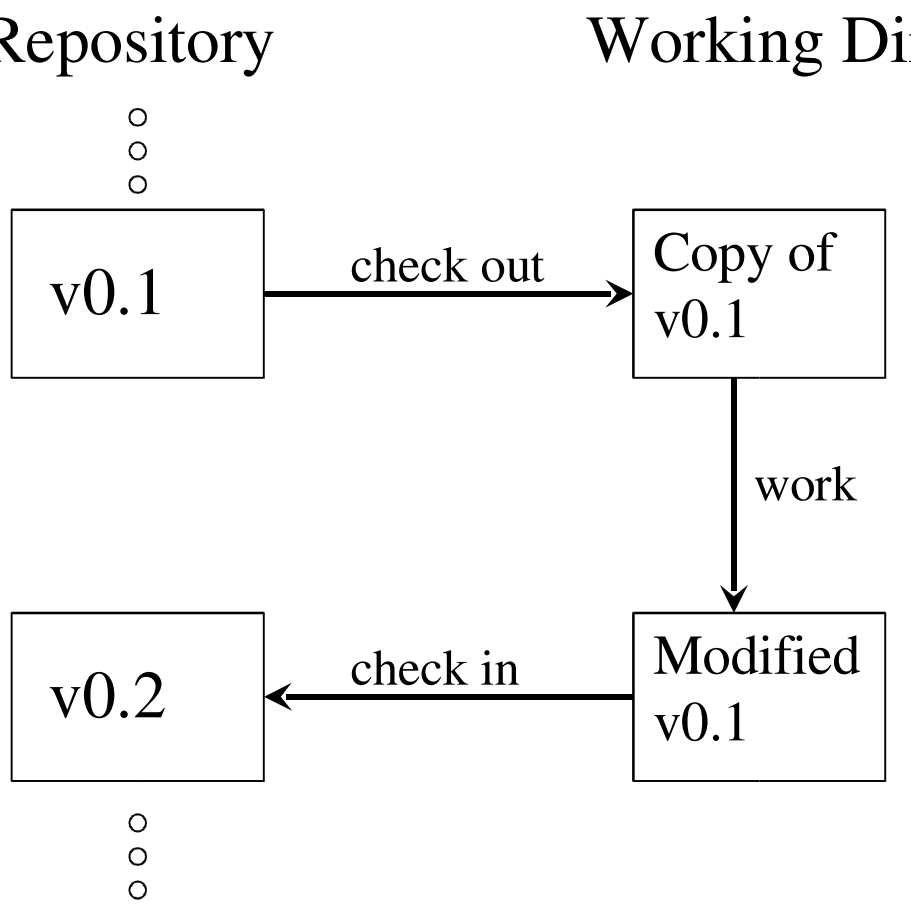
How?

- Keep a global repository for the project.
- Each user keeps a working directory.
- *Concepts of* ***checking out****, and* ***checking in***

Checking Out. Checking In.

- Checking out
  - A version is copied from the repository
    - Typically “Check out the latest”
    - Or: “Revision 3”, “Yesterday noon”
- Work
  - Edit, add, remove, rename files
- Checking in
  - Working directory ***atomically*** copied to repository
  - Result: new version

Checking Out. Checking In.



How?

- Keep a global repository for the project.
- Each user keeps a working directory.
- Concepts of *checking out*, and *checking in*
- *Mechanisms for **merging***

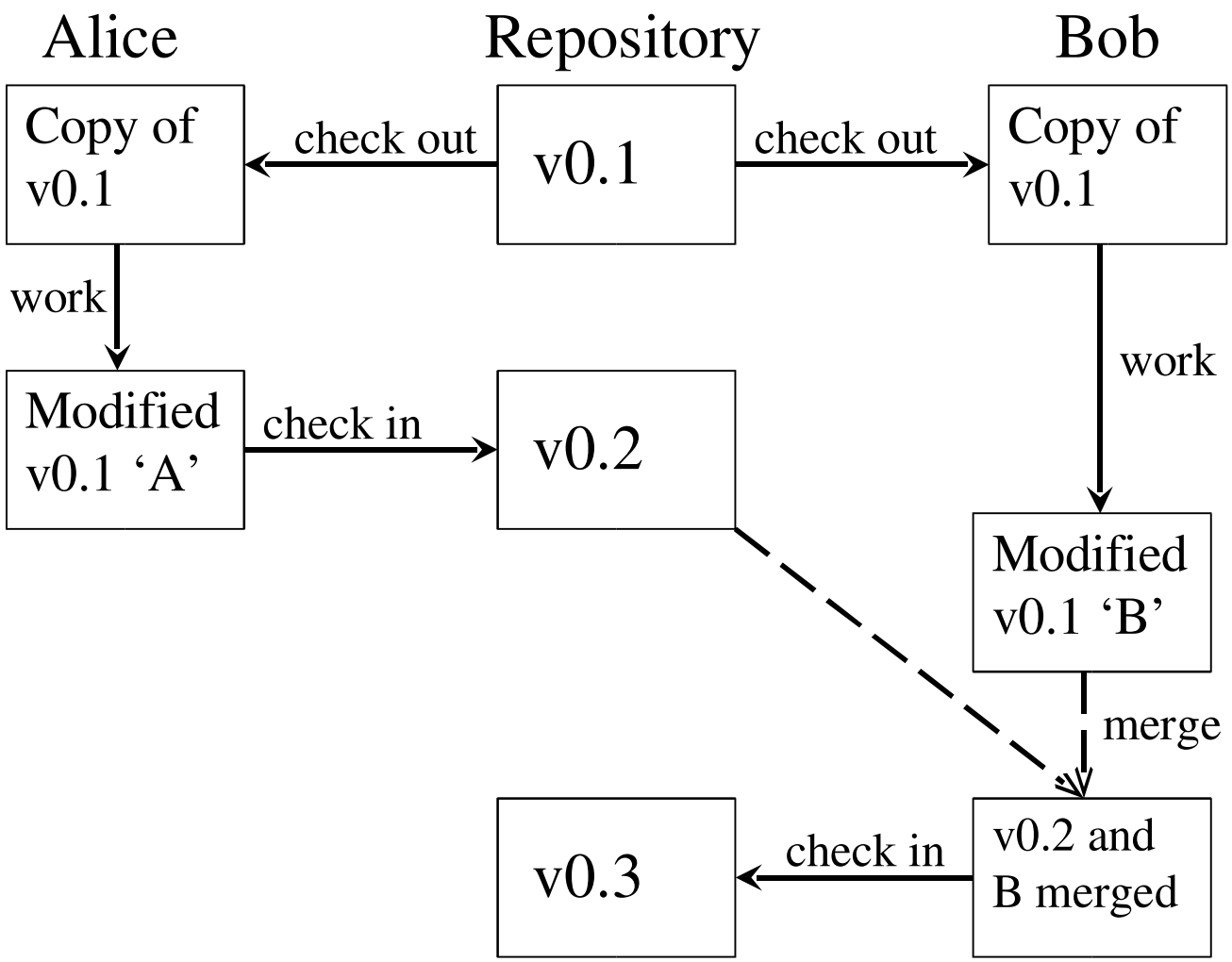
Conflicts and Merging

- Two people check out.
- Both modify foo.c
- Each wants to check in a new version.
- Whose is the ***correct*** new version?

Conflicts and Merging

- Conflict
  - Independent changes which “overlap”
  - ***Textual*** overlap detected by revision control
  - ***Semantic*** conflict cannot be
- Merge displays conflicting updates to each file
- Pick which code goes into the new version
  - A, B, NOTA
- Picture now, example later

Conflicts and Merging



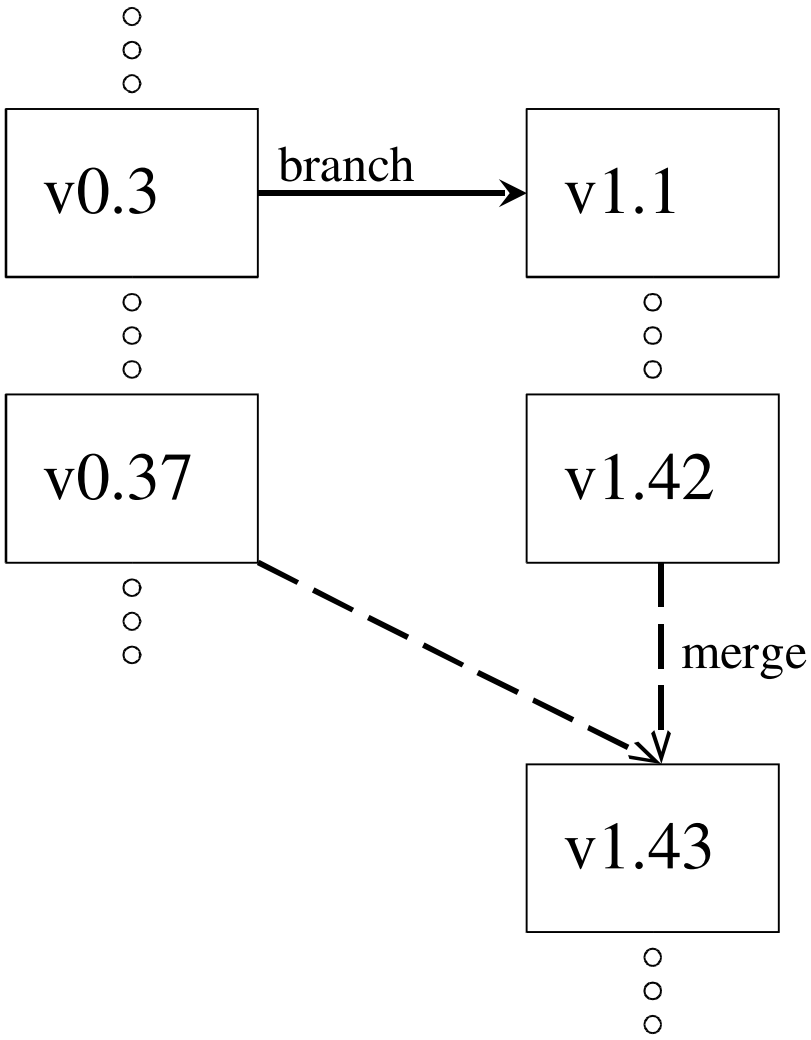
How?

- Keep a global repository for the project.
- Each user keeps a working directory.
- Concepts of *checking out*, and *checking in*
- Mechanisms for *merging*
- *Mechanisms for **branching***

Branching

- A branch is a ***sequence of versions***
  - (not really...)
- Changes on one branch don't affect others
- Project may contain many branches
- Why branch?
  - Implement a new “major” feature
  - Begin an independent sequence of development

Branching



The actual branching and merging take place in a particular user's working directory, but this is what such a sequence would look like to the repository.

Branch Life Cycle

- “The Trunk”
  - “Release 1.0”, “Release 2.0”, “Release 3.0”, ...
- Release 1.0 ***maintenance*** branch
  - 1.0.1, 1.0.2, ...
  - Bug-fix updates as long as 1.0 has users
- Internal ***development*** branches
  - 1.1.1, 1.1.2, ...
  - Probably 1.1.1.client, 1.1.1.server

Branch Life Cycle

- Successful development branch
  - Merged back to parent
  - No further versions
- Unsuccessful development branch
  - Some changes pulled out?
  - No further versions
- Maintenance branch
  - “End of Life”: No further versions

Are Branches ***Deleted?***

- Generally a bad idea
  - ***Complicated*** data structure update
    - [Not a well-tested code path]
  - History can ***always*** turn out to be useful

Source Control Software

- CVS
  - very widely used
  - mature, lots of features
  - default behavior often wrong
- OpenCM
  - security-conscious design
  - not widely used
- BitKeeper
  - Favored by Linus Torvalds
  - “Special” license restrictions
- SubVersion
  - lots of potential
  - not ready yet
- PerForce
  - commercial
  - conceptually reasonable design
  - works ok

Dave's Raves

- CVS
  - Commit: atomic if you are careful
  - Named snapshots: if you are careful
  - Branching: works if you are careful
  - The ***core operations*** require care & expertise!!!
- Many commercial products
  - Require full-time person, huge machine
  - Punitive GUI
  - Poor understanding of data structure requirements

Recommendation for 15-410

- PRCS, Project Revision Control System
  - Small “conceptual throw weight”
  - Easy to use, state is visible
  - No bells & whistles
- Opportunity to learn revision control ***concepts***
  - Quick start when joining research project/job
  - They will probably not be using PRCS

Getting Started

- Add 410 programs to your path (in bash):
  - `$export PATH=/afs/cs.cmu.edu/academic/class/15410-f03/bin:$PATH`
- Set PRCS_REPOSITORY
  - `$export PRCS_REPOSITORY=/afs/cs.cmu.edu/academic/class/15412-s03-users/group-99/REPOSITORY`

Creating A New Project

- In a working directory:
  - `$prcs checkout P`
  - P is the name of the project
- Creates a file: P.prj

The Project File

```
;; -*- Prcs -*-
(Created-By-Prcs-Version 1 3 0)
(Project-Description "")
(Project-Version P 0 0)
(Parent-Version -*- -*- -*-)
(Version-Log "Empty project.")
(New-Version-Log "")
(Checkin-Time "Wed, 15 Jan 2003 21:38:47 -0500")
(Checkin-Login zra)
(Populate-Ignore ())
(Project-Keywords)
(Files
;; This is a comment.  Fill in files here.
;; For example:  (prcs/checkout.cc ())
)
(Merge-Parents)
(New-Merge-Parents)
```

Description of project.

Make notes about changes before checking in a new version

List of files

Using the Project File

- Adding Files
  - `$prcs populate P file1 file2 … fileN`
  - To add ***every*** file in a directory
    - `$prcs populate P`
- Removing, renaming files
  - See handout

Checking In

- Checking in
  - `$prcs checkin P`
  - check in will fail if there are conflicts.

Conflicts and Merging

- Suppose this file is in the repository for project P:

```
#include <stdlib.h>
#include <stdio.h>

int main(void)
{
        printf("Hello World!");
        return 0;
}
```

Conflicts and Merging

- Suppose that Alice and Charlie check out this version, and make changes:

Alice's Changes

```
#include <stdlib.h>
#include <stdio.h>

#define SUPER 0

int main(void)
{
        /* prints "Hello World"
           to stdout */
        printf("Hello World!");
        return SUPER;
}
```

Charlie's Changes

```
#include <stdlib.h>
#include <stdio.h>

int main(void)
{
        /* this, like, says
           hello, and stuff */
        printf("Hello Hercules!");
        return 42;
}
```

Conflicts and Merging

- Suppose Alice checks in first.
- If Charlie wants to check in he must perform a merge
  - `$prcs merge`
  - The default merge option performs a CVS-like merge.

Conflicts and Merging

- The file after a merge

```
#include <stdlib.h>
#include <stdio.h>

#define SUPER 0

int main(void)
{
<<<<<<< 0.2(w)/hello.c Wed, 19 Feb 2003 21:26:36 -0500 zra (P/0_hello.c 1.2 644)
        /* this, like, says hello, and stuff */
        printf("Hello Hercules!");
        return 42;
=======
        /* prints "Hello World" to stdout */
        printf("Hello World!");
        return SUPER;
>>>>>>> 0.3/hello.c Wed, 19 Feb 2003 21:36:53 -0500 zra (P/0_hello.c 1.3 644)
}
```

Conflicts and Merging

- Pick/create the desired version
  - Check that into the repository.

Branching

- To create the first version of a new branch:
  - `$prcs checkin -rWednesday P`
- To merge with branch X version 37:
  - `$prcs merge -rX.37 P`

Information

- To get a version summary about P:
  - `$prcs info P`
  - with version logs:
    - `$prcs info -l P`

Suggestions

- Develop a convention for naming revisions
  - Date
  - Type of revision(bug-fix, commenting, etc.)
  - Short phrase
- When to branch?
  - Bug fixing?
    - Check out, fix, check in to same branch
  - Attempting COW Fork after regular Fork works?
    - Branching probably a good idea.

Summary

- We can now:
  - Create projects
  - Check source in/out
  - Merge, and
  - Branch
- See PRCS documentation:
  - Complete list of commands
  - Useful options for each command.