# 15-410

***"...Goals: Time Travel, Parallel Universes..."***

# Source Control
# Sep. 19, 2008

**Dave Eckhardt**

**Roger Dannenberg**

**Zach Anderson (S '03)**

# 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**

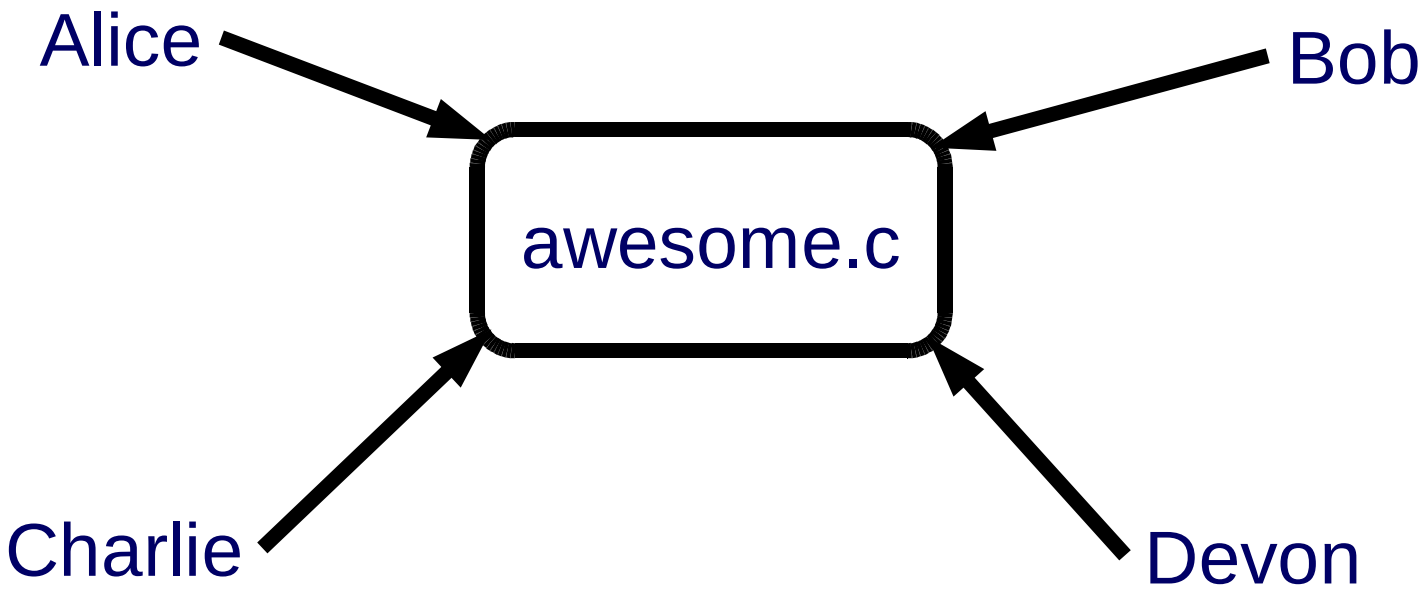
**Parallel universes**

- **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 / Revision / Configuration**

- 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 group-wide**

- **Whoever has read access**
- **“Commit access” often separate**

# 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 3.1.4”, “Yesterday noon”

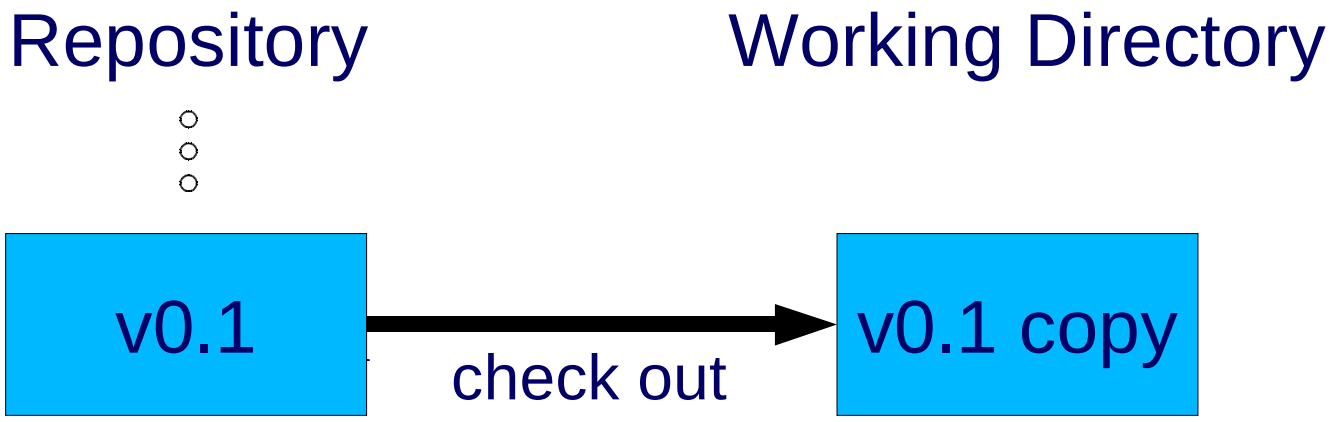
**Work**

- Edit, add, remove, rename files

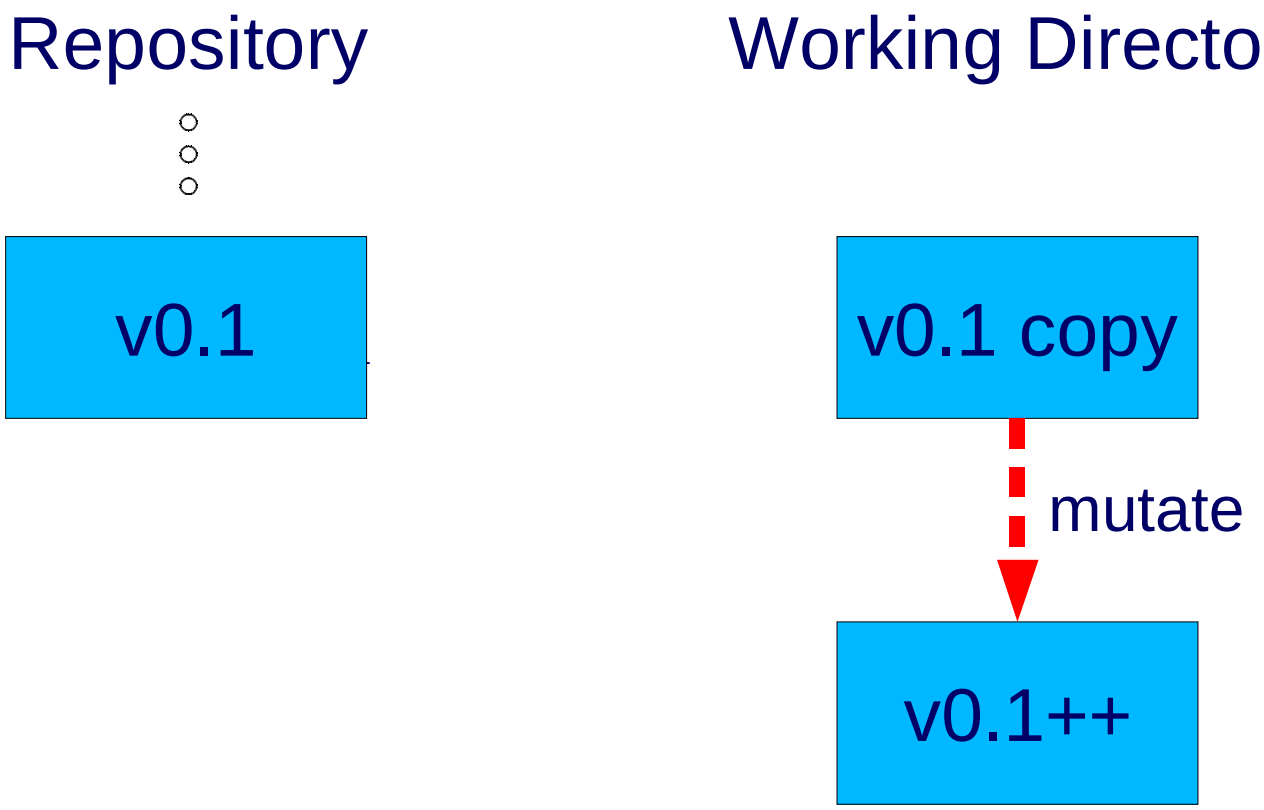
**Checking in**

- Working directory ⇒ repository *atomically*
- Result: new version

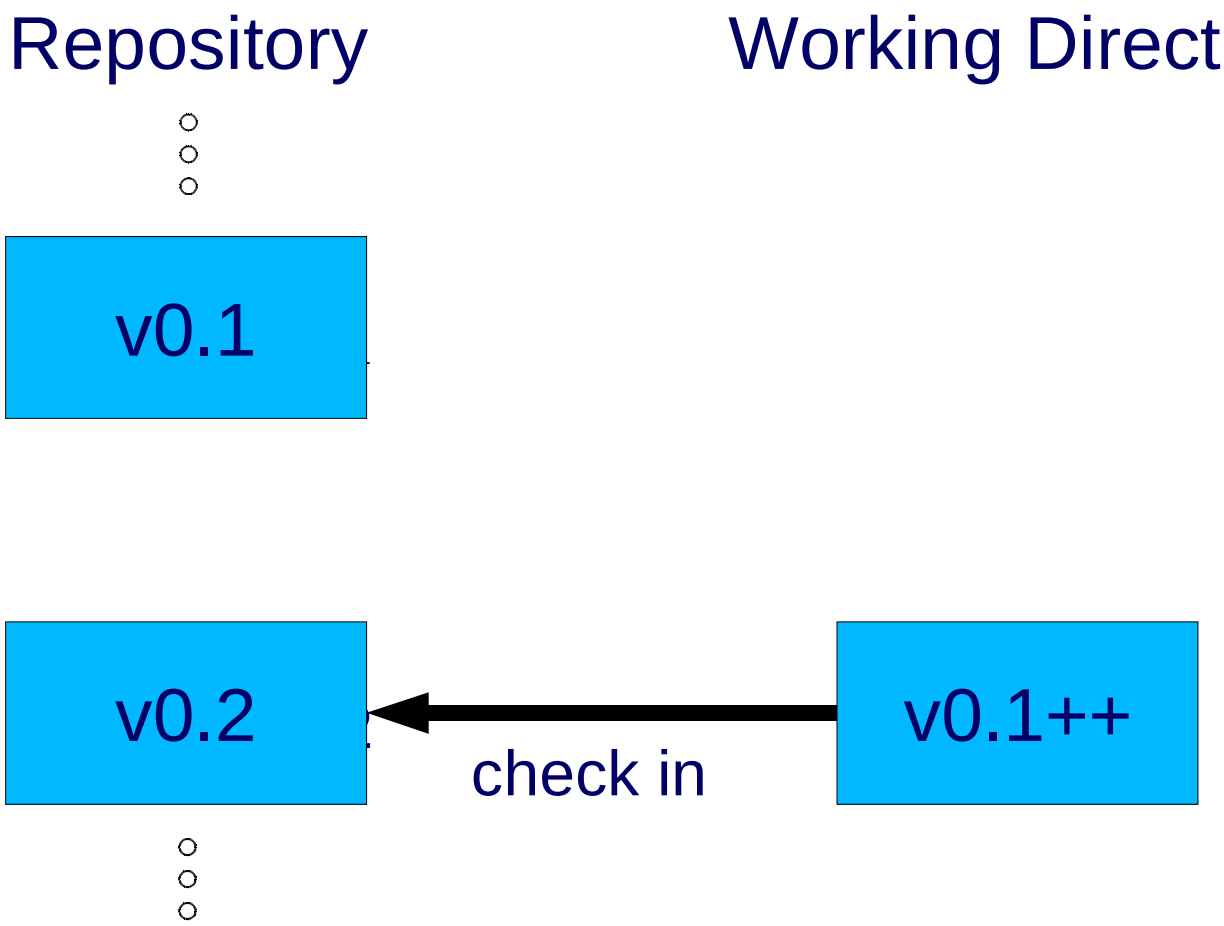
# Checking Out. Checking In.



# Checking Out. Checking In.



# 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**

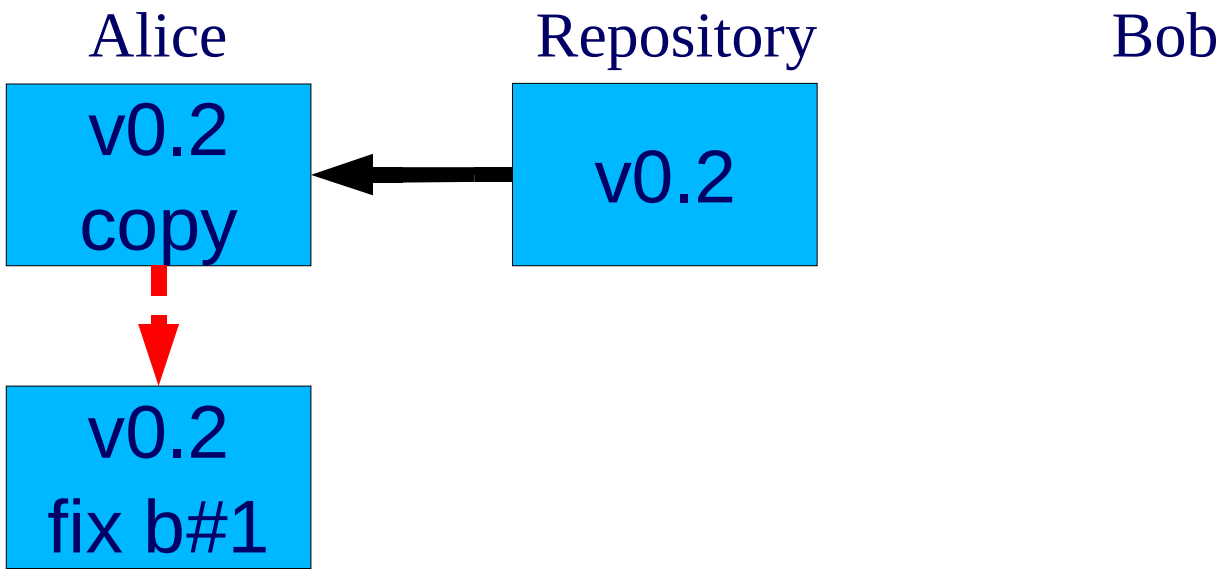
**Merge displays conflicting updates per file**

**Pick which code goes into the new version**

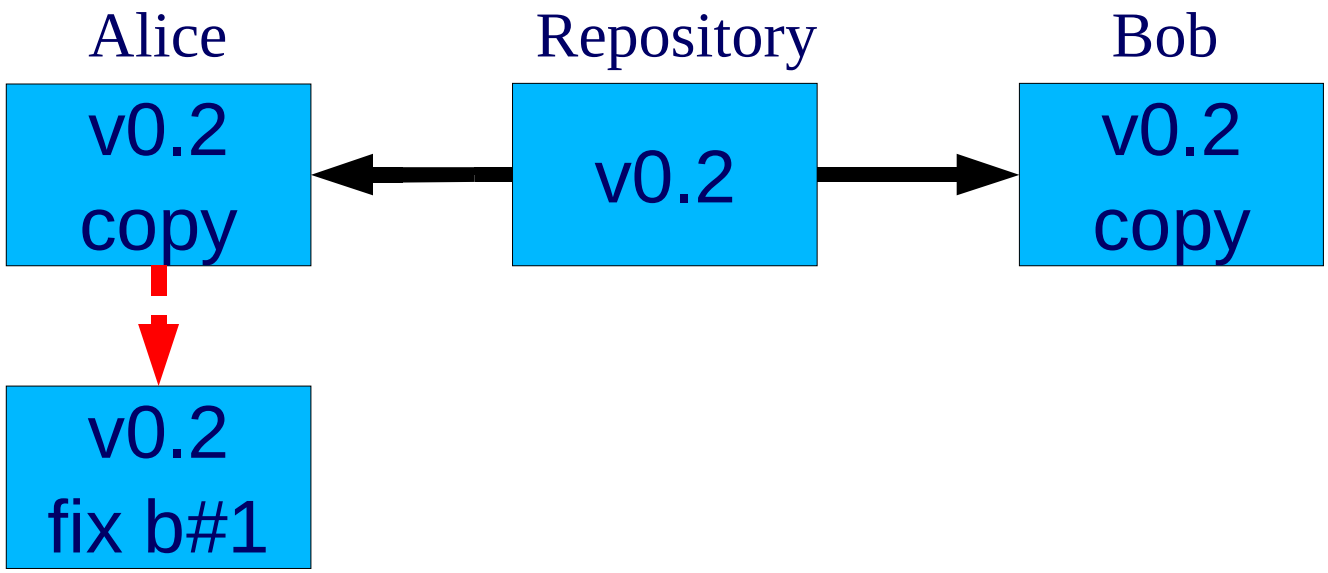
- **A, B, NOTA**

**Story now, real-life example later**

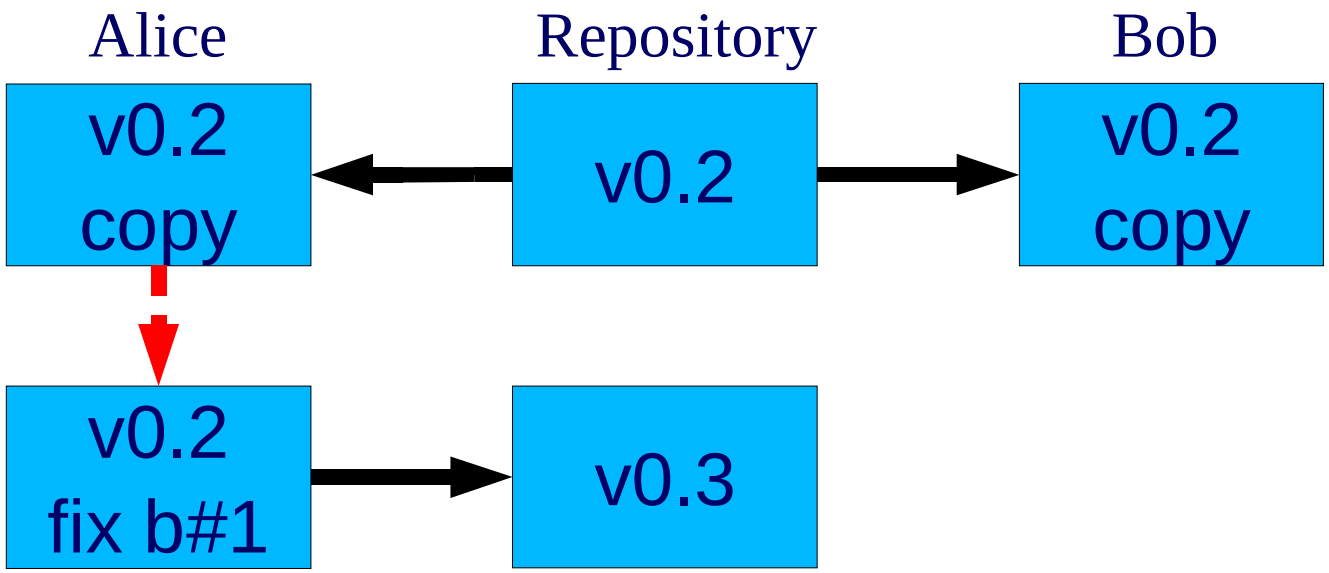
# Alice Begins Work



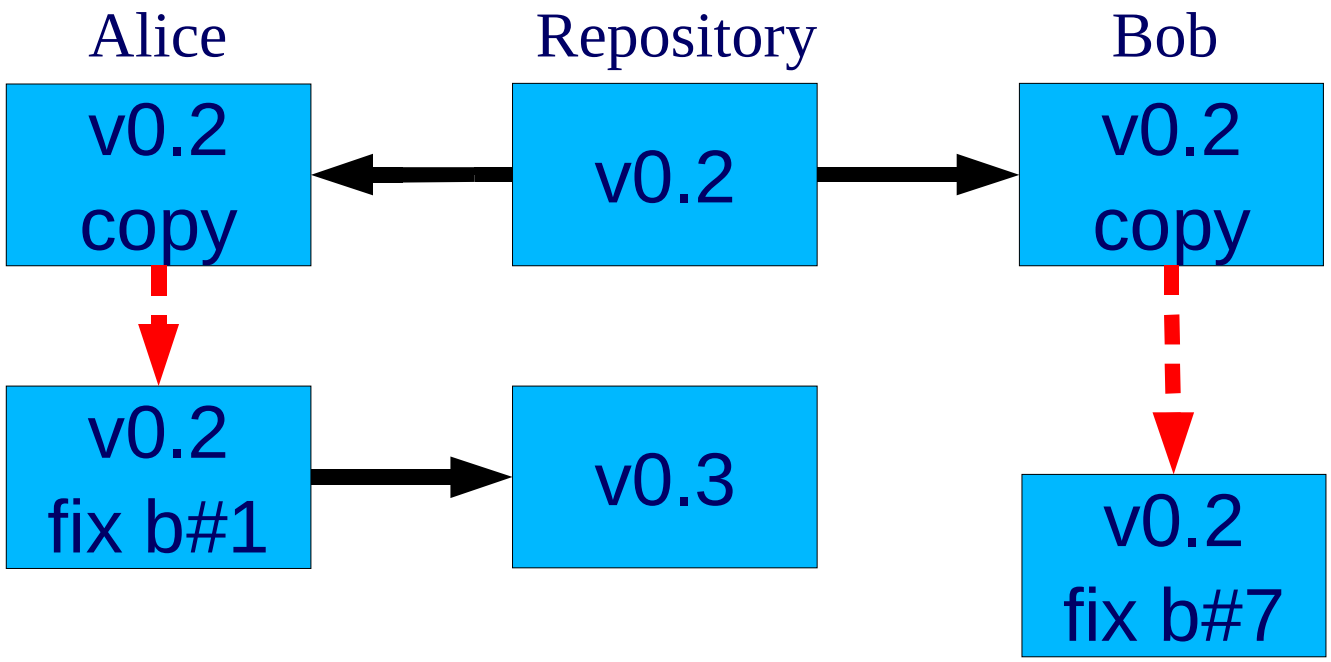
# Bob Arrives, Checks Out



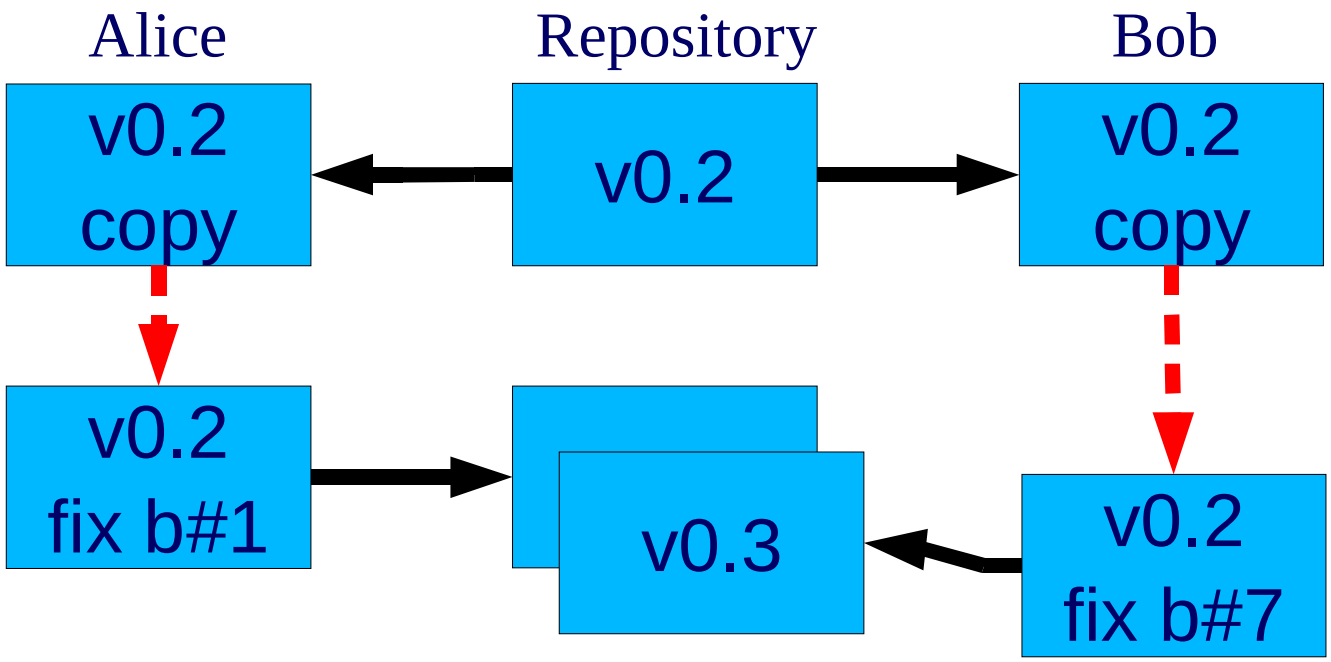
# Alice Commits, Bob Has Coffee



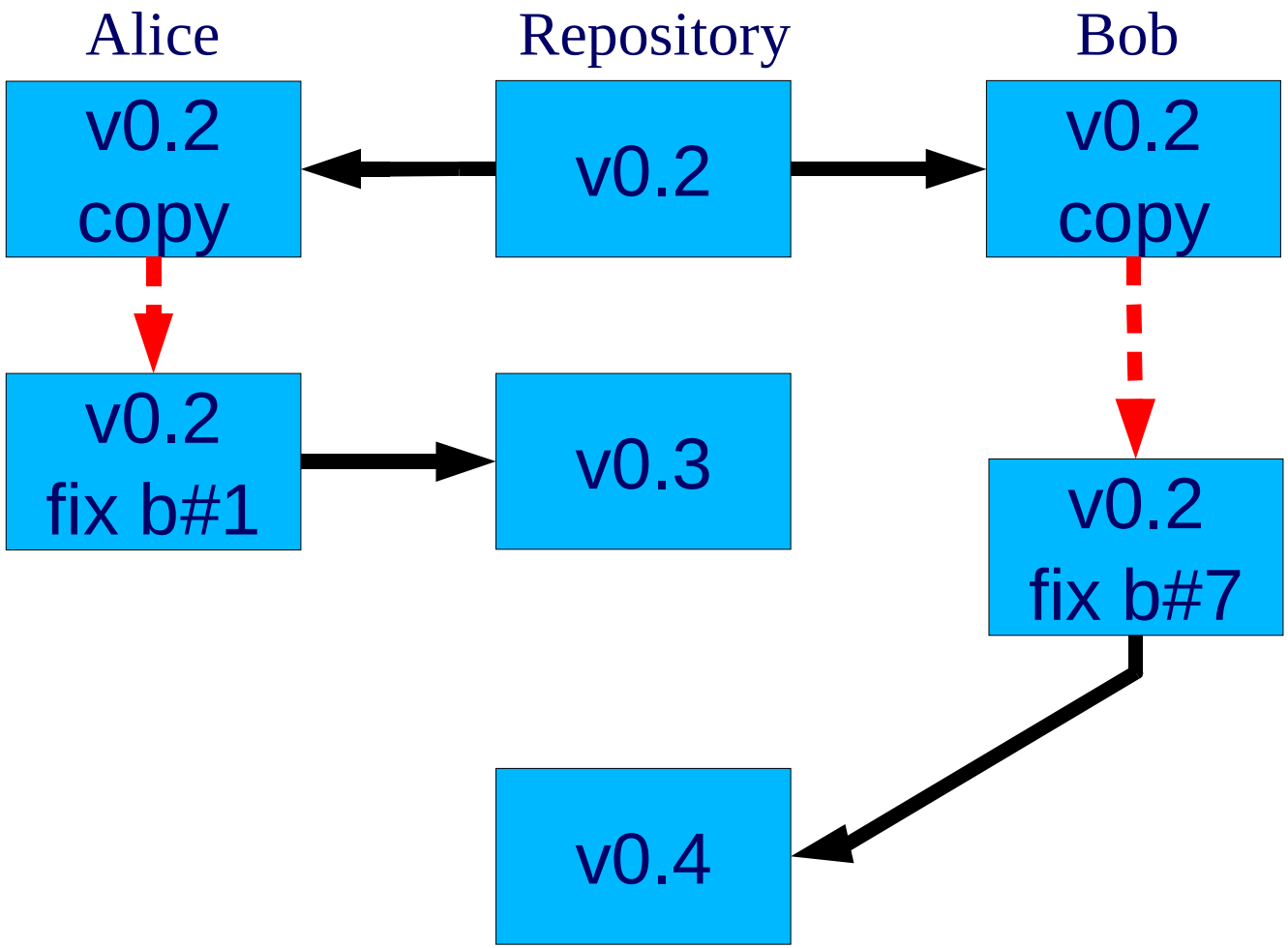
# Bob Fixes Something Too



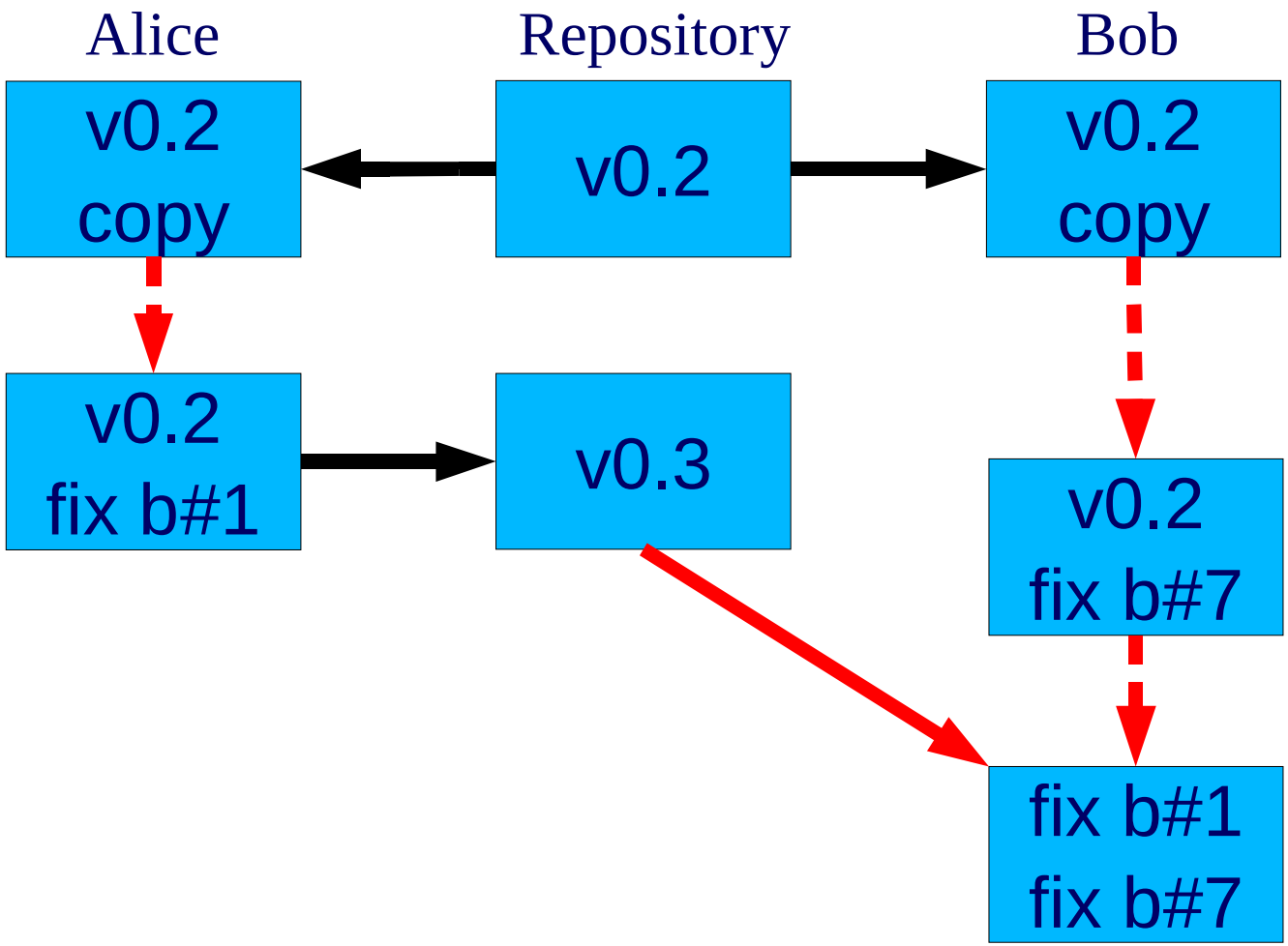
# Wrong Outcome



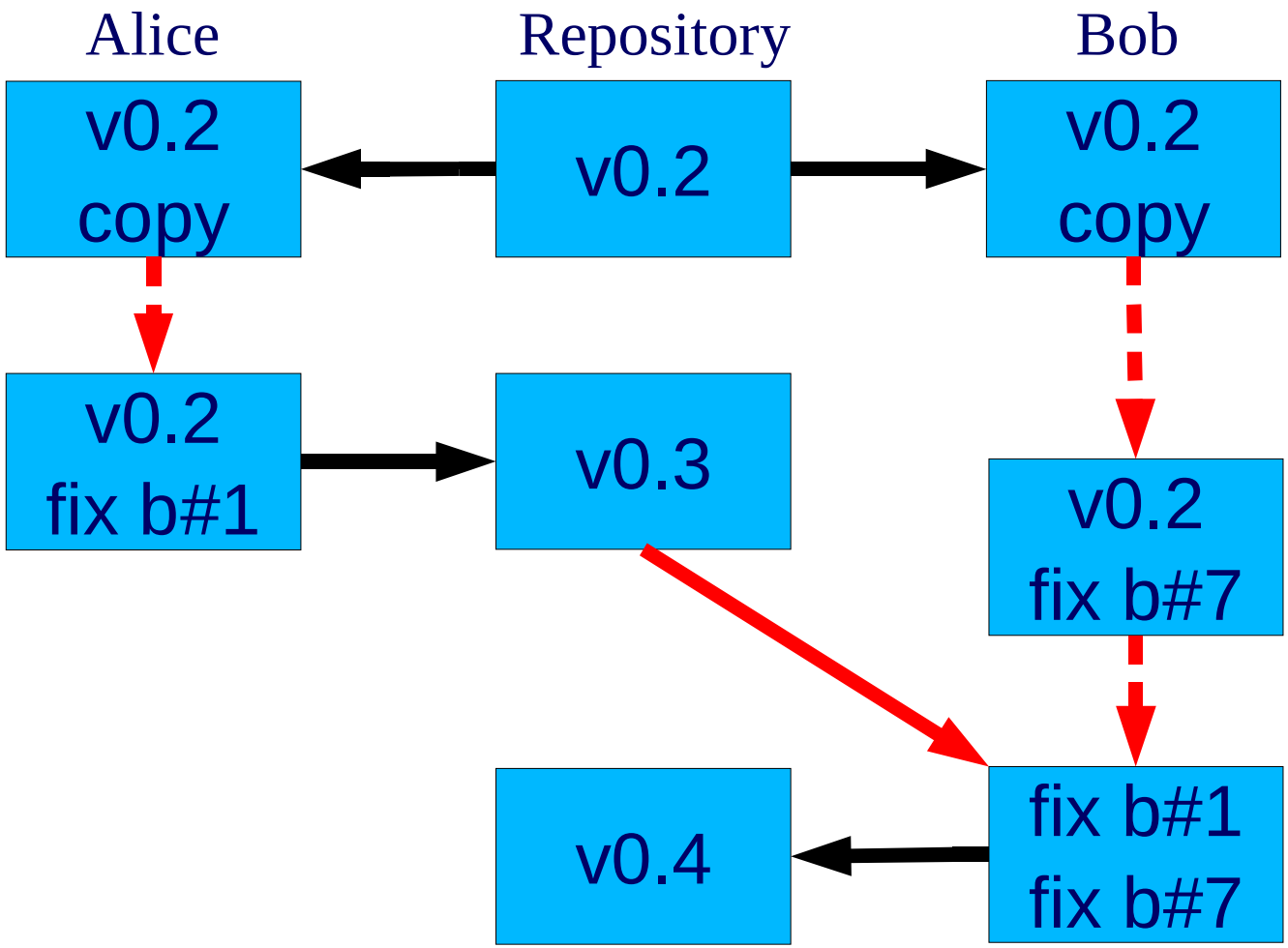
# “Arguably Less Wrong”



# Merge, Bob, Merge!



# Committing Genuine Progress



# 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...)**

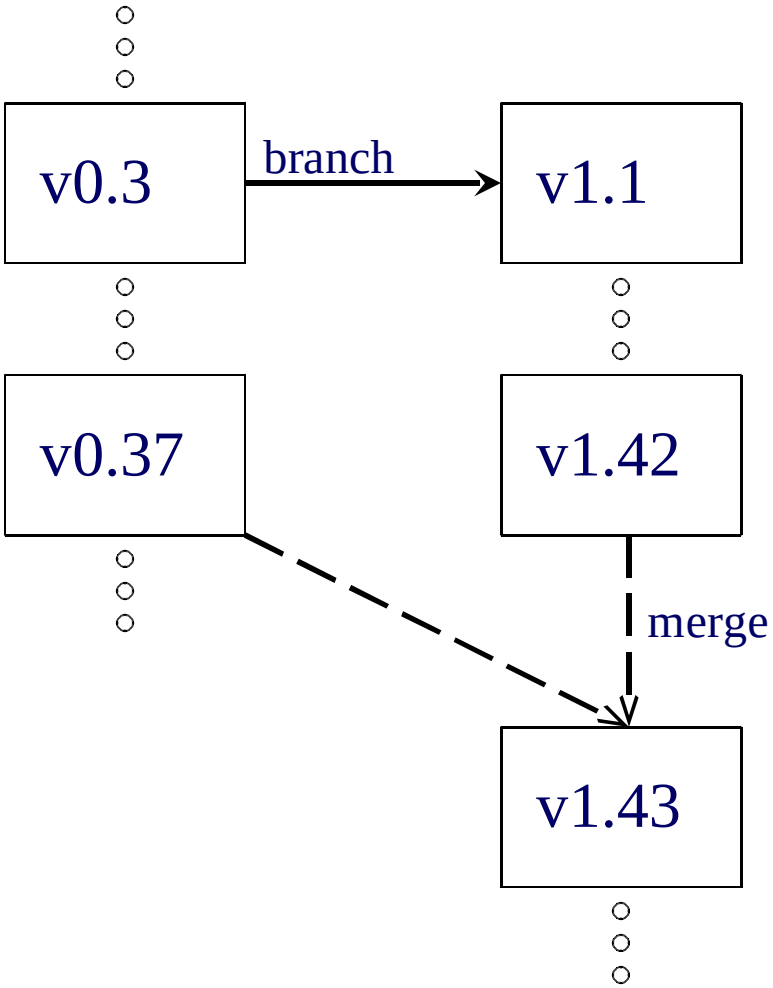
**Changes on one branch don't affect others**

**Project may contain many branches**

**Why branch?**

- **Implement a new “major” feature**
- **Begin a temporary 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 1.0 *maintenance*** branch

- **After 1.0: 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

**"Development excursion" branch model**

- **Create branch to fix bug #99 in v1.1**
- **One or more people make 7 changes**
- **Branch "collapses" back to trunk**
  - **Merge 1.1.bug99.7 against 1.1.12**
  - **Result: 1.1.13**
  - **There will be no 1.1.bug99.8**
    - In some systems, there *can't* be

# Branch Life Cycle

**"Controlled isolation" branch model**

- Server people work on 1.3.server
  - Fix server code
  - Run stable client test suite vs. new server
- Client people work on 1.3.client
  - Fix client code
  - Run new client test suite vs. stable server
- Note
  - Branches do *not* collapse after one merge!

# Branch Life Cycle

**"Controlled isolation" branch model**

- **Periodic merges - example**
  - **1.3.server.45, 1.3.12 ⇒ 1.3.13**
  - **1.3.client.112, 1.3.13 ⇒ 1.3.14**
  - **Each group can keep working while one person "pushes up" a version to the parent**
- **When should server team "pull down" 1.3.14 changes?**
  - **1.3.server.47, 1.3.14 ⇒ 1.3.server.48?**
  - **1.3.server.99, 1.3.14 ⇒ 1.3.server.100?**
  - **Efficiency now vs. merge cost later...**

# 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?*

**Consider the repository "data structure"**

- Revisions of each file (coded as deltas)
- Revisions of the directory tree

**Branch delete**

- *Complicated* data structure update
  - [Not a well-tested code path]
- Generally a bad idea
  - History could *always* be useful later...

# Source Control Opinions

## 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 (svn)

- SVN > CVS (design)
- SVN > CVS (size)
- Doesn't work in AFS
- Yes, it does
- No, it doesn't?

## PerForce

- commercial
- reasonable design
- works well
- big server

# Source Control Opinions

## Others

- Mercurial (“hg”)
  - Merge-once branches
- Bazaar (“bzr”)
- git
  - Recently revamped
- Monotone
- arch
- Darcs (“patch algebra”)

## Generally

- Promising plans
- Ready yet?

# Dave's Raves

## CVS

- Commit: atomic if you are careful
- Named snapshots: if you are careful
- Branching: works if you are careful
- *Core operations* require care & expertise!!!

## Many commercial products

- Require full-time person, huge machine
- Punitive click-click-click GUI
- Poor understanding of data structure requirements

# Recommendation for 15-410

**You can use CVS if you're used to it**

- Also: SVN, hg, arch, ...

**PRCS, Project Revision Control System**

- Small “conceptual throw weight”
- Easy to use, state is visible (single text file)
- No bells & whistles

**Setting 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 (.bashrc):**

- `$ export PATH=/afs/cs.cmu.edu/academic/class/15410-f08/bin:$PATH`

**Set environment variables (also .bashrc):**

- `$ export PRCS_REPOSITORY=/afs/cs.cmu.edu/academic/class/15410-f08-users/group-99/REPOSITORY`
- `$ export PRCS_LOGQUERY=1`

# Creating A New Project

**In a blank working directory:**

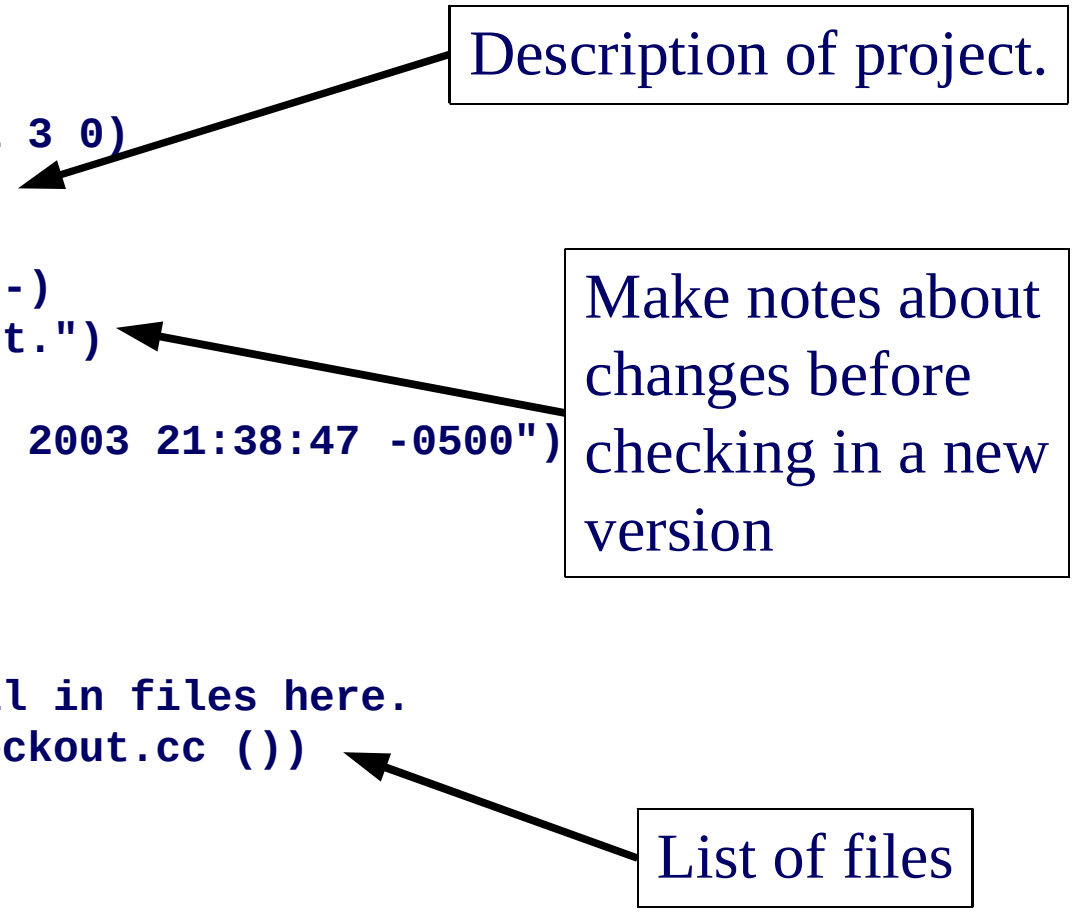
```
$ prcs checkout P
```

- **P is the name of the new 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)
```



# Using the Project File

## Adding Files

```
$ prcs populate P file1 file2 … fileN
```

- To add *every* file in a directory
  - `$ prcs populate P`
  - Rarely what you want!!!

## Removing, renaming files

- See course web

# Checking In

## Checking in

```
$ prcs checkin P
```

- Check-in will fail if there are conflicts.
- Hey, we forgot to talk about 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!\n");
        return 0;
}
```

# Conflicts and Merging

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

Alice's Version

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

#define SUPER 0

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

Charlie's Version

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

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

# Conflicts and Merging

**Suppose Alice checks in first**

```
$ prcs checkin
```

**Now Charlie must perform a merge**

```
$ prcs checkin ⇒ will fail
$ prcs merge
```

- Default merge option performs a CVS-like merge.

```
$ prcs checkin ⇒ should work now
```

# Merge Mutilation

```
#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 -rExperimental_VM
  Kern.prj
```

**To merge with branch X version 37:**

```
$ prcs merge -rX.37 Kern.prj
```

# 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
- Trying COW fork since regular fork works?
  - Branching probably a good idea.
- “Any time you want commits kept secret”

# Summary

**We can now:**

- Create projects
- Check source in/out
- Merge, and
- Branch

**See PRCS documentation**

- Ours, official –on Projects web page
- Complete list of commands
- Useful options for each command.