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SOFTENG 254

21/09/2012

SE Software Engineering

The University of Auckland

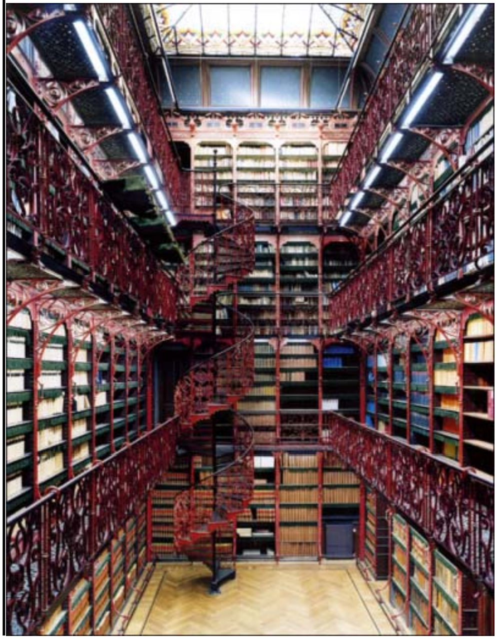
Quality Assurance
Version Control 1

Part II - Lecture 6

Today's Outline

- Version Control
- Managing Concurrency

Version Control



← *Have always used version control*

Has never used version control →

Version Control

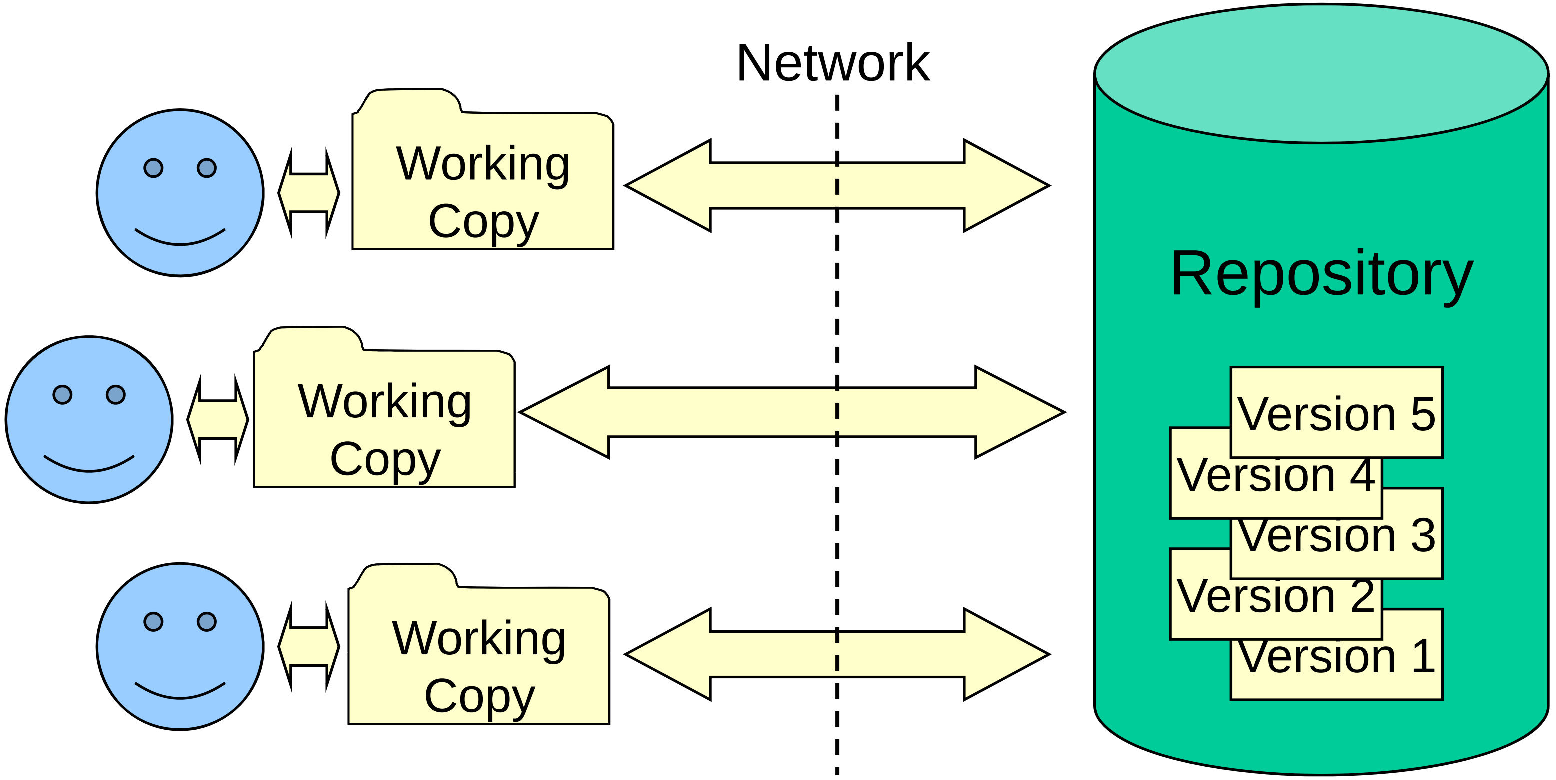
Common problems in a software project:

- A change needs to be **undone**
- Old code that was **overwritten** would be useful again
- Several developers work on the same program part **simultaneously**
- How do I get the **latest version** of the code?

The solution: a Version Control System (VCS)

- Manages a **common repository** for all artefacts
- Controls **concurrent access**
- Creates new **version** for each change (redo/undo possible)
- Helps to **merge** several contributions to same part

Version Control System



- Developers work on their **local working copies**
- Developers **synchronize** their working copy with the repository
- Repository usually uses **delta encoding** for the versions
- Two ways to **avoid conflicts**: locking and merging

Product Space and Version Space

Product space: What is versioned? How is the data organized?

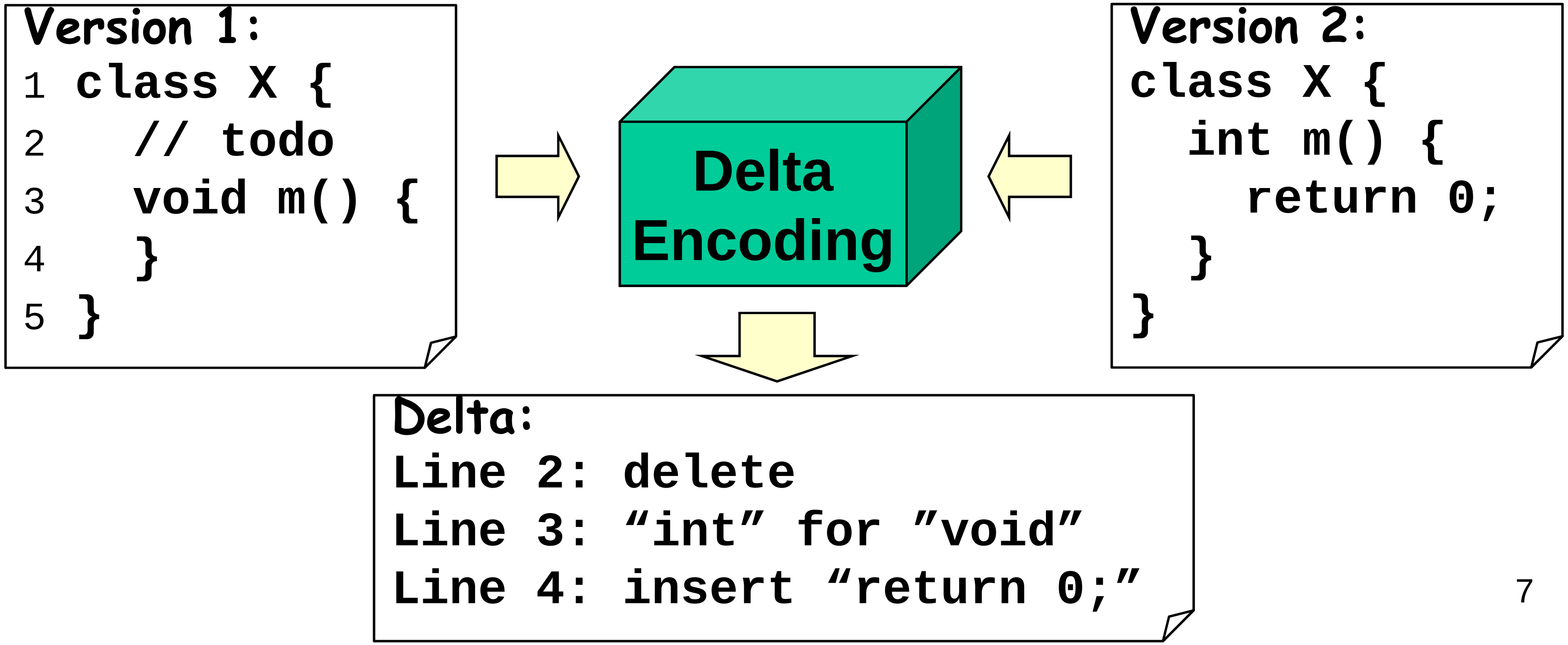
- **Just files**: each file has a version number which is increased when the file is changed (e.g. CVS)
- **Files and folders**: the whole file-folder structure has a single version number which is increased for any change done to any file/folder (e.g. SVN)
- **Other data models**, e.g. PD model in PDStore (instances, links)

Version Space: How is it versioned? How are versions organized?

- **Version identifiers**:
  e.g. serial numbers (1, 2, 3, …), dates (e.g. 20060901), …
- **Version history**:
  - How are versions ordered? Parent-version / child-version
  - Versions with several parents? -> Merging
  - Versions with several children? -> Branching

Delta Encoding

- Storing every version of a file takes up a lot space
- Idea: just store differences between versions
- Differences ("deltas" / "diffs") can be calculated automatically with various algorithms
- Deltas can be recorded in a separate file and used to update files (e.g. for "patches")



Version 1:

```
1 class X {
2   // todo
3   void m() {
4   }
5 }
```

Delta Encoding

Version 2:

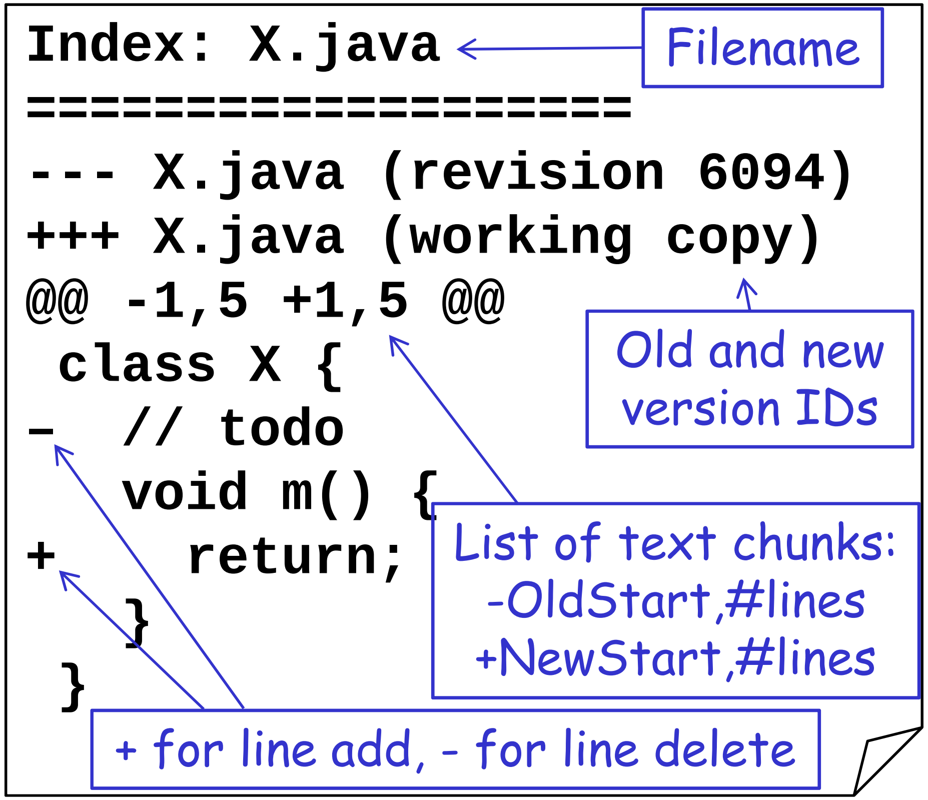
```
class X {
  int m() {
    return 0;
  }
}
```

Delta:

```
Line 2: delete
Line 3: "int" for "void"
Line 4: insert "return 0;"
```

The Unified Diff Format

- Standard format for exchanging patches understood by most VCS
- Example:
  remove comment and insert "return;"
- **Line-oriented**:
  only full line insertions and full line deletions
- No line parts or moving
- Some leading and trailing lines for each chunk for "fuzzy" patching (applying patch to version where it does not fit exactly)



```
Index: X.java
===================
--- X.java (revision 6094)
+++ X.java (working copy)
@@ -1,5 +1,5 @@
 class X {
-  // todo
   void m() {
+    return;
   }
 }
```

Filename

Old and new version IDs

List of text chunks:
-OldStart,#lines
+NewStart,#lines

+ for line add, - for line delete

Branches & Tags

Branches: different copies of a project which are developed simultaneously; “self-maintained lines of development” (**`/branches`**)

- One main branch (**`/trunk`**)
- Maintenance branches: used for maintaining old versions which are still widely used (e.g. commercial OS)
- Experimental branches: used for trying out new features before merging them into the trunk
- Personal developer branches: for people trying out their own ideas

Tags: particular marked versions of the project (**`/tags`**)

- Can be used to refer to and recreate an old version
- Actually also like a copy of the project at a particluar point in time
- Difference to branches: usually not changed any more

Version Control Best Practices

1. Complete **one change** at a time and commit it
   - If you committing several changes together you cannot undo/redo them individually
   - If you don't commit and your hard disk crashes…
   - Continuous integration (see XP)
2. Only commit changes that preserve system **integrity**
   - No "breaking changes" that make compilation or tests fail
3. Commit only **source files** (e.g. not **`.class`** files)
4. Write a **log entry** for each change
   - What has been changed and why
5. **Communicate** with the other developers
   - See who else is working on a part before changing it
   - Discuss and agree on a design
   - Follow the project guidelines & specifications

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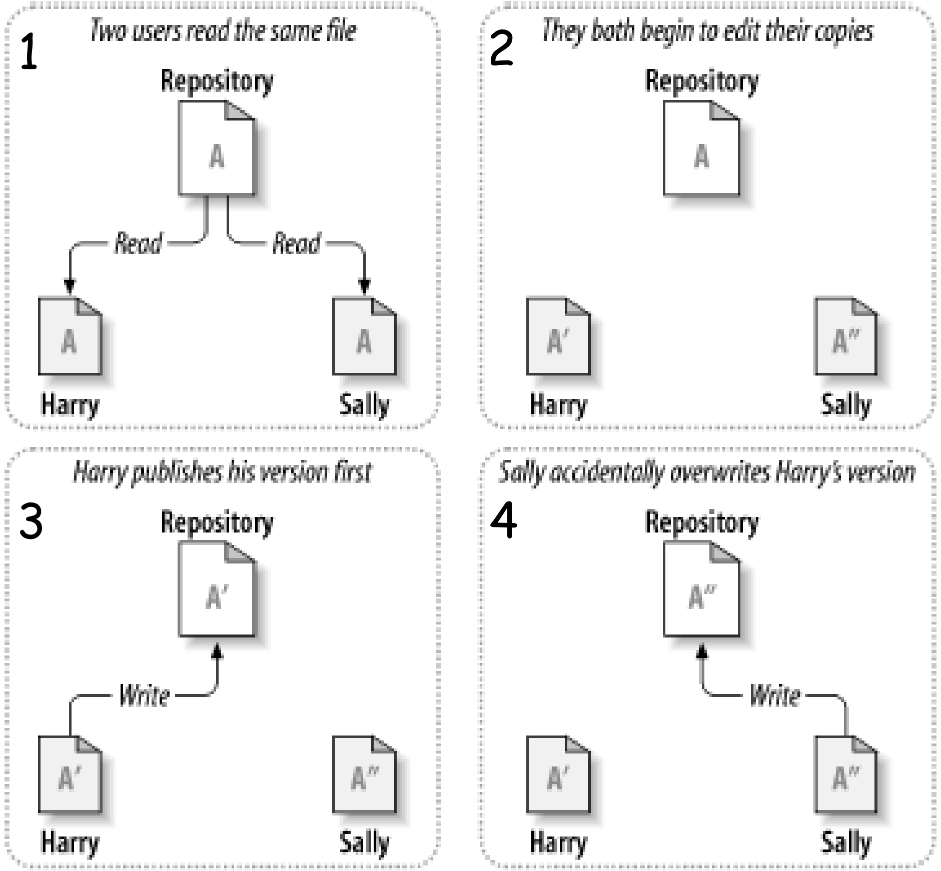
Managing Concurrency

Concurrent File Access: "Lost Update" Problem

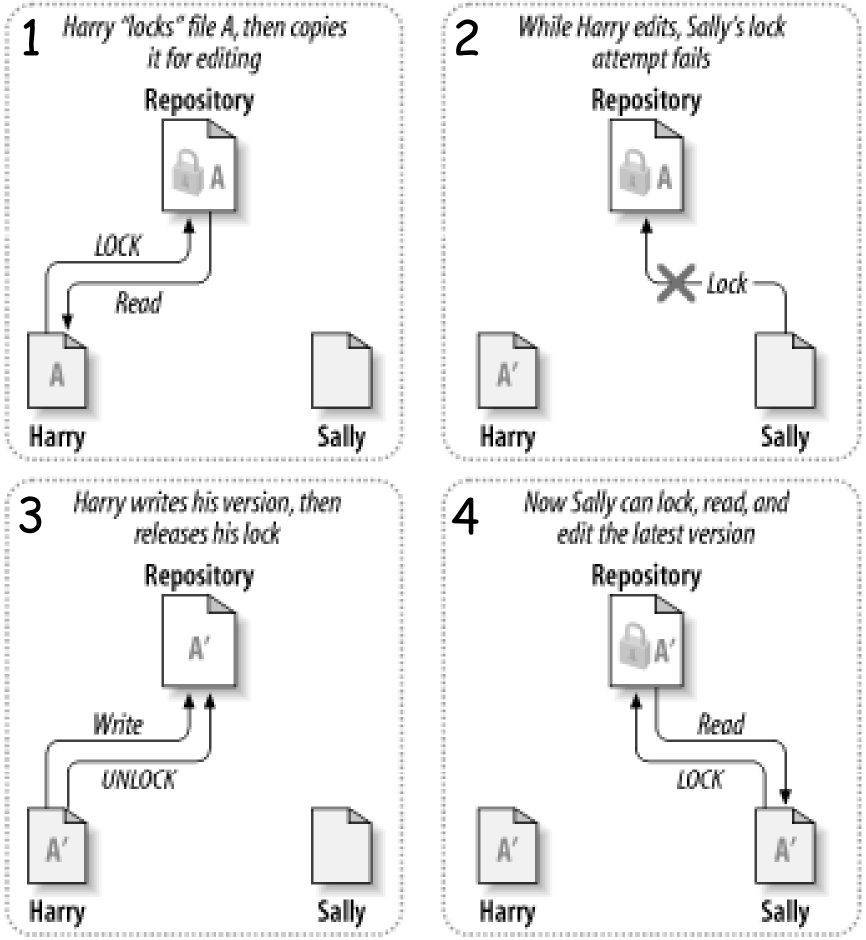
- When sharing files developers can accidentally **overwrite** each others changes
- Consider two developers working on the same file
- Two approaches for solving this:
  - Reserved checkouts ("locking")
  - Unreserverd checkouts ("merging")
- Many old version control systems support only locking (e.g. RCS, SCCS)
- Newer systems offer merging
- Both approaches have disadvantages


1
Two users read the same file
Repository
A
Read
Read
A
Harry
A
Sally
2
They both begin to edit their copies
Repository
A
A′
Harry
A″
Sally
3
Harry publishes his version first
Repository
A′
Write
A′
Harry
A″
Sally
4
Sally accidentally overwrites Harry's version
Repository
A″
Write
A′
Harry
A″
Sally

Images taken from the SVN Book (see resources page)

Locking (Reserved Checkouts)

- Only one person can edit a file at a time
- Before getting write access developer has to **acquire the lock** of the file
- Attempts to get lock while someone else has it fail
- Sally has to wait for Harry to release the lock
- Access to files is **serialized**
- Workflow: lock-modify-unlock


1
Harry "locks" file A, then copies it for editing
Repository
A
LOCK
Read
A
Harry
Sally
2
While Harry edits, Sally's lock attempt fails
Repository
A
Lock
A'
Harry
Sally
3
Harry writes his version, then releases his lock
Repository
A'
Write
UNLOCK
A'
Harry
Sally
4
Now Sally can lock, read, and edit the latest version
Repository
A'
Read
LOCK
A'
Harry
A'
Sally

Merging (Unreserved Checkouts)

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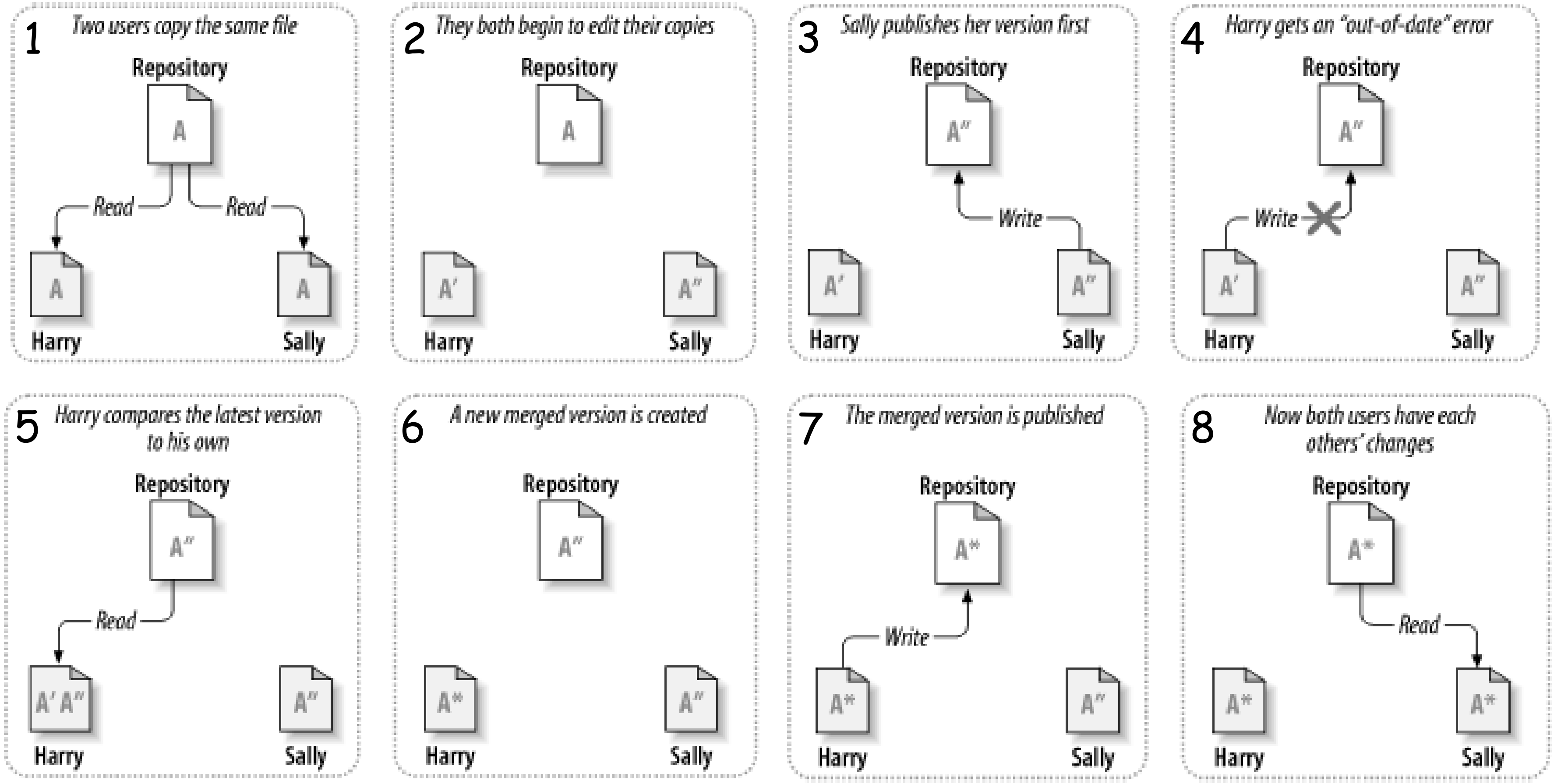
- Everybody can modify their working copy whenever they want
- But own changes have to be merged with changes of others before they can be written to repository (copy-modify-merge)



1 Two users copy the same file
Repository
A
Read
Read
A
A
Harry
Sally
2 They both begin to edit their copies
Repository
A
A′
A″
Harry
Sally
3 Sally publishes her version first
Repository
A″
Write
A′
A″
Harry
Sally
4 Harry gets an "out-of-date" error
Repository
A″
Write
A′
A″
Harry
Sally
5 Harry compares the latest version to his own
Repository
A″
Read
A′ A″
A″
Harry
Sally
6 A new merged version is created
Repository
A″
A*
A″
Harry
Sally
7 The merged version is published
Repository
A*
Write
A*
A″
Harry
Sally
8 Now both users have each others' changes
Repository
A*
Read
A*
A*
Harry
Sally

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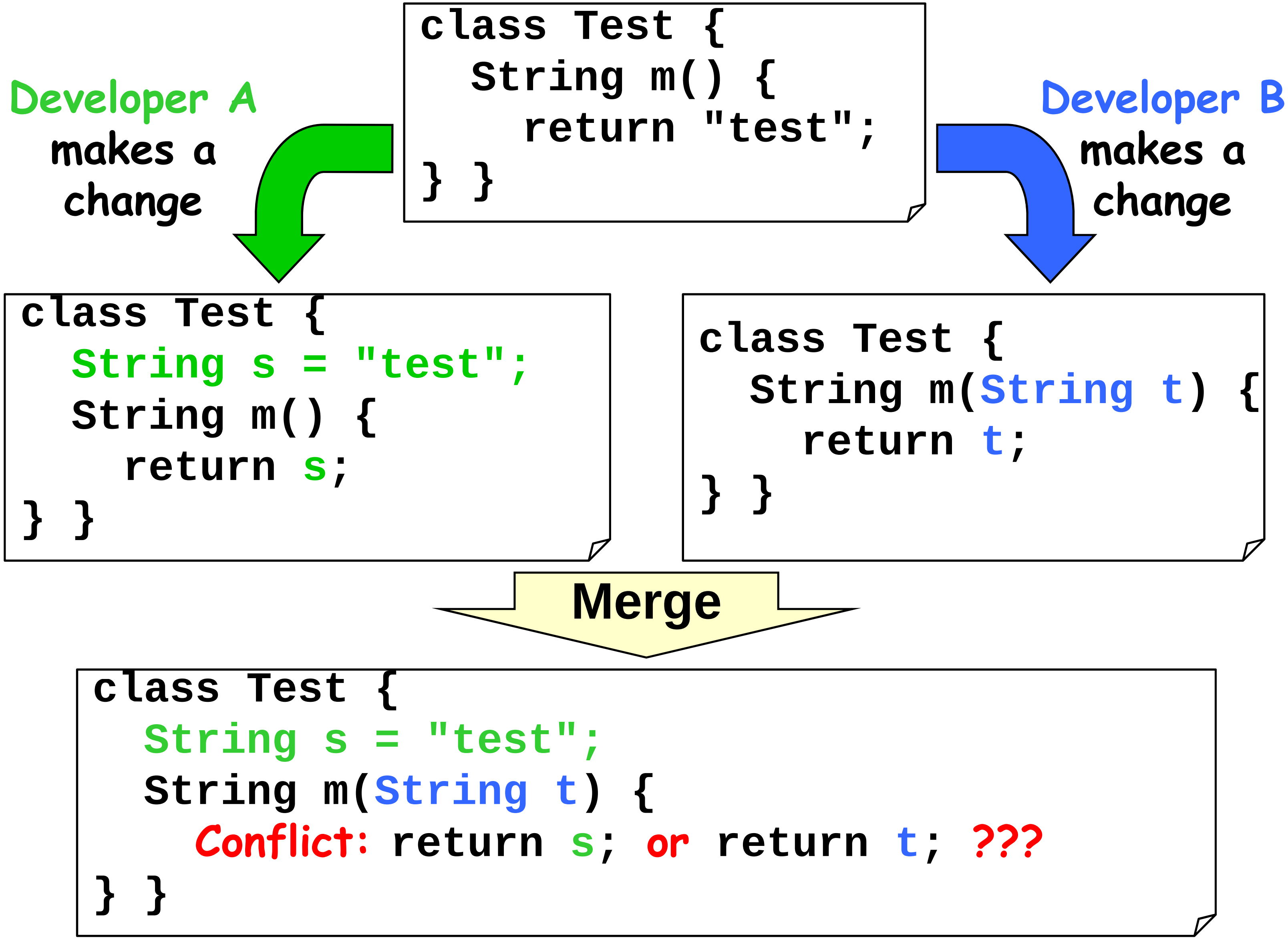
Merging Example



```
class Test {
  String m() {
    return "test";
} }
```

Developer A makes a change

Developer B makes a change

```
class Test {
  String s = "test";
  String m() {
    return s;
} }
```

```
class Test {
  String m(String t) {
    return t;
} }
```

Merge

```
class Test {
  String s = "test";
  String m(String t) {
    Conflict: return s; or return t; ???
} }
```

Merging: Textual and Semantic Conflicts

- Textual conflicts
  - Changes of different developers are very close or **overlapping** each other (“overlap”)
  - Merge tool cannot automatically combine them
  - Merge tool **detects** such conflicts & reports them to the user
  - Version control system will refuse to write a file with unresolved textual conflicts to the repository
- Semantic conflicts (logical conflicts)
  - Changes are semantically incompatible, but may not be overlapping (e.g. in different files)
  - E.g. developer A changes method signature of method **m**, developer B inserts method calls to **m** using the old signature
  - Non-overlapping semantic conflicts are **not detected** by a generic merge algorithm!!!
  - Can be avoided by following specifications and communicating with others
- Both textual and semantic conflicts have to be resolved by the user

Locking vs. Merging

Arguments against locking and for merging

1. Administrative problems: people forget releasing their locks; frequently administrators have to do it
2. Unnecessary serialization: very counter-productive
   - Locking prevents people from editing different parts of the same file
   - In reality conflicts occur rarely and can be resolved without problems
   - Conflicts usually indicate lack of communication
     - Developers have not agreed on a proper design
     - With mutual agreement on design conflicts are usually straightforward to merge
3. False sense of security: locking does not prevent semantic conflicts of distributed changes (i.e. in different files)

Locking vs. Merging

Arguments for locking and against merging

1. "Unmergeable" files: a generic merging tool does not work for all file types
   - For some formats (e.g. for Java class files) generic merging leads to many conflicts
   - Conflicts can be very hard to resolve (e.g. for binary formats)
   - One of two conflicting changes get lost (because they cannot be merged)
2. Tradition: an organization might have always used a locking VCS

Today's Summary

- A **Version Control System** manages the different versions of all artefacts in a project
  - Many local working copies and one shared repository
  - Compressed with delta encoding
- **Prevents lost updates** through locking or merging
  - Supports automatic merging and detects textual conflicts
  - Cannot detect non-textual sematic conflicts
  - Conflicts always have to be resolved manually

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Quiz

1. What is delta encoding? Give an example.
2. What is the difference between locking and merging? When should each of it be used?
3. What is a semantic conflict? Why can it be a problem?