

# Code versioning & Git

GIGA Doctorate School

Christophe Phillips, Ir Ph.D.



# Program

- ▶ Why “Version Control” ?
- ▶ Basics of Version Control (VC)
- ▶ Git as a VC solution
- ▶ Being Git practical with GitHub/GitLab
- ▶ Conclusions & reference



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## Example 1, “last version?”

### Real life example

- ▶ Hey can you send me the source of that article XYZ?

- ▶ Sure, ...hum, well, ...

`article.tar.bz2`

There it is!

`article_final.tar.bz2`

No this one is more recent

`article_final2.tar.bz2`

Wait, this is one even more so

`article_last.tar.bz2`

Hold on, that should be it

`article_20180705_bis.tar.bz2`

Or maybe...

- ▶ Poor man’s versioning → date & comment in archive file name



## Example 2, “collaborate?”

### ▶ One person in charge

Send an email with:

“Changes made:

- updated help part of file1.m
- corrected a bug in file2.m
- Added a new feature to handle .png images in file3.m

See the attached files.”

### ▶ One shared file, e.g. through Dropbox or on server

→ Incompatible parallel versions, overwritten files, lost changes,...  
depending on “who saved last”



## Example 3, “mess with yourself!”

A simple way to “shoot oneself in the foot”:

1. Take a snap shot archive of current stable version commonly, = copy your code in a new folder
2. Begin implementing your new crazy experimental idea.
3. Fix some bugs in old code, revealed during testing.
4. Your idea was crap, discard experimental version.
5. Start back from stable version archive.
6. You lost your bug fixes, which also applied to the stable version...  
Or was it ?



# Why Version Control

## Key questions:

- ▶ Do you work in a team?
- ▶ Has it ever happened that you were working on a file, and someone else was working on the same file at the same time? Did you lose your changes to that file because of that? Or ended up with incompatible code?
- ▶ Have you ever saved a file, and then wanted to revert the changes you made? Have you ever wished you could see what a file looked like some time ago?
- ▶ Have you ever found a bug in your project and wanted to know when that bug got into your files?

**If any “Yes”, then use a VC system !**



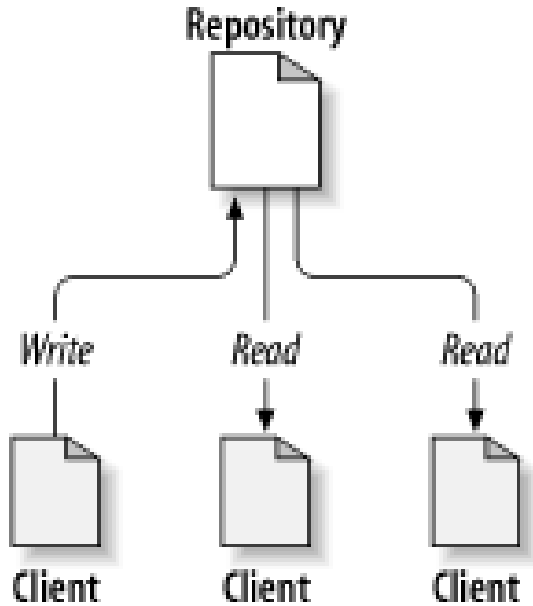
# Program

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# Centralized file management

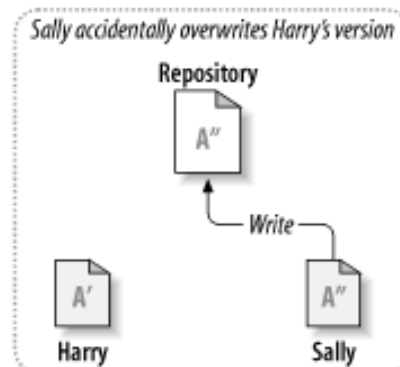
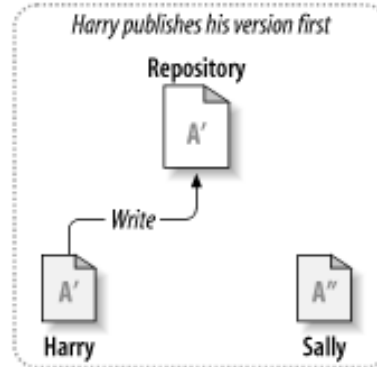
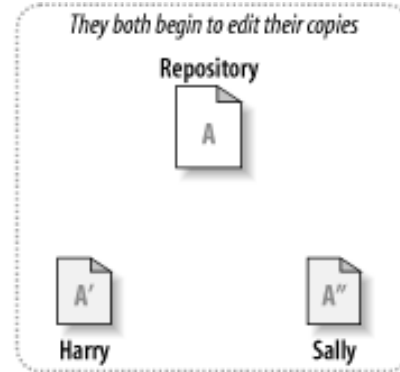
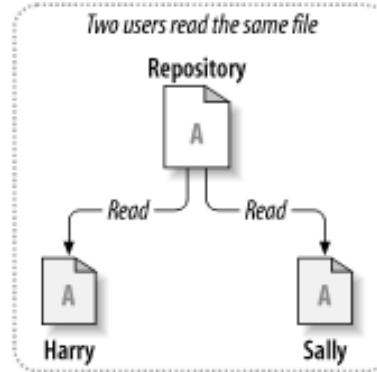
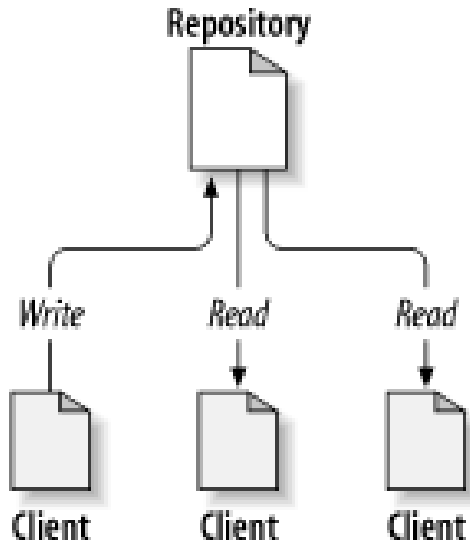


- ▶ One central **repository**, on a **server**.
- ▶ (Stores the files and their history.)
- ▶ Many **clients**, i.e. users, connecting to the repository.
- ▶ Each client has one or more **working copies**, i.e. a local copy of the files, where changes are made



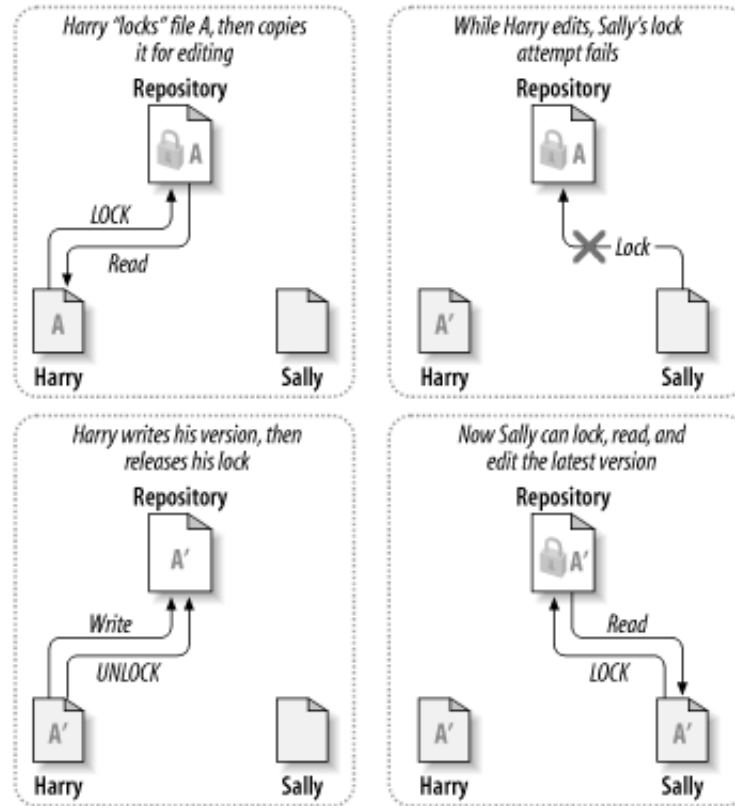
# File sharing & Collaboration Problem

Centralized VC model



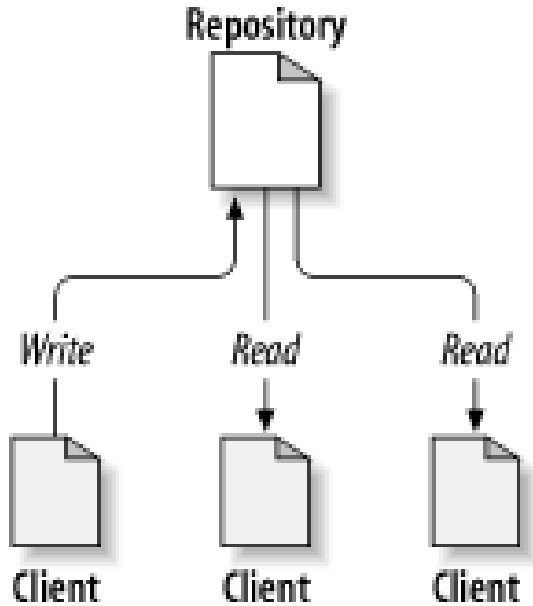


# Locking solution





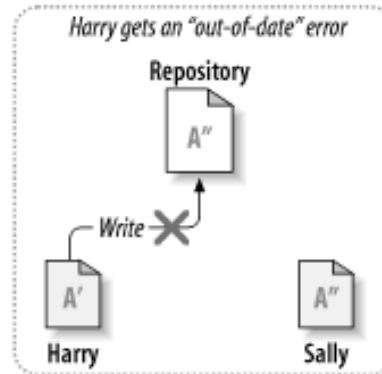
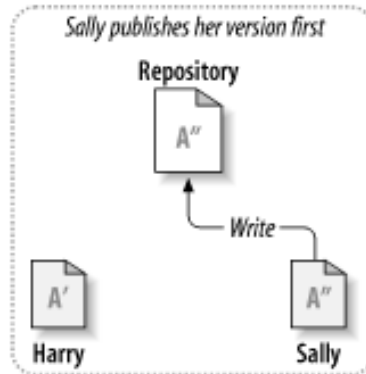
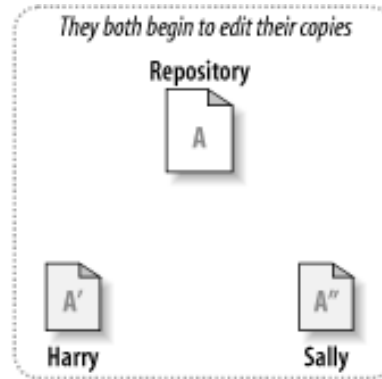
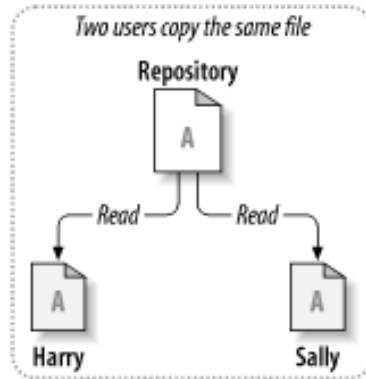
## Centralized VC model



- ▶ One central **repository**, on a server.
- ▶ Stores the **files** and their **history**.
- ▶ Many **clients**, i.e. users connecting to the repo
- ▶ Each client has one or more **working copies**, i.e. a local copy of the files, where changes are made
- ▶ A **revision** identifies a point in time of the repo, it is denoted by a number.

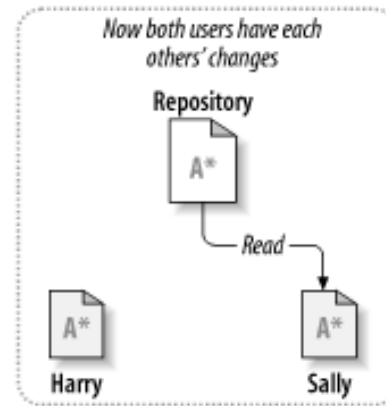
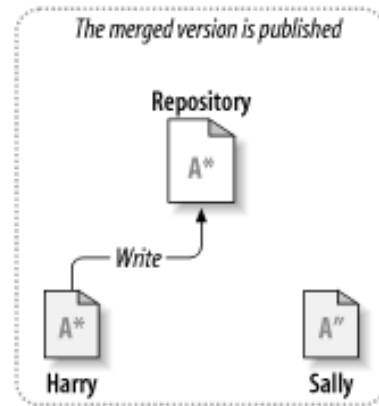
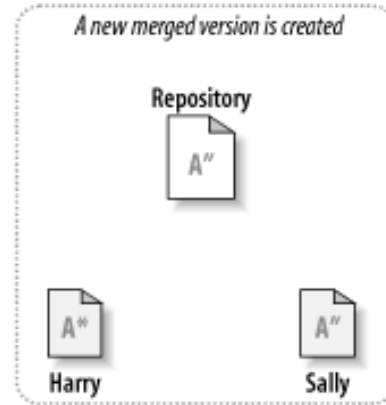
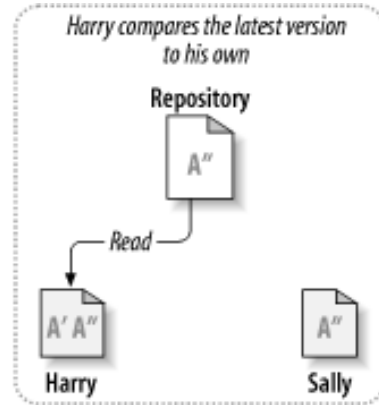


# Copy-Modify-Merge Solution

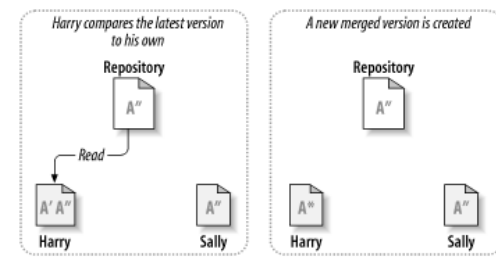




# Copy-Modify-Merge Solution



# File merging & conflicts



When updating files are “updated” automatically.

- ▶ **Merged** files:

all changes, yours & from server, are automatically merged into **your** files (if possible).

→ manual check recommended...

- ▶ **Conflicted** files:

your changes and those on the server are NOT compatible, no automatic merging possible

→ manual intervention necessary! **Your** responsibility.



## Resolving conflicts

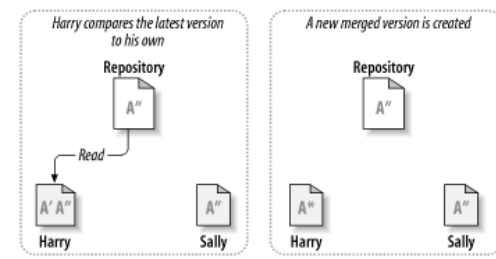
When updating your working copy:

- ▶ If some files have changed *both in the repository and in your working copy*, there can be a **conflict**
- ▶ It is **your responsibility** to fix conflicts, by inspecting the diverging changes and
  - choose your own version, or
  - choose repository version, or
  - choose previous version, or
  - mix both versions



# Binary files...

- ▶ Merging works on text-based files (code/document)
- ▶ With binary files (images, .ppt, .pdf, .doc, .xls, ...)
  - Updating overwrites the file...
  - but previous versions still available in history!
- ▶ Use Markdown (.md), comma-/tab-separated values (.csv/.tsv) or JSON (.json) files instead of Word or Excel files !





## How to...

- ▶ Create repository or get code from repository:
  - check out/clone code, or update code
- ▶ Work on your code/files:
  - bug fixes and/or new features
- ▶ Publish your changes to the repository
  - re-updating and fixing conflicts, if necessary

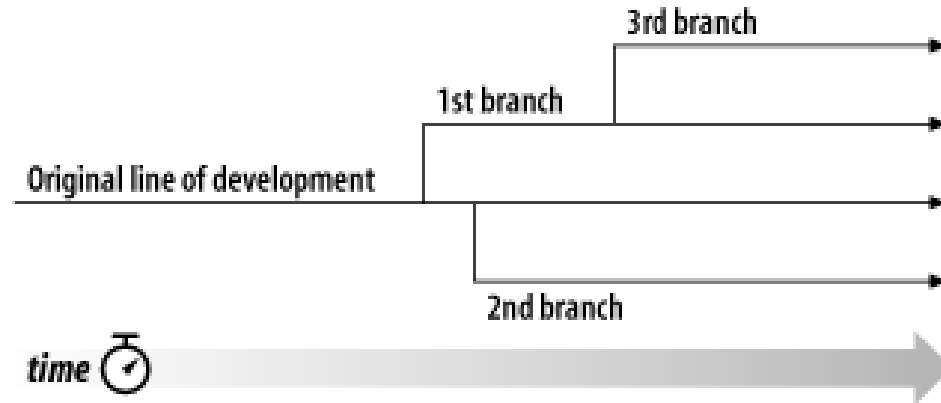
### Note:

- ▶ Split your commits into logical steps
- ▶ Add description!!!



## Code branch

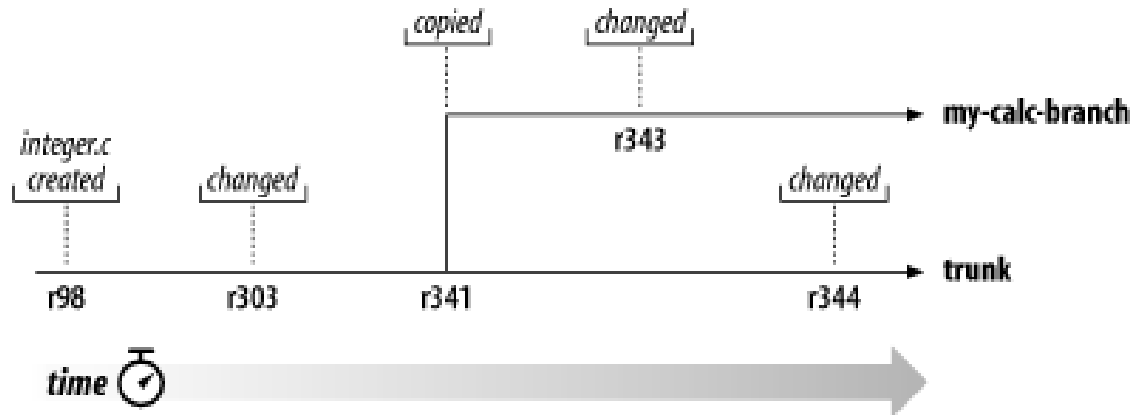
*“...a line of development that exists independently of another line, yet still shares a common history if you look far enough back in time. A branch always begins life as a copy of something, and moves on from there, generating its own history.”*





# Branching

- ▶ Work on a branch as you would on any other folder, e.g. `code_v1`, `code_v2`, ...
- ▶ File histories in branches also stored!





## Branch merging

= synchronizing two branches

- ▶ When developing a branch, you'll want to synch with “main trunk” from time to time (e.g. for bug fixes)
- ▶ When merging, you can encounter conflicts, to be resolved as before
- ▶ If you want to integrate a branch back to “main trunk”, you can merge it back (e.g. adding new features).



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## What is “Git” ?

- ▶ currently the most popular distributed versioning system
- ▶ free open-source software
- ▶ cross-platform (originally for Linux but now also on MacOS and Windows)
- ▶ very efficient, very powerful but can be very complex
- ▶ some GUIs and IDEs plugins
- ▶ no global revision numbers, “hashes” instead
- ▶ created by Linus Torvalds, 1<sup>st</sup> release in 2005



# Git, pro's & con's

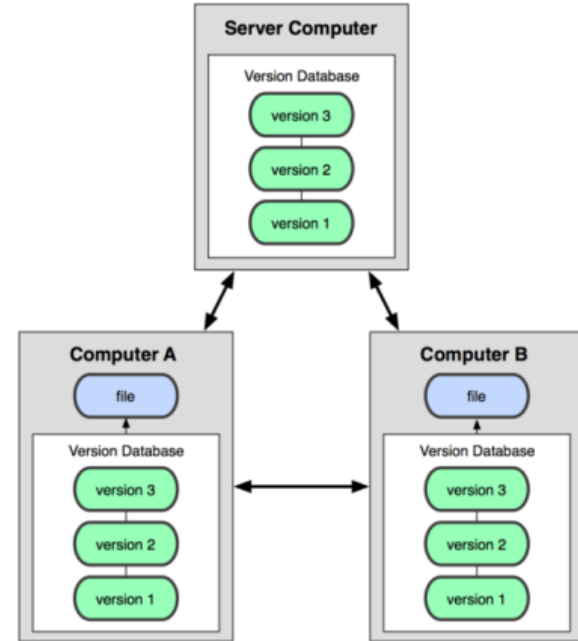
## Pro's

- ▶ Every working copy is a full backup of the data
- ▶ You can work off-line
- ▶ You can do micro-commits
- ▶ Allows private work, eases experimental jump in

## Cons

- ▶ More complex (decentralized → “parallel worlds”)
- ▶ Less control on project evolution
- ▶ Less sharing?

## Decentralized model





# Git Cheat Sheet

## Git Basics

<code>git init &lt;directory&gt;</code>	Create empty Git repo in specified directory. Run with no arguments to initialize the current directory as a git repository.
<code>git clone &lt;repo&gt;</code>	Clone repo located at <repo> onto local machine. Original repo can be located on the local filesystem or on a remote machine via HTTP or SSH.
<code>git config user.name &lt;name&gt;</code>	Define author name to be used for all commits in current repo. Devs commonly use <code>--global</code> flag to set config options for current user.
<code>git add &lt;directory&gt;</code>	Stage all changes in <directory> for the next commit. Replace <directory> with a <file> to change a specific file.
<code>git commit -m "message"</code>	Commit the staged snapshot, but instead of launching a text editor, use <message> as the commit message.
<code>git status</code>	List which files are staged, unstaged, and untracked.
<code>git log</code>	Display the entire commit history using the default format. For customization see additional options.
<code>git diff</code>	Show unstaged changes between your index and working directory.

## Undoing Changes

<code>git revert &lt;commit&gt;</code>	Create new commit that undoes all of the changes made in <commit>, then apply it to the current branch.
<code>git reset &lt;file&gt;</code>	Remove <file> from the staging area, but leave the working directory unchanged. This unstages a file without overwriting any changes.
<code>git clean -n</code>	Shows which files would be removed from working directory. Use the <code>-f</code> flag in place of the <code>-n</code> flag to execute the clean.

## Rewriting Git History

<code>git commit --amend</code>	Replace the last commit with the staged changes and last commit combined. Use with nothing staged to edit the last commit's message.
<code>git rebase &lt;base&gt;</code>	Rebase the current branch onto <base>. <base> can be a commit ID, a branch name, a tag, or a relative reference to HEAD.
<code>git reflog</code>	Show a log of changes to the local repository's HEAD. Add <code>--relative-date</code> flag to show date info or <code>--all</code> to show all refs.

## Git Branches

<code>git branch</code>	List all of the branches in your repo. Add a <branch> argument to create a new branch with the name <branch>.
<code>git checkout -b &lt;branch&gt;</code>	Create and check out a new branch named <branch>. Drop the <code>-b</code> flag to checkout an existing branch.
<code>git merge &lt;branch&gt;</code>	Merge <branch> into the current branch.

## Remote Repositories

<code>git remote add &lt;name&gt; &lt;url&gt;</code>	Create a new connection to a remote repo. After adding a remote, you can use <name> as a shortcut for <url> in other commands.
<code>git fetch &lt;remote&gt; &lt;branch&gt;</code>	Fetches a specific <branch>, from the repo. Leave off <branch> to fetch all remote refs.
<code>git pull &lt;remote&gt;</code>	Fetch the specified remote's copy of current branch and immediately merge it into the local copy.
<code>git push &lt;remote&gt; &lt;branch&gt;</code>	Push the branch to <remote>, along with necessary commits and objects. Creates named branch in the remote repo if it doesn't exist.



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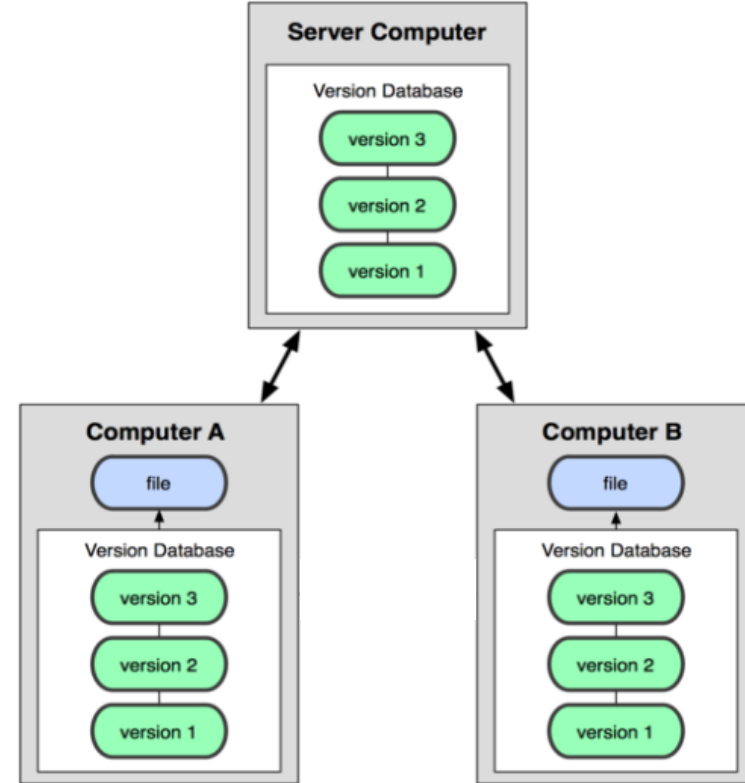


# Git & GitHub/GitLab

- ▶ **Git**
  - “version control system” software
  - language with its commands
- ▶ **GitHub.com** (& GitLab.com)
  - web-based Git repository hosting system
  - servers from a private company
- ▶ **GitLab.uliege.be**
  - web-based Git repository hosting system
  - hosted at ULiège. 😊

<https://github.com>

<https://gitlab.uliege.be/>





## GitHub & GitLab features

- ▶ Code versioning
  - + branching, merging, releases
- ▶ Code documentation and Wiki
  - build knowledge for the team
- ▶ Issue tracking
  - discuss problems & requests in a forum
- ▶ Management
  - access rights, visibility, groups/teams, ...

Cyclotron Research Centre

In vivo imaging with positron emission tomography and magnetic resonance imaging as well as electrophysiology

University of Liège, Belgium | <http://www.giga.ulg.ac.be> | [c.phillips@ulg.ac.be](mailto:c.phillips@ulg.ac.be)

Repositories 78 | People 87 | Teams 56 | Projects 0 | Settings

### Pinned repositories

Customize pinned repositories

- spm\_auto\_reorient**  
A few routines to perform "auto reorient" in SPM  
Matlab 3 stars 1 fork
- BIDS\_tools**  
Tools to create and process BIDS-organized datasets  
Matlab 1 star
- USwithLesion**  
"Unified Segmentation" for brain images showing focal brain lesions.


Search repositories... | Type: All | Language: All | [New](#)

### Sleep

Private

Sleep group codes

Matlab Updated 19 hours ago




### Cofitage

Private

Doc & procedures for Cofitage experiment

Updated 21 hours ago




### pyActigraphy

Private

Package to analyse actigraphy data

python open-source analysis actigraphy actimetry

Python 1 star GPL-3.0 Updated 3 days ago




### MSPProcess\_ELdata

Private

Processing of the MS data (+healthy controls) from EL, all acquired @CyclotronResearchCentre

Matlab GPL-3.0 Updated 7 days ago




### Top languages

- Matlab
- Python
- C++
- Shell
- TeX

### People

87 >



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CyclotronResearchCentre/USwLesion

GitHub, Inc. [US] | https://github.com/CyclotronResearchCentre/USwLesion

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Unified Segmentation for lesioned brain

Manage topics

102 commits 3 branches 0 releases 2 contributors 72.15 MB

Branch: master New pull request

Create new file Upload files Find file Close or download

CPernet get volumes for BRAT Latest commit ebc3485 on 13 Oct 2015

References	Putting references aside	2 years ago
Script_and_batches	Revert "Merge remote-tracking branch 'refs/remotes/origin/MPMExtended..."	2 years ago
validation	get volumes for BRAT	2 years ago
gIgnore	Further modifying the image_overlap function	17 B 2 years ago
ObuseOvu3ip.txt	Revert "Merge remote-tracking branch 'refs/remotes/origin/MPMExtended..."	802 B 2 years ago
README.md	Update text content	4.87 KB 3 years ago
crc_ExtractParam.m	Ensures only seg8.mat files from USwL is selected	7.67 KB 3 years ago
crc_MPMsmooth.m	Bug fix, code cleaning & added feature	4.29 KB 3 years ago
crc_USwL.m	Express min size of lesion in mm3 and not voxels	30.01 KB 3 years ago
crc_USwL_defaults.m	Express min size of lesion in mm3 and not voxels	5.96 KB 3 years ago
crc_USwL_get_defaults.m	Including the defaults in the batch	1.69 KB 3 years ago
crc_USwL_my_defaults.m	Modified defaults	1.06 KB 3 years ago
crc_USwL_with_testing_code.m	Clearing up unnecessary functions.	30.61 KB 3 years ago
crc_check_flag.m	Adding 3D display functions	1.15 KB 3 years ago
crc_disp_3Dlesion.m	Fix typos in help	8.86 KB 2 years ago
crc_disp_results.m	Improved display function	2.4 KB 3 years ago
crc_hist.m	Playing with the MPM values	3.65 KB 3 years ago
crc_lesion_cleanup.m	more flexibility in opt for image overlap	2.16 KB 2 years ago
tbx_cfg_USwLesion.m	Allow the use of the CRC-MPM specific tpm + update empty batch	1.11 KB 3 years ago
tbx_cfg_MPMsmooth.m	Updating the help, copyright, and reference	3.48 KB 3 years ago
tbx_cfg_ParEx.m	Adding some help text	5.78 KB 3 years ago
tbx_cfg_USwL.m	Silly bug fix.	19.08 KB 3 years ago

README.md

## USwLesion

Unified Segmentation with lesions in the brain

The aim is to extend the "unified segmentation" (US, Ashburner et al. 2005) to brain images with lesional tissue. This was originally developed to process multiple sclerosis MR images. We are using the standard structural MRI but also quantitative MR images, aka. multi-parametric maps or MPM. Because we are dealing with VBQ/MPM data we also include the specific smoothing proposed by Draganski et al. 2011

This development should lead to an SPM12 compatible toolbox with a matlabbatch interface.

Here is how the code is organized:

- the matlabbatch configuration files are all the 'tbx\_cfg\_\*.m' and 'tbx\_cfg\_\*.m' files

CyclotronResearchCentre/USwLesion

GitHub, Inc. [US] | https://github.com/CyclotronResearchCentre/USwLesion/tree/StructImage\_notMPM

Manage topics

255 commits 3 branches 0 releases 2 contributors 72.15 MB

Branch: StructImage\_not... View #9

Create new file Upload files Find file Close or download

This branch is 154 commits ahead, 1 commit behind master. Compare

ChristophePhilips Setting options and making sure, they're actually used. Latest commit d878f8a on 3 May

References	Rearranging script/batch/tpm files	2 years ago
Script_and_batches	Rearranging script/batch/tpm files	2 years ago
eTPM	typo	6 months ago
validation	Cosmetic	2 years ago
gIgnore	Improving main fct + batching	24 B a year ago
README.md	Update text content	4.87 KB 3 years ago
crap.m	Adding ICV creation function	920 B a year ago
crc_ExtractParam.m	Parameter extraction	8.03 KB 11 months ago
crc_ExtractParam_MPM.m	Renaming & improvements	13.34 KB 11 months ago
crc_ExtractParam_qMRB.m	Improved parameter extraction	18.6 KB 8 months ago
crc_USwL.m	Removing lesion trimming from main function	39.33 KB 7 months ago
crc_USwL_defaults.m	Adapting defaults and main cfg for new feature	6.83 KB 7 months ago
crc_USwL_get_defaults.m	Including the defaults in the batch	1.69 KB 3 years ago
crc_USwL_my_defaults.m	Updating defaults	1.95 KB 8 months ago
crc_USwL_with_testing_code.m	Clearing up unnecessary functions.	30.61 KB 3 years ago
crc_binarize_seg.m	More flexible binarization	8.79 KB 2 years ago
crc_build_JCVmsk.m	Updating fct call to name change	3.71 KB 8 months ago
crc_check_flag.m	Improved functionality.	1.61 KB 6 months ago
crc_disp_3Dlesion.m	Fix typos in help	8.86 KB 2 years ago
crc_disp_results.m	Improved display function	2.4 KB 3 years ago
crc_fix_JCV.m	Update and rename crc_fix_msk.m to crc_fix_JCV.m	4.86 KB 8 months ago
crc_fix_LesMsk.m	Proper default integration	5.2 KB 7 months ago
crc_fix_MPMIntens.m	Setting options and making sure, they're actually used.	7.85 KB 5 months ago
crc_inhWarp_masks.m	Typo	2.88 KB a year ago
crc_hist.m	Playing with the MPM values	3.65 KB 3 years ago
crc_lesion_cleanup.m	Better help + code improvement	5.56 KB 8 months ago
crc_lesion_volumes.m	Function to extract volumetric info from lesion	1.37 KB 2 years ago
crcowl_MPMsmooth.m	Re-arranging specific smoothing function	3.08 KB a year ago
tbx_cfg_USwLesion.m	Adapting defaults and main cfg for new feature	1.73 KB 7 months ago
tbx_run_USwL.m	Cfg part sorted	1.66 KB 8 months ago
tbx_cfg_MPMsmooth.m	Small fix, select "modulated" warped tissue classes	4.45 KB a year ago
tbx_cfg_ParEx.m	Adding some help text	5.78 KB 3 years ago
tbx_cfg_USwL.m	Cosmetic -> correcting comments	18.7 KB 7 months ago
tbx_cfg_URIs_FdCVmsk.m	Fixing sub-function naming	3.42 KB 8 months ago
tbx_cfg_URIs_FLesMsk.m	Cosmetic changes of sub-function names	4.4 KB 7 months ago
tbx_cfg_URIs_FMPPM.m	Setting options and making sure, they're actually used.	7.25 KB 5 months ago

README.md

## USwLesion



Issues - CyclotronResearchCentre · x

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Filters  Labels Milestones [New issue](#)

8 Open 2 Closed Author Labels Projects Milestones Assignee Sort

- doesn't work without MPMs **bug** #11 opened on 23 Jul by CPermet
- batch output y\* normalization parameter **enhancement** #10 opened on 19 Jun by CPermet
- modulation **enhancement** #8 opened on 26 Jan by CPermet
- crc\_meanHausdorffDist normalization **enhancement** #6 opened on 12 Jul 2016 by CPermet
- Cleanup option from SPM -> remove? **bug** #5 opened on 12 Jun 2016 by ChristophePhillips
- Image matching approaches **enhancement** #3 opened on 31 May 2016 by ChristophePhillips
- Need to improve function 'crc\_USwLm' **enhancement** #2 opened on 18 May 2016 by ChristophePhillips
- options **enhancement** #1 opened on 23 Sep 2015 by CPermet

ProTip! Type  on any issue or pull request to go back to the issue listing page.

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crc\_meanHausdorffDist normal: x

GitHub, Inc. [US] | https://github.com/CyclotronResearchCentre/USwLesion/issues/6

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## 6 crc\_meanHausdorffDist normalization #6

**Open** CPermet opened this issue on 12 Jul 2016 · 3 comments

**Assignees** No one—assign yourself

**Labels** **enhancement**

**Projects** None yet

**Milestone** No milestone

**Notifications** [Unsubscribe](#)  
You're receiving notifications because you commented.

**2 participants**

**Lock conversation**

CPermet commented on 12 Jul 2016

Hey Chris,

could you add a normalization factor? last time I think we agreed on dividing by the total number of voxels from one of the images so that max is 1

cheers

ChristophePhillips added the **enhancement** label on 14 Jul 2016

ChristophePhillips commented on 14 Jul 2016

Thinking of the issue with large values for the Hausdorff distance, it's not that simple. My impression is that when a cluster is missing, then you end up with large H-distance. In other words the H-distance only provides useful information (how well do blob contours match) when there is a match between the blobs. We could condition the H-distance to only matching blobs?

Let me come up with a demo case and some tests. :-)

CPermet commented on 14 Jul 2016

ok not sure I follow here - what I talking about is that between subjects we have comparable values so in the loop I add  
if normalize  
D12 = D12 / max(D12);  
D21 = D21 / max(D21);  
end

ChristophePhillips commented on 15 Jul 2016 · edited

I do not think this is the right way to deal with the very variable H-dist values returned. The distance is expressed in mm, averaged over the contours of the blobs in the pair of images. This thus some "absolute" measure. If it's big, then it means some border was, on average, very far away from a border in the other image. :(

In fact H-dist is only useful when the blobs in both images are matching, like [here](#). On the other hand if the blobs are not overlapping at all, then H-dist doesn't mean much at all, only how far away (on average) the borders of 2 non-overlapping blobs are located which boils down to about the distance between their centre of gravity. See the test with img3 and img3b in [testing\\_imgOverlap.m](#). (Available in the branch [MPMExtendedTPM4](#))

Possible solution:  
Only calculate the H-distance for blobs that are matching across the images. Then the measure would only be interpretable in combination with the cluster TP/FP counts...

ChristophePhillips referenced this issue on 21 Nov 2016

[possible normalization for HD](#) [4480c9a](#)

ChristophePhillips added a commit that referenced this issue on 26 Oct 2017

[updates brain parts masks](#) [03d1592](#)





# Program

- ▶ Why “Version Control” ?
- ▶ Basics of Version Control (VC)
- ▶ Git as a VC solution
- ▶ Being Git practical with GitHub/GitLab
- ▶ **Conclusions & reference**



## “Reasons” not to VC ?

- ▶ “It’s only a small bit of code to try out an idea on my data...”  
→ This how breakthroughs happen and papers follow!
- ▶ “Nobody else will ever be interested in this...”  
→ If you are, someone else will necessarily be!
- ▶ “My code is not ready yet...”  
→ The ULTIMATE reason to actually version your code!

Major hurdle is **psychological** or **carelessness**.



## Some wisdom

*"Writing software as if we are the only person that ever has to comprehend it is one of the biggest mistakes and false assumptions that can be made."*

- Karolina Szczur



## Code Versioning conclusion

- ▶ **Absolutely necessary to manage any project that relies on code, script, batch,...**
- ▶ Useful to keep track of changes, improvements & bug fixes over time
- ▶ Even more so with multiple developers/users
  - start alone → team interest → available to the community
- ▶ Open science → paper + code + data accessible



# References

- ▶ J. D. Blischak et al., *A Quick Introduction to Version Control with Git and GitHub*, PLOS Computational Biology, 12(1): e1004668, 2016  
<http://dx.doi.org/10.1371/journal.pcbi.1004668>
- ▶ [https://en.wikipedia.org/wiki/Version\\_control](https://en.wikipedia.org/wiki/Version_control)
- ▶ <https://en.wikipedia.org/wiki/Git>
- ▶ <https://git-scm.com/docs>
- ▶ <https://services.github.com/on-demand/downloads/github-git-cheat-sheet.pdf>
- ▶ <http://github.com/>
- ▶ <http://gitlab.com>
- ▶ <https://gitlab.uliege.be/>
- ▶ Git GUI: <https://desktop.github.com/> & <https://www.sourcetreeapp.com/>
- ▶ [https://www.campus.uliege.be/cms/c\\_9096862/fr/services-internet-intranet-offerts](https://www.campus.uliege.be/cms/c_9096862/fr/services-internet-intranet-offerts)



Finally

*"Programming is like pinball.  
The reward for doing it is  
the opportunity of doing it again."*

– Unknown

Thank you for your attention!





