Software Engineering for Economists

7. Version Control, Part II: Git with a Shared Repository

Philipp Zahn

Department of Economics, University of St. Gallen

Collaboration

- Science in general (Hand, 2010):

  [...] *half of EU research articles had international co-authors in 2007, more than twice the level of two decades ago.*

- Economics I (Ellison, 2002):

  In the 1970s only 30 percent of the articles in the top five journals were coauthored. In the 1990s about 60 percent were coauthored. In the longer run the trend is even more striking: in 1959 only 3 percent of the articles in the JPE were coauthored.

- Economics II (Card and DellaVigna, 2013):

  [...] *the number of authors per paper* [in one of the top-5 journals] *has increased from 1.3 in 1970 to 2.3 in 2012*

Collaboration

- Need effective means for working with others
- Same issue is to keep multiple machines in sync

Just work on Dropbox?

- Sensitive data
- Simultaneous work

  `Some Paper (Philipp's conflicted copy 2016-10-15).tex`

$\Rightarrow$ **Fully automated synchronisation tools do not scale to complex (=real-world) workflows**

What Git has to add

- A (clear) protocol that supports complex workflows
- (Easy) merging of plain text files

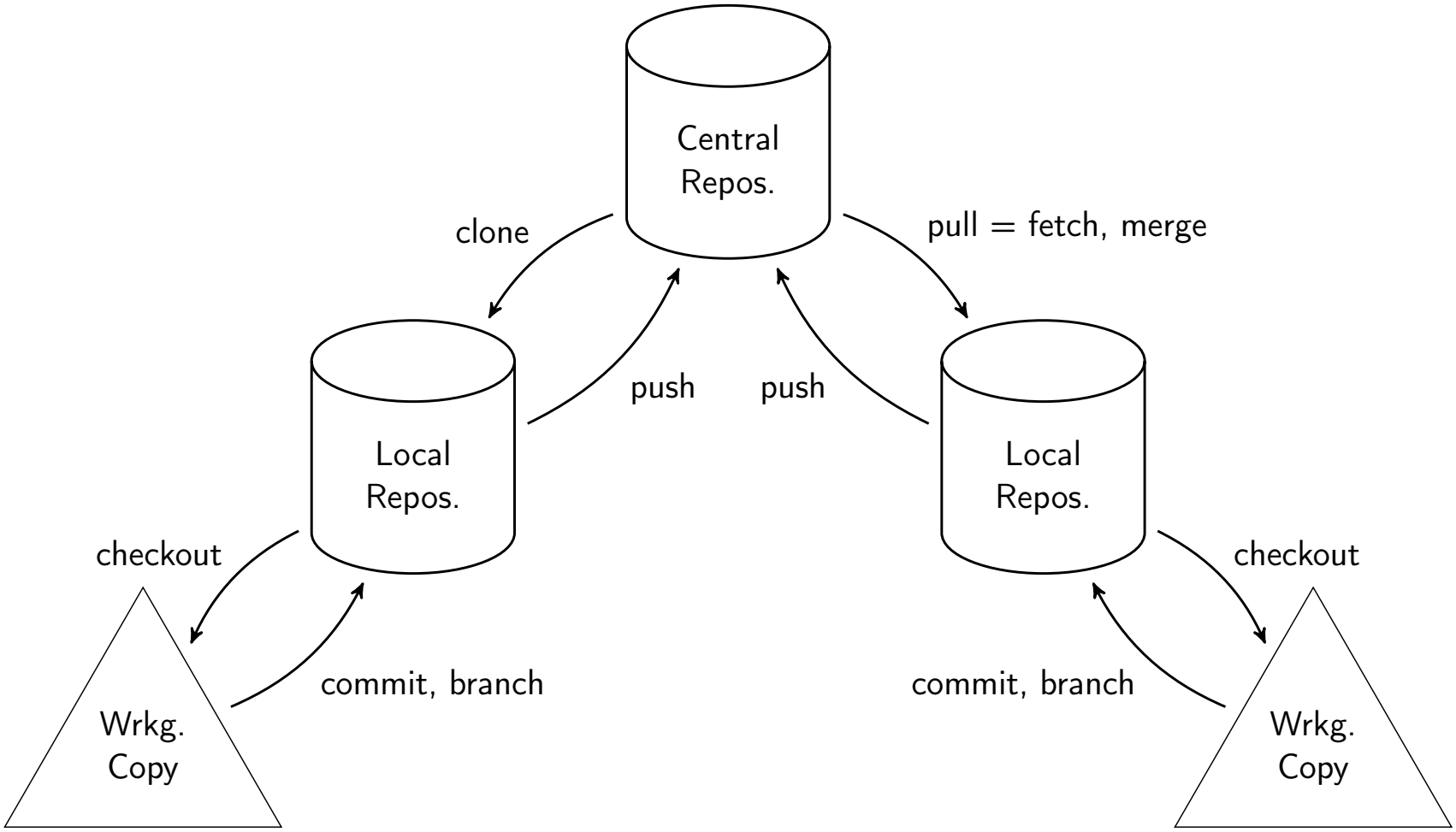
Plan for this lecture

- "Vocabulary" and basic concepts
- Creating a new project on github
- Basic workflow with a central repository
- Dealing with conflicting merges
- Local files unknown to Git that would be overwritten
- Recommended workflow

Github

- Please create a github account
- There are educational accounts
- Use it for your group project
- Add me as a user: *pzahn*
- Github usefull tool for software collaborations

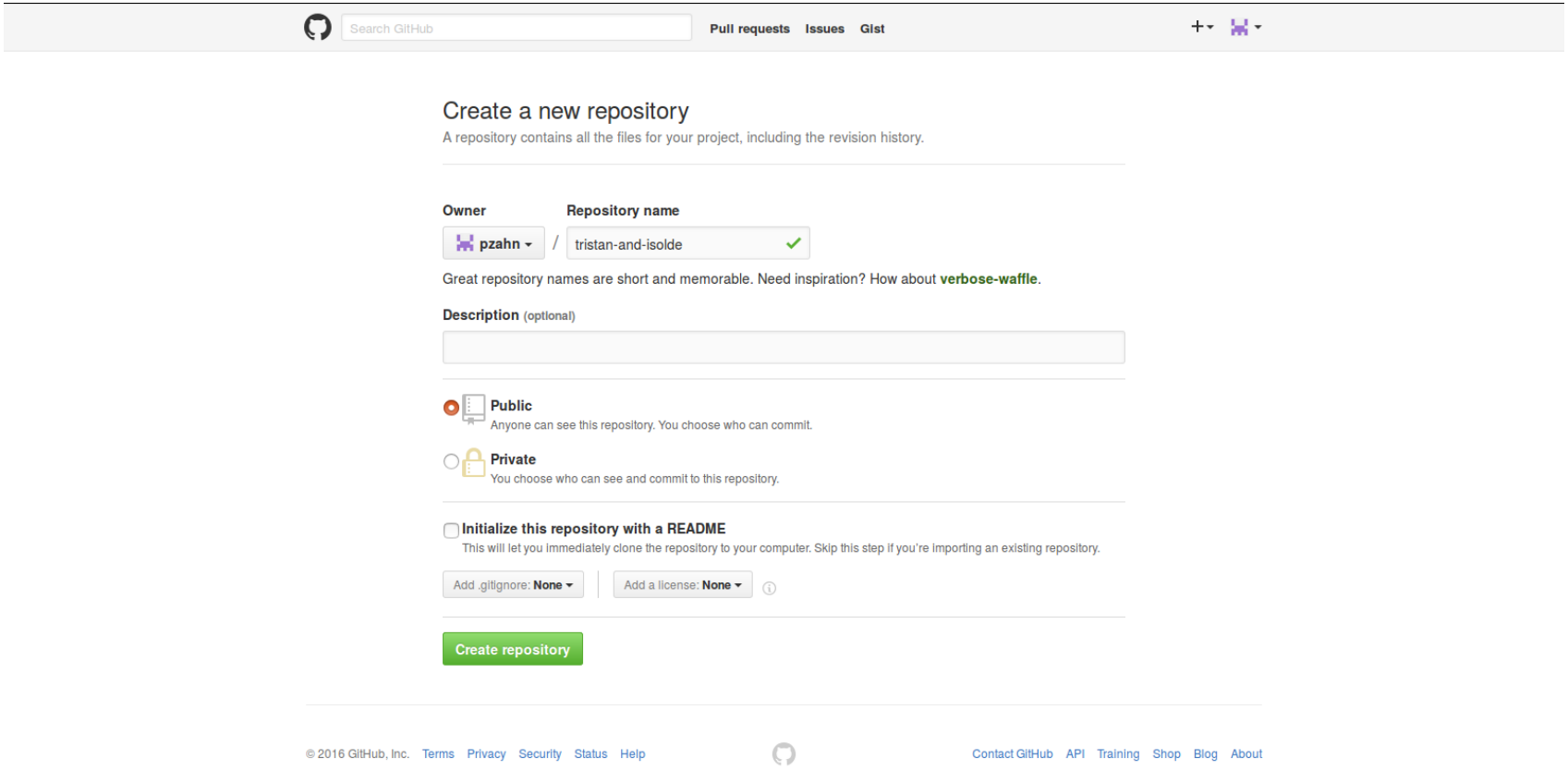
Schematic Git workflow



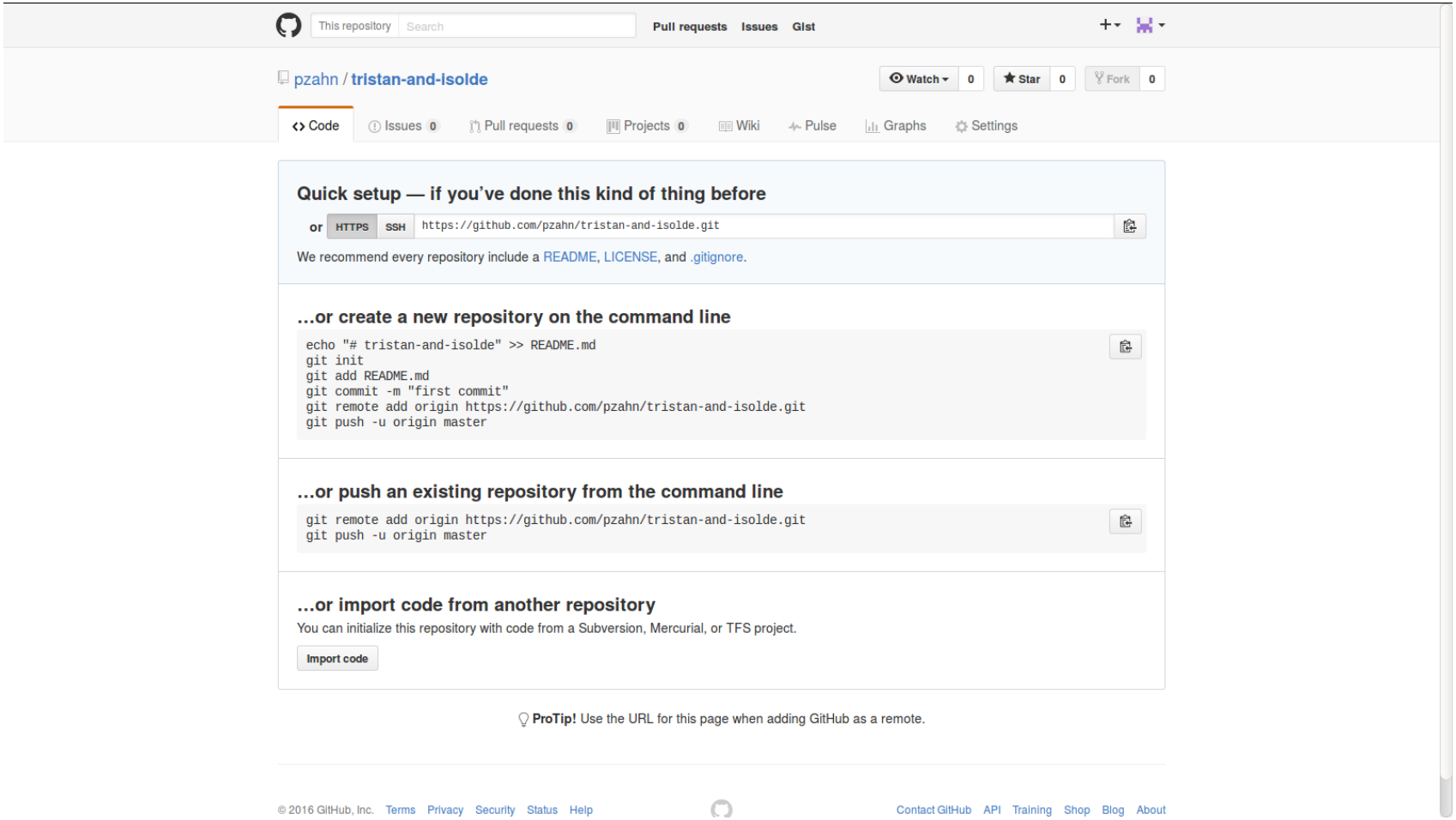
Create a new project on github

- We initate a project on github
- Will see other features later

New project on github



New project on github



Making a local clone of the project

Go to the parent folder of where you want your project to live

```
$ git clone https://github.com/pzahn/tristan-and-isolde.git

Cloning into 'tristan-and-isolde'...
Username for 'https://github.com/pzahn/tristan-and-isolde.git': xxx
Password for 'https://xxx@git.yyy.de':
warning: You appear to have cloned an empty repository.
```

Tristan's heart script

Add a Python script and the `.gitignore` file to the project

Spyder (Python 3.4)

muller/Projects/IAME/test/prog-econ

File explorer

Name

heart.py

Editor - /Users/philippmuller/Projects/IAME/test/prog-econ/heart.py

heart.py

```python
import scipy
import matplotlib.pyplot as plt


def plot_heart():
    fig = plt.figure()

    x = scipy.linspace(-2, 2, 1000)
    y1 = scipy.sqrt(1 - (abs(x) - 1) ** 2)
    y2 = -3 * scipy.sqrt(1 - (abs(x) / 2) ** 0.5)

    plt.fill_between(x, y1, color='red')
    plt.fill_between(x, y2, color='red')
    plt.xlim([-2.5, 2.5])
    plt.text(
        0,
        -0.4,
        '1solde',
        fontsize=24,
        fontweight='bold',
        color='white',
        horizontalalignment='center'
    )

    return fig


if __name__ == '__main__':
    heart_fig = plot_heart()
    heart_fig.show()
```

IPython console

Console 5307/A

```
In [2]:
```

Console | IPython console | History log

Permissions: RW End-of-lines: LF Encoding: ASCII Line: 31 Column: 1 Memory: 93 %

Tristan's local Git preparations

Add the Python script to the index to prepare first commit

```
$ git add heart.py

$ git status

  On branch master

  Initial commit

  Changes to be committed:
    (use "git reset HEAD <file>..." to unstage)

    new file:   heart.py
```

Tristan's local Git preparations

Commit first version to the **local** repository

```
$ git commit -m "First version of heart."

[master (root-commit) 819aec2] First version of heart.
 1 file changed, 30 insertions(+)
 create mode 100644 heart.py

$ git status

  On branch master
nothing to commit, working directory clean
```

First push to the remote repository

Now push the changes made to the local repository to the remote (central) repository

```
$ git push origin master

Username for 'https://github.com/pzahn/tristan-and-isolde.git': tri
Password for 'https://tristan@git.yyy.de':

Counting objects: 4, done.
Delta compression using up to 2 threads.
Compressing objects: 100% (4/4), done.
Writing objects: 100% (4/4), 631 bytes | 0 bytes/s, done.
Total 4 (delta 0), reused 0 (delta 0)
To https://github.com/pzahn/tristan-and-isolde.git/tristan-and-isol
 * [new branch]      master -> master
```

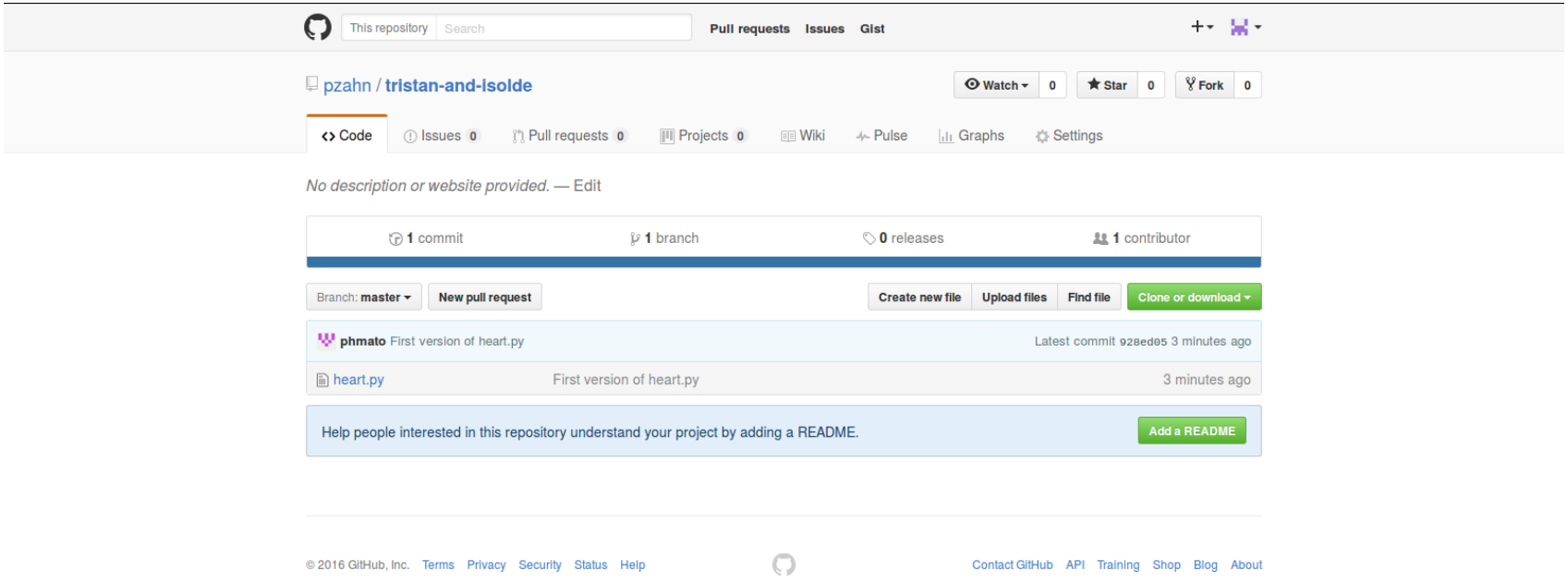
First push to the remote repository

Next, have a look at:

`http://git-scm.com/docs/git-credential-store`

Automate, automate, automate!

Isolde finds the code online



Isolde clones the repository

Assume Isolde changed to the folder of her workspace on the command line. There, she clones the project from the **remote** repository

```
$ git clone https://github.com/pzahn/tristan-and-isolde.git/tristan-and
```

```
Cloning into 'tristan-and-isolde'...
Username for 'https://github.com/pzahn/tristan-and-isolde.git': isolde
Password for 'https://isolde@git.yyy.de':
fatal: unable to access 'https://github.com/pzahn/tristan-and-isolde.gi
The requested URL returned error: 500
```

Wrong credentials are the No. 1 cause of 500 errors.

Isolde clones the repository

Make sure to enter the username and password correctly

```
$ git clone https://github.com/pzahn/tristan-and-isolde.git/tristan

Cloning into 'tristan-and-isolde'...
Username for 'https://github.com/pzahn/tristan-and-isolde.git': iso
Password for 'https://isolde@git.yyy.de':
remote: Counting objects: 4, done.
remote: Compressing objects: 100% (4/4), done.
remote: Total 4 (delta 0), reused 0 (delta 0)
Unpacking objects: 100% (4/4), done.
Checking connectivity... done
```

Isolde changes the code

Spyder (Python 3.4)

muller/Projects/IAME/test/prog-econ

File explorer

Name

heart.py

Editor - /Users/philippmuller/Projects/IAME/test/prog-econ/heart.py

heart.py

```python
import scipy
import matplotlib.pyplot as plt


def plot_heart():
    fig = plt.figure()

    x = scipy.linspace(-2, 2, 1000)
    y1 = scipy.sqrt(1 - (abs(x) - 1) ** 2)
    y2 = -3 * scipy.sqrt(1 - (abs(x) / 2) ** 0.5)

    plt.fill_between(x, y1, color='red')
    plt.fill_between(x, y2, color='red')
    plt.xlim([-2.5, 2.5])
    plt.text(
        0,
        -1.2,
        'Tristan\n&\nIsolde',
        fontsize=24,
        fontweight='bold',
        color='white',
        horizontalalignment='center'
    )

    return fig


if __name__ == '__main__':
    heart_fig = plot_heart()
    heart_fig.show()
```

IPython console

Console 5307/A

```
In [2]:
```

Console | IPython console | History log

Permissions: RW End-of-lines: LF Encoding: ASCII Line: 31 Column: 1 Memory: 93 %

She is happy, commits, and pushes

Add Python file to the index and commit

```
$ git add heart.py

$ git status

  On branch master
  Changes to be committed:
    (use "git reset HEAD <file>..." to unstage)

    modified:   heart.py

$ git commit -m "Included Tristan in the heart's message."
[master 10737a6] Included Tristan in the heart's message.
 1 file changed, 2 insertions(+), 2 deletions(-)
```

She is happy, commits, and pushes

```
$ git push origin master

Username for 'https://github.com/pzahn/tristan-and-isolde.git': iso
Password for 'https://isolde@git.yyy.de':
Counting objects: 5, done.
Delta compression using up to 2 threads.
Compressing objects: 100% (2/2), done.
Writing objects: 100% (3/3), 325 bytes | 0 bytes/s, done.
Total 3 (delta 1), reused 0 (delta 0)
To https://github.com/pzahn/tristan-and-isolde.git/tristan-and-isol
   819aec2..ba7e4bb  master -> master
```

At the same time . . .

At the same time . . .

Spyder (Python 3.4)

File explorer

Name

heart.py

Editor - /Users/philippmuller/Projects/IAME/test/prog-econ/heart.py

heart.py

```python
import scipy
import matplotlib.pyplot as plt


def plot_heart():
    fig = plt.figure()

    x = scipy.linspace(-2, 2, 1000)
    y1 = scipy.sqrt(1 - (abs(x) - 1) ** 2)
    y2 = -3 * scipy.sqrt(1 - (abs(x) / 2) ** 0.5)

    plt.fill_between(x, y1, color='red')
    plt.fill_between(x, y2, color='red')
    plt.xlim([-2.5, 2.5])
    plt.text(
        0,
        -0.4,
        'Isolde',
        fontsize=24,
        fontweight='bold',
        color='white',
        horizontalalignment='center'
    )

    return fig


if __name__ == '__main__':
    heart_fig = plot_heart()
    heart_fig.show()
```

IPython console

Console 5307/A

```
In [4]:
```

Console | IPython console | History log

Permissions: RW End-of-lines: LF Encoding: ASCII Line: 31 Column: 1 Memory: 93 %

At the same time . . .

He commits again and intends to push . . .

```
$ git add heart.py

$ git commit -m "Fixed typo."
[master 466dfba] Fixed typo.
 1 file changed, 1 insertion(+), 1 deletion(-)
```

What has happened?

. . . but there is an error message on the command line

```
$ git push origin master

Username for 'https://github.com/pzahn/tristan-and-isolde.git': tristan
Password for 'https://tristan@git.yyy.de':
To https://github.com/pzahn/tristan-and-isolde.git/tristan-and-isolde.g
 ! [rejected]        master -> master (fetch first)
error: failed to push some refs to
'https://github.com/pzahn/tristan-and-isolde.git/tristan-and-isolde.git

Updates were rejected because the remote contains work that you do
not have locally. This is usually caused by another repository pushing
to the same ref. You may want to first merge the remote changes (e.g.,
'git pull') before pushing again.
See the 'Note about fast-forwards' in 'git push --help' for details.
```

What has happened?

Translation

This error can be a bit overwhelming at first, do not fear. **Simply put, git cannot make the change on the remote without losing commits, so it refuses the push.** Usually this is caused by another user pushing to the same branch. You can remedy this by fetching and merging the remote branch, or using git pull to perform both at once.

origin/master

Included Tristan in ...

c36927205

origin/master

First version of heart.

b53eb951

tristan/master

Fixed a typo.

b442e769

isolde/master

Included Tristan in ...

c36927205

tristan/master

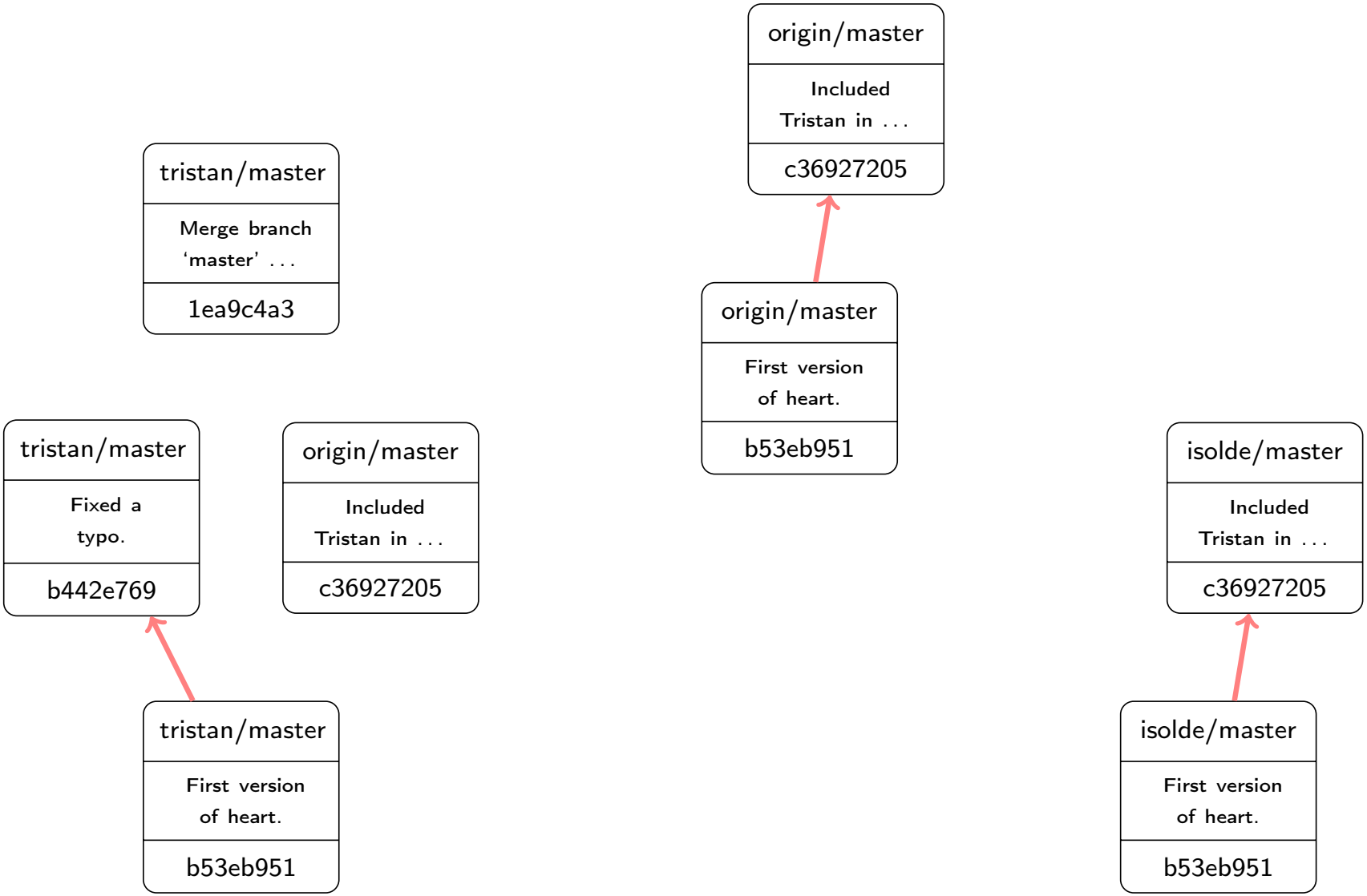
First version of heart.

b53eb951

isolde/master

First version of heart.

b53eb951


origin/master
Included Tristan in ...
c36927205
tristan/master
Merge branch 'master' ...
1ea9c4a3
origin/master
First version of heart.
b53eb951
tristan/master
Fixed a typo.
b442e769
origin/master
Included Tristan in ...
c36927205
isolde/master
Included Tristan in ...
c36927205
tristan/master
First version of heart.
b53eb951
isolde/master
First version of heart.
b53eb951

Tristan configures and pulls the remote

The pull is essentially a fetch followed by a merge.

However, there are conflicts

```
$ git pull origin master

Username for 'https://github.com/pzahn/tristan-and-isolde.git': tris
Password for 'https://tristan@git.yyy.de':

From https://github.com/pzahn/tristan-and-isolde.git/tristan-and-iso
 * branch            master     -> FETCH_HEAD
Auto-merging heart.py
CONFLICT (content): Merge conflict in heart.py
Automatic merge failed; fix conflicts and then commit the result.
```

Tristan solves merge conflicts

Spyder (Python 3.4)

muller/Projects/IAME/test/prog-econ

File explorer

Name	Size
heart.py	640

Editor - /Users/philippmuller/Projects/IAME/test/prog-econ/heart.py

heart.py*

```
def plot_heart():
    fig = plt.figure()

    x = scipy.linspace(-2, 2, 1000)
    y1 = scipy.sqrt(1 - (abs(x) - 1) ** 2)
    y2 = -3 * scipy.sqrt(1 - (abs(x) / 2) ** 0.5)

    plt.fill_between(x, y1, color='red')
    plt.fill_between(x, y2, color='red')
    plt.xlim([-2.5, 2.5])
    plt.text(
        0,

        <<<<<<< HEAD
        -0.4,
        =======
        -1.2,
        >>>>>>> master

        <<<<<<< HEAD
        'Isolde',
        =======
        'Tristan\n&\nIsolde',
        >>>>>>> master

        fontsize=24,
        fontweight='bold',
        color='white',
        horizontalalignment='center'
    )

    return fig


if __name__ == '__main__':
    heart_fig = plot_heart()
    heart_fig.show()
```

IPython console

Console 5307/A

```
In [8]:
```

Console | IPython console | History log

Permissions: RW End-of-lines: LF Encoding: ASCII Line: 42 Column: 1 Memory: 92 %

Tristan solves merge conflicts

Spyder (Python 3.4)

muller/Projects/IAME/test/prog-econ

File explorer

Name

heart.py

Editor - /Users/philippmuller/Projects/IAME/test/prog-econ/heart.py

heart.py

```python
import scipy
import matplotlib.pyplot as plt


def plot_heart():
    fig = plt.figure()

    x = scipy.linspace(-2, 2, 1000)
    y1 = scipy.sqrt(1 - (abs(x) - 1) ** 2)
    y2 = -3 * scipy.sqrt(1 - (abs(x) / 2) ** 0.5)

    plt.fill_between(x, y1, color='red')
    plt.fill_between(x, y2, color='red')
    plt.xlim([-2.5, 2.5])
    plt.text(
        0,
        -1.2,
        'Tristan\n&\nIsolde',
        fontsize=24,
        fontweight='bold',
        color='white',
        horizontalalignment='center'
    )

    return fig


if __name__ == '__main__':
    heart_fig = plot_heart()
    heart_fig.show()

```

IPython console

Console 5307/A

```
In [6]:
```

Console | IPython console | History log

Permissions: RW End-of-lines: LF Encoding: ASCII Line: 11 Column: 1 Memory: 93 %

Tools to resolve conflicts

- Different editors come with different support tools to make resolving conflicts easier
- Vim: vimdiff
- Sublime: Git Conflict Editor

Git Conflict Resolver (Sublime Text Editor)

Git Conflict Resolver ships with five commands: `"Find Next Conflict"`, `"Keep Ours"`, `"Keep Theirs"`, `"Keep Common Ancestor"` and `"Show Conflict Files"`.

Git Conflict Resolver (Sublime Text Editor)

Say we encounter a merge conflict

heart.py — tristan-and-isolde UNREGISTERED

FOLDERS
- tristan-and-isolde
  - .gitignore
  - heart.pdf
  - heart.py
  - LICENSE
  - README.md

heart.py

```
1  import scipy
2  import matplotlib.pyplot as plt
3
4
5  def plot_heart():
6      fig = plt.figure()
7
8      x = scipy.linspace(-2, 2, 1000)
9      y1 = scipy.sqrt(1 - (abs(x) - 1) ** 2)
10     y2 = -3 * scipy.sqrt(1 - (abs(x) / 2) ** 0.5)
11
12     plt.fill_between(x, y1, color='red')
13     plt.fill_between(x, y2, color='red')
14     plt.xlim([-2.5, 2.5])
15     plt.text(
16         0,
17         -1.2,
18 <<<<<<< HEAD
19         '1solde',
20 =======
21         'Isold3',
22 >>>>>>> dev
23         fontsize=24,
24         fontweight='bold',
25         color='white',
26         horizontalalignment='center'
27     )
28
29     return fig
30
31 # some changes
32 if __name__ == '__main__':
33     heart_fig = plot_heart()
34     heart_fig.show()
35     heart_fig.savefig('heart.pdf')
```

Line 10, Column 23 Spaces: 4 Python

Git Conflict Resolver (Sublime Text Editor)

We can invoke the plugin to choose from standardized options

heart.py — tristan-and-isolde

UNREGISTERED

FOLDERS

- tristan-and-isolde
  - .gitignore
  - heart.pdf
  - heart.py
  - LICENSE
  - README.md

heart.py

```
1  import scipy
2  import matplotlib.pyplot as pl
3
4
5  def plot_heart():
6      fig = plt.figure()
7
8      x = scipy.linspace(-2, 2,
9      y1 = scipy.sqrt(1 - (abs(x
10     y2 = -3 * scipy.sqrt(1 - (abs(x) / 2) ** 0.5)
11
12     plt.fill_between(x, y1, color='red')
13     plt.fill_between(x, y2, color='red')
14     plt.xlim([-2.5, 2.5])
15     plt.text(
16         0,
17         -1.2,
18 <<<<<<< HEAD
19         '1solde',
20 =======
21         'Isold3',
22 >>>>>>> dev
23         fontsize=24,
24         fontweight='bold',
25         color='white',
26         horizontalalignment='center'
27     )
28
29     return fig
30
31 # some changes
32 if __name__ == '__main__':
33     heart_fig = plot_heart()
34     heart_fig.show()
35     heart_fig.savefig('heart.pdf')
```

resol

- Git Conflict **Resol**ver: Keep Ours
- Git Conflict **Resol**ver: Keep Theirs
- Git Conflict **Resol**ver: Find Next Conflict
- Git Conflict **Resol**ver: Keep Common Ancestor
- Git Conflict **Resol**ver: Show Conflict Files
- **Preferences**: Package Control Settings – Default
- **Preferences**: Package Control Settings – User

Line 10, Column 23 | Spaces: 4 | Python

Git Conflict Resolver (Sublime Text Editor)

Sublime will then adjust our code accordingly

heart.py — tristan-and-isolde

UNREGISTERED

FOLDERS

- tristan-and-isolde
  - .gitignore
  - heart.pdf
  - heart.py
  - LICENSE
  - README.md

heart.py

```python
import scipy
import matplotlib.pyplot as plt


def plot_heart():
    fig = plt.figure()

    x = scipy.linspace(-2, 2, 1000)
    y1 = scipy.sqrt(1 - (abs(x) - 1) ** 2)
    y2 = -3 * scipy.sqrt(1 - (abs(x) / 2) ** 0.5)

    plt.fill_between(x, y1, color='red')
    plt.fill_between(x, y2, color='red')
    plt.xlim([-2.5, 2.5])
    plt.text(
        0,
        -1.2,
        '1solde',
        fontsize=24,
        fontweight='bold',
        color='white',
        horizontalalignment='center'
    )

    return fig

# some changes
if __name__ == '__main__':
    heart_fig = plot_heart()
    heart_fig.show()
    heart_fig.savefig('heart.pdf')
```

Line 10, Column 23 Spaces: 4 Python

Commit the merged file

Check the current status and add the modified file

```
$ git status

  On branch master
  You have unmerged paths.
    (fix conflicts and run "git commit")

  Unmerged paths:
    (use "git add <file>..." to mark resolution)

    both modified:      heart.py

no changes added to commit
(use "git add" and/or "git commit -a")

$ git add heart.py
```

Commit the merged file

Commit by using the default commit message after a merge

```
$ git commit

[master 3842604] Merge branch 'master' of
https://github.com/pzahn/tristan-and-isolde.git/tristan-and-isolde

$ git log

commit 38426040e4843a690b54287dc4f2f9f12424391c
Merge: 466dfba ba7e4bb
Author: Hans-Martin v. Gaudecker <hmgaudecker@uni-bonn.de>
Date:   Thu Oct 24 14:07:29 2013 +0200

    Merge branch 'master' of https://github.com/pzahn/tristan-and-isol

    Conflicts:
        heart.py
```

The standard case

- Explicitly distinguishing between the **fetch** and **merge** steps in a **pull** is seldom necessary
- Git will quietly do a **fast-forward** or **recursive** merge
  - No changes at all in your repository and working copy
  - Non-conflicting changes in your repository and working copy (different files or separate chunks of the same file affected in the two branches)
- Need to watch out for some weird cases
  - Add the same function at the top and at the bottom of a Python script and wonder why the first one never gets called...

Existing files would be overwritten by a pull

Tristan adjusts his code so `heart.pdf` is created

Spyder (Python 3.4)

muller/Projects/IAME/test/prog-econ

File explorer

Name	Size
heart.py	640

Editor - /Users/philippmuller/Projects/IAME/test/prog-econ/heart.py

heart.py

```python
import scipy
import matplotlib.pyplot as plt


def plot_heart():
    fig = plt.figure()

    x = scipy.linspace(-2, 2, 1000)
    y1 = scipy.sqrt(1 - (abs(x) - 1) ** 2)
    y2 = -3 * scipy.sqrt(1 - (abs(x) / 2) ** 0.5)

    plt.fill_between(x, y1, color='red')
    plt.fill_between(x, y2, color='red')
    plt.xlim([-2.5, 2.5])
    plt.text(
        0,
        -1.2,
        'Tristan\n&\nIsolde',
        fontsize=24,
        fontweight='bold',
        color='white',
        horizontalalignment='center'
    )

    return fig


if __name__ == '__main__':
    heart_fig = plot_heart()
    heart_fig.show()
    heart_fig.savefig('heart.pdf')
```

IPython console

Console 5307/A

```
In [8]:
```

Console | IPython console | History log

Permissions: RW End-of-lines: LF Encoding: ASCII Line: 19 Column: 21 Memory: 93 %

Existing files would be overwritten by a pull

He adds `heart.pdf` (Note: we need the force switch here), commits and . . .

```
$ ls

heart.pdf   heart.py

$ git add heart.pdf -f

$ git commit -m "Added the heart itself to Git. Bad idea..."

[master aeeac81] Added the heart itself to Git. Bad idea...
 1 file changed, 0 insertions(+), 0 deletions(-)
 create mode 100644 heart.pdf
```

Existing files would be overwritten by a pull

. . . pushes

```
$ git push origin master

Username for 'https://github.com/pzahn/tristan-and-isolde.git': trista
Password for 'https://tristan@git.yyy.de':

Counting objects: 13, done.
Delta compression using up to 2 threads.
Compressing objects: 100% (7/7), done.
Writing objects: 100% (9/9), 37.62 KiB | 0 bytes/s, done.
Total 9 (delta 2), reused 0 (delta 0)
To https://github.com/pzahn/tristan-and-isolde.git/tristan-and-isolde.
   ba7e4bb..aeeac81  master -> master
```

Existing files would be overwritten by a pull

Isolde also created `heart.pdf`, not added to index or committed

Spyder (Python 3.4)

File explorer

Name | Size

heart.py 640

Editor - /Users/philippmuller/Projects/IAME/test/prog-econ/heart.py

heart.py

```python
import scipy
import matplotlib.pyplot as plt


def plot_heart():
    fig = plt.figure()

    x = scipy.linspace(-2, 2, 1000)
    y1 = scipy.sqrt(1 - (abs(x) - 1) ** 2)
    y2 = -3 * scipy.sqrt(1 - (abs(x) / 2) ** 0.5)

    plt.fill_between(x, y1, color='red')
    plt.fill_between(x, y2, color='red')
    plt.xlim([-2.5, 2.5])
    plt.text(
        0,
        -1.2,
        'tristan\\&\\isolde',
        fontsize=24,
        fontweight='bold',
        color='white',
        horizontalalignment='center'
    )

    return fig


if __name__ == '__main__':
    heart_fig = plot_heart()
    heart_fig.show()
    heart_fig.savefig('heart.pdf')
```

IPython console

Console 5307/A

```
In [8]:
```

Console | IPython console | History log

Permissions: RW End-of-lines: LF Encoding: ASCII Line: 19 Column: 21 Memory: 93 %

Existing files would be overwritten by a pull

- Tristan's push happend before
- Thus, while Isolde was making her changes, the **remote** repository on the Server changed

Existing files would be overwritten by a pull

Isolde pulls from the **remote** repository and runs intro trouble

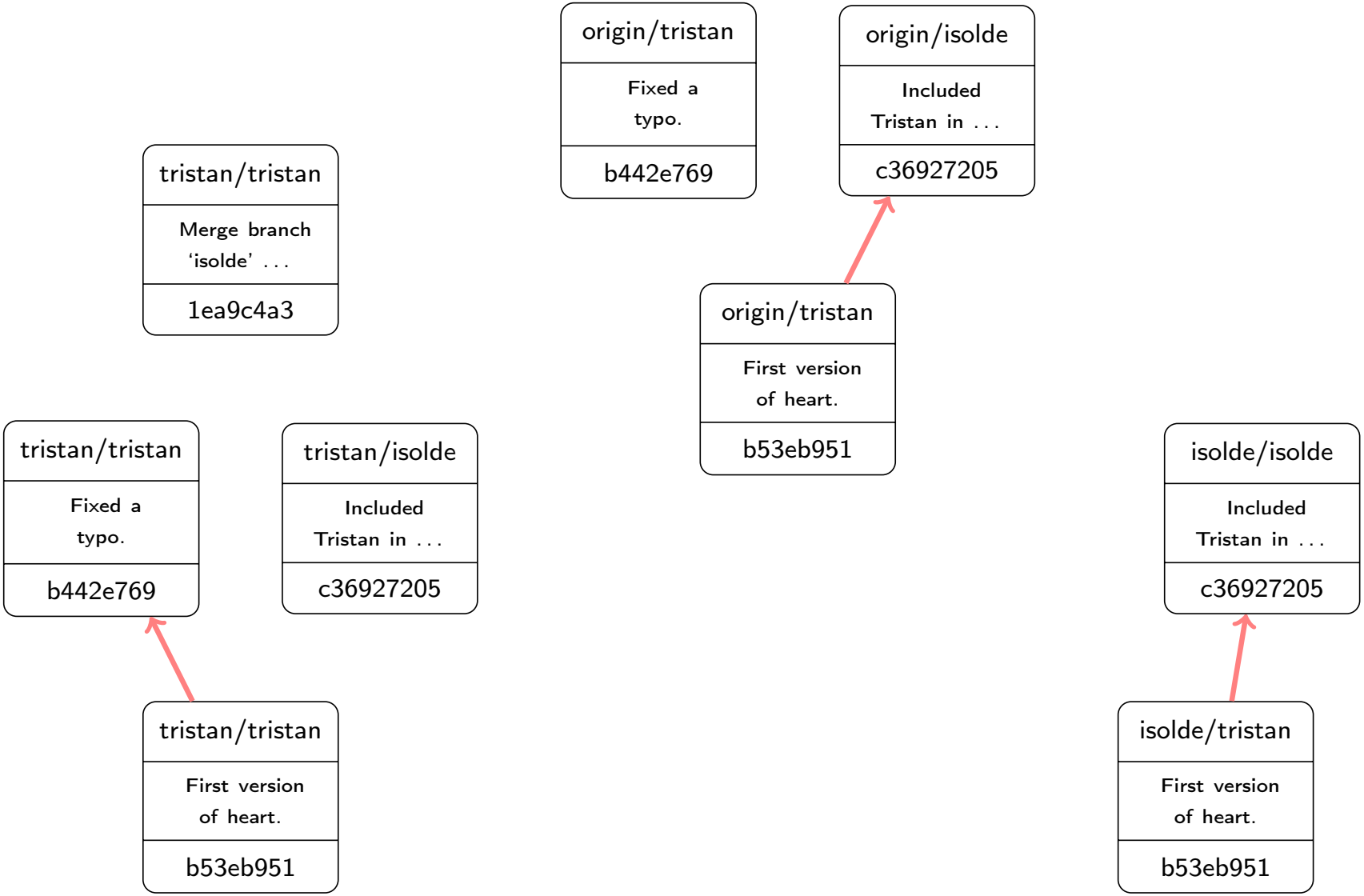
```
$ git pull origin master

Username for 'https://github.com/pzahn/tristan-and-isolde.git': isolde
Password for 'https://isolde@git.yyy.de':

remote: Counting objects: 13, done.
remote: Compressing objects: 100% (7/7), done.
remote: Total 9 (delta 2), reused 0 (delta 0)
Unpacking objects: 100% (9/9), done.
From https://github.com/pzahn/tristan-and-isolde.git/tristan-and-isolde
 * branch            master     -> FETCH_HEAD
Updating ba7e4bb..aeeac81

error: The following untracked working tree files would be
overwritten by merge:
    heart.pdf
Please move or remove them before you can merge.
Aborting
```

Existing files would be overwritten by a pull

This issue can be overcome by moving the file or deleting it beforehand

Recommended workflow in teams

- Everybody has his or her own branch
- Frequent merges
- Potentially a master branch where only universally accepted changes enter
- Benefits:
  - Freedom to merge only when it is convenient
  - You can always push your changes upstream
  - No "murky" `FETCH_HEAD`'s etc.


origin/tristan
Fixed a typo.
b442e769
origin/isolde
Included Tristan in ...
c36927205
tristan/tristan
Merge branch 'isolde' ...
1ea9c4a3
origin/tristan
First version of heart.
b53eb951
tristan/tristan
Fixed a typo.
b442e769
tristan/isolde
Included Tristan in ...
c36927205
isolde/isolde
Included Tristan in ...
c36927205
tristan/tristan
First version of heart.
b53eb951
isolde/tristan
First version of heart.
b53eb951

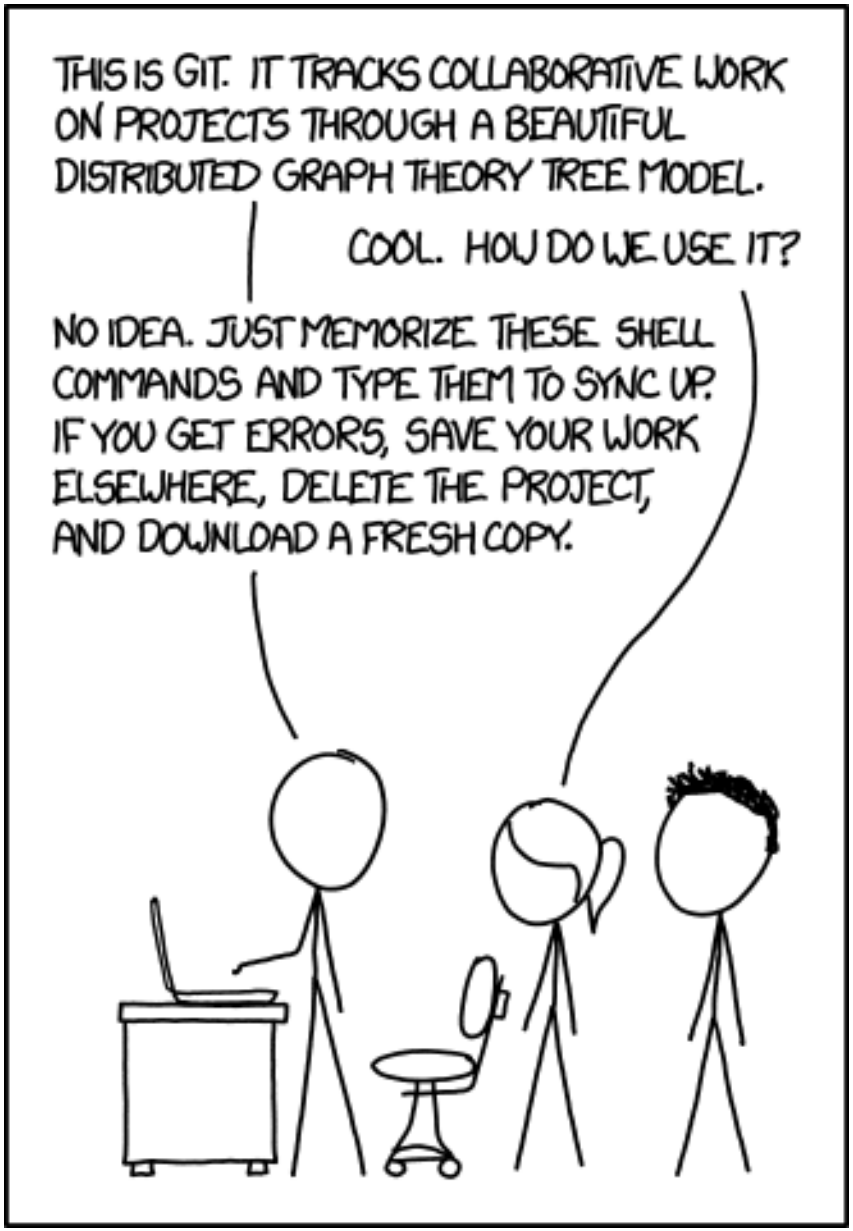
Recommended workflow in teams

- If you encounter merge conflicts frequently, it is a sign that something is wrong with the workflow in your project
  - Not talking to co-authors as often as you should?
  - Responsibilities not clearly assigned?
- Git helps you detect this

Wrapping up

- Git provides powerful tools for teams' workflows
- Scales up all the way from single developers to Linux kernel development
- It sure is not for the faint of heart
- But what we have seen should get you started
  - Don't be afraid to play around
  - Not much can go wrong if you push to the central repository frequently
- Ask questions in the forum on the server

The easy way out . . .



Acknowledgements

- This course is based on the course `Effective Programming Practices for Economists` designed by `Hans-Martin von Gaudecker` for economists.
- The material has been adapted and shortened. Remaining errors are mine.