PyDriller Documentation

Release 1.0

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CHAPTER 1

Overview / Install

PyDriller is a Python framework that helps developers on mining software repositories. With PyDriller you can easily extract information from any Git repository, such as commits, developers, modifications, diffs, and source codes, and quickly export CSV files.

1.1 Requirements

- Python 3.4 or newer
- Git

1.2 Installing PyDriller

Installing PyDriller is easily done using pip. Assuming it is installed, just run the following from the command-line:

```
# pip install pydriller
```

This command will download the latest version of GitPython from the Python Package Index and install it to your system. This will also install the necessary dependencies.

1.3 Source Code

PyDriller's git repo is available on GitHub, which can be browsed at:

- https://github.com/ishepard/pydriller

and cloned using:

```
$ git clone https://github.com/ishepard/pydriller
$ cd pydriller
```

Optionally (but suggested), make use of virtualenv:

```
$ virtualenv -p python3 venv
$ source venv/bin/activate
```

Install the requirements:

```
$ pip install -r requirements
$ unzip test-repos.zip
```

and run the tests using pytest:

```
$ pytest
```

1.4 How to cite PyDriller

```
@inbook{PyDriller,
    title = "PyDriller: Python Framework for Mining Software Repositories",
    abstract = "Software repositories contain historical and valuable information␣
↪about the overall development of software systems. Mining software repositories␣
↪(MSR) is nowadays considered one of the most interesting growing fields within␣
↪software engineering. MSR focuses on extracting and analyzing data available in␣
↪software repositories to uncover interesting, useful, and actionable information␣
↪about the system. Even though MSR plays an important role in software engineering␣
↪research, few tools have been created and made public to support developers in␣
↪extracting information from Git repository. In this paper, we present PyDriller, a␣
↪Python Framework that eases the process of mining Git. We compare our tool against␣
↪the state-of-the-art Python Framework GitPython, demonstrating that PyDriller can␣
↪achieve the same results with, on average, 50% less LOC and significantly lower␣
↪complexity.URL: https://github.com/ishepard/pydrillerMaterials: https://doi.org/10.
↪5281/zenodo.1327363Pre-print: https://doi.org/10.5281/zenodo.1327411",
    author = "Spadini, Davide and Aniche, Maurício and Bacchelli, Alberto",
    year = "2018",
    doi = "10.1145/3236024.3264598",
    booktitle = "The 26th ACM Joint European Software Engineering Conference and␣
↪Symposium on the Foundations of Software Engineering (ESEC/FSE)",
}
```

CHAPTER 2

Getting Started

Using PyDriller is very simple. You only need to create *RepositoryMining*: this class will receive in input the path to the repository and will return a generator that iterates over the commits. For example:

```
for commit in RepositoryMining('path/to/the/repo').traverse_commits():
    print('Hash {}, author {}'.format(commit.hash, commit.author.name))
```

will print the name of the developers for each commit.

Inside *RepositoryMining*, you will have to configure which projects to analyze, for which commits, for which dates etc. For all the possible configurations, have a look at *Configuration*.

We can also pass a list of repositories (both local and remote), and PyDriller will analyze sequentially. In case of a remote repository, PyDriller will clone it in a temporary folder, and delete it afterwards. For example:

```
urls = ["repos/repo1", "repos/repo2", "https://github.com/ishepard/pydriller.git",
↪"repos/repo3", "https://github.com/apache/hadoop.git"]
for commit in RepositoryMining(path_to_repo=urls).traverse_commits():
    print("Project {}, commit {}, date {}".format(
            commit.project_path, commit.hash, commit.author_date))
```

Let's make another example: print all the modified files for every commit. This does the magic:

```
for commit in RepositoryMining('path/to/the/repo').traverse_commits():
    for modification in commit.modifications:
        print('Author {} modified {} in commit {}'.format(commit.author.name,␣
↪modification.filename, commit.hash))
```

That's it!

Behind the scenes, PyDriller opens the Git repository and extracts all the necessary information. Then, the framework returns a generator that can iterate over the commits.

Furthermore, PyDriller can calculate structural metrics of every file changed in a commit. To calculate these metrics, Pydriller relies on Lizard, a powerful tool that can analyze source code of many different programming languages, both at class and method level!

```
for commit in RepositoryMining('path/to/the/repo').traverse_commits():
    for mod in commit.modifications:
        print('{} has complexity of {}, and it contains {} methods'.format(
              mod.filename, mod.complexity, len(mod.methods)))
```

CHAPTER 3

Configuration

One of the main advantage of using PyDriller to mine software repositories, is that is highly configurable. Let's start with selecting which commit to analyze.

3.1 Selecting projects to analyze

The only required parameter of *RepositoryMining* is **path_to_repo**, which specifies the repo(s) to analyze. It must be of type *str* or *List[str]*, meaning analyze only one repository or more than one.

Furthermore, PyDriller supports both local and remote repositories: if you pass an URL, PyDriller will automatically create a temporary folder, clone the repository, run the study, and finally delete the temporary folder.

For example, the following are all possible inputs for *RepositoryMining*:

```
# analyze only 1 local repository
url = "repos/pydriller/"

# analyze 2 local repositories
url = ["repos/pydriller/", "repos/anotherrepo/"]

# analyze both local and remote
url = ["repos/pydriller/", "https://github.com/apache/hadoop.git", "repos/anotherrepo
↪"]

# analyze 1 remote repository
url = "https://github.com/apache/hadoop.git"
```

To keep track of what project PyDriller is analyzing, the *Commit* object has a property called **project_name**.

3.2 Selecting the Commit Range

By default, PyDriller analyzes all the commits in the repository. However, filters can be applied to *RepositoryMining* to visit *only specific* commits.

- **single** *(str)*: single hash of the commit. The visitor will be called only on this commit

FROM:

- **since** *(datetime)*: only commits after this date will be analyzed
- **from_commit** *(str)*: only commits after this commit hash will be analyzed
- **from_tag** *(str)*: only commits after this commit tag will be analyzed

TO:

- **to** *(datetime)*: only commits up to this date will be analyzed
- **to_commit** *(str)*: only commits up to this commit hash will be analyzed
- **to_tag** *(str)*: only commits up to this commit tag will be analyzed

ORDER:

- **reversed_order** *(bool)*: by default PyDriller returns the commits in chronological order (from the oldest to the newest, the contrary of *git log*). If you need viceversa instead, put this field to **True**.

Examples:

```
# Analyze single commit
RepositoryMining('path/to/the/repo', single='6411e3096dd2070438a17b225f44475136e54e3a
↪').traverse_commits()

# Since 8/10/2016
RepositoryMining('path/to/the/repo', since=datetime(2016, 10, 8, 17, 0, 0)).traverse_
↪commits()

# Between 2 dates
dt1 = datetime(2016, 10, 8, 17, 0, 0)
dt2 = datetime(2016, 10, 8, 17, 59, 0)
RepositoryMining('path/to/the/repo', since=dt1, to=dt2).traverse_commits()

# Between tags
from_tag = 'tag1'
to_tag = 'tag2'
RepositoryMining('path/to/the/repo', from_tag=from_tag, to_tag=to_tag).traverse_
↪commits()

# Up to a date
dt1 = datetime(2016, 10, 8, 17, 0, 0, tzinfo=to_zone)
RepositoryMining('path/to/the/repo', to=dt1).traverse_commits()

# !!!!! ERROR !!!!! THIS IS NOT POSSIBLE
RepositoryMining('path/to/the/repo', from_tag=from_tag, from_commit=from_commit).
↪traverse_commits()
```

IMPORTANT: it is **not** possible to configure more than one filter of the same category (for example, more than one *from*). It is also **not** possible to have the *single* filter together with other filters!

3.3 Filtering commits

PyDriller comes with a set of common commit filters that you can apply:

- **only_in_branch** *(str)*: only analyses commits that belong to this branch.
- **only_no_merge** *(bool)*: only analyses commits that are not merge commits.
- **only_authors** *(List[str])*: only analyses commits that are made by these authors. The check is made on the username, NOT the email.
- **only_commits** *(List[str])*: only these commits will be analyzed.
- **only_releases** *(bool)*: only commits that are tagged ("release" is a term of GitHub, does not actually exist in Git)
- **filepath** *(str)*: only commits that modified this file will be analyzed.
- **only_modifications_with_file_types** *(List[str])*: only analyses commits in which at least one modification was done in that file type, e.g., if you pass ".java", then, the it will visit only commits in which at least one Java file was modified; clearly, it will skip other commits.

Examples:

```
# Only commits in branch1
RepositoryMining('path/to/the/repo', only_in_branch='branch1').traverse_commits()

# Only commits in branch1 and no merges
RepositoryMining('path/to/the/repo', only_in_branch='branch1', only_no_merge=True).
↪traverse_commits()

# Only commits of author "ishepard" (yeah, that's me)
RepositoryMining('path/to/the/repo', only_authors=['ishepard']).traverse_commits()

# Only these 3 commits
RepositoryMining('path/to/the/repo', only_commits=['hash1', 'hash2', 'hash3']).
↪traverse_commits()

# Only commit that modified "Matricula.javax"
RepositoryMining('path/to/the/repo', filepath='Matricula.javax').traverse_commits()

# Only commits that modified a java file
RepositoryMining('path/to/the/repo', only_modifications_with_file_types=['.java']).
↪traverse_commits()
```

CHAPTER 4

Commit Object

A Commit object has all the information of a Git commit, and much more. More specifically:

- **hash** *(str)*: hash of the commit
- **msg** *(str)*: commit message
- **author** *(Developer)*: commit author (name, email)
- **author_date** *(datetime)*: authored date
- **author_timezone** *(int)*: author timezone (expressed in seconds from epoch)
- **committer** *(Developer)*: commit committer (name, email)
- **committer_date** *(datetime)*: commit date
- **committer_timezone** *(int)*: commit timezone (expressed in seconds from epoch)
- **branches** *(List[str])*: List of branches that contain this commit
- **in_main_branch** *(Bool)*: True if the commit is in the main branch
- **merge** *(Bool)*: True if the commit is a merge commit
- **modifications** *(List[Modifications])*: list of modified files in the commit (see *Modifications*)
- **parents** *(Set[str])*: list of the commit parents
- **project_name** *(str)*: project name
- **project_path** *(str)*: project path

Example:

```
for commit in RepositoryMining('path/to/the/repo').traverse_commits():
    print(
        'The commit {} has been modified by {}, '
        'committed by {} in date {}'.format(
            commit.hash,
            commit.author.name,
```

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```
            commit.committer.name,
            commit.committer_date
        )
    )
```

CHAPTER 5

Modifications

You can get the list of modified files, as well as their diffs and current source code. To that, all you have to do is to get the list of *Modifications* that exists inside Commit. A modification object has the following fields:

- **old_path**: old path of the file (can be _None_ if the file is added)
- **new_path**: new path of the file (can be _None_ if the file is deleted)
- **change_type**: type of the change: can be Added, Deleted, Modified, or Renamed.
- **diff**: diff of the file as Git presents it (e.g., starting with @@ xx,xx @@).
- **source_code**: source code of the file (can be _None_ if the file is deleted)
- **source_code_before**: source code of the file before the change (can be _None_ if the file is added)
- **added**: number of lines added
- **removed**: number of lines removed
- **nloc**: Lines Of Code (LOC) of the file
- **complexity**: Cyclomatic Complexity of the file
- **token_count**: Number of Tokens of the file
- **methods**: list of methods of the file. The list might be empty if the programming language is not supported or if the file is not a source code file.

For example:

```
for commit in RepositoryMining('path/to/the/repo').traverse_commits():
    for m in commit.modifications:
        print(
            "Author {}".format(commit.author.name),
            " modified {}".format(m.filename),
            " with a change type of {}".format(m.change_type.name),
            " and the complexity is {}".format(m.complexity)
        )
```

CHAPTER 6

GitRepository

GitRepository is a wrapper for the most common utilities of Git. It receives in input the path to repository, and it takes care of the rest. For example, with GitRepository you can checkout a specific commit:

```
gr = GitRepository('test-repos/git-1/')
gr.checkout('a7053a4dcd627f5f4f213dc9aa002eb1caf926f8')
```

However, **be careful!** Git checkout changes the state of the repository on the hard disk, hence you should not use this command if other processes (maybe threads? or multiple repository mining?) read from the same repository.

GitRepository also contains a function to parse the a *diff*, very useful to obtain the list of lines added or deleted for future analysis. For example, if we run this:

```
diff = '@@ -2,6 +2,7 @@ aa'+\
    ' bb'+\
    '-cc'+\
    ' log.info(\"aa\")'+\
    '+log.debug(\"b\")'+\
    ' dd'+\
    ' ee'+\
    ' ff'
gr = GitRepository('test-repos/test1')
parsed_lines = gr.parse_diff(diff)

added = parsed_lines['added']
deleted = parsed_lines['deleted']

print('Added: {}'.format(added))       # result: Added: [(4, 'log.debug("b")')]
print('Deleted: {}'.format(deleted))   # result: Deleted: [(3, 'cc')]
```

the result is:

```
Added: [(4, 'log.debug("b")')]
Deleted: [(3, 'cc')]
```

Another very useful API (especially for researchers ;)) is the one that, given a commit, allows you to retrieve all the commits that last "touched" the modified lines of the file (if you pass a bug fixing commit, it will retrieve the bug inducing).

PS: Since PyDriller 1.9, this function uses (if available) "git hyper-blame" (check this for more info).

Let's see an example:

```
# commit abc modified line 1 of file A
# commit def modified line 2 of file A
# commit ghi modified line 3 of file A
# commit lmn deleted lines 1 and 2 of file A

gr = GitRepository('test-repos/test5')

commit = gr.getcommit('lmn')
buggy_commits = gr.get_commits_last_modified_lines(commit)
print(buggy_commits)      # result: (abc, def)
```

Since in commit **lmn** 2 lines were deleted (line 1 and 2), PyDriller can retrieve the commits in which those lines were last modified (in our example, commit **abc** and **def**).

Checkout the API reference of this class for the complete list of the available functions.

CHAPTER 7

API Reference

7.1 GitRepository

This module includes 1 class, GitRepository, representing a repository in Git.

class `pydriller.git_repository.`**`GitRepository`**(*path: str*)

Class representing a repository in Git. It contains most of the logic of PyDriller: obtaining the list of commits, checkout, reset, etc.

`__init__`(*path: str*)

Init the Git RepositoryMining.

Parameters **`path`** (*str*) – path to the repository

`__module__ = 'pydriller.git_repository'`

`checkout`(*_hash: str*) → None

Checkout the repo at the speficied commit. BE CAREFUL: this will change the state of the repo, hence it should *not* be used with more than 1 thread.

Parameters **`_hash`** – commit hash to checkout

`files`() → List[str]

Obtain the list of the files (excluding .git directory).

Returns List[str], the list of the files

`get_commit`(*commit_id: str*) → pydriller.domain.commit.Commit

Get the specified commit.

Parameters **`commit_id`** (*str*) – hash of the commit to analyze

Returns Commit

`get_commit_from_gitpython`(*commit: git.objects.commit.Commit*) → pydriller.domain.commit.Commit

Build a PyDriller commit object from a GitPython commit object. This is internal of PyDriller, I don't think users generally will need it.

Parameters **commit** (*GitCommit*) – GitPython commit

Returns Commit commit: PyDriller commit

get_commit_from_tag(*tag: str*) → pydriller.domain.commit.Commit

Obtain the tagged commit.

Parameters **tag** (*str*) – the tag

Returns Commit commit: the commit the tag referred to

get_commits_last_modified_lines(*commit: pydriller.domain.commit.Commit, modification: pydriller.domain.commit.Modification = None, hashes_to_ignore_path: str = None*) → Dict[str, Set[str]]

Given the Commit object, returns the set of commits that last "touched" the lines that are modified in the files included in the commit. It applies SZZ.

IMPORTANT: for better results, we suggest to install Google depot_tools first (see https://dev.chromium.org/developers/how-tos/install-depot-tools). This allows PyDriller to use "git hyper-blame" instead of the normal blame. If depot_tools are not installed, PyDriller will automatically switch to the normal blame.

The algorithm works as follow: (for every file in the commit)

1- obtain the diff

2- obtain the list of deleted lines

3- blame the file and obtain the commits were those lines were added

Can also be passed as parameter a single Modification, in this case only this file will be analyzed.

Parameters

- **commit** (Commit) – the commit to analyze
- **modification** (Modification) – single modification to analyze
- **hashes_to_ignore_path** (*str*) – path to a file containing hashes of commits to ignore. Requires "git hyper-blame".

Returns the set containing all the bug inducing commits

get_commits_modified_file(*filepath: str*) → List[str]

Given a filepath, returns all the commits that modified this file (following renames).

Parameters **filepath** (*str*) – path to the file

Returns the list of commits' hash

get_head() → pydriller.domain.commit.Commit

Get the head commit.

Returns Commit of the head commit

get_list_commits(*branch: str = None, reverse_order: bool = True*) → Generator[[pydriller.domain.commit.Commit, None], None]

Return a generator of commits of all the commits in the repo.

Returns Generator[Commit], the generator of all the commits in the repo

get_tagged_commits()

Obtain the hash of all the tagged commits.

Returns list of tagged commits (can be empty if there are no tags)

git

GitPython object Git.

Returns Git

hyper_blame_available

parse_diff(*diff: str*) → Dict[str, List[Tuple[int, str]]]

Given a diff, returns a dictionary with the added and deleted lines. The dictionary has 2 keys: "added" and "deleted", each containing the corresponding added or deleted lines. For both keys, the value is a list of Tuple (int, str), corresponding to (number of line in the file, actual line).

Parameters **diff** (*str*) – diff of the commit

Returns Dictionary

repo

GitPython object Repo.

Returns Repo

reset() → None

Reset the state of the repo, checking out the main branch and discarding local changes (-f option).

total_commits() → int

Calculate total number of commits.

Returns the total number of commits

7.2 RepositoryMining

This module includes 1 class, RepositoryMining, main class of PyDriller.

class pydriller.repository_mining.**RepositoryMining**(*path_to_repo: Union[str, List[str]], single: str = None, since: datetime.datetime = None, to: datetime.datetime = None, from_commit: str = None, to_commit: str = None, from_tag: str = None, to_tag: str = None, reversed_order: bool = False, only_in_branch: str = None, only_modifications_with_file_types: List[str] = None, only_no_merge: bool = False, only_authors: List[str] = None, only_commits: List[str] = None, only_releases: bool = False, filepath: str = None*)

This is the main class of PyDriller, responsible for running the study.

__init__(*path_to_repo: Union[str, List[str]], single: str = None, since: datetime.datetime = None, to: datetime.datetime = None, from_commit: str = None, to_commit: str = None, from_tag: str = None, to_tag: str = None, reversed_order: bool = False, only_in_branch: str = None, only_modifications_with_file_types: List[str] = None, only_no_merge: bool = False, only_authors: List[str] = None, only_commits: List[str] = None, only_releases: bool = False, filepath: str = None*)

Init a repository mining. The only required parameter is "path_to_repo": to analyze a single repo, pass the absolute path to the repo; if you need to analyze more repos, pass a list of absolute paths.

Furthermore, PyDriller supports local and remote repositories: if you pass a path to a repo, PyDriller will run the study on that repo; if you pass an URL, PyDriller will clone the repo in a temporary folder, run the study, and delete the temporary folder.

Parameters

- **path_to_repo** (*Union[str,List[str]]*) – absolute path (or list of absolute paths) to the repository(ies) to analyze
- **single** (*str*) – hash of a single commit to analyze
- **since** (*datetime*) – starting date
- **to** (*datetime*) – ending date
- **from_commit** (*str*) – starting commit (only if *since* is None)
- **to_commit** (*str*) – ending commit (only if *to* is None)
- **from_tag** (*str*) – starting the analysis from specified tag (only if *since* and *from_commit* are None)
- **to_tag** (*str*) – ending the analysis from specified tag (only if *to* and *to_commit* are None)
- **reversed_order** (*bool*) – whether the commits should be analyzed in reversed order
- **only_in_branch** (*str*) – only commits in this branch will be analyzed
- **only_modifications_with_file_types** (*List[str]*) – only modifications with that file types will be analyzed
- **only_no_merge** (*bool*) – if True, merges will not be analyzed
- **only_authors** (*List[str]*) – only commits of these authors will be analyzed (the check is done on the username, NOT the email)
- **only_commits** (*List[str]*) – only these commits will be analyzed
- **filepath** (*str*) – only commits that modified this file will be analyzed

__module__ = 'pydriller.repository_mining'

traverse_commits() → Generator[[pydriller.domain.commit.Commit, None], None]

Analyze all the specified commits (all of them by default), returning a generator of commits.

7.3 Commit

This module contains all the classes regarding a specific commit, such as Commit, Modification, ModificationType and Method.

class pydriller.domain.commit.**Commit**(*commit: git.objects.commit.Commit, project_path: pathlib.Path, main_branch: str*)

Class representing a Commit. Contains all the important information such as hash, author, dates, and modified files.

__init__(*commit: git.objects.commit.Commit, project_path: pathlib.Path, main_branch: str*) → None

Create a commit object.

Parameters

- **commit** – GitPython Commit object

- **project_path** – path to the project (temporary folder in case of a remote repository)
- **main_branch** – main branch of the repo

__module__ = 'pydriller.domain.commit'

author
Return the author of the commit as a Developer object.

Returns author

author_date
Return the authored datetime.

Returns datetime author_datetime

author_timezone
Author timezone expressed in seconds from epoch.

Returns int timezone

branches
Return the set of branches that contain the commit.

Returns set(str) branches

committer
Return the committer of the commit as a Developer object.

Returns committer

committer_date
Return the committed datetime.

Returns datetime committer_datetime

committer_timezone
Author timezone expressed in seconds from epoch.

Returns int timezone

hash
Return the SHA of the commit.

Returns str hash

in_main_branch
Return True if the commit is in the main branch, False otherwise.

Returns bool in_main_branch

merge
Return True if the commit is a merge, False otherwise.

Returns bool merge

modifications
Return a list of modified files.

Returns List[Modification] modifications

msg
Return commit message.

Returns str commit_message

parents
Return the list of parents SHAs.

Returns List[str] parents

project_name
Return the project name.

Returns project name

class pydriller.domain.commit.**Method**(*func*)
This class represents a method in a class. Contains various information extracted through Lizard.

__init__(*func*)
Initialize a method object. This is calculated using Lizard: it parses the source code of all the modifications in a commit, extracting information of the methods contained in the file (if the file is a source code written in one of the supported programming languages).

__module__ = 'pydriller.domain.commit'

class pydriller.domain.commit.**Modification**(*old_path: str, new_path: str, change_type: pydriller.domain.commit.ModificationType, diff_and_sc: Dict[str, str]*)
This class contains information regarding a modified file in a commit.

__init__(*old_path: str, new_path: str, change_type: pydriller.domain.commit.ModificationType, diff_and_sc: Dict[str, str]*)
Initialize a modification. A modification carries on information regarding the changed file. Normally, you shouldn't initialize a new one.

__module__ = 'pydriller.domain.commit'

added
Return the total number of added lines in the file.

Returns int lines_added

complexity
Calculate the Cyclomatic Complexity of the file.

Returns Cyclomatic Complexity of the file

filename
Return the filename. Given a path-like-string (e.g. "/Users/dspadini/pydriller/myfile.py") returns only the filename (e.g. "myfile.py")

Returns str filename

methods
Return the list of methods in the file. Every method contains various information like complexity, loc, name, number of parameters, etc.

Returns list of methods

new_path
New path of the file. Can be None if the file is deleted.

Returns str new_path

nloc
Calculate the LOC of the file.

Returns LOC of the file

old_path
Old path of the file. Can be None if the file is added.

Returns str old_path

removed
Return the total number of deleted lines in the file.

Returns int lines_deleted

token_count
Calculate the token count of functions.

Returns token count

class pydriller.domain.commit.**ModificationType**
Type of Modification. Can be ADD, COPY, RENAME, DELETE, MODIFY or UNKNOWN.

ADD = 1

COPY = 2

DELETE = 4

MODIFY = 5

RENAME = 3

UNKNOWN = 6

__module__ = 'pydriller.domain.commit'

7.4 Developer

This module includes only 1 class, Developer, representing a developer.

class pydriller.domain.developer.**Developer**(*name: str*, *email: str*)
This class represents a developer. We save the email and the name.

__init__(*name: str*, *email: str*)
Class to identify a developer.

Parameters

- **name** (*str*) – name and surname of the developer
- **email** (*str*) – email of the developer

__module__ = 'pydriller.domain.developer'

CHAPTER 8

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