pysubgroup Documentation

Release stable

mgbckr

Aug 11, 2023

CONTENTS

1 Contents **3**

1.1 pysubgroup . . . 3
1.2 Components . . . 6
1.3 Contributing . . . 12
1.4 License . . . 16
1.5 Contributors . . . 20
1.6 Changelog . . . 21
1.7 pysubgroup . . . 25

2 Indices and tables **43**

Python Module Index **45**

Index **47**

pysubgroup is a Python package that enables subgroup discovery in Python+pandas (scipy stack) data analysis environment. It provides for a lightweight, easy-to-use, extensible and freely available implementation of state-of-the-art algorithms, interestingness measures and presentation options.

Start reading here: *Overview*

Prototype phase

This library is still in a prototype phase. It has, however, been already successfully employed in active application projects.

CHAPTER

ONE

CONTENTS

1.1 pysubgroup

pysubgroup is a Python package that enables subgroup discovery in Python+pandas (scipy stack) data analysis environment. It provides for a lightweight, easy-to-use, extensible and freely available implementation of state-of-the-art algorithms, interestingness measures and presentation options.

This library is still in a prototype phase. It has, however, been already successfully employed in active application projects.

1.1.1 Subgroup Discovery

Subgroup Discovery is a well established data mining technique that allows you to identify patterns in your data. More precisely, the goal of subgroup discovery is to identify descriptions of data subsets that show an interesting distribution with respect to a pre-specified target concept. For example, given a dataset of patients in a hospital, we could be interested in subgroups of patients, for which a certain treatment X was successful. One example result could then be stated as:

"While in general the operation is successful in only 60% of the cases", for the subgroup of female patients under 50 that also have been treated with drug d, the success rate was 82%."

Here, a variable *operation success* is the target concept, the identified subgroup has the interpretable description *female=True AND age<50 AND drug_D = True*. We call these single conditions (such as *female=True*) selection expressions or short *selectors*. The interesting behavior for this subgroup is that the distribution of the target concept differs significantly from the distribution in the overall general dataset. A discovered subgroup could also be seen as a rule:

```
female=True AND age<50 AND drug_D = True ==> Operation_outcome=SUCCESS
```

Computationally, subgroup discovery is challenging since a large number of such conjunctive subgroup descriptions have to be considered. Of course, finding computable criteria, which subgroups are likely interesting to a user is also an eternal struggle. Therefore, a lot of literature has been devoted to the topic of subgroup discovery (including some of my own work). Recent overviews on the topic are for example:

- Herrera, Franciso, et al. "An overview on subgroup discovery: foundations and applications." Knowledge and information systems 29.3 (2011): 495-525.
- Atzmueller, Martin. "Subgroup discovery." Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery 5.1 (2015): 35-49.
- And of course, my point of view on the topic is summarized in my dissertation:

Prerequisites and Installation

pysubgroup is built to fit in the standard Python data analysis environment from the scipy-stack. Thus, it can be used just having pandas (including its dependencies numpy, scipy, and matplotlib) installed. Visualizations are carried out with the matplotlib library.

pysubgroup consists of pure Python code. Thus, you can simply download the code from the repository and copy it in your `site-packages` directory. pysubgroup is also on PyPI and should be installable using: `pip install pysubgroup`

Note: Some users complained about the **pip installation not working**. If, after the installation, it still doesn't find the package, then do the following steps:

1. Find where the directory `site-packages` is.
2. Copy the folder `pysubgroup`, which contains the source code, into the `site-packages` directory. (WARNING: This is not the main repository folder. The `pysubgroup` folder is inside the main repository folder, at the same level as `doc`)
3. Now you can import the module with `import pysubgroup`.

1.1.2 How to use:

A simple use case (here using the well known *titanic* data) can be created in just a few lines of code:

```
import pysubgroup as ps

# Load the example dataset
from pysubgroup.datasets import get_titanic_data
data = get_titanic_data()

target = ps.BinaryTarget ('Survived', True)
searchspace = ps.create_selectors(data, ignore=['Survived'])
task = ps.SubgroupDiscoveryTask (
    data,
    target,
    searchspace,
    result_set_size=5,
    depth=2,
    qf=ps.WRAccQF())
result = ps.DFS().execute(task)
```

The first line imports *pysubgroup* package. The following lines load an example dataset (the popular titanic dataset).

Therafter, we define a target, i.e., the property we are mainly interested in (_'survived'}. Then, we define the searchspace as a list of basic selectors. Descriptions are built from this searchspace. We can create this list manually, or use an utility function. Next, we create a SubgroupDiscoveryTask object that encapsulates what we want to find in our search. In particular, that comprises the target, the search space, the depth of the search (maximum numbers of selectors combined in a subgroup description), and the interestingness measure for candidate scoring (here, the Weighted Relative Accuracy measure).

The last line executes the defined task by performing a search with an algorithm—in this case beam search. The result of this algorithm execution is stored in a SubgroupDiscoveryResults object.

To just print the result, we could for example do:

```
print(result.to_dataframe())
```

to get:

1.1.3 Key classes

Here is an outline on the most important classes:

- Selector: A Selector represents an atomic condition over the data, e.g., *age* < *50*. There several subtypes of Selectors, i.e., NominalSelector (color==BLUE), NumericSelector (age < 50) and NegatedSelector (a wrapper such as not selector1)
- SubgroupDiscoveryTask: As mentioned before, encapsulates the specification of how an algorithm should search for interesting subgroups
- SubgroupDicoveryResult: These are the main outcome of a subgroup disovery run. You can obtain a list of subgroups using the `to_subgroups()` or to a dataframe using `to_dataframe()`
- Conjunction: A conjunction is the most widely used SubgroupDescription, and indicates which data instances are covered by the subgroup. It can be seen as the left hand side of a rule.

1.1.4 License

We are happy about anyone using this software. Thus, this work is put under an Apache license. However, if this constitutes any hindrance to your application, please feel free to contact us, we am sure that we can work something out.

```
Copyright 2016-2019 Florian Lemmerich

Licensed under the Apache License, Version 2.0 (the "License");
you may not use this file except in compliance with the License.
You may obtain a copy of the License at

http://www.apache.org/licenses/LICENSE-2.0

Unless required by applicable law or agreed to in writing, software
distributed under the License is distributed on an "AS IS" BASIS,
WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
See the License for the specific language governing permissions and
limitations under the License.
```

1.1.5 Warning

- Beam-Search is bugged at the moment and does not use beam width, see: https://github.com/flemmerich/pysubgroup/issues/37
- GP-growth is in an experimental stage.

1.1.6 Cite

If you are using pysubgroup for your research, please consider citing our demo paper:

```
Lemmerich, F., & Becker, M. (2018, September). pysubgroup: Easy-to-use subgroup␣
↪discovery in python. In Joint European Conference on Machine Learning and Knowledge␣
↪Discovery in Databases (ECMLPKDD). pp. 658-662.
```

bibtex:

```
@inproceedings{lemmerich2018pysubgroup,
  title={pysubgroup: Easy-to-use subgroup discovery in python},
  author={Lemmerich, Florian and Becker, Martin},
  booktitle={Joint European Conference on Machine Learning and Knowledge Discovery in␣
↪Databases},
  pages={658--662},
  year={2018}
}
```

1.1.7 Note

This project has been set up using PyScaffold 4.5. For details and usage information on PyScaffold see https://pyscaffold.org/.

1.2 Components

1.2.1 GP-Growth

This tree based algorithm uses a condensed representation (a so called valuation basis) to find interesting subgroups. The main advantage of this approach is, that the (potentially large) database has to be scanned only twice and thereafter all the necessary information is represented as more compact pattern-tree. Gp-growth is a generalisation of the popular fp-growth algorithm. So refer to instructional material on fp-growth for more in depth knowledge on the workings of this tree based algorithm.

Contents

- *GP-Growth*
  - *Basic usage*
  - *Create a custom target*

Basic usage

The basic usage of the gp-growth algorithm is not very different from the usage of any other algorithm in this package.

```
import pysubgroup as ps

# Load the example dataset
from pysubgroup.datasets import get_titanic_data
data = get_titanic_data()

target = ps.NominalSelector ('Survived', True)
searchspace = ps.create_selectors(data, ignore=['Survived'])
task = ps.SubgroupDiscoveryTask (data, target, dearchspace, result_set_size=5, depth=2,␣
↪qf=ps.WRAccQF())
GpGrowth.execute(task)
```

But beware that gp-growth is using an exhaustive search strategy! This can greatly increase the runtime for high search depth. You can specify the `mode` argument in the constructor of GpGrowth to run gp-growth either bottom up (`mode='b_u'`) or top down (`mode='b_u'`). As gp growth is a generalisation of fp-growth you can also perform standard fp-growth using gp_growth by using the CountQF (*Frequent Itemset Targets*) quality function.

Create a custom target

If you consider to use the gp-growth algorithm for your custom target that is totally possible if you find a valuation basis. We will now first introduce the concept of a valuation basis and thereafter outline the gp-growth interface that you have to support to use your quality function with our gp-growth implementation.

Valuation Basis

Think of a valuation basis as a codensed representation of a subgroup that allows to quickly compute the same representation for a union of two disjoint subgroups.

We call the function which takes the valuation basis of two disjoint sets and computes the valuation basis for the unified set `merge`. The function that compute the necessary statistics from a valuation basis `stats_from_basis`.

Now we can formulate: Given two disjoint sets A and B with $A \cap B = \varnothing$ and their valuation bases $v(A)$ and $v(B)$ with their functions `stats_from_basis` and `merge` as defined above, we can compute the properties of $A \cup B$ instead of from the union of the instances from the merged valuation basis. This can be summarized through the following equation:

$$props\_from\_instances(A \cup B) = props\_from\_basis(merge(v(A), v(B)))$$

Required Methods

To make a target and quality function suitable for gp-growth you have to provide several methods (all methods start with `gp_` to indicate that they are used in the gp-growth algorithm). In addition to the standard quality function methods (see *Custom Quality Function*) the following methods should be implemented to make a quality funciton usable with gp_growth.

```
class MyGpQualityFunction
    def gp_get_basis(self, row_index):
    """ returns the valuation basis of the element at this row_index """
```

(continues on next page)

(continued from previous page)

```
        pass

    def gp_get_null_vector(self):
    """ returns the zero element of the valuation basis """
        pass

    @staticmethod
    def gp_merge(v_l, v_r):
    """ merges the v_r valuation basis into the v_l valuation basis inplace! """
        pass

    def gp_get_statistics(self, cover_arr, v):
    """ computes the statistics for this quality function from the valuation basis v """
        pass

    @property
    def gp_requires_cover_arr(self) -> bool:
    """ returns a boolean value that indicates whether a cover array is required when␣
↪calling the gp_get_statistics function

        usually this value is False
    """
        pass
```

Saving a gp_tree

It is possible to save a gp tree to a txt file for e.g. debugging purpose. You therefor have to implementd the gp_to_str function which takes a valuation basis and returns a string representation. It is an intentional choide to not call the `str` function on the valuation basis directly.

```
def gp_to_str(self, basis) -> str:
""" returns a string representation of the valuation basis """
    pass
```

1.2.2 Selectors

Selectors are objects that if applied to a dataset yield a set of instances. If an instance is retured from a selector we say that the selectors covers that instance. While the term selectors usually only refers to basic selectors, conjunctions and disjunctions as well as negated selectors are also in a general sense selectors. Broadly speaking anything that implements the code:*covers* function is a selector. We will first introduce the frequently used basic selectors and thereafter the more general selectors that are the conjunction and disjunction. We conclude the chapter by showing how to implement a selectors yourself.

Basic Selectors

The pysubgroup package provides two basic selectors: The EqualitySelector and the IntervalSelector. Lets start by exploring the EqualitySelector:

```
import pysubgroup as ps
import pandas as pd

# create dataset
first_names = ['Alex', 'Anna', 'Alex']
sur_names = ['Smith', 'Johnson', 'Williams']
ages =  [40, 25, 32]
df = pd.DataFrame.from_dict({'First_name':first_names, 'Sur_name': sur_names, 'age':ages}
↪)

# create selector
alex_selector = ps.EqualitySelector('First_name', 'Alex')
age_selector = ps.EqualitySelector('age', 22)
# apply selectors to dataframe
print('instances with ', str(alex_selector), alex_selector.covers(df))
print('instances with', str(age_selector), age_selector.covers(df))
```

```
instances with  First_name=='Alex' [ True False  True]
instances with age==22 [False False False]
```

The output indicates that the first and third instance in the dataset have a first name that is equal to `'Alex'`. The second output shows that no instances in our dataset is of age 22. The EqualitySelector selector can be used on many different datatypes, but is most useful on binary, string and categorical data. In addition to the EqualitySelector the pysubgroup package also provides the IntervalSelector. The following codes selects all instances from the database, which are in the age range 18 (included) to 40 (excluded).

```
interval_selector = ps.IntervalSelector('age', 18, 40)
print(interval_selector.covers(df))
```

```
[False  True  True]
```

The outpu shows that the second and third instance in our dataset have an age within the interval $[18, 40)$.

Selectors are the building block of all rules generated with the pysubgroup package. If you want to write your own custom selector that is not a problem see customselector for references.

Negations

The pysubgroup package also provides the NegatedSelector class that takes any selector (not just basic ones) and inverts it.

```
inverted_selector = ps.NegatedSelector(alex_selector)
print('instances with first name not equal to Alex', inverted_selector.covers(df))
```

```
instances with first name not equal to Alex [False  True False]
```

The output is: `instances with first name not equal to Alex [False, True, False]`.

Conjunctions

Most of the rules that are generated with the pysubgroup package use conjunctions to form more complex queries. Continuing the running example from above we can find all persons whose name is Alex *and* which have an age in the interval $[18, 40)$ like so:

```
conj = ps.Conjunction([interval_selector, alex_selector])
print('instances with', str(conj), conj.covers(df))
```

```
instances with First_name=='Alex' AND age: [18:40[ [False False  True]
```

The output shows that only the last instance is covered by our conjunction.

Disjunctions

The pysubgroup package also provides disjunctions with the `Disjunction` class. Continuing the running example we can find all persons whose name is Alex *or* which have an age in the interval $[18, 40)$ like so:

```
disj = ps.Disjunction([interval_selector, alex_selector])
print('instances with', str(disj), disj.covers(df))
```

```
instances with First_name=='Alex' OR age: [18:40[ [ True  True  True]
```

We can see that all instances are covered by our conjunction.

Implementing your own

As already mentioned in the introduction on selectors, anything that provides a cover function is a selector. In this case we will show how to implement a custom basic selector that checks whether a string contains a given substring:

```
class StrContainsSelector:
    def __init__(self, column, substr):
        self.column = column
        self.substr = substr

    def covers(self, df):
        return df[self.column].str.contains(self.substr).to_numpy()

contains_selector = StrContainsSelector('Sur_name','m')
print(contains_selector.covers(df))
```

```
[ True False  True]
```

The output shows that only the first and last instance contain an m in their name. In addition to the covers function it is certainly advised to also implement the `__str__` and `__repr__` functions. This selector can now be added to the searchspace for any algorithm execution.

1.2.3 Targets and Quality Functions

To define the goal of our subgroup discovery task, we use targets and quality functions. Targets are used to define which attributes play a significant role and can provide common statistics for a subgroup in question. Quality functions assign a score to each subgroup. These scores are used by all the algorithms to determine the most interesting subgroups.

Frequent Itemset Targets

The most simple target is the *FITarget* with its associated quality functions *CountQF* and *AreaQf*. The CountQF simple counts the number of instances covered by the subgroup in question. The AreaQF multiplies the depth or length of the subgroup description with the number of instances covered by that description.

Binary Targets

For Boolean or Binary Targets we provide the *ChiSquaredQF* as well as the *StandardQF* quality functions. The *StandardQF* quality function uses a parameter α to weight the relative size $\frac{N_{SG}}{N}$ of a subgroup and multiplies it with the differences in relations of positive instances p to the number of instances N

$$\left(\frac{N_{SG}}{N}\right)^{\alpha}\left(\frac{p_{SG}}{N_{SG}}-\frac{p}{N}\right)$$

The *StandardQF* also supports an optimistic estimate.

The *ChiSquaredQF* is calculated based on the following contigency table which is then passed to the scipy chi2_contigency function. The small n represents the number of negative instances and should not be confused with the capital N which represents the total number of instances.

p_{SG}	$p-p_{SG}$
n_{SG}	$n-n_{SG}$

Nominal Targets

Currently pysubgroup only supports nominal targets as binary targets. So you can look for deviations of one nominal value with respect to all othe nominal values.

Numeric Targets

For numeric targets pysubgroup offers the *StandardQFNumeric* which is defined similar to the StandardQF

$$\left(\frac{N_{SG}}{N}\right)^{\alpha}(\mu_{SG}-\mu)$$

where μ_{SG} and μ are the mean value for the subgroup and entire dataset respectively. For the *StandardQFNumeric* we offer three optimistic estimates: Average, Summation and Ordering. These are in detail described in Florian Lemmerich's dissertation. You can choose between the different optimistic estimates by using the keyword argument `estimator` the different options are `'sum'`, `'average'`, and `'order'`

Custom Quality Function

To create a custom quality function that works will all algorithms except gp_growth.

```
class MyQualityFunction:
    def calculate_constant_statistics(self, task):
        """ calculate_constant_statistics
            This function is called once for every execution,
            it should do any preparation that is necessary prior to an execution.
        """
        pass

    def calculate_statistics(self, subgroup, data=None):
        """ calculates necessary statistics
            this statistics object is passed on to the evaluate
            and optimistic_estimate functions
        """
        pass

    def evaluate(self, subgroup, statistics_or_data=None):
        """ return the quality calculated from the statistics """
        pass

    def optimistic_estimate(self, subgroup, statistics=None):
        """ returns optimistic estimate
            if one is available return it otherwise infinity"""
        pass
```

1.3 Contributing

```
TODO: UPDATE THIS
```

Welcome to `pysubgroup` contributor's guide.

This document focuses on getting any potential contributor familiarized with the development processes, but other kinds of contributions are also appreciated.

If you are new to using git or have never collaborated in a project previously, please have a look at contribution-guide.org. Other resources are also listed in the excellent guide created by FreeCodeCamp[1].

Please notice, all users and contributors are expected to be **open, considerate, reasonable, and respectful**. When in doubt, Python Software Foundation's Code of Conduct is a good reference in terms of behavior guidelines.

[1] Even though, these resources focus on open source projects and communities, the general ideas behind collaborating with other developers to collectively create software are general and can be applied to all sorts of environments, including private companies and proprietary code bases.

1.3.1 Issue Reports

If you experience bugs or general issues with `pysubgroup`, please have a look on the issue tracker. If you don't see anything useful there, please feel free to fire an issue report.

Tip: Please don't forget to include the closed issues in your search. Sometimes a solution was already reported, and the problem is considered **solved**.

New issue reports should include information about your programming environment (e.g., operating system, Python version) and steps to reproduce the problem. Please try also to simplify the reproduction steps to a very minimal example that still illustrates the problem you are facing. By removing other factors, you help us to identify the root cause of the issue.

1.3.2 Documentation Improvements

You can help improve `pysubgroup` docs by making them more readable and coherent, or by adding missing information and correcting mistakes.

`pysubgroup` documentation uses Sphinx as its main documentation compiler. This means that the docs are kept in the same repository as the project code, and that any documentation update is done in the same way as a code contribution. We are using CommonMark with MyST extensions as our markup language.

Tip: Please notice that the GitHub web interface provides a quick way of propose changes in `pysubgroup`'s files. While this mechanism can be tricky for normal code contributions, it works perfectly fine for contributing to the docs, and can be quite handy.

If you are interested in trying this method out, please navigate to the `docs` folder in the source repository, find which file you would like to propose changes and click in the little pencil icon at the top, to open GitHub's code editor. Once you finish editing the file, please write a message in the form at the bottom of the page describing which changes have you made and what are the motivations behind them and submit your proposal.

When working on documentation changes in your local machine, you can compile them using tox :

```
tox -e docs
```

and use Python's built-in web server for a preview in your web browser (`http://localhost:8000`):

```
python3 -m http.server --directory 'docs/_build/html'
```

1.3.3 Code Contributions

Submit an issue

Before you work on any non-trivial code contribution it's best to first create a report in the issue tracker to start a discussion on the subject. This often provides additional considerations and avoids unnecessary work.

Create an environment

Before you start coding, we recommend creating an isolated virtual environment to avoid any problems with your installed Python packages. This can easily be done via either virtualenv:

```
virtualenv <PATH TO VENV>
source <PATH TO VENV>/bin/activate
```

or Miniconda:

```
conda create -n pysubgroup python=3 six virtualenv pytest pytest-cov
conda activate pysubgroup
```

Clone the repository

1. Create an user account on GitHub if you do not already have one.
2. Fork the project repository: click on the *Fork* button near the top of the page. This creates a copy of the code under your account on GitHub.
3. Clone this copy to your local disk:

   ```
   git clone git@github.com:YourLogin/pysubgroup.git
   cd pysubgroup
   ```

4. You should run:

   ```
   pip install -U pip setuptools -e .
   ```

   to be able to import the package under development in the Python REPL.

5. Install pre-commit:

   ```
   pip install pre-commit
   pre-commit install
   ```

   pysubgroup comes with a lot of hooks configured to automatically help the developer to check the code being written.

Implement your changes

1. Create a branch to hold your changes:

   ```
   git checkout -b my-feature
   ```

   and start making changes. Never work on the main branch!

2. Start your work on this branch. Don't forget to add docstrings to new functions, modules and classes, especially if they are part of public APIs.
3. Add yourself to the list of contributors in `AUTHORS.rst`.
4. When you're done editing, do:

   ```
   git add <MODIFIED FILES>
   git commit
   ```

to record your changes in git.

Please make sure to see the validation messages from pre-commit and fix any eventual issues. This should automatically use flake8/black to check/fix the code style in a way that is compatible with the project.

Important: Don't forget to add unit tests and documentation in case your contribution adds an additional feature and is not just a bugfix.

Moreover, writing a descriptive commit message is highly recommended. In case of doubt, you can check the commit history with:

```
git log --graph --decorate --pretty=oneline --abbrev-commit --all
```

to look for recurring communication patterns.

---

5. Please check that your changes don't break any unit tests with:

   ```
   tox
   ```

   (after having installed tox with `pip install tox` or `pipx`).

   You can also use tox to run several other pre-configured tasks in the repository. Try `tox -av` to see a list of the available checks.

Submit your contribution

1. If everything works fine, push your local branch to the remote server with:

   ```
   git push -u origin my-feature
   ```

2. Go to the web page of your fork and click "Create pull request" to send your changes for review.

Troubleshooting

The following tips can be used when facing problems to build or test the package:

1. Make sure to fetch all the tags from the upstream repository. The command `git describe --abbrev=0 --tags` should return the version you are expecting. If you are trying to run CI scripts in a fork repository, make sure to push all the tags. You can also try to remove all the egg files or the complete egg folder, i.e., `.eggs`, as well as the `*.egg-info` folders in the `src` folder or potentially in the root of your project.

2. Sometimes tox misses out when new dependencies are added, especially to `setup.cfg` and `docs/requirements.txt`. If you find any problems with missing dependencies when running a command with tox, try to recreate the `tox` environment using the `-r` flag. For example, instead of:

   ```
   tox -e docs
   ```

   Try running:

   ```
   tox -r -e docs
   ```

3. Make sure to have a reliable tox installation that uses the correct Python version (e.g., 3.7+). When in doubt you can run:

```
tox --version
# OR
which tox
```

If you have trouble and are seeing weird errors upon running tox, you can also try to create a dedicated virtual environment with a tox binary freshly installed. For example:

```
virtualenv .venv
source .venv/bin/activate
.venv/bin/pip install tox
.venv/bin/tox -e all
```

4. Pytest can drop you in an interactive session in the case an error occurs. In order to do that you need to pass a `--pdb` option (for example by running `tox -- -k <NAME OF THE FALLING TEST> --pdb`). You can also setup breakpoints manually instead of using the `--pdb` option.

1.3.4 Maintainer tasks

Releases

If you are part of the group of maintainers and have correct user permissions on PyPI, the following steps can be used to release a new version for `pysubgroup`:

1. Make sure all unit tests are successful.
2. Tag the current commit on the main branch with a release tag, e.g., `v1.2.3`.
3. Push the new tag to the upstream repository, e.g., `git push upstream v1.2.3`
4. Clean up the `dist` and `build` folders with `tox -e clean` (or `rm -rf dist build`) to avoid confusion with old builds and Sphinx docs.
5. Run `tox -e build` and check that the files in `dist` have the correct version (no `.dirty` or git hash) according to the git tag. Also check the sizes of the distributions, if they are too big (e.g., > 500KB), unwanted clutter may have been accidentally included.
6. Run `tox -e publish -- --repository pypi` and check that everything was uploaded to PyPI correctly.

1.4 License

```
                                 Apache License
                           Version 2.0, January 2004
                        http://www.apache.org/licenses/

   TERMS AND CONDITIONS FOR USE, REPRODUCTION, AND DISTRIBUTION

   1. Definitions.

      "License" shall mean the terms and conditions for use, reproduction,
      and distribution as defined by Sections 1 through 9 of this document.
```

(continues on next page)

(continued from previous page)

```
      "Licensor" shall mean the copyright owner or entity authorized by
      the copyright owner that is granting the License.

      "Legal Entity" shall mean the union of the acting entity and all
      other entities that control, are controlled by, or are under common
      control with that entity. For the purposes of this definition,
      "control" means (i) the power, direct or indirect, to cause the
      direction or management of such entity, whether by contract or
      otherwise, or (ii) ownership of fifty percent (50%) or more of the
      outstanding shares, or (iii) beneficial ownership of such entity.

      "You" (or "Your") shall mean an individual or Legal Entity
      exercising permissions granted by this License.

      "Source" form shall mean the preferred form for making modifications,
      including but not limited to software source code, documentation
      source, and configuration files.

      "Object" form shall mean any form resulting from mechanical
      transformation or translation of a Source form, including but
      not limited to compiled object code, generated documentation,
      and conversions to other media types.

      "Work" shall mean the work of authorship, whether in Source or
      Object form, made available under the License, as indicated by a
      copyright notice that is included in or attached to the work
      (an example is provided in the Appendix below).

      "Derivative Works" shall mean any work, whether in Source or Object
      form, that is based on (or derived from) the Work and for which the
      editorial revisions, annotations, elaborations, or other modifications
      represent, as a whole, an original work of authorship. For the purposes
      of this License, Derivative Works shall not include works that remain
      separable from, or merely link (or bind by name) to the interfaces of,
      the Work and Derivative Works thereof.

      "Contribution" shall mean any work of authorship, including
      the original version of the Work and any modifications or additions
      to that Work or Derivative Works thereof, that is intentionally
      submitted to Licensor for inclusion in the Work by the copyright owner
      or by an individual or Legal Entity authorized to submit on behalf of
      the copyright owner. For the purposes of this definition, "submitted"
      means any form of electronic, verbal, or written communication sent
      to the Licensor or its representatives, including but not limited to
      communication on electronic mailing lists, source code control systems,
      and issue tracking systems that are managed by, or on behalf of, the
      Licensor for the purpose of discussing and improving the Work, but
      excluding communication that is conspicuously marked or otherwise
      designated in writing by the copyright owner as "Not a Contribution."

      "Contributor" shall mean Licensor and any individual or Legal Entity
      on behalf of whom a Contribution has been received by Licensor and
```

(continues on next page)

(continued from previous page)

```
    subsequently incorporated within the Work.

 2. Grant of Copyright License. Subject to the terms and conditions of
    this License, each Contributor hereby grants to You a perpetual,
    worldwide, non-exclusive, no-charge, royalty-free, irrevocable
    copyright license to reproduce, prepare Derivative Works of,
    publicly display, publicly perform, sublicense, and distribute the
    Work and such Derivative Works in Source or Object form.

 3. Grant of Patent License. Subject to the terms and conditions of
    this License, each Contributor hereby grants to You a perpetual,
    worldwide, non-exclusive, no-charge, royalty-free, irrevocable
    (except as stated in this section) patent license to make, have made,
    use, offer to sell, sell, import, and otherwise transfer the Work,
    where such license applies only to those patent claims licensable
    by such Contributor that are necessarily infringed by their
    Contribution(s) alone or by combination of their Contribution(s)
    with the Work to which such Contribution(s) was submitted. If You
    institute patent litigation against any entity (including a
    cross-claim or counterclaim in a lawsuit) alleging that the Work
    or a Contribution incorporated within the Work constitutes direct
    or contributory patent infringement, then any patent licenses
    granted to You under this License for that Work shall terminate
    as of the date such litigation is filed.

 4. Redistribution. You may reproduce and distribute copies of the
    Work or Derivative Works thereof in any medium, with or without
    modifications, and in Source or Object form, provided that You
    meet the following conditions:

    (a) You must give any other recipients of the Work or
        Derivative Works a copy of this License; and

    (b) You must cause any modified files to carry prominent notices
        stating that You changed the files; and

    (c) You must retain, in the Source form of any Derivative Works
        that You distribute, all copyright, patent, trademark, and
        attribution notices from the Source form of the Work,
        excluding those notices that do not pertain to any part of
        the Derivative Works; and

    (d) If the Work includes a "NOTICE" text file as part of its
        distribution, then any Derivative Works that You distribute must
        include a readable copy of the attribution notices contained
        within such NOTICE file, excluding those notices that do not
        pertain to any part of the Derivative Works, in at least one
        of the following places: within a NOTICE text file distributed
        as part of the Derivative Works; within the Source form or
        documentation, if provided along with the Derivative Works; or,
        within a display generated by the Derivative Works, if and
        wherever such third-party notices normally appear. The contents
```

(continues on next page)

(continued from previous page)

```
        of the NOTICE file are for informational purposes only and
        do not modify the License. You may add Your own attribution
        notices within Derivative Works that You distribute, alongside
        or as an addendum to the NOTICE text from the Work, provided
        that such additional attribution notices cannot be construed
        as modifying the License.

    You may add Your own copyright statement to Your modifications and
    may provide additional or different license terms and conditions
    for use, reproduction, or distribution of Your modifications, or
    for any such Derivative Works as a whole, provided Your use,
    reproduction, and distribution of the Work otherwise complies with
    the conditions stated in this License.

5. Submission of Contributions. Unless You explicitly state otherwise,
    any Contribution intentionally submitted for inclusion in the Work
    by You to the Licensor shall be under the terms and conditions of
    this License, without any additional terms or conditions.
    Notwithstanding the above, nothing herein shall supersede or modify
    the terms of any separate license agreement you may have executed
    with Licensor regarding such Contributions.

6. Trademarks. This License does not grant permission to use the trade
    names, trademarks, service marks, or product names of the Licensor,
    except as required for reasonable and customary use in describing the
    origin of the Work and reproducing the content of the NOTICE file.

7. Disclaimer of Warranty. Unless required by applicable law or
    agreed to in writing, Licensor provides the Work (and each
    Contributor provides its Contributions) on an "AS IS" BASIS,
    WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or
    implied, including, without limitation, any warranties or conditions
    of TITLE, NON-INFRINGEMENT, MERCHANTABILITY, or FITNESS FOR A
    PARTICULAR PURPOSE. You are solely responsible for determining the
    appropriateness of using or redistributing the Work and assume any
    risks associated with Your exercise of permissions under this License.

8. Limitation of Liability. In no event and under no legal theory,
    whether in tort (including negligence), contract, or otherwise,
    unless required by applicable law (such as deliberate and grossly
    negligent acts) or agreed to in writing, shall any Contributor be
    liable to You for damages, including any direct, indirect, special,
    incidental, or consequential damages of any character arising as a
    result of this License or out of the use or inability to use the
    Work (including but not limited to damages for loss of goodwill,
    work stoppage, computer failure or malfunction, or any and all
    other commercial damages or losses), even if such Contributor
    has been advised of the possibility of such damages.

9. Accepting Warranty or Additional Liability. While redistributing
    the Work or Derivative Works thereof, You may choose to offer,
    and charge a fee for, acceptance of support, warranty, indemnity,
```

(continues on next page)

(continued from previous page)

```
   or other liability obligations and/or rights consistent with this
   License. However, in accepting such obligations, You may act only
   on Your own behalf and on Your sole responsibility, not on behalf
   of any other Contributor, and only if You agree to indemnify,
   defend, and hold each Contributor harmless for any liability
   incurred by, or claims asserted against, such Contributor by reason
   of your accepting any such warranty or additional liability.

END OF TERMS AND CONDITIONS

APPENDIX: How to apply the Apache License to your work.

   To apply the Apache License to your work, attach the following
   boilerplate notice, with the fields enclosed by brackets "[]"
   replaced with your own identifying information. (Don't include
   the brackets!)  The text should be enclosed in the appropriate
   comment syntax for the file format. We also recommend that a
   file or class name and description of purpose be included on the
   same "printed page" as the copyright notice for easier
   identification within third-party archives.

Copyright 2020 Florian Lemmerich

Licensed under the Apache License, Version 2.0 (the "License");
you may not use this file except in compliance with the License.
You may obtain a copy of the License at

    http://www.apache.org/licenses/LICENSE-2.0

Unless required by applicable law or agreed to in writing, software
distributed under the License is distributed on an "AS IS" BASIS,
WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
See the License for the specific language governing permissions and
limitations under the License.
```

1.5 Contributors

- Florian Lemmerich (flemmerich) florian@lemmerich.net
- Martin Becker (mgbckr) mgbckr@informatik.uni-rostock.de
- Felix Stamm (Feelx234)

1.6 Changelog

1.6.1 [0.7.6] - 2020-05-20

Some internal changes to the continuous integration pipeline on top of version 0.7.6.

1.6.2 [0.7.5] - 2020-05-20

Moved to pyscaffold, src/test structure and GitHub Actions.

1.6.3 [0.7.1] - 2020-05-20

Added

- you can now additionally provide **constraints** to SubgroupDiscovery
  - **MinSupportConstraint** added
- you can now run the slow tests py passing `--runslow` to pytest
- `Conjunction`, `Disjunction` and Selectors now all have the public property `.selectors` that provides all basic selectors involved

Removed

- support for weights has been removed, it will probably be added in the future as seperate targets and Quality functions.

Changed

- `create_numeric_selector_for_attribute` has been renamed to `create_numeric_selectors_for_attribute` (inserting an `s`) This brings it in lign with the corresponding name shema for nominal.

Changed internally

- statistics are now also store along with score and description
- The function `ps.get_cover_array_and_size` was added, it allows for a consistent way to acces a cover array (a.k.a. sth to be thrown into a dataframe or a numpy array)
- algorithm tests now also call the `to_subgroups` and `to_dataframe` methods to check they work with that algorithm
- the order of `calculate_statistics` and `get_base_statistics` are now in lign with that of quality functions (first subgroup then data)
- the size of a subgroup specified in a statistics object is now called `size_sg` uniformly. This avoids confusion with the `size` attribute of numpy arrays etc.

1.6.4 [0.7.0] - 2020-04-24

This update prepares pysubgroup for a better future. To do so we had to break backwards compatibility. Many of the classes that you know and love have been renamed so as to make their purpose more clear.

Changed:

- SubgroupDescription is now called Conjunction
- NominalTarget is now called BinaryTarget
- algorithms now return a SubgroupDiscoveryResult object
- the structure of quality functions changed (see documentation for more info)

Added

- pysubgroup now has a bunch of tests
- some algorithms and quality functions support numba for just in time compilation
- ModelTarget
- gp-growth
- 3 types of Representations (bitset, set, numpy-set)
- Refinement operator
- Disjunction
- New algorithms

1.6.5 [0.6.2.1] - 2019-20-11

Added

- Apriori now has the option to disable numba using the use_numba flag
- SimpleSrach now has a progressbar (enabled via the show_progress=True flag)
- The number of quality function evaluations can now be tracked using the CountCallsInterestingMeasure as a wrapper
- StandardQfNumeric now offers three different options to calculate the optimistic estimate
  - 'sum' (default) sums the values larger then the dataset mean (cf. Lemmerich 2014 p. 81 top)
  - 'average' uses the maximum target values as estimate (cf. Lemmerich 2014 p. 82 center)
  - 'order' uses ordering based bounds (cf. Lemmerich 2014 p. 89 bottom)

Bugfix

- Apriori now calculates the constant statistics before using representation
- DFS now properly works with any quality function

Improvements

- Apriori now reuses the compiled numba function
- Nominal target now uses subgroup.size to access the size of a subgroup representation
- StaticSpecializationOperator now avoids checking refinements of the same attribute
- test_algorithms_numeric now checks more algorithms

1.6.6 [0.6.2] - 2019-31-10

Changed

- **SubgroupDescription** has been replaced with **Conjunction**
- Selector *.covers* function returns a numpy array instead of a pandas Series (speedup on dense data)
- Conjunction *.selectors* is renamed to Conjunction.*_selectors*
- quality functions have a different interface
  - calculate_constant_statistics(self, task) caches necessary precomputation
  - calculate_statistics(self, subgroup, data=None) returns a namedtuple with necessary statistics
  - evaluate(self, subgroup, statistics=None) computes quality from provided statistics
  - optimistic_estimate(self, subgroup, statistics=None) computes optimistic estimate from provided statistics
-

Added

- Conjunction (replaces SubgroupDescription)
- Disjunction
- DNF (Disjunctive Normal Form)
- representations (given a dataset selectors are queried only once)
  - BitsetRepresentation
  - SetRepresentation
  - NumpySetRepresentation
- SimpleSearch algorithm
- DFS (Depth first search) using a representation for StandardQF
- tests
  - access to datasets for testing is provided through DataSets class
  - tests for selector classes (NominalSelector, NumericSelector)

    - __eq__
    - __lt__
    - __hash__ similarity
    - uniqueness of selectors
    - cover function for NominalSelector
  - tests for Conjunction, Disjuntion
    - __eq__
    - __lt__
    - __hash__ similarity
    - cover
  - tests for algorithms with nominal target concept on the creditg dataset (StandardQF(1) + NominalSearchSpace, StandardQF(1)+Nominal&Numeric Searchspace, StandardQF(0.5)+Nominal&Numeric Searchspace)
    - Apriori
    - SimpleDFS
    - BeamSearch
    - DFS_bitset
    - DFS_set
    - DFS_numpy_sets
    - SimpleSearch
  - tests for algorithms with numeric target concept (StandardQFNumeric)
    - Apriori
    - SimpleDFS
    - DFSNumeric
  - tests for algorithm with fi target (CountQF)
    - Apriori
    - DFS
  - tests for algorithms to find the best Disjunctions
    - Apriori
    - Generalising BFS

Improvements

- Apriori algorithm now runs significantly faster due to precomputing and usage of list comprehension

1.7 pysubgroup

1.7.1 pysubgroup package

Submodules

pysubgroup.algorithms module

Created on 29.04.2016

@author: lemmerfn

class pysubgroup.algorithms.**Apriori**(*representation_type=None*, *combination_name='Conjunction'*, *use_numba=True*)

Bases: object

execute(*task*)

get_next_level(*promising_candidates*)

get_next_level_candidates(*task*, *result*, *next_level_candidates*)

get_next_level_candidates_vectorized(*task*, *result*, *next_level_candidates*)

get_next_level_numba(*promising_candidates*)

class pysubgroup.algorithms.**BeamSearch**(*beam_width=20*, *beam_width_adaptive=False*)

Bases: object

Implements the BeamSearch algorithm. Its a basic implementation

execute(*task*)

class pysubgroup.algorithms.**BestFirstSearch**

Bases: object

execute(*task*)

class pysubgroup.algorithms.**DFS**(*apply_representation*)

Bases: object

Implementation of a depth-first-search with look-ahead using a provided datastructure.

execute(*task*)

search_internal(*task*, *result*, *sg*)

class pysubgroup.algorithms.**DFSNumeric**

Bases: object

execute(*task*)

search_internal(*task*, *prefix*, *modification_set*, *result*, *bitset*)

tpl

alias of `size_mean_parameters`

class pysubgroup.algorithms.**GeneralisingBFS**

Bases: `object`

execute(*task*)

class pysubgroup.algorithms.**SimpleDFS**

Bases: `object`

execute(*task*, *use_optimistic_estimates=True*)

search_internal(*task*, *prefix*, *modification_set*, *result*, *use_optimistic_estimates*)

class pysubgroup.algorithms.**SimpleSearch**(*show_progress=True*)

Bases: `object`

execute(*task*)

class pysubgroup.algorithms.**SubgroupDiscoveryTask**(*data*, *target*, *search_space*, *qf*, *result_set_size=10*, *depth=3*, *min_quality=-inf*, *constraints=None*)

Bases: `object`

Capsulates all parameters required to perform standard subgroup discovery

pysubgroup.algorithms.**constraints_satisfied**(*constraints*, *subgroup*, *statistics=None*, *data=None*)

pysubgroup.binary_target module

Created on 29.09.2017

@author: lemmerfn

class pysubgroup.binary_target.**BinaryTarget**(*target_attribute=None*, *target_value=None*, *target_selector=None*)

Bases: *BaseTarget*

calculate_statistics(*subgroup*, *data*, *cached_statistics=None*)

covers(*instance*)

get_attributes()

get_base_statistics(*subgroup*, *data*)

statistic_types = ('size_sg', 'size_dataset', 'positives_sg', 'positives_dataset', 'size_complement', 'relative_size_sg', 'relative_size_complement', 'coverage_sg', 'coverage_complement', 'target_share_sg', 'target_share_complement', 'target_share_dataset', 'lift')

class pysubgroup.binary_target.**ChiSquaredQF**(*direction='both'*, *min_instances=5*, *stat='chi2'*)

Bases: *SimplePositivesQF*

ChiSquaredQF which test for statistical independence of a subgroup against it's complement

...

static chi_squared_qf(*instances_dataset*, *positives_dataset*, *instances_subgroup*, *positives_subgroup*, *min_instances=5*, *bidirect=True*, *direction_positive=True*, *index=0*)

Performs chi2 test of statistical independence

Test whether a subgroup is statistically independent from it's complement (see scipy.stats.chi2_contingency).

Parameters

instances_dataset –

positives_dataset,
instances_subgroup, positives_subgroup : int

counts of subgroup and dataset

:param
[positives_dataset,]

instances_subgroup, positives_subgroup : int

counts of subgroup and dataset

Parameters

- **min_instances** (*int, optional*) – number of required instances, if less -inf is returned for that subgroup
- **bidirect** (*bool, optional*) – If true both directions are considered interesting else direction_positive decides which direction is interesting
- **direction_positive** (*bool, optional*) – Only used if bidirect=False; specifies whether you are interested in positive (True) or negative deviations
- **index** (*{0, 1}, optional*) – decides whether the test statistic (0) or the p-value (1) should be used

static chi_squared_qf_weighted(*subgroup*, *data*, *weighting_attribute*, *effective_sample_size=0*, *min_instances=5*)

evaluate(*subgroup*, *target*, *data*, *statistics=None*)

class pysubgroup.binary_target.**GeneralizationAware_StandardQF**(*a*)

Bases: *GeneralizationAwareQF_stats*

evaluate(*subgroup*, *target*, *data*, *statistics=None*)

get_max(**args*)

class pysubgroup.binary_target.**LiftQF**

Bases: *StandardQF*

Lift Quality Function

LiftQF is a StandardQF with a=0. Thus it treats the difference in ratios as the quality without caring about the relative size of a subgroup.

class pysubgroup.binary_target.**SimpleBinomialQF**

Bases: *StandardQF*

Simple Binomial Quality Function

SimpleBinomialQF is a StandardQF with a=0.5. It is an order equivalent approximation of the full binomial test if the subgroup size is much smaller than the size of the entire dataset.

class pysubgroup.binary_target.**SimplePositivesQF**

Bases: *AbstractInterestingnessMeasure*

calculate_constant_statistics(*data*, *target*)

calculate_statistics(*subgroup*, *target*, *data*, *statistics=None*)

gp_get_null_vector()

gp_get_params(*_cover_arr*, *v*)

gp_get_stats(*row_index*)

gp_merge(*left*, *right*)

property gp_requires_cover_arr

gp_size_sg(*stats*)

gp_to_str(*stats*)

tpl

alias of PositivesQF_parameters

class pysubgroup.binary_target.**StandardQF**(*a*)

Bases: *SimplePositivesQF*, *BoundedInterestingnessMeasure*

StandardQF which weights the relative size against the difference in averages

The StandardQF is a general form of quality function which for different values of a is order equivalen to many popular quality measures.

a

used as an exponent to scale the relative size to the difference in averages

Type
float

evaluate(*subgroup*, *target*, *data*, *statistics=None*)

optimistic_estimate(*subgroup*, *target*, *data*, *statistics=None*)

optimistic_generalisation(*subgroup*, *target*, *data*, *statistics=None*)

static standard_qf(*a*, *instances_dataset*, *positives_dataset*, *instances_subgroup*, *positives_subgroup*)

class pysubgroup.binary_target.**WRAccQF**

Bases: *StandardQF*

Weighted Relative Accuracy Quality Function

WRAccQF is a StandardQF with a=1. It is order equivalent to the difference in the observed and expected number of positive instances.

pysubgroup.constraints module

class pysubgroup.constraints.**MinSupportConstraint**(*min_support*)

Bases: object

gp_is_satisfied(*node*)

gp_prepare(*qf*)

property is_monotone

is_satisfied(*subgroup*, *statistics=None*, *data=None*)

pysubgroup.datasets module

pysubgroup.datasets.**get_credit_data**()

pysubgroup.datasets.**get_titanic_data**()

pysubgroup.fi_target module

Created on 29.09.2017

@author: lemmerfn

class pysubgroup.fi_target.**AreaQF**

Bases: *SimpleCountQF*

evaluate(*subgroup*, *target*, *data*, *statistics=None*)

class pysubgroup.fi_target.**CountQF**

Bases: *SimpleCountQF*, *BoundedInterestingnessMeasure*

evaluate(*subgroup*, *target*, *data*, *statistics=None*)

optimistic_estimate(*subgroup*, *target*, *data*, *statistics=None*)

class pysubgroup.fi_target.**FITarget**

Bases: *BaseTarget*

calculate_statistics(*subgroup_description*, *data*, *cached_statistics=None*)

get_attributes()

get_base_statistics(*subgroup*, *data*)

statistic_types = ('size_sg', 'size_dataset')

class pysubgroup.fi_target.**SimpleCountQF**

Bases: *AbstractInterestingnessMeasure*

calculate_constant_statistics(*data*, *target*)

calculate_statistics(*subgroup_description*, *target*, *data*, *statistics=None*)

gp_get_null_vector()

gp_get_params(*_cover_arr*, *v*)

gp_get_stats(*_*)

gp_merge(*left*, *right*)

gp_requires_cover_arr = False

gp_size_sg(*stats*)

gp_to_str(*stats*)

tpl

alias of `CountQF_parameters`

pysubgroup.gp_growth module

class pysubgroup.gp_growth.**GpGrowth**(*mode='b_u'*)

Bases: `object`

add_if_required(*prefix*, *gp_stats*)

calculate_quality_function_for_patterns(*task*, *results*, *arrs*)

check_constraints(*node*)

check_tree_is_ordered(*root*, *prefix=None*)

Verify that the nodes of a tree are sorted in ascending order

convert_results_to_subgroups(*results*, *selectors_sorted*)

create_copy_of_path(*nodes*, *new_nodes*, *stats*)

create_copy_of_tree_top_down(*from_root*, *nodes=None*, *parent=None*, *is_valid_class=None*)

create_initial_tree(*arrs*)

create_new_tree_from_nodes(*nodes*)

execute(*task*)

get_nodes_upwards(*node*)

get_stats_for_class(*cls_nodes*)

get_top_down_tree_for_class(*cls_nodes*, *cls*, *is_valid_class*)

merge_trees_top_down(*nodes*, *mutable_root*, *from_root*, *is_valid_class*)

nodes_to_cls_nodes(*nodes*)

normal_insert(*root*, *nodes*, *new_stats*, *classes*)

prepare_selectors(*search_space*, *data*)

recurse(*cls_nodes*, *prefix*, *is_single_path=False*)

recurse_top_down(*cls_nodes*, *root*, *depth_in=0*)

remove_selectors_with_low_optimistic_estimate(*s*, *search_space_size*)

setup(*task*)

setup_constraints(*constraints*, *qf*)

setup_from_quality_function(*qf*)

to_file(*task*, *path*)

pysubgroup.gp_growth.**identity**(*x*, **args*, ***kwargs*)

pysubgroup.measures module

Created on 28.04.2016

@author: lemmerfn

class pysubgroup.measures.**AbstractInterestingnessMeasure**

Bases: ABC

ensure_statistics(*subgroup*, *target*, *data*, *statistics=None*)

class pysubgroup.measures.**BoundedInterestingnessMeasure**

Bases: *AbstractInterestingnessMeasure*

class pysubgroup.measures.**CombinedInterestingnessMeasure**(*measures*, *weights=None*)

Bases: *BoundedInterestingnessMeasure*

calculate_constant_statistics(*data*, *target*)

calculate_statistics(*subgroup*, *target*, *data*, *cached_statistics=None*)

evaluate(*subgroup*, *target*, *data*, *statistics=None*)

evaluate_from_statistics(*instances_dataset*, *positives_dataset*, *instances_subgroup*, *positives_subgroup*)

optimistic_estimate(*subgroup*, *target*, *data*, *statistics=None*)

class pysubgroup.measures.**CountCallsInterestingMeasure**(*qf*)

Bases: *BoundedInterestingnessMeasure*

calculate_statistics(*sg*, *target*, *data*, *statistics=None*)

class pysubgroup.measures.**GeneralizationAwareQF**(*qf*)

Bases: *AbstractInterestingnessMeasure*

calculate_constant_statistics(*data*, *target*)

calculate_statistics(*subgroup*, *target*, *data*, *statistics=None*)

evaluate(*subgroup*, *target*, *data*, *statistics=None*)

class ga_tuple(*subgroup_quality*, *generalisation_quality*)

Bases: tuple

generalisation_quality

Alias for field number 1

subgroup_quality
Alias for field number 0

get_qual_and_previous_qual(*subgroup*, *target*, *data*)

class pysubgroup.measures.**GeneralizationAwareQF_stats**(*qf*)
Bases: *AbstractInterestingnessMeasure*

calculate_constant_statistics(*data*, *target*)

calculate_statistics(*subgroup*, *target*, *data*, *statistics=None*)

evaluate(*subgroup*, *target*, *data*, *statistics=None*)

ga_tuple
alias of ga_stats_tuple

get_max(**args*)

get_stats_and_previous_stats(*subgroup*, *target*, *data*)

pysubgroup.measures.**maximum_statistic_filter**(*result_set*, *statistic*, *maximum*)

pysubgroup.measures.**minimum_quality_filter**(*result_set*, *minimum*)

pysubgroup.measures.**minimum_statistic_filter**(*result_set*, *statistic*, *minimum*, *data*)

pysubgroup.measures.**overlap_filter**(*result_set*, *data*, *similarity_level=0.9*)

pysubgroup.measures.**overlaps_list**(*sg*, *list_of_sgs*, *data*, *similarity_level=0.9*)

pysubgroup.measures.**unique_attributes**(*result_set*, *data*)

pysubgroup.model_target module

class pysubgroup.model_target.**EMM_Likelihood**(*model*)
Bases: *AbstractInterestingnessMeasure*

calculate_constant_statistics(*data*, *target*)

calculate_statistics(*subgroup*, *target*, *data*, *statistics=None*)

evaluate(*subgroup*, *target*, *data*, *statistics=None*)

get_tuple(*sg_size*, *params*, *cover_arr*)

gp_get_params(*cover_arr*, *v*)

property gp_requires_cover_arr

tpl
alias of *EMM_Likelihood*

class pysubgroup.model_target.**PolyRegression_ModelClass**(*x_name='x'*, *y_name='y'*, *degree=1*)
Bases: object

calculate_constant_statistics(*data*, *target*)

fit(*subgroup*, *data=None*)

gp_get_null_vector()

gp_get_params(*v*)

gp_get_stats(*row_index*)

static gp_merge(*u*, *v*)

property gp_requires_cover_arr

gp_size_sg(*stats*)

gp_to_str(*stats*)

likelihood(*stats*, *sg*)

loglikelihood(*stats*, *sg*)

class pysubgroup.model_target.**beta_tuple**(*beta*, *size_sg*)

Bases: tuple

beta

Alias for field number 0

size_sg

Alias for field number 1

pysubgroup.numeric_target module

Created on 29.09.2017

@author: lemmerfn

class pysubgroup.numeric_target.**NumericTarget**(*target_variable*)

Bases: object

calculate_statistics(*subgroup*, *data*, *cached_statistics=None*)

get_attributes()

get_base_statistics(*subgroup*, *data*)

statistic_types = ('size_sg', 'size_dataset', 'mean_sg', 'mean_dataset', 'std_sg', 'std_dataset', 'median_sg', 'median_dataset', 'max_sg', 'max_dataset', 'min_sg', 'min_dataset', 'mean_lift', 'median_lift')

class pysubgroup.numeric_target.**StandardQFNumeric**(*a*, *invert=False*, *estimator='sum'*)

Bases: *BoundedInterestingnessMeasure*

class Average_Estimator(*qf*)

Bases: object

calculate_constant_statistics(*data*, *target*)

get_data(*data*, *target*)

get_estimate(*subgroup*, *sg_size*, *sg_mean*, *cover_arr*, *_*)

class Ordering_Estimator(*qf*)

Bases: object

calculate_constant_statistics(*data*, *target*)

get_data(*data*, *target*)

get_estimate(*subgroup*, *sg_size*, *sg_mean*, *cover_arr*, *target_values_sg*)

get_estimate_numpy(*values_sg*, *_*, *mean_dataset*)

class Summation_Estimator(*qf*)

Bases: object

calculate_constant_statistics(*data*, *target*)

get_data(*data*, *target*)

get_estimate(*subgroup*, *sg_size*, *sg_mean*, *cover_arr*, *_*)

calculate_constant_statistics(*data*, *target*)

calculate_statistics(*subgroup*, *target*, *data*, *statistics=None*)

evaluate(*subgroup*, *target*, *data*, *statistics=None*)

optimistic_estimate(*subgroup*, *target*, *data*, *statistics=None*)

static standard_qf_numeric(*a*, *_*, *mean_dataset*, *instances_subgroup*, *mean_sg*)

tpl

alias of StandardQFNumeric_parameters

class pysubgroup.numeric_target.StandardQFNumericMedian(*a*, *invert=False*, *estimator='sum'*)

Bases: *BoundedInterestingnessMeasure*

class Average_Estimator(*qf*)

Bases: object

calculate_constant_statistics(*data*, *target*)

get_data(*data*, *target*)

get_estimate(*subgroup*, *sg_size*, *sg_mean*, *cover_arr*, *_*)

class Ordering_Estimator(*qf*)

Bases: object

calculate_constant_statistics(*data*, *target*)

get_data(*data*, *target*)

get_estimate(*subgroup*, *sg_size*, *sg_mean*, *cover_arr*, *target_values_sg*)

get_estimate_numpy(*values_sg*, *_*, *mean_dataset*)

class Summation_Estimator(*qf*)

Bases: object

calculate_constant_statistics(*data*, *target*)

get_data(*data*, *target*)

get_estimate(*subgroup*, *sg_size*, *sg_median*, *cover_arr*, *_*)

calculate_constant_statistics(*data*, *target*)

calculate_statistics(*subgroup*, *target*, *data*, *statistics=None*)

evaluate(*subgroup*, *target*, *data*, *statistics=None*)

optimistic_estimate(*subgroup*, *target*, *data*, *statistics=None*)

static standard_qf_numeric(*a*, *_*, *median_dataset*, *instances_subgroup*, *median_sg*)

tpl

alias of `StandardQFNumericMedian_parameters`

class pysubgroup.numeric_target.**StandardQFNumericTscore**(*a*, *invert=False*, *estimator='sum'*)

Bases: *BoundedInterestingnessMeasure*

class **Average_Estimator**(*qf*)

Bases: `object`

calculate_constant_statistics(*data*, *target*)

get_data(*data*, *target*)

get_estimate(*subgroup*, *sg_size*, *sg_mean*, *cover_arr*, *_*)

class **Ordering_Estimator**(*qf*)

Bases: `object`

calculate_constant_statistics(*data*, *target*)

get_data(*data*, *target*)

get_estimate(*subgroup*, *sg_size*, *sg_mean*, *cover_arr*, *target_values_sg*)

get_estimate_numpy(*values_sg*, *_*, *mean_dataset*)

class **Summation_Estimator**(*qf*)

Bases: `object`

calculate_constant_statistics(*data*, *target*)

get_data(*data*, *target*)

get_estimate(*subgroup*, *sg_size*, *sg_mean*, *cover_arr*, *_*)

calculate_constant_statistics(*data*, *target*)

calculate_statistics(*subgroup*, *target*, *data*, *statistics=None*)

evaluate(*subgroup*, *target*, *data*, *statistics=None*)

optimistic_estimate(*subgroup*, *target*, *data*, *statistics=None*)

static standard_qf_numeric(*a*, *_*, *mean_dataset*, *instances_subgroup*, *mean_sg*, *std_sg*)

tpl

alias of `StandardQFNumericTscore_parameters`

pysubgroup.refinement_operator module

class pysubgroup.refinement_operator.**RefinementOperator**

Bases: object

class pysubgroup.refinement_operator.**StaticGeneralizationOperator**(*selectors*)

Bases: object

refinements(*sG*)

class pysubgroup.refinement_operator.**StaticSpecializationOperator**(*selectors*)

Bases: object

refinements(*subgroup*)

pysubgroup.representations module

class pysubgroup.representations.**BitSetRepresentation**(*df*, *selectors_to_patch*)

Bases: *RepresentationBase*

Conjunction

alias of *BitSet_Conjunction*

Disjunction

alias of *BitSet_Disjunction*

patch_classes()

patch_selector(*sel*)

class pysubgroup.representations.**BitSet_Conjunction**(**args*, ***kwargs*)

Bases: *Conjunction*

append_and(*to_append*)

compute_representation()

n_instances = 0

property size_sg

class pysubgroup.representations.**BitSet_Disjunction**(**args*, ***kwargs*)

Bases: *Disjunction*

append_or(*to_append*)

compute_representation()

property size_sg

class pysubgroup.representations.**NumpySetRepresentation**(*df*, *selectors_to_patch*)

Bases: *RepresentationBase*

Conjunction

alias of *NumpySet_Conjunction*

patch_classes()

patch_selector(*sel*)

class pysubgroup.representations.**NumpySet_Conjunction**(**args*, ***kwargs*)

Bases: *Conjunction*

all_set = None

append_and(*to_append*)

compute_representation()

property size_sg

class pysubgroup.representations.**RepresentationBase**(*new_conjunction*, *selectors_to_patch*)

Bases: object

patch_all_selectors()

patch_classes()

patch_selector(*sel*)

undo_patch_classes()

class pysubgroup.representations.**SetRepresentation**(*df*, *selectors_to_patch*)

Bases: *RepresentationBase*

Conjunction

alias of *Set_Conjunction*

patch_classes()

patch_selector(*sel*)

class pysubgroup.representations.**Set_Conjunction**(**args*, ***kwargs*)

Bases: *Conjunction*

all_set = {}

append_and(*to_append*)

compute_representation()

property size_sg

pysubgroup.subgroup_description module

Created on 28.04.2016

@author: lemmerfn

class pysubgroup.subgroup_description.**BooleanExpressionBase**

Bases: ABC

abstract append_and(*to_append*)

abstract append_or(*to_append*)

class pysubgroup.subgroup_description.**Conjunction**(*selectors*)

Bases: *BooleanExpressionBase*

append_and(*to_append*)

append_or(*to_append*)

covers(*instance*)

property depth

static from_str(*s*)

pop_and()

pop_or()

property selectors

class pysubgroup.subgroup_description.**DNF**(*selectors=None*)

Bases: *Disjunction*

append_and(*to_append*)

append_or(*to_append*)

pop_and()

class pysubgroup.subgroup_description.**Disjunction**(*selectors=None*)

Bases: *BooleanExpressionBase*

append_and(*to_append*)

append_or(*to_append*)

covers(*instance*)

property selectors

class pysubgroup.subgroup_description.**EqualitySelector**(**args*, ***kwargs*)

Bases: *SelectorBase*

property attribute_name

property attribute_value

classmethod compute_descriptions(*attribute_name*, *attribute_value*, *selector_name*)

covers(*data*)

static from_str(*s*)

property selectors

set_descriptions(*attribute_name*, *attribute_value*, *selector_name=None*)

class pysubgroup.subgroup_description.**IntervalSelector**(**args*, ***kwargs*)

Bases: *SelectorBase*

property attribute_name

classmethod compute_descriptions(*attribute_name*, *lower_bound*, *upper_bound*, *selector_name=None*)

classmethod compute_string(*attribute_name*, *lower_bound*, *upper_bound*, *rounding_digits*)

covers(*data_instance*)

static from_str(*s*)

property lower_bound

property selectors

set_descriptions(*attribute_name*, *lower_bound*, *upper_bound*, *selector_name=None*)

property upper_bound

class pysubgroup.subgroup_description.**NegatedSelector**(**args*, ***kwargs*)

Bases: *SelectorBase*

property attribute_name

covers(*data_instance*)

property selectors

set_descriptions(*selector*)

class pysubgroup.subgroup_description.**SelectorBase**(**args*, ***kwargs*)

Bases: ABC

abstract set_descriptions(**args*, ***kwargs*)

pysubgroup.subgroup_description.**create_nominal_selectors**(*data*, *ignore=None*)

pysubgroup.subgroup_description.**create_nominal_selectors_for_attribute**(*data*, *attribute_name*, *dtypes=None*)

pysubgroup.subgroup_description.**create_numeric_selectors**(*data*, *nbins=5*, *intervals_only=True*, *weighting_attribute=None*, *ignore=None*)

pysubgroup.subgroup_description.**create_numeric_selectors_for_attribute**(*data*, *attr_name*, *nbins=5*, *intervals_only=True*, *weighting_attribute=None*)

pysubgroup.subgroup_description.**create_selectors**(*data*, *nbins=5*, *intervals_only=True*, *ignore=None*)

pysubgroup.subgroup_description.**get_cover_array_and_size**(*subgroup*, *data_len=None*, *data=None*)

pysubgroup.subgroup_description.**get_size**(*subgroup*, *data_len=None*, *data=None*)

pysubgroup.subgroup_description.**remove_target_attributes**(*selectors*, *target*)

pysubgroup.utils module

Created on 02.05.2016

@author: lemmerfn

class pysubgroup.utils.**BaseTarget**

Bases: object

all_statistics_present(*cached_statistics*)

class pysubgroup.utils.**SubgroupDiscoveryResult**(*results*, *task*)

Bases: object

to_dataframe(*statistics_to_show=None*, *autoround=False*, *include_target=False*)

to_descriptions(*include_stats=False*)

to_latex(*statistics_to_show=None*)

to_table(*statistics_to_show=None*, *print_header=True*, *include_target=False*)

pysubgroup.utils.**add_if_required**(*result*, *sg*, *quality*, *task:* SubgroupDiscoveryTask, *check_for_duplicates=False*, *statistics=None*, *explicit_result_set_size=None*)

> **Important:** Only add/remove subgroups from *result* by using *heappop* and *heappush* to ensure order of subgroups by quality.

pysubgroup.utils.**conditional_invert**(*val*, *invert*)

pysubgroup.utils.**count_bits**(*bitset_as_int*)

pysubgroup.utils.**derive_effective_sample_size**(*weights*)

pysubgroup.utils.**equal_frequency_discretization**(*data*, *attribute_name*, *nbins=5*, *weighting_attribute=None*)

pysubgroup.utils.**find_set_bits**(*bitset_as_int*)

pysubgroup.utils.**float_formatter**(*x*, *digits=2*)

pysubgroup.utils.**intersect_of_ordered_list**(*list_1*, *list_2*)

pysubgroup.utils.**is_categorical_attribute**(*data*, *attribute_name*)

pysubgroup.utils.**is_numerical_attribute**(*data*, *attribute_name*)

pysubgroup.utils.**minimum_required_quality**(*result*, *task*)

pysubgroup.utils.**overlap**(*sg*, *another_sg*, *data*)

pysubgroup.utils.**perc_formatter**(*x*)

pysubgroup.utils.**powerset**(*[1,2,3]) --> () (1,) (2,) (3,) (1,2) (1,3) (2,3) (1,2,3*)

pysubgroup.utils.**prepare_subgroup_discovery_result**(*result*, *task*)

pysubgroup.utils.**remove_selectors_with_attributes**(*selector_list*, *attribute_list*)

pysubgroup.utils.**results_df_autoround**(*df*)

pysubgroup.utils.**to_bits**(*list_of_ints*)

pysubgroup.visualization module

pysubgroup.visualization.**compare_distributions_numeric**(*sgs*, *data*, *bins*)

pysubgroup.visualization.**plot_distribution_numeric**(*sg*, *data*, *bins*)

pysubgroup.visualization.**plot_npspace**(*result_df*, *data*, *annotate=True*, *fixed_limits=False*)

pysubgroup.visualization.**plot_roc**(*result_df*, *data*, *qf=<pysubgroup.binary_target.StandardQF object>*, *levels=40*, *annotate=False*)

pysubgroup.visualization.**plot_sgbars**(*result_df*, *_*, *ylabel='target share'*, *title='Discovered Subgroups'*, *dynamic_widths=False*, *_suffix=''*)

pysubgroup.visualization.**similarity_dendrogram**(*result*, *data*)

pysubgroup.visualization.**similarity_sgs**(*sgd_results*, *data*, *color=True*)

pysubgroup.visualization.**supportSetVisualization**(*result*, *in_order=True*, *drop_empty=True*)

Module contents

CHAPTER

TWO

INDICES AND TABLES

- genindex
- modindex
- search

PYTHON MODULE INDEX

p

pysubgroup, 41
pysubgroup.algorithms, 25
pysubgroup.binary_target, 26
pysubgroup.constraints, 29
pysubgroup.datasets, 29
pysubgroup.fi_target, 29
pysubgroup.gp_growth, 30
pysubgroup.measures, 31
pysubgroup.model_target, 32
pysubgroup.numeric_target, 33
pysubgroup.refinement_operator, 36
pysubgroup.representations, 36
pysubgroup.subgroup_description, 37
pysubgroup.utils, 40
pysubgroup.visualization, 41

INDEX

A

a (*pysubgroup.binary_target.StandardQF attribute*), 28
AbstractInterestingnessMeasure (*class in pysubgroup.measures*), 31
add_if_required() (*in module pysubgroup.utils*), 40
add_if_required() (*pysubgroup.gp_growth.GpGrowth method*), 30
all_set (*pysubgroup.representations.NumpySet_Conjunction attribute*), 37
all_set (*pysubgroup.representations.Set_Conjunction attribute*), 37
all_statistics_present() (*pysubgroup.utils.BaseTarget method*), 40
append_and() (*pysubgroup.representations.BitSet_Conjunction method*), 36
append_and() (*pysubgroup.representations.NumpySet_Conjunction method*), 37
append_and() (*pysubgroup.representations.Set_Conjunction method*), 37
append_and() (*pysubgroup.subgroup_description.BooleanExpressionBase method*), 37
append_and() (*pysubgroup.subgroup_description.Conjunction method*), 38
append_and() (*pysubgroup.subgroup_description.Disjunction method*), 38
append_and() (*pysubgroup.subgroup_description.DNF method*), 38
append_or() (*pysubgroup.representations.BitSet_Disjunction method*), 36
append_or() (*pysubgroup.subgroup_description.BooleanExpressionBase method*), 37
append_or() (*pysubgroup.subgroup_description.Conjunction method*), 38
append_or() (*pysubgroup.subgroup_description.Disjunction method*), 38
append_or() (*pysubgroup.subgroup_description.DNF method*), 38
Apriori (*class in pysubgroup.algorithms*), 25
AreaQF (*class in pysubgroup.fi_target*), 29
attribute_name (*pysubgroup.subgroup_description.EqualitySelector property*), 38
attribute_name (*pysubgroup.subgroup_description.IntervalSelector property*), 38
attribute_name (*pysubgroup.subgroup_description.NegatedSelector property*), 39
attribute_value (*pysubgroup.subgroup_description.EqualitySelector property*), 38

B

BaseTarget (*class in pysubgroup.utils*), 40
BeamSearch (*class in pysubgroup.algorithms*), 25
BestFirstSearch (*class in pysubgroup.algorithms*), 25
beta (*pysubgroup.model_target.beta_tuple attribute*), 33
beta_tuple (*class in pysubgroup.model_target*), 33
BinaryTarget (*class in pysubgroup.binary_target*), 26
BitSet_Conjunction (*class in pysubgroup.representations*), 36
BitSet_Disjunction (*class in pysubgroup.representations*), 36
BitSetRepresentation (*class in pysubgroup.representations*), 36
BooleanExpressionBase (*class in pysubgroup.subgroup_description*), 37
BoundedInterestingnessMeasure (*class in pysubgroup.measures*), 31

C

calculate_constant_statistics() (*pysubgroup.binary_target.SimplePositivesQF method*), 28
calculate_constant_statistics() (*pysubgroup.fi_target.SimpleCountQF method*), 29

calculate_constant_statistics() (*pysubgroup.measures.CombinedInterestingnessMeasure method*), 31
calculate_constant_statistics() (*pysubgroup.measures.GeneralizationAwareQF method*), 31
calculate_constant_statistics() (*pysubgroup.measures.GeneralizationAwareQF_stats method*), 32
calculate_constant_statistics() (*pysubgroup.model_target.EMM_Likelihood method*), 32
calculate_constant_statistics() (*pysubgroup.model_target.PolyRegression_ModelClass method*), 32
calculate_constant_statistics() (*pysubgroup.numeric_target.StandardQFNumeric method*), 34
calculate_constant_statistics() (*pysubgroup.numeric_target.StandardQFNumeric.AverageEvaluator method*), 33
calculate_constant_statistics() (*pysubgroup.numeric_target.StandardQFNumeric.OrderingEvaluator method*), 34
calculate_constant_statistics() (*pysubgroup.numeric_target.StandardQFNumeric.SummationEvaluator method*), 34
calculate_constant_statistics() (*pysubgroup.numeric_target.StandardQFNumericMedian method*), 35
calculate_constant_statistics() (*pysubgroup.numeric_target.StandardQFNumericMedian.AverageEvaluator method*), 34
calculate_constant_statistics() (*pysubgroup.numeric_target.StandardQFNumericMedian.OrderingEvaluator method*), 34
calculate_constant_statistics() (*pysubgroup.numeric_target.StandardQFNumericMedian.SummationEvaluator method*), 34
calculate_constant_statistics() (*pysubgroup.numeric_target.StandardQFNumericTscore method*), 35
calculate_constant_statistics() (*pysubgroup.numeric_target.StandardQFNumericTscore.AverageEvaluator method*), 35
calculate_constant_statistics() (*pysubgroup.numeric_target.StandardQFNumericTscore.OrderingEvaluator method*), 35
calculate_constant_statistics() (*pysubgroup.numeric_target.StandardQFNumericTscore.SummationEvaluator method*), 35
calculate_quality_function_for_patterns() (*pysubgroup.gp_growth.GpGrowth method*), 30
calculate_statistics() (*pysubgroup.binary_target.BinaryTarget method*), 26
calculate_statistics() (*pysubgroup.binary_target.SimplePositivesQF method*), 28
calculate_statistics() (*pysubgroup.fi_target.FITarget method*), 29
calculate_statistics() (*pysubgroup.fi_target.SimpleCountQF method*), 29
calculate_statistics() (*pysubgroup.measures.CombinedInterestingnessMeasure method*), 31
calculate_statistics() (*pysubgroup.measures.CountCallsInterestingMeasure method*), 31
calculate_statistics() (*pysubgroup.measures.GeneralizationAwareQF method*), 31
calculate_statistics() (*pysubgroup.measures.GeneralizationAwareQF_stats method*), 32
calculate_statistics() (*pysubgroup.model_target.EMM_Likelihood method*), 32
calculate_statistics() (*pysubgroup.numeric_target.NumericTarget method*), 33
calculate_statistics() (*pysubgroup.numeric_target.StandardQFNumeric method*), 34
calculate_statistics() (*pysubgroup.numeric_target.StandardQFNumericMedian method*), 35
calculate_statistics() (*pysubgroup.numeric_target.StandardQFNumericTscore method*), 35
check_constraints() (*pysubgroup.gp_growth.GpGrowth method*), 30
check_tree_is_ordered() (*pysubgroup.gp_growth.GpGrowth method*), 30
chi_squared_qf() (*pysubgroup.binary_target.ChiSquaredQF static method*), 26
chi_squared_qf_weighted() (*pysubgroup.binary_target.ChiSquaredQF static method*), 27
ChiSquaredQF (*class in pysubgroup.binary_target*), 26
CombinedInterestingnessMeasure (*class in pysubgroup.measures*), 31
compare_distributions_numeric() (*in module pysubgroup.visualization*), 41
compute_descriptions() (*pysubgroup.subgroup_description.EqualitySelector*

class method), 38
compute_descriptions() (*pysubgroup.subgroup_description.IntervalSelector class method*), 38
compute_representation() (*pysubgroup.representations.BitSet_Conjunction method*), 36
compute_representation() (*pysubgroup.representations.BitSet_Disjunction method*), 36
compute_representation() (*pysubgroup.representations.NumpySet_Conjunction method*), 37
compute_representation() (*pysubgroup.representations.Set_Conjunction method*), 37
compute_string() (*pysubgroup.subgroup_description.IntervalSelector class method*), 39
conditional_invert() (*in module pysubgroup.utils*), 40
Conjunction (*class in pysubgroup.subgroup_description*), 37
Conjunction (*pysubgroup.representations.BitSetRepresentation attribute*), 36
Conjunction (*pysubgroup.representations.NumpySetRepresentation attribute*), 36
Conjunction (*pysubgroup.representations.SetRepresentation attribute*), 37
constraints_satisfied() (*in module pysubgroup.algorithms*), 26
convert_results_to_subgroups() (*pysubgroup.gp_growth.GpGrowth method*), 30
count_bits() (*in module pysubgroup.utils*), 40
CountCallsInterestingMeasure (*class in pysubgroup.measures*), 31
CountQF (*class in pysubgroup.fi_target*), 29
covers() (*pysubgroup.binary_target.BinaryTarget method*), 26
covers() (*pysubgroup.subgroup_description.Conjunction method*), 38
covers() (*pysubgroup.subgroup_description.Disjunction method*), 38
covers() (*pysubgroup.subgroup_description.EqualitySelector method*), 38
covers() (*pysubgroup.subgroup_description.IntervalSelector method*), 39
covers() (*pysubgroup.subgroup_description.NegatedSelector method*), 39
create_copy_of_path() (*pysubgroup.gp_growth.GpGrowth method*), 30
create_copy_of_tree_top_down() (*pysubgroup.gp_growth.GpGrowth method*), 30
create_initial_tree() (*pysubgroup.gp_growth.GpGrowth method*), 30
create_new_tree_from_nodes() (*pysubgroup.gp_growth.GpGrowth method*), 30
create_nominal_selectors() (*in module pysubgroup.subgroup_description*), 39
create_nominal_selectors_for_attribute() (*in module pysubgroup.subgroup_description*), 39
create_numeric_selectors() (*in module pysubgroup.subgroup_description*), 39
create_numeric_selectors_for_attribute() (*in module pysubgroup.subgroup_description*), 39
create_selectors() (*in module pysubgroup.subgroup_description*), 39

D

depth (*pysubgroup.subgroup_description.Conjunction property*), 38
derive_effective_sample_size() (*in module pysubgroup.utils*), 40
DFS (*class in pysubgroup.algorithms*), 25
DFSNumeric (*class in pysubgroup.algorithms*), 25
Disjunction (*class in pysubgroup.subgroup_description*), 38
Disjunction (*pysubgroup.representations.BitSetRepresentation attribute*), 36
DNF (*class in pysubgroup.subgroup_description*), 38

E

EMM_Likelihood (*class in pysubgroup.model_target*), 32
ensure_statistics() (*pysubgroup.measures.AbstractInterestingnessMeasure method*), 31
equal_frequency_discretization() (*in module pysubgroup.utils*), 40
EqualitySelector (*class in pysubgroup.subgroup_description*), 38
evaluate() (*pysubgroup.binary_target.ChiSquaredQF method*), 27
evaluate() (*pysubgroup.binary_target.GeneralizationAware_StandardQF method*), 27
evaluate() (*pysubgroup.binary_target.StandardQF method*), 28
evaluate() (*pysubgroup.fi_target.AreaQF method*), 29
evaluate() (*pysubgroup.fi_target.CountQF method*), 29
evaluate() (*pysubgroup.measures.CombinedInterestingnessMeasure method*), 31
evaluate() (*pysubgroup.measures.GeneralizationAwareQF method*), 31
evaluate() (*pysubgroup.measures.GeneralizationAwareQF_stats method*), 32
evaluate() (*pysubgroup.model_target.EMM_Likelihood method*), 32
evaluate() (*pysubgroup.numeric_target.StandardQFNumeric method*), 34

evaluate() (*pysubgroup.numeric_target.StandardQFNumericMedian method*), 35
evaluate() (*pysubgroup.numeric_target.StandardQFNumericTscore method*), 35
evaluate_from_statistics() (*pysubgroup.measures.CombinedInterestingnessMeasure method*), 31
execute() (*pysubgroup.algorithms.Apriori method*), 25
execute() (*pysubgroup.algorithms.BeamSearch method*), 25
execute() (*pysubgroup.algorithms.BestFirstSearch method*), 25
execute() (*pysubgroup.algorithms.DFS method*), 25
execute() (*pysubgroup.algorithms.DFSNumeric method*), 25
execute() (*pysubgroup.algorithms.GeneralisingBFS method*), 26
execute() (*pysubgroup.algorithms.SimpleDFS method*), 26
execute() (*pysubgroup.algorithms.SimpleSearch method*), 26
execute() (*pysubgroup.gp_growth.GpGrowth method*), 30

F

find_set_bits() (*in module pysubgroup.utils*), 40
fit() (*pysubgroup.model_target.PolyRegression_ModelClass method*), 32
FITarget (*class in pysubgroup.fi_target*), 29
float_formatter() (*in module pysubgroup.utils*), 40
from_str() (*pysubgroup.subgroup_description.ConjunctionSelector static method*), 38
from_str() (*pysubgroup.subgroup_description.EqualitySelector static method*), 38
from_str() (*pysubgroup.subgroup_description.IntervalSelector static method*), 39

G

ga_tuple (*pysubgroup.measures.GeneralizationAwareQF_stats attribute*), 32
generalisation_quality (*pysubgroup.measures.GeneralizationAwareQF.ga_tuple attribute*), 31
GeneralisingBFS (*class in pysubgroup.algorithms*), 26
GeneralizationAware_StandardQF (*class in pysubgroup.binary_target*), 27
GeneralizationAwareQF (*class in pysubgroup.measures*), 31
GeneralizationAwareQF.ga_tuple (*class in pysubgroup.measures*), 31
GeneralizationAwareQF_stats (*class in pysubgroup.measures*), 32
get_attributes() (*pysubgroup.binary_target.BinaryTarget method*), 26
get_attributes() (*pysubgroup.fi_target.FITarget method*), 29
get_attributes() (*pysubgroup.numeric_target.NumericTarget method*), 33
get_base_statistics() (*pysubgroup.binary_target.BinaryTarget method*), 26
get_base_statistics() (*pysubgroup.fi_target.FITarget method*), 29
get_base_statistics() (*pysubgroup.numeric_target.NumericTarget method*), 33
get_cover_array_and_size() (*in module pysubgroup.subgroup_description*), 39
get_credit_data() (*in module pysubgroup.datasets*), 29
get_data() (*pysubgroup.numeric_target.StandardQFNumeric.Average_Es method*), 33
get_data() (*pysubgroup.numeric_target.StandardQFNumeric.Ordering_E method*), 34
get_data() (*pysubgroup.numeric_target.StandardQFNumeric.Summation_ method*), 34
get_data() (*pysubgroup.numeric_target.StandardQFNumericMedian.Ave method*), 34
get_data() (*pysubgroup.numeric_target.StandardQFNumericMedian.Ord method*), 34
get_data() (*pysubgroup.numeric_target.StandardQFNumericMedian.Sum method*), 34
get_data() (*pysubgroup.numeric_target.StandardQFNumericTscore.Aver method*), 35
get_data() (*pysubgroup.numeric_target.StandardQFNumericTscore.Orde method*), 35
get_data() (*pysubgroup.numeric_target.StandardQFNumericTscore.Sum method*), 35
get_estimate() (*pysubgroup.numeric_target.StandardQFNumeric.Average_Estimator method*), 33
get_estimate() (*pysubgroup.numeric_target.StandardQFNumeric.Ordering_Estimator method*), 34
get_estimate() (*pysubgroup.numeric_target.StandardQFNumeric.Summation_Estimato method*), 34
get_estimate() (*pysubgroup.numeric_target.StandardQFNumericMedian.Average_Estim method*), 34
get_estimate() (*pysubgroup.numeric_target.StandardQFNumericMedian.Ordering_Est method*), 34
get_estimate() (*pysubgroup.numeric_target.StandardQFNumericMedian.Summation_E method*), 35

get_estimate() (*pysubgroup.numeric_target.StandardQFNumericTscore.Average_Estimator method*), 35
get_estimate() (*pysubgroup.numeric_target.StandardQFNumericTscore.Ordering_Estimator method*), 35
get_estimate() (*pysubgroup.numeric_target.StandardQFNumericTscore.Summation_Estimator method*), 35
get_estimate_numpy() (*pysubgroup.numeric_target.StandardQFNumeric.Ordering_Estimator method*), 34
get_estimate_numpy() (*pysubgroup.numeric_target.StandardQFNumericMedian.Ordering_Estimator method*), 34
get_estimate_numpy() (*pysubgroup.numeric_target.StandardQFNumericTscore.Ordering_Estimator method*), 35
get_max() (*pysubgroup.binary_target.GeneralizationAwareQF method*), 27
get_max() (*pysubgroup.measures.GeneralizationAwareQF method*), 32
get_next_level() (*pysubgroup.algorithms.Apriori method*), 25
get_next_level_candidates() (*pysubgroup.algorithms.Apriori method*), 25
get_next_level_candidates_vectorized() (*pysubgroup.algorithms.Apriori method*), 25
get_next_level_numba() (*pysubgroup.algorithms.Apriori method*), 25
get_nodes_upwards() (*pysubgroup.gp_growth.GpGrowth method*), 30
get_qual_and_previous_qual() (*pysubgroup.measures.GeneralizationAwareQF method*), 32
get_size() (*in module pysubgroup.subgroup_description*), 39
get_stats_and_previous_stats() (*pysubgroup.measures.GeneralizationAwareQF_stats method*), 32
get_stats_for_class() (*pysubgroup.gp_growth.GpGrowth method*), 30
get_titanic_data() (*in module pysubgroup.datasets*), 29
get_top_down_tree_for_class() (*pysubgroup.gp_growth.GpGrowth method*), 30
get_tuple() (*pysubgroup.model_target.EMM_Likelihood method*), 32
gp_get_null_vector() (*pysubgroup.binary_target.SimplePositivesQF method*), 28
gp_get_null_vector() (*pysubgroup.fi_target.SimpleCountQF method*), 29
gp_get_null_vector() (*pysubgroup.model_target.PolyRegression_ModelClass method*), 33
gp_get_params() (*pysubgroup.binary_target.SimplePositivesQF method*), 28
gp_get_params() (*pysubgroup.fi_target.SimpleCountQF method*), 29
gp_get_params() (*pysubgroup.model_target.EMM_Likelihood method*), 32
gp_get_params() (*pysubgroup.model_target.PolyRegression_ModelClass method*), 33
gp_get_stats() (*pysubgroup.binary_target.SimplePositivesQF method*), 28
gp_get_stats() (*pysubgroup.fi_target.SimpleCountQF method*), 30
gp_get_stats() (*pysubgroup.model_target.PolyRegression_ModelClass method*), 33
gp_is_satisfied() (*pysubgroup.constraints.MinSupportConstraint method*), 29
gp_merge() (*pysubgroup.binary_target.SimplePositivesQF method*), 28
gp_merge() (*pysubgroup.fi_target.SimpleCountQF method*), 30
gp_merge() (*pysubgroup.model_target.PolyRegression_ModelClass static method*), 33
gp_prepare() (*pysubgroup.constraints.MinSupportConstraint method*), 29
gp_requires_cover_arr (*pysubgroup.binary_target.SimplePositivesQF property*), 28
gp_requires_cover_arr (*pysubgroup.fi_target.SimpleCountQF attribute*), 30
gp_requires_cover_arr (*pysubgroup.model_target.EMM_Likelihood property*), 32
gp_requires_cover_arr (*pysubgroup.model_target.PolyRegression_ModelClass property*), 33
gp_size_sg() (*pysubgroup.binary_target.SimplePositivesQF method*), 28
gp_size_sg() (*pysubgroup.fi_target.SimpleCountQF method*), 30
gp_size_sg() (*pysubgroup.model_target.PolyRegression_ModelClass*

method), 33
gp_to_str() (*pysubgroup.binary_target.SimplePositivesQF method*), 28
gp_to_str() (*pysubgroup.fi_target.SimpleCountQF method*), 30
gp_to_str() (*pysubgroup.model_target.PolyRegression_ModelClass method*), 33
GpGrowth (*class in pysubgroup.gp_growth*), 30

I

identity() (*in module pysubgroup.gp_growth*), 31
intersect_of_ordered_list() (*in module pysubgroup.utils*), 40
IntervalSelector (*class in pysubgroup.subgroup_description*), 38
is_categorical_attribute() (*in module pysubgroup.utils*), 40
is_monotone (*pysubgroup.constraints.MinSupportConstraint property*), 29
is_numerical_attribute() (*in module pysubgroup.utils*), 40
is_satisfied() (*pysubgroup.constraints.MinSupportConstraint method*), 29

L

LiftQF (*class in pysubgroup.binary_target*), 27
likelihood() (*pysubgroup.model_target.PolyRegression_ModelClass method*), 33
loglikelihood() (*pysubgroup.model_target.PolyRegression_ModelClass method*), 33
lower_bound (*pysubgroup.subgroup_description.IntervalSelector property*), 39

M

maximum_statistic_filter() (*in module pysubgroup.measures*), 32
merge_trees_top_down() (*pysubgroup.gp_growth.GpGrowth method*), 30
minimum_quality_filter() (*in module pysubgroup.measures*), 32
minimum_required_quality() (*in module pysubgroup.utils*), 40
minimum_statistic_filter() (*in module pysubgroup.measures*), 32
MinSupportConstraint (*class in pysubgroup.constraints*), 29
module
    pysubgroup, 41
    pysubgroup.algorithms, 25
    pysubgroup.binary_target, 26
    pysubgroup.constraints, 29
    pysubgroup.datasets, 29
    pysubgroup.fi_target, 29
    pysubgroup.gp_growth, 30
    pysubgroup.measures, 31
    pysubgroup.model_target, 32
    pysubgroup.numeric_target, 33
    pysubgroup.refinement_operator, 36
    pysubgroup.representations, 36
    pysubgroup.subgroup_description, 37
    pysubgroup.utils, 40
    pysubgroup.visualization, 41

N

n_instances (*pysubgroup.representations.BitSet_Conjunction attribute*), 36
NegatedSelector (*class in pysubgroup.subgroup_description*), 39
nodes_to_cls_nodes() (*pysubgroup.gp_growth.GpGrowth method*), 30
normal_insert() (*pysubgroup.gp_growth.GpGrowth method*), 30
NumericTarget (*class in pysubgroup.numeric_target*), 33
NumpySet_Conjunction (*class in pysubgroup.representations*), 37
NumpySetRepresentation (*class in pysubgroup.representations*), 36

O

optimistic_estimate() (*pysubgroup.binary_target.StandardQF method*), 28
optimistic_estimate() (*pysubgroup.fi_target.CountQF method*), 29
optimistic_estimate() (*pysubgroup.measures.CombinedInterestingnessMeasure method*), 31
optimistic_estimate() (*pysubgroup.numeric_target.StandardQFNumeric method*), 34
optimistic_estimate() (*pysubgroup.numeric_target.StandardQFNumericMedian method*), 35
optimistic_estimate() (*pysubgroup.numeric_target.StandardQFNumericTscore method*), 35
optimistic_generalisation() (*pysubgroup.binary_target.StandardQF method*), 28
overlap() (*in module pysubgroup.utils*), 40
overlap_filter() (*in module pysubgroup.measures*), 32
overlaps_list() (*in module pysubgroup.measures*), 32

P

patch_all_selectors() (*pysubgroup.representations.RepresentationBase method*), 37
patch_classes() (*pysubgroup.representations.BitSetRepresentation method*), 36
patch_classes() (*pysubgroup.representations.NumpySetRepresentation method*), 36
patch_classes() (*pysubgroup.representations.RepresentationBase method*), 37
patch_classes() (*pysubgroup.representations.SetRepresentation method*), 37
patch_selector() (*pysubgroup.representations.BitSetRepresentation method*), 36
patch_selector() (*pysubgroup.representations.NumpySetRepresentation method*), 36
patch_selector() (*pysubgroup.representations.RepresentationBase method*), 37
patch_selector() (*pysubgroup.representations.SetRepresentation method*), 37
perc_formatter() (*in module pysubgroup.utils*), 40
plot_distribution_numeric() (*in module pysubgroup.visualization*), 41
plot_npspace() (*in module pysubgroup.visualization*), 41
plot_roc() (*in module pysubgroup.visualization*), 41
plot_sgbars() (*in module pysubgroup.visualization*), 41
PolyRegression_ModelClass (*class in pysubgroup.model_target*), 32
pop_and() (*pysubgroup.subgroup_description.Conjunction method*), 38
pop_and() (*pysubgroup.subgroup_description.DNF method*), 38
pop_or() (*pysubgroup.subgroup_description.Conjunction method*), 38
powerset() (*in module pysubgroup.utils*), 40
prepare_selectors() (*pysubgroup.gp_growth.GpGrowth method*), 30
prepare_subgroup_discovery_result() (*in module pysubgroup.utils*), 40
pysubgroup
    module, 41
pysubgroup.algorithms
    module, 25
pysubgroup.binary_target
    module, 26
pysubgroup.constraints
    module, 29
pysubgroup.datasets
    module, 29
pysubgroup.fi_target
    module, 29
pysubgroup.gp_growth
    module, 30
pysubgroup.measures
    module, 31
pysubgroup.model_target
    module, 32
pysubgroup.numeric_target
    module, 33
pysubgroup.refinement_operator
    module, 36
pysubgroup.representations
    module, 36
pysubgroup.subgroup_description
    module, 37
pysubgroup.utils
    module, 40
pysubgroup.visualization
    module, 41

R

recurse() (*pysubgroup.gp_growth.GpGrowth method*), 30
recurse_top_down() (*pysubgroup.gp_growth.GpGrowth method*), 30
RefinementOperator (*class in pysubgroup.refinement_operator*), 36
refinements() (*pysubgroup.refinement_operator.StaticGeneralizationOperator method*), 36
refinements() (*pysubgroup.refinement_operator.StaticSpecializationOperator method*), 36
remove_selectors_with_attributes() (*in module pysubgroup.utils*), 40
remove_selectors_with_low_optimistic_estimate() (*pysubgroup.gp_growth.GpGrowth method*), 30
remove_target_attributes() (*in module pysubgroup.subgroup_description*), 39
RepresentationBase (*class in pysubgroup.representations*), 37
results_df_autoround() (*in module pysubgroup.utils*), 41

S

search_internal() (*pysubgroup.algorithms.DFS method*), 25

search_internal() (*pysubgroup.algorithms.DFSNumeric method*), 25
search_internal() (*pysubgroup.algorithms.SimpleDFS method*), 26
SelectorBase (*class in pysubgroup.subgroup_description*), 39
selectors (*pysubgroup.subgroup_description.Conjunction property*), 38
selectors (*pysubgroup.subgroup_description.Disjunction property*), 38
selectors (*pysubgroup.subgroup_description.EqualitySelector property*), 38
selectors (*pysubgroup.subgroup_description.IntervalSelector property*), 39
selectors (*pysubgroup.subgroup_description.NegatedSelector property*), 39
Set_Conjunction (*class in pysubgroup.representations*), 37
set_descriptions() (*pysubgroup.subgroup_description.EqualitySelector method*), 38
set_descriptions() (*pysubgroup.subgroup_description.IntervalSelector method*), 39
set_descriptions() (*pysubgroup.subgroup_description.NegatedSelector method*), 39
set_descriptions() (*pysubgroup.subgroup_description.SelectorBase method*), 39
SetRepresentation (*class in pysubgroup.representations*), 37
setup() (*pysubgroup.gp_growth.GpGrowth method*), 31
setup_constraints() (*pysubgroup.gp_growth.GpGrowth method*), 31
setup_from_quality_function() (*pysubgroup.gp_growth.GpGrowth method*), 31
similarity_dendrogram() (*in module pysubgroup.visualization*), 41
similarity_sgs() (*in module pysubgroup.visualization*), 41
SimpleBinomialQF (*class in pysubgroup.binary_target*), 27
SimpleCountQF (*class in pysubgroup.fi_target*), 29
SimpleDFS (*class in pysubgroup.algorithms*), 26
SimplePositivesQF (*class in pysubgroup.binary_target*), 28
SimpleSearch (*class in pysubgroup.algorithms*), 26
size_sg (*pysubgroup.model_target.beta_tuple attribute*), 33
size_sg (*pysubgroup.representations.BitSet_Conjunction property*), 36
size_sg (*pysubgroup.representations.BitSet_Disjunction property*), 36
size_sg (*pysubgroup.representations.NumpySet_Conjunction property*), 37
size_sg (*pysubgroup.representations.Set_Conjunction property*), 37
standard_qf() (*pysubgroup.binary_target.StandardQF static method*), 28
standard_qf_numeric() (*pysubgroup.numeric_target.StandardQFNumeric static method*), 34
standard_qf_numeric() (*pysubgroup.numeric_target.StandardQFNumericMedian static method*), 35
standard_qf_numeric() (*pysubgroup.numeric_target.StandardQFNumericTscore static method*), 35
StandardQF (*class in pysubgroup.binary_target*), 28
StandardQFNumeric (*class in pysubgroup.numeric_target*), 33
StandardQFNumeric.Average_Estimator (*class in pysubgroup.numeric_target*), 33
StandardQFNumeric.Ordering_Estimator (*class in pysubgroup.numeric_target*), 33
StandardQFNumeric.Summation_Estimator (*class in pysubgroup.numeric_target*), 34
StandardQFNumericMedian (*class in pysubgroup.numeric_target*), 34
StandardQFNumericMedian.Average_Estimator (*class in pysubgroup.numeric_target*), 34
StandardQFNumericMedian.Ordering_Estimator (*class in pysubgroup.numeric_target*), 34
StandardQFNumericMedian.Summation_Estimator (*class in pysubgroup.numeric_target*), 34
StandardQFNumericTscore (*class in pysubgroup.numeric_target*), 35
StandardQFNumericTscore.Average_Estimator (*class in pysubgroup.numeric_target*), 35
StandardQFNumericTscore.Ordering_Estimator (*class in pysubgroup.numeric_target*), 35
StandardQFNumericTscore.Summation_Estimator (*class in pysubgroup.numeric_target*), 35
StaticGeneralizationOperator (*class in pysubgroup.refinement_operator*), 36
StaticSpecializationOperator (*class in pysubgroup.refinement_operator*), 36
statistic_types (*pysubgroup.binary_target.BinaryTarget attribute*), 26
statistic_types (*pysubgroup.fi_target.FITarget attribute*), 29
statistic_types (*pysubgroup.numeric_target.NumericTarget attribute*), 33
subgroup_quality (*pysub-*

group.measures.GeneralizationAwareQF.ga_tuple attribute), 31
SubgroupDiscoveryResult (*class in pysubgroup.utils*), 40
SubgroupDiscoveryTask (*class in pysubgroup.algorithms*), 26
supportSetVisualization() (*in module pysubgroup.visualization*), 41

T

to_bits() (*in module pysubgroup.utils*), 41
to_dataframe() (*pysubgroup.utils.SubgroupDiscoveryResult method*), 40
to_descriptions() (*pysubgroup.utils.SubgroupDiscoveryResult method*), 40
to_file() (*pysubgroup.gp_growth.GpGrowth method*), 31
to_latex() (*pysubgroup.utils.SubgroupDiscoveryResult method*), 40
to_table() (*pysubgroup.utils.SubgroupDiscoveryResult method*), 40
tpl (*pysubgroup.algorithms.DFSNumeric attribute*), 25
tpl (*pysubgroup.binary_target.SimplePositivesQF attribute*), 28
tpl (*pysubgroup.fi_target.SimpleCountQF attribute*), 30
tpl (*pysubgroup.model_target.EMM_Likelihood attribute*), 32
tpl (*pysubgroup.numeric_target.StandardQFNumeric attribute*), 34
tpl (*pysubgroup.numeric_target.StandardQFNumericMedian attribute*), 35
tpl (*pysubgroup.numeric_target.StandardQFNumericTscore attribute*), 35

U

undo_patch_classes() (*pysubgroup.representations.RepresentationBase method*), 37
unique_attributes() (*in module pysubgroup.measures*), 32
upper_bound (*pysubgroup.subgroup_description.IntervalSelector property*), 39

W

WRAccQF (*class in pysubgroup.binary_target*), 28