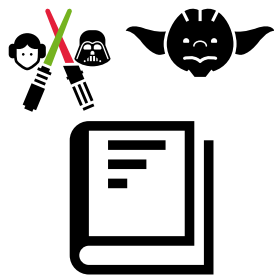

galactic user guide

The Galactic Organization <contact@thegalactic.org>



0.1.0

Contents

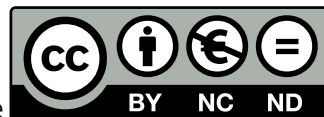
1	Introduction	4
2	Applications	4
2.1	The <code>galactic-laser-bin</code> tool	4
2.2	The <code>galactic-laser-ui</code> tool	6
3	Data readers	9
3.1	<i>YAML</i> data reader	10
3.2	<i>JSON</i> data reader	11
3.3	<i>CSV</i> data reader	11
3.4	<i>TOML</i> data reader	12
3.5	<i>INI</i> data reader	12
3.6	<i>TEXT</i> data reader	12
3.7	<i>FIMI</i> data reader	13
3.8	<i>Burmeister</i> data reader	13
3.9	<i>SLF</i> data reader	14
4	Explorers	16
4.1	Characteristics	16
4.1.1	<i>core</i>	16
4.1.2	<i>logical</i> characteristic plugin	17
4.1.3	<i>categorized</i> characteristic plugin	17
4.1.4	<i>numerical</i> characteristic plugin	19
4.1.5	<i>string</i> plugin	19
4.1.6	<i>chain</i> plugin	20
4.1.7	<i>sequence</i> plugin	21
4.2	Descriptions and predicates	22
4.2.1	<i>core</i>	22
4.2.1.1	Predicates	22
4.2.2	<i>logical</i> classical description plugin	23
4.2.2.1	Descriptions	23
4.2.3	<i>logical</i> clause description plugin	23
4.2.3.1	Predicates	23
4.2.3.2	Descriptions	25
4.2.4	<i>categorized</i> description plugin	25
4.2.4.1	Predicates	25
4.2.4.2	Descriptions	26

4.2.5	<i>numerical hull description plugin</i>	26
4.2.5.1	Predicates	26
4.2.5.2	Descriptions	27
4.2.6	<i>string match description plugin</i>	27
4.2.6.1	Predicates	27
4.2.6.2	Descriptions	28
4.2.7	<i>string distance description plugin</i>	28
4.2.7.1	Predicates	28
4.2.7.2	Descriptions	29
4.2.8	<i>chain plugin</i>	29
4.2.8.1	Predicates	29
4.2.8.2	Descriptions	30
4.2.9	<i>sequence match description plugin</i>	30
4.2.9.1	Predicates	31
4.2.9.2	Descriptions	31
4.2.10	<i>sequence distance description plugin</i>	31
4.2.10.1	Predicates	32
4.2.10.2	Descriptions	32
4.2.11	<i>triadic description plugin</i>	32
4.2.11.1	Predicates	33
4.2.11.2	Descriptions	33
4.3	Strategies	33
4.3.1	<i>core strategies</i>	33
4.3.2	Logical basic classical strategy	35
4.3.3	Logical clause basic strategy	35
4.3.4	<i>basic categorized subset strategy</i>	36
4.3.5	<i>numerical hull basic strategy</i>	37
4.3.6	Numerical hull quantile strategies	38
4.3.7	<i>string match basic strategies</i>	39
4.3.8	<i>string distance basic strategies</i>	41
4.3.9	<i>chain match basic strategies</i>	41
4.3.10	<i>sequence match basic strategy</i>	42
4.3.11	<i>sequence distance basic strategy</i>	43
4.3.12	<i>basic triadic strategies</i>	44
4.4	Measures	45
4.4.1	<i>core measures</i>	45
4.4.2	<i>entropy measure</i>	45

List of Figures

1	galactic-laser data window	7
2	galactic-laser data dialog	8
3	galactic-laser option chooser	9
4	galactic-laser action buttons	9

1 Introduction



This document is produced under the CC-by-nc-nd licence

The `py-galactic-bin` project includes several applications using the `py-galactic-core` library.

- `galactic-laser` is able to draw the Hasse diagram of a concept lattice using a data file and an optional explorer file.

2 Applications

2.1 The `galactic-laser-bin` tool

`galactic-laser-bin` is the console application able to draw the Hasse diagram of a concept lattice.

You can check the available options using:

```
$ galactic-laser-bin -h
```

or

```
$ galactic-laser-bin --help
```

```
$ galactic-laser-bin -h
usage: galactic-laser-bin [-h] [--explorer EXPLORER] [--mode {compact,full}]
                        [--join-irreducible-color JOIN-IRREDUCIBLE-COLOR]
```

¹© 2018-2020 the Galactic Organization. This document is licensed under CC-by-nc-nd (<https://creativecommons.org/licenses/by-nc-nd/4.0/deed.en>)

```
        [--meet-irreducible-color MEET-IRREDUCIBLE-COLOR]
        [--log]
        DATA [OUTPUT]
```

Create Hasse diagram image file from a data file.

positional arguments:

```
  DATA          data file using format: .yaml, .yml, .toml, .txt,
                  .slf, .json, .ini, .dat, .csv, .cxt
  OUTPUT         Hasse diagram image file in .pdf, .svg, .png, .jpg,
                  .jpeg or .dot format
```

optional arguments:

```
-h, --help          show this help message and exit
--explorer EXPLORER  explorer in .yaml format
--mode {compact,full}
                    display individuals in compact or full form
--join-irreducible-color JOIN-IRREDUCIBLE-COLOR
                    graphviz color for join irreducible concept (see
                    http://graphviz.org/doc/info/colors.html) or use
                    '#colorcode' from '#000000' 'to' '#FFFFFF'
--meet-irreducible-color MEET-IRREDUCIBLE-COLOR
                    graphviz color for meet irreducible concept (see
                    http://graphviz.org/doc/info/colors.html) or use
                    '#colorcode' from '#000000' 'to' '#FFFFFF'
--log              log operations
```

Do. Or do not. There is no try. - Yoda

You need to indicate a path for the image that will be generated and its extension.

Example:

```
$ galactic-laser-bin \
  --join-irreducible-color '#123456' \
  /data/animals.yaml \
  /data/animals.svg
```

2.2 The `galactic-laser-ui` tool

To launch the application, type in your terminal

```
$ galactic-laser-ui
```

The application window will open. Then you have to click on the data button.



Figure 1: galactic-laser data window

If nothing happens, check your installation of the *galactic* eco-system: [Installation guide](#).

This action will open a dialog box, then you will have to look for a supported data file.

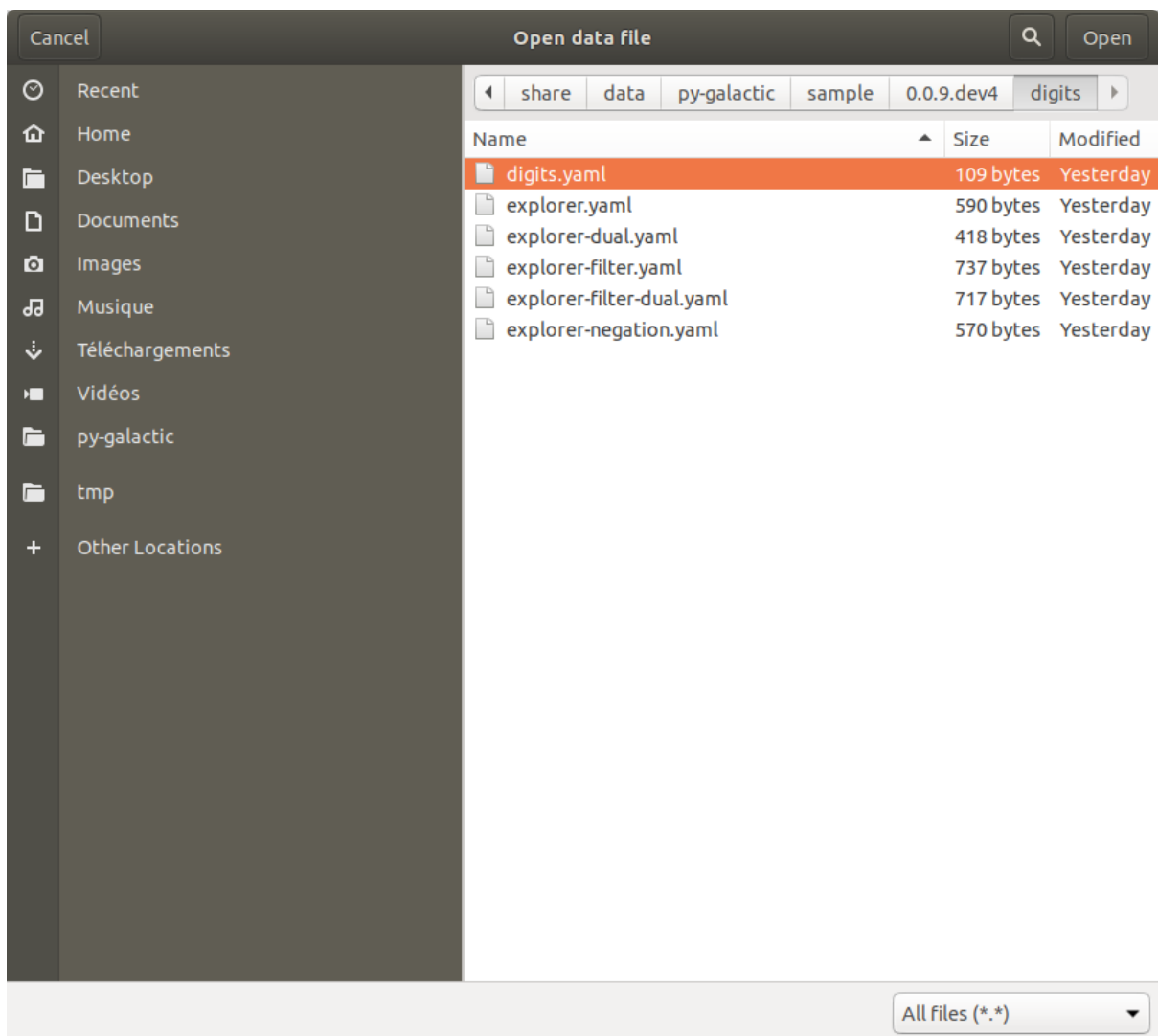


Figure 2: galactic-laser data dialog

Once the data file is chosen, you have several possible interactions.

It is possible to add an explorer file or the application will try to use a default behaviour.

You can change:

- the colors of the nodes for the current concept, the join-irreducible and the meet-irreducible;
- the node mode to the compact or complete nodes;
- the trace mode
- the draw mode.

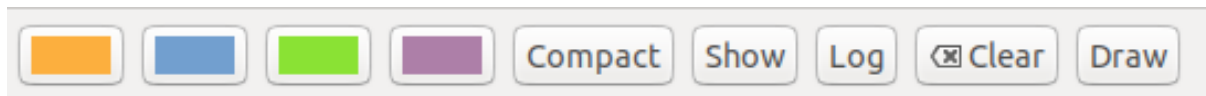


Figure 3: galactic-laser option chooser

To create the graph, just click on the 'Start' button.

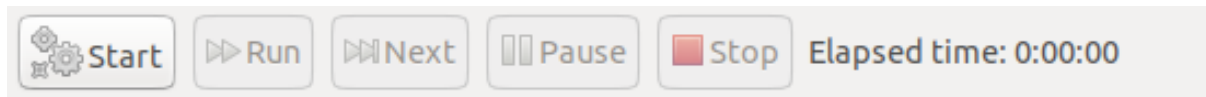


Figure 4: galactic-laser action buttons

Then you have two choices:

- click on the 'Next' button if you want to process step by step;
- click on the 'Run' button with the possibility to pause or stop.

If the drawing is just paused, there are possibilities to either continue or switch to the step-by-step mode.

If there is a press on the 'Stop' button the drawing will be stopped and you will have to start again from the beginning.

3 Data readers

Data readers are used by the different applications to read contexts. They are organized in plugins, so the *py-galactic-core* engine can be easily extended. For now on, here is the list of readers we have developed:

- *YAML* data reader
- *JSON* data reader
- *CSV* data reader
- *TOML* data reader
- *INI* data reader
- *TEXT* data reader
- *FIMI* data reader
- *Burmeister* data reader
- *SLF* data reader

Data reader	Boolean characteristics	Heterogenous characteristics	Complex characteristics
<i>YAML</i>	yes	yes	yes
<i>JSON</i>	yes	yes	yes
<i>CSV</i>	yes	yes	no
<i>TOML</i>	yes	yes	no
<i>INI</i>	yes	yes	no
<i>FIMI</i>	yes	no	no
<i>Text</i>	yes	no	no
<i>Burmeister</i>	yes	no	no
<i>SLF</i>	yes	no	no

3.1 *YAML* data reader

py-galactic-reader-yaml is a [YAML](#) data reader plugin for *py-galactic*.

It uses the `yaml.load` function of the [PyYAML](#) library.

The file extension is `.yaml` or `.yml`. The individuals are represented either by:

- a list: individuals are named by an integer starting from 0;
- a dictionary: individuals are named by their keys.

For example:

```
0: [c, e, s]
1: [o, s]
2: [e, p]
3: [o, p]
4: [c, e, s]
5: [o, p]
6: [c, e]
7: [o, p]
8: [c, e]
9: [c, o, s]
```

3.2 JSON data reader

py-galactic-reader-json is a [JSON](#) data reader plugin for *py-galactic*.

The file extension is `.json`. The individuals are either represented by a list or by a dictionary. For example:

```
{
  "#1": {
    "name": "Galois",
    "firstname": "Évariste"
  },
  "#2": {
    "name": "Wille",
    "firstname": "Rudolf"
  }
}
```

This reader uses the `json.load` function of the [python core library](#).

3.3 CSV data reader

py-galactic-reader-csv is a [CSV](#) data reader plugin for *py-galactic*.

The file extension is `.csv`. The first line of each column contains the names of the characteristics. Each new line contains a new individual with its values. For example, an extraction of [Fisher's IRIS](#) data:

```
"sepal length","sepal width","petal length","petal width","class"
5.1,3.5,1.4,0.2,Iris-setosa
4.9,3.0,1.4,0.2,Iris-setosa
4.7,3.2,1.3,0.2,Iris-setosa
4.6,3.1,1.5,0.2,Iris-setosa
5.0,3.6,1.4,0.2,Iris-setosa
7.0,3.2,4.7,1.4,Iris-versicolor
6.4,3.2,4.5,1.5,Iris-versicolor
6.9,3.1,4.9,1.5,Iris-versicolor
5.5,2.3,4.0,1.3,Iris-versicolor
6.5,2.8,4.6,1.5,Iris-versicolor
6.3,3.3,6.0,2.5,Iris-virginica
5.8,2.7,5.1,1.9,Iris-virginica
7.1,3.0,5.9,2.1,Iris-virginica
```

```
6.3,2.9,5.6,1.8,Iris-virginica
```

```
6.5,3.0,5.8,2.2,Iris-virginica
```

This reader uses the `csv.DictReader` class of the [python core library](#).

3.4 TOML data reader

py-galactic-reader-toml is a [TOML](#) data reader plugin for *py-galactic*.

The file extension is `.toml`. The individuals are represented in named sections by key = "value" pairs. For example:

```
[individual1]
  name = "Galois"
  firstname = "Évariste"
[individual2]
  name = "Wille"
  firstname = "Rudolf"
```

This reader uses the `toml.load` function of the [toml library](#).

3.5 INI data reader

py-galactic-reader-ini is an [INI](#) data reader plugin for *py-galactic*.

The file extension is `.ini`. The individuals are represented in named sections by key = "value" pairs. For example:

```
[#1]
name = "Galois"
firstname = "Évariste"
[#2]
name = "Wille"
firstname = "Rudolf"
```

This reader uses the `configparser.ConfigParser` class of the [python core library](#).

3.6 TEXT data reader

py-galactic-reader-text is a [TEXT](#) data reader plugin for *py-galactic*.

The file extension is `.txt`. There is a first section describing the observations and the attributes using the keywords `Observations` and `Attributes`, then each individual is described by a space separated list of attributes. For example:

```
Observations: 1 2 3 4
Attributes: a b c d e
1: a c
2: a b
3: b d e
4: c e
```

3.7 FIMI data reader

py-galactic-reader-fimi is a data reader plugin for *py-galactic*.

It uses the [FIMI format](#).

The file extension is `.dat` and the file format consists in describing each individual in one line using a space separated list of attribute names. For example:

```
c e s
o s
e p
o p
c e s
o p
c e
o p
c e
c o s
```

3.8 Burmeister data reader

py-galactic-reader-burmeister is a data reader plugin for *py-galactic*.

The *Burmeister* context format uses the extension `.cxt`.

Each file is structured as follows:

- the first line consists of a single B;
- the second line is an empty line (its content is ignored);
- the third and fourth lines contain the object and attribute count;

- the fifth line is an empty line (its content is ignored);
- after that, all objects and all attributes are listed, each on a line
- finally, the context is given as a combination of . and X, each row on its own line.

B

10

5

0

1

2

3

4

5

6

7

8

9

c

e

o

p

s

XX..X

..X.X

.X.X.

..XX.

XX..X

..XX.

XX...

..XX.

XX...

X.X.X

3.9 SLF data reader

py-galactic-reader-slf is a data reader plugin for *py-galactic*.

The file extension is `.slf`. The internal format is composed of 4 sections:

- the first section starts with a header containing the keyword `Lattice` surrounded by square brackets. It is followed by two lines containing the number of objects and the number of attributes;
- the second section starts with the keyword `Objects` surrounded by square brackets. It is followed by lines containing the names of the objects;
- the third section starts with the keyword `Attributes` surrounded by square brackets. It is followed by lines containing the names of the attributes;
- the fourth section starts with the keyword `Relation` surrounded by square brackets. It is followed by lines containing the binary relation expressed as a matrix composed of 0 and 1.

For example:

```
[Lattice]
10
5
[Objects]
0
1
2
3
4
5
6
7
8
9
[Attributes]
c
e
o
p
s
[Relation]
1 1 0 0 1
0 0 1 0 1
0 1 0 1 0
0 0 1 1 0
1 1 0 0 1
```

```
0 0 1 1 0
1 1 0 0 0
0 0 1 1 0
1 1 0 0 0
1 0 1 0 1
```

4 Explorers

Explorer files describe how a data file will be processed using a set of strategies. It's a file using the `yaml` format.

```
# ...
- !strategy.categorized.basic.Category
  # parameters of the strategy
- !strategy.numerical.basic.Normal
  # parameters of the strategy
# ...
```

Each `tagged` element is described using a dictionary containing:

- `arguments`: a list of arguments;
- `params`: a list of named parameters.

If the parameters of the element are only a list of arguments or a list of named parameters, you can use directly that list without the use of the (`'arguments'`, `'params'`) notation.

The components supported by the `py-galactic-core` engine comes either from the core library or from plugins.

4.1 Characteristics

4.1.1 core

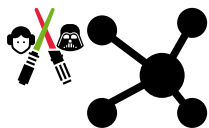
The `core` library exposes 2 characteristic classes known to the console utilities by the following names:

- `characteristic.core.Key` is used to describe an characteristic for a python object using array-like access;
- `characteristic.core.Property` is used to describe a characteristic for a python object using property-like access;

In the following table, the prefix `characteristic.core.` must be added to the names.

Name	Keyword parameters
Key	<ul style="list-style-type: none"> • <code>name</code>: to specify the characteristic name • <code>characteristic</code>: to specify an internal characteristic
Property	<ul style="list-style-type: none"> • <code>name</code>: to specify the characteristic name • <code>characteristic</code>: to specify an internal characteristic

4.1.2 *logical* characteristic plugin



py-galactic-characteristic-logical is a plugin package for *py-galactic*.

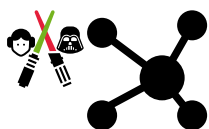
It exposes 1 characteristic classes known to the console utilities by the following name:

- `characteristic.logical.Bool`: to transform a characteristic to a boolean value;

In the following table, the prefix `characteristic.logical.` must be added to the names.

Name	Arguments
<code>Bool</code>	a characteristic to transform

4.1.3 *categorized* characteristic plugin



py-galactic-characteristic-categorized is a plugin package for *py-galactic*.

It exposes 1 characteristic class known to the console utilities by the following name:

- `characteristic.categorized.Category`: to specify a simple category characteristic;

In the following table, the prefix `characteristic.categorized.` must be added to the names.

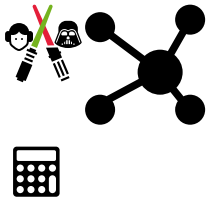
Name	Parameters
Category	<ul style="list-style-type: none"> • a characteristic containing the category

Name	Keyword parameters
Category	<ul style="list-style-type: none"> • <code>domain</code>: to specify the domain admitted by this category • <code>unknown</code>: to specify the value for specifying an unknown value

For example, to use the category characteristic stored in a key characteristic named `class` and to compare it with the admitted domain "Iris-setosa", "Iris-versicolor", "Iris-virginica", the following notation must be used in the *yaml* explorer file:

```
!characteristic.categorized.Category
arguments:
  - !characteristic.core.Key
    params:
      name: "class"
params:
  domain: ["Iris-setosa", "Iris-versicolor", "Iris-virginica"]
  unknown: unspecified
```

4.1.4 numerical characteristic plugin



py-galactic-characteristic-numerical is a plugin package for *py-galactic*.

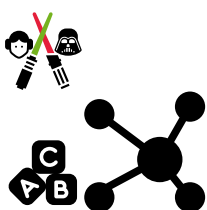
It exposes 2 characteristic classes known to the console utilities by the following names:

- `characteristic.numerical.Number`: to convert a characteristic to a number;
- `characteristic.numerical.Linear`: to apply a linear transformation to a number;

In the following table, the prefix `characteristic.numerical.` must be added to the names.

Name	Keyword parameters
Number	* <code>characteristic</code> : to specify the characteristic to convert
Linear	* <code>characteristic</code> : to specify the characteristic to linearize * <code>coefficient</code> : the coefficient of linearization

4.1.5 string plugin



py-galactic-characteristic-string is a plugin package for *py-galactic*.

It exposes 1 characteristic class known to the console utilities by the following name:

`characteristic.string.String` used to hold string values.

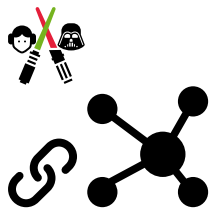
In the following table, the prefix `characteristic.string.` must be added to the names.

Name	Arguments
String	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the string * <code>alphabet</code>: to specify the alphabet of this characteristic

For example, to use the `String` characteristic stored in a key characteristic named `"string"` and alphabet `"abcdef"`, the following notation must be used in the `yaml` explorer file:

```
!predicate.string.String
params:
  characteristic: !characteristic.core.Key
    params:
      name: "string"
  alphabet: "abcdef"
```

4.1.6 chain plugin



`py-galactic-characteristic-chain` is a plugin package for `py-galactic`.

It exposes 1 characteristic class known to the console utilities by the following name:

`characteristic.chain.Chain` used to hold chain values.

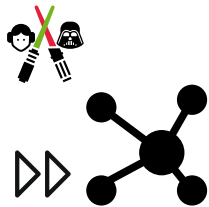
In the following table, the prefix `characteristic.chain.` must be added to the names.

Name	Arguments
Chain	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the chain * <code>alphabet</code>: to specify the alphabet of this characteristic

For example, to use the Chain characteristic stored in a key characteristic named "chain" and alphabet {"A", "B", "C"}, the following notation must be used in the *yaml* explorer file:

```
!predicate.chain.Chain
params:
  characteristic: !characteristic.core.Key
    params:
      name: "chain"
  alphabet: {"A","B","C"}
```

4.1.7 sequence plugin



py-galactic-characteristic-sequence is a plugin package for *py-galactic*.

It exposes 1 characteristic class known to the console utilities by the following name:

`characteristic.sequence.Sequence` used to hold sequence values.

In the following table, the prefix `characteristic.sequence.` must be added to the names.

Name	Arguments
Sequence	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the sequence * <code>alphabet</code>: to specify the alphabet of this characteristic

For example, to use the sequence predicate stored in a key characteristic named "sequence" and alphabet {"A", "B", "C"}, the following notation must be used in the *yaml* explorer file:

```
!characteristic.sequence.Sequence
params:
  characteristic: !characteristic.core.Key
    params:
      name: "sequence"
  alphabet: {"A","B","C"}
```

4.2 Descriptions and predicates

4.2.1 core

4.2.1.1 Predicates The *core* library exposes 2 predicate classes known to the console utilities by the following names:

- `predicate.core.Member` is used to describe a predicate for a python object using membership-like access.
- `predicate.core.Equal` is used to describe a predicate for a python object using equality.

In the following table, the prefix `predicate.core.` must be added to the names.

Name	Keyword parameters
Member	<ul style="list-style-type: none"> • <code>name</code>: to specify the member name • <code>characteristic</code>: to specify an internal characteristic
Equal	<ul style="list-style-type: none"> • <code>name</code>: to specify the characteristic name • <code>data</code>: to specify the value to compare

For example:

```
!predicate.core.Member
  params:
    name: c
```

describes a membership-like characteristic named `c`.

For example:

```
!predicate.core.Member
  characteristic:
    !characteristic.core.key
      name: v
  params:
    name: c
```

describe a membership-like characteristic named `c` accessible from the key-like parameter `v`. Thus, for the `yaml` data file:

```

1:
  v: [a,c]
  w: 2.3
2:
  v: [a,b]
  w: 1.2
3:
  v: [b,c]
  w: -5.6

```

The values of this characteristic for the individuals 1, 2 and 3 will be True, False and True.

4.2.2 logical classical description plugin



py-galactic-description-logical-classic is a plugin package for *py-galactic*.

4.2.2.1 Descriptions This plugin defines 1 description spaces for boolean characteristics:

- `description.logical.classic.Boolean`: the classical one defined on one boolean predicate producing either the predicate itself or none predicate.

4.2.3 logical clause description plugin



py-galactic-description-logical-clause is a plugin package for *py-galactic*.

4.2.3.1 Predicates It exposes 6 predicate classes known to the console utilities by the following names:

- `predicate.logical.clause.Not`: to get the *negation* of another boolean predicate;
- `predicate.logical.clause.And`: to get a logical *and* between other boolean predicates;
- `predicate.logical.clause.Or`: to get a logical *or* between other boolean predicates;
- `predicate.logical.clause.Equivalence`: to get a logical *equivalence* between other boolean predicates;
- `predicate.logical.clause.Nor`: to get a logical *nor* between other boolean predicates;
- `predicate.logical.clause.Nand`: to get a logical *nand* between ther boolean predicates.

In the following table, the prefix `predicate.logical.clause.` must be added to the names.

Name	Arguments
Not	a predicate to negate
And	a list of boolean predicates
Or	a list of boolean predicates
Equivalence	a list of boolean predicates
Nor	a list of boolean predicates
Nand	a list of boolean predicates

For example, to use the *negation* of a boolean predicate stored in a key membership characteristic named "prime", the following notation must be used in the *yaml* explorer file:

```
!predicate.logical.clause.Not
- !predicate.core.Member
  params:
    name: "prime"
```

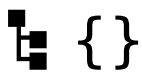
For example, to use the logical *and* of two boolean predicates stored in key membership characteristic named "prime" and "odd", the following notation must be used in the *yaml* explorer file:

```
!predicate.logical.clause.And
- !predicate.core.Member
  params:
    name: "prime"
- !predicate.core.Member
  params:
    name: "odd"
```


4.2.3.2 Descriptions This plugin defines 1 description space for boolean characteristics:

- `description.logical.clause.Logical`: the *logical* clause description defined on multiple boolean predicates producing clauses using predicates and their negations.

4.2.4 categorized description plugin



`py-galactic-description-categorized-subset` is a plugin package for `py-galactic`.

4.2.4.1 Predicates It exposes 1 predicate classes known to the console utilities by the following name:

- `predicate.categorized.subset.Category`: to specify a simple category predicate;

In the following table, the prefix `predicate.categorized.subset.` must be added to the names.

Name	Keyword parameters
Category	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic containing the category * <code>data</code>: to specify the values admitted by this category

For example, to use the category predicate stored in a key characteristic named "class" and to compare it with the admitted values "Iris-setosa", "Iris-versicolor", the following notation must be used in the `yaml` explorer file:

```
!predicate.categorized.subset.Category
arguments:
  - !characteristic.categorized.Category
    arguments:
      - !characteristic.core.Key
        params:
```

```

        name: "class"
    params:
        domain: ["Iris-setosa", "Iris-versicolor", "Iris-virginica"]
        unknown: unspecified
    pas:
        values: ["Iris-setosa", "Iris-versicolor"]

```

4.2.4.2 Descriptions This plugin exposes one description `description.categorized.subset.Category`

4.2.5 numerical hull description plugin



py-galactic-description-numerical-hull is a plugin package for *py-galactic*.

4.2.5.1 Predicates It exposes 3 predicate classes known to the console utilities by the following names:

- `predicate.numerical.hull.Positive`: to test if a characteristic is positive;
- `predicate.numerical.hull.LowerLimit`: to test if a characteristic is greater than a lower limit;
- `predicate.numerical.hull.UpperLimit`: to test if a characteristic is smaller than an upper limit.

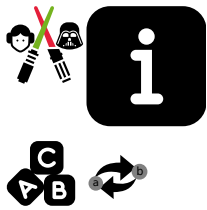
In the following table, the prefix `predicate.numerical.hull.` must be added to the names.

Name	Keyword parameters
Positive	* <code>characteristic</code> : to specify the characteristic to test
LowerLimit	* <code>characteristic</code> : to specify the characteristic to test * <code>limit</code> : to specify the limit * <code>strict</code> : to specify the test type

Name	Keyword parameters
UpperLimit	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic to test * <code>limit</code>: to specify the limit * <code>strict</code>: to specify the test type

4.2.5.2 Descriptions This plugin defines 1 description space `description.numerical.hull.Numerical` for numerical characteristics producing the equations of the convex hull defined by the individuals.

4.2.6 string match description plugin



`py-galactic-description-string-match` is a plugin package for `py-galactic`.

4.2.6.1 Predicates It exposes 2 predicate classes known to the console utilities by the following names:

- `predicate.string.SimpleMatch`: to specify a simple string predicate;
- `predicate.string.PrefixMatch`: to specify a string predicate with match to the prefix.

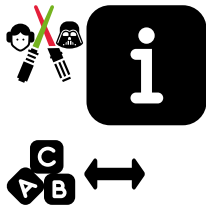
In the following table, the prefix `predicate.string.` must be added to the names.

Name	Keyword parameters
SimpleMatch	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the string * <code>string</code>: to specify the string of this characteristic
PrefixMatch	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the string * <code>prefix</code>: to specify the prefix of this characteristic

4.2.6.2 Descriptions This plugin defines 3 description space for string characteristics producing the regular expressions defined by the individuals.

- `description.string.SimpleMatch`
- `description.string.CompleteMatch`
- `description.string.PrefixMatch`

4.2.7 string distance description plugin



py-galactic-description-string-distance is a plugin package for *py-galactic*.

4.2.7.1 Predicates It exposes 1 predicate classes known to the console utilities by the following name:

- `predicate.string.DistanceMatch`: to specify a string predicate with match cardinality and distances.

In the following table, the prefix `predicate.string.` must be added to the names.

Name	Keyword parameters
DistanceMatch	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the string * <code>string</code>: to specify the string of this characteristic * <code>cardinality_min</code> to specify the minimal number of match with this string * <code>cardinality_max</code> to specify the maximal number of match with this string * <code>distances</code> contains a set of minimal and maximal distances between the elements of the string

Name	Keyword parameters
AffixMatch	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the chain * <code>affix</code>: to specify the affix of the characteristic * <code>start</code>: to specify the start position of affix in the chain * <code>orientation</code>: to specify the orientation of the search, 1 to specify from the beginning, and -1 to specify from the end.

For example, to use the Chain characteristic stored in a key characteristic named "chain" and to match it with the chain "chaintest", the following notation must be used in the *yaml* explorer file:

```
!predicate.chain.SimpleMatch
params:
  characteristic: !characteristic.core.Key
    params:
      name: "chain"
  chain: "chaintest"
```

4.2.8.2 Descriptions This plugin defines 3 description space for chain characteristics producing the common sub-chain, the common prefix, of the common affix defined by a collection of individuals.

- `description.chain.SimpleMatch`
- `description.chain.PrefixMatch`
- `description.chain.AffixMatch`

4.2.9 sequence match description plugin



py-galactic-description-sequence-match is a plugin package for *py-galactic*.

4.2.9.1 Predicates It exposes two predicate classes known to the console utilities by the following names:

- `predicate.sequence.SimpleMatch`: to specify a simple sequence predicate;

In the following table, the prefix `predicate.sequence.` must be added to the names.

Name	Keyword parameters
SequenceMatch	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the sequence * <code>sequence</code>: to specify the sequence of this characteristic

For example, to use the sequence predicate stored in a key characteristic named "sequence" and to match it with the sequence "sequencetest", the following notation must be used in the *yaml* explorer file:

```
!predicate.sequence.SequenceMatch
params:
  characteristic: !characteristic.core.Key
    params:
      name: "sequence"
  sequence: "sequencetest"
```

4.2.9.2 Descriptions This plugin defines one description spaces for sequence characteristics:

- `description.sequence.Simple`

4.2.10 *sequence distance* description plugin



py-galactic-description-sequence-distance is a plugin package for *py-galactic*.

4.2.10.1 Predicates It exposes one predicate classes known to the console utilities by the following names:

- `predicate.sequence.DistanceMatch`: to specify a distance sequence predicate.

In the following table, the prefix `predicate.sequence.` must be added to the names.

Name	Keyword parameters
<code>DistanceMatch</code>	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the sequence * <code>sequence</code>: to specify the sequence of this characteristic * <code>distances</code> contains a set of minimal and maximal distances between the elements of the string

For example, to use the sequence predicate stored in a key characteristic named "sequence" and to match it with the sequence "sequencetest", the following notation must be used in the *yaml* explorer file:

```
!predicate.sequence.SequenceMatch
params:
  characteristic: !characteristic.core.Key
    params:
      name: "sequence"
  sequence: "sequencetest"
```

4.2.10.2 Descriptions This plugin defines one description spaces for sequence characteristics:

- `description.sequence.Distance`

4.2.11 triadic description plugin



py-galactic-description-triadic-classic is a plugin package for *py-galactic*.

4.2.11.1 Predicates It exposes 1 predicate classe known to the console utilities by the following name:

- `predicate.triadic.classic.Triadic`: to express a triadic predicate.

In the following table, the prefix `predicate.triadic.classic.` must be added to the names.

Name	Arguments
Triadic	a list of characteristic

4.2.11.2 Descriptions This plugin defines 1 description spaces for triadic predicates:

- `description.triadic.classic.Triadic`: the triadic description.

4.3 Strategies

Strategies are used by the *galactic* core engine to produce new boolean attributes based on the individuals to partition. These attributes are in fact predicates defined on a description space.

4.3.1 core strategies

There are 2 strategies defined in the *core* library:

- `strategy.core.LimitFilter` which limits the successors to those whose measure does not exceed a limit;
- `strategy.core.SelectionFilter` which select the best or the worst successors.
- `strategy.core.Absurd` which select no successors.

They are a kind of filter strategy. They have to use a **measure**.

In the following tables, the prefix `strategy.core.` must be added to the names.

Name	Arguments
LimitFilter	a list of strategies
SelectionFilter	a list of strategies
Absurd	a list of descriptions

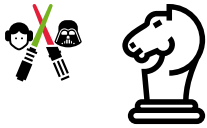
Name	Keyword parameter
LimitFilter	<ul style="list-style-type: none"> • <code>measure</code>: the measure used to select the strategies • <code>limit</code>: the limit not to be exceeded • <code>strict</code>: is the limit strict? • <code>lower</code>: is the limit a lower limit or an upper limit?
SelectionFilter	<ul style="list-style-type: none"> • <code>measure</code>: the measure used to select the strategies • <code>keep</code>: the number of best strategies (1 allows to keep only the very best ones, 2 allows to keep only the best and those whose measure is the second value, ...) • <code>maximize</code>: keep the best strategies or the worst • <code>decrease</code>: force the measure to increase (or decrease) • <code>strict</code>: decrease or increase strictly • <code>rate</code>: rate applied to the predecessor measure to force the decreasing (or increasing)

For example, to apply the 'SelectionFilter' over the quantile numerical strategy for a numerical characteristic named 'sepal width', the following notation must be used in the *yaml* explorer file:

```
!strategy.core.SelectionFilter
arguments:
  - !strategy.numerical.quantile.Quantile
    arguments:
      - !characteristic.numerical.Number
        characteristic: !characteristic.core.Key
          name: "sepal width"
    params:
      quantile: null
      lower: true
      count: null
params:
  measure: !measure.entropy.Entropy
  characteristic: !characteristic.core.Key
    name: "class"
```

| `maximize: false`

4.3.2 Logical basic classical strategy



py-galactic-strategy-logical-classic-basic is a plugin package for *py-galactic*.

It exposes 1 strategy class known to the console utilities by the following names:

- `strategy.logical.classic.basic.Boolean`: to specify a simple boolean strategy;

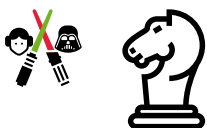
In the following table, the prefix `strategy.logical.classic.basic.` must be added to the names.

Name	Arguments
<code>Boolean</code>	a predicate to be used as a possible selector

For example, to use the basic logical boolean strategy for a boolean predicate name "prime", the following notation must be used in the *yaml* explorer file:

```
!strategy.logical.classic.basic.Boolean
arguments:
  - !characteristic.logical.Bool
  - !predicate.core.Member
  params:
    name: prime
```

4.3.3 Logical clause basic strategy



py-galactic-strategy-logical-clause-basic is a plugin package for *py-galactic*.

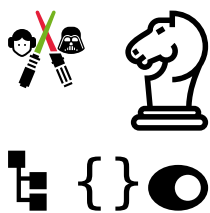
It exposes 1 strategy classes known to the console utilities by the following names:

- `strategy.logical.clause.basic.Dual`: to specify a dual strategy dealing with predicates and their negations.

In the following table, the prefix `strategy.logical.clause.basic.` must be added to the names.

Name	Arguments
Dual	a list of predicates to be used either as positive or negative

4.3.4 basic categorized subset strategy



py-galactic-strategy-categorized-subset-basic is a plugin package for *py-galactic*.

It exposes 1 strategy class known to the console utilities by the following name:

- `strategy.categorized.subset.basic.Category`: to specify a simple categorized strategy.

In the following tables, the prefix `strategy.categorized.subset.basic.` must be added to the names.

Name	Arguments
Category	a list of 1 modal characteristic

For example, to use the basic categorized strategy for a modal parameter named "class", the following notation must be used in the *yaml* explorer file:

```
!strategy.categorized.subset.basic.Category
- !characteristic.categorized.Category
  - !characteristic.core.Key
```

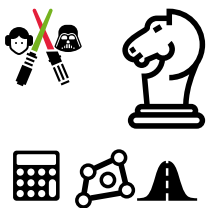
```
params:
  name: "class"
```

This strategy removes possible values for the defined modal characteristic reducing the set of individuals.

Note

This strategy can currently deal with only 1 modal characteristic.

4.3.5 numerical hull basic strategy



py-galactic-strategy-numerical-hull-basic is a plugin package for *py-galactic*.

It exposes 1 strategy class known to the console utilities by the following name:

- `strategy.numerical.basic.hull.Normal`: to specify a simple numerical strategy.

In the following tables, the prefix `strategy.numerical.hull.basic.` must be added to the names.

Name	Arguments
Normal	a list of numerical characteristics

Name	Keyword parameter
Normal	<ul style="list-style-type: none"> • <code>coefficient</code>: the multiplier coefficient of the standard deviation

For example, to use the basic numerical strategy for a couple of numerical characteristics named "sepal length" and "sepal width", the following notation must be used in the *yaml* explorer file:

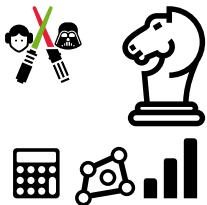
```
!strategy.numerical.basic.hull.Normal
arguments:
- !characteristic.numerical.Number
  params:
    characteristic: !characteristic.core.Key
    params:
      name: "sepal length"
- !characteristic.numerical.Number
  params:
    characteristic: !characteristic.core.Key
    params:
      name: "sepal width"
params:
  coefficient: 1
```

This strategy projects the 2-D points on the main axis of inertia and try to cut the individuals using 2 limits equal to the average plus or minus the standard deviation multiplied by the coefficient.

Note

This strategy can currently deal with only 2 numerical characteristics.

4.3.6 Numerical hull quantile strategies



py-galactic-strategy-numerical-hull-quantile is a plugin package for *py-galactic*.

It exposes 1 strategy class known to the console utilities by the following name:

- `strategy.numerical.hull.quantile.Quantile`: to specify a numerical strategy using quantiles to cut the individuals.

In the following tables, the prefix `strategy.numerical.hull.quantile.` must be added to the names.

Name	Arguments
Quantile	a list of 1 numerical characteristic

Name	Keyword parameter
Quantile	<ul style="list-style-type: none"> • <code>quantile</code>: the number of divisions of the individuals • <code>cut</code>: the location of the cut in the divisions

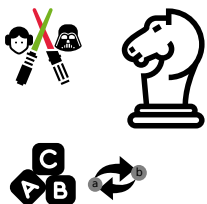
For example, to use the quantile strategy with 4 divisions for one numerical characteristic named "sepal width" with a cut set to the first and the last division, the following notation must be used in the *yaml* explorer file:

```
!strategy.numerical.quantile.hull.Quantile
arguments:
  - !characteristic.numerical.Number
    params:
      characteristic: !characteristic.core.Key
        params:
          name: "sepal width"
params:
  quantile: 4
```

Note

This strategy can currently deal with only 1 numerical characteristic.

4.3.7 string match basic strategies



py-galactic-strategy-string--match-basic is a plugin package for *py-galactic*.

It exposes three strategies classes known to the console utilities by the following name:

- `strategy.string.basic.SimpleMatch`: to specify a simple string strategy.
- `strategy.string.basic.PrefixMatch`: to specify a string strategy using the common prefix.
- `strategy.string.basic.CompleteMatch`: to specify a string strategy using maximal subsequences.

In the following tables, the prefix `strategy.string.basic.` must be added to the names.

Name	Arguments
<code>SimpleMatch</code>	<ul style="list-style-type: none">* <code>characteristic</code>: to specify the characteristic that hold the sequence.* <code>length</code>: to specify the length of the subsequence match* <code>window</code>: to specify a limit window to search for subsequences* <code>gaps</code>: to specify a limit gaps between elements of the subsequences
<code>CompleteMatch</code>	<ul style="list-style-type: none">* <code>characteristic</code>: to specify the characteristic that hold the string.
<code>PrefixMatch</code>	<ul style="list-style-type: none">* <code>characteristic</code>: to specify the characteristic that hold the string.

For example, to use the distance string strategy for a modal parameter named "class", and for length of match 3, and limit of 10, the following notation must be used in the *yaml* explorer file:

```
!strategy.string.basic.SimpleMatch
arguments:
  - !characteristic.core.Key
    name: "class"
params:
  length: 3
  window: 10
```

Note

This strategy can currently deal with only 1 modal characteristic.

4.3.8 string distance basic strategies

py-galactic-strategy-string-distance-basic is a plugin package for *py-galactic*.

It exposes three strategies classes known to the console utilities by the following name:

- `strategy.string.distance.basic.DistanceMatch`: to specify a string strategy that uses cardinality and distances between elements of the match.

In the following tables, the prefix `strategy.string.distance.basic.` must be added to the names.

Name	Arguments
DistanceMatch	* <code>characteristic</code> : to specify the characteristic that hold the string

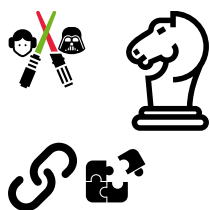
For example, to use the distance string strategy for a modal parameter named "class", and for length of match 3, and limit of 10, the following notation must be used in the *yaml* explorer file:

```
!strategy.string.distance.basic.DistanceMatch
arguments:
  - !characteristic.core.Key
    name: "class"
params:
  length: 3
  limit: 10
```

Note

This strategy can currently deal with only 1 modal characteristic.

4.3.9 chain match basic strategies



py-galactic-strategy-chain-match-basic is a plugin package for *py-galactic*.

It exposes three strategies classes known to the console utilities by the following name:

- `strategy.chain.basic.SimpleChainMatch`: to specify a simple chain strategy.
- `strategy.chain.basic.PrefixChainMatch`: to specify a chain strategy using common prefix.

In the following tables, the prefix `strategy.chain.basic.` must be added to the names.

Name	Arguments
SimpleMatch	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the chain * <code>length</code>: to specify the length of the match.
PrefixMatch	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the chain

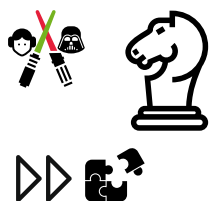
For example, to use the distance chain strategy for a modal parameter named "class", and for length of match 3, and limit of 10, the following notation must be used in the *yaml* explorer file:

```
!strategy.chain.basic.SimpleMatch
arguments:
  - !characteristic.core.Key
    name: "class"
params:
  length: 3
```

Note

This strategy can currently deal with only 1 modal characteristic.

4.3.10 *sequence match basic strategy*



py-galactic-strategy-sequence-match-basic is a plugin package for *py-galactic*.

It exposes a strategy classe known to the console utilities by the following name:

- `strategy.sequence.basic.SimpleMatch`: to specify a simple sequence strategy that use the subsequence of the given length, else of `length=2`.

- `strategy.sequence.basic.PrefixMatch`: to specify a prefix sequence strategy that use the common prefix.

In the following tables, the prefix `strategy.sequence.basic.` must be added to the names.

Name	Arguments
SimpleMatch	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the sequence. * <code>length</code>: to specify the length of the subsequence match
PrefixMatch	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the sequence.

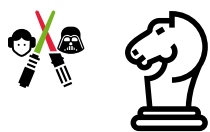
For example, to use the basic sequence strategy for a modal parameter named "sequence" and a length=4 of subsequence match, the following notation must be used in the *yaml* explorer file:

```
- !strategy.sequence.basic.SimpleMatch
  arguments:
    - !characteristic.core.Key
      name: "sequence"
  params:
    length: 4
```

Note

This strategy can currently deal with only 1 modal characteristic.

4.3.11 sequence distance basic strategy



py-galactic-strategy-sequence-distance-basic is a plugin package for *py-galactic*.

It exposes a strategy classe known to the console utilities by the following name:

- `strategy.sequence.basic.DistanceMatch`: to specify a simple sequence strategy that use the subsequence of the given length, else of length=2.

In the following tables, the prefix `strategy.sequence.basic.` must be added to the names.

Name	Arguments
DistanceMatch	<ul style="list-style-type: none"> * <code>characteristic</code>: to specify the characteristic that hold the sequence. * <code>length</code>: to specify the length of the subsequence match

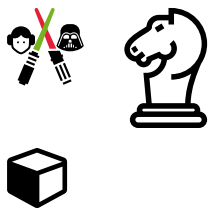
For example, to use the basic sequence strategy for a modal parameter named "sequence" and a length=4 of subsequence match, the following notation must be used in the *yaml* explorer file:

```
- !strategy.sequence.basic.DistanceMatch
  arguments:
    - !characteristic.core.Key
      name: "sequence"
  params:
    length: 4
```

Note

This strategy can currently deal with only 1 modal characteristic.

4.3.12 basic triadic strategies



py-galactic-strategy-triadic-classic-basic is a plugin package for *py-galactic*.

It exposes 1 strategy classes known to the console utilities by the following names:

- `strategy.triadic.classic.basic.Triadic`: to specify a simple triadic strategy;

In the following tables, the prefix `strategy.triadic.classic.basic.` must be added to the names.

Name	Arguments
Triadic	a list of characteristics

Name	Keyword parameter
Triadic	<ul style="list-style-type: none"> • <code>data</code>: the conditions; • <code>attributes</code>: the minimum number of attributes used in a new concept; • <code>conditions</code>: the minimum number of conditions used in a new concept.

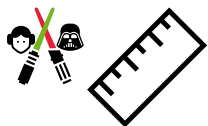
4.4 Measures

4.4.1 core measures

There are 3 measures in the *core* library:

- `measure.core.Cardinality` which computes the cardinality of the successor;
- `measure.core.PredecessorCardinality` which computes the cardinality of the predecessor;
- `measure.core.Confidence` which computes the cardinality ratio between the successor and the predecessor.

4.4.2 entropy measure



py-galactic-measure-entropy is a plugin package for *py-galactic*.

It exposes 1 measure class known to the console utilities by the following name:

- `measure.entropy.Entropy`: to compute the entropy of a successor.

In the following table, the prefix `measure.entropy.` must be added to the names.

Name	Keyword parameters
Entropy	<ul style="list-style-type: none">* <code>characteristic</code>: to specify the characteristic containing the category* <code>theta</code>: the float coefficient applied to individuals kept in the successor

For example, to use the entropy measure of a key characteristic named `class` for a characteristic named `sepal width` using the quantile strategy, the following notation must be used in the *yaml* explorer file:

```
!strategy.core.SelectionFilter
arguments:
  - !strategy.numerical.quantile.Quantile
    arguments:
      - !characteristic.numerical.Number
        characteristic: !characteristic.core.Key
          name: "sepal width"
    params:
      quantile: null
      lower: true
      count: null
params:
  measure: !measure.entropy.Entropy
  characteristic: !characteristic.core.Key
    name: "class"
  best: false
```

List of characteristics

<code>characteristic.core.Key</code>	16
<code>characteristic.core.Property</code>	16
<code>characteristic.logical.Bool</code>	17
<code>characteristic.categorized.Category</code>	18
<code>characteristic.numerical.Number</code>	19
<code>characteristic.numerical.Linear</code>	19
<code>characteristic.string.String</code>	19
<code>characteristic.chain.Chain</code>	20
<code>characteristic.sequence.Sequence</code>	21

List of predicates

<code>predicate.core.Member</code>	22
<code>predicate.core.Equal</code>	22
<code>predicate.logical.clause.Not</code>	24
<code>predicate.logical.clause.And</code>	24
<code>predicate.logical.clause.Or</code>	24
<code>predicate.logical.clause.Equivalence</code>	24
<code>predicate.logical.clause.Nor</code>	24
<code>predicate.logical.clause.Nand</code>	24
<code>predicate.categorized.subset.Category</code>	25
<code>predicate.numerical.hull.Positive</code>	26
<code>predicate.numerical.hull.LowerLimit</code>	26
<code>predicate.numerical.hull.UpperLimit</code>	26
<code>predicate.string.SimpleMatch</code>	27
<code>predicate.string.PrefixMatch</code>	27
<code>predicate.string.DistanceMatch</code>	28
<code>predicate.chain.SimpleMatch</code>	29
<code>predicate.chain.PrefixMatch</code>	29
<code>predicate.chain.AffixMatch</code>	29
<code>predicate.sequence.SimpleMatch</code>	31
<code>predicate.sequence.DistanceMatch</code>	32
<code>predicate.triadic.classic.Triadic</code>	33

List of descriptions

<code>description.logical.classic.Boolean</code>	23
--	----

description.logical.clause.Logical	25
description.categorized.subset.Category	26
description.numerical.hull.Numerical	27
description.string.SimpleMatch	28
description.string.CompleteMatch	28
description.string.PrefixMatch	28
description.string.DistanceMatch	29
description.chain.SimpleMatch	30
description.chain.PrefixMatch	30
description.chain.AffixMatch	30
description.sequence.Simple	31
description.sequence.Distance	32

List of strategies

strategy.core.LimitFilter	33
strategy.core.SelectionFilter	33
strategy.core.Absurd	33
strategy.logical.classic.basic.Boolean	35
strategy.logical.clause.basic.Dual	36
strategy.categorized.subset.basic.Category	36
strategy.numerical.basic.hull.Normal	37
strategy.numerical.hull.quantile.Quantile	38
strategy.chain.basic.SimpleChainMatch	42
strategy.chain.basic.PrefixChainMatch	42
strategy.sequence.basic.SimpleMatch	42
strategy.sequence.basic.PrefixMatch	43
strategy.sequence.basic.DistanceMatch	43
strategy.triadic.classic.basic.Triadic	44

List of measures

measure.core.Cardinality	45
measure.core.PredecessorCardinality	45
measure.core.Confidence	45
measure.entropy.Entropy	45