GALACTIC architecture

The **GALACTIC** Organization <contact@thegalactic.org>

2018-2023 [1]

[1]

2023-01-17

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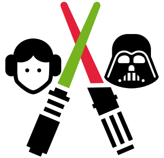
Acronym

GALACTIC stands for

GAlois
LAttices,
Concept
Theory,
Implicational systems and
Closures.



E Galois

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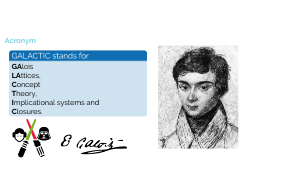
GALACTIC architecture
└Introduction
└Acronym
└Acronym



Acronym
GALACTIC stands for
GAlois
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- the **GALACTIC** logo is a tribute to the french mathematician Évariste Galois who died following a gallant duel at the age of twenty;
- it is also a graphical summary of lattice drawings.

Purpose

GALACTIC framework

Develop a framework on:

- **Lattice** theory[a]
- **F**ormal **C**oncept **A**nalysis[b].

[a] BARBUT, Marc et MONJARDET, Bernard. Ordre et classification, vols. 1 and 2. Hachette, Paris, France, 1970.

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GALACTIC architecture
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  └Purpose
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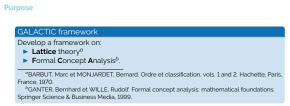

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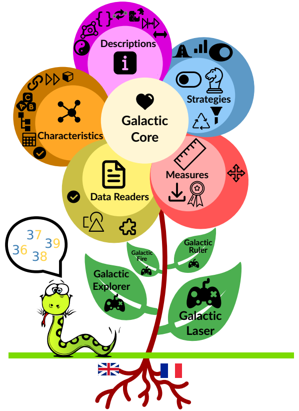

- the core library is the center of the flower;
- the applications are in the leaves;
- characteristic plugins are in the orange petal;
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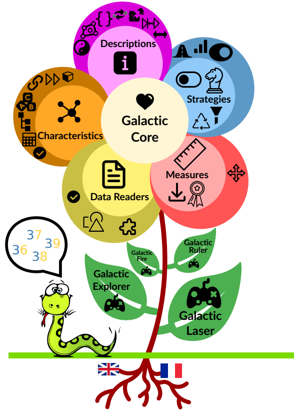

Written in python, Fully extensible

The **GALACTIC** framework is architecturally designed with:

- a core library

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GALACTIC architecture
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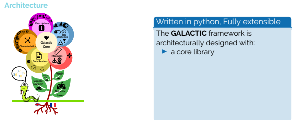
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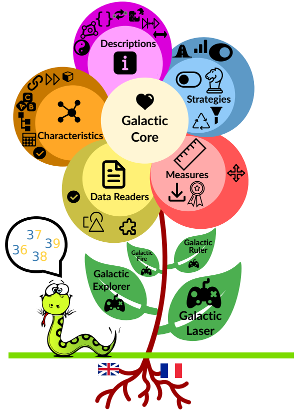

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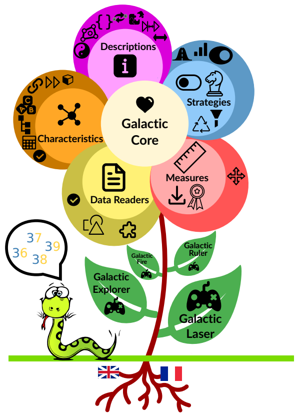

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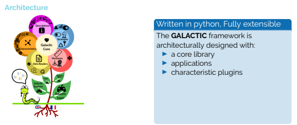
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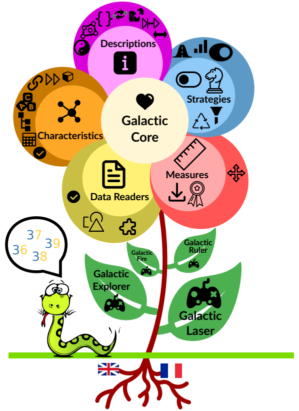

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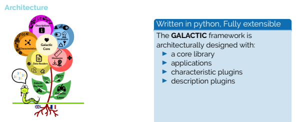
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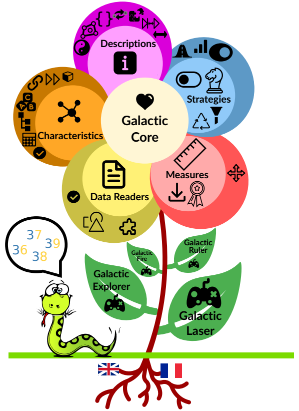

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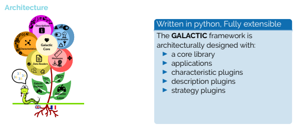
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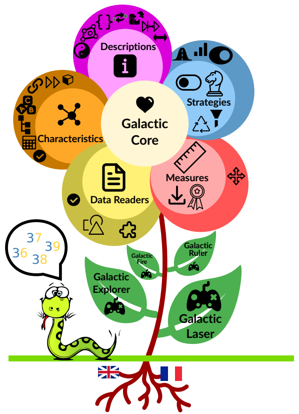

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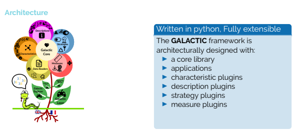
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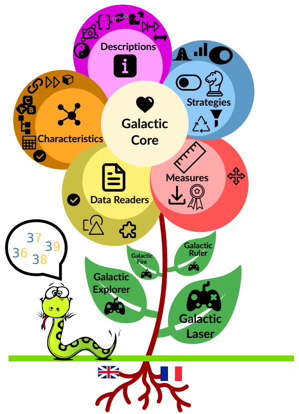

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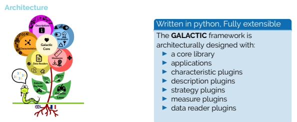
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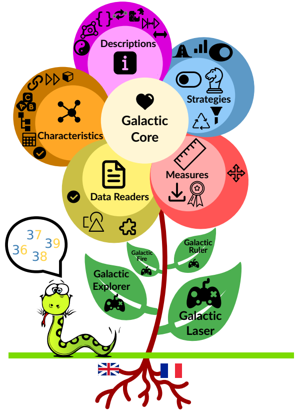

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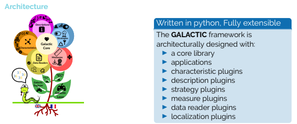

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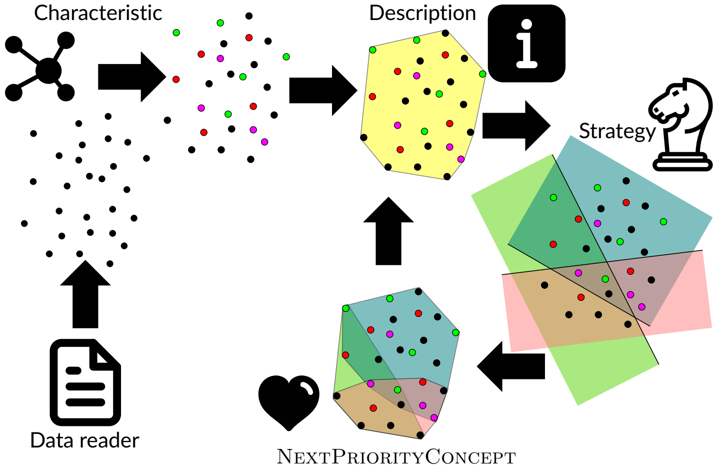
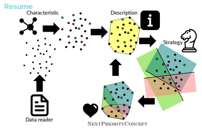
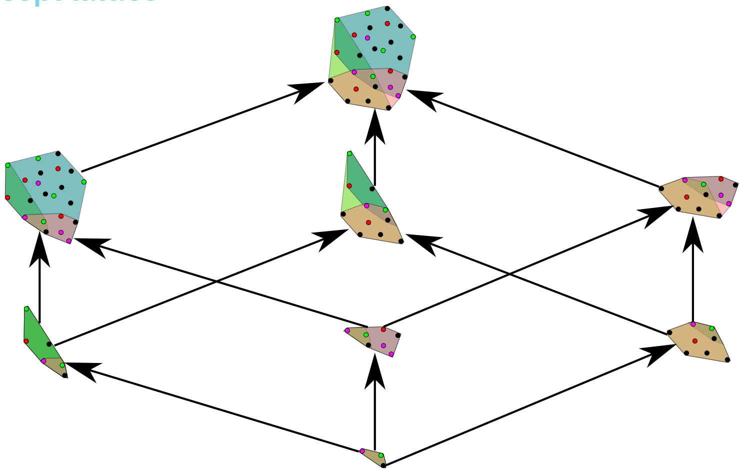
Resume





- data readers convert data files to context;
- subsets of individuals are described by sets of predicates called descriptions;
- strategies divide individuals into subsets;
- the NextPriorityConcept algorithm maintains the notion of **Lattice** during the process;
- the lattice can be converted into a minimum and consistent **Basis of rules**.

Concept lattice



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GALACTIC architecture
└Architecture
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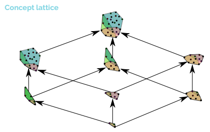
└Concept lattice



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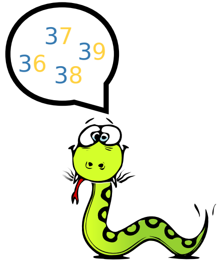
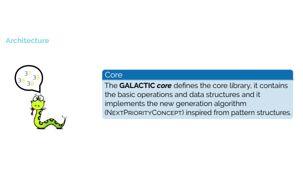


Core

The **GALACTIC *core*** defines the core library, it contains the basic operations and data structures and it implements the new generation algorithm (NextPriorityConcept) inspired from pattern structures.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Core
The **GALACTIC *core*** defines the core library, it contains the basic operations and data structures and it implements the new generation algorithm (NextPriorityConcept) inspired from pattern structures.

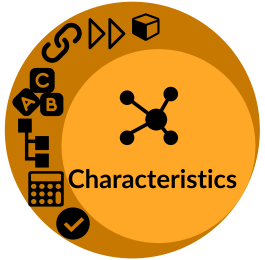
- written for python >= 3.6
- the NextPriorityConcept algorithm will be published in an international journal this autumn.

Sergei Kuznetsov was invited to the L3i in 2016, and after our discussions, we managed to propose this new algorithm.

Characteristic Plugins

Definition

Characteristic plugins define characteristics such as numerical characteristics, boolean characteristics.



Existing characteristic plugins:

- ✓ *Boolean* characteristics;
- *Numerical* characteristics;
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GALACTIC architecture
└Architecture
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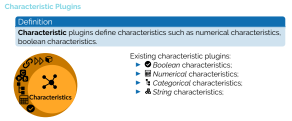
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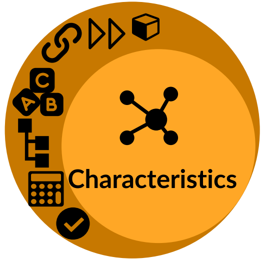

Existing characteristic plugins:

- 🔗 *Chain* characteristics;
- ▷▷ *Sequence* characteristics.
- *Triadic* characteristics.

In preparation:

- *Graph* characteristics.

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GALACTIC architecture
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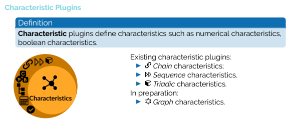
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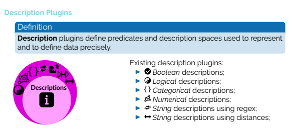
Description Plugins

Definition

Description plugins define predicates and description spaces used to represent and to define data precisely.

Existing description plugins:

- ✓ *Boolean* descriptions;
- ☯ *Logical* descriptions;
- { } *Categorical* descriptions;
- *Numerical* descriptions;
- ⇄ *String* descriptions using regex;
- ↔ *String* descriptions using distances;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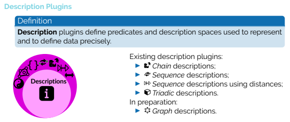
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Strategy Plugins

Definition

Strategy plugins define the way used to explore data, it uses descriptions to generate predecessors for each concept in the lattice.

Existing strategy plugins:

- ✓ *Boolean* strategy;
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- ▮ *Numerical quantile* strategy;
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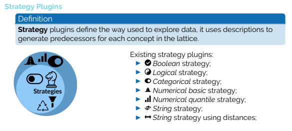
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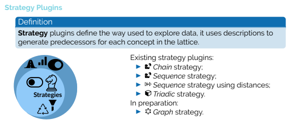

Strategy Plugins

Definition

Strategy plugins define the way used to explore data, it uses descriptions to generate predecessors for each node in the lattice.

There are 3 ♲ meta-strategies in the core library:

- ⏷ *Limit filter* which limits the predecessors to those whose measure does not exceed the limit;
- ⏷ *Selection filter* which selects the best or the worst predecessors;
- ◐ *Conditioned strategy* which triggers the execution of inner strategies when some conditions are met.

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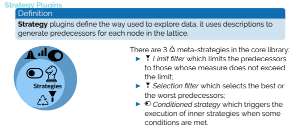
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Measure Plugins

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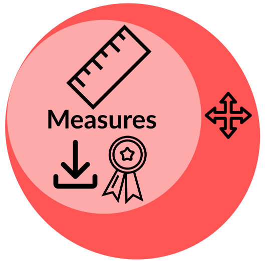
Measure plugins are parameters of the *filter strategies* predefined in the core library.



There are 3 measures in the core library:

- ⤓ predecessor *Cardinality*;
- ⤒ successor *Cardinality*;
- 🎖 *Confidence*.

One measure plugin has been developed:

- ✥ *Entropy* of the predecessor relatively to the successor.

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  └Plugins
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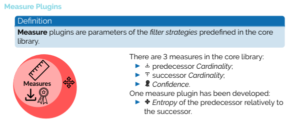
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Data Reader Plugins

Definition

Data readers plugins are used to read different types of data files. The *core* engine detects the file type using its extension.

Existing data reader plugins are:

- 🧩 *YAML*
- 🧩 *JSON*
- △ *CSV*
- △ *TOML*
- △ *INI*
- ✓ *TXT*
- ✓ *SLF*
- ✓ *DAT*
- ✓ *CXT*

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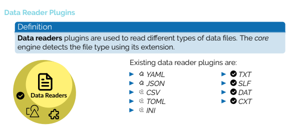
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- *TOML*
- *INI*
- *TXT*
- *SLF*
- *DAT*
- *CXT*

Localization Plugins

Definition

Localization plugins are used for translating the applications to other languages. The basic language is English.

- 🇫🇷 French translation of the **GALACTIC** applications.

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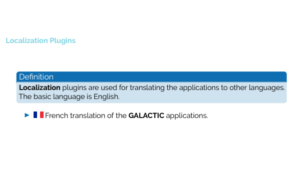
GALACTIC architecture
└Architecture
└Plugins
└Localization Plugins



Localization Plugins

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Applications

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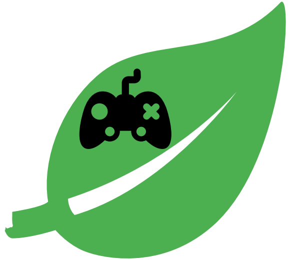

Existing applications are:

- **GALACTIC Laser**: for constructing the lattice and exploring data;
- **GALACTIC Explorer**: for explorating interactively the constructed lattice;
- **GALACTIC Ruler**: for extracting implication rules;
- **GALACTIC Fire**: for executing a system of rules.

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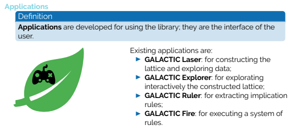
GALACTIC architecture
└Architecture
└Applications
└Applications



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Jupyter notebooks

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The library and its plugins are developed for an easy integration into *jupyter notebooks*:

- drawing lattices;
- displaying reduced contexts;
- displaying basis of rules;
- ...

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GALACTIC architecture
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  └Jupyter notebooks
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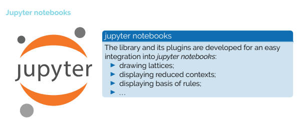

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Collaborative version control

git

The library is developed using the collaboration tool `git`, in the `gitlab` of the university. We are using

- ***pylint*** and ***flake8*** (with plugins) for testing code quality;
- ***tox*** for generating tests.

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GALACTIC architecture
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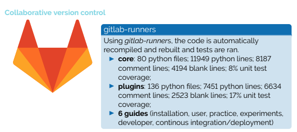
Collaborative version control

gitlab-runners

Using *gitlab-runners*, the code is automatically recompiled and rebuilt and tests are ran.

- **core**: 80 python files; 11949 python lines; 8187 comment lines; 4194 blank lines; 8% unit test coverage;
- **plugins**: 136 python files; 7451 python lines; 6634 comment lines; 2523 blank lines; 17% unit test coverage;
- **6 guides** (installation, user, practice, experiments, developer, continous integration/deployment)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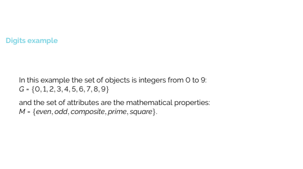
Digits example

In this example the set of objects is integers from 0 to 9: $G = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$

and the set of attributes are the mathematical properties: $M = \{even, odd, composite, prime, square\}$.



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digits	even	odd	composite	prime	square
0	x		x		x
1		x			x
2	x			x	
3		x		x	
4	x		x		x
5		x		x	
6	x		x		
7		x		x	
8	x		x		
9		x	x		x

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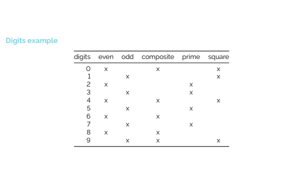
GALACTIC architecture
└Examples
  └Digits example
    └Digits example



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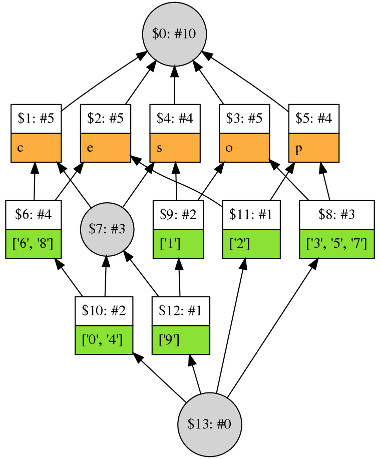
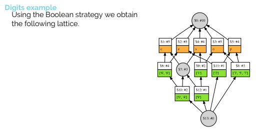
Digits example

Using the Boolean strategy we obtain the following lattice.




Digits example
Using the Boolean strategy we obtain the following lattice.

What's the Boolean strategy? Precise that it corresponds to the "classical" concept lattice.

Iris example

- this example consists of the iris flower data set, introduced by Ronald Fisher in 1936, represented by 150 samples from three species of Iris; setosa, virginica and versicolor;
- four features were measured from each sample: the length and the width of the sepals and petals, in centimeters.

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GALACTIC architecture
└Examples
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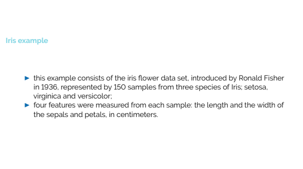

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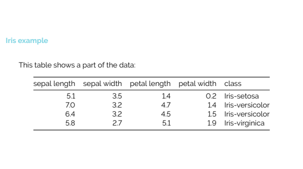
Iris example

This table shows a part of the data:

sepal length	sepal width	petal length	petal width	class
5.1	3.5	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
5.8	2.7	5.1	1.9	Iris-virginica



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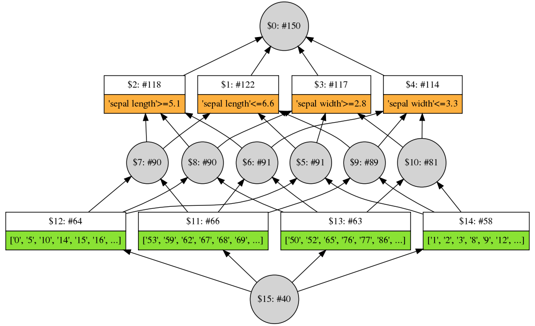
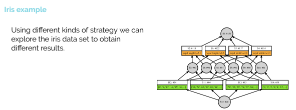
Iris example

Using different kinds of strategy we can explore the iris data set to obtain different results.

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Conclusion

- the version 0.4 was published on January 8th, 2022;
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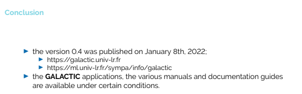
- the **GALACTIC** applications, the various manuals and documentation guides are available under certain conditions.



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Perspectives

- plugins for sequences (characteristics and strategies):
  - trajectories, and sequences of terms in text mining;
  - DA3T project and two thesis: 2018, 2019;
- maturation of **GALACTIC**:
  - nicer interface;
  - nicer visualisation of characteristics into the concepts;
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GALACTIC architecture
└Conclusion
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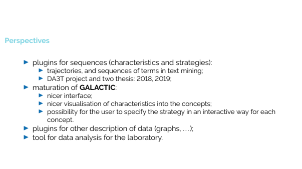

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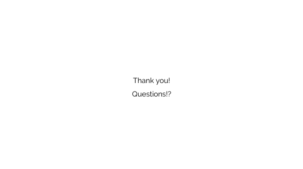
Questions!?



Thank you!

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