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GALACTIC architecture

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



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Acronym

GALACTIC stands for

GAlois

LAttices.

Concept

Theory,

Implicational systems and

Closures.









- 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
- Formal Concept Analysis^b.

^aBARBUT, Marc et MONJARDET, Bernard. Ordre et classification, vols. 1 and 2. Hachette, Paris, France, 1970.

^bGANTER, Bernhard et WILLE, Rudolf. Formal concept analysis: mathematical foundations. Springer Science & Business Media, 1999.

GALACTIC architecture
Introduction
Purpose
Purpose

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Formal Concept Analysis

Formal Concept Analysis

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"BURBUT Mare and MONUNCET, Bennat Concept analysis mathematical foundation

"CANTER, Bennbert at WILLE, Buddle from at concept analysis mathematical foundation."

Architecture

Architecture



GALACTIC architecture

Architecture └─Architecture —Architecture



- the core library is the center of the flower;
- the applications are in the leaves;
- · characteristic plugins are in the orange petal;
- strategy plugins are in the blue petal;
- · measure plugins are in the red petal;
- data reader plugins are in the yellow petal;
- · localization plugins are in the roots.

—Architecture —Architecture



Architecture

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Written in python, Fully extensible

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

a core library

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Architecture —Architecture —Architecture



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Conclusion





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Architecture



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

- a core library
- applications
- characteristic plugins
- description plugins





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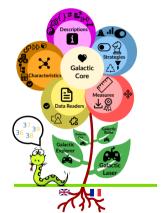
- a core library
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- characteristic plugins
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Introduction Architecture

Conclusion

Resume Characteristic Description Strategy Data reader NEXTPRIORITYCONCEPT

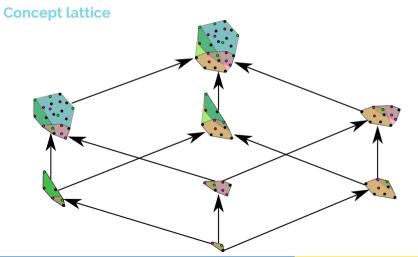
GALACTIC architecture -Architecture —Architecture ─Resume



- 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.



Conclusion

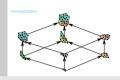


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Architecture

Architecture

Concept lattice 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.







- 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.

Architecture
Plugins
Applications

Definition

Characteristic Plugins

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



Existing characteristic plugins:

- ▶ **Soolean** characteristics:
- ► *Numerical* characteristics:
- Categorical characteristics;
- & String characteristics;

GALACTIC architecture

Architecture

Plugins

Characteristic Plugins



Architecture
Plugins
Applications

Collaborative version control

Characteristic Plugins

Definition

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



Existing characteristic plugins:

- ► & Chain characteristics:
- ► № Sequence characteristics.
- ► **Triadic** characteristics.

In preparation:

► *\$ Graph* characteristics.

GALACTIC architecture

Architecture

Plugins

Characteristic Plugins

Controlled Rugins

Controlled Considerate players define characteristics such as numerical characteristics.

Existing characteristics.

Existing characteristics players

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In preparation.

**In Separe characteristics*

In preparation.

Architecture
Plugins
Applications

Description Plugins

Definition

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



Existing description plugins:

- ► Boolean descriptions;
- ► ② Logical descriptions;
- ► {} Categorical descriptions;
- ▶ Ø Numerical descriptions;
- String descriptions using regex;
- ► → String descriptions using distances;

GALACTIC architecture

└─Architecture

└─Plugins

└─Description Plugins

Description Plugins

Control Description plugins define predicates and description spaces used to represent to the description plugins define data procisely

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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:

- ► **L** Chain descriptions;
- ► ◆ Sequence descriptions;
- ► > Sequence descriptions using distances;
- ► ♥ *Triadic* descriptions.

In preparation:

► \$\phi\$ Graph descriptions.

GALACTIC architecture

Architecture -Plugins Description Plugins



- In preparation:

 Graph descriptions

Architecture
Plugins
Applications

Collaborative version control

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:

- ► **Ø** Boolean strateav:
- ► **②** Logical strategy:
- ► Categorical strategy:
- ► A Numerical basic strategy;
- Numerical quantile strategy;
- ► String strategy;
- ► → String strategy using distances;

GALACTIC architecture

Architecture

Plugins

Strategy Plugins



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Collaborative version control

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:

- ► Chain strategy:
- ► Sequence strategy;
- ► ► Sequence strategy using distances,
- ► ♥ *Triadic* strategy.

In preparation:

► \$\alpha\$ Graph strategy.

GALACTIC architecture

Architecture

Plugins

Strategy Plugins

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Definition

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



- Existing strategy plugins
 Chain strategy;
 Sequence strategy
- b' Sequence strategy;
 W Sequence strategy using distance
 Triadic strategy.
- ► ♥ Triadic strategy.
 In preparation:
 ► ♥ Graph strategy.

Plugins

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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 \(\triangle \) meta-strategies in the core library:

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

GALACTIC architecture

Architecture

Plugins

Strategy Plugins





- There are 3 ♠ meta-strategies in the core libi

 Tumit filter which limits the predecess
 - 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.

Definition

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.

GALACTIC architecture -Architecture —Plugins ☐ Measure Plugins



Pluains

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

► **⊘** TXT

►
♪ JSON

► SLF

► [©] CSV

▶ Ø DAT

► ¹⁄₂ TOML

► **⊘** CXT

► [®] INI

GALACTIC architecture

-Architecture

—Plugins

└ Data Reader Plugins

engine detects the file type using its extension



► a YAML ► a JSON ► ® CSV ► ® TOML B INI



Architecture

Plugins

Applications

Collaborative version control

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.



Definition
Localization plugins are used for translating the applications to other languages

► French translation of the GALACTIC applications.

Architecture Conclusion Applications

Applications

Definition

Applications are developed for using the library; they are the interface of the user.



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.

GALACTIC architecture -Architecture —Applications ☐ Applications





Collaborative version control

Collaborative version control

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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.

GALACTIC architecture

Architecture -Collaborative version control Collaborative version control



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Collaborative version control

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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Architecture

Collaborative version control

Collaborative version control





Conclusio



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- ▶ the version 0.4 was published on January 8th, 2022;
 - https://galactic.univ-lr.fr
 - https://ml.univ-lr.fr/sympa/info/galactic
- ▶ the **GALACTIC** applications, the various manuals and documentation guides are available under certain conditions.

GALACTIC architecture
Conclusion
Conclusion
Conclusion

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