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, CIRAD



, Univ. Paul-Valéry Montpellier 3



CONCEPTS'24

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- 2 RCA implications
- 3 Requirements
- 4 FCAvizIR
- 5 Conclusion

Context

Analyzing data through implications in FCA/RCA setting

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- “What can we remember and gather from the data forgetting the objects?
Answers to this question would help in abstracting the meaning of things”
[Duquenne, 2013]

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A Few Current Applications

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- Environmental domain (Knomana): Understanding relations between therapeutic plants, pests (bioagressors), and affected organisms to find or hypothesize solutions in phytotherapy [Mahrach et al., 2021]

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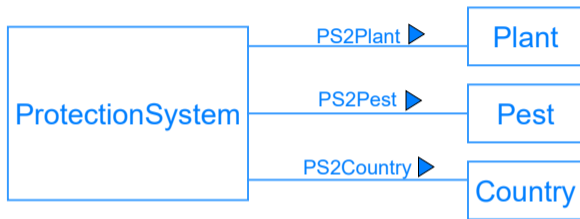
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RCA in a nutshell

Dataset model: Several formal contexts (4) and relational contexts (3)

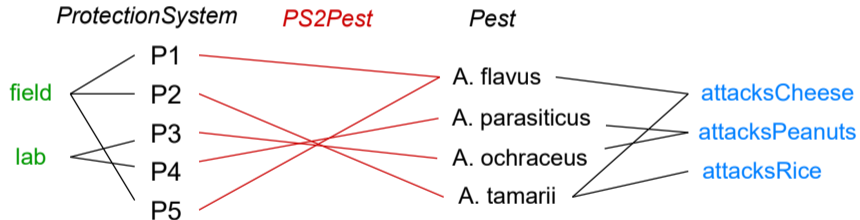


Excerpt from Knomana [Silvie et al., 2021]

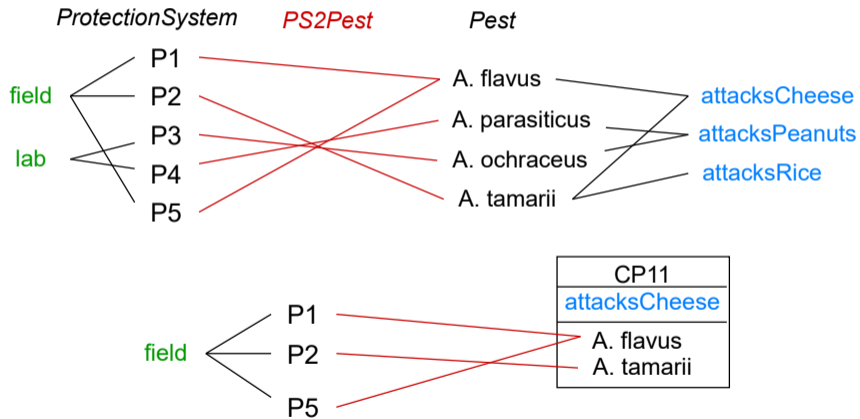
P1 (Protection System in the field) developed in Namibia (Country): Cinnamomum zeylanicum (Plant) is used to control Aspergillus flavus (Pest)

A protection system indicates
a plant usage to control a pest (bioagressor) in a given country

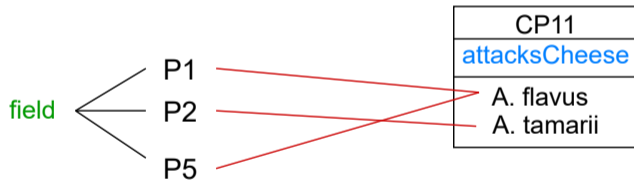
From the dataset to Pest concept CP11



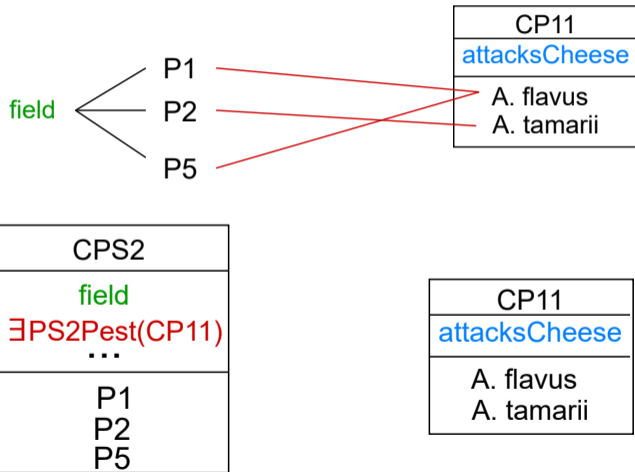
From the dataset to Pest concept CP11



From Pest concept CP11 to Relational Attribute \exists PS2Pest(CP11) and Protection System concept CPS2



From Pest concept CP11 to Relational Attribute \exists PS2Pest(CP11) and Protection System concept CPS2



Simplification of Relational Attribute \exists PS2Pest(CP11) using simplified intent attacksCheese

CPS2
field \exists PS2Pest(CP11) ...
P1 P2 P5

CP11
attacksCheese
A. flavus A. tamarii

Simplification of Relational Attribute \exists PS2Pest(CP11) using simplified intent attacksCheese

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field \exists PS2Pest(CP11) ...
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CP11
attacksCheese
A. flavus A. tamarii

CPS2
field \exists PS2Pest(attacksCheese) ...
P1 P2 P5

CP11
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A. flavus A. tamarii

Application to the whole model (4 formal contexts and 3 relational contexts): extended formal context Protection System

ProtSyst	field	lab	\exists PS2Pest(attacksRice)	\exists PS2Pest(attacksCheese)	\exists PS2Pest(attacksPeanuts)	\exists PS2Pest(aspergillus)	\exists PS2Country(australAfrica)	\exists PS2Country(westernAfrica)	\exists PS2Plant(contraceptive)	\exists PS2Plant(antidysenteric)	\exists PS2Plant(lauraceae*)	\exists PS2Plant(asteraceae**)	\exists PS2Plant(aromatic&evergreen)
P1	x			x		x	x				x		x
P2	x		x	x		x	x				x		x
P3		x			x	x		x				x	x
P4		x			x	x		x	x			x	x
P5	x			x		x	x			x		x	x

Implications are computed from the extended formal context Protection System

A few implications of the Duquenne-Guigues base of implications
[Guigues and Duquenne, 1986]:

$\exists PS2Pest(aspergillus), \exists PS2Plant(lauraceae \& comestible \& applicOil), \exists PS2Plant(aromatic \& evergreen)$
 $\Rightarrow field, \exists PS2Pest(attacksCheese), \exists PS2Country(australAfrica)$

$\exists PS2Pest(aspergillus), \exists PS2Country(westernAfrica), \exists PS2Plant(aromatic \& evergreen) \Rightarrow$
 $lab, \exists PS2Pest(attacksPeanuts), \exists PS2Plant(asteraceae \& toxic \& applicEssentialOil \& applicExtract)$

$\exists PS2Pest(attacksPeanuts), \exists PS2Pest(aspergillus), \exists PS2Plant(aromatic \& evergreen) \Rightarrow$
 $lab, \exists PS2Country(westernAfrica), \exists PS2Plant(asteraceae \& toxic \& applicEssentialOil \& applicExtract)$

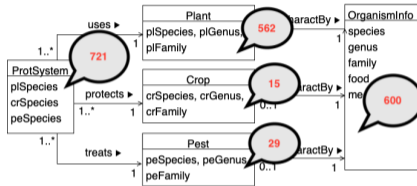
(...)

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Facing the number and complexity of implications

Example on a real data model [Mahrach et al., 2021]



Duquenne-Guigues bases of implications (# implications with support $\neq 0$)

- 1391 on protection systems
- 1815 on plants
- 70 on crops
- 80 on pests
- 1168 on organism information

Facing the number and complexity of implications

Principles

- Visualization to support result exploration

Facing the number and complexity of implications

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- Juxtapose and coordinate different views
[Baldonado et al., 2000, Roberts, 2007]

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- “overview first, zoom and filter, then details on demand”
[Shneiderman, 1996]

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Principles

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- **Separate relations and their targets in relational attributes**

Facing the number and complexity of implications

Principles

- Visualization to support result exploration
- Juxtapose and coordinate different views
[Baldonado et al., 2000, Roberts, 2007]
- “overview first, zoom and filter, then details on demand”
[Shneiderman, 1996]
- Separate relations and their targets in relational attributes
- Use the content of the implications

Requirements

- **R0 Filtering** with various **metrics** to rapidly localize implications with certain values of these metrics

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- **R1 Clustering** based on **common elements** (relations or attributes) in their premise or conclusion.
- **R2 Estimating** the **quantity** of implications in the formed groups.

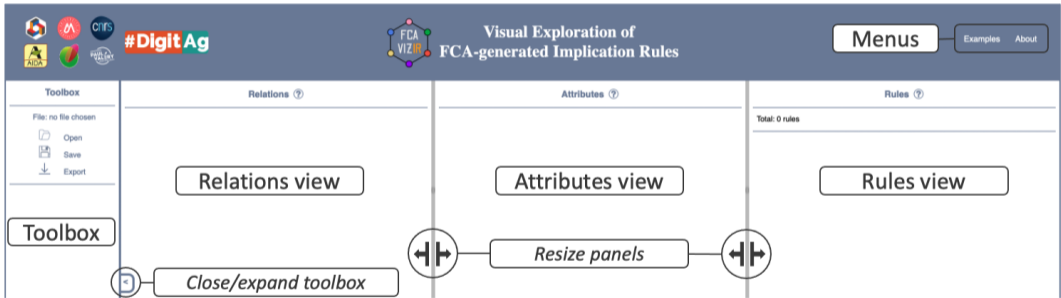
Requirements

- **R0 Filtering** with various **metrics** to rapidly localize implications with certain values of these metrics
- **R1 Clustering** based on **common elements** (relations or attributes) in their premise or conclusion.
- **R2 Estimating** the **quantity** of implications in the formed groups.
- **R3 Navigating** among **topic-based** implication groups by refining/enlarging the selection step-by-step.

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Overview

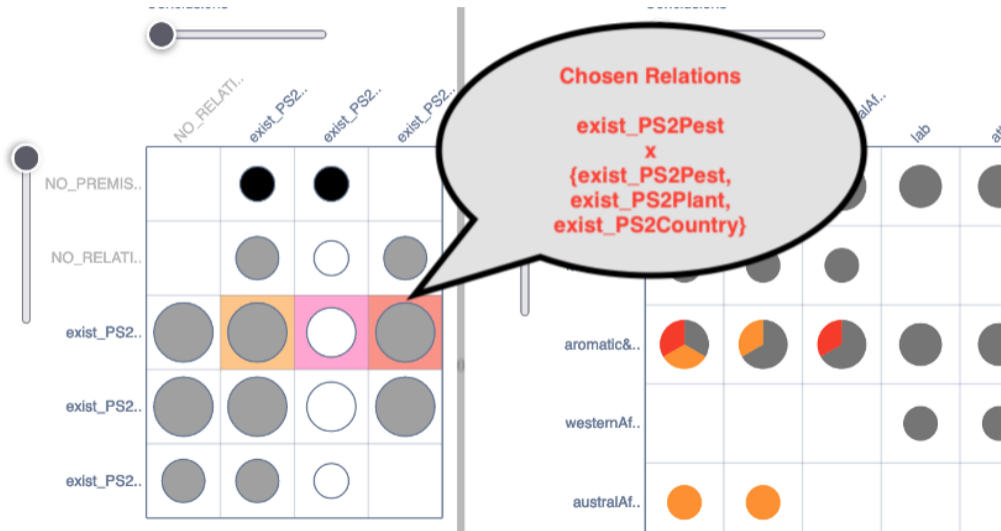


Toolbox / Parameters

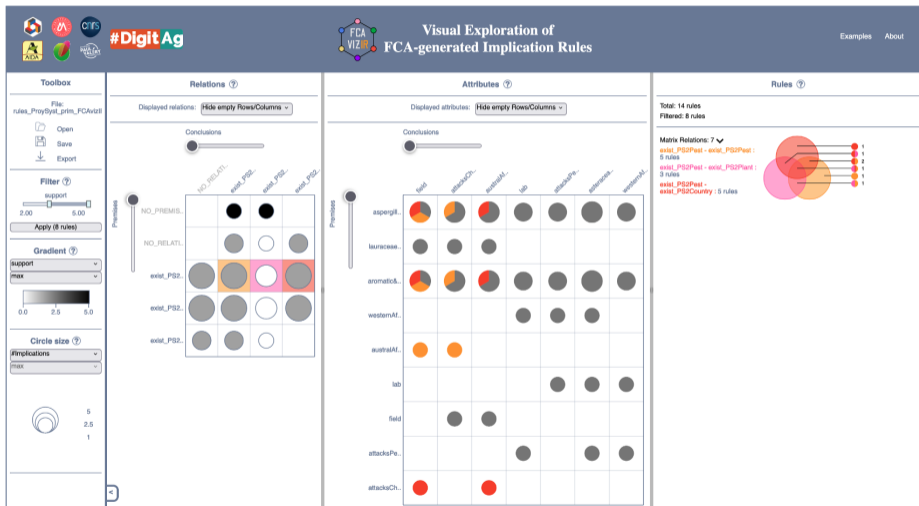
The screenshot shows the FCAvizIR interface with several callout boxes highlighting specific features:

- File:** rules_Proysyst_prim_FCAvizIR
 - Open
 - Save
 - Export
- Filter:** support (slider from 2.00 to 5.00)
 - Apply (8 rules)
- Gradient:** support (dropdown), max (dropdown)
 - Color scale from 0.0 to 5.0
- Circle size:** #Implications (dropdown), max (dropdown)
 - Visual representation of circle sizes for 5, 2.5, and 1 implications.
- Relations:** Hide empty Rows/Columns (checkbox), Conclusions (slider)
 - Grid of relations with circles of varying sizes and colors.
 - Callout for 'exist_PS2Pest' relation.
- Legend:** Hide empty Rows/Columns (checkbox), Selected Attributes, All Attributes

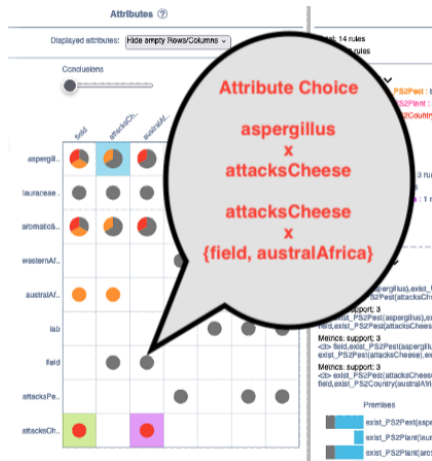
Relation Selection




Relation Selection (result)



Attribute Selection



Attribute Selection (result)



Visual Exploration of FCA-generated Implication Rules

[Examples](#) [About](#)

Toolbox

File:
rules_ProjGst_prim_FCAvizIR

Open
Save
Export


Filter

support
2.00 — 5.00

Apply (8 rules)

Gradient


support
max



0.0 2.5 5.0

Circle size

Implications
max



5

2.5

1

Relations

Displayed relations: Hide empty Rows/Columns

Conclusions

	NO_RELATL.	exist_PS2Pest	exist_PS2Plant	exist_PS2Country
NO_PREMIS.	●	●		
NO_RELATL.	●	○	○	○
exist_PS2Pest	●	●	●	●
exist_PS2Plant	●	○	○	○
exist_PS2Country	●	○	○	○

Attributes

Displayed attributes: Hide empty Rows/Columns

Conclusions

	field	attacksCh.	australAF.	lab	attacksPe.	attacksCh.	westamAF.
aspergill.	●	●	●	●	●	●	●
lauraceae.	●	●	●				
aromatick.	●	●	●				
westamAF.				●	●	●	
australAF.	●	●					
lab					●	●	●
field		●	●				
attacksPe.				●		●	●
attacksCh.	●	●					

Rules

Total: 14 rules
Filtered: 8 rules

Matrix Relations: 7

- exist_PS2Pest - exist_PS2Pest : 5 rules
- exist_PS2Pest - exist_PS2Plant : 3 rules
- exist_PS2Pest - exist_PS2Country : 5 rules

Matrix Attributes: 4

- aspergillus - attacksCheese : 3 rules
- attacksCheese - field : 1 rules
- attacksCheese - australAfrica : 1 rules

Filtered rules: 4

Metrics: support: 2

```
<> exist_PS2Pest(aspergillus),exist_PS2Plant(lauraceae&aromatic&apple&orange),exist_PS2Plant(aromatic&evergreen) => field,exist_PS2Pest(attacksCheese),exist_PS2Country(australAfrica)
```

Metrics: support: 3

```
<> exist_PS2Pest(aspergillus),exist_PS2Country(australAfrica),exist_PS2Plant(aromatic&evergreen) => field,exist_PS2Pest(attacksCheese)
```

Metrics: support: 3

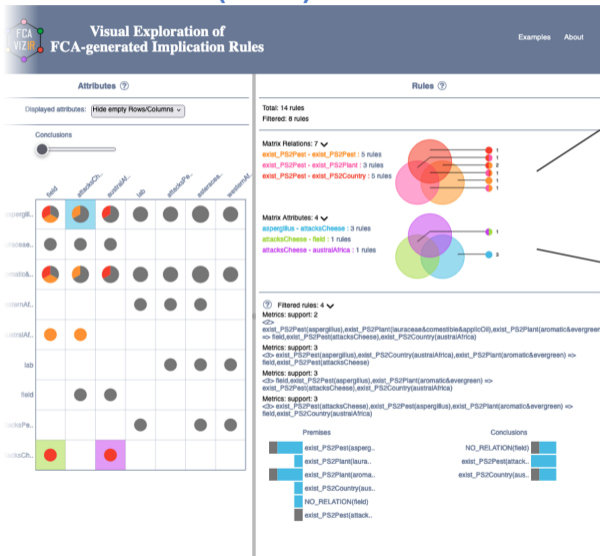
```
<> field,exist_PS2Pest(aspergillus),exist_PS2Plant(aromatic&evergreen) => exist_PS2Pest(attacksCheese),exist_PS2Country(australAfrica)
```

Metrics: support: 3

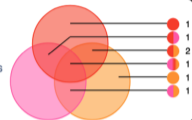
```
<> exist_PS2Pest(attacksCheese),exist_PS2Pest(aspergillus),exist_PS2Plant(aromatic&evergreen) => field,exist_PS2Country(australAfrica)
```

Premises	Conclusions
exist_PS2Pest(aspergillus)	NO_RELATION(field)
exist_PS2Plant(lauraceae)	exist_PS2Pest(attacksCheese)
exist_PS2Plant(aromatic)	exist_PS2Country(australAfrica)
exist_PS2Country(australAfrica)	
NO_RELATION(field)	
exist_PS2Pest(attacksCheese)	

Attribute Selection (detail)

**Matrix Relations: 7** ▼

exist_PS2Pest - exist_PS2Pest : 5 rules
 exist_PS2Pest - exist_PS2Plant : 3 rules
 exist_PS2Pest - exist_PS2Country : 5 rules

**Matrix Attributes: 4** ▼

aspergillus - attacksCheese : 3 rules
 attacksCheese - field : 1 rules
 attacksCheese - australAfrica : 1 rules



Premise Selection

Visual Exploration of FCA-generated Implication Rules

Attributes ?

Displayed attributes: Hide empty Rows/Columns

Conclusions

Matrix Relations: 7

- exist_PS2Pest - exist_PS2Pest : 6 rules
- exist_PS2Pest - exist_PS2Plant : 3 rules
- exist_PS2Pest - exist_PS2Country : 8 rules

Matrix Attributes: 4

- aspergillus - attacksCheese : 3 rules
- attacksCheese - field : 1 rules
- attacksCheese - australAfrica : 1 rules

Filtered rules: 4

Metrics: support: 2

```
<<> exist_PS2Pest(aspergillus),exist_PS2Plant(lauraceae&comestible&applicOil),exist_PS2Plant(aromatic&evergreen) => field,exist_PS2Pest(attacksCheese),exist_PS2Country(australAfrica)
```

Metrics: support: 3

```
<<> exist_PS2Pest(aspergillus),exist_PS2Country(australAfrica),exist_PS2Plant(aromatic&evergreen) => field,exist_PS2Pest(attacksCheese)
```

Metrics: support: 3

```
<<> field,exist_PS2Pest(aspergillus),exist_PS2Plant(aromatic&evergreen) => exist_PS2Pest(attacksCheese),exist_PS2Country(australAfrica)
```

Metrics: support: 3

```
<<> exist_PS2Pest(attacksCheese),exist_PS2Pest(aspergillus),exist_PS2Plant(aromatic&evergreen) => field,exist_PS2Country(australAfrica)
```

Premises

- exist_PS2Pest(aspergillus)
- exist_PS2Plant(lauraceae&comestible&applicOil)
- exist_PS2Plant(aromatic&evergreen)
- NO_RELATION(field)
- exist_PS2Pest(attacksCheese)

Conclusions

- NO_RELATION(field)
- exist_PS2Pest(attacksCheese)
- exist_PS2Country(australAfrica)

Filtered rules: 4

Metrics: support: 2

```
<<> exist_PS2Pest(aspergillus),exist_PS2Plant(lauraceae&comestible&applicOil),exist_PS2Plant(aromatic&evergreen) => field,exist_PS2Pest(attacksCheese),exist_PS2Country(australAfrica)
```

Metrics: support: 3

```
<<> exist_PS2Pest(aspergillus),exist_PS2Country(australAfrica),exist_PS2Plant(aromatic&evergreen) => field,exist_PS2Pest(attacksCheese)
```

Metrics: support: 3

```
<<> field,exist_PS2Pest(aspergillus),exist_PS2Plant(aromatic&evergreen) => exist_PS2Pest(attacksCheese),exist_PS2Country(australAfrica)
```

Metrics: support: 3

```
<<> exist_PS2Pest(attacksCheese),exist_PS2Pest(aspergillus),exist_PS2Plant(aromatic&evergreen) => field,exist_PS2Country(australAfrica)
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Premises

- exist_PS2Pest(aspergillus)
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- NO_RELATION(field)
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Conclusions

- NO_RELATION(field)
- exist_PS2Pest(attacksCheese)
- exist_PS2Country(australAfrica)

Selection of *exist_PS2Pest(attacksCheese)*

Filtered rules: 1

Metrics: support: 3

```
<<> exist_PS2Pest(attacksCheese),exist_PS2Pest(aspergillus),exist_PS2Plant(aromatic&evergreen) => field,exist_PS2Country(australAfrica)
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Premises

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Premise Selection (result)



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Conclusion

FCAvizIR

- Visual approach to assist exploration of RCA implications

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- Visual approach to assist exploration of RCA implications
- **Web platform**

Conclusion

FCAvizIR

- Visual approach to assist exploration of RCA implications
- Web platform
- Interactive views, filtering (R0), group by shared items (R1), group size visualization (R2), topic-based navigation (R3)

Future work

Implications and models specificities

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- Focus on particular cases: cyclic models, models with long paths

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- **Taxonomies on attributes**

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Connect to other tools FCA4J (<https://www.lirmm.fr/fca4j/>), RCAviz (<https://rcaviz.lirmm.fr/>), etc.

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Back to applications for full scale application with experts and end-users

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Back to applications for full scale application with experts and end-users

- Knomana

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Back to applications for full scale application with experts and end-users

- Knomana
- Software Product Lines
- Digital debate

¡Gracias por su atención!



`https://fcavizir.lirmm.fr/`





Implication files prepared with `https://www.lirmm.fr/fca4j/`



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Grant ANR-16-CONV-0004 **anr**[®]



ANR SmartFCA project
Grant ANR-21-CE23-0023 **anr**[®]

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