

# Augmented Visualization of Association Rules for Data Mining

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# Outline

- Overview
- Visualization in Data Mining
- The VAM-MD Scheme
- Case study: Association Rules with SOM
- Experimental Prototype
- Evaluation and Analysis of Results
- Conclusions & Future Work

# Overview

- **The Data Mining (DM) Process is complex:**
  - obstacles on data setting
  - several entities involved
  - research is needed
- **The outputs of the KDD process are focused on data:**
  - robust algorithms for DM models.
  - reliable data results.
  - massive data support.

# Overview...

But...

- on a massive amount of data the pattern recognition task is hard.
  - is not easy to reach the entity data.
  - lack of understanding about the model structure.
- 
- As a result; Output goals (knowledge) from the KDD process must be improved:
    - interaction with KDD entities.
    - how the entities are constructed.
    - better understanding of the underlying data mining model...

How? an option, **use visualization.**

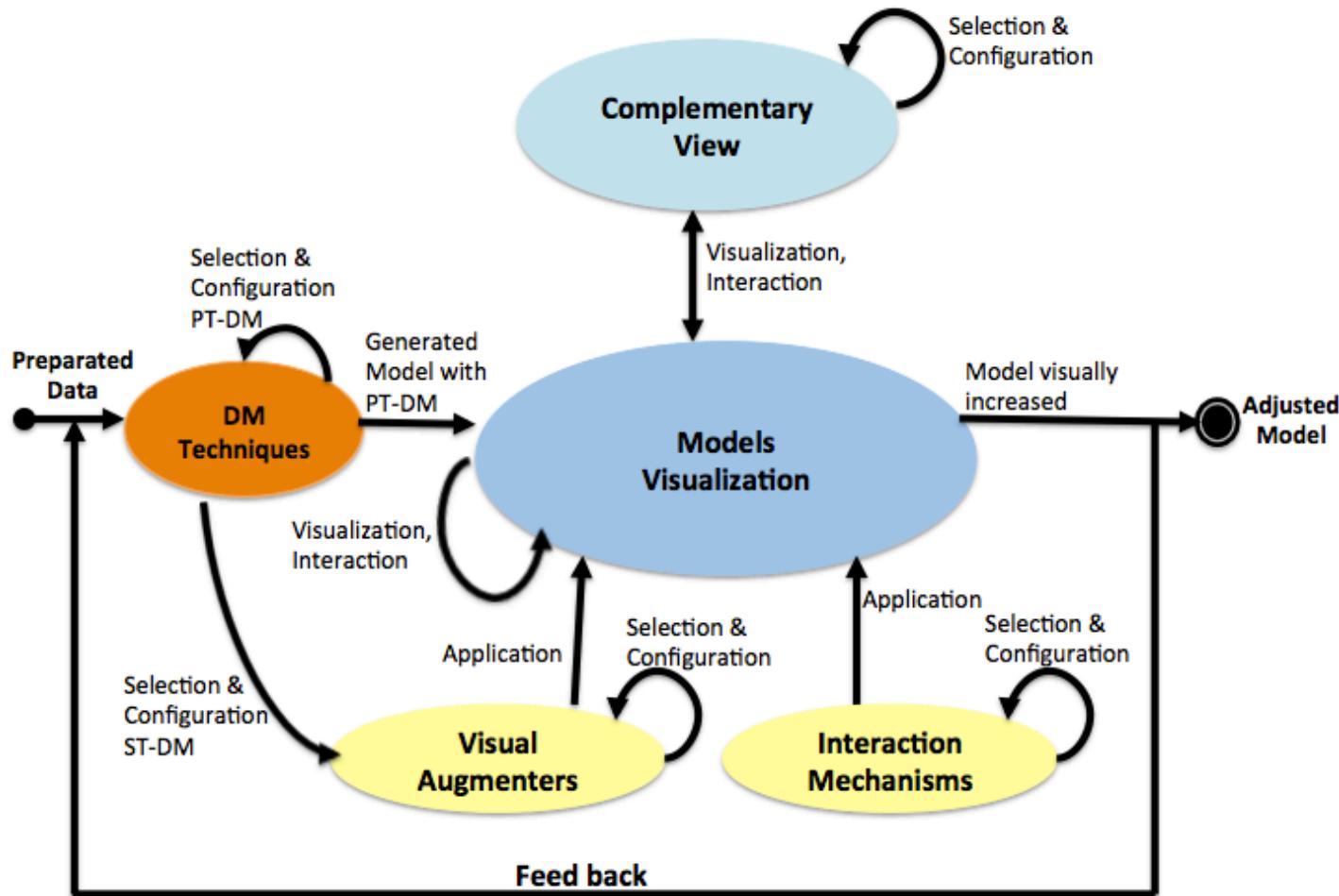
# Visualization in Data Mining

- Visualization is slowly being considered on the KDD process.
- The role of visualization is not defined as a part of the KDD process.
- Visualization key factors:
  - preliminary data understanding.
  - DM tasks could be improved at the problem formulation phase.
  - issues with High-Dimensional datasets.
  - comparison and validation between similar models from the human visual perspective.
- Visualization in: Data, Models and Patterns.

# The VAM-MD Scheme

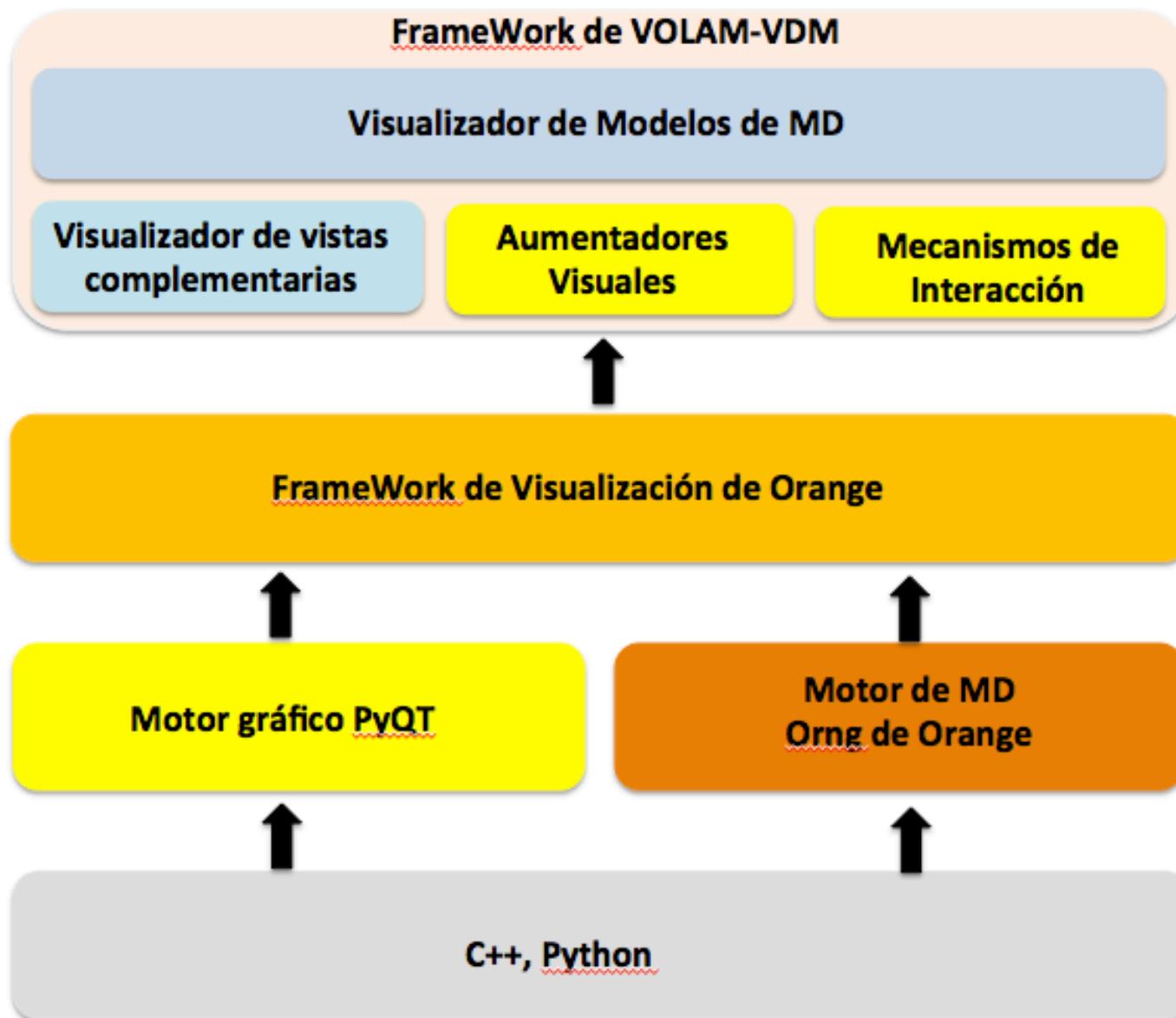
- VAM-MD: Augmented Visualization for Data Mining Models (*Spanish's acronym*)
- Research Goal:
  - **Improve the understandability of data mining models through the use of visualizations.**
- Features:
  - **visual perception model with user interaction.**
  - **focused on the step of adjusting or tuning of the model DM.**
  - **it brings the concept of ‘Augmented Visualization’ for DM models.**
  - **use of traditional graphical artifacts** (applied to the data of the model components).
  - **combination of DM techniques** (multi-scheme approach on two layers for techniques):
    - PT-DM: Primary DM technique (model to adjust)
    - ST-DM: Secondary DM technique (exploratory model)

# The VAM-MD scheme...



- Characteristics or conditions of visual augmenters:
  - provide a complementary viewing.
  - ad-hoc data domain.
  - the ST-DM should be descriptive.

# The VAM-MD scheme...



# Case Study: Association Rules with SOM

- Main problem:
  - Lack of user understanding about inner-working DM model structure and mechanical.
- In the case of Association Rules (AR) models is more complex, because of:
  - many rules.
  - massive amount of data.
  - high dimensionality in the data.
  - structure.

# In General, the AR models analysis is:

Generated sets of large itemsets:

Size of set of large itemsets L(1): 8

Size of set of large itemsets L(2): 13

Size of set of large itemsets L(3): 2

Best rules found:

1. venomous=false tail=true 71 ==> backbone=true 71      conf: (1)
2. tail=true 75 ==> backbone=true 74      conf: (0.99)
3. backbone=true tail=true 74 ==> venomous=false 71      conf: (0.96)
4. backbone=true 83 ==> venomous=false 79      conf: (0.95)
5. breathes=true 80 ==> fins=false 76      conf: (0.95)
6. airborne=false 77 ==> feathers=false 73      conf: (0.95)
7. tail=true 75 ==> venomous=false 71      conf: (0.95)
8. tail=true 75 ==> backbone=true venomous=false 71      conf: (0.95)
9. breathes=true venomous=false 75 ==> fins=false 71      conf: (0.95)
10. breathes=true 80 ==> venomous=false 75      conf: (0.94)



Static rule; poor or no interaction  
with components

Statistics & general information:  
instances, rules, confidence,  
support, etc.

Statistics &  
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Data mining SOM technique,  
provides:

- Data dispersion in each rule,
- Spatial distribution &

Generated sets of large itemsets:

Size of set of large itemsets L(1): 8

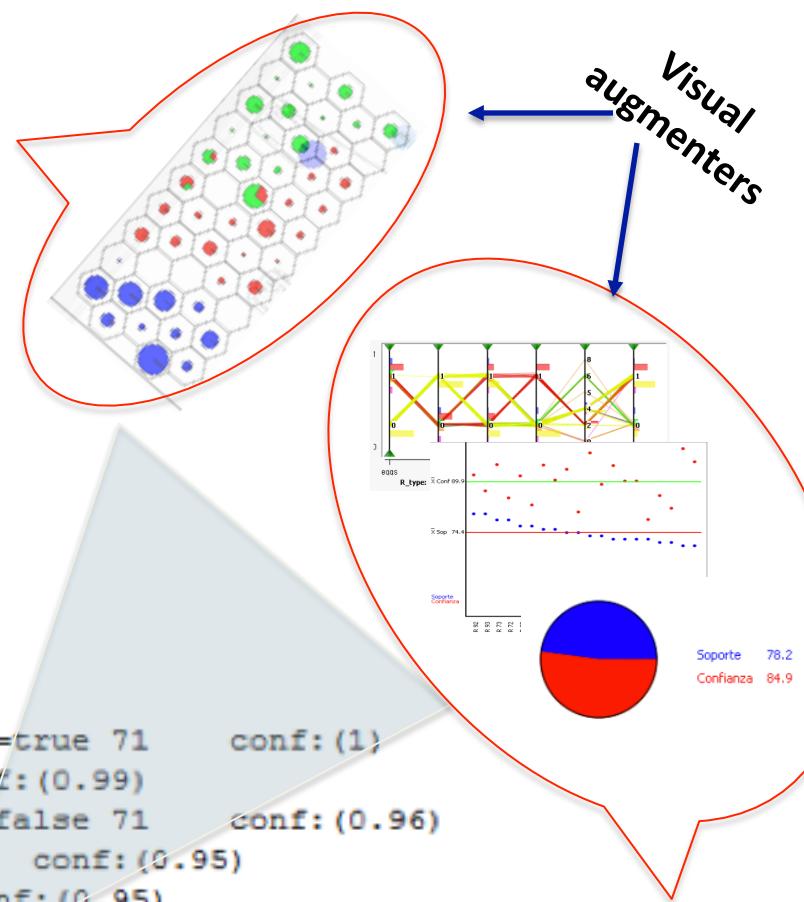
Size of set of large itemsets L(2): 13

Size of set of large itemsets L(3): 2

Best rules found:

1. venomous=false tail=true 71 ==> backbone=true 71 conf: (1)
2. tail=true 75 ==> backbone=true 74 conf: (0.99)
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- Compares rules (quantitatively).  
- Dynamic AR model (navigable)



**Visualization &  
interaction  
(with model and its  
components )**

# Experimental Prototype

- The prototype implements the VAM-MD scheme.
- Hierarchical structure is covered by the scheme with:
  - PT-DM: AR (Association Rules) , DT (Decision Trees), ...
  - ST-DM: SOM, clustering, ...
- Visual elements:
  - data table, pie chart, scatter plot, box-plot, etc.
- User actions:
  - Zoom (in/out), select, drag & drop, tuning, transparency for context, etc.

# Experimental Prototype...

VOLAM - VDM Explorador de modelos

Datos T. Primaria DM

Modelos Predictivos Árbol de Decisión

Modelos Descriptivos Reglas de Asociación

Elementos Visuales Crear por regla Contrair Reglas

Técnicas Secundarias DM SOM TS2 TS3

Datos Reglas de asociación

Medidas mostradas:  Soporte  Confianza

Rules Sep Conf

- # fin=0
  - Regla 00 | fin=0 -> venomous=0 0.762 0.917
  - Regla 02 | fin=0 -> breathes=1 0.752 0.905
  - Regla 07 | fin=0 -> domestic=0 0.713 0.857
- # breathes=1
  - Regla 03 | breathes=1 -> fin=0 0.752 0.958
  - Regla 01 | breathes=1 -> venomous=0 0.743 0.938
- # backbone=1
  - Regla 05 | backbone=1 -> venomous=0 0.782 0.952
  - Regla 07 | backbone=1 -> tail=1 0.733 0.882
- # tail=1
  - Regla 05 | backbone=1 tail=1 -> ve... 0.783 0.958
- # airborne=0
  - Regla 00 | airborne=1 -> feathers=0 0.723 0.948
- # domestic=0
  - Regla 02 | domestic=0 -> venomous=0 0.882 0.928
  - Regla 06 | domestic=0 -> fin=0 0.713 0.818
- # tail=1
  - Regla 06 | tail=1 -> backbone=1 0.733 0.987
  - # venomous=0
    - Regla 04 | tail=1 venomous=0 -> ba... 0.783 1.000
  - # backbone=1
    - Regla 05 | tail=1 backbone=1 -> ve... 0.783 0.958
- # venomous=0
  - Regla 03 | venomous=0 -> domestic=0 0.882 0.871
  - Regla 02 | venomous=0 -> backbone=1 0.782 0.849
  - Regla 09 | venomous=0 -> fin=0 0.762 0.828
  - Regla 00 | venomous=0 -> breathes=1 0.743 0.806
  - Regla 18 | venomous=0 -> feathers=0 0.723 0.785
- # tail=1
  - Regla 04 | venomous=0 tail=1 -> ba... 0.783 1.000
- # feathers=0
  - Regla 00 | feathers=0 -> airborne=1 0.723 0.901

SOM Vis Opciones SOM

Opciones:

- None
- U-Matrix
- Component planes  
hair

Mostrar Grilla

Histograma  Mostrar histograma

Zoom: 35

Información  Mostrar tooltip

Nivel de Transparencia: 10

Colores R\_type

- Diagrama de torta
- Valor mayoritario
- Prob. Valor mayoritario

Report

Técnica Secundaria DM

amphibian

bird

fish

mammal

reptile

# Experimental Prototype...

**VOLAM - VDM Explorador de modelos**

**Datos** **T. Primaria DM** **Datos** **Reglas de asociación**

Medidas mostradas:  Soporte  Confianza

Rules	Sop	Conf
▲ fins=0		
Regla 88   fins=0 -> venomous=0	0.762	0.917
Regla 82   fins=0 -> breathes=1	0.752	0.905
Regla 97   fins=0 -> domestic=0	0.713	0.857
▲ breathes=1		
Regla 83   breathes=1 -> fins=0	0.752	0.950
Regla 81   breathes=1 -> venomous=0	0.743	0.938
▲ backbone=1		
Regla 73   backbone=1 -> venomous=0	0.782	0.952
Regla 77   backbone=1 -> tail=1	0.733	0.892
▲ tail=1		
Regla 425   backbone=1 tail=1 -> ve...	0.703	0.959
▲ airborne=0		
Regla 8   airborne=0 -> feathers=0	0.723	0.948
▲ domestic=0		
Regla 92   domestic=0 -> venomous=0	0.802	0.920
Regla 96   domestic=0 -> fins=0	0.713	0.818
▲ tail=1		
Regla 76   tail=1 -> backbone=1	0.733	0.987
▲ venomous=0		
Regla 424   tail=1 venomous=0 -> ba...	0.703	1.000
▲ backbone=1		
Regla 425   tail=1 backbone=1 -> ve...	0.703	0.959
▲ venomous=0		
Regla 93   venomous=0 -> domestic=0	0.802	0.871
Regla 72   venomous=0 -> backbone=1	0.782	0.849
Regla 89   venomous=0 -> fins=0	0.762	0.828
Regla 80   venomous=0 -> breathes=1	0.743	0.806
Regla 18   venomous=0 -> feathers=0	0.723	0.785
▲ tail=1		
Regla 424   venomous=0 tail=1 -> ba...	0.703	1.000
▲ feathers=0		
Regla 9   feathers=0 -> airborne=0	0.723	0.901
Regla 19   feathers=0 -> venomous=0	0.723	0.901

Diferencia Soporte y Confianza

Regla	Distancia
92	0.118
93	0.069
73	0.17
72	0.067
88	0.154
89	0.066
83	0.198
82	0.152
81	0.195
80	0.064
76	0.254
77	0.159
8	0.225
9	0.178
19	0.178
18	0.062
97	0.144
96	0.105
424	0.297
425	0.256

Report

Técnicas Secundarias DM  SOM  TS2  TS3  TS4

**Técnica Secundaria DM**

**Soporte vs Confianza**

# Evaluation and Analysis of Results

- The proposed approach **was tested on a controlled experiment.**
- A benchmark test **was developed to assess the usefulness of the proposed approach** to perform some data mining tasks.
- The experiment:
  - The test was performed on 17 users, each one with different levels of DM process.

# Evaluation and Analysis of Results...

- Objectives of the controlled experiment:
  - To assess usefulness provided by the combination and application of the SOM technique on the components of a AR.
  - To get a description of the level of effectiveness of the prototype software.
  - To check empirically if users are able to get a better understanding of the AR model, applying the SOM technique.

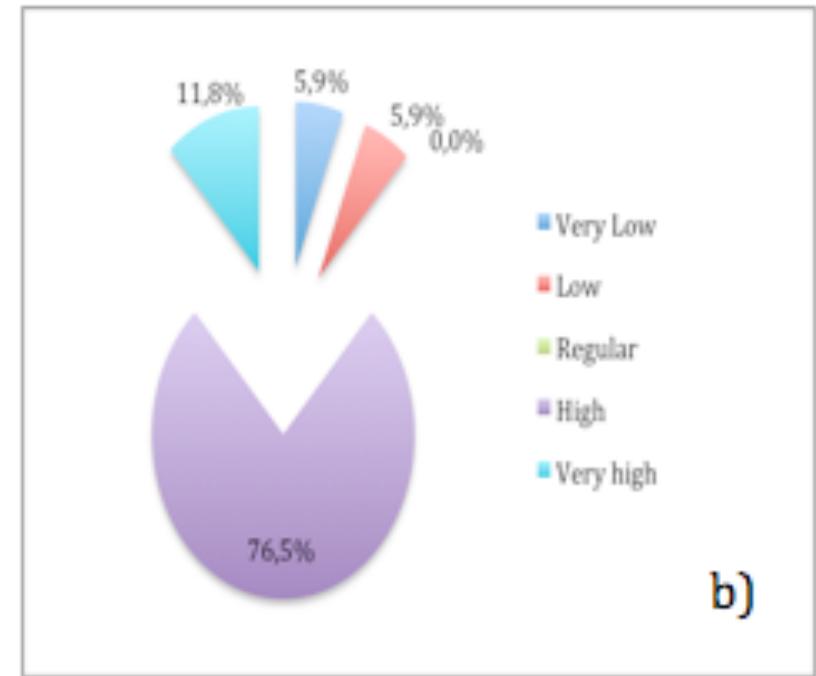
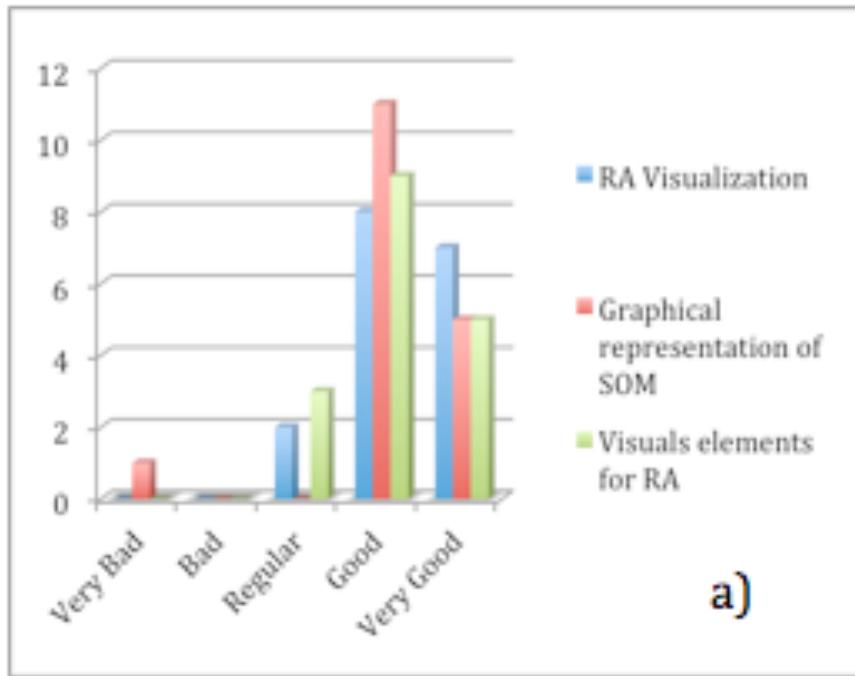
# Evaluation and Results Analysis...

- The controlled experiment considers:
  - With both tools (Prototype & Weka), users should:
    - generate a AR model,
    - visualize and interact with the model, and
    - interpret patterns or rules obtained using the options available on the two software tools.
  - Focus on interaction and usefulness.

# Evaluation and Analysis of Results

- Results:
  - The experimental prototype was **widely accepted** by the users.
  - The key factors were **usability and performance**.
  - The users consider the prototype successful on **showing relationships in data**.
  - Wide assessment of prototype software for the actual utility of the options and parameters offered, in order to get a better understanding of the AR model.
  - It was successful on **augmenting the model understanding** from user point of view.

# Evaluation and Analysis of Results



a) Level of acceptance of views available to describe the AR model.

b) Ability to describe the data on the AR model using the SOM technique

# Conclusions

- **The VAM-MD scheme and its components serve as a guide** for building visualizations that support the task of analysis and exploration of AR models, in their stage of refinement or adjustment.
- The positive perception obtained in the controlled experiment, giving rise to hold **the convenience and utility of combining a complementary technique with a previously generated model**.
- **The combination of visualization techniques can improve the understanding of AR models**, compared to other tools.
- **Visual elements or graphical artifacts provided in the software prototype, applied to the data in each rule of the AR model, meet to support the analysis and exploration of the generated model**.

# Future Work

- **To formalize the VAM-DM abstract model**, developing formal specification to approach all components.
- **To explore (add) other data mining techniques** for:
  - PT-DM & ST-DM.
- **To include other visual elements**, some of them should be ad-hoc to each kind of model.
- **The interaction mechanisms must be improved** to enhance the model perception.



Thank you...  
questions?

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