Semios
relecture automatisée des exigences

IRIT
Institut de Recherche
en Informatique de Toulouse

Industrial requirements classification for redundancy and inconsistency detection in **SEMIOS**

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Plan

- Introduction
- Industrial Context
- Workflow
  - ✓ Preprocesses: Filtering noise, Detecting business terms
  - ✓ Clustering method: K-means
  - ✓ Experimentation (Dataset, validation, results)
- Discussion and Conclusion

Projet CLE-ELENAA

CLE (**C**ontrat de Recherche **L**aboratoires-**E**ntreprises)
ELENAA (des **E**xigences en **L**anguEs **N**aturelles à leurs **A**nalyses **A**utomatiques)

Partners

ONERA
THE FRENCH AEROSPACE LAB

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Objectif

- Development of a prototype system of analysis of inconsistency and redundancy in requirements
- Demonstrable to customers

How to finance?

Help from the region Support Contract Midi-Pyrénées Innovation 115 365 € / 2 years

Projet CLE-ELENAA

Prometil company, Toulouse, France

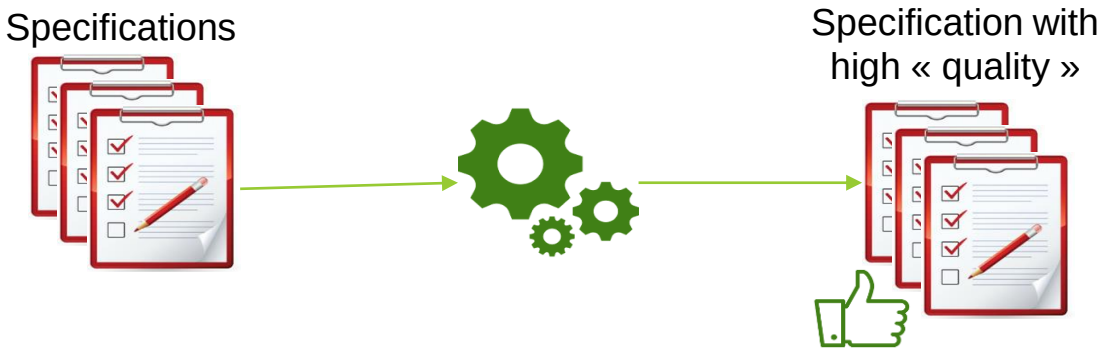
- Specialized in Requirements Engineering since 2007
- Software « Semios for Requirements » first released in 2015
- Major clients in Aerospace, Automotive, Naval

IRIT SIG, Toulouse, France

- Research team specialized in Generalized Information Systems
- Collaboration with Prometil since 2015

  on the subject of « Requirements quality analysis »

Industrial Context (1)



- Data from different domains
  - Aeronautic, Automobile, Spatial, Finance, Energy
- How to deal with each domain specification ?
  - Acronyms, Business terms

Quality criteria

IEEE830	ISO29148
Correct	Unambiguous
Unambiguous	Singular
Complete	**Consistent**
Verifiable	Complete
Traceable	Feasible
Consistent	Traceable
Modifiable	Verifiable
Ranked	
Non-Redundant	

Others.....

INCOSE

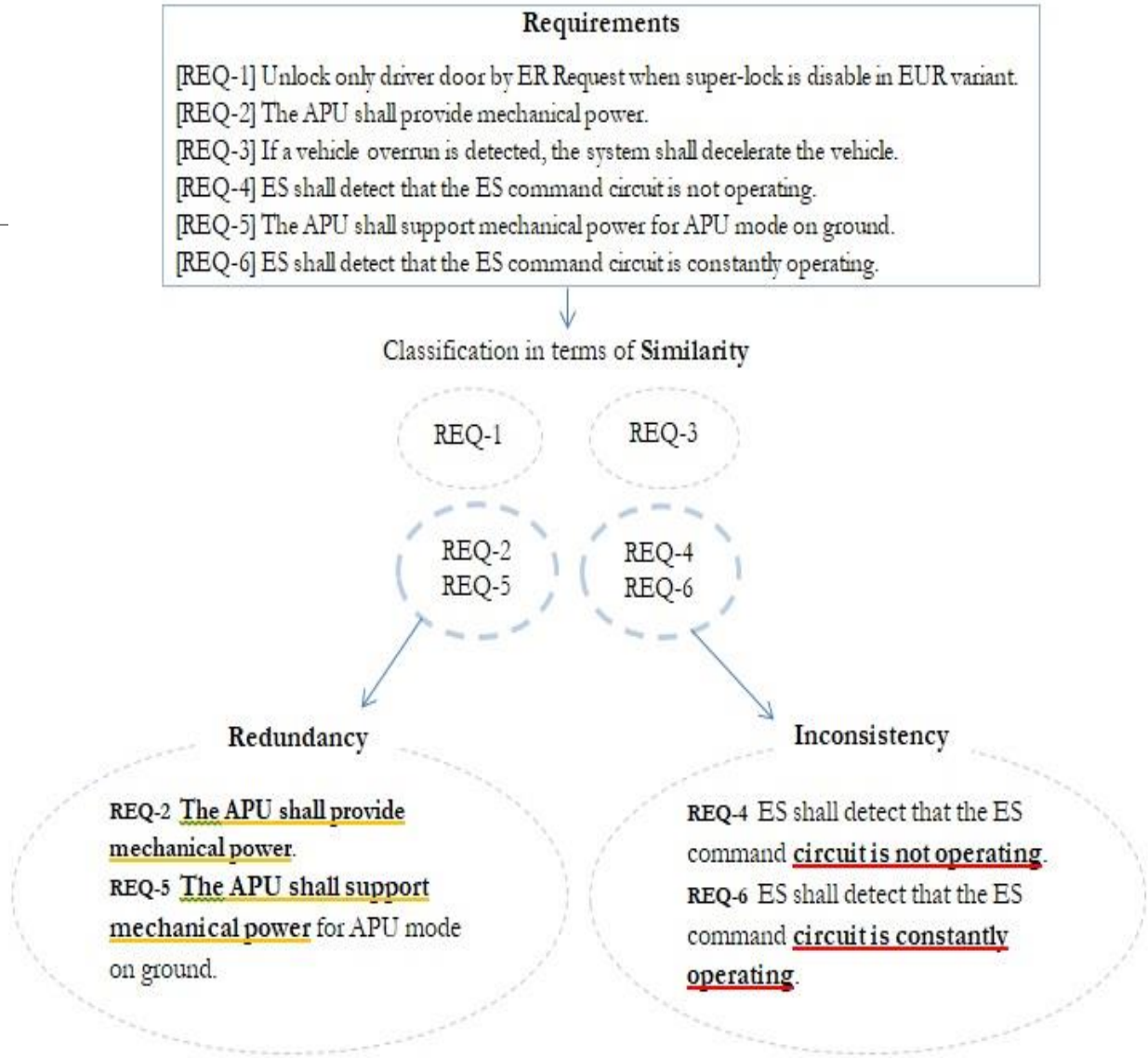
IREB

ARP4754

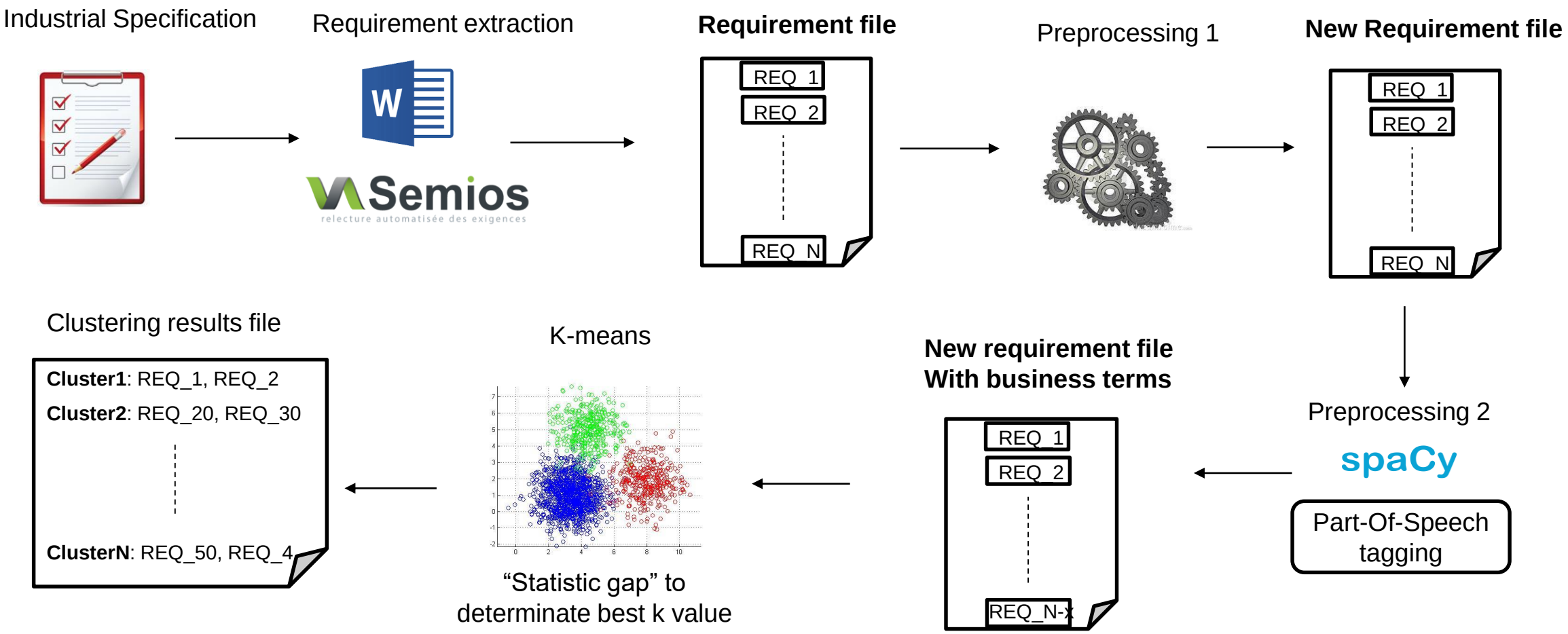
ASD-STE100

Industrial Context (2)

- Redundancy and inconsistency detection requires
  - Manual processing: **need an "expert"** in the field
  - Take time for analysis (especially for a large size specifications)
  - Not always obvious ...



Workflow


Industrial Specification
Requirement extraction
Semios
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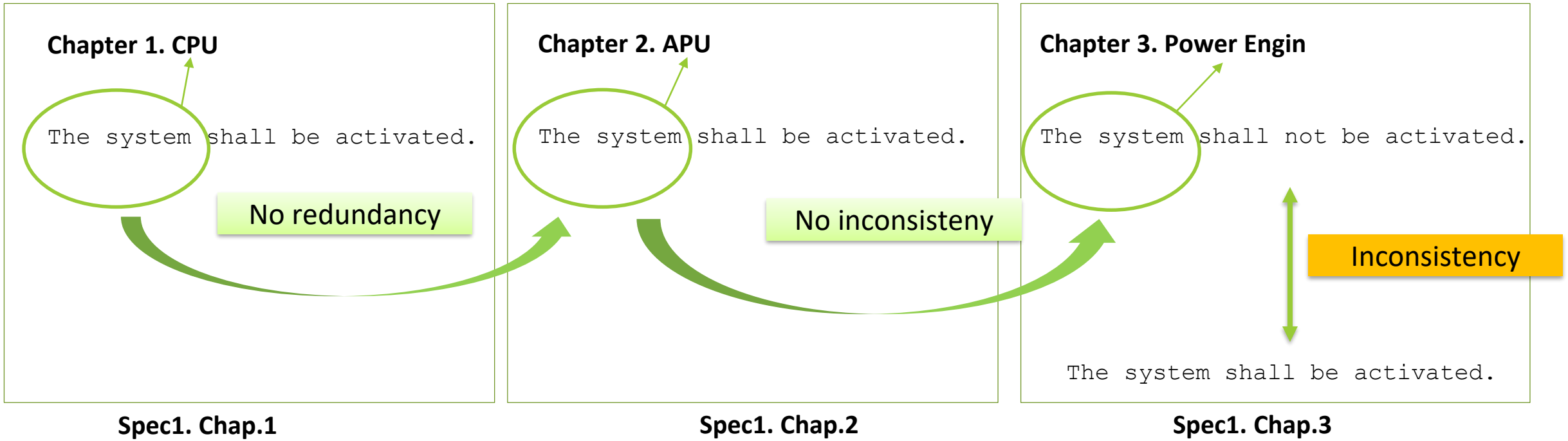
Requirement file
REQ_1
REQ_2
REQ_N
Preprocessing 1
New Requirement file
REQ_1
REQ_2
REQ_N
Preprocessing 2
spaCy
Part-Of-Speech tagging
New requirement file With business terms
REQ_1
REQ_2
REQ_N-x
K-means
"Statistic gap" to determinate best k value
Clustering results file
Cluster1: REQ_1, REQ_2
Cluster2: REQ_20, REQ_30
ClusterN: REQ_50, REQ_4

Preprocessing (1): filtering noisy requirements

- **Goal:** discard **identical** requirements belonging to the **different chapters**

False positives

- **Example**



Preprocessing (2): spaCy

- **Goal:** detect **bussiness terms**
- The most used 13 combination patterns in **business terms** by RE expert
  - noun-noun (e.g. `runway overrun`)
  - adjective-noun (e.g. `normal mode`)
  - proper noun- noun (e.g. `BSP data`)
  - adjective-adjective-noun (e.g. `amber visual indication`)
  - noun-noun-noun (e.g. `output voltage value`)
  - …
- **POS tagging**: Annotate part-of-speech tags on documents

Example: `Unlock only driver door by DR request SW when superlock is disable in EUR variant.`

https://spacy.io/api/

Preprocessing (2): spaCy

Unlock **PROPN** only **ADV** driver **NOUN** door **NOUN** by **ADP** DR **PROPN** request **NOUN** SW **PROPN**

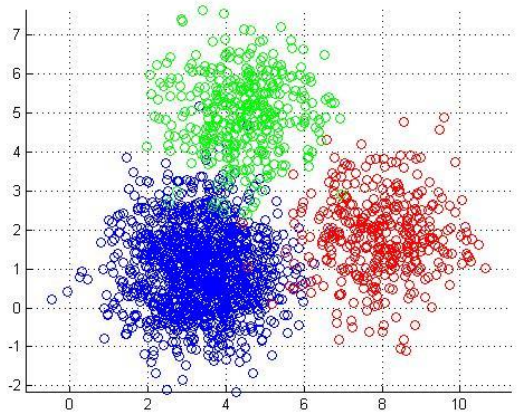
when **ADV** superlock **NOUN** is **VERB** disable **ADJ** in **ADP** EUR **PROPN** variant **NOUN**

- **Preprocessing output**
  - Unlock only driver door by DR request SW when superlock is disable in EUR variant.
  - Unlock only **driver_door** by **DR_request** SW when superlock is disable in **EUR_variant.**

K-means

- Approach: unsupervised learning
- Goal: cluster the data into k groups
- Prerequisite: predefined value of k as an input
- **Best value of K**:

  based on **Statistic gap** (Tibshirani et al., 2001) vs based on **RE expert**



*Expert with more than 15 years of experience in an industrial domain

Datasets

- Texts following various kinds of business style and format guidelines imposed by companies
- Texts coming from various industrial areas: Aerospace, Automobile

	Number of requirements	Observation
Corpus1	913	Randomly chosen with no a priori information of redundancy and inconsistency according to our expert*
Corpus2	326	Randomly chosen with no a priori information of redundancy and inconsistency according to our expert*

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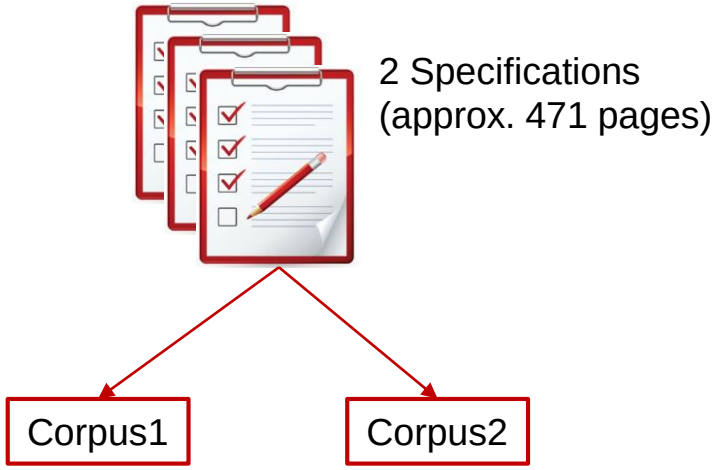

Validation

- Only clusters with more than one requirement
- **"Strict" Validation (SV)**
  - Relevant cluster = **100% correct** requirements (fully redundant or inconsistent requirements)
  - Clusters with partially relevant requirements: discarded
  - For example
    - Cluster1={requirement1, requirement2, requirement3, requirement4}
    - Cluster 1 **is relevant only if all** the 4 requirements are similar (redundant/ inconsistent)
- **"Average" Validation (AV)**
  - Calculate the average of relevant requirements per cluster
  - For example
    - Cluster1={requirement1, requirement2, requirement3, requirement4} :
    - if only requirement1 and requirement2 are similar (redundant/ inconsistent) → Cluster1 is 50% relevant

K-means : Example of results

Cluster1:

1. The approval shall be **stamped** in conformance with 5.2.4, and recorded.
2. The approval shall be **marked** in conformance with 5.2.4, and recorded.

Redundancy

Cluster2:

1. Digital_state : (switch conversion) states are calculated using input_voltage.
2. Digital_state : (switch conversion) states are calculated **for frequency external_inputs** using input_voltage.

Redundancy

Cluster3:

1. The range of the transducer shall **be -0.5 to + 3.25_Psid**.
2. The range of the transducer shall **be -90 to + 90_Psid**.

Inconsistency

Cluster4:

1. SYS 3WSV_Command_circuit shall **be activated**.
2. SYS 3WSV_Command_circuit shall **not be activated**.

Inconsistency

Experimental results

Table 1: Results: new number Of requirements, best value of K, validation results and the associated number of relevant clusters for each data set

Dataset	New nb. of req.	Best value of K		SV (Nb. of relevant clusters)	AV (Nb. of relevant clusters)
		Based on statistic gap	Based on RE expert		
Corpus1	902	38	–	11.11% (4)	26.17% (31)
		–	721	48.69% (56)	51.31% (64)
Corpus2	280	42	–	8.33% (2)	19.54% (11)
		–	224	76% (19)	76% (19)

Discussion

- Approach tested on **real industrial datasets** → domain independent, different types of requirements in NL, no a priori knowledge
- Statistic gap for a best K-value→ **not the best way** to calculate the « optimal » value in RE context
- K-value defined by RE expert according to the errors rate (20%) → **significantly improve** results

Conclusion

- First step for detecting redundancy and inconsistency
- Collaboration between academic and industrial (ELENAA project)
- ML algorithms to solve clients needs

- Results implemented in an industrial product

Thanks for your attention!

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