



WEBINARS 2019

Applying Machine Learning Techniques to the Flexible Assessment of Requirements Quality

Thursday, 26 September 2019

Presenters' profile

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- Local partners: France, Germany, Italy, Spain and Japan
- Customers in different countries along United States, Europe and Asia
- TRC Headquarters is based on Madrid (Spain)
- United Kingdom TRC office
- Scandinavian TRC office (Sweden)



TRC WEBINARS 2019

The REUSE Company (TRC)

Tools and solutions for knowledge Traceability, Reuse and Quality management

Specialized in the application of **Semantic Analysis Technologies** to a wide range of industries (Aerospace, Defense, Automotive, Railway, Energy...)

Focus: System/Software **Reuse, Traceability and Quality**. The integration of tools and technology from **The REUSE Company** facilitates the representation, analysis and exploitation of knowledge and enables a knowledge-centric systems engineering approach.

Mission: promoting system/software and knowledge reuse within any organization, by offering **processes, methods, tools** and **services**. Technology fully integrated within the organization production chain.



NewControl



REVaMP²



AMASS
Assurance and Certification of CPS

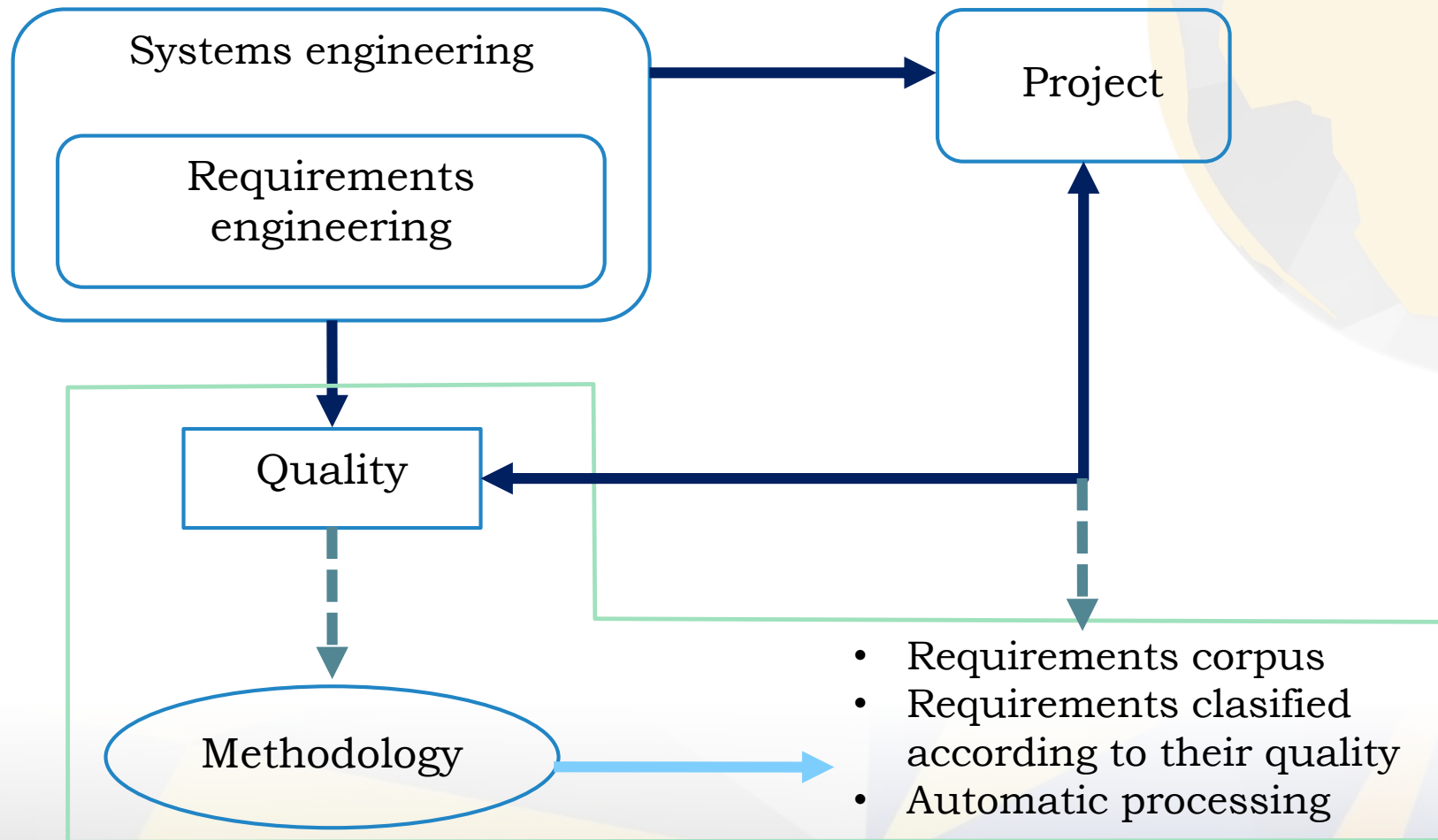
Innovative technologies applied to
Knowledge Reuse

Eugenio Parra



- Visiting Professor at the Computer Science Department at Universidad Carlos III de Madrid.
- A Quality Metrics Architect and an Artificial Intelligence Architect collaborating with The REUSE Company.
- His research includes studying new approaches for quality analysis based on artificial intelligence techniques, in combination with semantic approaches interests for Requirements Engineering, Natural Language Processing and Artificial Intelligence.
- Research papers publications on topics such as reuse of knowledge and improvement of the quality of requirements.
- Participates as a researcher in different EU projects, with contributions in AMASS (H2020/ECSEL) and CRYSTAL (ART Call 2012: 332830).

Applying machine learning techniques in requirements engineering



Objectives of the methodology

- Emulate the quality classification that would be provided by a project and domain expert on requirements
- Optimize the quality of the requirements through automatic correction suggestions

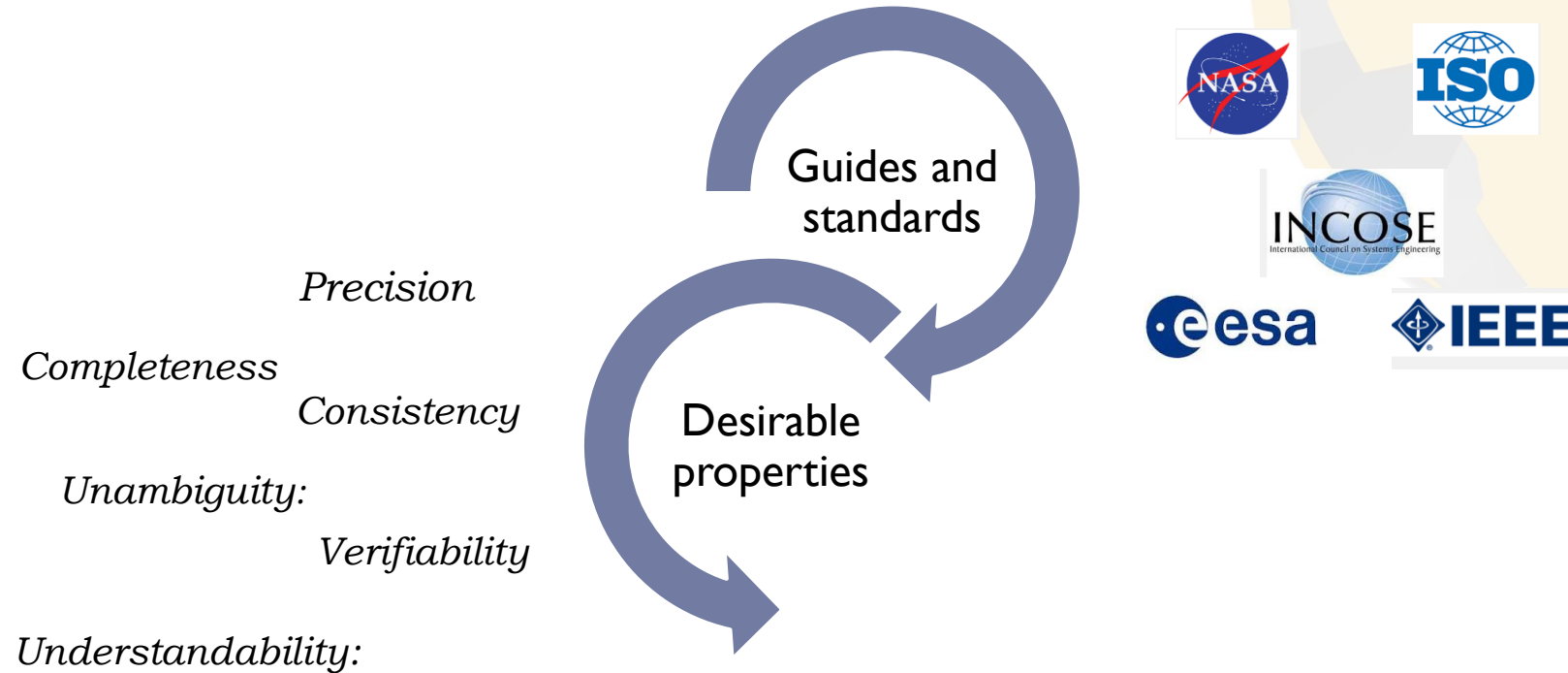
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From qualitative properties to quantifiable indicators



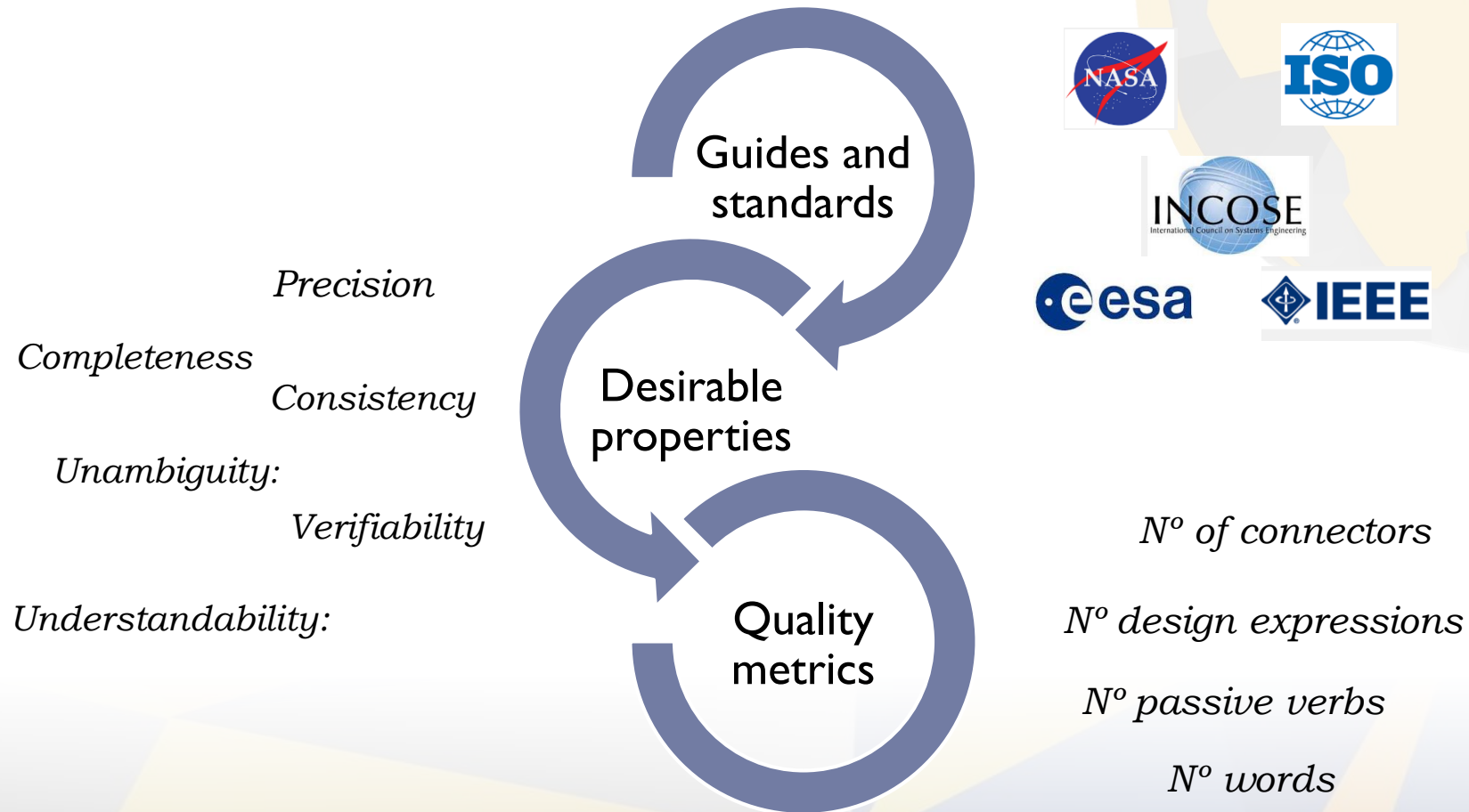
Génova, G., et al (2013)

From qualitative properties to quantifiable indicators



Génova, G., et al (2013)

From qualitative properties to quantifiable indicators



Génova, G., et al (2013)

Extracting quality metrics



RQA

Quality metrics	
No. of paragraphs	Nº of indefinite articles
No. of words	Imperative mode
No. of conjunctions	Nº of imprecise quantifiers
Nº of Rationale sentences	Style Guide
Nº of Flow sentences	Nº of expressions in conditional mode.
Nº of Parenthesis	Nº of vague adverbs
No. of negative expressions	Nº of vague adjectives
Nº of characters between punctuation marks	Nº of escape clauses
Nº of verbs in passive voice	Nº of open-ended expressions
Incorrect Punctuation (Readability)	Nº of Superfluous Infinitives
No. of speculative expressions	Incorrect Spelling
Nº of subjective expressions	Statement And/Or

Steps of the methodology

Classifier Generation

- Create a corpus of classified requirements
- Extract quality metrics for each requirement
- Create learning instances
- Generate the classifier

Quality estimation of the new requirements

- Extract metrics from the new requirements
- Generate evaluation instances
- Estimate the quality of the new requirement

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Classifier Generation.

Corpus of classified requirements



RQA



Quality metrics

	A	B	C	D	E
1	ID-Requirement	Acronyms	Connectors	Dependencies	Domain verbs
2	2049	16,00	13,00	0,00	1,00
3	2050	0,00	2,00	0,00	0,00
4	2051	3,00	3,00	0,00	0,00
5	2052	0,00	1,00	0,00	0,00
6	2053	1,00	3,00	0,00	0,00
7	2054	1,00	1,00	0,00	1,00
8	2055	0,00	0,00	0,00	0,00



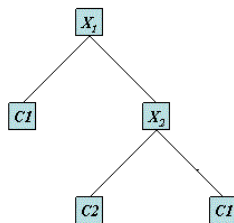
Learning instance of each requirement

Metric 1	Metric 2	...	Metric N -1	Metric N	Class
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Values of the quality metrics of a requirement

Quality of the requirement

Classifier



Quality estimation of the new requirements.

Corpus of NEW requirements



RQA



Quality metrics

	A	B	C	D	E
1	ID-Requirement	Acronyms	Connectors	Dependencies	Domain verbs
2	2049	16,00	13,00	0,00	1,00
3	2050	0,00	2,00	0,00	0,00
4	2051	3,00	3,00	0,00	0,00
5	2052	0,00	1,00	0,00	0,00
6	2053	1,00	3,00	0,00	0,00
7	2054	1,00	1,00	0,00	1,00
8	2055	0,00	0,00	0,00	0,00

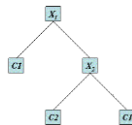


Evaluation instance of each new requirement

Metric 1	Metric 2	...	Metric N -1	Metric N
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Values of the quality metrics of
a new requirement

QUALITY



Example of quality estimation of the new requirement



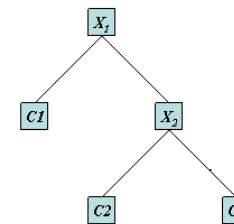
The system shall send the War662 warning message to the safety module when the temperature exceeds 60 degrees Celsius.



The system shall have a good communication with the safety module in order to ensure a high level of security and shall alert the user when some problem occurs.

Suppose a classifier was generated with the Algorithm C 4.5

Classifier



Example of quality estimation of the new requirement



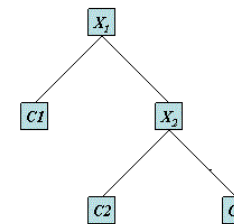
The system shall send the War662 warning message to the safety module when the temperature exceeds 60 degrees Celsius.



The system shall have **a good** communication with the safety module **in order to** ensure **a high** level of security **and** shall alert the user when **some** problem occurs.

Suppose a classifier was generated with the Algorithm C 4.5

Classifier



Example of quality estimation of the new requirement

Quality metrics	Requirement 1	Requirement 2
No. of paragraphs	1	1
No. of words	19	29
Nº of rationale sentences	0	1
Nº of characters between punctuation marks	118	160
Nº of subjective expressions	0	3
Nº of indefinite articles	0	2
Imperative mode	1	1
Statement And/Or	0	1

Rule triggered for the requirement 1

Nº of paragraphs <= 4 AND
Nº of words <= 50 AND
Imperative mode > 0 AND
Nº of subjective expressions < 1 THEN

GOOD QUALITY

Rule triggered for the requirement 2

Nº of indefinite articles >= 2 AND
Nº of words <= 50 AND
Nº of subjective expressions > 0 AND
Statement And/Or >= 1 THEN

BAD QUALITY

Experimentation

Algorithm

- C 4.5
- PART
- Bagging C 4.5
- Bagging PART
- Boosting C 4.5
- Boosting PART



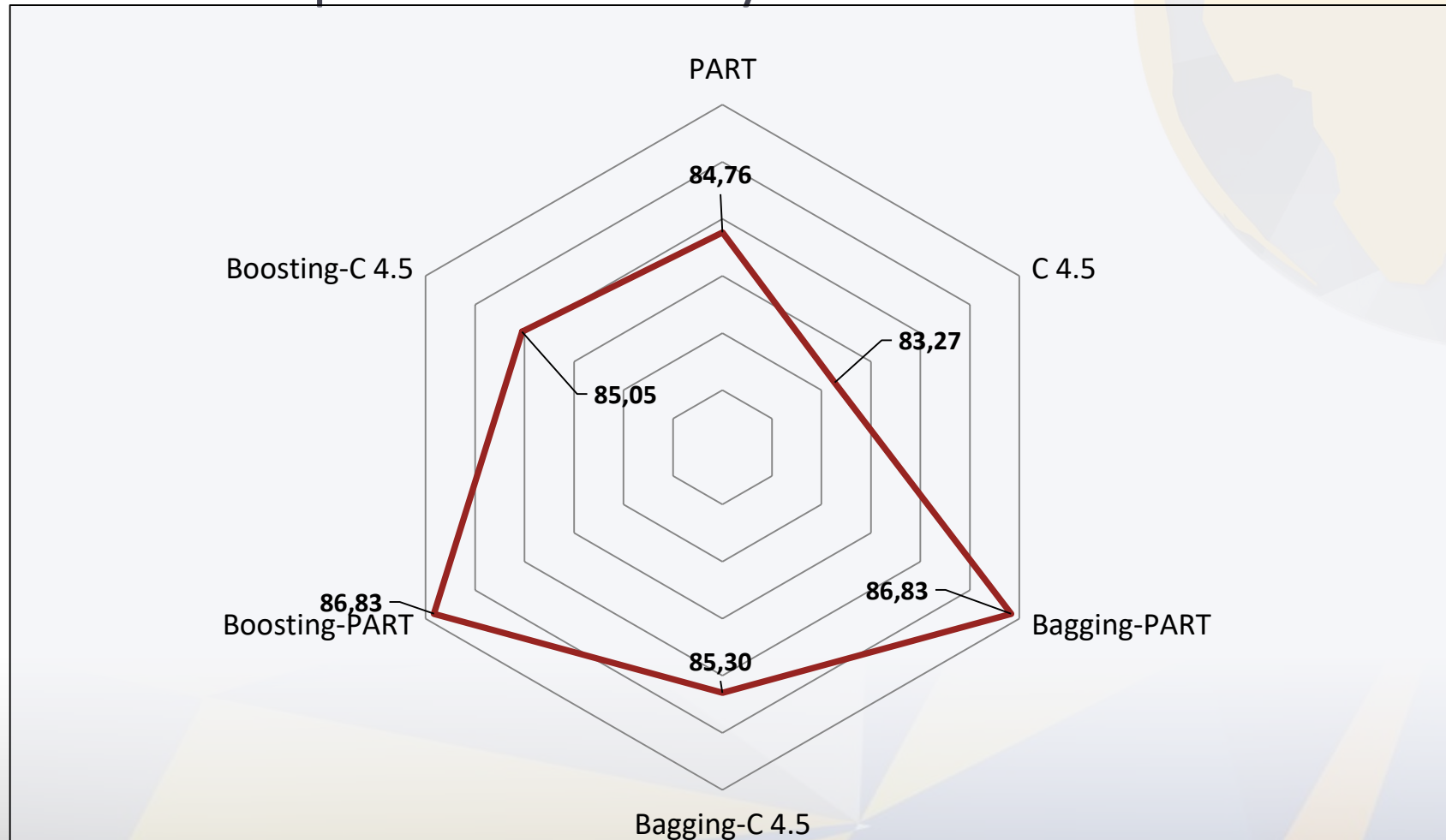
Requirements corpus

1035 Classified requirements

- 545 Good quality
- 490 Bad quality

Experimentation

Results comparison: accuracy

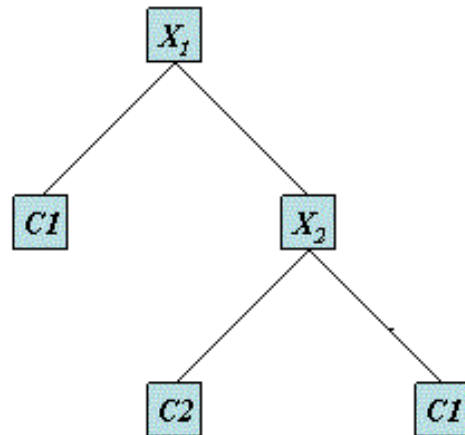


Parra, E., et al (2015)

Improving the quality of the requirements

If the requirement is evaluated with bad quality

- Select the rule that needs less changes to transform the quality of the requirement



Nº of indefinite articles	>=	2	AND
Nº of subjective expressions	>	0	AND
Nº of verbs in passive voice	>	0	THEN

BAD QUALITY

Nº of words	>	60	AND
Nº of paragraphs	>	2	AND
Nº of vague adverbs	>	2	AND
Statement And/Or	>=	3	THEN

BAD QUALITY

Imperative mode	==	0	AND
Nº of verbs in passive voice	>	0	AND
No. of words	<	7	THEN

BAD QUALITY

Conclusions

- A method has been presented to assess the quality of requirements in a flexible way using machine learning techniques.
- The method was evaluated with an experiment using a set of requirements provided by INCOSE
- A suggestion module was created based on the classifier in order to improve the quality of the requirements.

Improving the process

- Add new metrics based on a complete ontology.



Knowledge Manager

Next webinar

➤ Topic:

➤ **A Practical Way to Implement ISO 15288 V&V Processes: The V&V Studio**

- The Verification and Validation processes of the ISO 15288 describe in a general way how to perform V&V for a complex system. However, the standard also suggests the need to apply V&V not only to the right side of the V-Model but also to the requirements, architecture and design processes outcomes, along the left side of the V-Model.

➤ Dates:

- October 22 and 24



Other Events:

- **AI4SE Workshop**
- The first workshop on the application of Artificial Intelligence for Systems Engineering.
- INCOSE event
- November 12-13
- <http://www.kr.inf.uc3m.es/ai4se/>







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