

# A Goal-Question-Metrics Model for Configuration Knowledge Bases

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# Outline

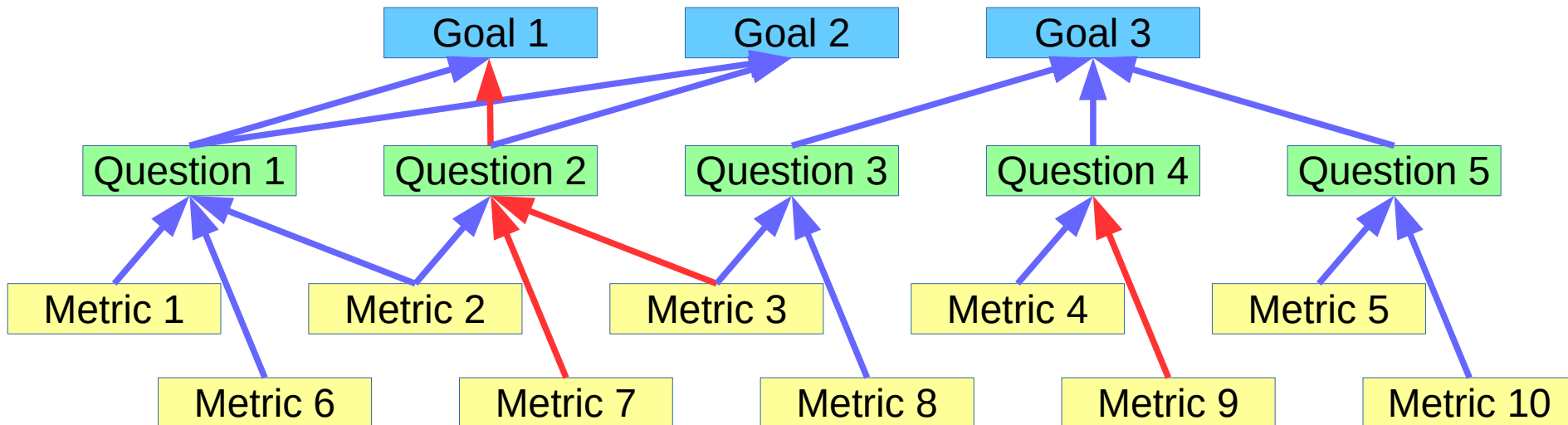
- Introduction
- GQM-model
  - Goals
  - Questions
  - Metrics
- Interpretation
- Summary

# Introduction

- Constraint-based configuration knowledge bases are changing over time
- Maintenance is time consuming and error prone
  - Detect anomalies
  - Understand the knowledge base
  - Optimize the knowledge base
- Different techniques to reduce the maintenance effort
  - Recommendation
  - Anomaly management
  - Simulation
  - **KB evaluation**

# Introducing GQM

- Depicted from software engineering
  - Measure metrics
  - Aggregate metrics to answer questions
  - Aggregate questions to achieve goals



## GQM: goals

- A configuration knowledge base must be **maintainable**, such that it is easy to change the semantics of the knowledge base in a desired manner.
- A configuration knowledge base must be **understandable**, such that the effort for a maintainability task for a knowledge engineer can be evaluated.
- A configuration knowledge base must be **functional**, such that it represents a part of the real world (e.g. a bike configuration knowledge base).

# GQM: questions

- Q1: Is the configuration knowledge base **complete**?
- Q2: Does the configuration knowledge base contain **anomalies**?
- Q3: Does the configuration knowledge base have an admissible **performance**?
- Q4: Is the configuration knowledge base **modifiable**?
- Q5: Is the configuration knowledge base **understandable**?

## GQM: metrics (selected)

- Restriction rate: how many constraints are in the knowledge base?

$$RR_2 = \frac{|C|}{|V|} \sum_{c_i \in C} \frac{\# vars(c_i)}{|V|}$$

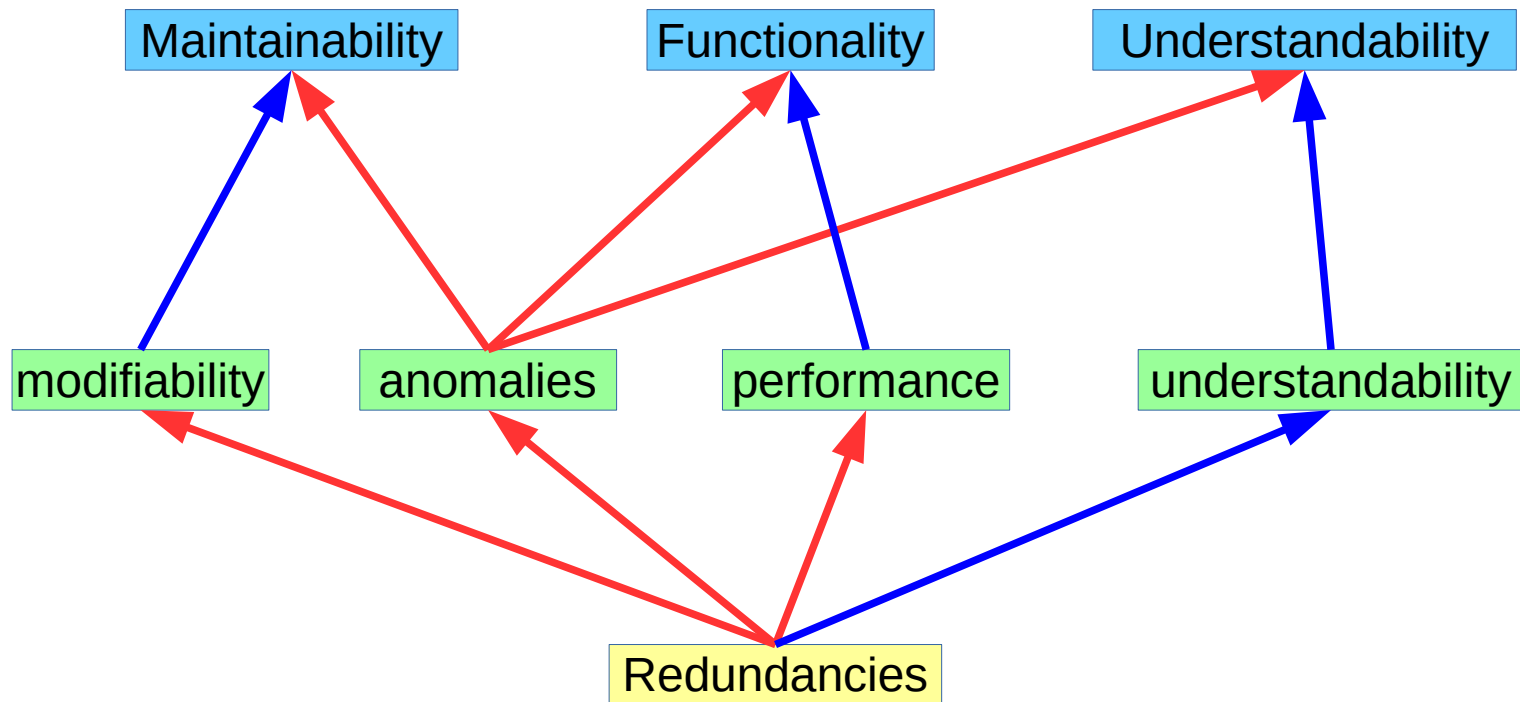
- Coverage: how many variants are consistent?

$$coverage(C) = \frac{\text{number of consistent variants}}{\text{number of all possible variants}}$$

- Variable Inheritance Factor: how important is a variable?

$$VIF(v_i) = \frac{\sum_{c_i \in C} \begin{cases} 1 & v_i \in c_i \\ 0 & \text{otherwise} \end{cases}}{|C|}$$

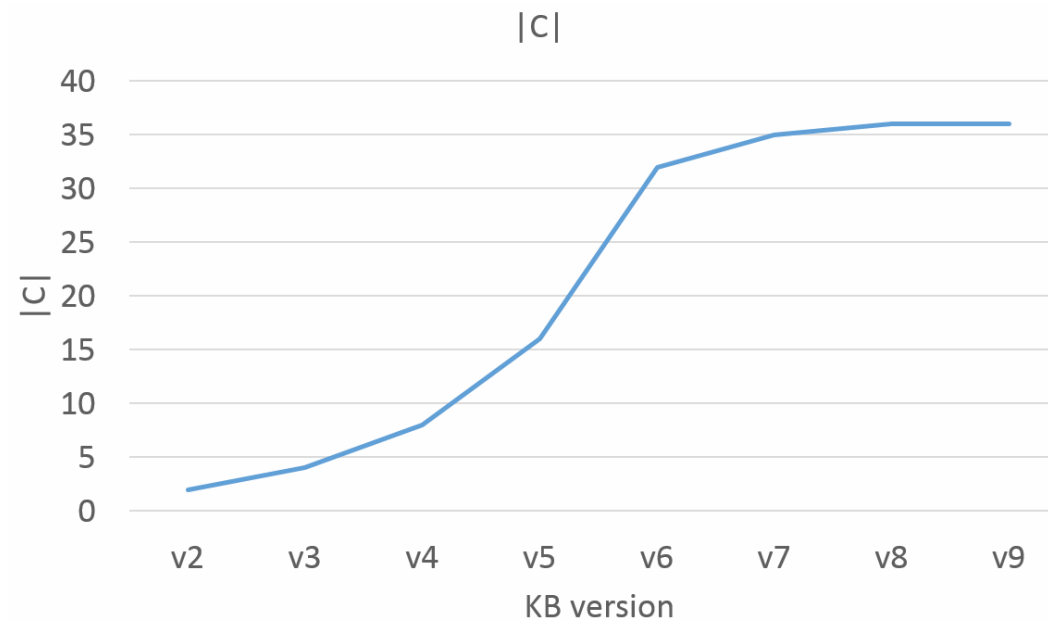
# GQM with the metric redundancies





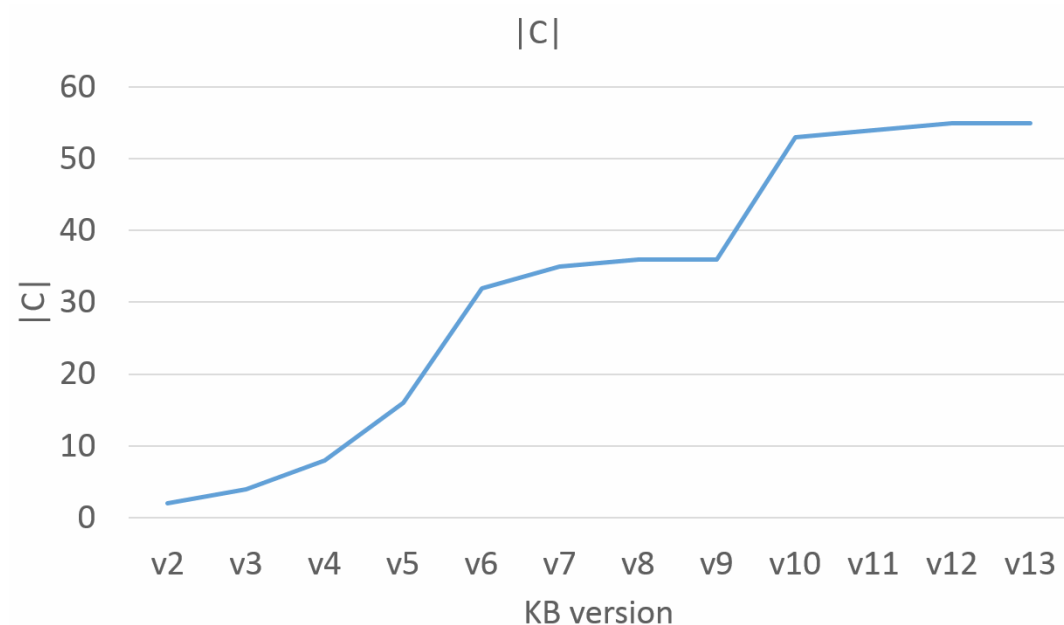
# Evaluating completeness

- KB life cycle
  - **initial tasks**



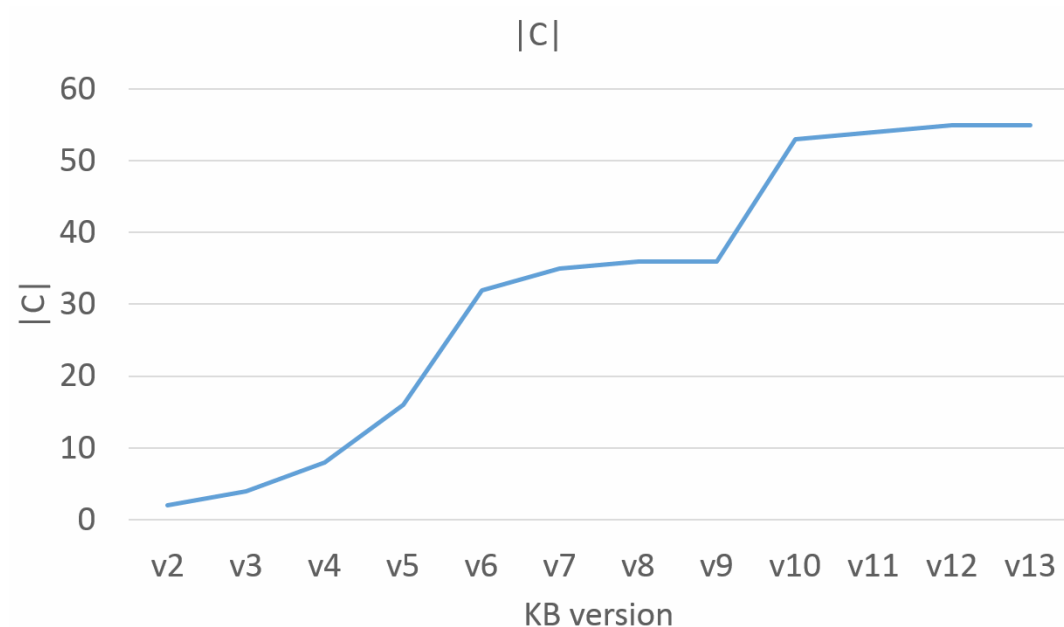
# Evaluating completeness

- KB life cycle:
  - initial tasks
  - **maintenance tasks**



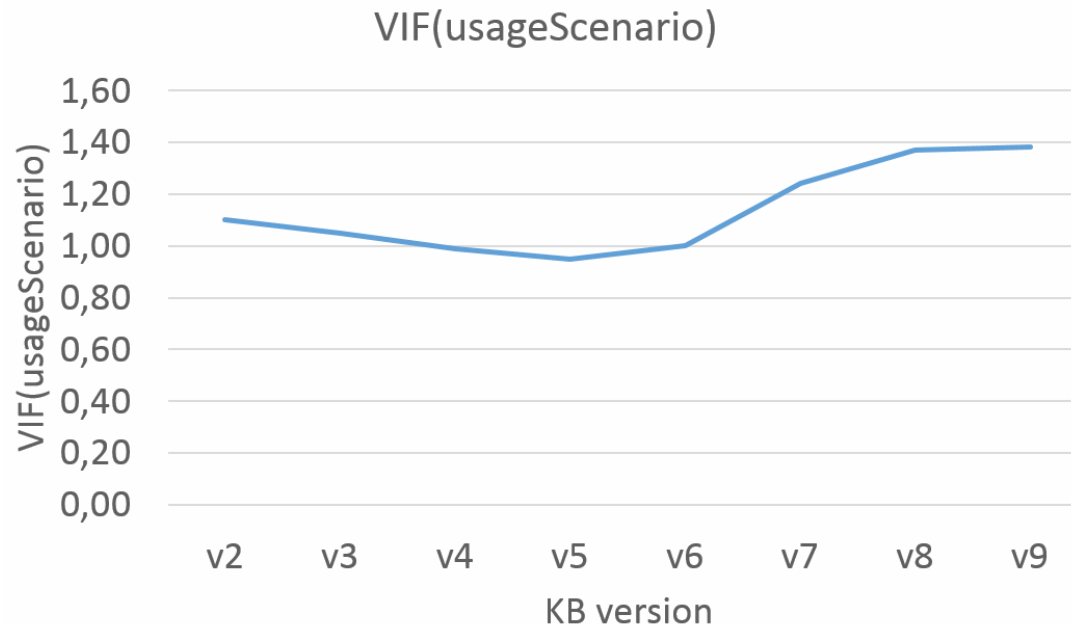
# Evaluating completeness

- KB life cycle:
  - **KB development**
  - initial tasks
  - maintenance tasks



# Interpretation of metrics

- Explaining the values based on the history of the knowledge base



# Conclusion

- GQM helps to measure the knowledge base
- Aggregation of metrics into questions and goals
- Compare the results with previous versions
- Getting tendencies of goals / questions / metrics
- Further research
  - Weighting the relationships
  - Empirical studies

# References

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# Link between goals and questions

	Maintainability	Usability	Functionality
Q1 (completeness)			+
Q2 (anomalies)	-	-	-
Q3 (performance)			+
Q4 (modifiability)	+		
Q5 (understandability)		+	

# Link between questions and metrics

	Q1 completeness	Q2 anomalies	Q3 performance	Q4 modifiability	Q5 understandability
V	+		-		
domsize	+		-		
C	+		-		
CS	-	-		-	
Delta	-	-		-	
MCCS					+
MCDelta					+
R		-	-	-	
MCR					+
DE		-	-	-	-
FM		-	-	-	-
UR		-	-	-	-
RR				-	-
RR2				-	-
VIF				-	-
Coverage				-	-