

Requirements More than Text

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The Epicenter – Anton Paar

- Highly diverse product portfolio
- 4200+ employees worldwide
- Different levels of specification quality

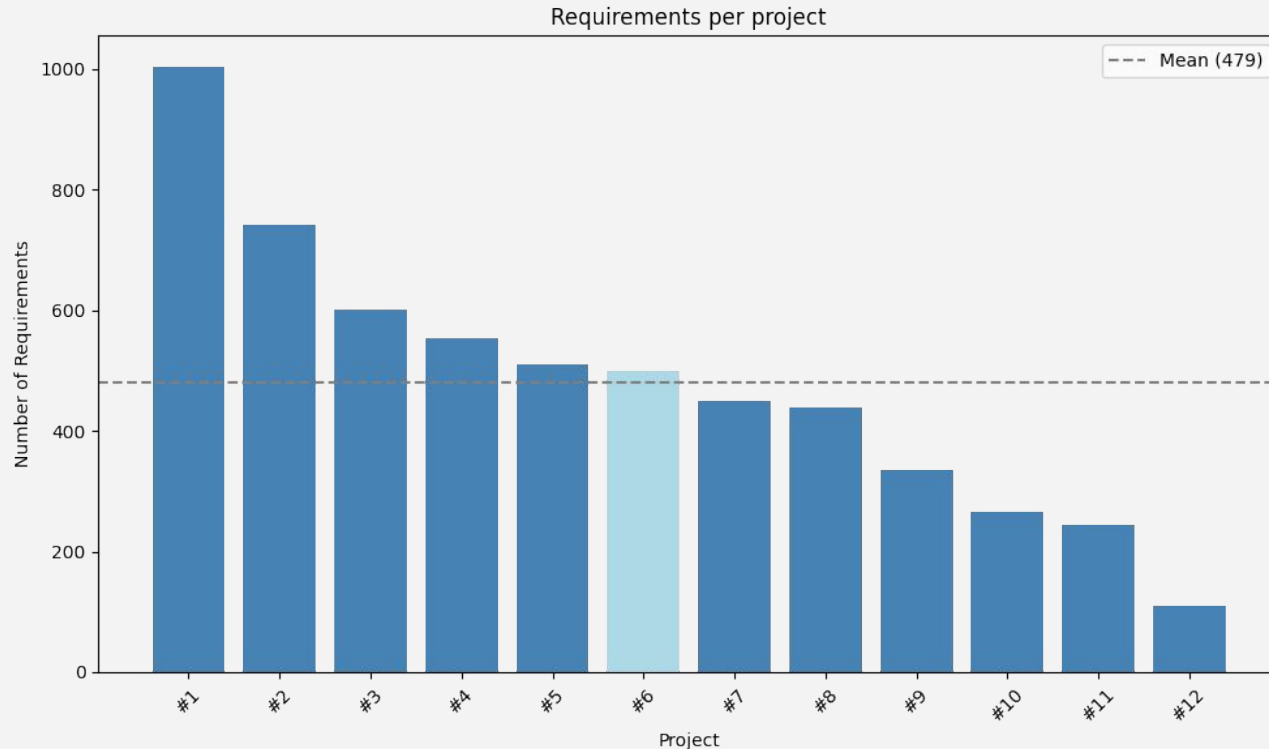


Requirements Engineering

- Internal process
- Dedicated requirement engineers
- 3 hierarchical levels of requirements
- Project was for **internal use** only
- 1 man operation
- Goal: proof of concept



The Data



5757
requirements

253 507
words

1 419 248
characters

Pipeline

Step 1

Step 2

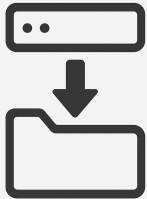
Step 3

Step 4

Step 5

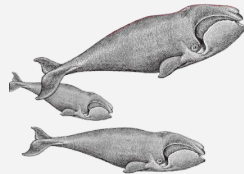
Extraction

manual work
bulk export



Preprocessing

classic NLP
methods



**Create
Embeddings**

OpenAI
Embeddings



OpenAI

Clustering

UMAP
HDBSCAN



Reformulation

OpenAI API
Custom prompt
IREB principles



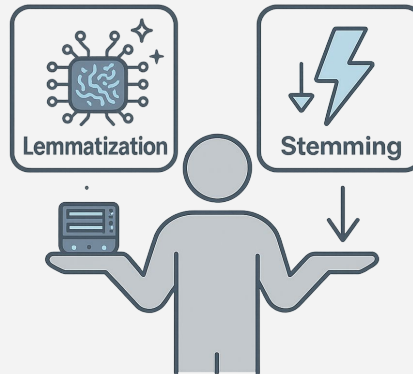
OpenAI

Preprocessing Pipeline

The system shall record temperature readings from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ with $\pm 0.1\text{ }^{\circ}\text{C}$ accuracy in ≤ 3 seconds.

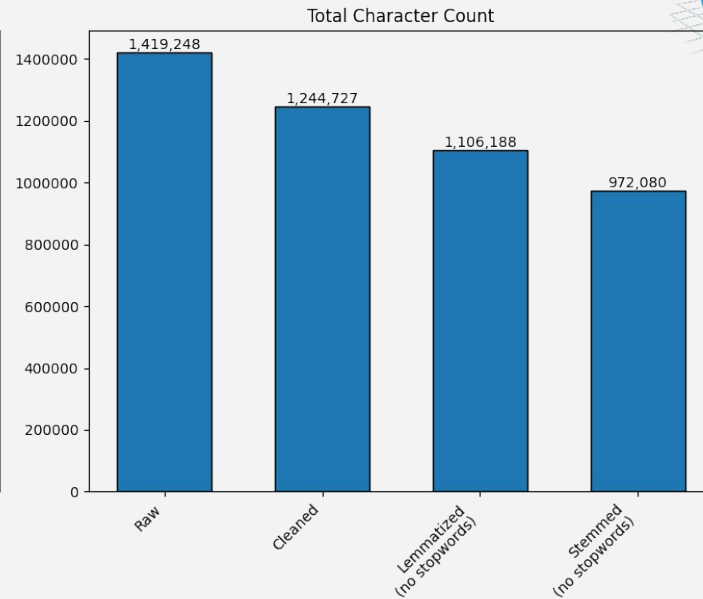
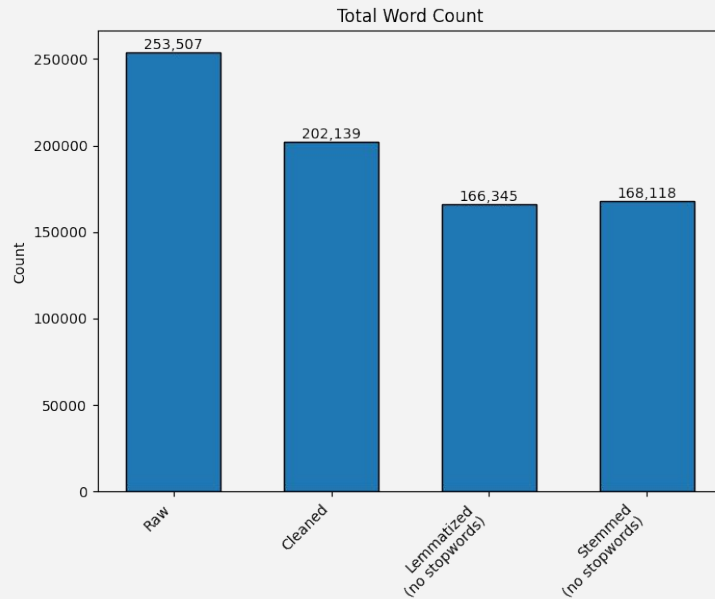
Lemma: system shall record temperature reading accuracy second

Porter: system shall record temperatur read accuraci second



First Findings

- Separation of text and numbers needed

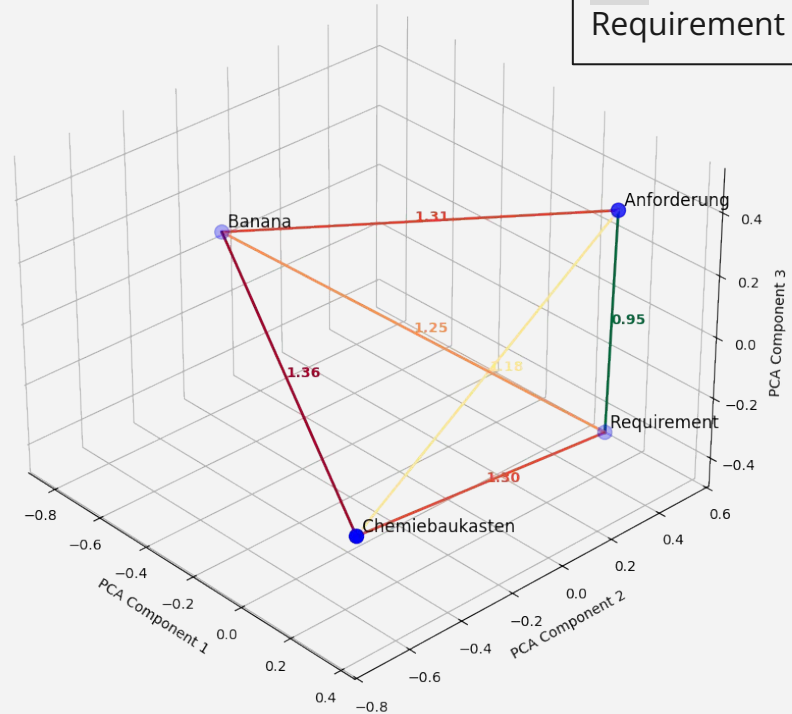


Embeddings

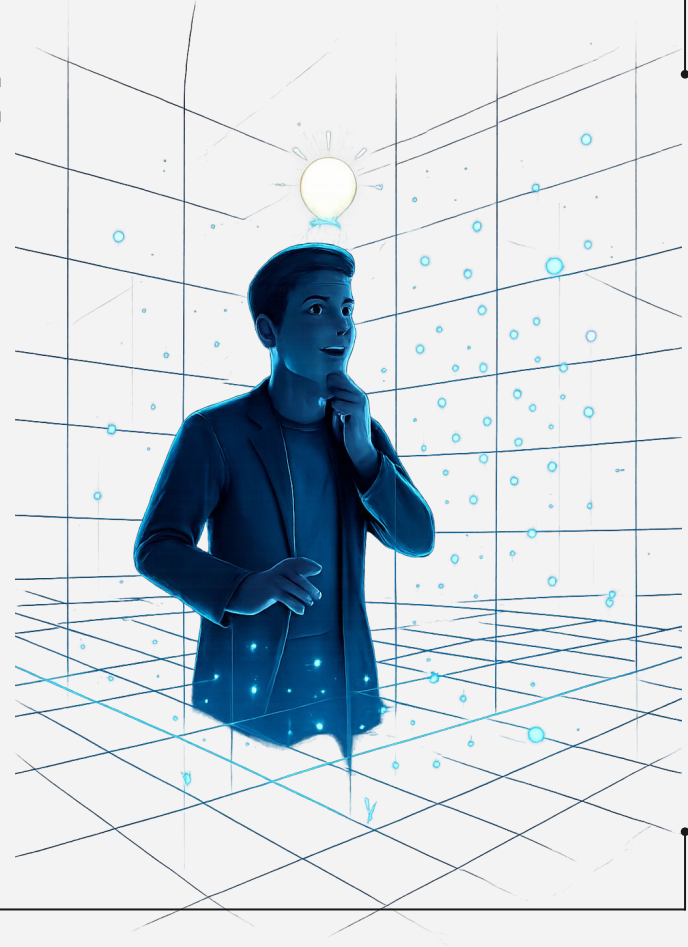
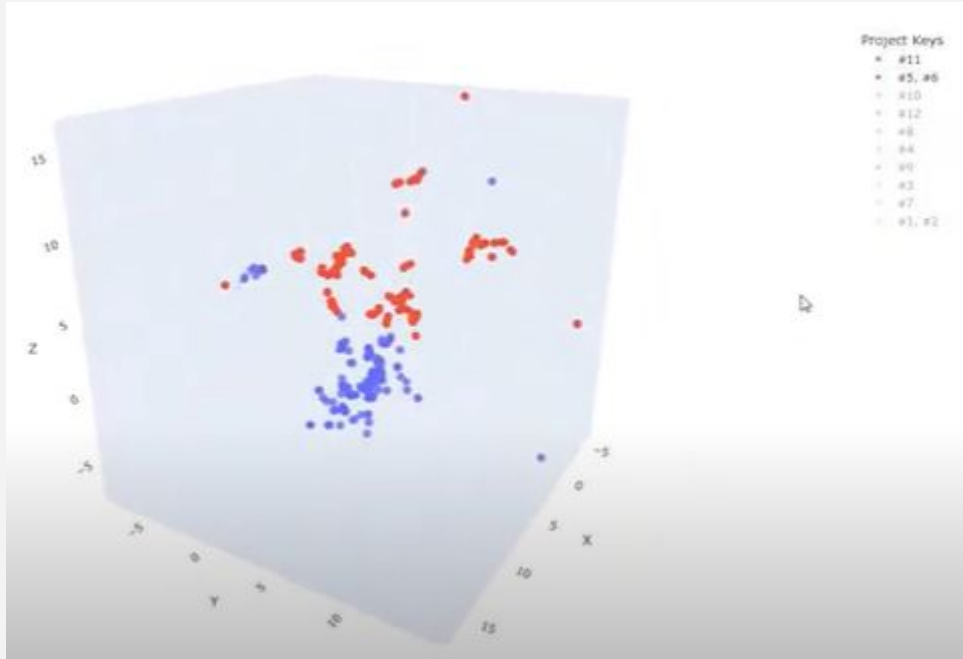
- 220 615 tokens
- 1.84MB requirements
- 108MB embeddings

Banana
Requirement

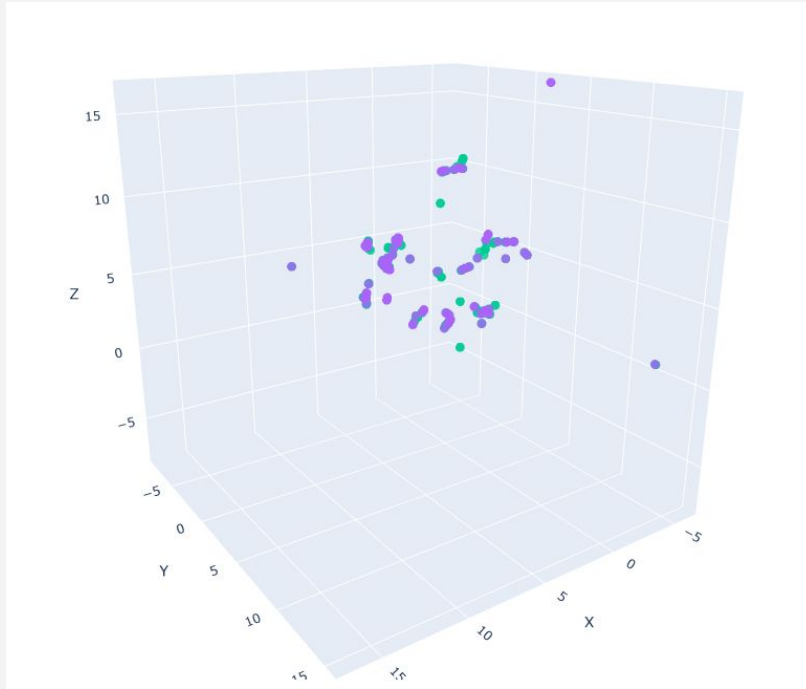
```
def getEmbedding(client, text, model=EMBEDDING_MODEL,
                  dimensions=EMBEDDING_DIMENSIONS):
    response = client.embeddings.create(
        model=model,
        dimensions=dimensions,
        input=text
    )
    tokens_used = response.usage.total_tokens
    prompt_tokens = response.usage.prompt_tokens
    return prompt_tokens, tokens_used, response.data[0]
```



Embeddings by Project



Embeddings by Project



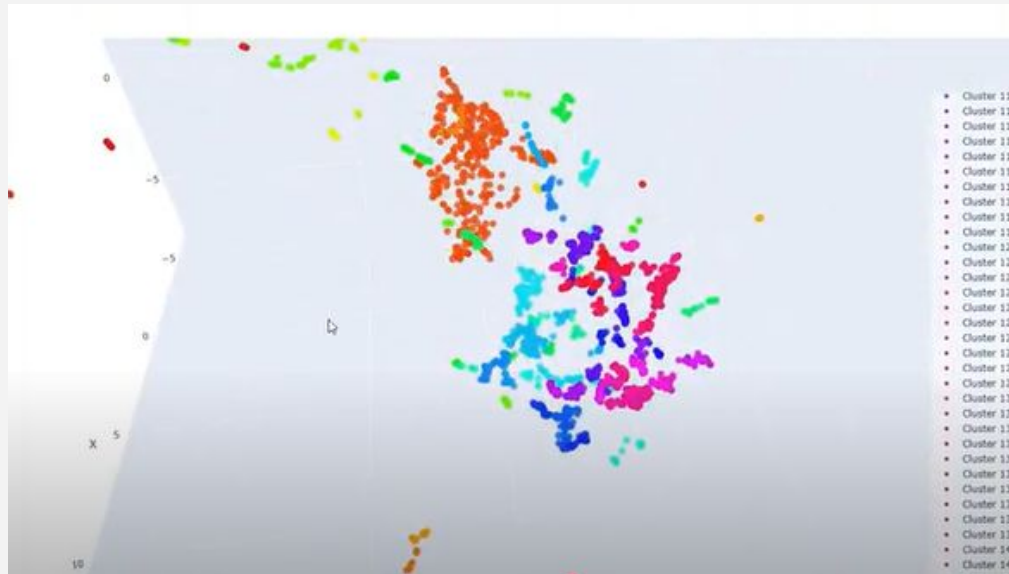
- #10 and #12
- single points can be many requirements
- Does it look similar?
- Same type of device
- Different project teams

Embeddings

- Is it just a pretty plot?
 - One-Way-Street
- Mathematics
 - Calculations
- Remember Anton Paar
- What if...

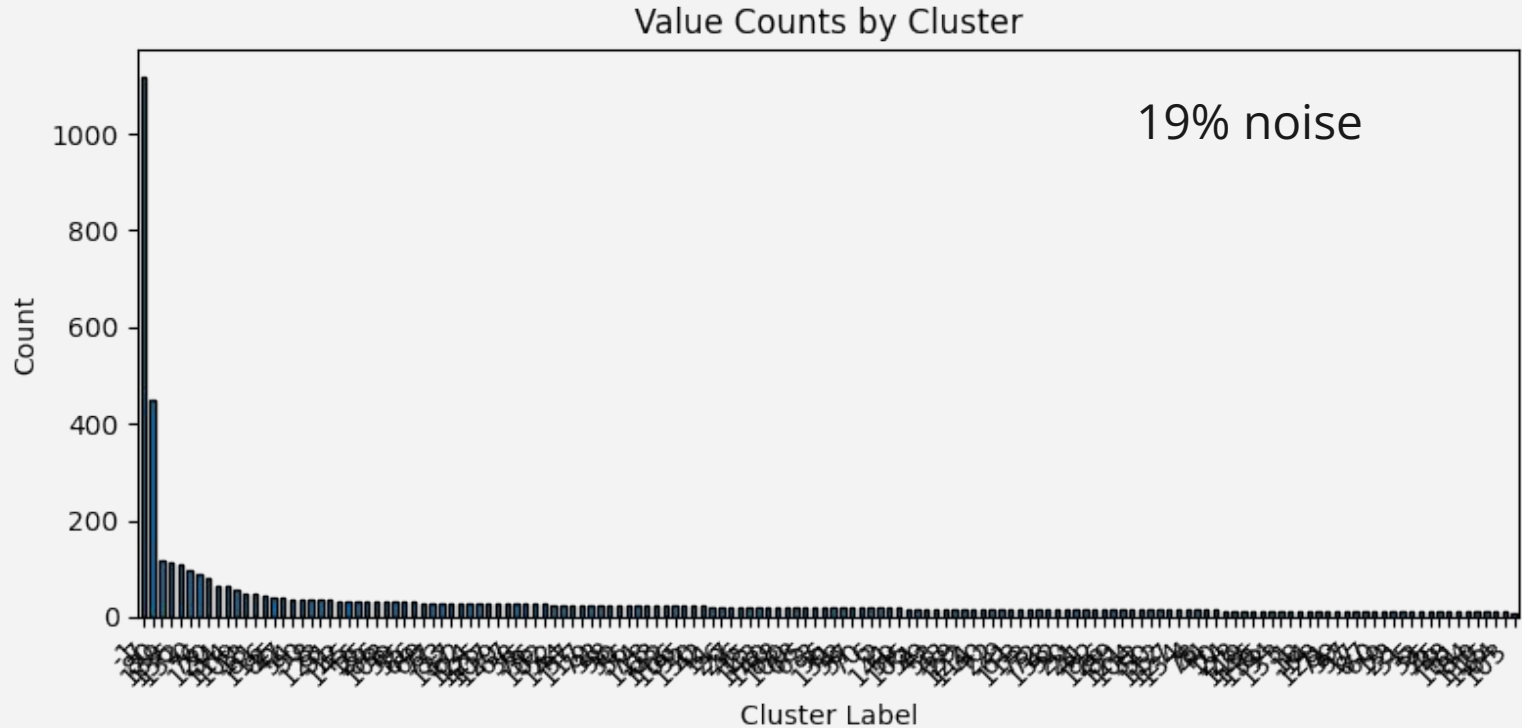


Clustering - Plot

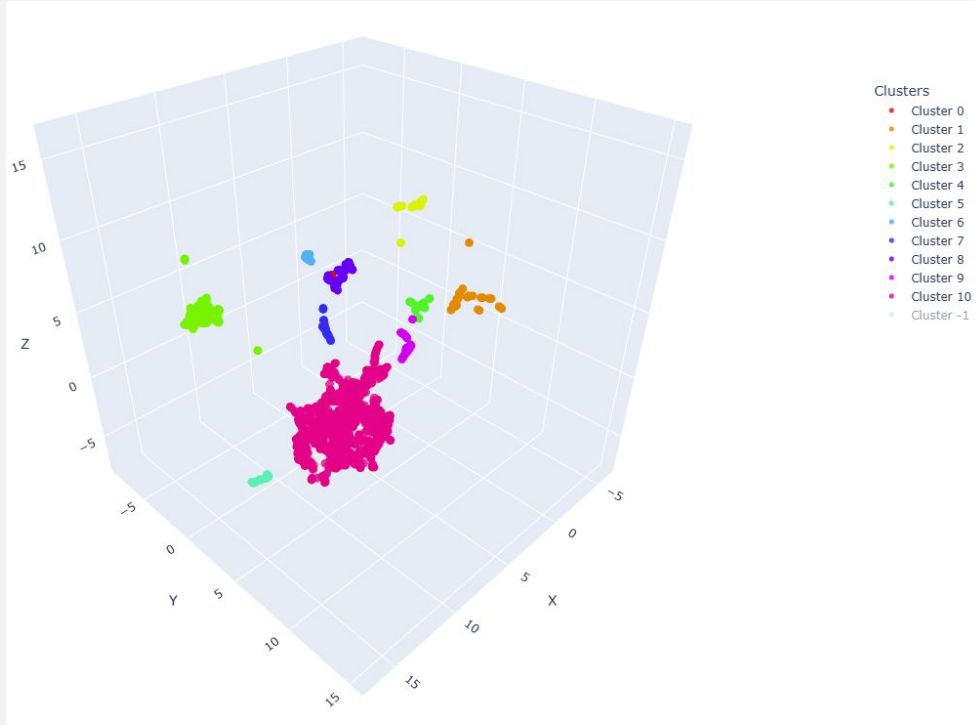


- 141 clusters
- Cluster -1 is noise
- cluster color coding

Clustering

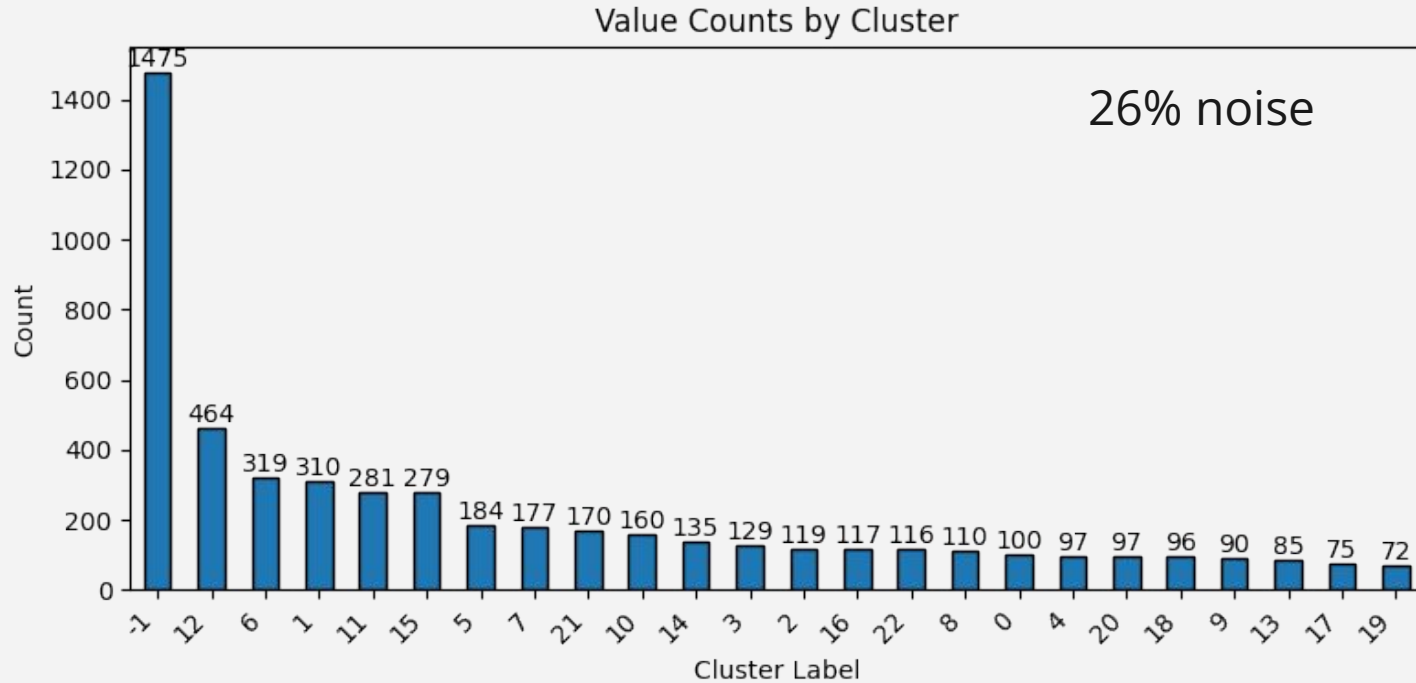


Clustering - Plot



- parameter tweaked
- 11 clusters
- easier to handle
- harder to generalize

Clustering - dense and strict



Post-Clustering - Identification

- 10 Requirements per Cluster
- Custom Prompt
- Example cluster classifications:
 - Error Logging and Performance Monitoring System
 - Data Management and System Status Notifications
 - This category encompasses a variety of requirements related to handling, measurement, and system operational constraints.



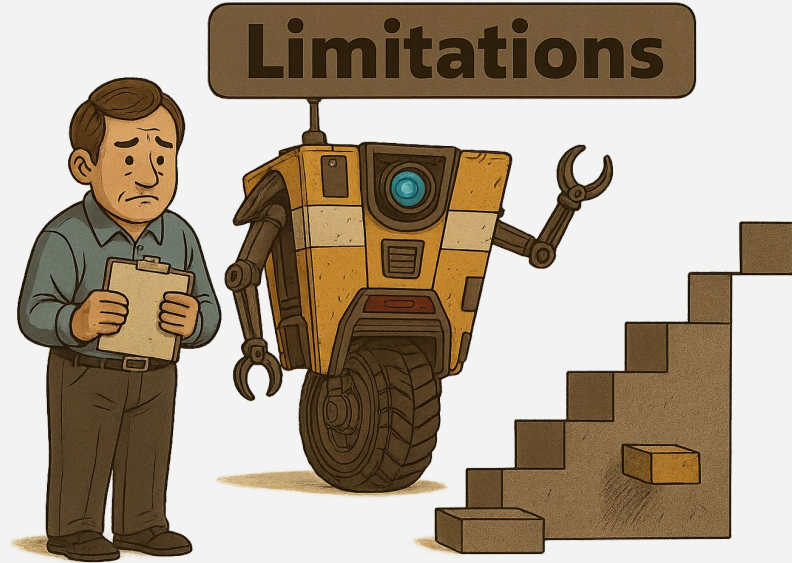
Post-Clustering - Rewriting

- max. 20 requirements per cluster
- Before: I want to see good results of the measurement.
- After: The system shall display measurement results with appropriate units and reference values.



Limitations

- Acceptance criteria lost
- Duplicates not removed
- Conflicts not detected
- Not quite optimized
 - Prompts
 - Parameters
 - Requirement Selection



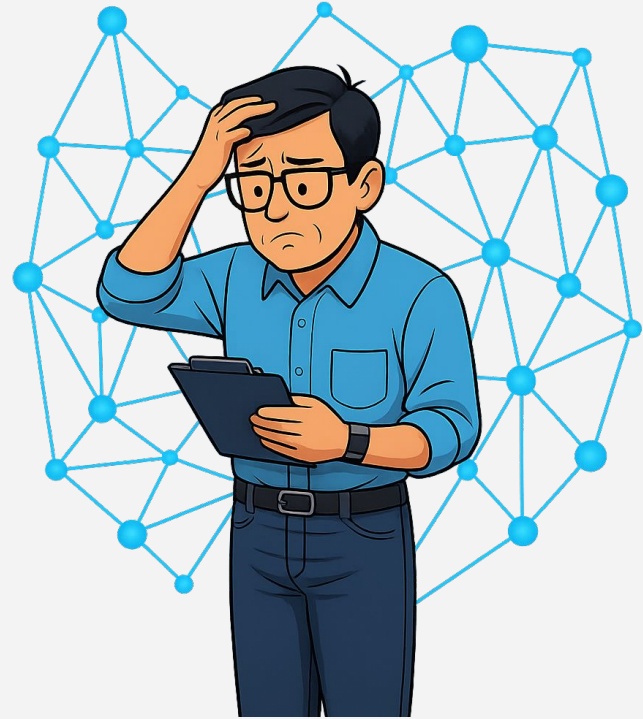
Achievements

- Proof of concept
 - cluster identification
 - (subjective) quality improvement
- Prompt is already used in Custom GPTs
 - Quality improvement



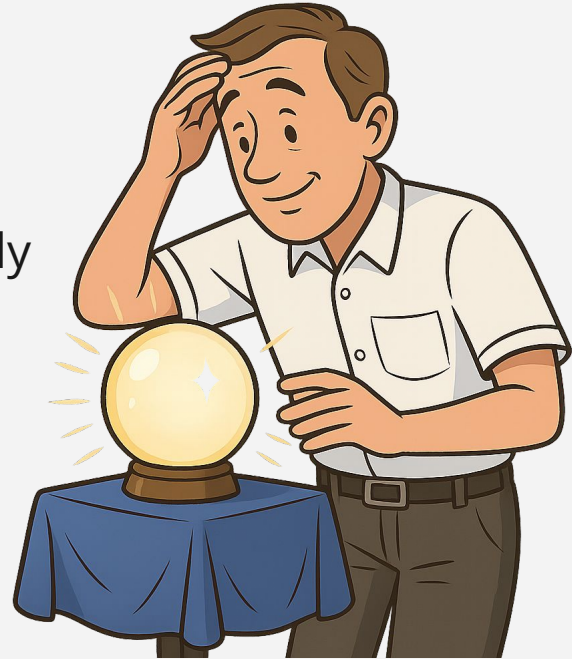
Challenges

- Prompt Engineering
 - consistent answers
- Domain Variety
- Parameter Finetuning



Roadmap

- Near future:
 - Centralize requirements
 - Rewrite requirements automatically
 - Connection to live system
- Far future:
 - Cluster detection
 - Company vector database



Wrap-Up

- Rapid Development lead to possibly big impact
- Outlook is promising
- Requirements Engineering is evolving





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