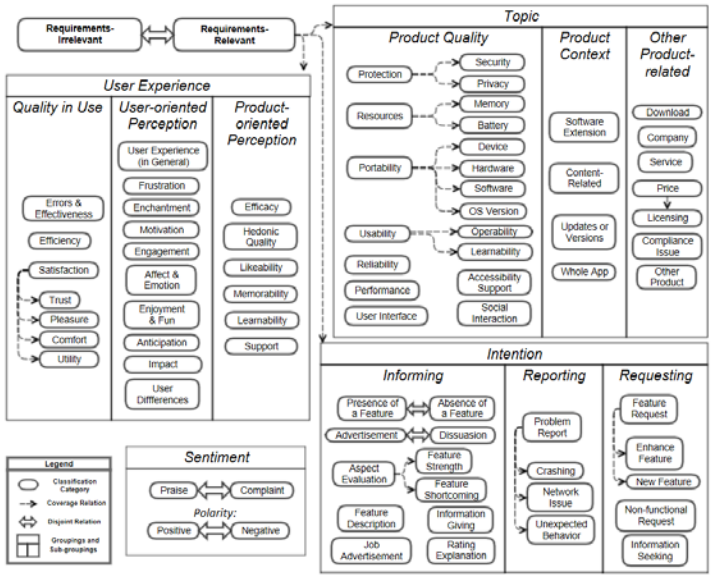
A TAXONOMY FOR USER FEEDBACK CLASSIFICATIONS

Rubens Santos, Eduard C. Groen, Karina Villela



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What do we want?

A BENCHMARKING

of user feedback classification approaches for RE (CrowdRE)

When do we *have* it?

Now, see…

the differences between the approaches we found

actually make it kind of difficult to make [illegible] comparison

that tells us reliably which approaches may be better suited for RE

so that we are still several steps away from performing a benchmarking

which may require researchers to re-do analyses or to provide us with their data

in order for us to perform those analyses ourselves for their results to be comparable

on the various levels that these analyses currently differ to such great extents

…not now…!

The Idea of Our Benchmarking is Simple…

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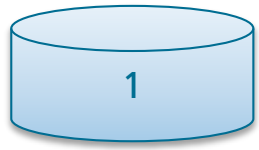
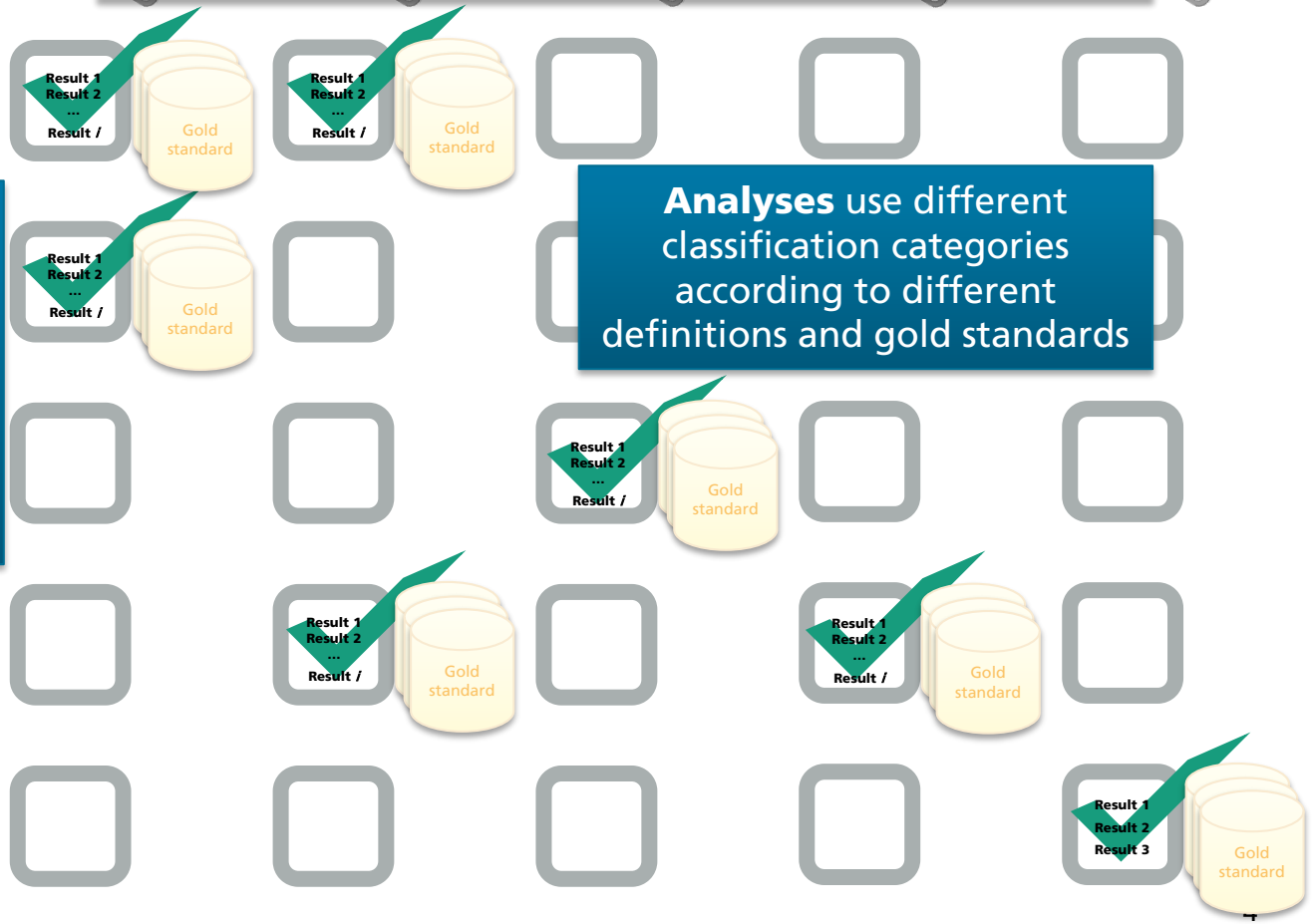
…The Reality of this Benchmarking is Difficult…

Algorithms are used in combination with different combinations of other **NLP techniques**, including primary and secondary machine learning features, semi-supervised classification algorithms, and pre-processing techniques



Datasets differ, among other things, in size (number of entries), object granularity (sentence vs. review), sources covered (e.g., app stores, social media), and mean text object size.

Analyses use different classification categories according to different definitions and gold standards



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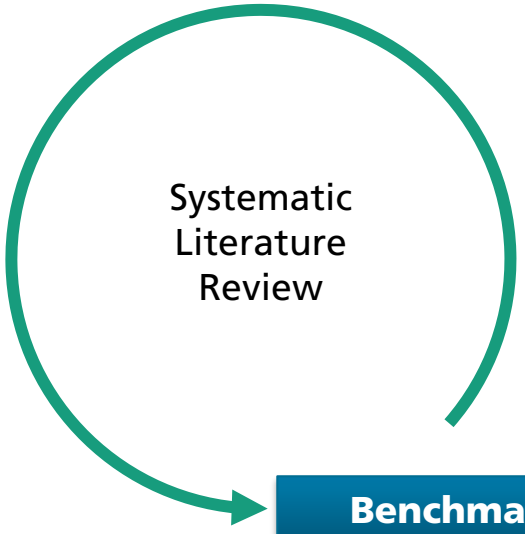
…But We *Are* Doing This Benchmarking

Algorithms are used in combination with different combinations of other **NLP techniques**, including primary and secondary machine learning features, semi-supervised classification algorithms, and pre-processing techniques

Hurdle 2: An overview of user feedback classification approaches

Datasets differ, among other things, in size (number of entries), object granularity (sentence vs. review), sources covered (e.g., app stores, social media), and mean text object size.



Analyses use different classification categories according to different definitions and gold standards

Hurdle 1: A taxonomy for user feedback classifications

Focus of this presentation

Benchmarking

Hurdle 3 and further:

- Comparing datasets
- Assessing the influence of NLP techniques
- Aligning analyses
- Etc.

Systematic Literature Review

- Conducted according to Kitchenham, with an SLR protocol specifying:
  - objectives / research questions,
  - a search strategy with inclusion/exclusion criteria & a search string,
  - a data extraction strategy.

- **Note:** The SLR is not the main focus of this presentation!
  - We're showing a "byproduct" in a preliminary form
    - Focusing only on the *first* hurdle that we had to overcome
  - We wanted to get this material out there, so *you* can work with it!

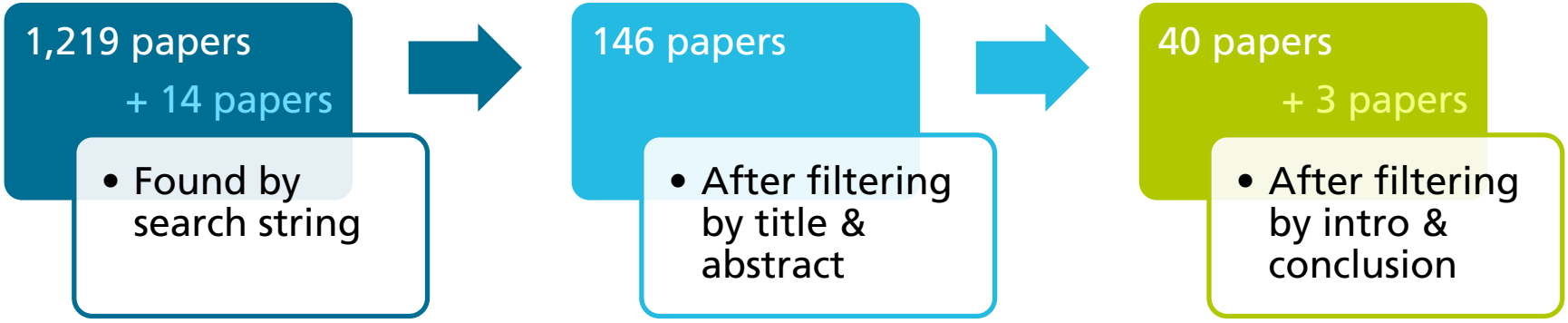
SLR: Objectives

Overall Objective: What are the state-of-the-art automated approaches for assisting the task of requirements extraction from user feedback acquired from the crowd, and which NLP techniques and features do they use?

- **Objective 1:** Regarding requirements elicitation from user feedback acquired from the crowd, what are the state-of-art automated approaches for classifying user feedback?
- **Objective 2:** How do such approaches classify user feedback?
  - **Objective 2.1:** What are the different sets of categories in which user feedback is classified?
  - **Objective 2.2:** Which automated techniques are used?
  - **Objective 2.3:** What are the characteristics of the user feedback these approaches aim to classify?

SLR: Paper Search

Performed March 2018 (+ December 2018)



EC1: not English
EC2: before 2013
EC3: not peer-reviewed

IC1: filters out irrelevant user feedback
IC2: classifies into predetermined categories
EC4: not RE / unrelated title
EC5: not on req. extraction from user feedback
EC6: tool not (usable) for requirement extraction
EC7: tool does not process textual user feedback
EC8: manual processing without automation

SLR: Data Extraction from 43 Papers

1. **Dataset-related information**
   - *E.g., dataset size in number of entries, object granularity, sources, mean text object size*

2. **NLP techniques applied**
   - *E.g., algorithms, parsers, ML features, text pre-processing techniques*

3. **User feedback classification categories** → Taxonomy
   - *E.g., name, definition, rationale/goal*

Hurdle for Benchmarking

- Papers propose/use many disjunct classification structures and categories
  - Need for harmonization
    → **Taxonomy**

Taxonomy Composition
Step 1: Collect and Complete Categories

- Overview of classification categories (name, definition, source)
- Verification step that all relevant information was collected

- **Note:** Our approach is descriptive; we include all categories that:
  - Are used in the literature
  - Have garnered useful results in user feedback
  - Examples:
    - The ISO 25010 software product quality characteristic "Maintainability" was not found in user feedback → exclude
    - "Freedom from Risk" & "Context Coverage" were omitted from papers on the ISO 25010 quality-in-use characteristics → exclude
    - "Job Advertisement" was used in literature → include

Taxonomy Composition
Step 2: Merge Similar Categories

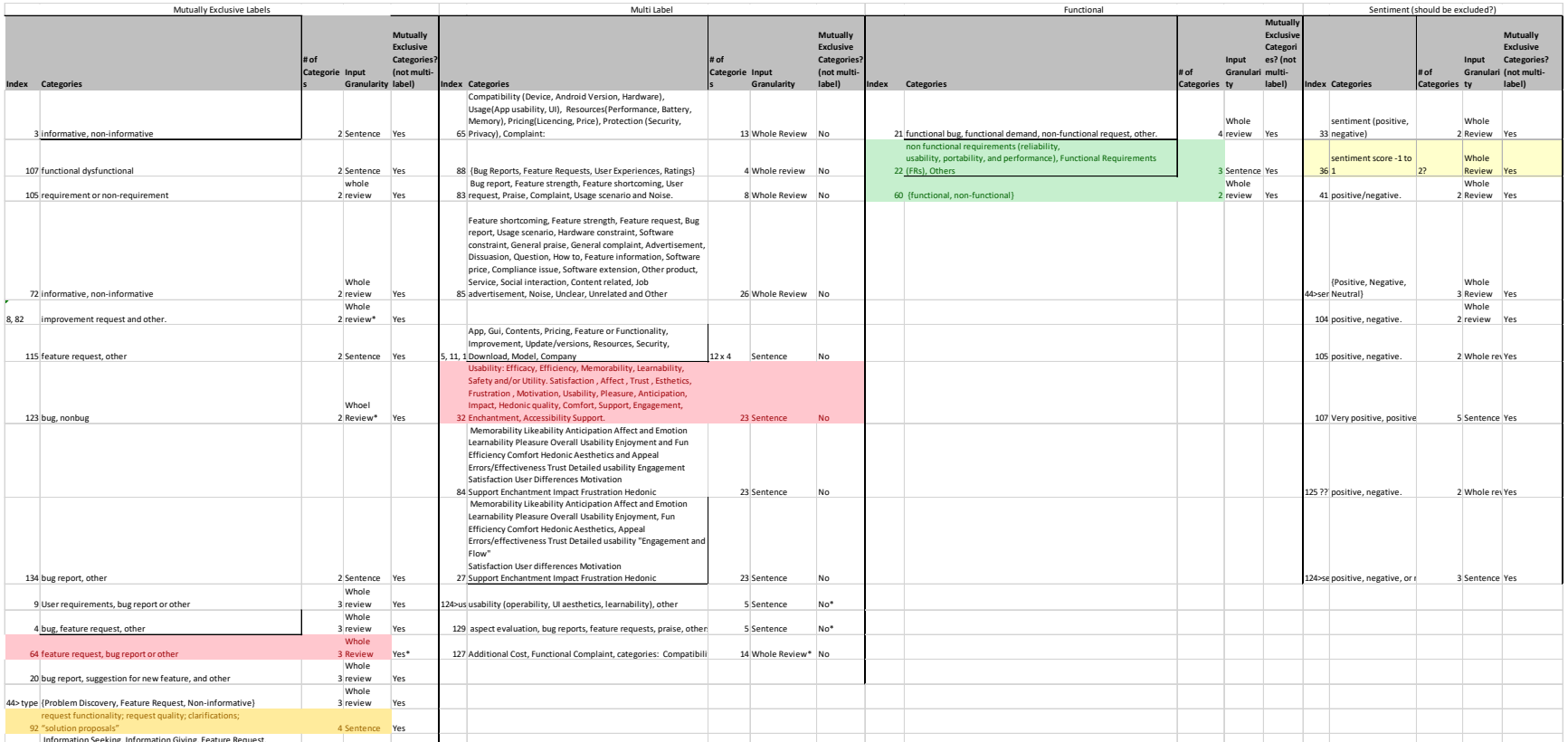
- Harmonization of categories by definition
  - Merging categories that intend to filter the same type of text, even if they have a different name
  - Determining the most appropriate name and description for this category

- Example: “Feature Request”
  - Requests for functional enhancements
  - Most prevalent name in the literature is “Feature Request”
    - In some papers “User Requirements”, “Functional Requirements” or “Request”
  - Definition was based on papers P1 and P31

Taxonomy Composition

Step 3: Group Related Categories 1/5

- We sorted papers by their compatibility of categories
  - Mutually exclusive labels, multi-label, functional labels only
  - Sentiment did not really fit anywhere → omit?

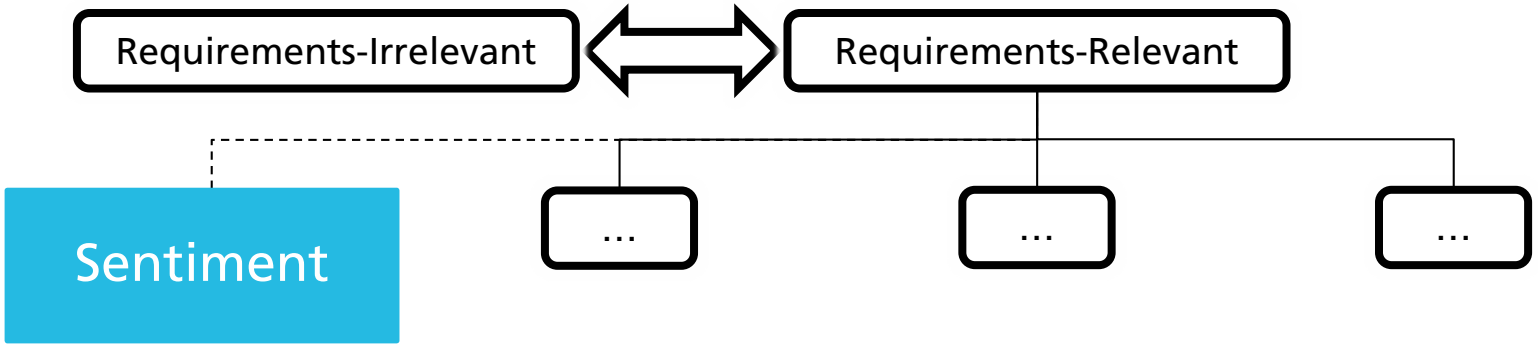


Mutually Exclusive Labels					Multi Label					Functional					Sentiment (should be excluded?)				
Index	Categories	# of Categories	Input Granularity	Mutually Exclusive Categories? (not multi-label)	Index	Categories	# of Categories	Input Granularity	Mutually Exclusive Categories? (not multi-label)	Index	Categories	# of Categories	Input Granularity	Mutually Exclusive Categories? (not multi-label)	Index	Categories	# of Categories	Input Granularity	Mutually Exclusive Categories? (not multi-label)
3	informative, non-informative	2	Sentence	Yes	65	Compatibility (Device, Android Version, Hardware), Usage(App usability, UI), Resources(Performance, Battery, Memory), Pricing(Licencing, Price), Protection (Security, Privacy), Complaint:	13	Whole Review	No	21	functional bug, functional demand, non-functional request, other.	4	Whole review	Yes	33	sentiment (positive, negative)	2	Whole Review	Yes
107	functional dysfunctional	2	Sentence	Yes	88	{Bug Reports, Feature Requests, User Experiences, Ratings}	4	Whole review	No	22	non functional requirements (reliability, usability, portability, and performance), Functional Requirements (FRs), Others	3	Sentence	Yes	36	sentiment score -1 to 1	2?	Whole Review	Yes
105	requirement or non-requirement	2	whole review	Yes	83	Bug report, Feature strength, Feature shortcoming, User request, Praise, Complaint, Usage scenario and Noise.	8	Whole Review	No	60	{functional, non-functional}	2	Whole review	Yes	41	positive/negative.	2	Whole Review	Yes
72	informative, non-informative	2	Whole review	Yes	85	Feature shortcoming, Feature strength, Feature request, Bug report, Usage scenario, Hardware constraint, Software constraint, General praise, General complaint, Advertisement, Dissuasion, Question, How to, Feature information, Software price, Compliance issue, Software extension, Other product, Service, Social interaction, Content related, Job advertisement, Noise, Unclear, Unrelated and Other	26	Whole Review	No							44>ser	{Positive, Negative, Neutral}	3	Whole Review	Yes
8, 82	improvement request and other.	2	Whole review*	Yes											104	positive, negative.	2	Whole review	Yes
115	feature request, other	2	Sentence	Yes	5, 11, 1	App, Gui, Contents, Pricing, Feature or Functionality, Improvement, Update/versions, Resources, Security, Download, Model, Company	12 x 4	Sentence	No						105	positive, negative.	2	Whole rev	Yes
123	bug, nonbug	2	Whoel Review*	Yes	32	Usability: Efficacy, Efficiency, Memorability, Learnability, Safety and/or Utility. Satisfaction , Affect , Trust , Esthetics, Frustration , Motivation, Usability, Pleasure, Anticipation, Impact, Hedonic quality, Comfort, Support, Engagement, Enchantment, Accessibility Support.	23	Sentence	No						107	Very positive, positive	5	Sentence	Yes
					84	Memorability Likeability Anticipation Affect and Emotion Learnability Pleasure Overall Usability Enjoyment and Fun Efficiency Comfort Hedonic Aesthetics and Appeal Errors/Effectiveness Trust Detailed usability Engagement Satisfaction User Differences Motivation Support Enchantment Impact Frustration Hedonic	23	Sentence	No						125 ??	positive, negative.	2	Whole rev	Yes
134	bug report, other	2	Sentence	Yes	27	Memorability Likeability Anticipation Affect and Emotion Learnability Pleasure Overall Usability Enjoyment, Fun Efficiency Comfort Hedonic Aesthetics, Appeal Errors/effectiveness Trust Detailed usability "Engagement and Flow" Satisfaction User differences Motivation Support Enchantment Impact Frustration Hedonic	23	Sentence	No						124>se	positive, negative, or r	3	Sentence	Yes
9	User requirements, bug report or other	3	Whole review	Yes	124>us	usability (operability, UI aesthetics, learnability), other	5	Sentence	No*										
4	bug, feature request, other	3	Whole review	Yes	129	aspect evaluation, bug reports, feature requests, praise, other	5	Sentence	No*										
64	feature request, bug report or other	3	Whole Review	Yes*	127	Additional Cost, Functional Complaint, categories: Compatibili	14	Whole Review*	No										
20	bug report, suggestion for new feature, and other	3	Whole review	Yes															
44> type	{Problem Discovery, Feature Request, Non-informative}	3	Whole review	Yes															
92	request functionality; request quality; clarifications; "solution proposals"	4	Sentence	Yes															
	Information Seeking, Information Giving, Feature Request																		

Taxonomy Composition
Step 3: Group Related Categories 2/5

Realization: Classification is primarily concerned with:

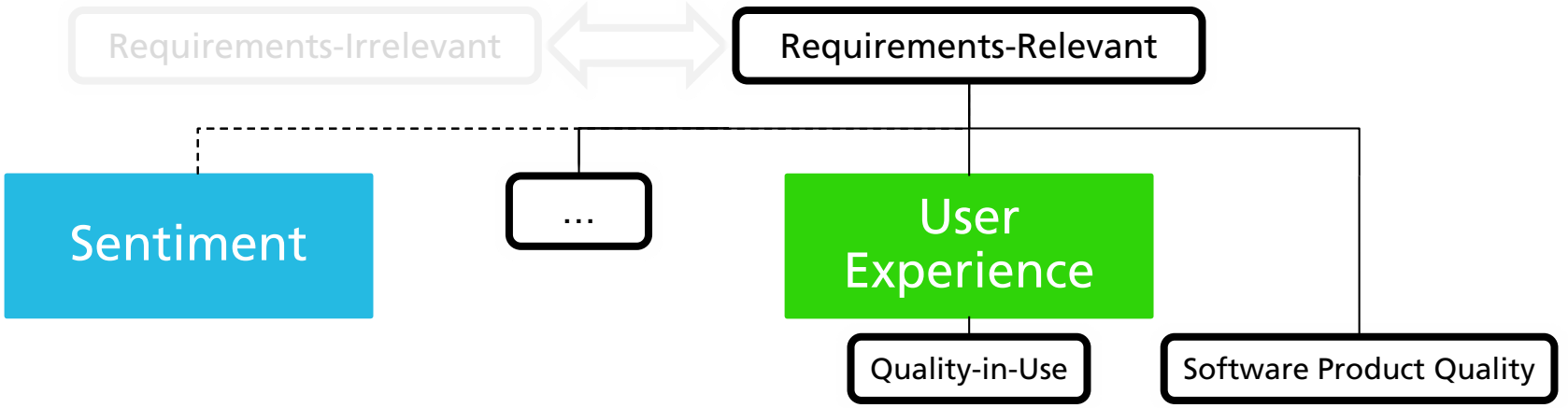
- "Is this text snippet relevant from an RE perspective?"
  - If YES: Classify as relevant in some way
    - Either into one category, or several categories
  - If NO: Discard



Taxonomy Composition
Step 3: Group Related Categories 3/5

Initial basis for framework

- ISO 25010 software product quality (P11, P24)
- Existing categories in **user experience (UX)** research (P2, P17, P26, P27)
- ISO 25010 quality-in-use (P2, P17, P26, P27)

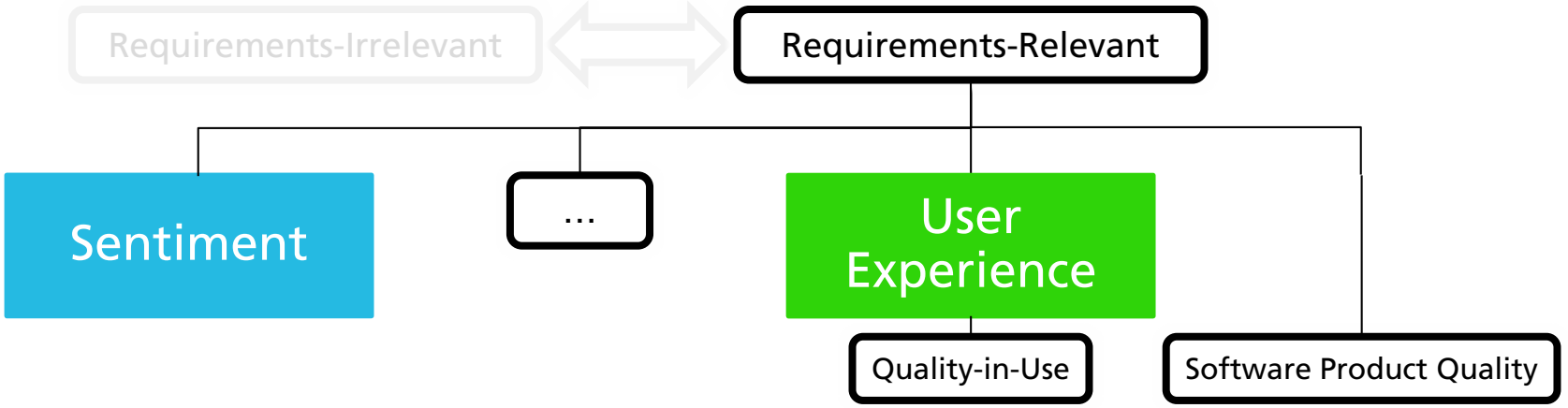


Taxonomy Composition

Step 3: Group Related Categories 4/5

Indications for grouping categories 1/2

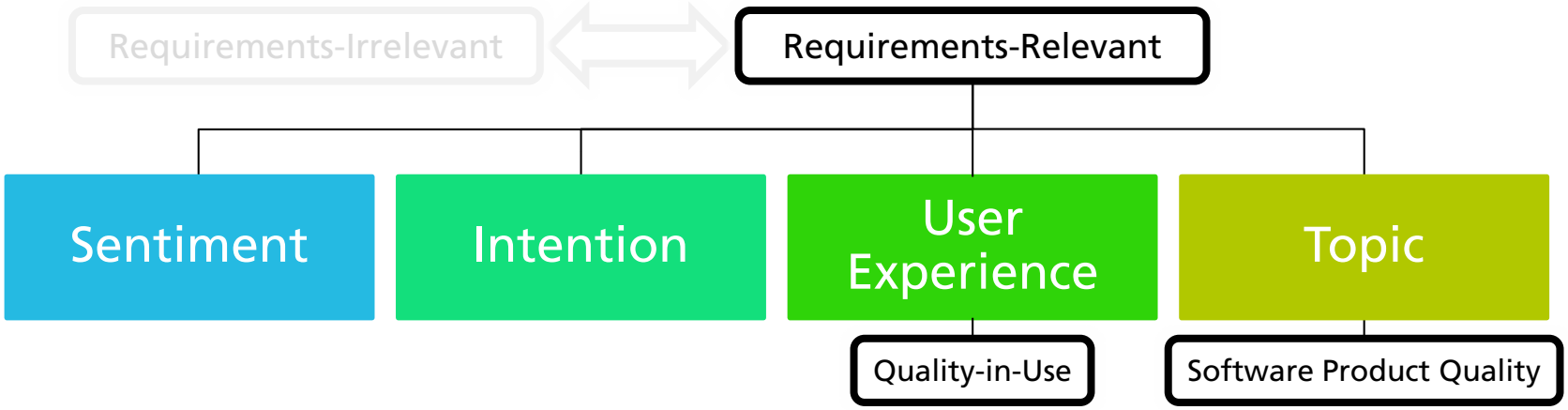
- Refinements of framework components
  - *E.g., "Battery" refines ISO 25010 "Resource Utilization"*
- Relationships between papers
  - *E.g., same authors, references to similar work (especially UX)*
- Patterns
  - *E.g., what do the categories aim to filter from the texts?*



Taxonomy Composition
Step 3: Group Related Categories 5/5

Indications for grouping categories 2/2

- Suggestions for grouping
  - Maalej and Nabil (2015) suggested types of **topics**
    - Compatible with ISO 25010 software product quality
  - Panichella et al. (2016) suggested author's **intention**



Taxonomy Composition

Step 4: Identify Logical Subgroups for More Structure

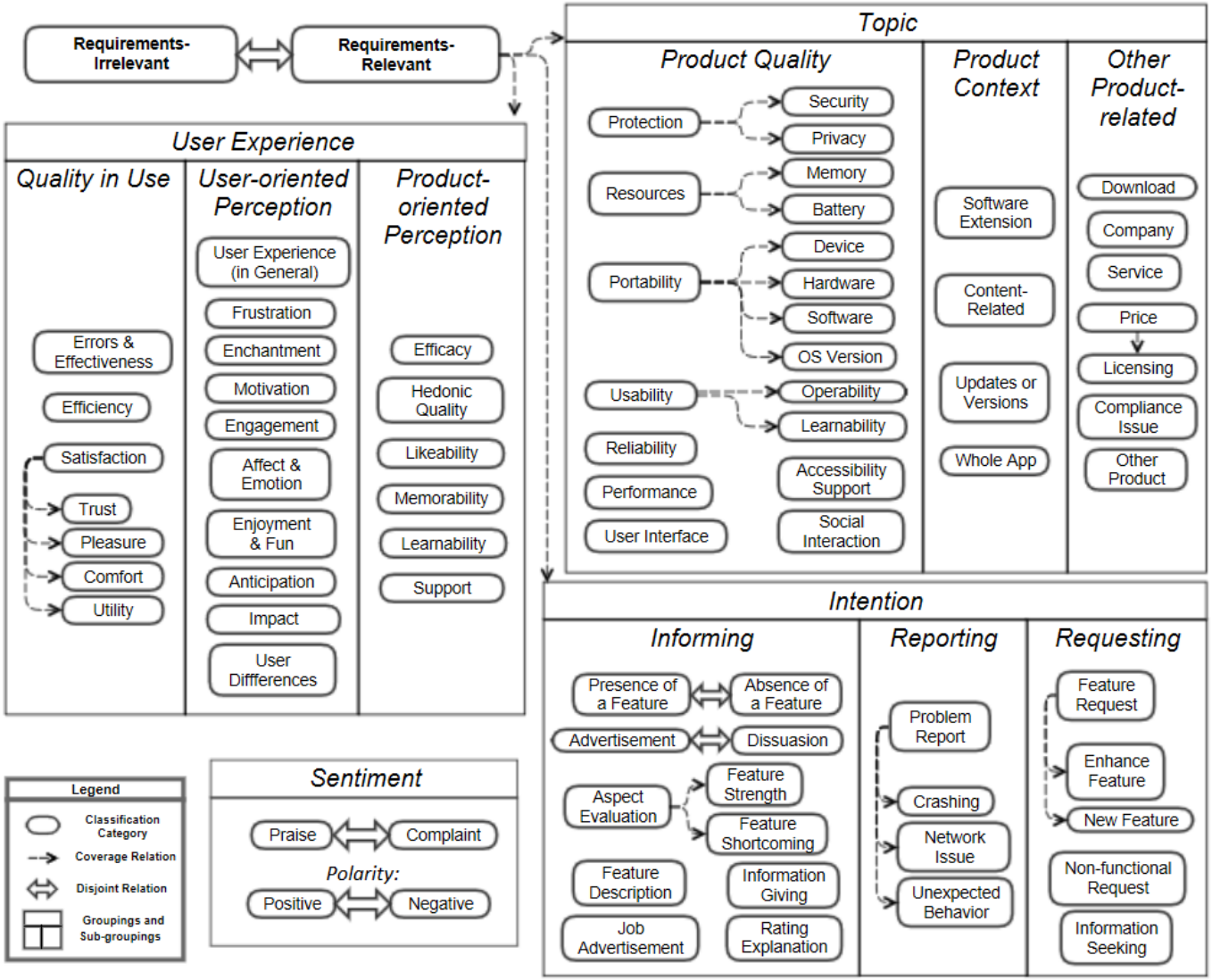
Sentiment	Intention	User Experience	Topic
	• Requesting • Informing • Reporting	• Quality in Use • User-oriented Perception • Product-oriented Perception	• Product Quality • Product Context • Other Product-related Aspects

Taxonomy Composition
Step 5: Perform an Early Validation

- Individual commenting sessions
  - Five domain experts
    - 3 RE, 2 UX; 3 experienced in academia + industry
  - Result: clearer distinctions or partial cluster reorganizations

Taxonomy for User Feedback Classification Categories

Preliminary



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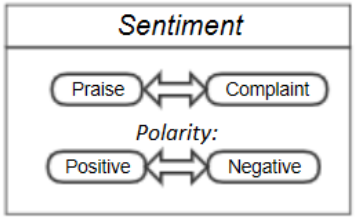
Sentiment | Intention | User Experience | Topic

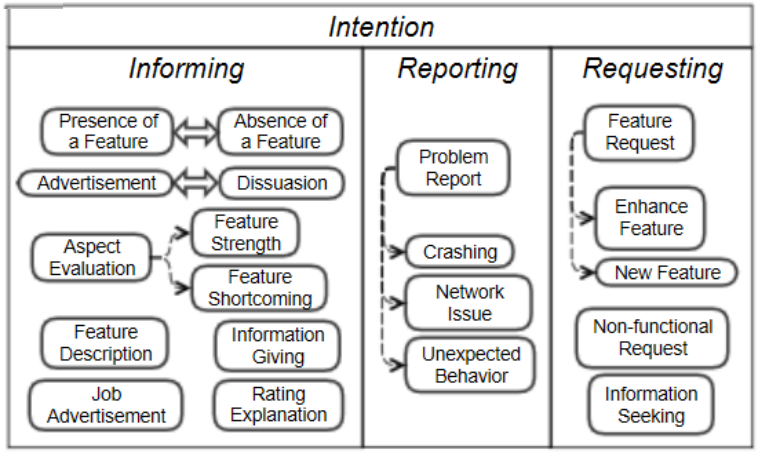
- **Assumption:** Sentiment helps determine how users feel about the product
  - Usually in the form of classic **sentiment analysis**
    - Polarity (positive, negative), sometimes intensity
  - Categorization into “Praise” and “General Complaint” (P14)
    - Assesses user perception even with short user feedback



- ➢ Sentiment is especially useful to be used in combination with other groups from the taxonomy

Sentiment | **Intention** | User Experience | Topic

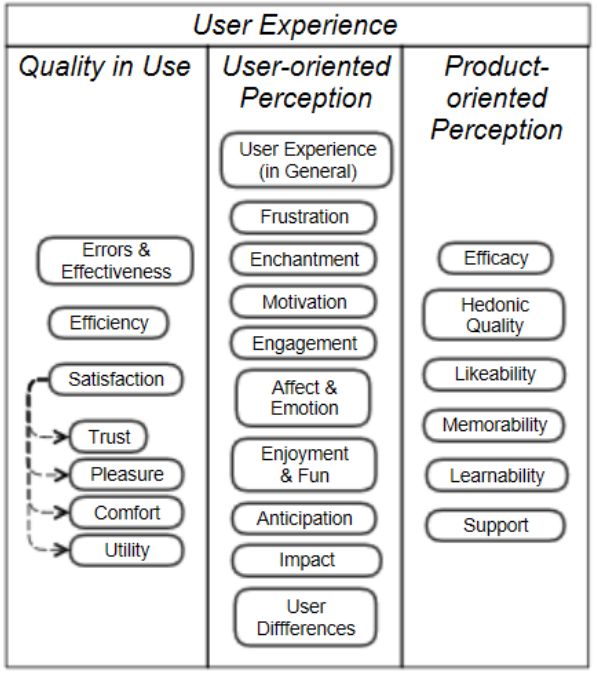
- **Assumption:** Understanding why a user provides feedback helps determine the requirements (P9, P10, P35, P36)
  - *Informing:* Persuade / dissuade other crowd members, or to justify why a particular star rating was given
  - *Reporting:* Point out a problem or defect to the developer
  - *Requesting:* Requests to add new / reintroduce previous functional aspects; remove, modify, or enhance existing features or qualities



"Job Advertisement" classifies user feedback on Twitter regarding a job offering at a software company that may be of interest to non-technical stakeholders such as marketing representatives, and for the general public (P14)

Sentiment | Intention | **User Experience** | Topic

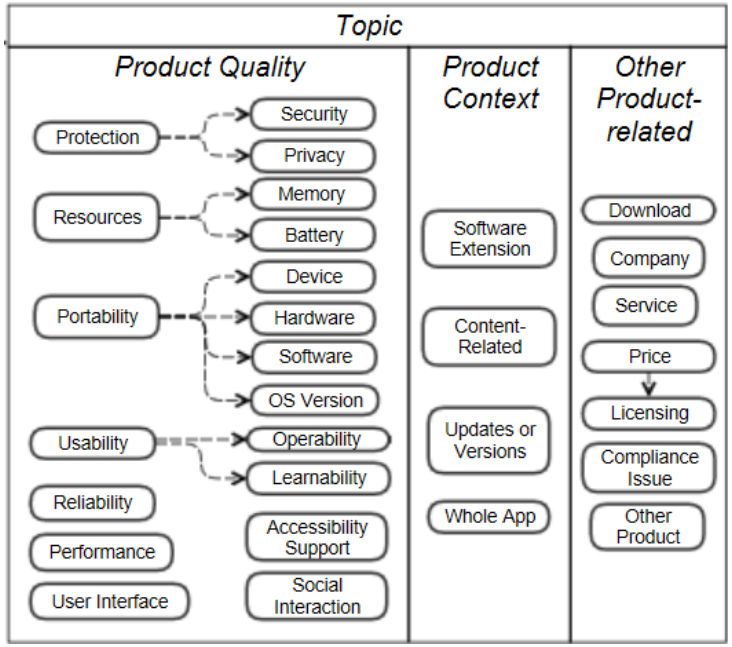
- **Assumption:** Users provide user feedback based by their practical (user) experience with the product
  - Therefore: aspects of UX relate to RE
- Opinion based on the user's perception and their response to the (anticipated) use of the product → inherently ambiguous
  - Emotions, motivation, expectations



➢ Especially helpful to determine degree of product / feature acceptance

Sentiment | Intention | User Experience | **Topic**

- **Assumption:** Users share their opinion on specific (requirement-related) topics
  - May reveal requirements if the user provided sufficient information



- *Product quality* aspects for quality requirements (cf. ISO 25010)
- *Product context* on interfaces, accessible content, behavior in a particular version, or general opinions
- *Other product-related aspects:* Users' opinions on the pricing, company (including developers or service), comparison to competitor products

Applying the Taxonomy

- We share our taxonomy so **it may help** ***you***
  - Inspire you to consider existing groups for other purposes than those for which you used them so far
  - Inform a decision on a time-intensive analysis with high-quality results vs. a quicker but less thorough outcome
  - Suggest the use of multiple groups in combination

Table 1: Suitability of classification groups for typical RE activities.

Analysis Goal	Sentiment	Intention	User Experience	Topic
Elicit Requirements		×		×
Measure Product Acceptance	×		×	×
Understand Usage Context		×	×	
Identify Software Problems	×	×		×
Identify and Prioritize Ideas		×		×
Identify Unique Selling Propositions	×	×	×	×
Identify Process Improvements			×	×

Keep in Mind:

- The taxonomy is **preliminary**
  - Seeks to be a source of inspiration for research and industry applications; not to impose a standardization
  - Suggests a possible harmonization between the kinds of analysis performed and the naming used for the categories
  - More validation & testing of its practical applicability needed
- The taxonomy is **descriptive** at this point
  - We organized the existing classification categories from the literature
  - No analysis yet of potential categories that theoretically could be useful, or that are used in commercial tools on the market
  - Categories with different names were merged
  - “Learnability” appears twice (counted as once)

Key Findings

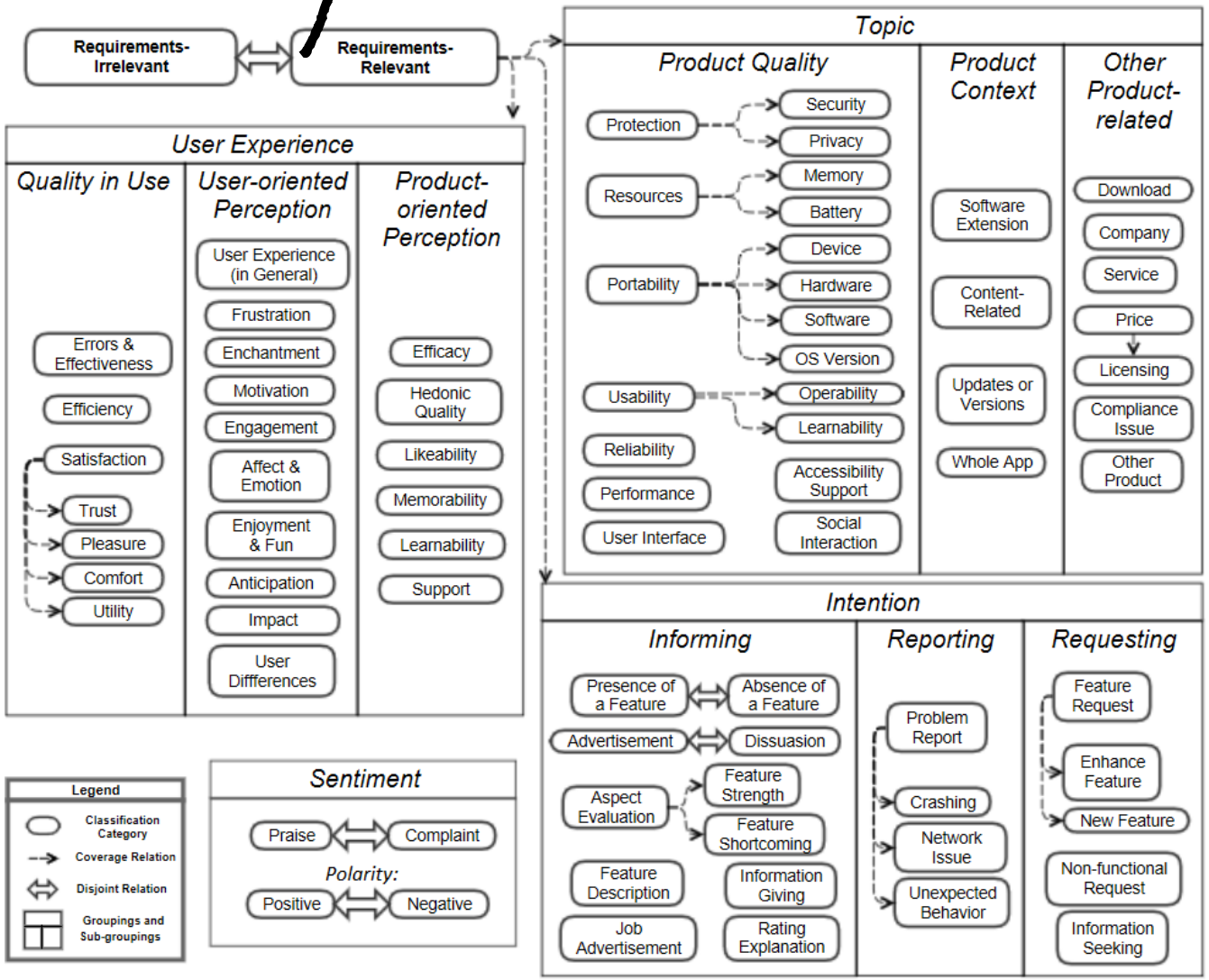
- Our preliminary taxonomy of user feedback classification categories for RE (CrowdRE) consists of **four groups with 78 categories**
- Lack of a structure caused a proliferation of categories
  - Contributed by providing a **harmonization**
- Many RE-related purposes for user feedback, thus many categories
  - Focus on what the user finds important in their **intention**, **experience** and **topics** addressed; supported by **sentiment**
- The various groups differ in degree of detail, ease of configuring and conducting the analysis
  - For most purposes, classifications from different groups can be used
    - Strong correlation makes them complimentary
    - Similar to, for example, ISO 25010 software product quality

Future Work

- Validating and further ripening of the taxonomy
  - Possible prescriptive expansion (challenge: needs validation too)
  - Assessment of existing commercial tools' classifications

- Contribution to our benchmarking
  - Provides a structured, harmonized framework facilitating comparisons
  - Could suggest metrics for comparing and evaluating the quality of classification tools according to the same structure
  - Could support guidelines in a larger quality framework for classification in RE (CrowdRE)

Thank you! (For now…)



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