

TRACEABILITY AND INFORMATION RETRIEVAL

Group 2

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Manual Traceability

- Ad-hoc creation of links
- Other method: Add keywords to all requirements
 - Match based on keywords
 - Overhead to add keywords!
- Problems:
 - Error prone
 - Find traces to other design documents
 - Maintain traces
 - Introduce traces to an existing project is very hard

Automated Traceability

- Automate the generation of links!
- Traceability tasks
 1. Document parsing (Identify requirements)
 2. Candidate link generation
 3. Candidate link evaluation
 4. Traceability analysis (Reports)
- Documents may include: Text, UML, Code, ...
- Does not aim to achieve complete automation

Automated Traceability Goals

- Believability
 - Create accurate candidate links
 - Scale to large trace sets
- Discernability
 - Support the analyst to differ between true and false candidates
- Endurability
 - Include the feedback from prior candidate link evaluation

Automated Traceability Goals

- High quality values:

$$recall = \frac{\text{Correct links} \cap \text{Retrieved links}}{\text{Correct links}} \rightarrow \text{Type II Error}$$

$$precision = \frac{\text{Correct links} \cap \text{Retrieved links}}{\text{Retrieved links}} \rightarrow \text{Type I Error}$$

- Reduce complexity:
 - Trace from high level (N) to low level elements (m)
→ N * M Possible links
 - Sort the candidates by a “confidence level”
(lag = Number of false links above each good link)

Why IR-Methods?

- Problem of Requirements Tracing → Similar to the Standard Problem of Information Retrieval
- Concept of requirement “similarity”
- What distinguishes the analyst from a IR-Method?
 - “hunches”
 - Jumping to conclusions
 - Ignoring assignments prescribed by any specific methodology

Automation method

RETRO

- Special purpose tool for Requirements Tracing
- Export in XML forms (e.g. Requirements Traceability Matrix)
- IR-Toolbox as central functional unit
 - TF-idf vector retrieval
 - TF-idf retrieval + Simple Thesaurus
 - Latent Semantic Indexing

RETRO
File Action Data Help

CM1

TRACE BROWSE

High Level Document Elements

No	ID	STATUS
3	SRS5.12.3.2	Not Satisfied
4	SRS5.12.3.3	Not Satisfied
5	SRS5.12.3.4	Not Satisfied
6	SRS5.12.3.5	Not Satisfied
7	SRS5.12.3.6	Satisfied
8	SRS5.12.3.7	Not Satisfied

Low Level Document Elements

No	WEIGHT	ID	STATUS
0	0.13599	DPUSDS5.1	Link
1	0.11962	DPUSDS5.1	No Link
2	0.08226	DPUSDS5.1...	Link
3	0.08222	DPUSDS5.1...	Default

High Level Element Text

The DPU-CCM shall, in rejecting a command, report an error in DPU_HK indicating the byte-code of the command being rejected in the LSB of the errno as described in 03691-DPUSDP-01.

Low Level Element Text

Error Collection and Reporting The DPU-CCM CSC provides a centralized error reporting interface, ccmErrEnq(), that other FSW tasks use to report errors. Each time it wakes, ccmTask() checks to see if it is time to form an error/event packet for transmission to the ground. If so, ccmTask() calls ccmHkMkError() to actually create the packet and forward it to DPU-SCUI for transmission to the ground.

FILTER ☐ LOCAL ☒ GLOBAL

0.07

Display The Low Level Elements

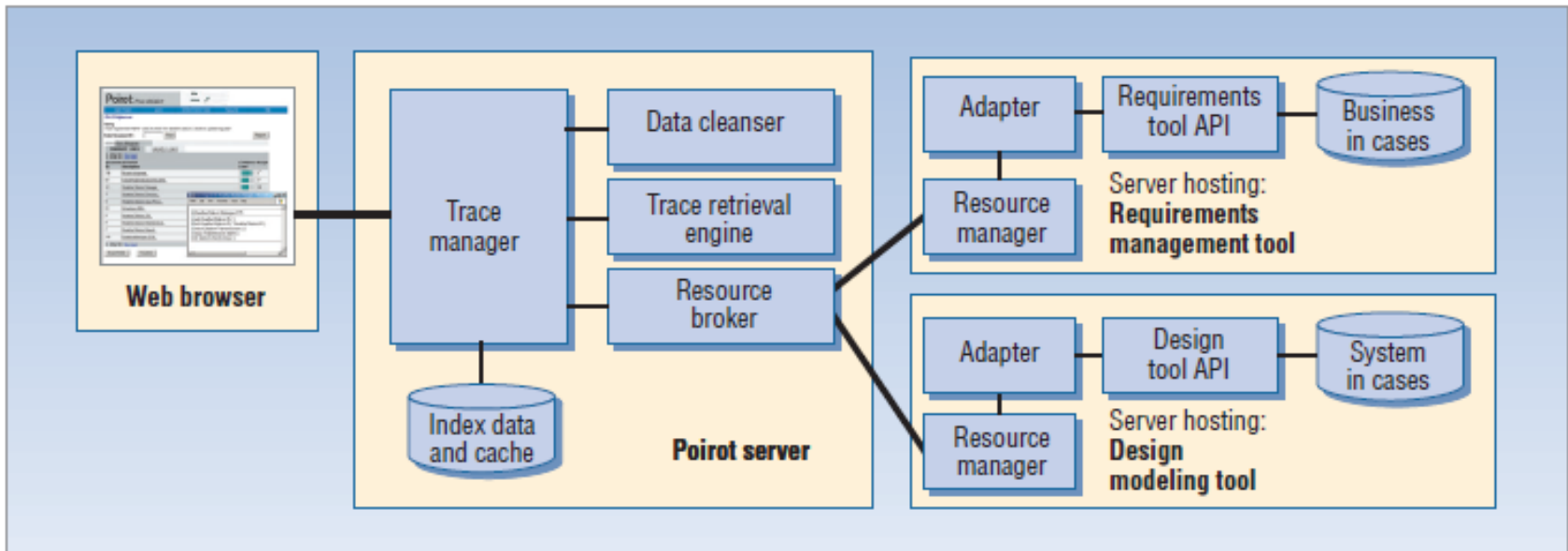
- ☒ By Requirement
- ☐ By Weighths
- ☐ In Document Order

Trace All Trace Current Save Trace Complete Trace

Tracing Completed

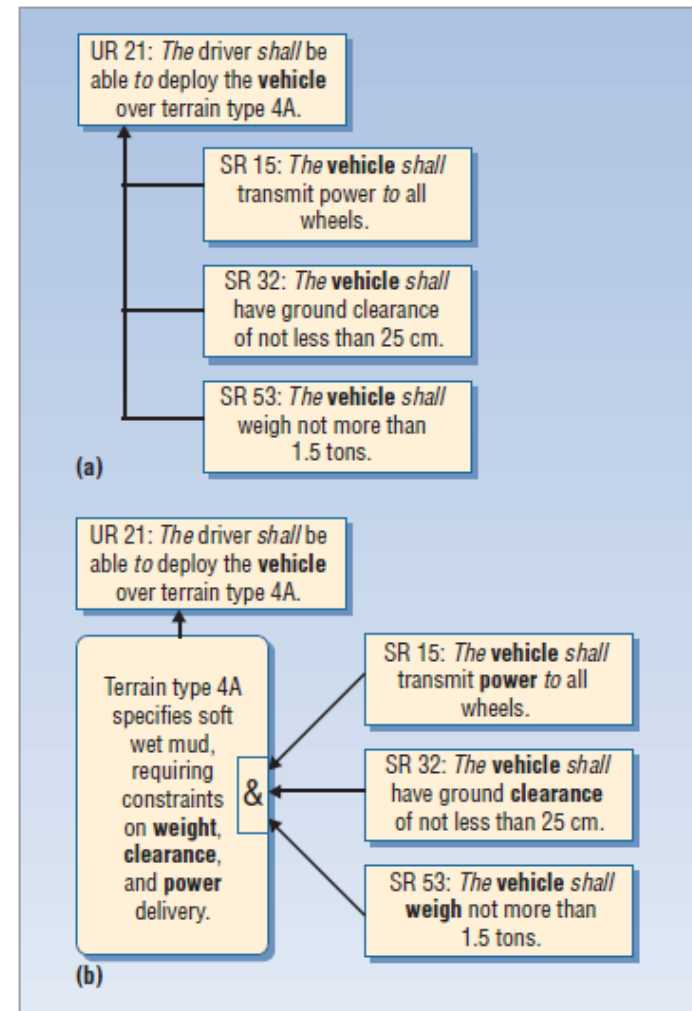
Best Practices

- Traceability environment → Support in-place traceability



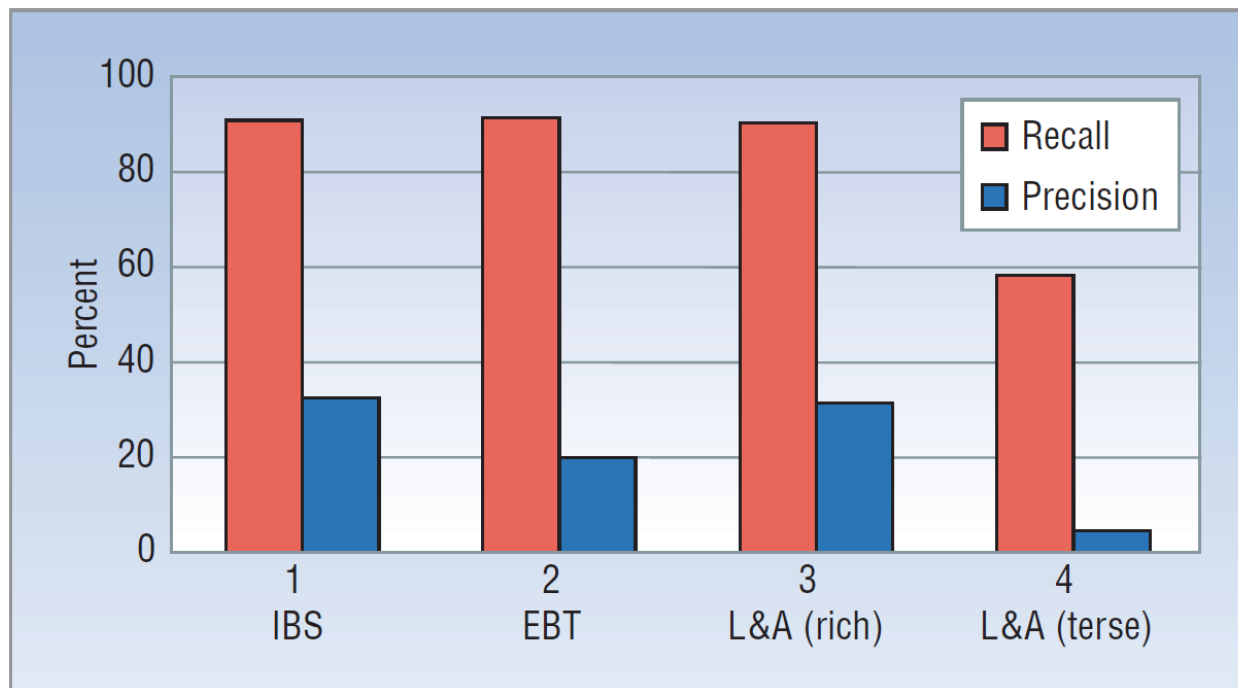
Best Practices

- Creating traceable artifacts
 - Use a well defined project glossary
 - Write quality requirements
 - Construct a meaningful hierarchy
 - Create rich content



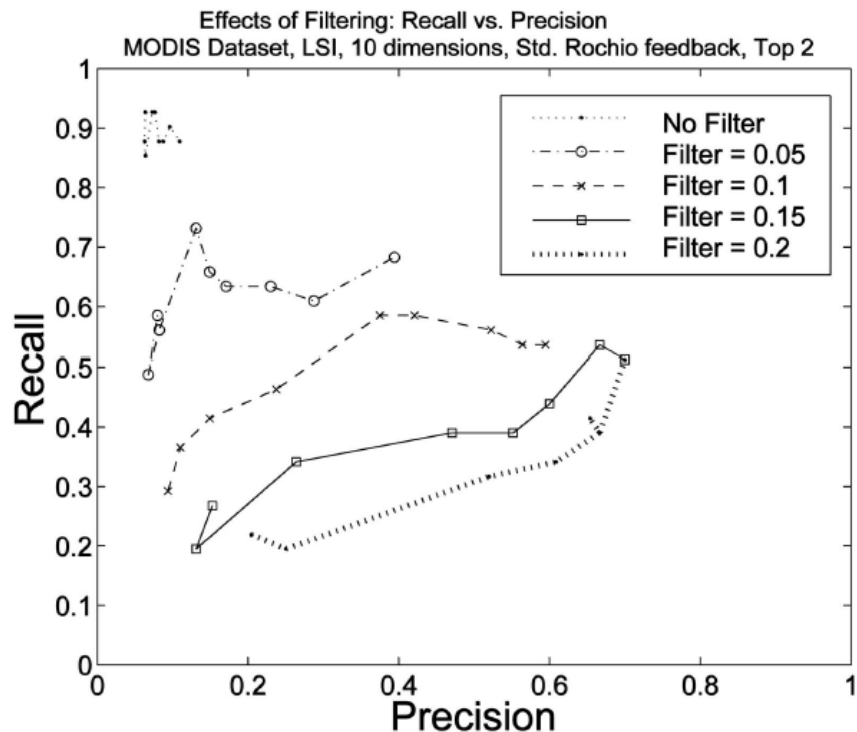
Evaluation / Results

- In Practice a high recall is required!

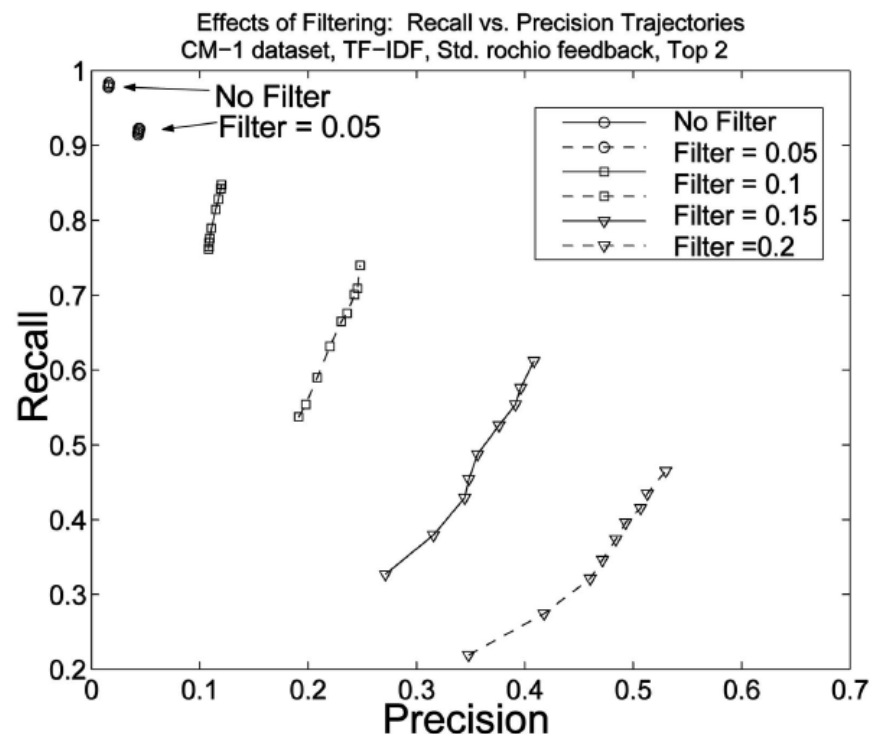


- Not every data set performs well!
- Structured and specified artifacts return better results.

Dataset A (41 Links)



Dataset B (361 Links)



Data point = iteration (Evaluate the top 2 candidates)

Filter = Only consider results with a “confidence level” above

- Same IR Algorithm run against different datasets
- Tradeoff between recall and precision

Summary

- Candidate links can be found by applying IR techniques.
 - Results heavily depend on datasets and quality
- Use feedback loops and “confidence levels” to scale
 - Only show the * most possible links
 - Reanalyze the data based on the decisions
- High trust in the tool is required
- Cannot replace the human analyst