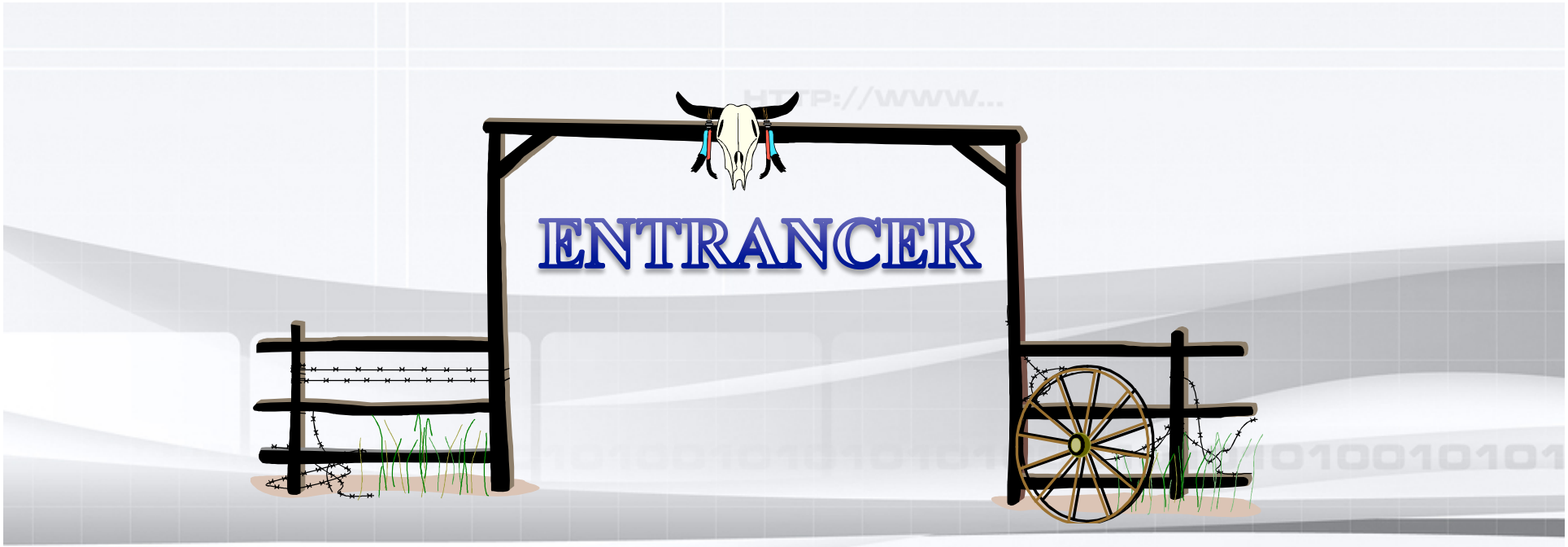

Enhancing Software Traceability By Automatically Expanding Corpora With Relevant Documentation

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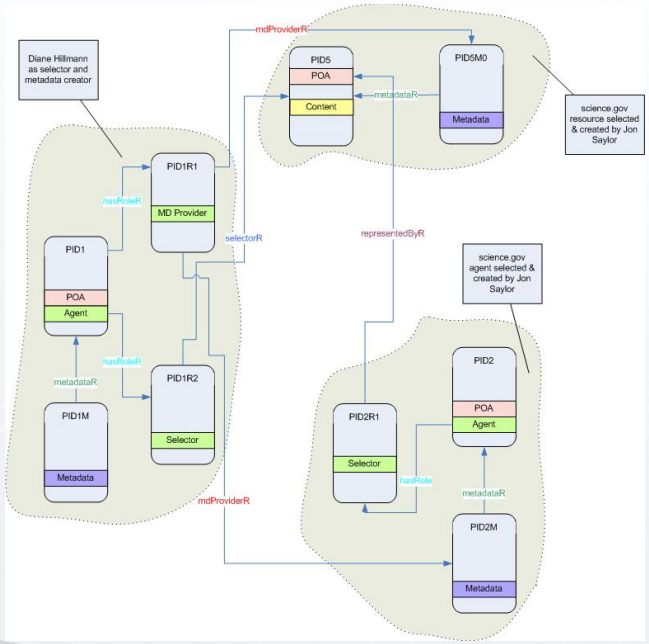
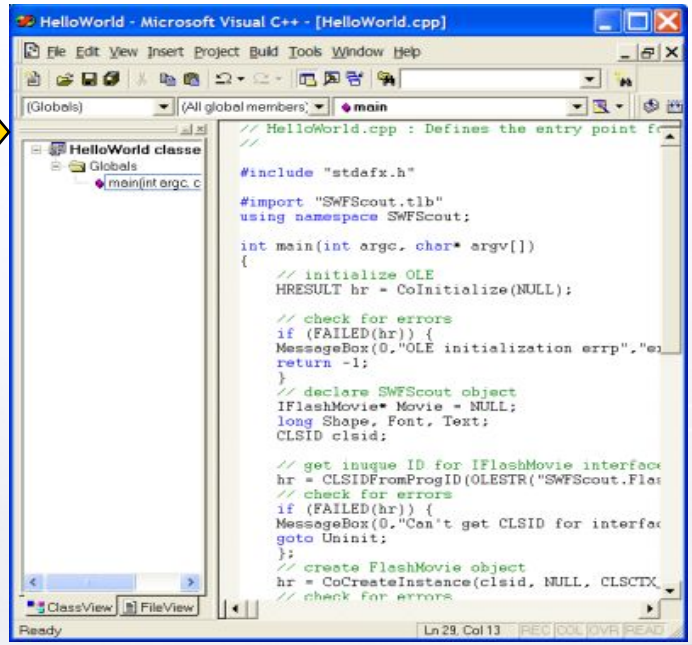
Evan Moritz, Bogdan Dit, Denys Poshyvanyk: *College of William and Mary*

Requirements Traceability (RT)

- Mapping requirements to software artifacts
  - Requirements are expressed using text, diagrams, or schemas
  - Software artifacts include code, configuration data, and databases
- Requirements traceability leads to better code understanding





Tracing Requirements

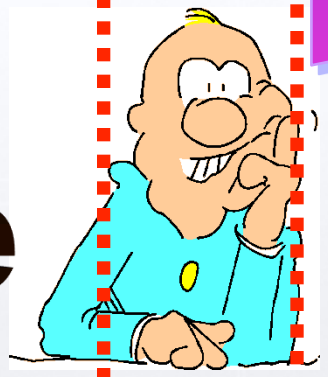
locate

service

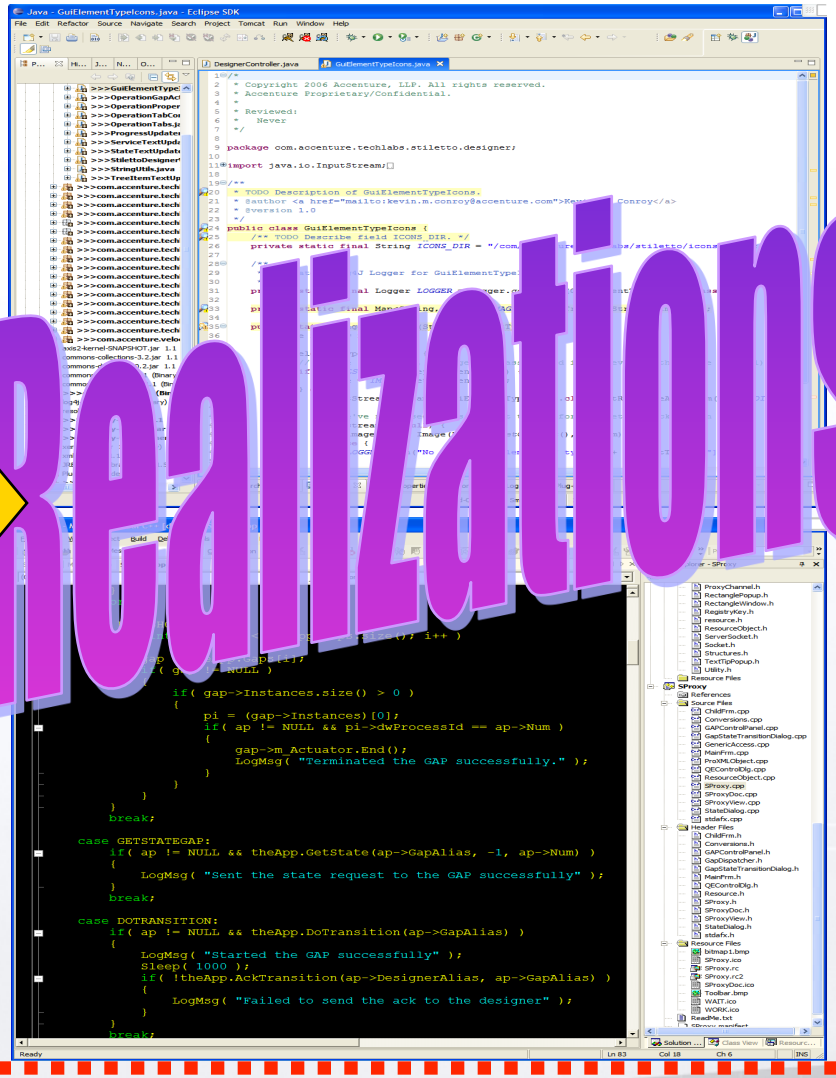
XML

secure

Abstractions



Realizations



Traceability Links

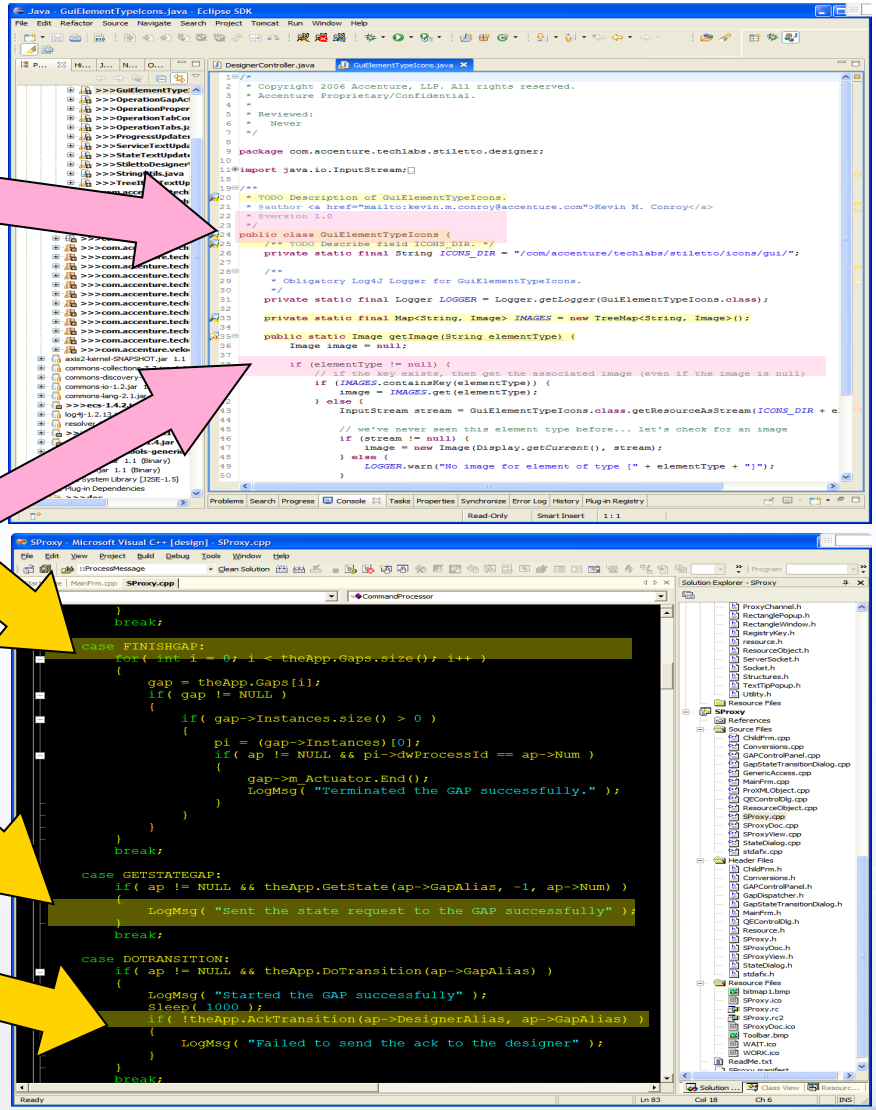
locate

service

send

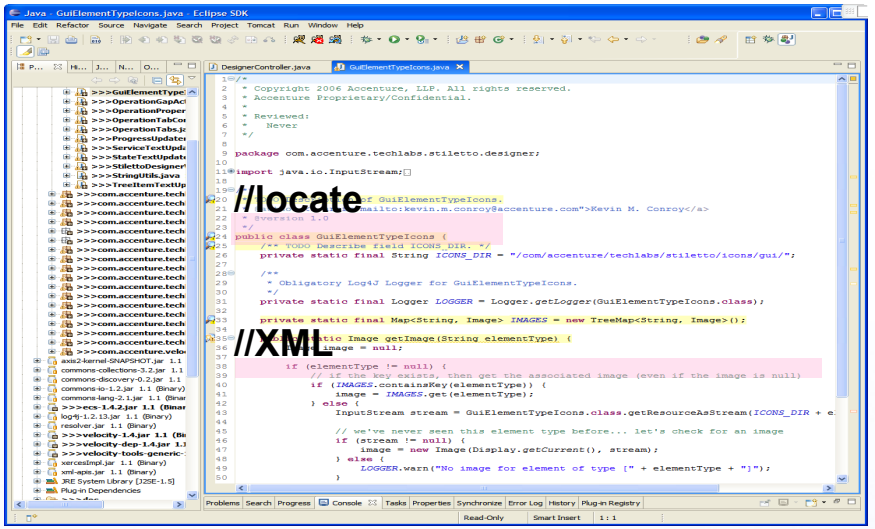
XML

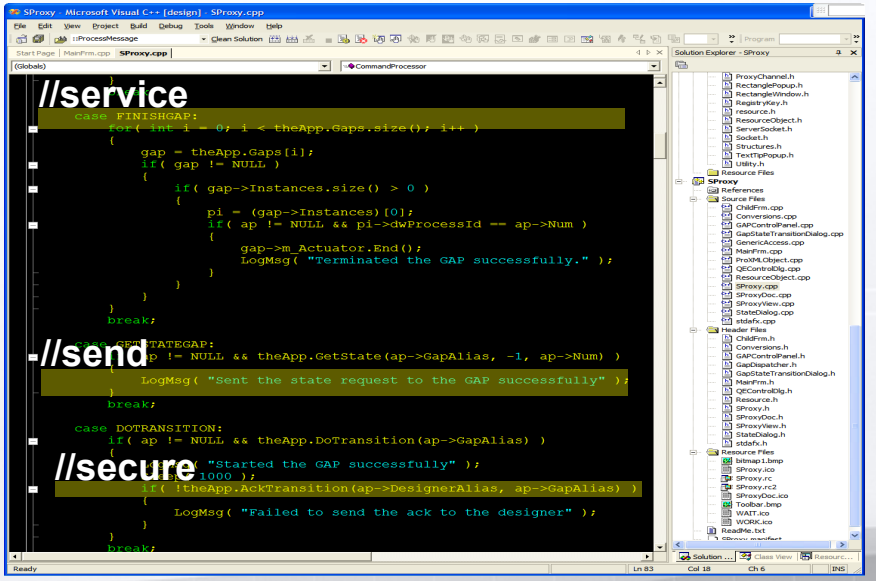
secure



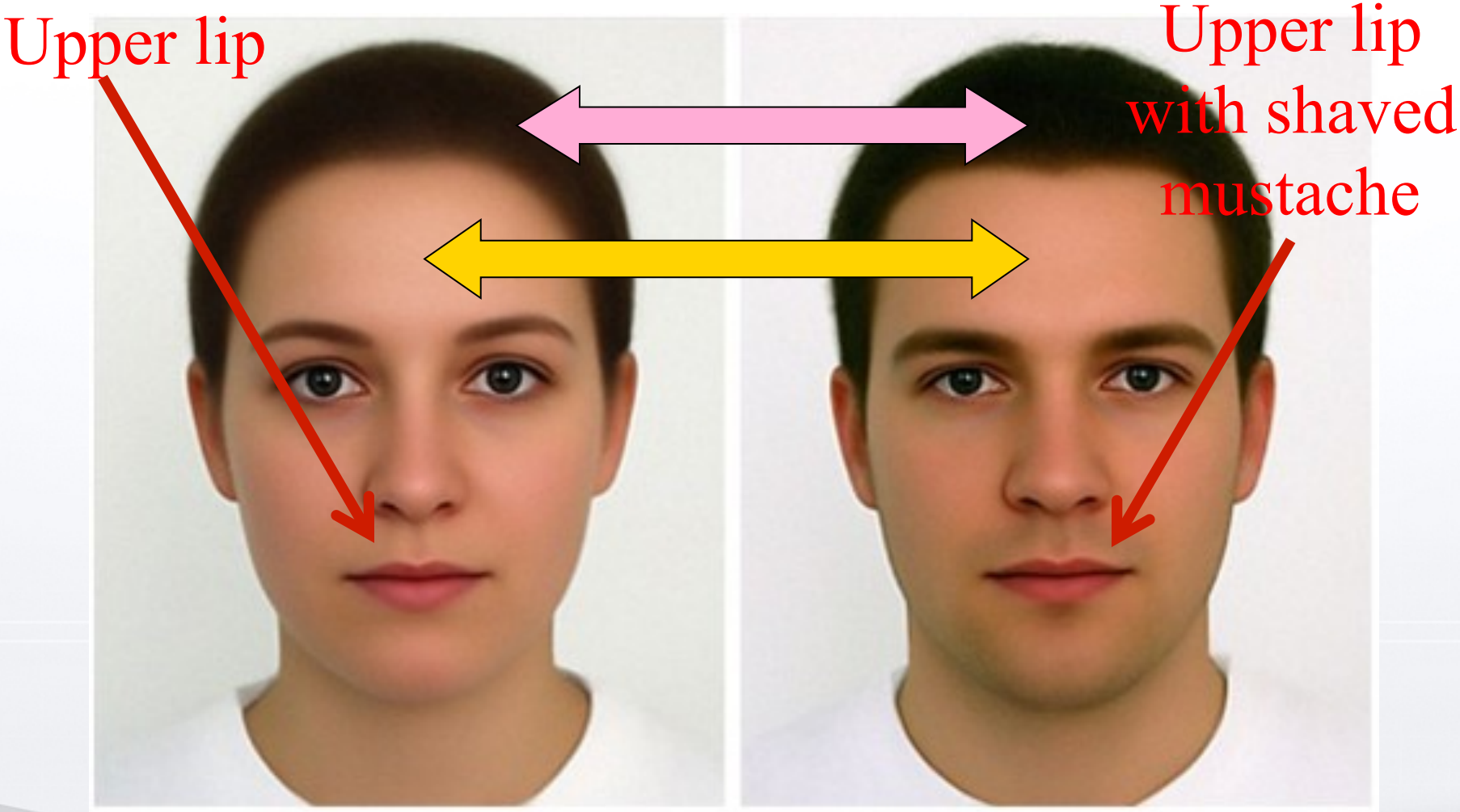
Traceability Links (TLs)

- TLs are mappings between concepts in high-level requirements and design documents and program entities
- TLs can be viewed as matches between words in requirements and code.

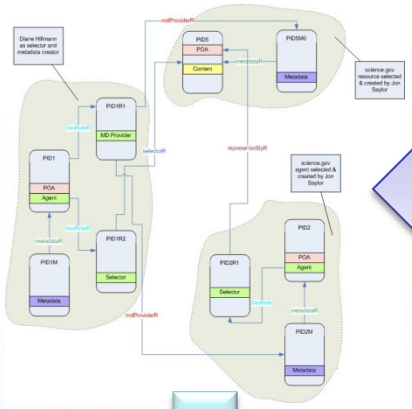


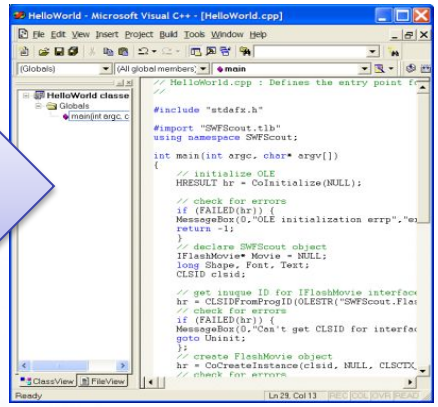


Traceability Is a Similarity Measure



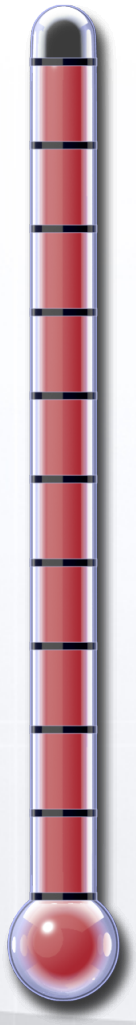
Traceability Is a Similarity Measure





word
matching

The Problem



Ouch!

Low precision of TLs

Incorrect TLs

Vocabulary problem

Missed TLs

Polysemy

Lower accuracy

Synonymy

It is a norm

Different stakeholders

Our Hypotheses

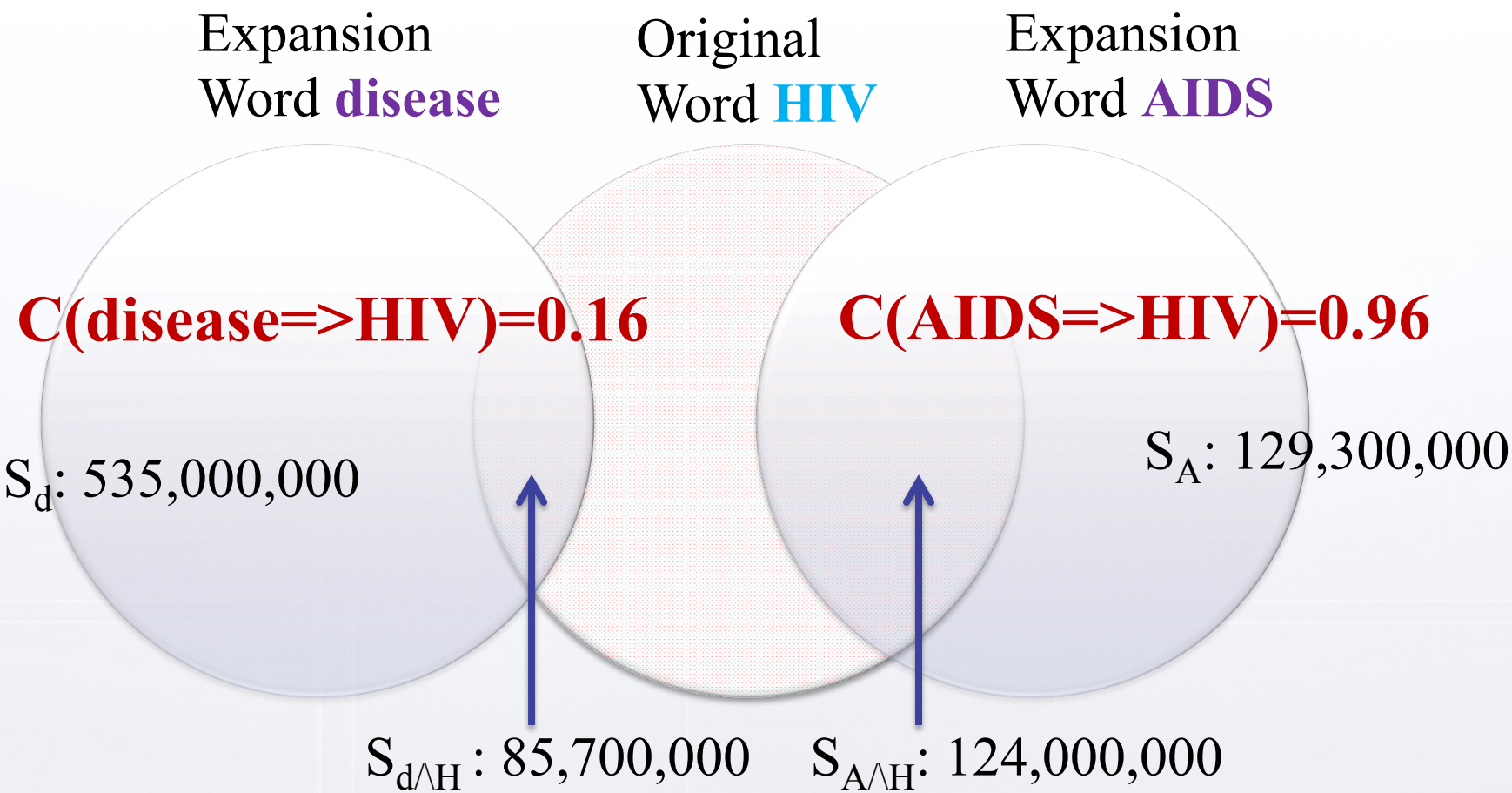
It is possible to increase the precision of information retrieval approaches that are based on syntagmatic associations

- by expanding the vocabulary of artifacts using related words.
- by using JDK API calls as semantic anchors.
- by using the hybrid of syntagmatic and paradigmatic vocabulary expansions.

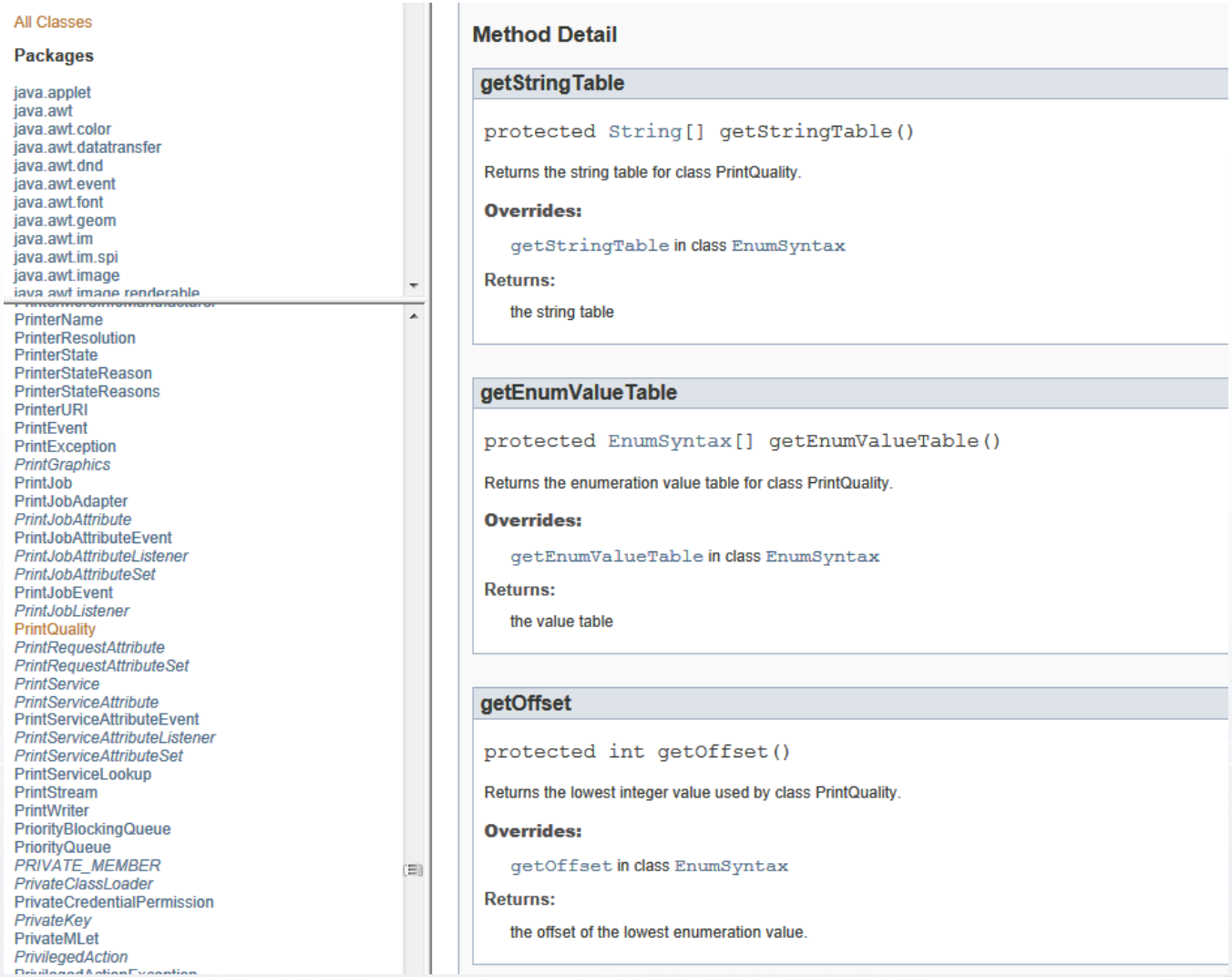
Key Question

How to expand the vocabulary automatically in a semantically meaningful and systematic way in order to increase the accuracy of automatic traceability approaches?

Expansion With Related Words



Expanding JDK API Calls



Experiments

We used TraceLab

- http://www.coest.org

We experimented with multiple IR approaches

- VSM, LSI, JS, LDA, RTM

Corpus Treatment Methods

Strawman — Our baseline method

- Complete source code corpus is treated as bag of words.

JDK expansion — Replaced JDK API calls with their corresponding description in the JDK documentation.

- Identifiers are split.
- Comments are discarded.

J+W — Extension of JDK expansion where

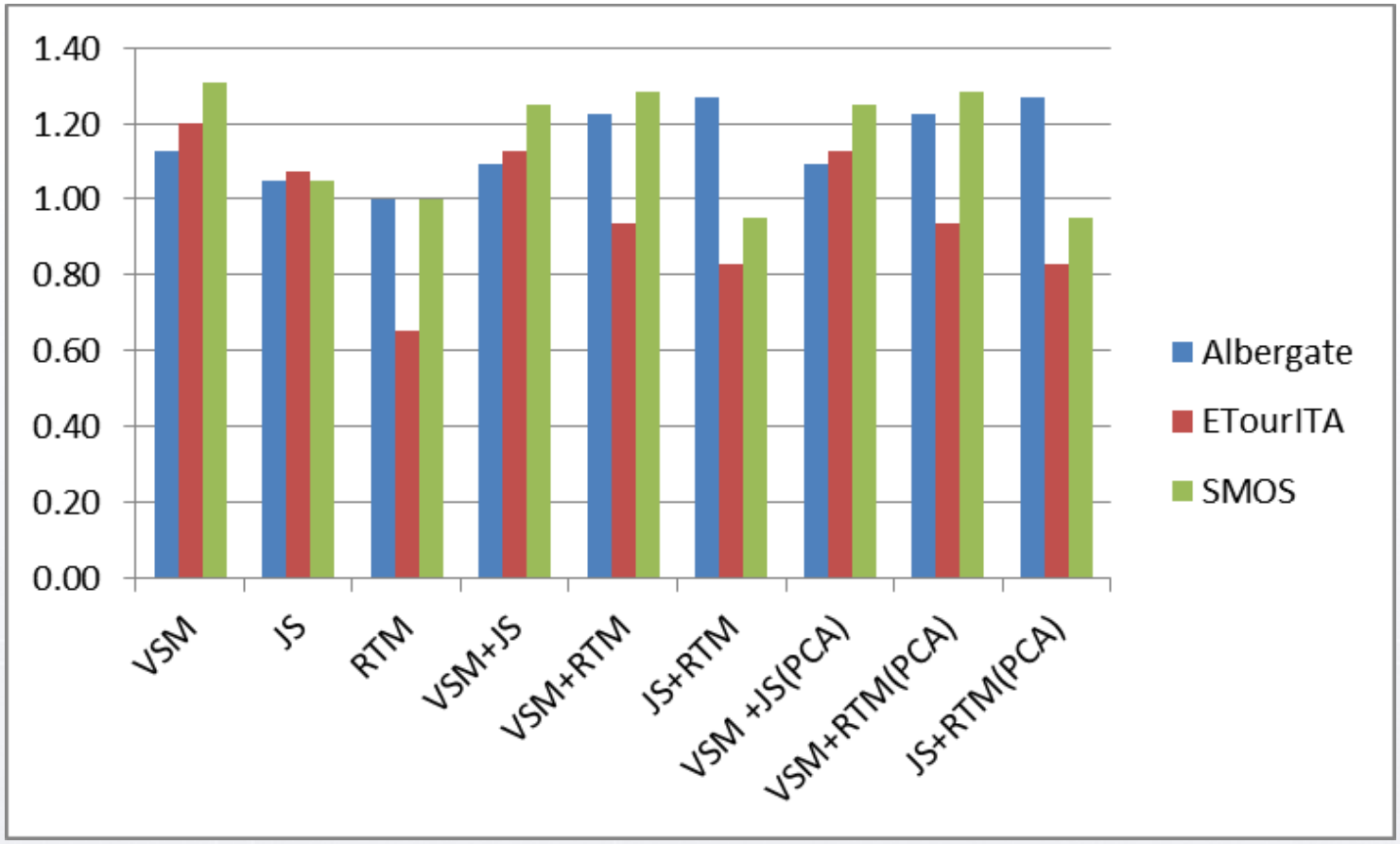
- Wordnet synsets of dictionary words found in the corpus are injected.

J+S — Expansion of S and JDK

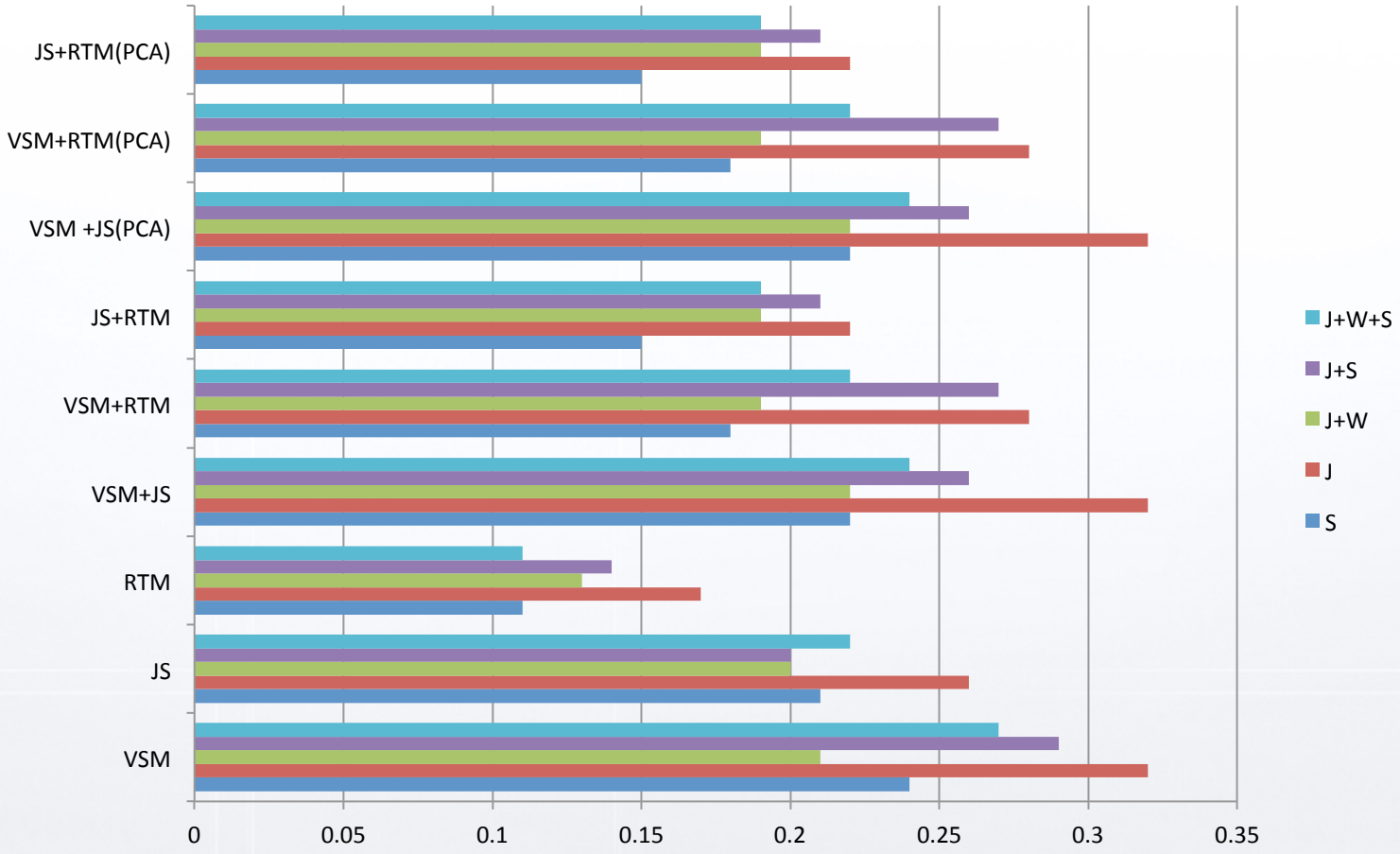
- Comments are included.

J+S+W — is ENTRANCER

Summary of Results



Summary of Results For Albergate



Results

RQ1

Expanding the corpus with the documentation JDK API calls only is often not enough to get higher precision of traceability links when applying word match similarity methods.

RQ2

expansion of the corpus with a combined documentation from the JDK API calls and Wordnet does not always result in a higher precision of traceability links

Results

RQ3

including words from comments results in a higher precision of traceability links when expanding the corpus with a combined documentation from the JDK API calls and Wordnet.

RQ4

There is a correlation between the size of the corpus and higher precision of recovered TLs.

RQ5

using VSM results in a higher precision of traceability links when expanding the corpus with a combined documentation from the JDK API calls and Wordnet

It Is Just the Tip of The Iceberg

We need systematic methods to expand the corpora to experiment with traceability and to increase the precision of different traceability approaches.

Conclusions

An automatic approach for ENhancing TRAceability usiNg API Calls and rElevant woRds (ENTRANCER).

This is the first comprehensive study of an automated approach that expands the base multilingual corpora, i.e., Italian and English.

We showed that ENTRANCER can increase the precision of the recovered TLs by up to 31% in the best case.

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http://www.cs.uic.edu/~drmark/entrancer.htm