Design and Implementation of an Expert Recommendation System for Making Design Decisions

Kevin Koch, Advisor: M.Sc. Manoj Mahabaleshwar, Garching, 11.12.2017

Software Engineering betrieblicher Informationssysteme (sebis)
Fakultät für Informatik
Technische Universität München

wwwmatthes.in.tum.de

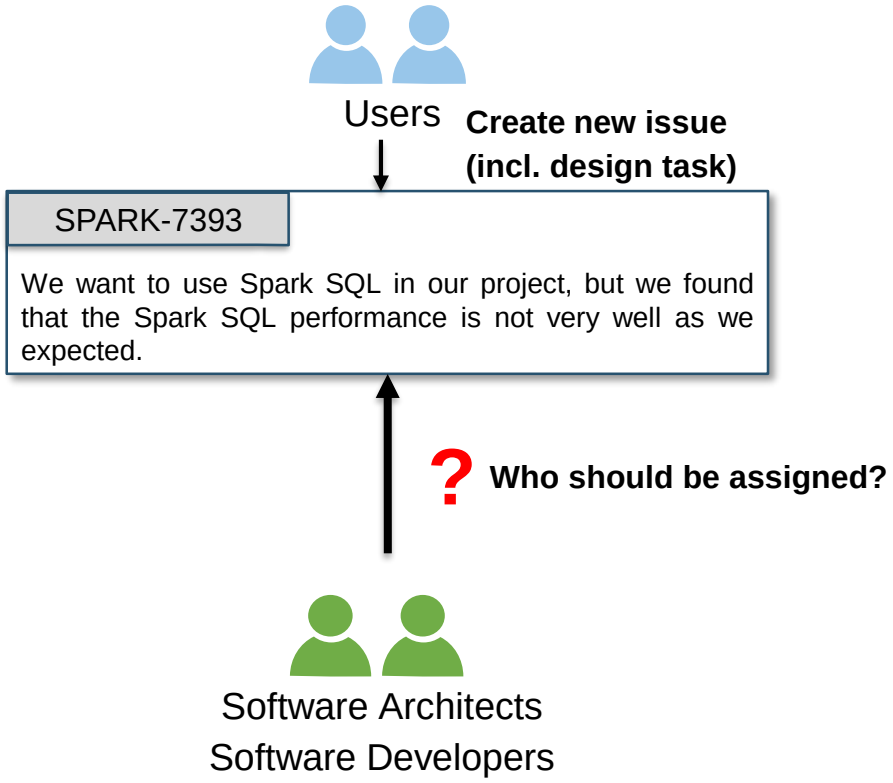
Agenda

1. Introduction
2. Research Questions
3. Methodology - Understanding Design Decisions
4. Approach for Expert Recommendation
5. Timeline
6. Sources

1. Introduction
Example Scenario

Apache Spark

- Issues captured since early 2014
- Versions from 0.9.0 to 2.1.0
- # contributors - **1,146**
- # issues - **21,660**



1. Introduction
Problem areas

How are design decisions made?

- Individual or Group-Decision Making
- Naturalistic Decision Making, Rational Decision Making or Bounded Rational Decision Making
- Underlying process in context of design?

Who makes design decisions?

- Which people are involved?
- Exist specific roles for decision makers?

How are information accessed?

- Who has expertise in what?
- Is knowledge about possible solutions tacit or explicit?

…

1. Introduction
Design Problems

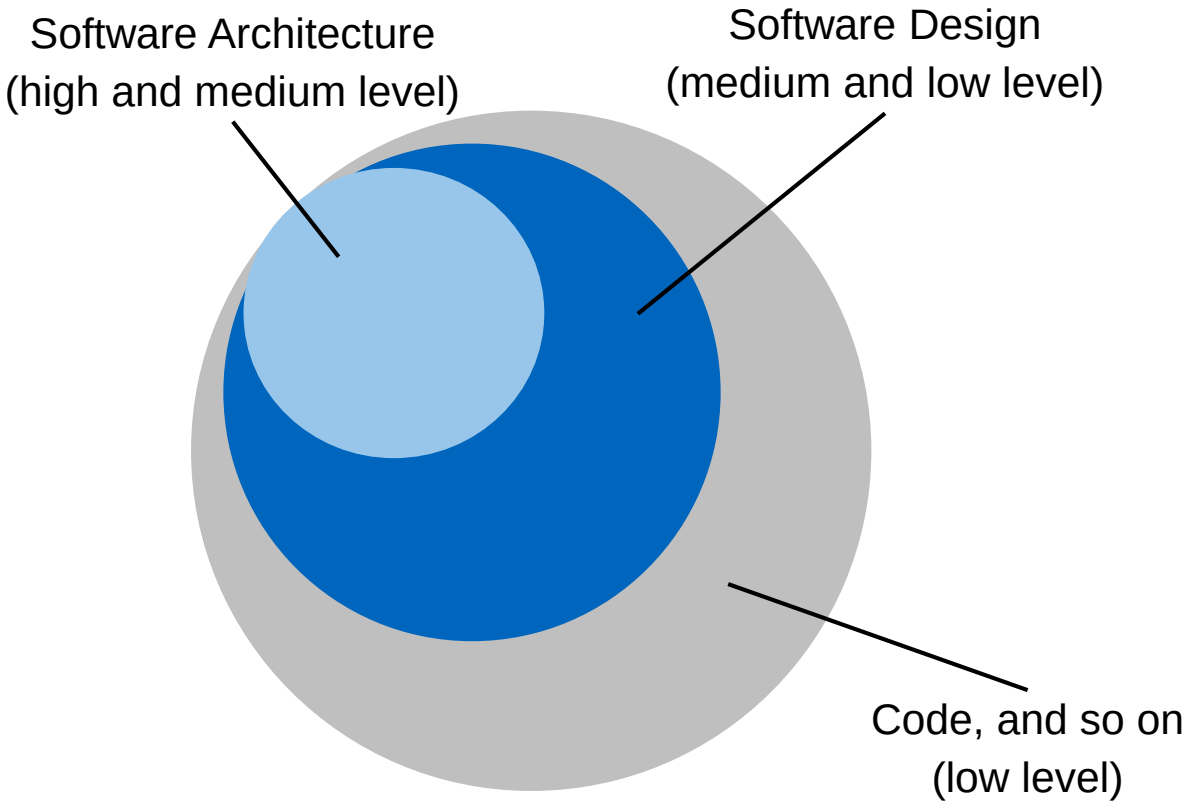
Design problems are wicked problems [1]

Characteristics [2]:

- There is no definitive formulation of a wicked problem
- Wicked problems have no stopping rule
- Solutions are not true or false, but good or bad
- There is no immediate and no ultimate test of a solution to a wicked problem
- Every solution to a wicked problem is a “one-shot operation”

Reasoning and final decision must consider various options

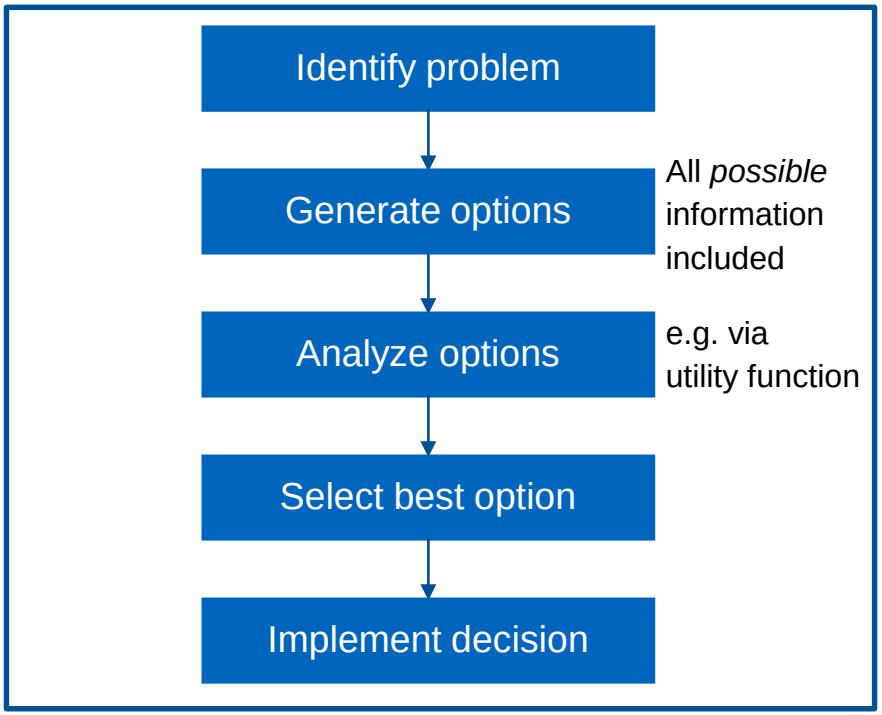
1. Introduction
Design Problems Structure [3] [4]



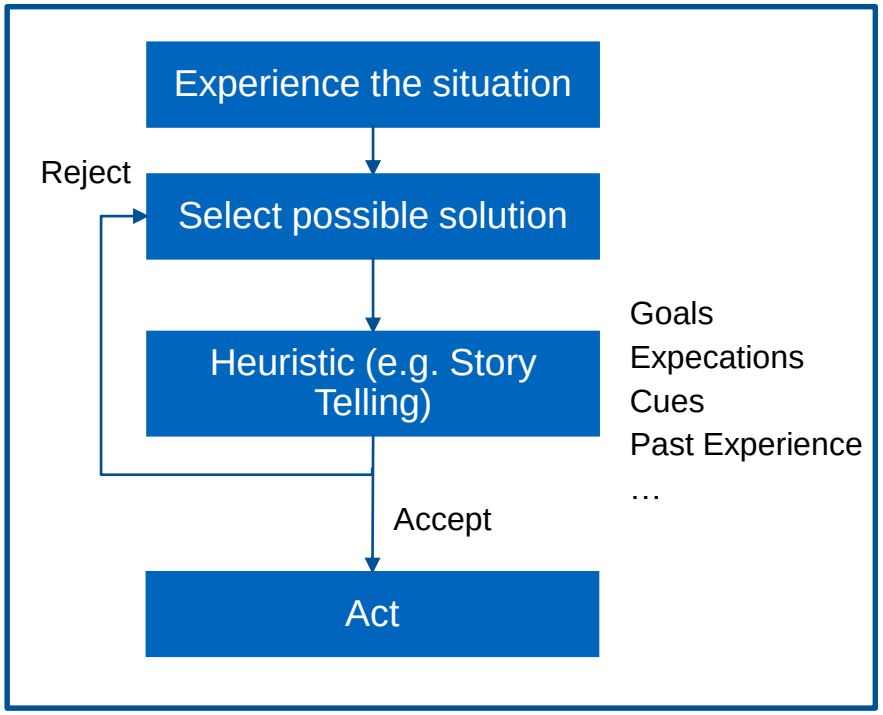
Software architecture and software design problems are in focus

1. Introduction
Decision Making Process

Rational Decision Making [5]

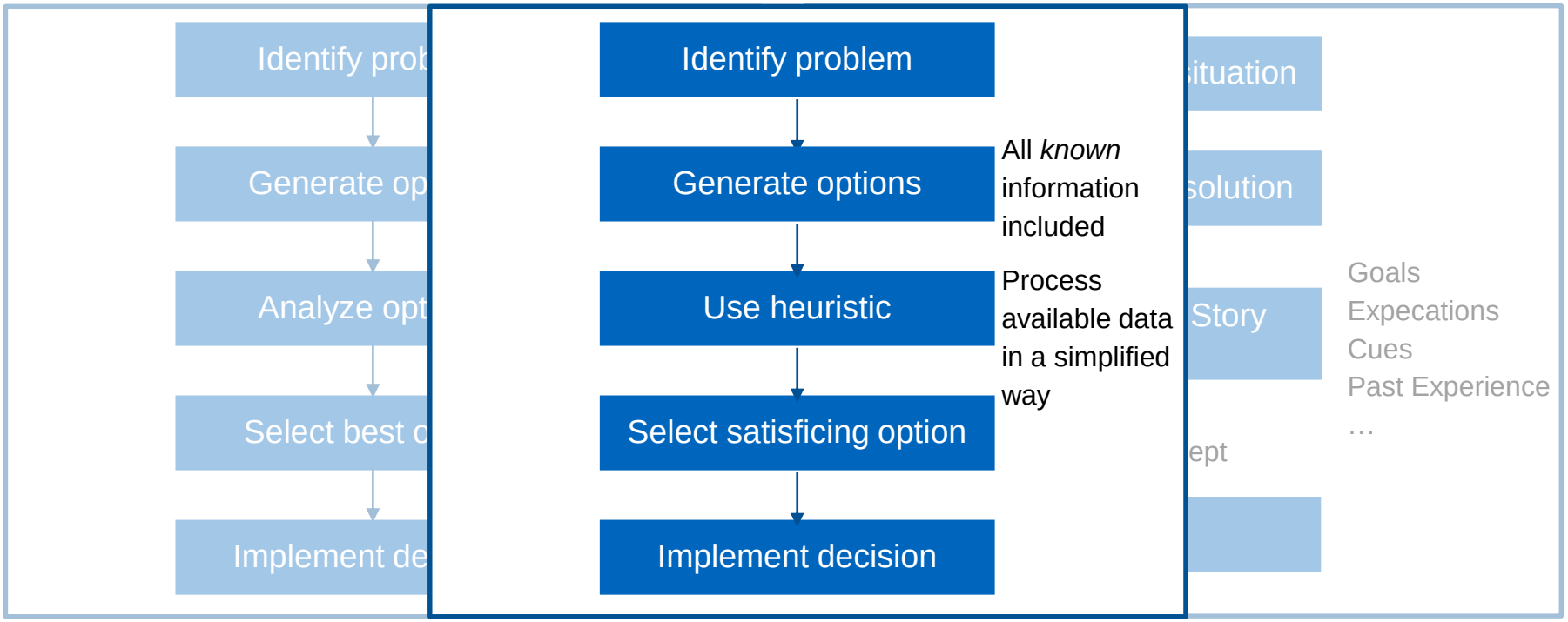


Naturalistic Decision Making [6]



1. Introduction
Decision Making Process

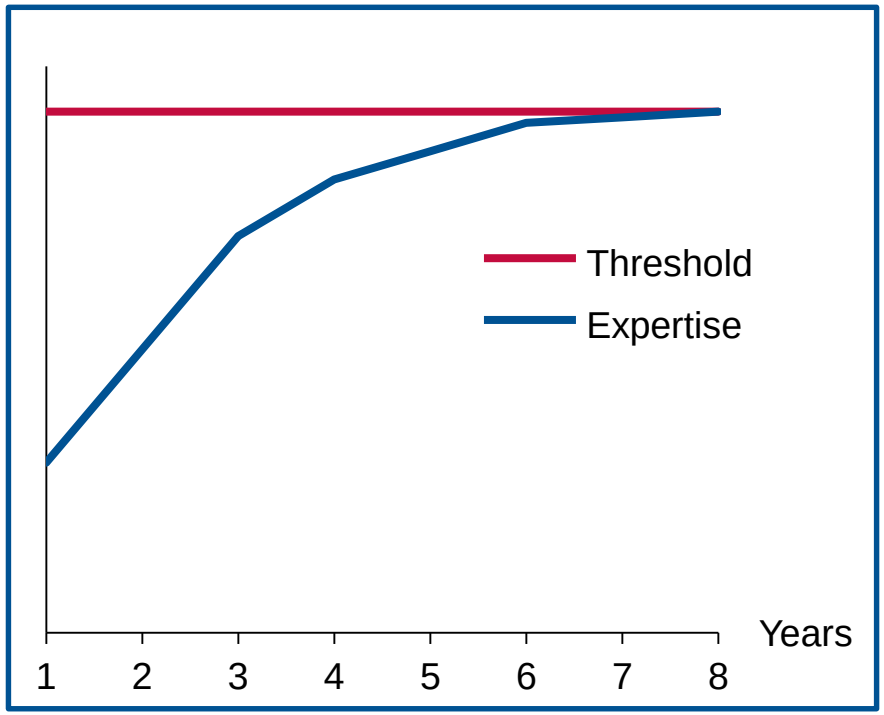
Bounded Rational Decision Making [7]



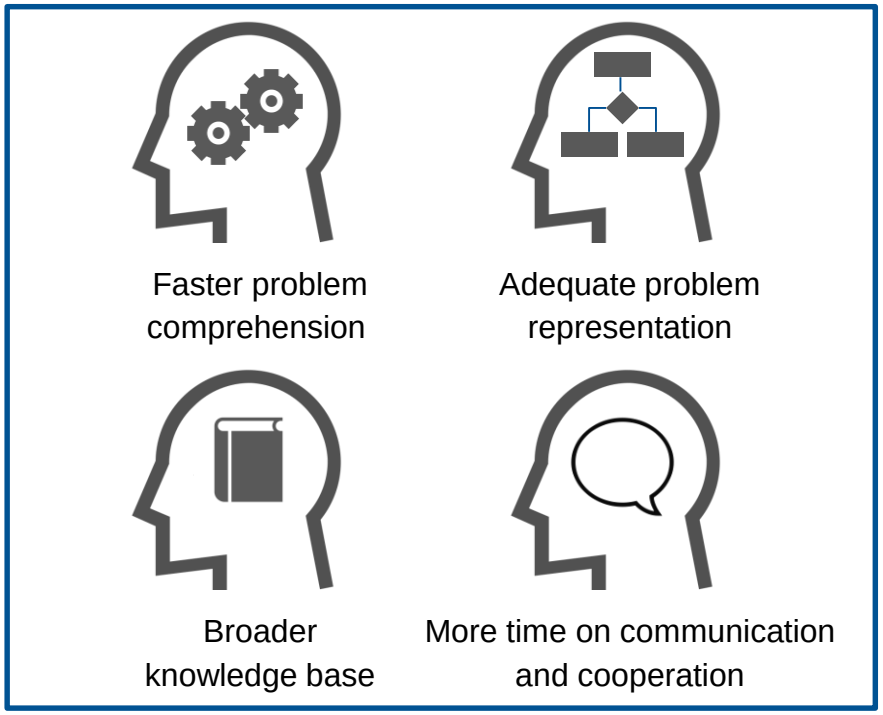
Designers either follow NDM or (B)RDM depending on the context [8]

1. Introduction
Expertise in Design

Long Experience [9] [10]



High Performance [9]



Increased expertise leads to better design solutions [9]

1. Introduction
Global Software Engineering [11]

Worldwide & distributed

“New“ Tools to tackle coordination

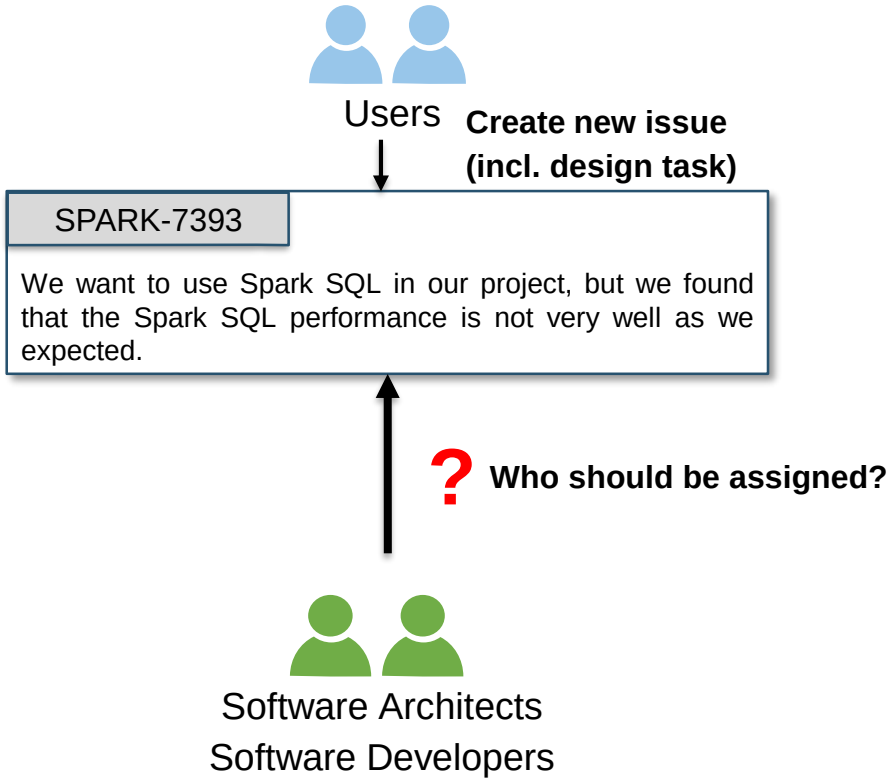
JIRA
GitHub
Bitbucket
Yammer
The Enterprise Social Network
...

Changes environment for decisions + need to know who to involve

1. Introduction
Example Scenario

Apache Spark

- Issues captured since early 2014
- Versions from 0.9.0 to 2.1.0
- # contributors - **1,146**
- # issues - **21,660**



1. Introduction
Example Scenario

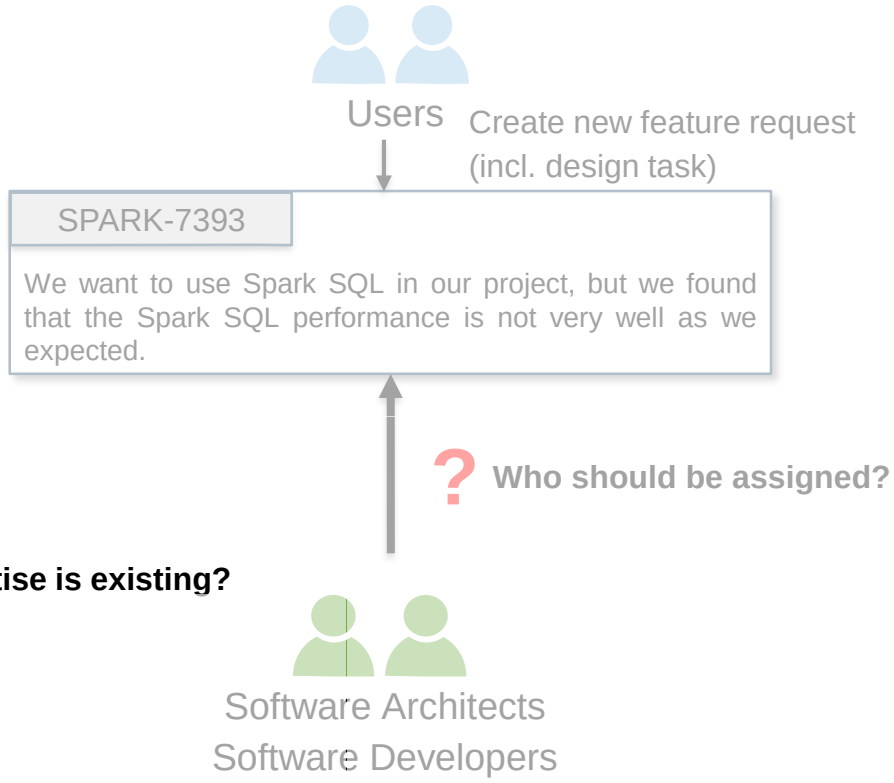
Apache Spark

- Issues captured since early 2014
- Versions from 0.9.0 to 2.1.0
- # contributors - 1,146
- # issues - 21,660

Analysis of existing issues

Expertise Identification

Architectural Elements | Software Quality Attributes | … ? **What kind of expertise is existing?**



1. Introduction
Example Scenario

Apache Spark

- Issues captured since early 2014
- Versions from 0.9.0 to 2.1.0
- # contributors - 1,146
- # issues - 21,660

Analysis of existing issues

Expertise Identification

Architectural Elements

Software Quality Attributes

…

? **Are there specific roles with certain responsibilities or influence?**

Expertise Profiles / Roles

Software Architects
Software Developers

? **Who should be assigned?**

Users

Create new feature request (incl. design task)

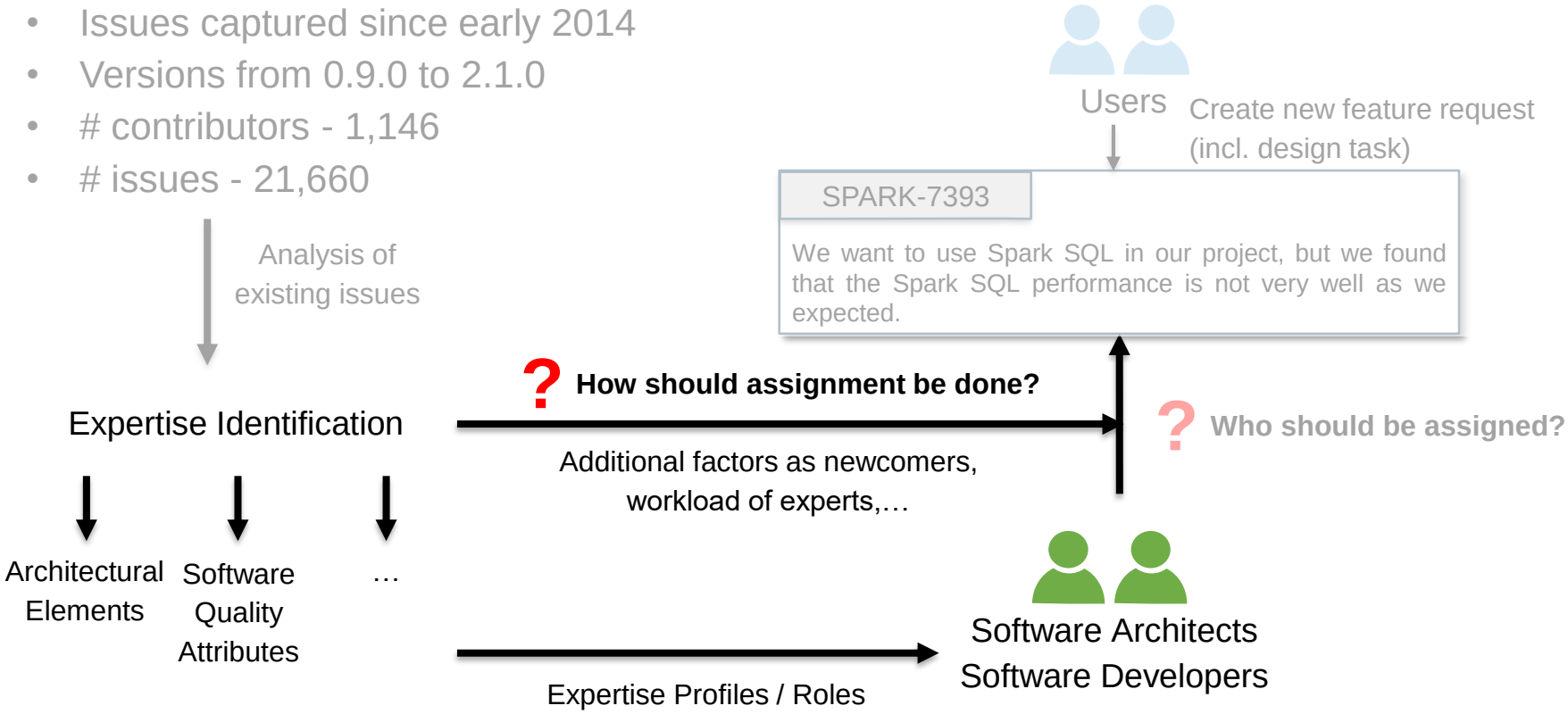
SPARK-7393

We want to use Spark SQL in our project, but we found that the Spark SQL performance is not very well as we expected.

1. Introduction
Example Scenario

Apache Spark

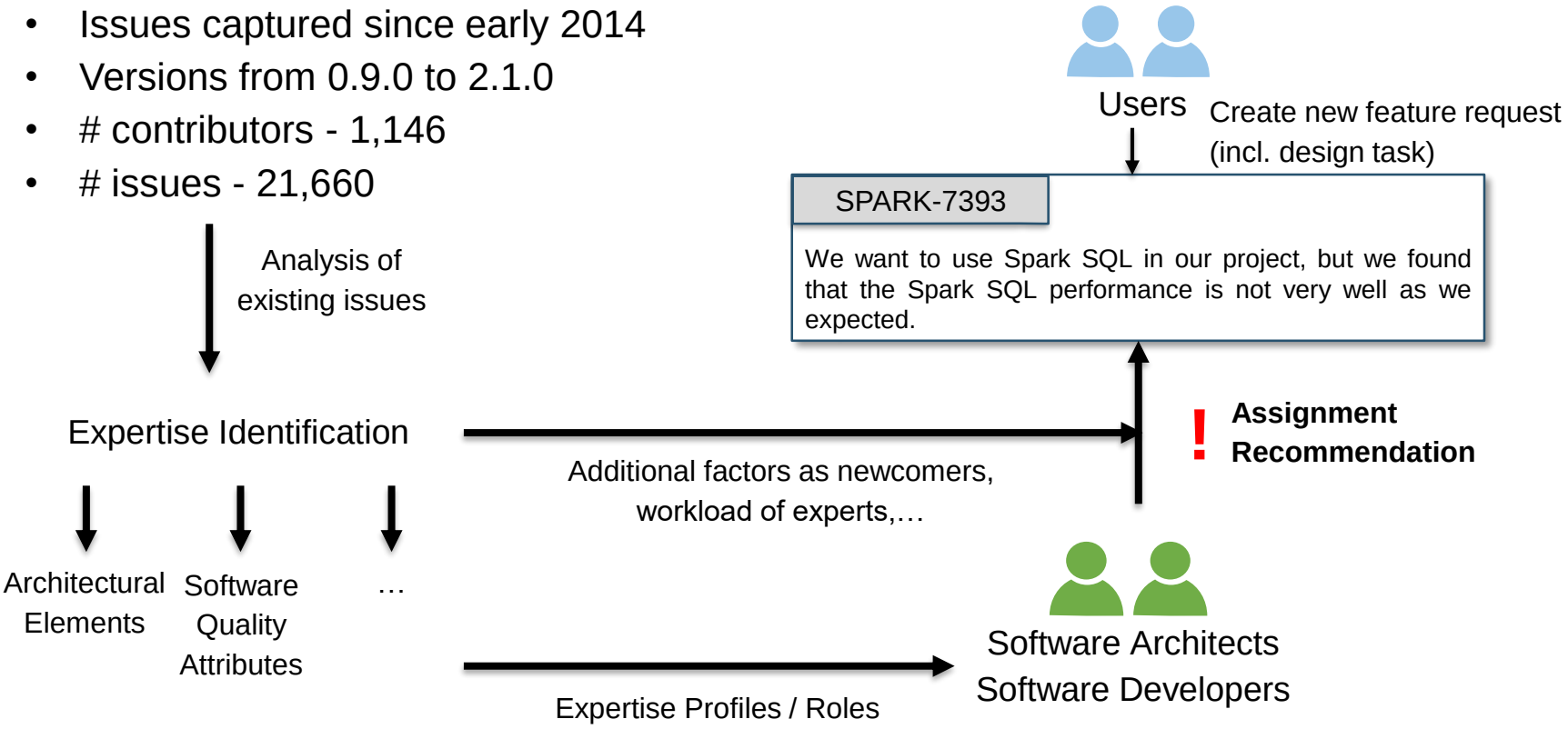
- Issues captured since early 2014
- Versions from 0.9.0 to 2.1.0
- # contributors - 1,146
- # issues - 21,660



1. Introduction
Example Scenario

Apache Spark

- Issues captured since early 2014
- Versions from 0.9.0 to 2.1.0
- # contributors - 1,146
- # issues - 21,660



2. Research Questions

How to quantify/measure the expertise of software architects and developers in the context of design decision-making process?	?
What are the separate roles taken during the decision-making process to address design decisions?	?
How to automatically identify experts to address design decisions and allocate roles to the recommended experts?	?

3. Methodology
(Systematic) Literature Review [12]

Approach:

1. Inspect for previous literature research on design decisions **(completed)**
2. Define review protocol (sources, queries, inclusion/exclusion criteria, quality criteria,…) **(completed)**
3. Perform literature review **(in progress)**
4. Merge with previous found literature related to topic
5. Analysis via meta-ethnography

3. Methodology
Case Study [13]

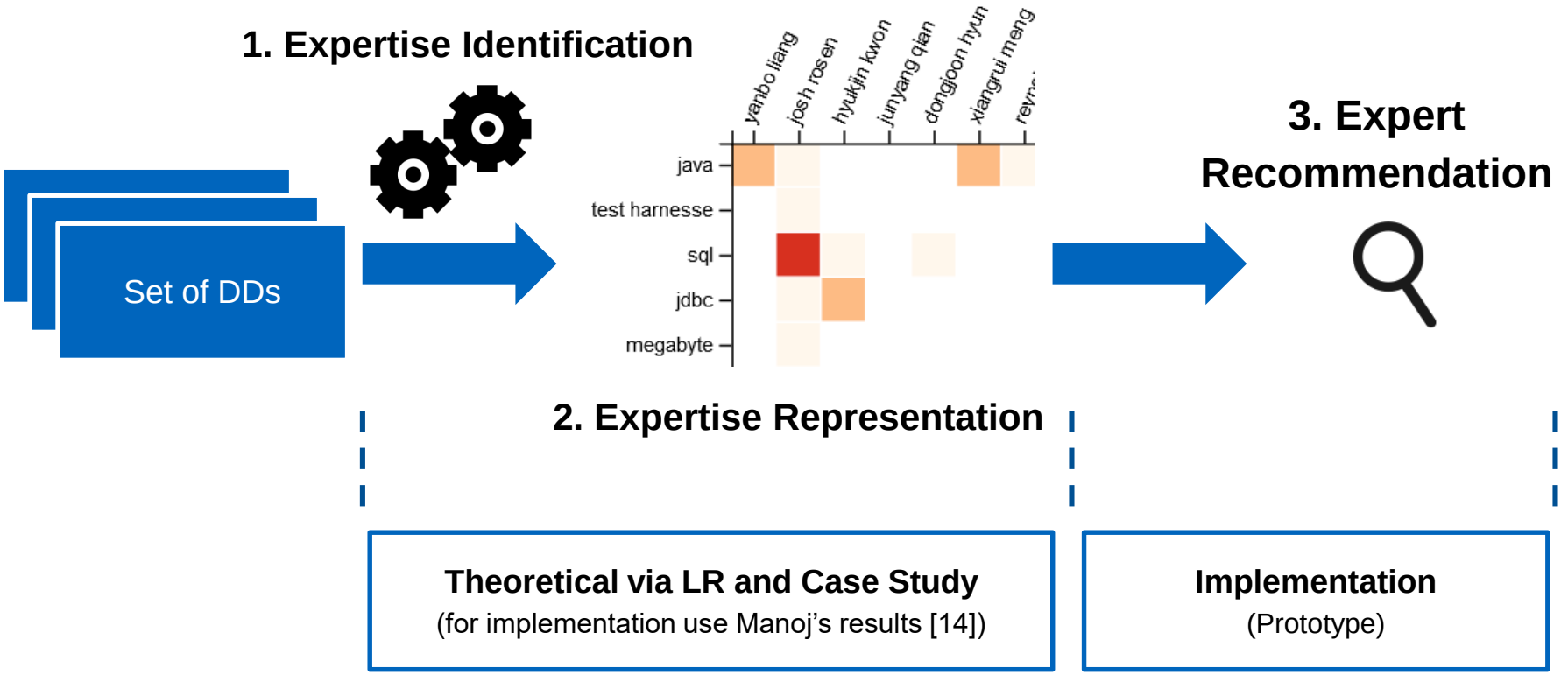
Interviews with architects and developers from industry (Siemens) to examine common practice problems

Example Questions:

- How do you assign people to design issues and in general?
- How are architects engaged in design decisions?
- What is your onboarding process for new employees, especially developers and designers/architects?
- …

LR + case study = identify requirements for an expert recommender

4. Approach for Expert Recommendation
General Overview



4. Approach for Expert Recommendation
Evaluation

Quantitative Historical Evaluation [15]:

- Correctness via Precision and Recall

$$\text{precision} = \frac{TP}{TP + FP}$$

$$\text{recall} = \frac{TP}{TP + FN}$$

TP = true positive, FP = false positive, FN = false negative

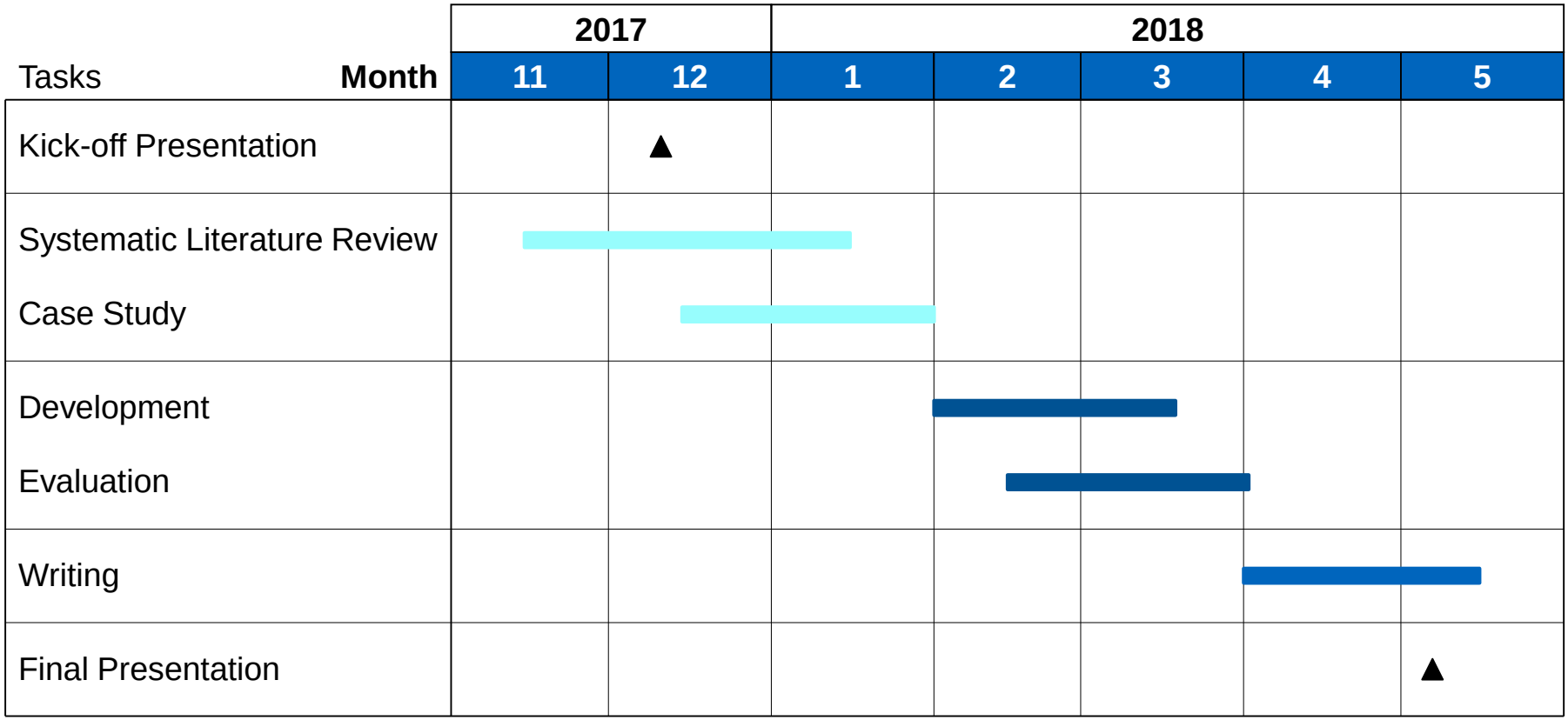
- Compare developed algorithm with other known expert recommender algorithms

Qualitative Evaluation via Case Study:

- Feedback on a Siemens project for proposed solutions

Quantitative and qualitative evaluation ensures triangulation

5. Timeline


2017
2018
Tasks
Month
11
12
1
2
3
4
5
Kick-off Presentation
Systematic Literature Review
Case Study
Development
Evaluation
Writing
Final Presentation

6. Sources

[1] Rittel, H. W. (1987). *The reasoning of designers*. Montreal: IGP.

[2] Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy sciences*, *4*(2), 155-169.

[3] Abrahamsson, P., Babar, M. A., & Kruchten, P. (2010). Agility and architecture: Can they coexist?. IEEE Software, 27(2).

[4] Jansen, A., & Bosch, J. (2005). Software architecture as a set of architectural design decisions. *WICSA 2005. 5th Working IEEE/IFIP Conference on Software Architecture* (S. 109-120). IEEE.

[5] Simon, H. A. (1978). Rationality as process and as product of thought. *The American economic review*, 1-16.

[6] Zsambok, C. E. and G. A. Klein (1997). Naturalistic decision making, L. Erlbaum Associates.

[7] Simon, Herbert A. "A behavioral model of rational choice." *The quarterly journal of economics* 69.1 (1955): 99-118.

[8] Zannier, C., Chiasson, M., & Maurer, F. (2007). A model of design decision making based on empirical results of interviews with software designers. *Information and Software Technology, 49*(6), S. 637-653.

[9] Sonnentag, S., Niessen, C., & Volmer, J. (2006). Expertise in software design.

[10] Zhou, M., & Mockus, A. (2010, November). Developer fluency: Achieving true mastery in software projects. In *Proceedings of the eighteenth ACM SIGSOFT international symposium on Foundations of software engineering* (pp. 137-146). ACM.

6. Sources

[11] Herbsleb, J. D. (2007, May). Global software engineering: The future of socio-technical coordination. In *2007 Future of Software Engineering* (pp. 188-198). IEEE Computer Society.

[12] Keele, S. (2007). Guidelines for performing systematic literature reviews in software engineering. In Technical report, Ver. 2.3 EBSE Technical Report. EBSE. sn.

[13] Runeson, P., & Höst, M. (2009). Guidelines for conducting and reporting case study research in software engineering. Empirical software engineering, 14(2), 131.

[14] Manoj's Paper work in progress

[15] Avazpour, I., Pitakrat, T., Grunske, L., & Grundy, J. (2014). Dimensions and metrics for evaluating recommendation systems. In M. Robillard, W. Maalej, R. Walker, & T. Zimmermann, Recommendation systems in software engineering (S. 245-273). Heidelberg: Springer.

Questions?

(Systematic) Literature Review (1/2)

Sources:

Databases

- ACM Digital Library
- Science Direct
- IEEE Xplore

Conferences

- European Conference on Software Architecture (ECSA)
- International Conference on Software Architecture (ICSA)
- Working IEEE/IFIP Conference on Software Architecture (WICSA)
- International Conference on Design Science Research in Information Systems and Technology

Query:

- TIKEAB:("software design" AND "decision making“ AND expert*) OR TIKEAB:("software design" AND role AND expert*)

Around 1.000 results

(Systematic) Literature Review (2/2)

Inclusion Criteria:

- Any study that quantifies expertise in the context of software development & design
- Any study that inspects roles in the context of software development & design

Exclusion Criteria:

- Any study that does not focus on the development or the process of development of software systems
- Any study that inspected student behavior
- Any study that is not a primary study
- Any study that does not pass the quality criteria

Study Selection Procedures:

1. Identify relevant studies from databases and journals
2. Exclude studies based on titles
3. Exclude studies based on reading the abstract
4. Obtain papers
5. Final selection based on quality criteria