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


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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

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

Who should be assigned?

Software Architects
Software Developers
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


Software architecture and software design problems are in focus
1. Introduction
Decision Making Process

Rational Decision Making [5]

- Identify problem
- Generate options
- Analyze options
- Select best option
- Implement decision

Naturalistic Decision Making [6]

- Experience the situation
- Select possible solution
  - Heuristic (e.g. Story Telling)
  - Goals
  - Expecations
  - Cues
  - Past Experience
- Accept
- Act

All possible information included

e.g. via utility function
1. Introduction

Decision Making Process

Bounded Rational Decision Making [7]

- Identify problem
- Generate options
- Use heuristic
- Select satisficing option
- Implement decision

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

Expertise in Design

Increased expertise leads to better design solutions [9]

Long Experience [9] [10]

High Performance [9]

- Faster problem comprehension
- Adequate problem representation
- Broader knowledge base
- More time on communication and cooperation

Graph showing the increase in expertise and threshold over years.
1. Introduction

Worldwide & distributed

“New” Tools to tackle coordination

Changes environment for decisions + need to know who to involve
1. Introduction
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Analysis of existing issues

Expertise Identification

Architectural Elements
Software Quality Attributes

Who should be assigned?

What kind of expertise is existing?

Software Architects
Software Developers

Create new feature request (incl. design task)

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- Architectural Elements
- Software Quality Attributes
- ...
1. Introduction
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Analysis of existing issues

Expertise Identification

Additional factors as newcomers, workload of experts,…

Who should be assigned?

How should assignment be done?

Expertise Profiles / Roles

Software Architects

Software Developers
1. Introduction
Example Scenario

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Analysis of existing issues

Expertise Identification

SPARK-7393
Additional factors as newcomers, workload of experts,…

Assignment Recommendation

Software Architects
Software Developers
Expertise Profiles / Roles

Create new feature request (incl. design task)
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

1. Expertise Identification
   - Set of DDs

2. Expertise Representation
   - Theoretical via LR and Case Study
     (for implementation use Manoj’s results [14])
   - Implementation (Prototype)

3. Expert Recommendation

Set of ADDs

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

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6. Sources


6. Sources


[14] Manoj’s Paper work in progress

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
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(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