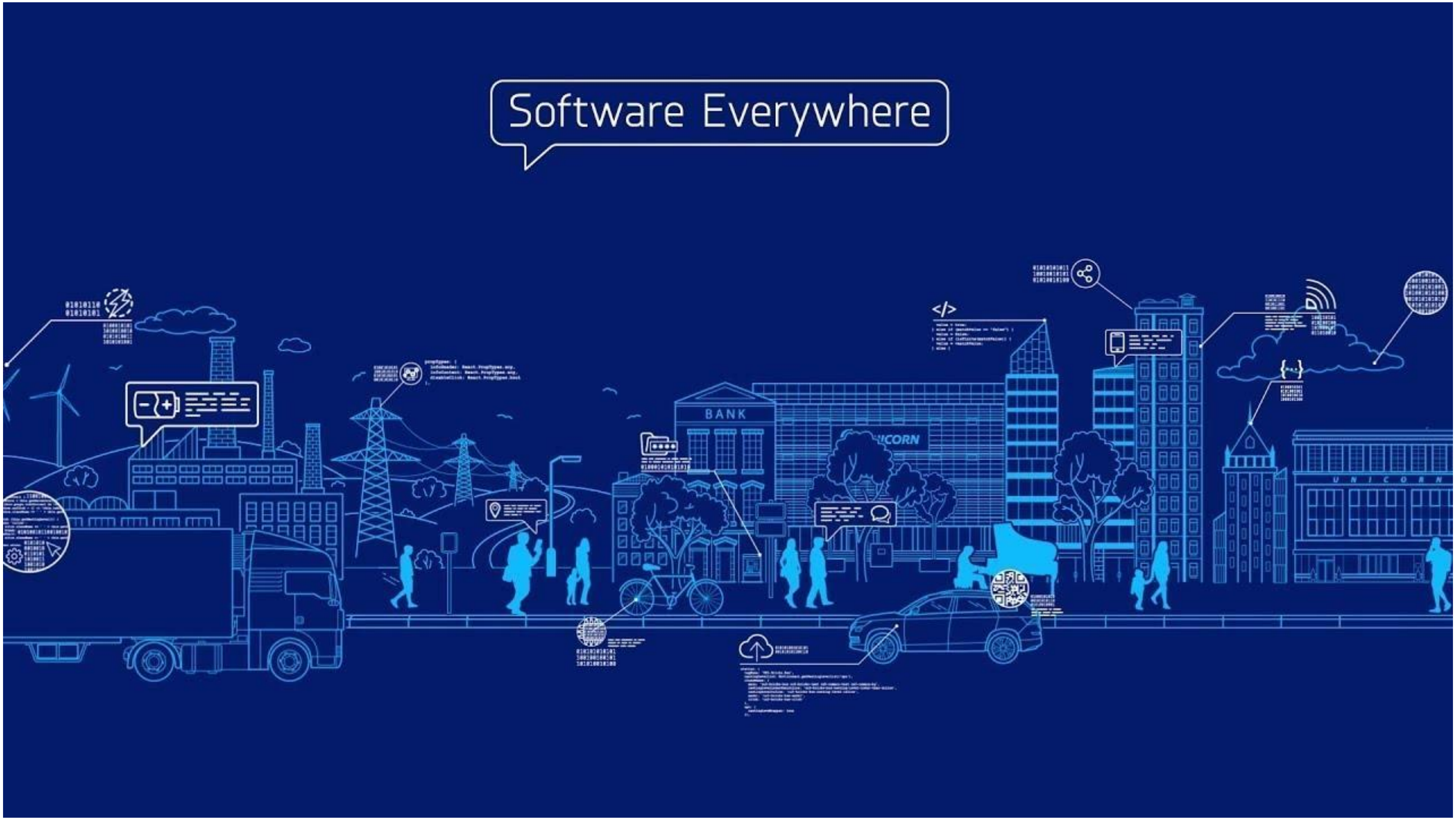
Thesis Proposal

Software Engineering

- G. S. Varma


Software Everywhere
BANK
UNICORN
U N I C O R N

- “ $1.1 Trillion in Assets Affected by Software Bugs in **2016** “

  - Software Fail Watch Annual Report, [Tricentis]

Static Code Analysis

- It helps in prevention of bugs.
- It examines code without execution.

- Detects Vulnerabilities :

  - Injections
  - Cross Site Scripting (XSS)
  - Buffer Overflow, and Dead Code etc

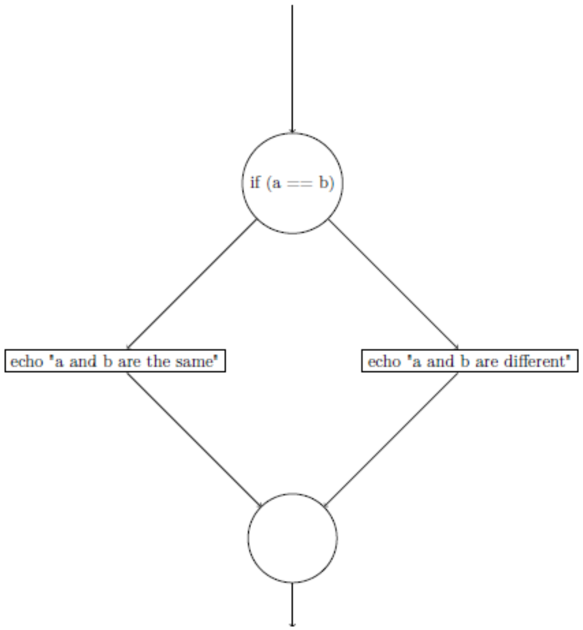
Static Code Analysis

- There are different techniques followed for analysing source code.

- Example: Data Flow Analysis

- Source code → Basic blocks

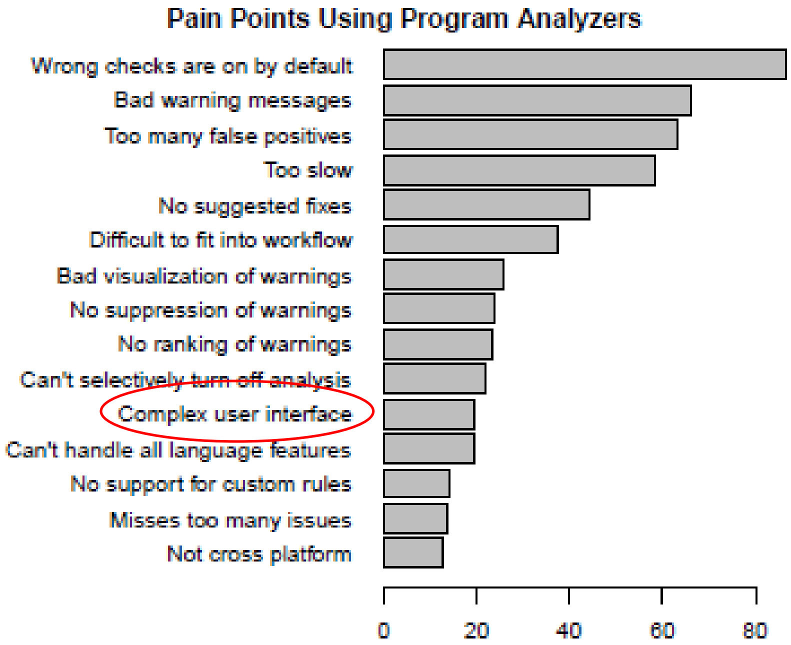
```
$a = 0;

$b = 1;

If ($a == $b)

{ # start of block

echo "a and b are the same";

} # end of block

else { # start of block

echo "a and b are different";

} # end of block
```



Static Code Analysis

- Tools :
  - IDE Notifications,
  - IDE tools,
  - Dedicated tools,
  - Linters
  - CLI tools.

- Research Papers:
  - Maria et. al.
  - Johnson et. al.



- Found: developers facing issues in using tools

- Most importantly, USABILITY issue.

SARIF

- Static Analysis Results Interchange Format (SARIF)
- Standard representation of bug warnings in a JSON format

Multiple Tools

- Developers seem to use multiple static analysis tools each having own coverage.

- Research trends:

- Using multiple static analysis tools in order to prioritise the bug warning alerts

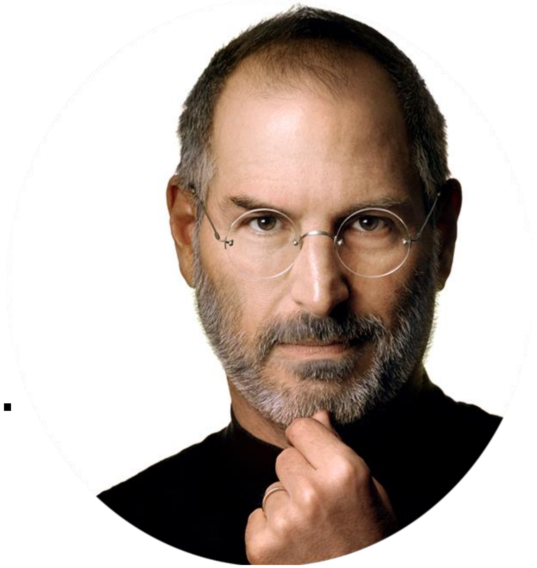
- Using results of three different static analysis tools for a programming language, Java and merges them together in order to show warnings to the developer

But USABILITY is not addressed…

Multiple Tools

- **SARIF** scope - different analysis tools results can be integarted
- Need for addressing Usability issue

“You can't connect the dots looking forward;



you can only connect them looking backwards.

So you have to trust that the dots will somehow connect in your future.”

— Steve Jobs

Thesis Topic

Integration of Multiple Static Analysis Tools

in a Single Interface

Thesis Work Plan

- Problem Statement
- Research Questions
- What Current Tools do?
- Our Approaches
- Evaluation
- Time Plan

Problem Statement

- How to integrate the results of multiple static analysis tools

  in a unified user interface?

Research Questions

1. How to display results of the same codebase from different analysis tools?

2. What feedback works to know that the bug fixing is on-going?

3. How to carry traceability of bug fixing?

Thesis Work Plan

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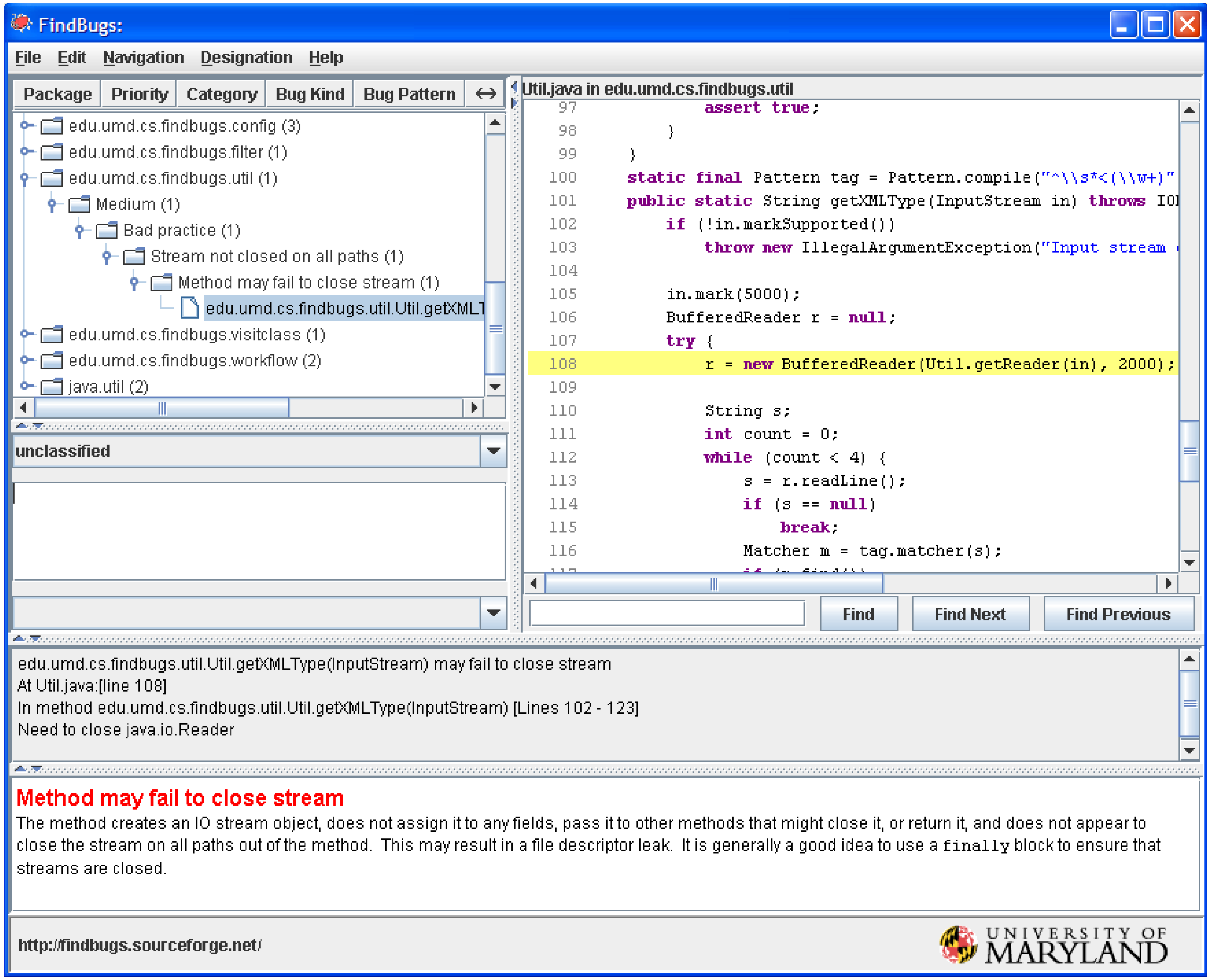
What Current Tools do? - RQ 1

- FindBugs



edu.umd.cs.findbugs.config (3)
edu.umd.cs.findbugs.filter (1)
edu.umd.cs.findbugs.util (1)
Medium (1)
Bad practice (1)
Stream not closed on all paths (1)
Method may fail to close stream (1)
edu.umd.cs.findbugs.util.Util.getXMLT
edu.umd.cs.findbugs.visitclass (1)
edu.umd.cs.findbugs.workflow (2)
java.util (2)

Util.java in edu.umd.cs.findbugs.util

```
 97                assert true;
 98            }
 99        }
100        static final Pattern tag = Pattern.compile("^\\s*<(\\w+)"
101        public static String getXMLType(InputStream in) throws IOI
102            if (!in.markSupported())
103                throw new IllegalArgumentException("Input stream
104
105            in.mark(5000);
106            BufferedReader r = null;
107            try {
108                r = new BufferedReader(Util.getReader(in), 2000);
109
110                String s;
111                int count = 0;
112                while (count < 4) {
113                    s = r.readLine();
114                    if (s == null)
115                        break;
116                    Matcher m = tag.matcher(s);
```

edu.umd.cs.findbugs.util.Util.getXMLType(InputStream) may fail to close stream
At Util.java:[line 108]
In method edu.umd.cs.findbugs.util.Util.getXMLType(InputStream) [Lines 102 - 123]
Need to close java.io.Reader

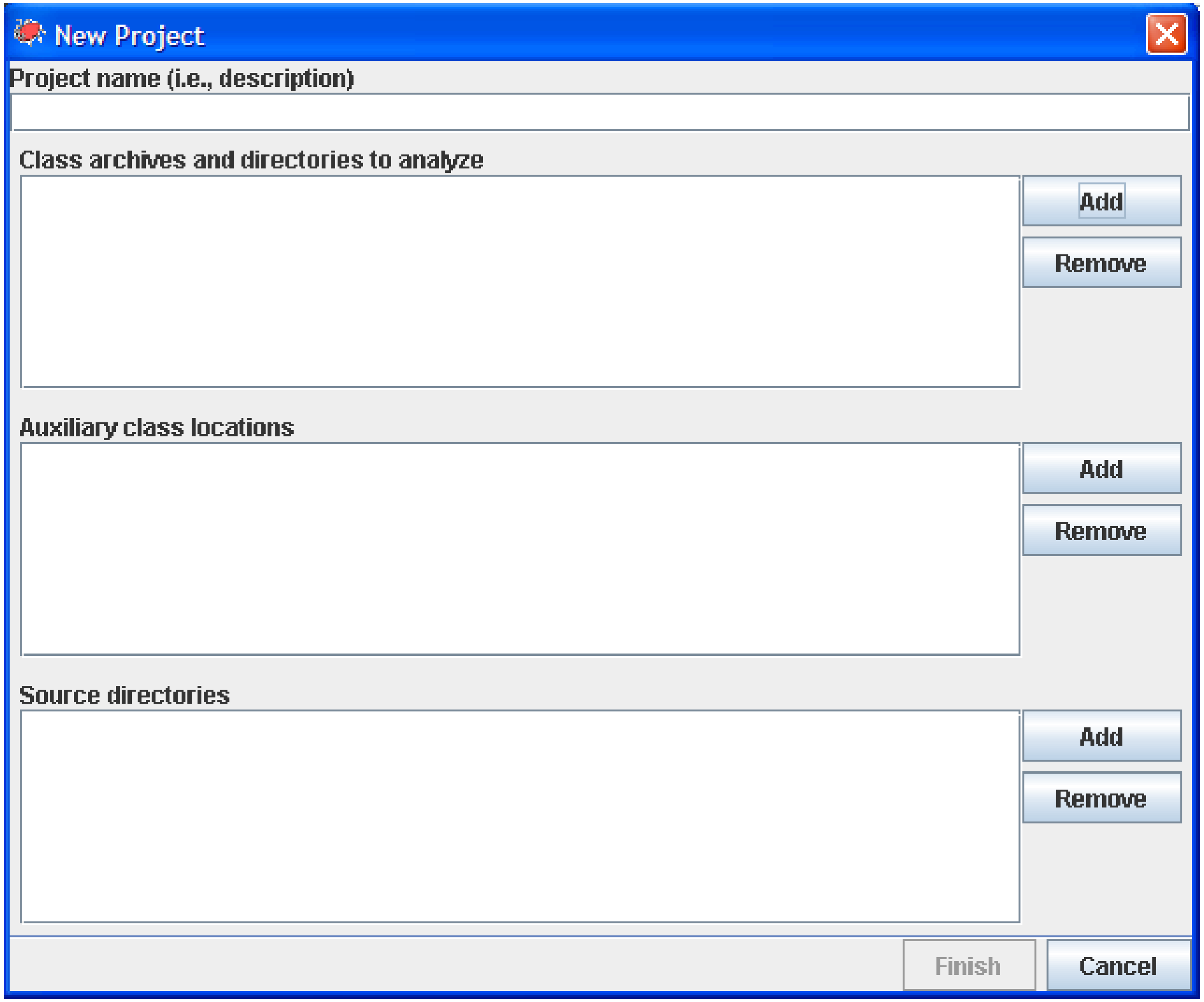
Method may fail to close stream

The method creates an IO stream object, does not assign it to any fields, pass it to other methods that might close it, or return it, and does not appear to close the stream on all paths out of the method. This may result in a file descriptor leak. It is generally a good idea to use a `finally` block to ensure that streams are closed.

http://findbugs.sourceforge.net/

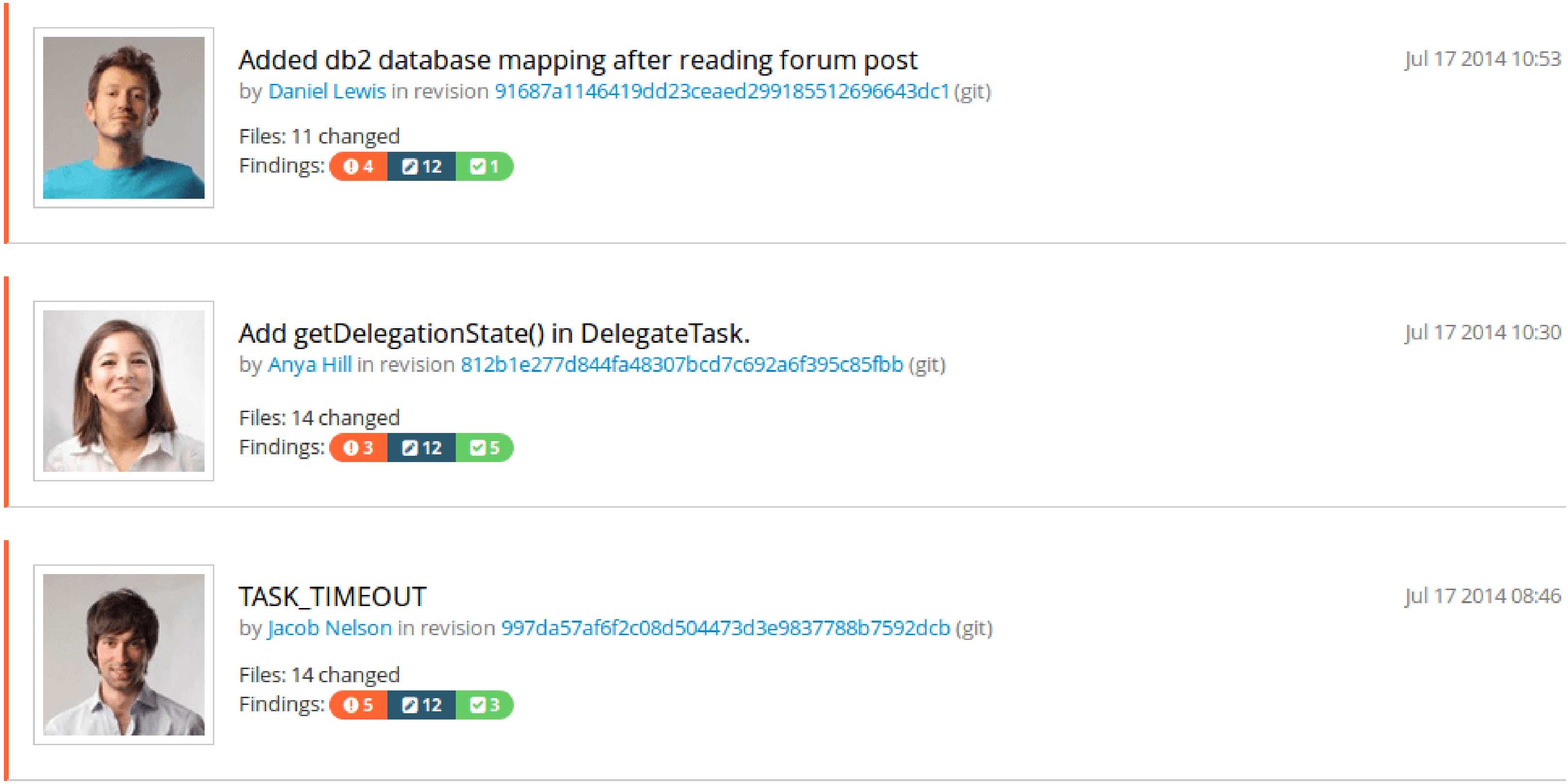
What Current Tools do? - RQ 2

- FindBugs


New Project
Project name (i.e., description)
Class archives and directories to analyze
Add
Remove
Auxiliary class locations
Add
Remove
Source directories
Add
Remove
Finish
Cancel

What Current Tools do? - RQ 3

- TeamScale



Added db2 database mapping after reading forum post

by Daniel Lewis in revision 91687a1146419dd23ceaed299185512696643dc1 (git)

Jul 17 2014 10:53

Files: 11 changed

Findings: ❗4 ✎12 ☑1

Add getDelegationState() in DelegateTask.

by Anya Hill in revision 812b1e277d844fa48307bcd7c692a6f395c85fbb (git)

Jul 17 2014 10:30

Files: 14 changed

Findings: ❗3 ✎12 ☑5

TASK_TIMEOUT

by Jacob Nelson in revision 997da57af6f2c08d504473d3e9837788b7592dcb (git)

Jul 17 2014 08:46

Files: 14 changed

Findings: ❗5 ✎12 ☑3

Thesis Work Plan

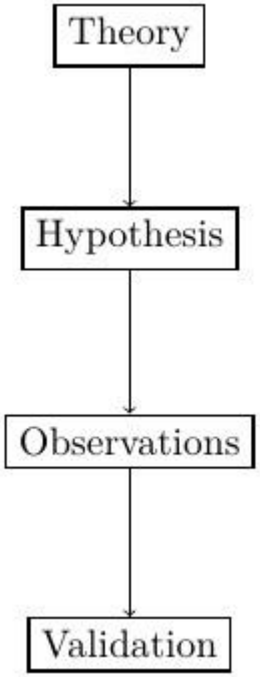
- Problem Statement
- Research Questions
- What Current Tools do?
- Our Approaches
- Evaluation
- Time Plan

Our Approaches

- Research different techniques that tackle the respective research question in other domains of software engineering.
- Adapt those techniques and design own techniques for the domain of static analysis.
- Design prototypes with a wireframe tool of those techniques to improve the usability of integrating analysis tools.
- Design user studies that evaluate the efficiency of those techniques, with professional code developers.
- Run the user studies and report on their results.
- Loop 2 to 5

Our Approaches

- Research Methodology - Deductive inference
- Software Engineering disciplines:
  - Complex datasets
  - Compiler reporting
  - Continuous integration
  - Refactoring tools
  - Issue tracker
  - Stack Overflow
  - Gamification
  - Usability Engineering



Our Approaches

- Complex datasets:

  - Dix et. al. - more complex grouping and linking of datasets in the context of a user interface of Spreadsheets application.

    Design lesson : extensibility of columns

  - Gaur et. al.

    - linear search problem in indexing as it takes more time for large volumes of data. So, different parameters are introduced to decrease computation time.

    Example: Searching for toy

Our Approaches

- Compiler reporting

Horning et. al

- error logging with statistics

- stating what kind of bugs are not found along with bugs found

Our Approaches

- Refactoring tools

Dustinca

- barrier of discoverability
- introduced a smart tag for code can be refactored.
- 'on-board' phase _ **Gamification**

Hayashi et. al. - task level commits in order to maintain edit history

Our Approaches

- Issue tracker

Baysal et. al. :

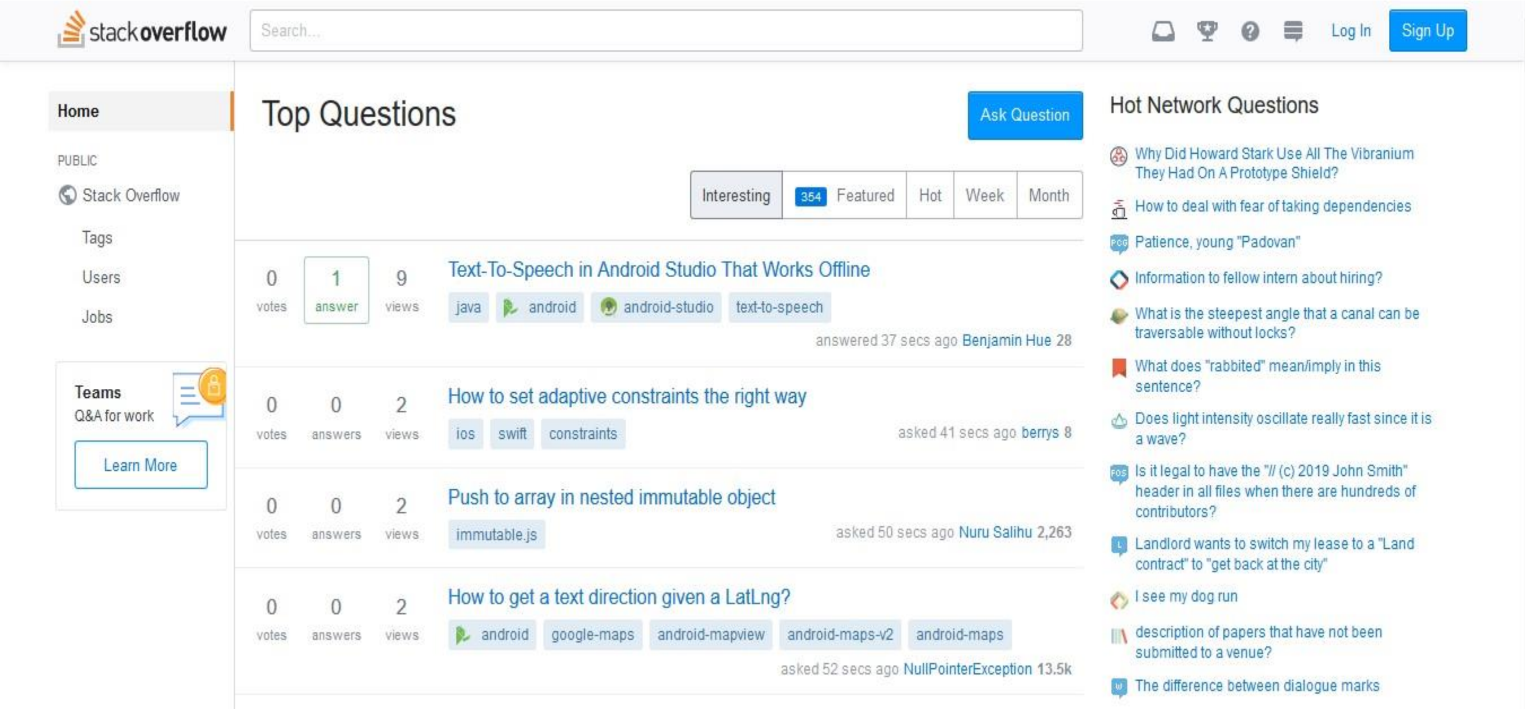
  - Information overload
  - Expressiveness

Ideal to describe the priory as per team decision instead of personal choice.

Our Approaches

- Stack Overflow

- Wang et. al. : 10934198 questions on a 'User Interface' topic
- Treude et. al. : 72.30 % questions have between 2 and 4 tags



Top Questions

0 votes 1 answer 9 views
Text-To-Speech in Android Studio That Works Offline
java android android-studio text-to-speech
answered 37 secs ago Benjamin Hue 28

0 votes 0 answers 2 views
How to set adaptive constraints the right way
ios swift constraints
asked 41 secs ago berrys 8

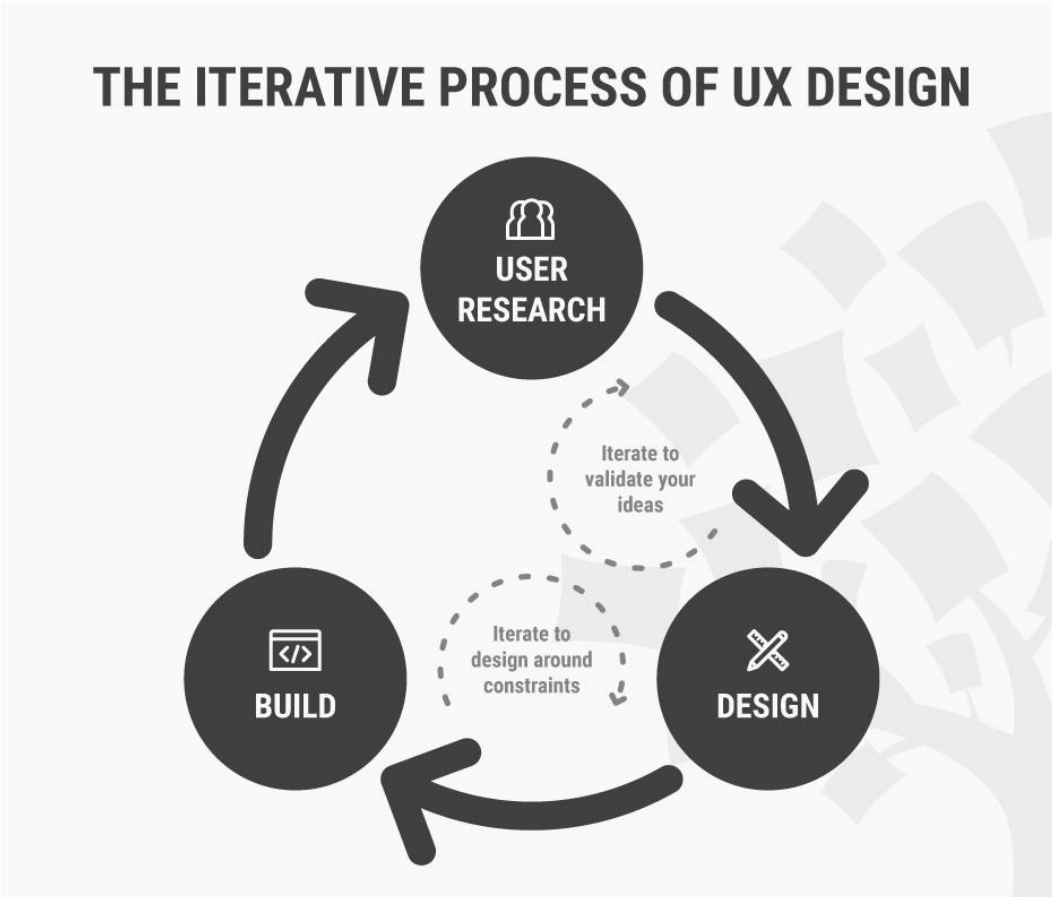
0 votes 0 answers 2 views
Push to array in nested immutable object
immutable.js
asked 50 secs ago Nuru Salihu 2,263

0 votes 0 answers 2 views
How to get a text direction given a LatLng?
android google-maps android-mapview android-maps-v2 android-maps
asked 52 secs ago NullPointerException 13.5k

Hot Network Questions

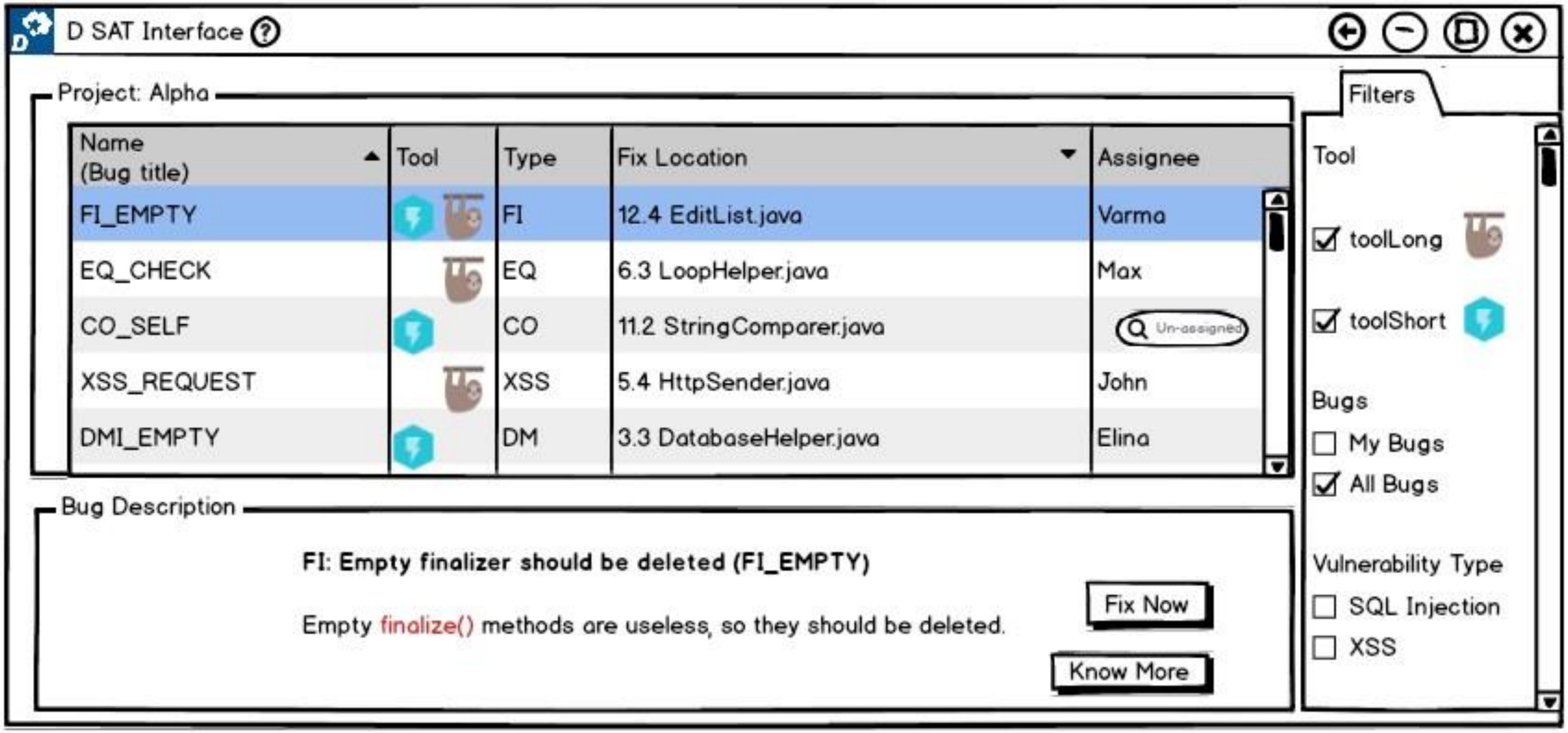
- Why Did Howard Stark Use All The Vibranium They Had On A Prototype Shield?
- How to deal with fear of taking dependencies
- Patience, young "Padovan"
- Information to fellow intern about hiring?
- What is the steepest angle that a canal can be traversable without locks?
- What does "rabbited" mean/imply in this sentence?
- Does light intensity oscillate really fast since it is a wave?
- Is it legal to have the "// (c) 2019 John Smith" header in all files when there are hundreds of contributors?
- Landlord wants to switch my lease to a "Land contract" to "get back at the city"
- I see my dog run
- description of papers that have not been submitted to a venue?
- The difference between dialogue marks

UX Design Cycle


THE ITERATIVE PROCESS OF UX DESIGN
USER RESEARCH
DESIGN
BUILD
Iterate to validate your ideas
Iterate to design around constraints

Example: RQ 1

- Prototype 1



Project: Alpha

Name (Bug title) ▲	Tool	Type	Fix Location ▼	Assignee
FI_EMPTY	⬢ 🦥	FI	12.4 EditList.java	Varma
EQ_CHECK	🦥	EQ	6.3 LoopHelper.java	Max
CO_SELF	⬢	CO	11.2 StringComparer.java	Un-assigned
XSS_REQUEST	🦥	XSS	5.4 HttpSender.java	John
DMI_EMPTY	⬢	DM	3.3 DatabaseHelper.java	Elina

Bug Description

FI: Empty finalizer should be deleted (FI_EMPTY)

Empty finalize() methods are useless, so they should be deleted.

Tool

☑ toolLong 🦥

☑ toolShort ⬢

Bugs

☐ My Bugs

☑ All Bugs

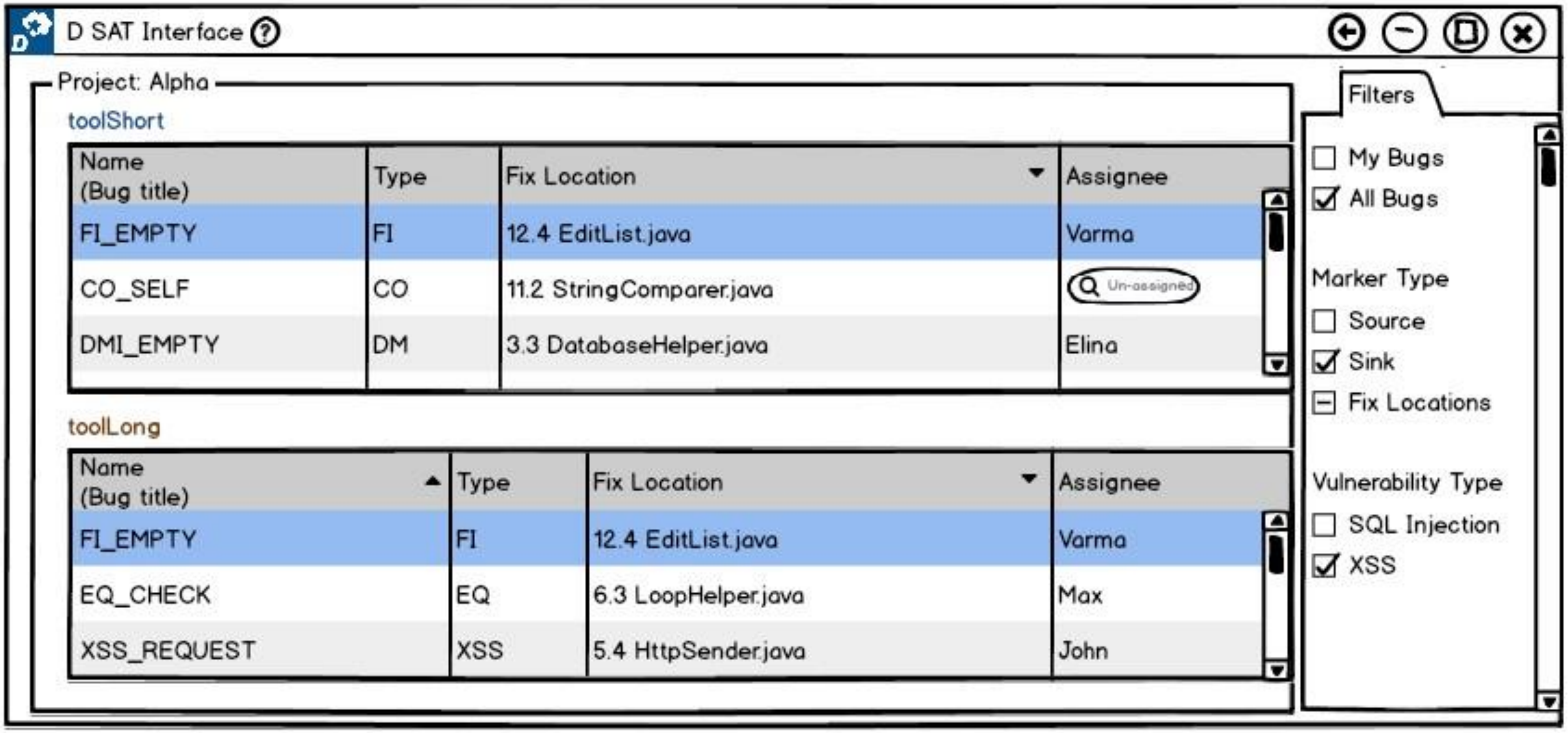
Vulnerability Type

☐ SQL Injection

☐ XSS

Example: RQ 1

- Prototype 2



D SAT Interface ?

Project: Alpha

toolShort

Name (Bug title)	Type	Fix Location	Assignee
FI_EMPTY	FI	12.4 EditList.java	Varma
CO_SELF	CO	11.2 StringComparer.java	Un-assigned
DMI_EMPTY	DM	3.3 DatabaseHelper.java	Elina

toolLong

Name (Bug title)	Type	Fix Location	Assignee
FI_EMPTY	FI	12.4 EditList.java	Varma
EQ_CHECK	EQ	6.3 LoopHelper.java	Max
XSS_REQUEST	XSS	5.4 HttpSender.java	John

Filters

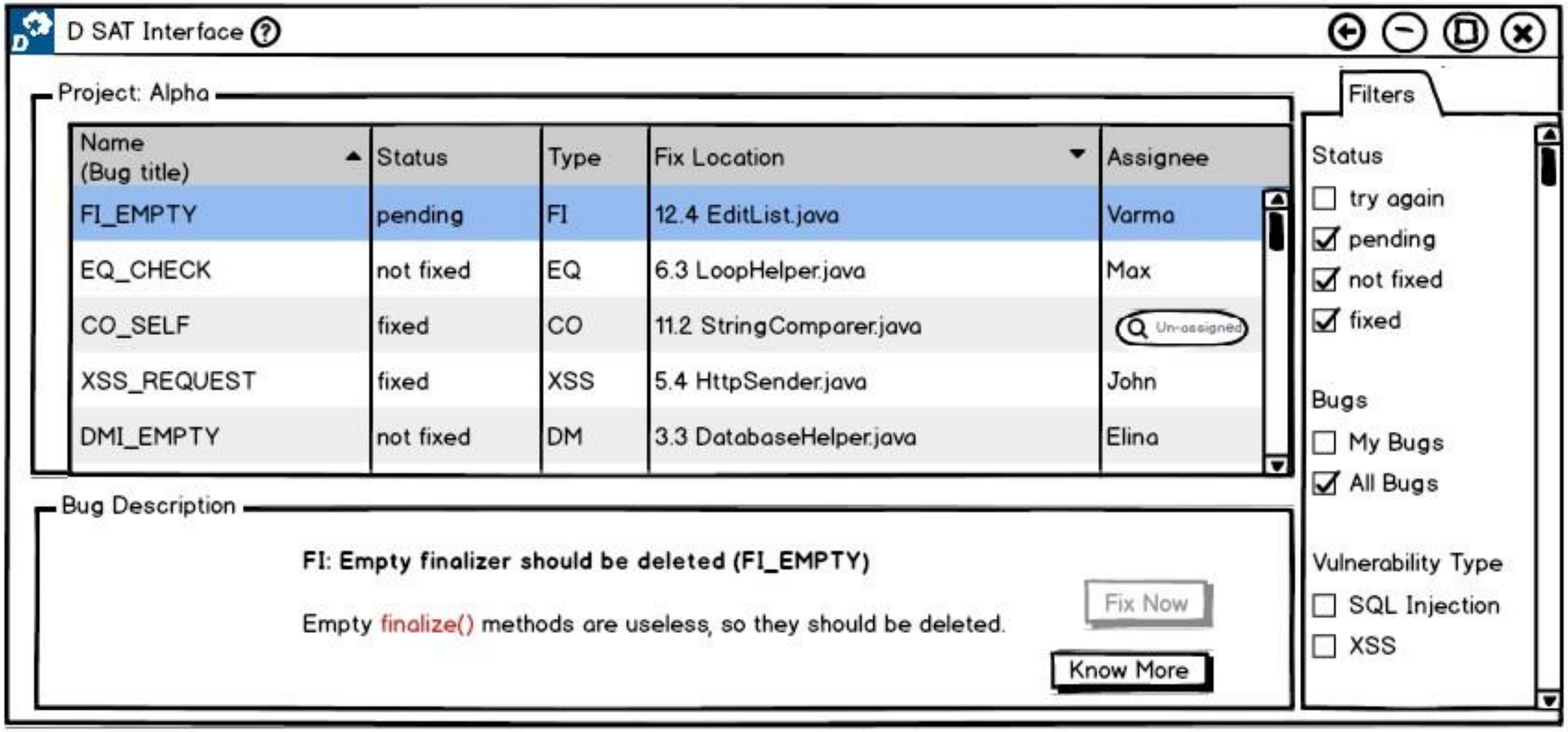
□ My Bugs
☑ All Bugs

Marker Type
□ Source
☑ Sink
⊟ Fix Locations

Vulnerability Type
□ SQL Injection
☑ XSS

Example: RQ 2

- Prototype 1



Project: Alpha

Name (Bug title)	Status	Type	Fix Location	Assignee
FI_EMPTY	pending	FI	12.4 EditList.java	Varma
EQ_CHECK	not fixed	EQ	6.3 LoopHelper.java	Max
CO_SELF	fixed	CO	11.2 StringComparer.java	Un-assigned
XSS_REQUEST	fixed	XSS	5.4 HttpSender.java	John
DMI_EMPTY	not fixed	DM	3.3 DatabaseHelper.java	Elina

Bug Description

FI: Empty finalizer should be deleted (FI_EMPTY)

Empty finalize() methods are useless, so they should be deleted.

Filters

Status

☐ try again
☑ pending
☑ not fixed
☑ fixed

Bugs

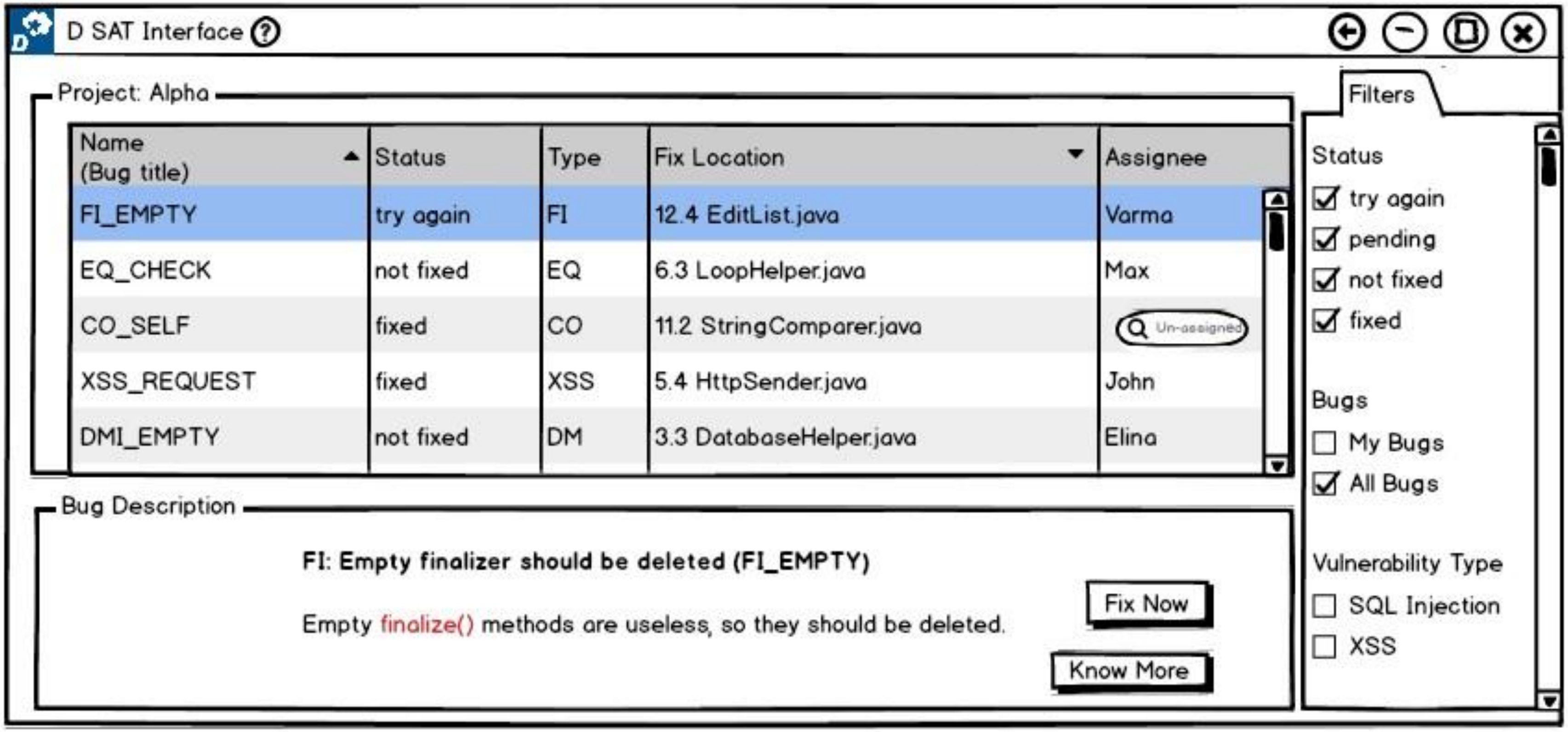
☐ My Bugs
☑ All Bugs

Vulnerability Type

☐ SQL Injection
☐ XSS

Example: RQ 2

- Prototype 2



Project: Alpha

Name (Bug title)	Status	Type	Fix Location	Assignee
FI_EMPTY	try again	FI	12.4 EditList.java	Varma
EQ_CHECK	not fixed	EQ	6.3 LoopHelper.java	Max
CO_SELF	fixed	CO	11.2 StringComparer.java	Un-assigned
XSS_REQUEST	fixed	XSS	5.4 HttpSender.java	John
DMI_EMPTY	not fixed	DM	3.3 DatabaseHelper.java	Elina

Bug Description

FI: Empty finalizer should be deleted (FI_EMPTY)

Empty finalize() methods are useless, so they should be deleted.

Filters

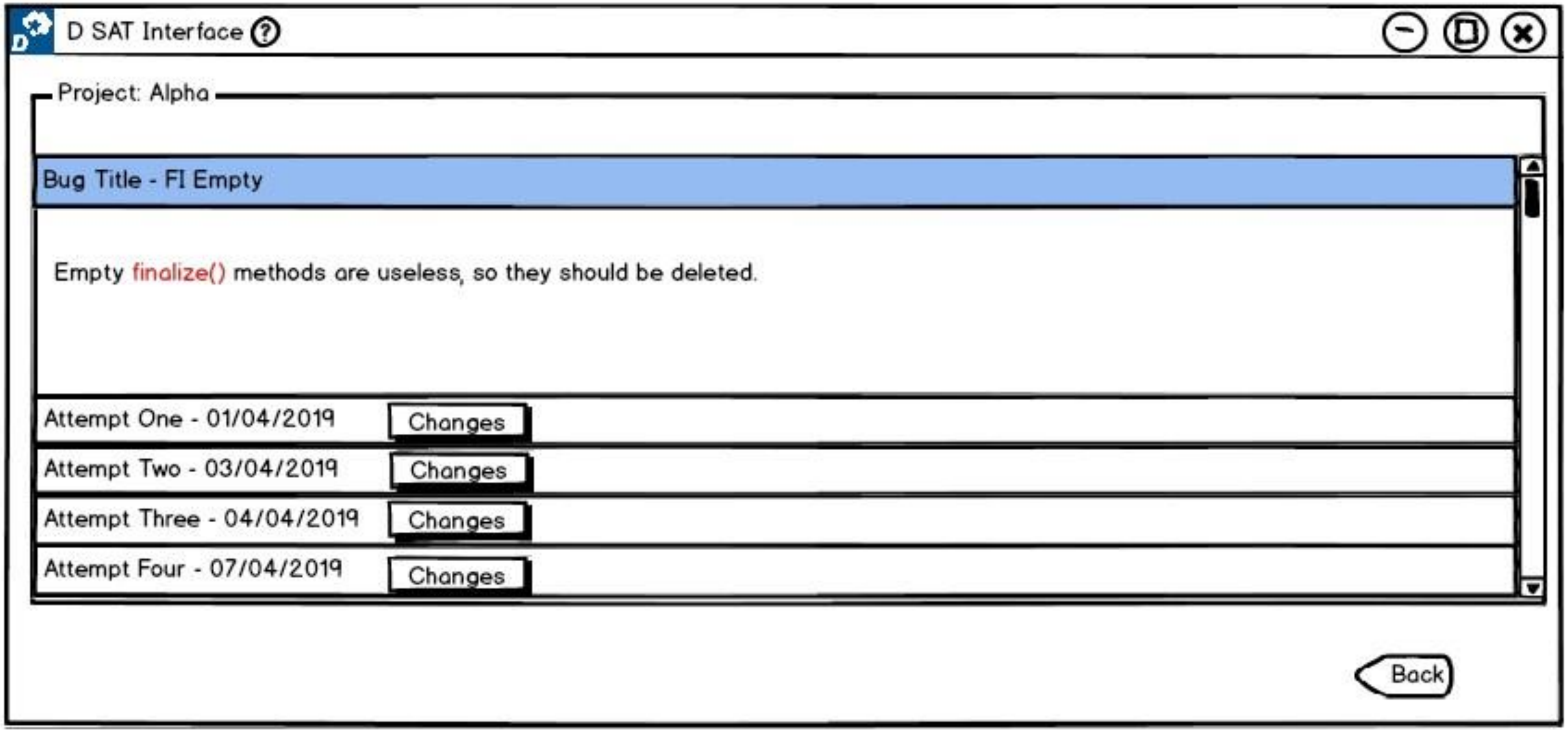
Status
- ☑ try again
- ☑ pending
- ☑ not fixed
- ☑ fixed

Bugs
- □ My Bugs
- ☑ All Bugs

Vulnerability Type
- □ SQL Injection
- □ XSS

Example: RQ 3

- Prototype 1



D SAT Interface

Project: Alpha

Bug Title - FI Empty

Empty finalize() methods are useless, so they should be deleted.

Attempt One - 01/04/2019 Changes

Attempt Two - 03/04/2019 Changes

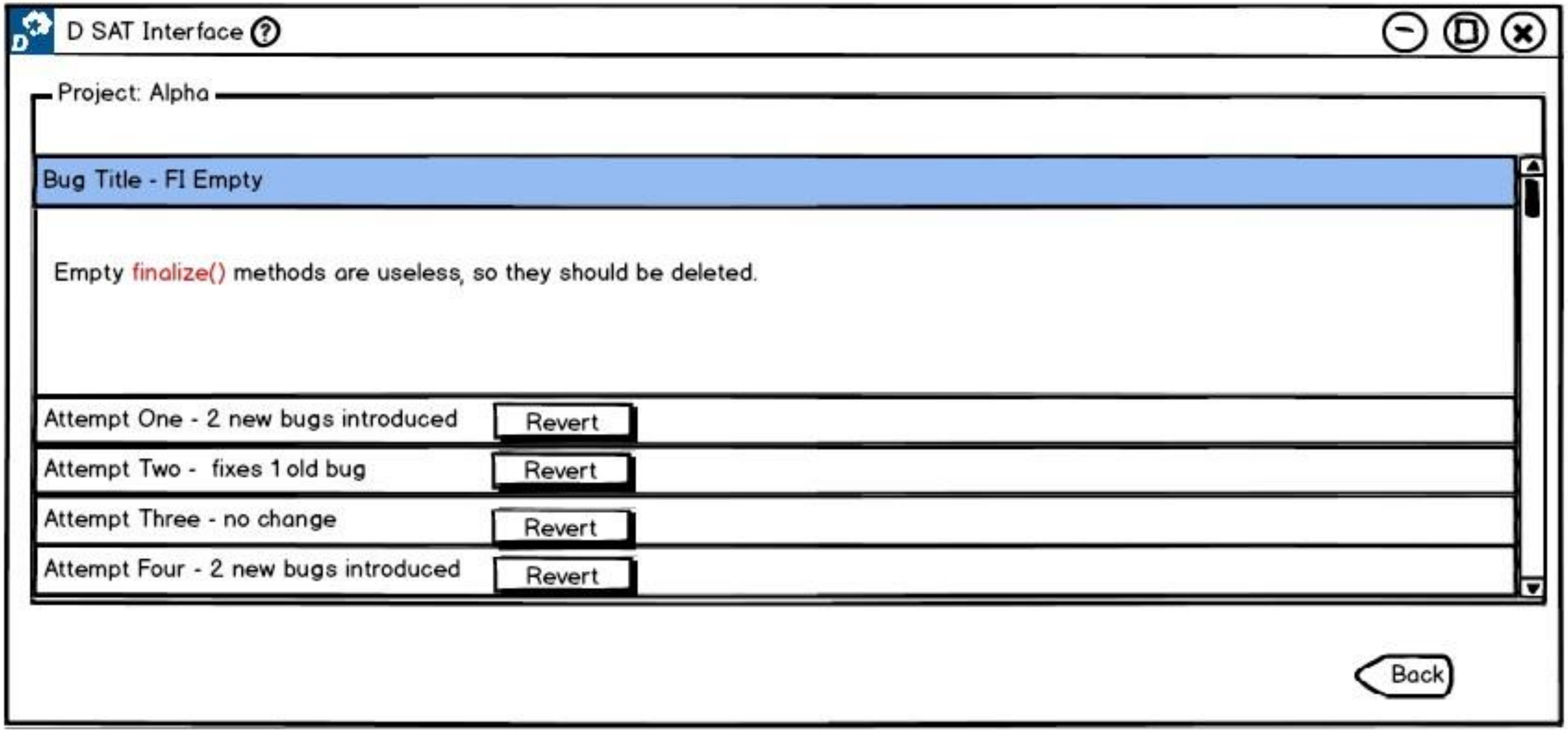
Attempt Three - 04/04/2019 Changes

Attempt Four - 07/04/2019 Changes

Back

Example: RQ 3

- Prototype 2



Project: Alpha

Bug Title - FI Empty

Empty finalize() methods are useless, so they should be deleted.

Attempt One - 2 new bugs introduced

Attempt Two - fixes 1 old bug

Attempt Three - no change

Attempt Four - 2 new bugs introduced

Thesis Work Plan

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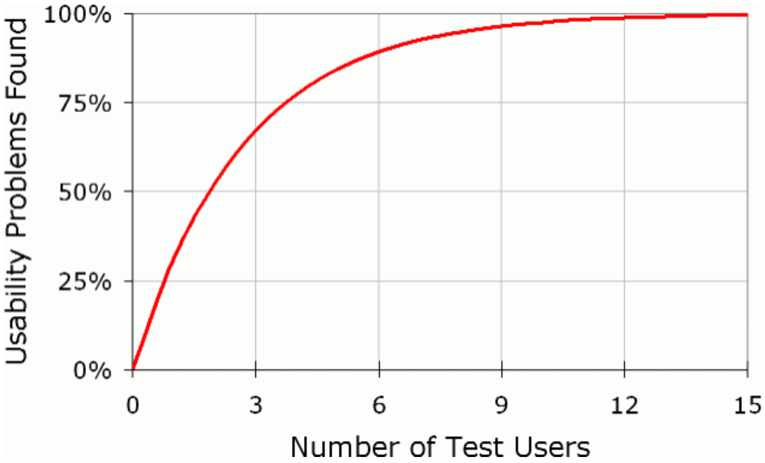
Evaluation

- Experimental Design

- Number of Test Users:

  Dr. Nielsen recommends - **5**



- Order of evaluation:

  Users tend to learn – order of presenting prototyes is altered

Evaluation – Usability Inspection Methods

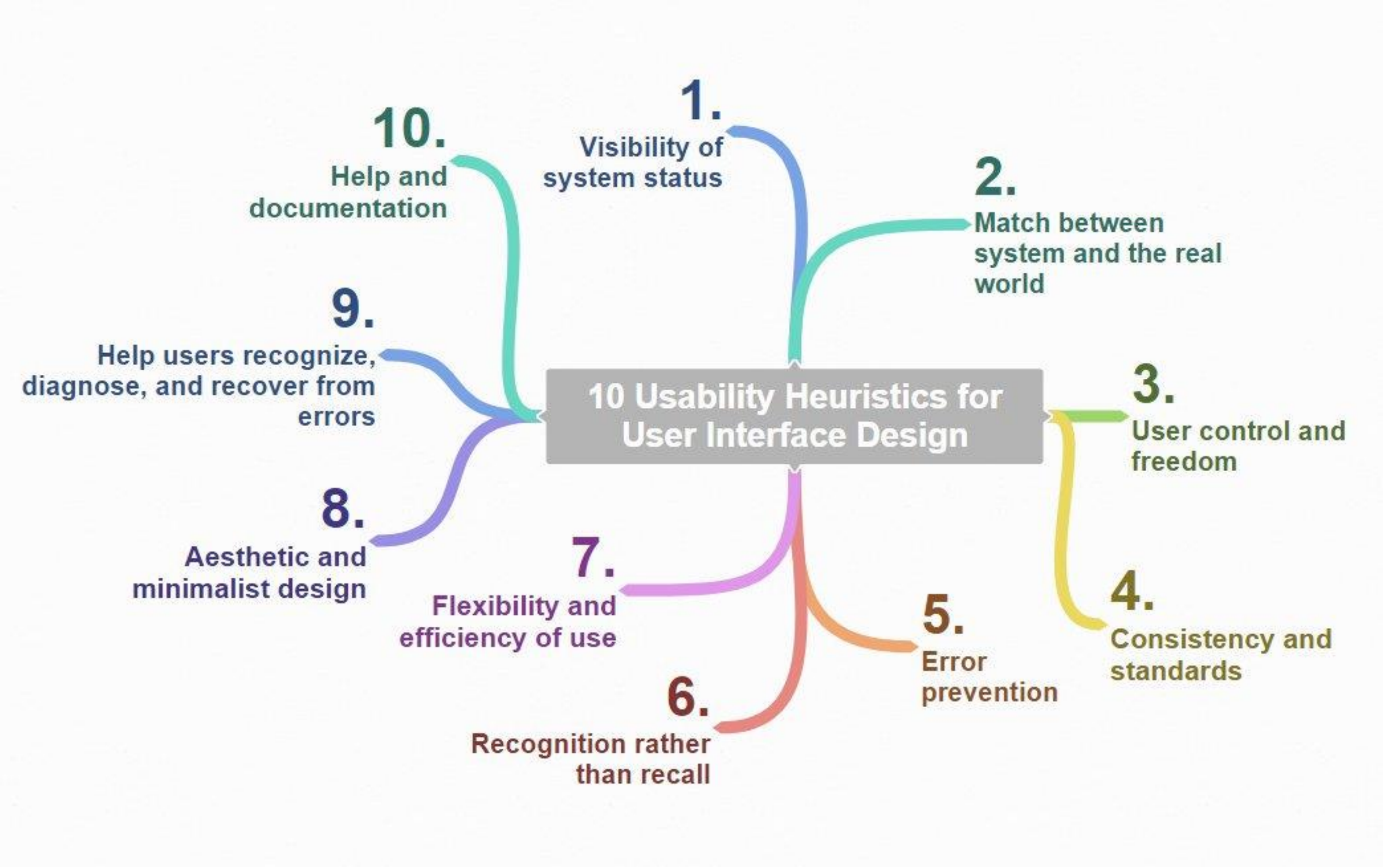
- Cognitive Walkthrough

For each step to a predefined task, the following aspects are analysed.

- Will the user try and achieve the right outcome?
- Will the user notice that the correct action is available to them?
- Will the user associate the correct action with the outcome they expect to achieve?
- If the correct action is performed; will the user see that progress is being made towards their intended outcome?

Evaluation – Usability Inspection Methods

- Heuristic Evaluation



10 Usability Heuristics for User Interface Design
1. Visibility of system status
2. Match between system and the real world
3. User control and freedom
4. Consistency and standards
5. Error prevention
6. Recognition rather than recall
7. Flexibility and efficiency of use
8. Aesthetic and minimalist design
9. Help users recognize, diagnose, and recover from errors
10. Help and documentation

Evaluation – Usability Inspection Methods

- Heuristic Evaluation

Each problem w.r.t. a heuristic is rated accordingly; 0 – 4

0 - do not agree this is a usability problem

1 - cosmetic problem

2 - minor usability problem

3 - major usability problem (important to fix)

4 - usability catastrophe (imperative to fix)

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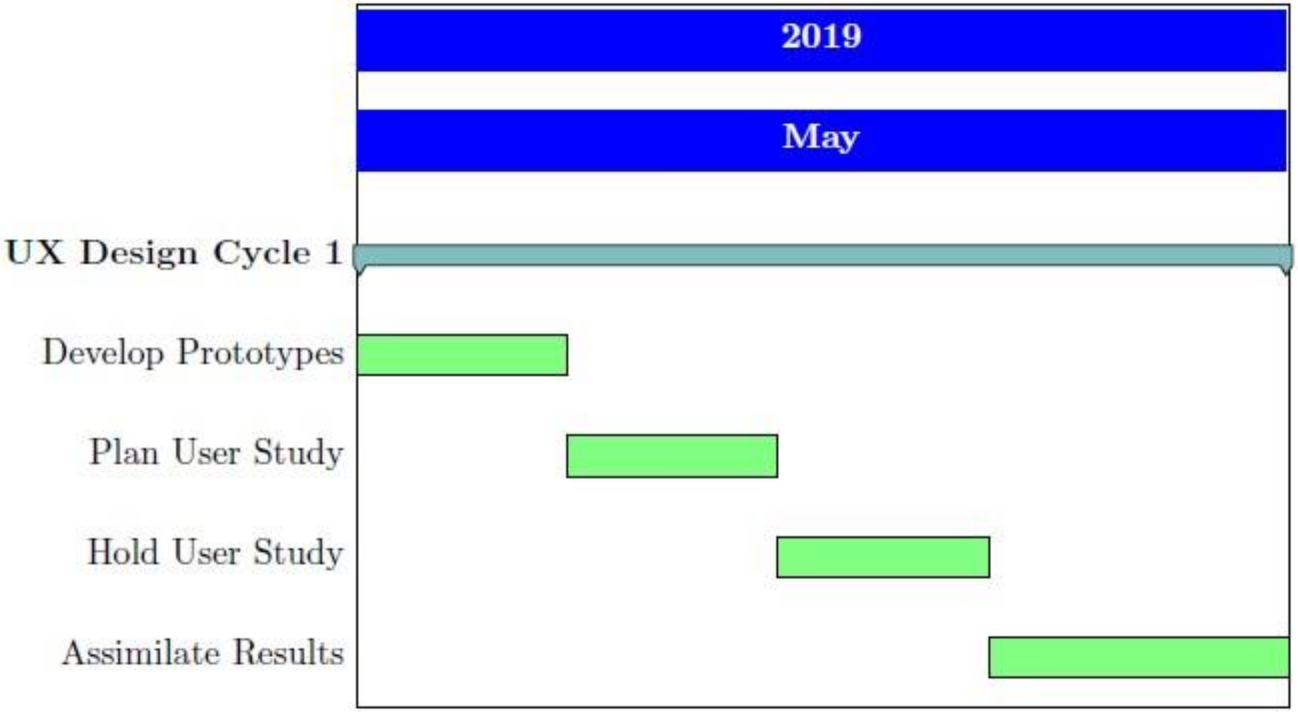
Time Plan

- Official Time Frame : 5 Months [May – September]

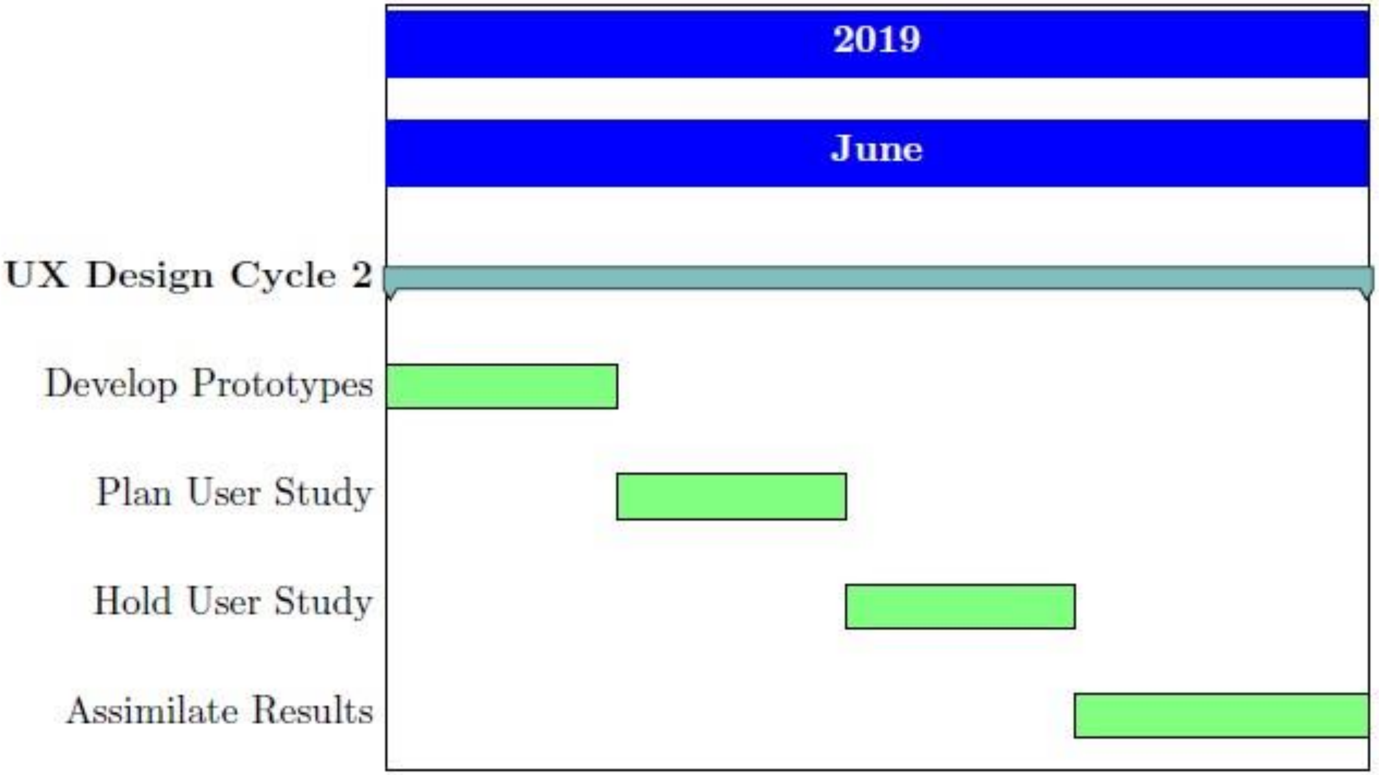
- 4 Milestones, Each Month with weekly tasks

1. UX Design Cycle Iteration 1
2. UX Design Cycle Iteration 2
3. UX Design Cycle Iteration 3
4. Thesis Documentation

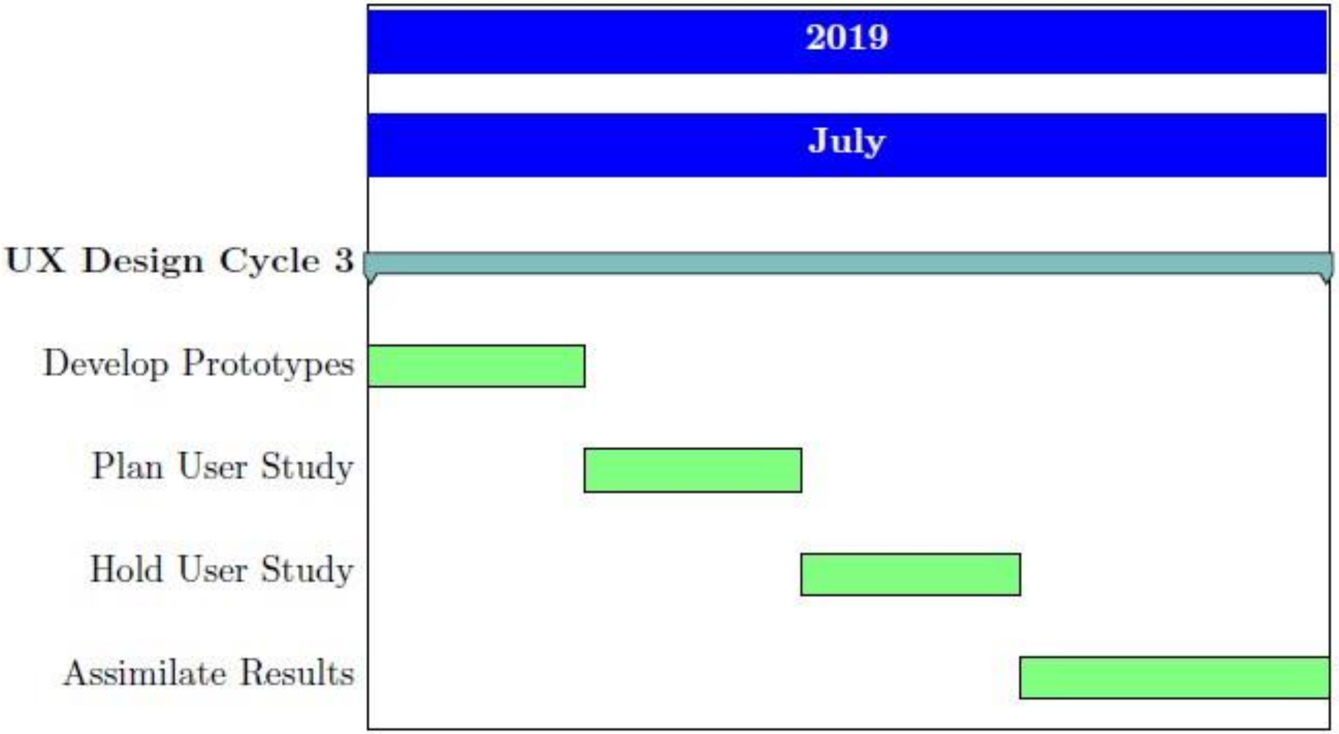
Milestone 1


2019
May
UX Design Cycle 1
Develop Prototypes
Plan User Study
Hold User Study
Assimilate Results

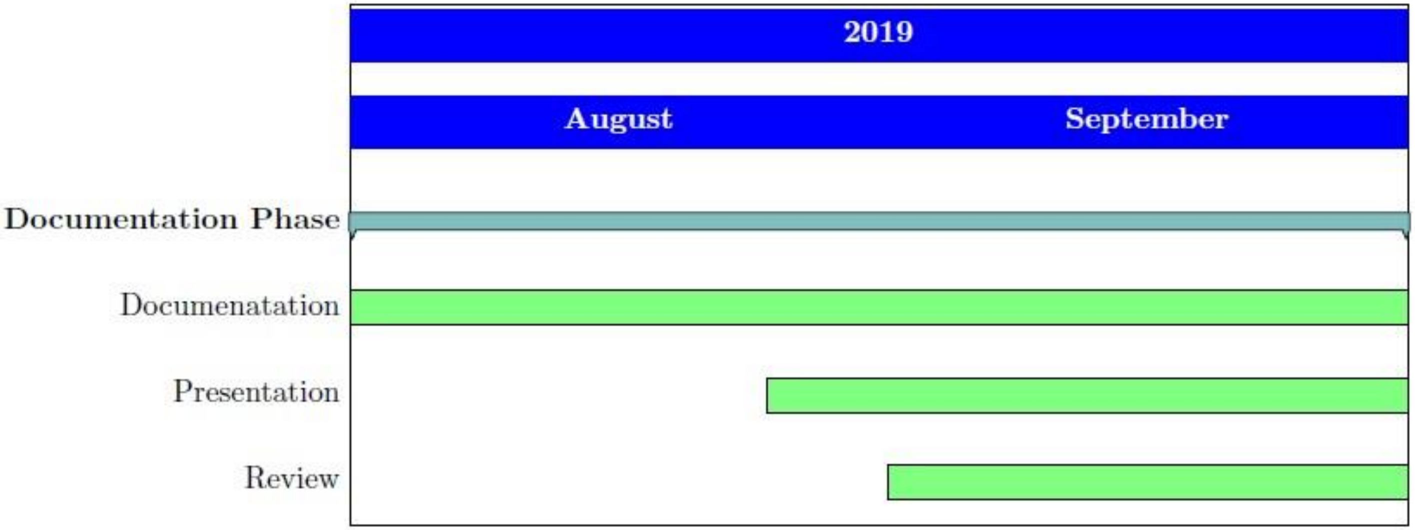
Milestone 2


2019
June
UX Design Cycle 2
Develop Prototypes
Plan User Study
Hold User Study
Assimilate Results

Milestone 3


2019
July
UX Design Cycle 3
Develop Prototypes
Plan User Study
Hold User Study
Assimilate Results

Milestone 4


2019
August
September
Documentation Phase
Documenatation
Presentation
Review

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