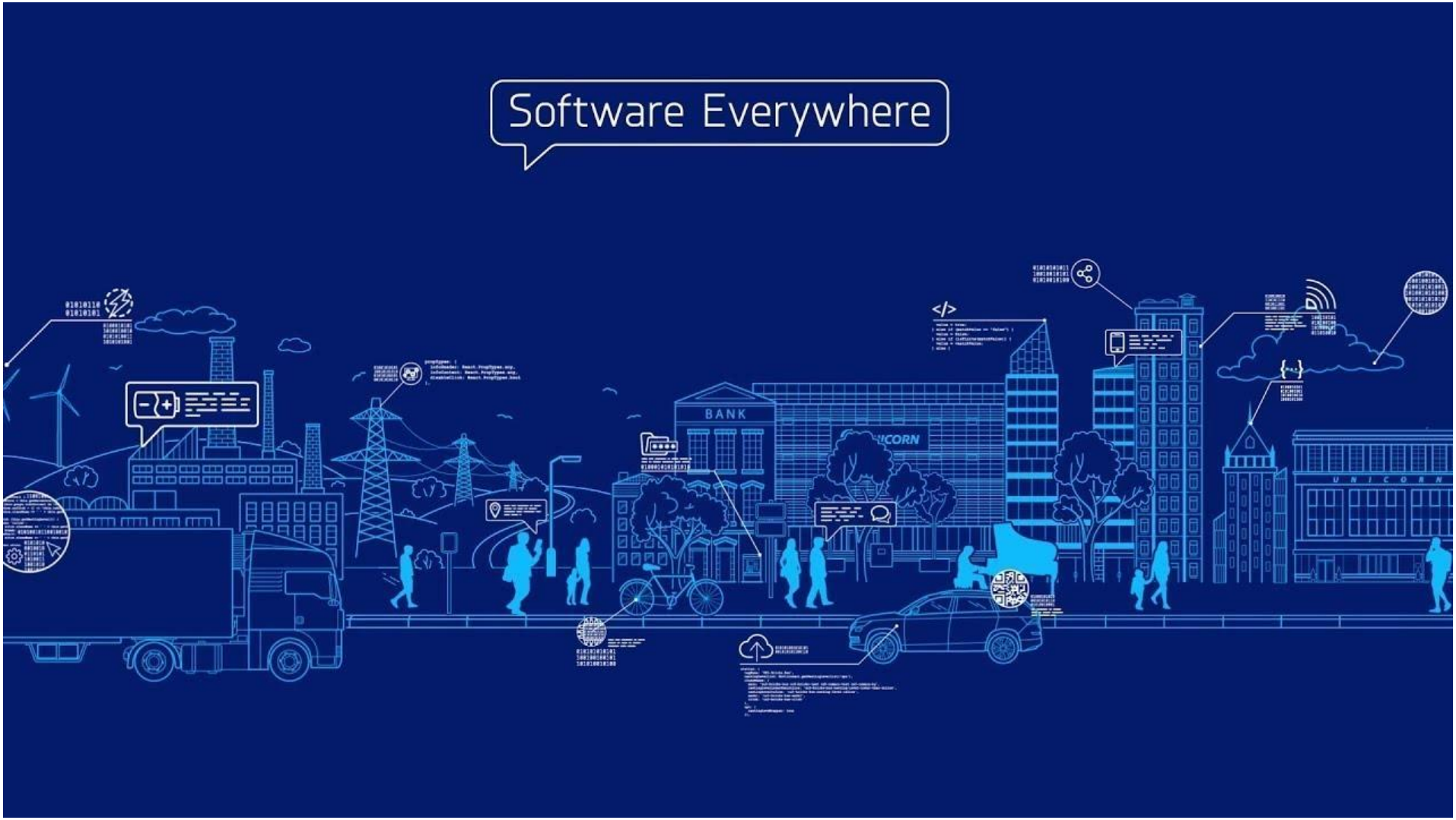
HEINZ NIXDORF INSTITUT
UNIVERSITÄT PADERBORN

Integration of Multiple Static Analysis Tools in a Single Interface

- G. S. Varma

- Supervisors:
- Prof. Dr. Eric Bodden
- Dr.-Ing. Ben Hermann



- https://unicorn.com/en/software-everywhere

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

  - Software Fail Watch Annual Report, Tricentis

❖ https://www.tricentis.com/news/software-fail-watch-says-1-1-trillion-in-assets-affected-by-software-bugs-in-2016/

Static Code Analysis

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

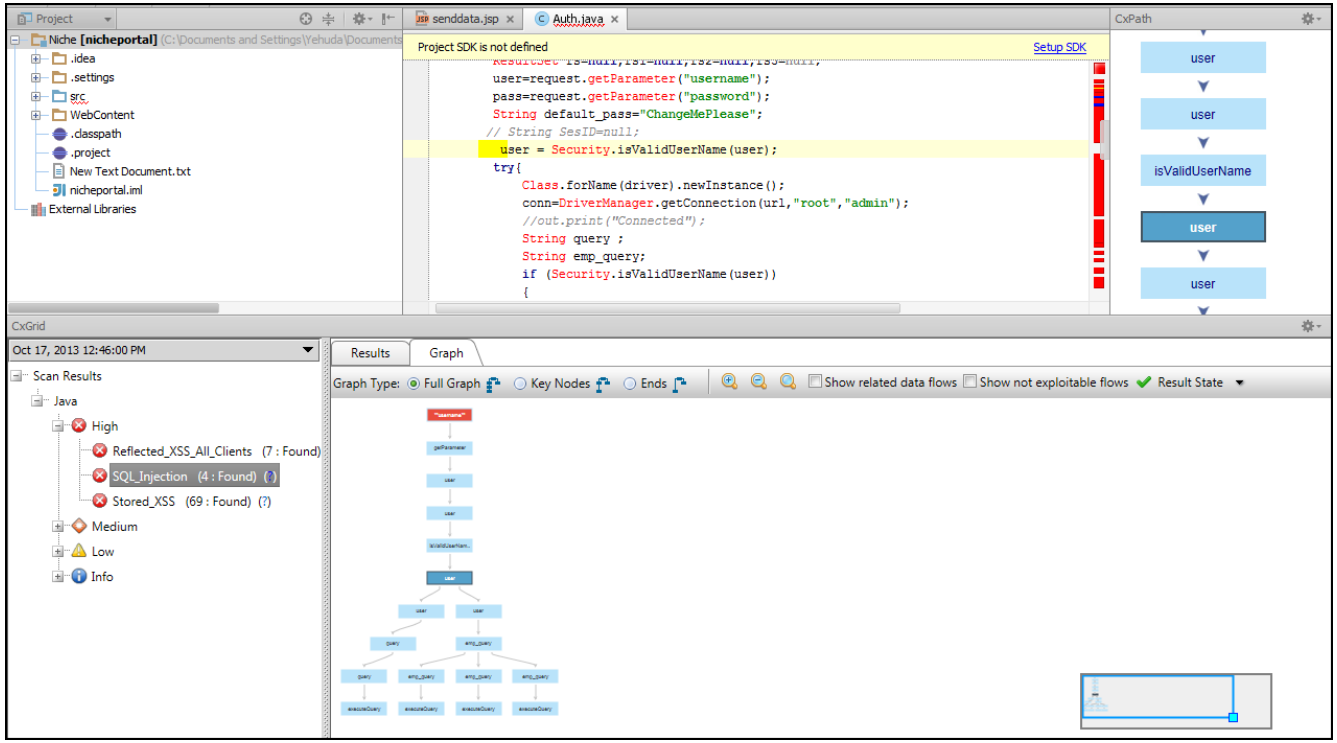
- Detects vulnerabilities :

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

❖ Designing code analyses for Large Software Systems (DECA). url: https://www.hni.uni-paderborn.de/swt/lehre/deca/.

Static Code Analysis

- Tools :
  - IDE notifications
  - IDE tools
  - Dedicated tools
  - Linters
  - CLI tools



- Checkmarx – Application Security Testing and Static Code Analysis. url: https://www.checkmarx.com/
- CxViewer - Plugins | JetBrains, url: https://plugins.jetbrains.com/plugin/7593-cxviewer
- FindBugs™ - Find Bugs in Java Programs. url: http://findbugs.sourceforge.net/.

Static Code Analysis

- Johnson et. al.
  - Tool output
  - Result understandability

Usability Issues

- Christakis et. al.

- Brittany Johnson, Yoonki Song, Emerson Murphy-Hill, and Robert Bowdidge. 2013. Why don't software developers use static analysis tools to find bugs?. In *Proceedings of the 2013 International Conference on Software Engineering* (ICSE '13). IEEE Press, Piscataway, NJ, USA, 672-681.
- Maria Christakis and Christian Bird. 2016. What developers want and need from program analysis: an empirical study. In *Proceedings of the 31st IEEE/ACM International Conference on Automated Software Engineering* (ASE 2016). ACM, New York, NY, USA, 332-343. DOI: https://doi.org/10.1145/2970276.2970347

Multiple Tools

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

- Research trends:

  - Prioritise the bug warning alerts

    (Flynn et. al.)

  - Merges 3 tools for Java to show warnings

    (Meng et. al.)

- Lori Flynn, William Snavely, David Svoboda, Nathan VanHoudnos, Richard Qin, Jennifer Burns, David Zubrow, Robert Stoddard, and Guillermo Marce-Santurio. 2018. Prioritizing alerts from multiple static analysis tools, using classification models. In *Proceedings of the 1st International Workshop on Software Qualities and Their Dependencies* (SQUADE '18). ACM, New York, NY, USA, 13-20. DOI: https://doi.org/10.1145/3194095.3194100

- N. Meng, Q. Wang, Q. Wu and H. Mei, "An Approach to Merge Results of Multiple Static Analysis Tools (Short Paper)," *2008 The Eighth International Conference on Quality Software*, Oxford, 2008, pp. 169-174.doi: 10.1109/QSIC.2008.30

Multiple Tools

- Tricorder
  - ReviewBot
  - Separate bug coverage by separate tool
  - Evaluation: Summative – Click rates

(Sadowski et. al.)

- Parfait
  - Scalability (easy , expensive analysis)
  - Precision (bug track – real, no, potential)

(Cifuentes et. al.)

But USABILITY is not addressed…

- Caitlin Sadowski, Jeffrey van Gogh, Ciera Jaspan, Emma Söderberg, and Collin Winter. 2015. Tricorder: building a program analysis ecosystem. In *Proceedings of the 37th International Conference on Software Engineering - Volume 1* (ICSE '15), Vol. 1. IEEE Press, Piscataway, NJ, USA, 598-608.
- Cristina Cifuentes and Bernhard Scholz. 2008. Parfait: designing a scalable bug checker. In *Proceedings of the 2008 workshop on Static analysis* (SAW '08). ACM, New York, NY, USA, 4-11. DOI=http://dx.doi.org/10.1145/1394504.1394505

Problem Statement

- How to integrate the results of multiple static analysis tools

  in a unified user interface?

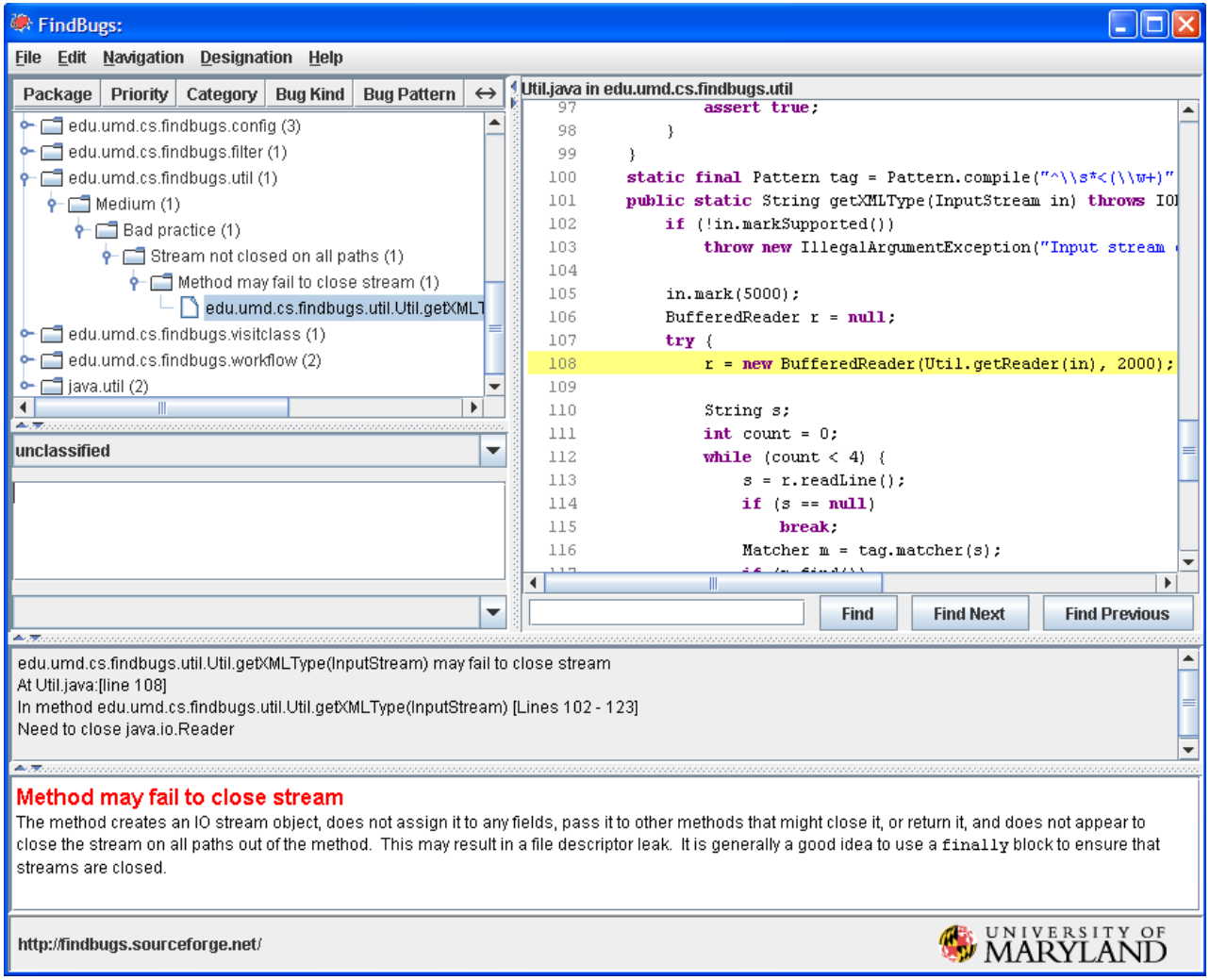
  - 3 Research Questions

Research Question 1

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

What Current Tools do? - RQ 1: .. display results!

- FindBugs



What Current Tools do? - RQ 1: .. display results!

- Tricorder

```
package com.google.devtools.staticanalysis;

public class Test {
```

Lint
Java
1:02 AM, Aug 21
Missing a Javadoc comment.
Please fix
Not useful

```
  public boolean foo() {
    return getString() == "foo".toString();
```

ErrorProne
StringEquality
1:03 AM, Aug 21
String comparison using reference equality instead of value equality
(see http://code.google.com/p/error-prone/wiki/StringEquality)
Please fix
Suggested fix attached: show
Not useful

```
  }

  public String getString() {
    return new String("foo");
  }
}
```

Research Question 2

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

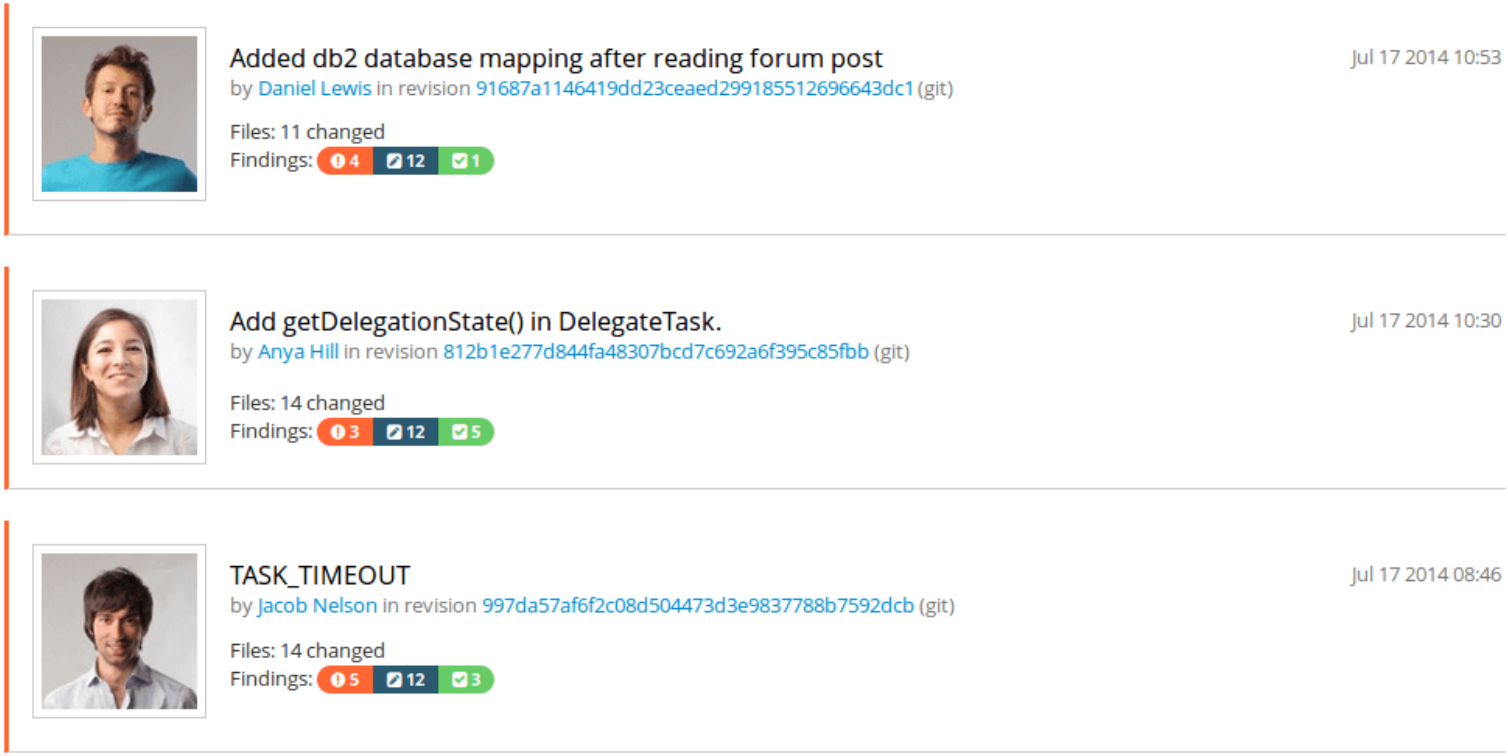
- What current tools do?
  - Traditional approach – Nightly Builds

Research Question 3

- How to carry traceability of bug fixing?

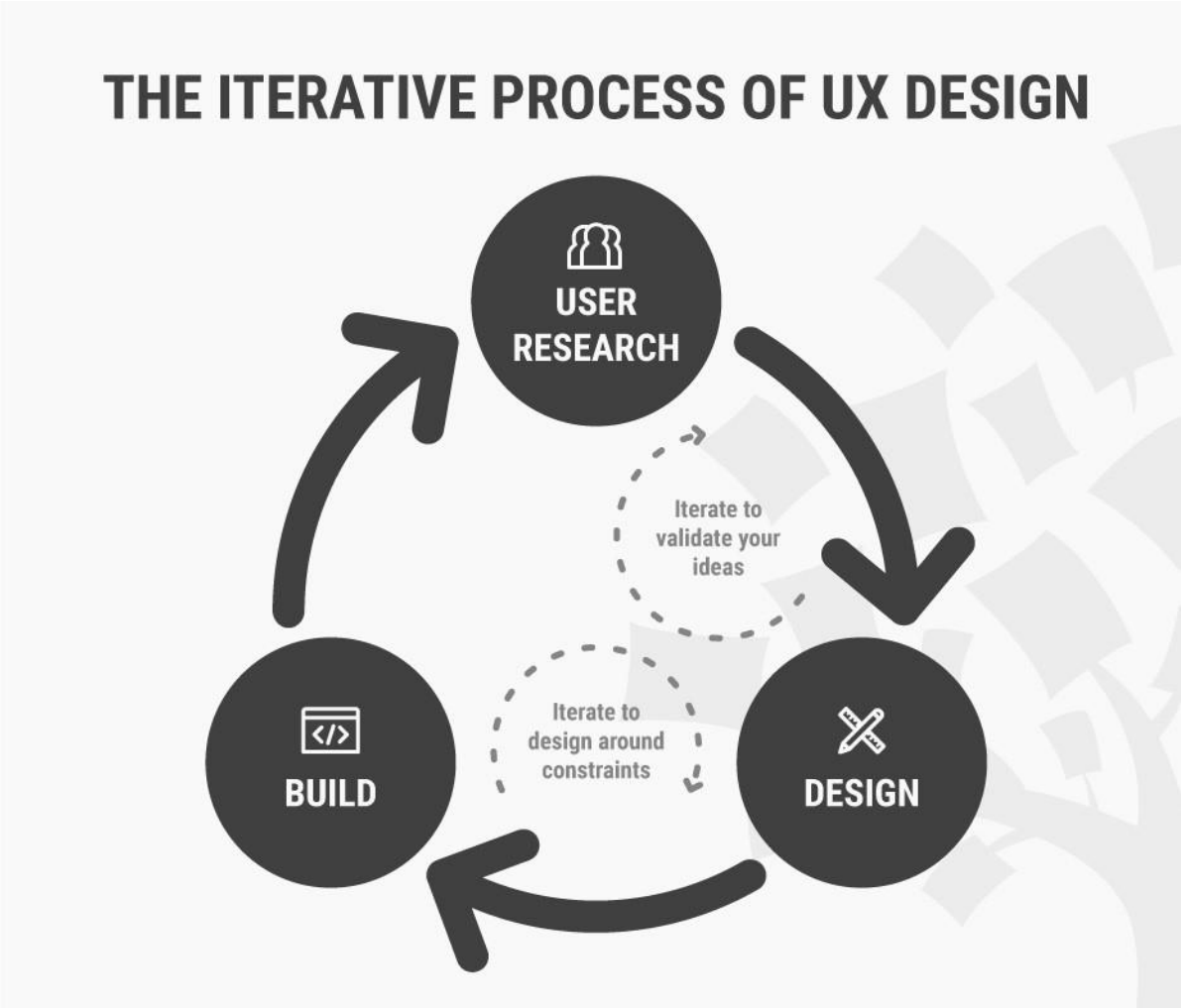
What Current Tools do? - RQ 3: .. traceability!

- Teamscale



- Teamscale. url: https://www.cqse.eu/en/products/teamscale/features/.

Our Approaches



- How to Change Your Career from Graphic Design to UX Design. url: https://www.interaction-design.org/literature/article/how-to-change-your-career-fromgraphic-design-to-ux-design.

Our Approaches

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

Our Approaches – research existing scenarios!

- Complex datasets:
  - Dix et. al. - complex grouping and linking of datasets for Spreadsheets application

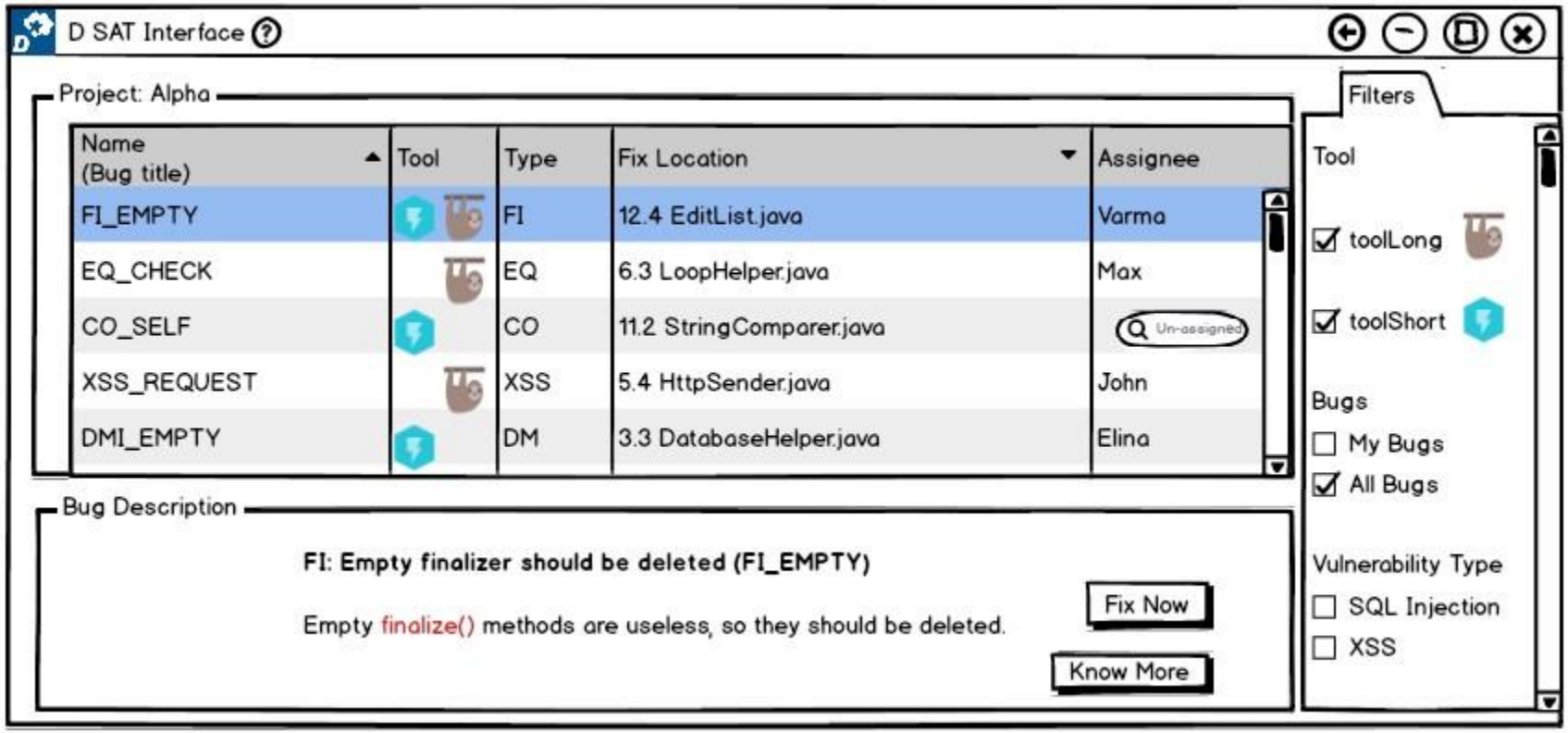
    Design lesson : extensibility of columns

- Issue tracker
  - Baysal et. al. :
    - Information overload
    - Expressiveness

- Alan Dix, Rachel Cowgill, Christina Bashford, Simon McVeigh, and Rupert Ridgewell. 2016. Spreadsheets as User Interfaces. In *Proceedings of the International Working Conference on Advanced Visual Interfaces* (AVI '16), Paolo Buono, Rosa Lanzilotti, and Maristella Matera (Eds.). ACM, New York, NY, USA, 192-195. DOI: https://doi.org/10.1145/2909132.2909271
- Olga Baysal, Reid Holmes, and Michael W. Godfrey. 2014. No issue left behind: reducing information overload in issue tracking. In *Proceedings of the 22nd ACM SIGSOFT International Symposium on Foundations of Software Engineering* (FSE 2014). ACM, New York, NY, USA, 666-677. DOI: https://doi.org/10.1145/2635868.2635887

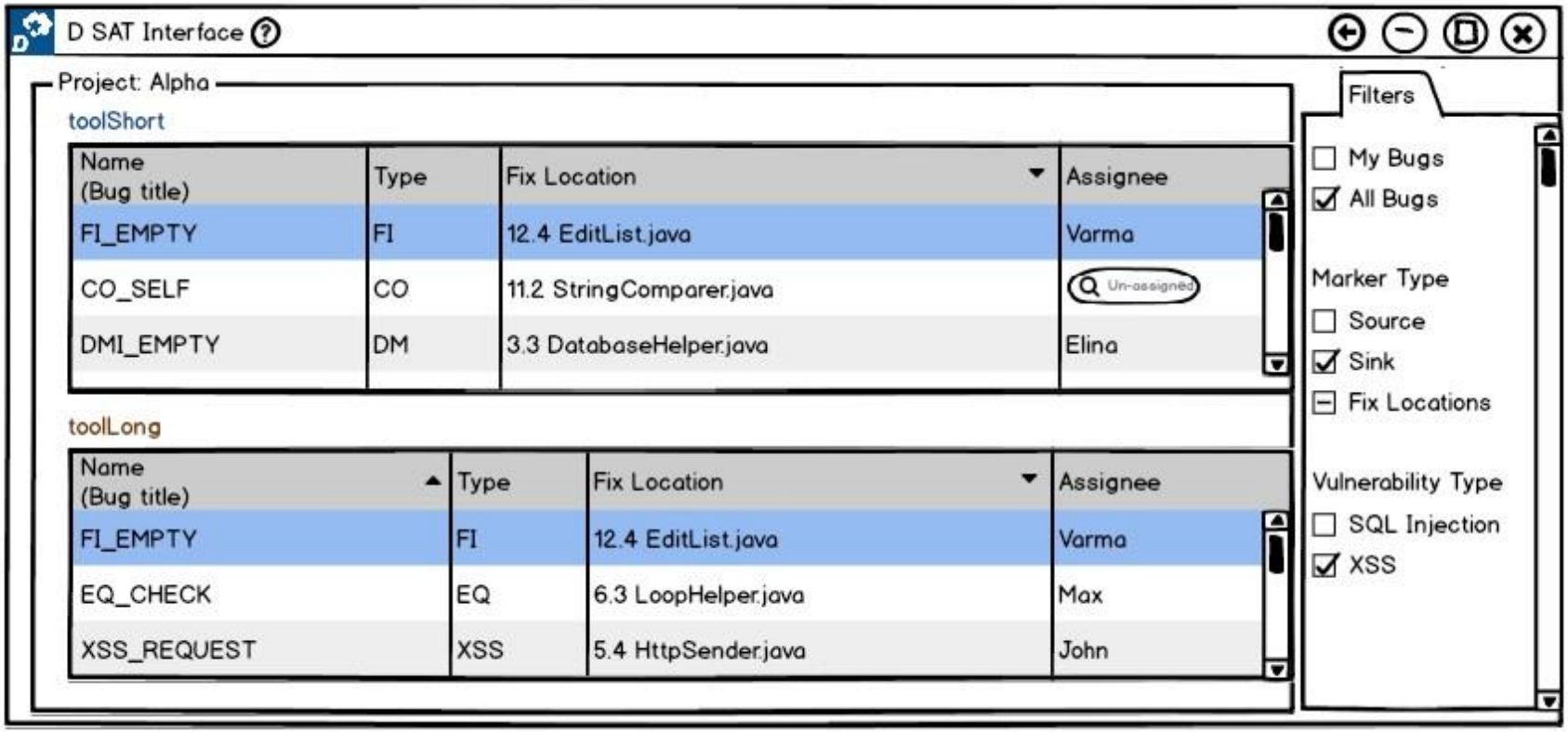
Example: RQ 1 - .. display results!

- Prototype 1



Example: RQ 1 - .. display results!

- Prototype 2



Evaluation

- Experimental Design
  - Recruit Test Users
  - Order of evaluation altered
  - Usability inspection methods: Cognitive Walkthrough, Heuristic Evaluation
  - Perform Tasks
    - Example: Find a bug which is reported in common by available tools.

Evaluation – Usability Inspection Methods

- Cognitive Walkthrough

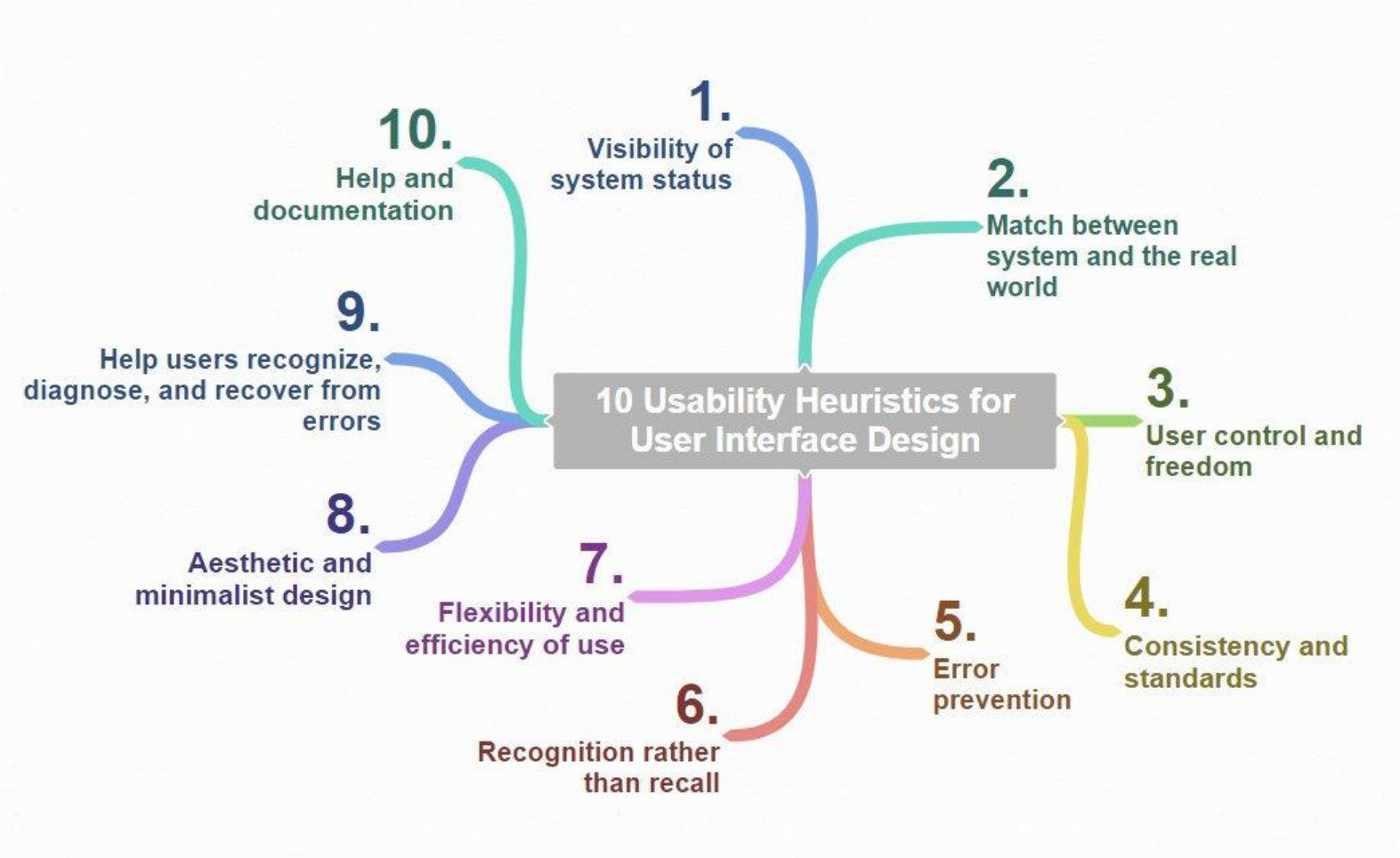
For each step to a predefined task, the following aspects are analysed.

- 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?

❖ Jakob Nielsen. “Usability inspection methods”. In: Conference companion on Human factors in computing systems. ACM. 1994, pp. 413–414.

Evaluation – Usability Inspection Methods

- Heuristic Evaluation



- 10 Heuristics for User Interface Design: Article by Jakob Nielsen. Available online at https://www.nngroup.com/articles/ten-usability-heuristics/, checked on 5/1/2019. Image credits: Miran Janezic

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

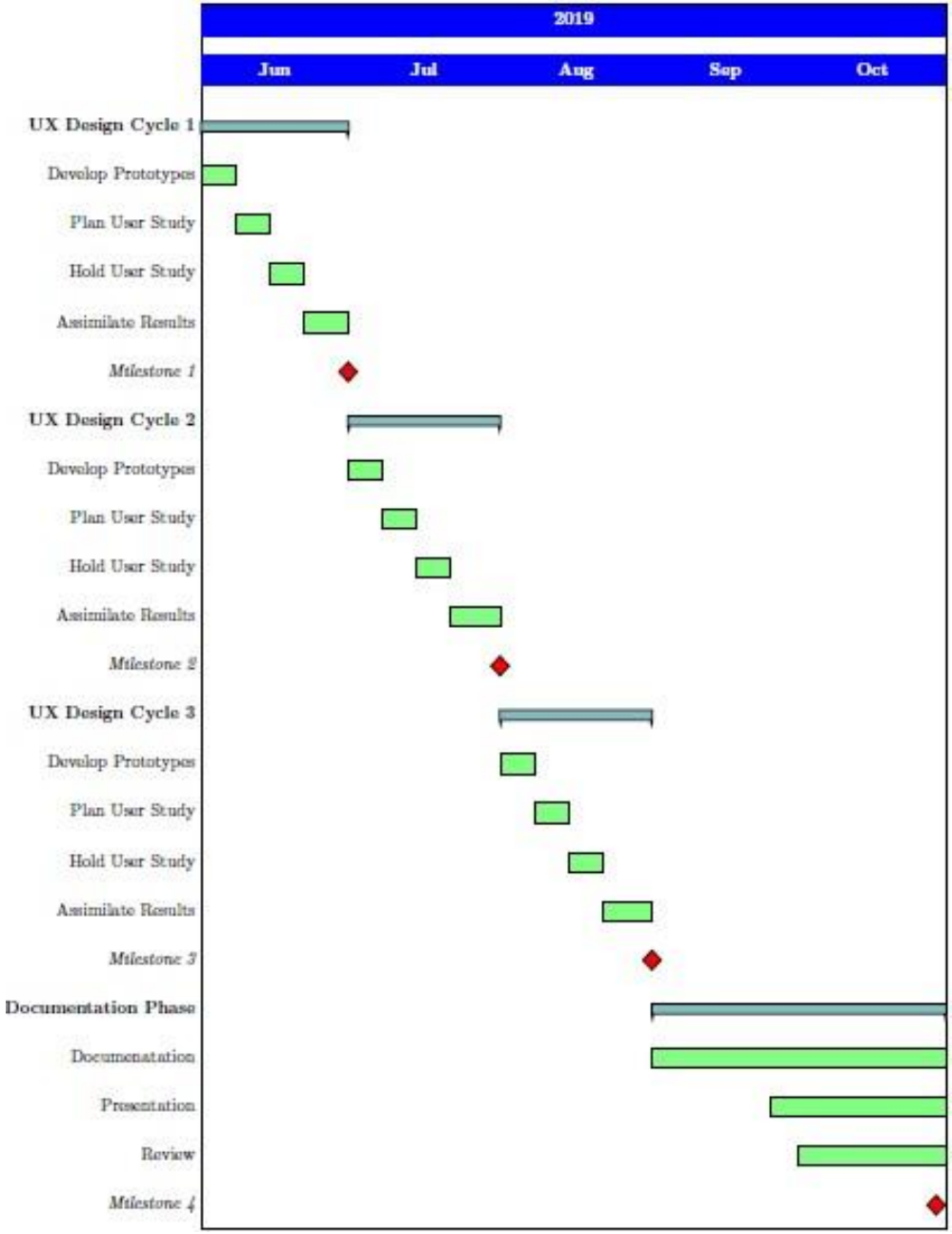
3 - major usability problem (important to fix)

4 - usability catastrophe (imperative to fix)

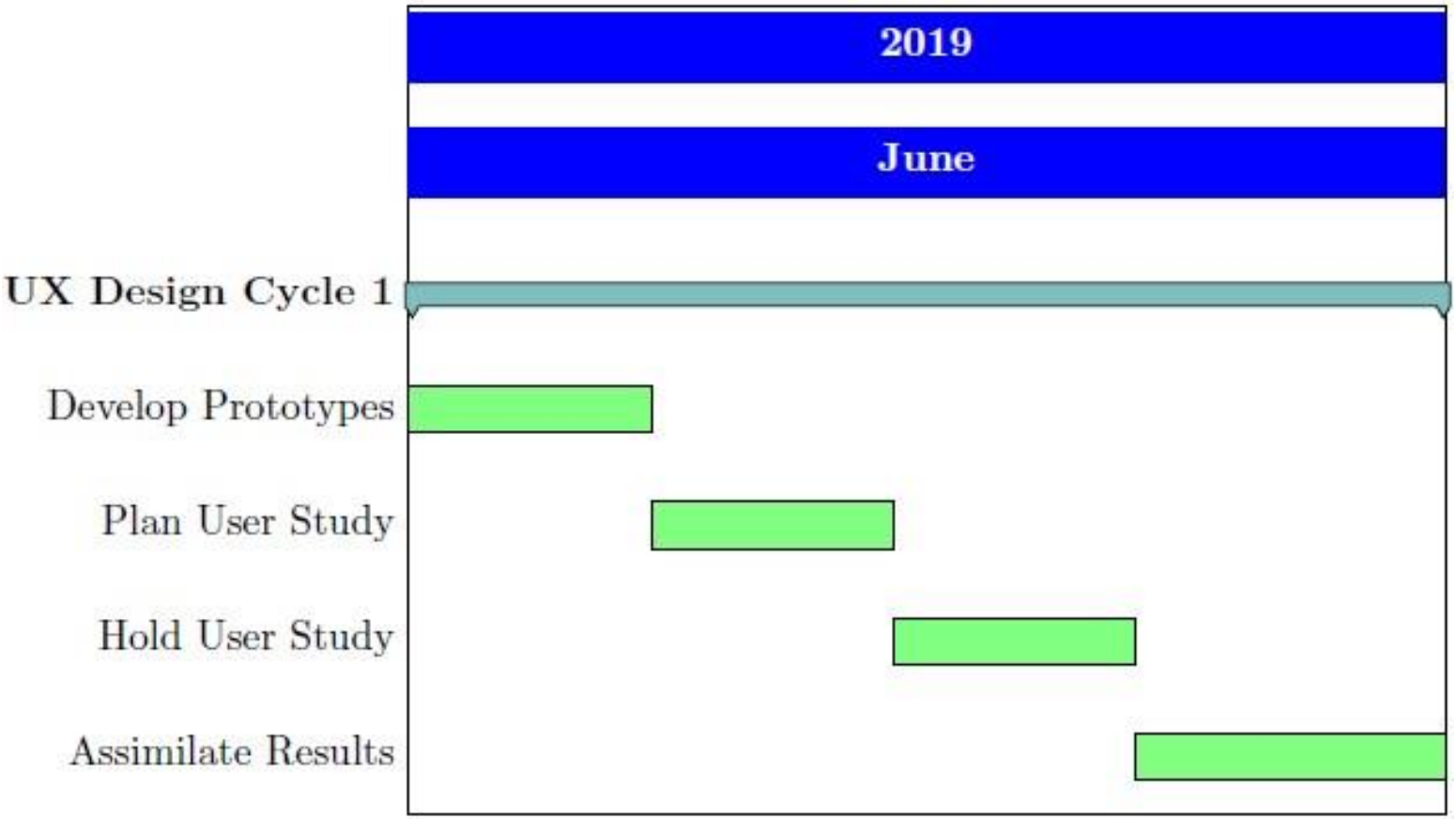
Comparative Study

Time Plan

- Official Time: 5 Months
- Milestones: 4

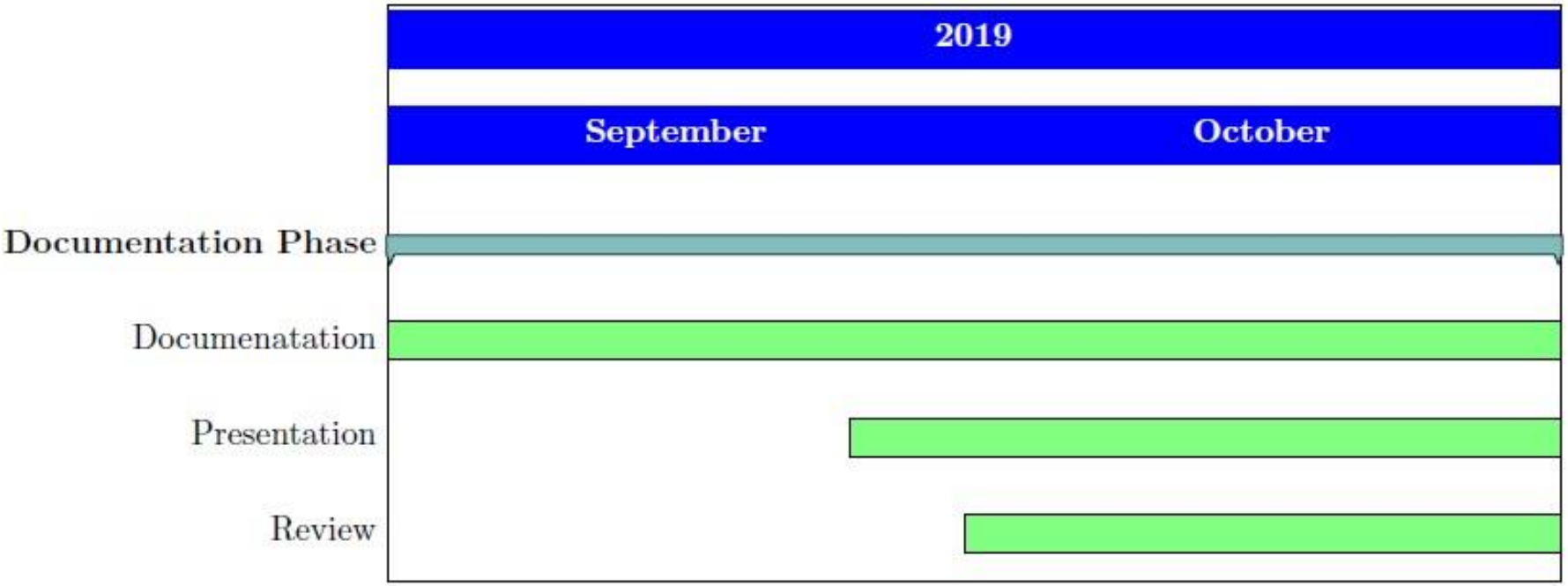


Milestones 1 2 3



Similarly in July and August...

Milestone 4


2019
September
October
Documentation Phase
Documenatation
Presentation
Review

Summary

- Importance of Static Analysis tools
- Usage of Multiple Static Analysis tools

- Need for a single user interface for multiple tools

- This Thesis work follows UX Design Cycle to achieve usable prototypes focussing on research questions such as,

  - How to display results of the same codebase from different analysis tools?
  - What feedback works to know that the bug fixing is on-going?
  - How to carry traceability of bug fixing?