

# Measuring the Efficacy of Code Clone Information: An Empirical Study

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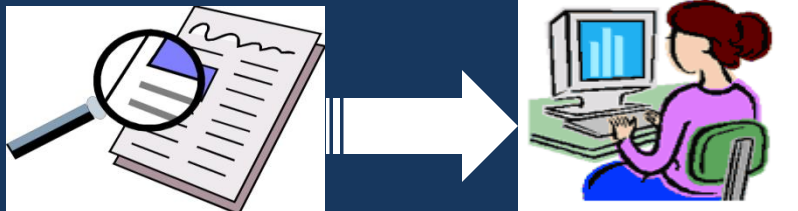
THE UNIVERSITY OF  
**ALABAMA**  
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# A quick word on code clones

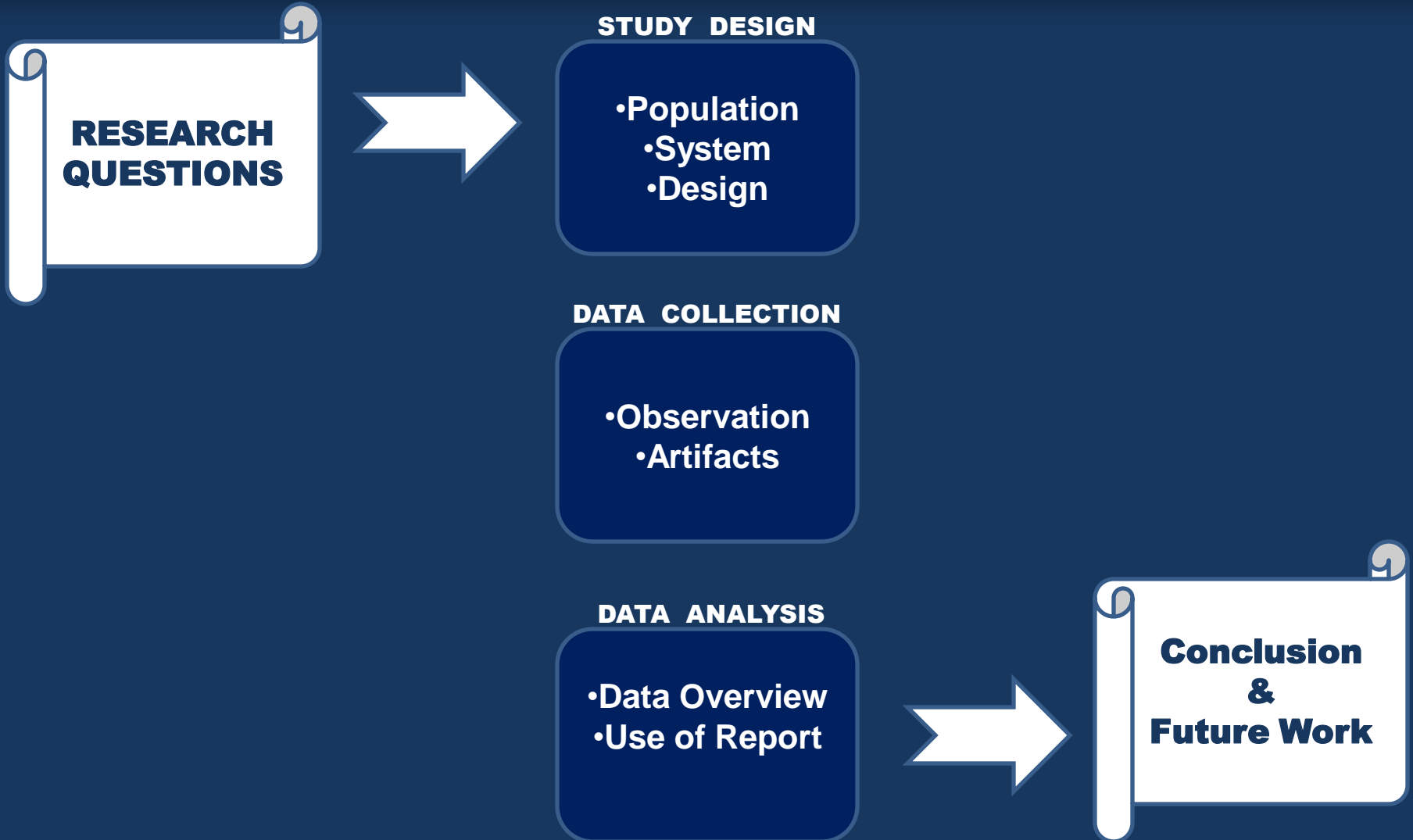
Clone Detection tools → Clone Report

What are Code Clones?

Why care about clones?



# Outline



# Research Questions

**Research Question 1:** How do developers use a clone information report in bug localization task?

**Research Question 1.1:** Will developers use the clone information report?

**Research Question 1.2:** Does the clone information aid developers in successfully identifying where multiple changes must be made?

**Research Question 1.3:** Does the clone information lead developers to identify false-positives?

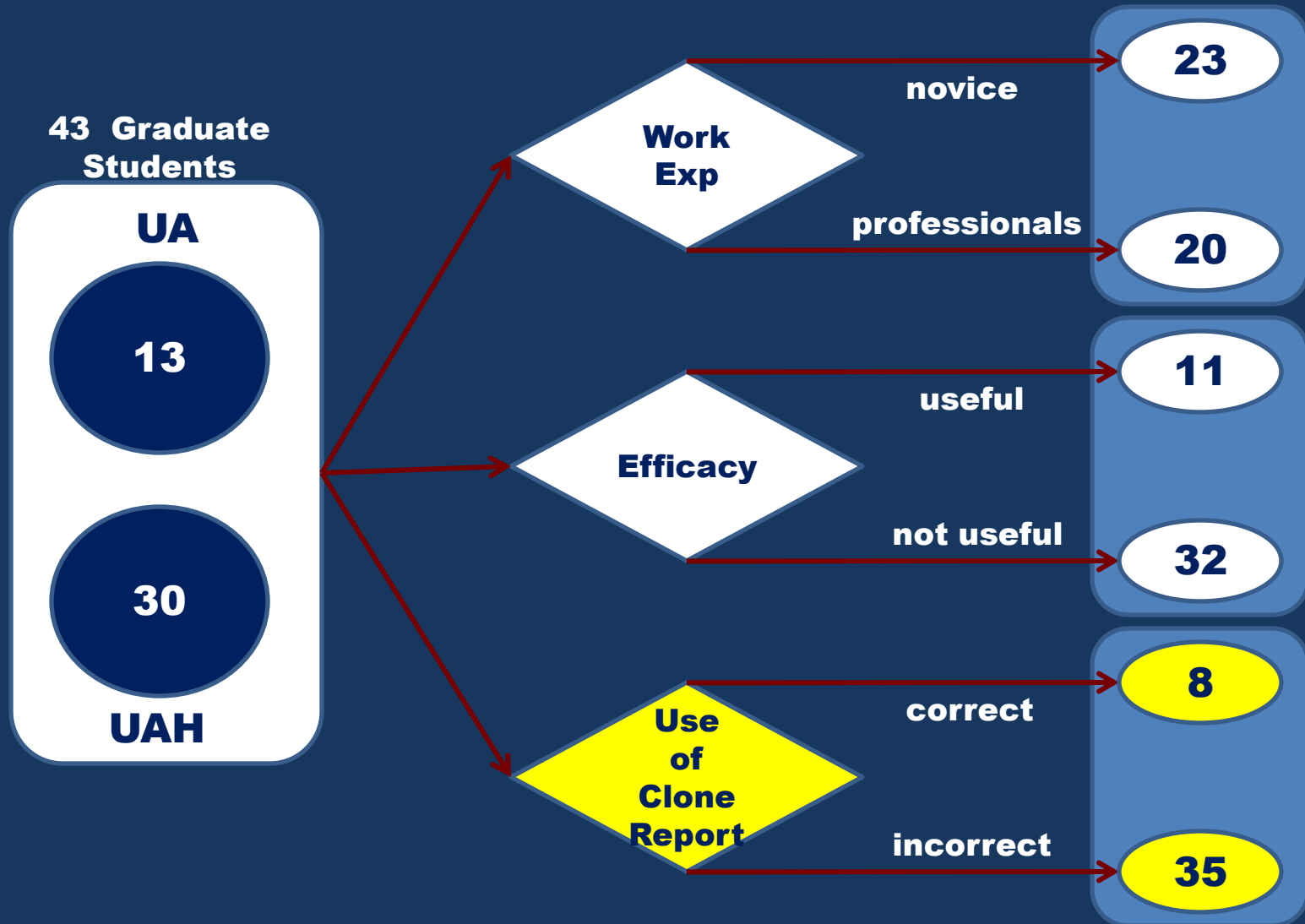
**Research Question 2:** Do novice and professional developers use the clone information differently? If so, how?

# Participants

Study Design

Data Collection

Data Analysis



# The Task, The Code & The Report

Study Design

Data Collection

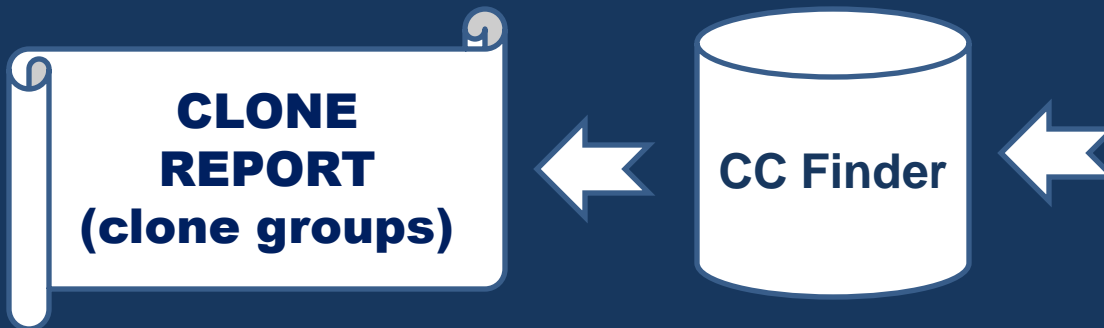
Data Analysis

## The Task Assigned:

- Bug localization
- System requirement
  - Large enough
  - Small enough
  - Cloned and non-cloned bug to control for the placebo effect.

### Apache Ant 1.6.5

- Small to middle size system
- Two seeded bugs
- Bugs available on Bugzilla repository
- One cloned with two instantiations
- One non-cloned



# The Empirical Study

Study Design

Data Collection

Data Analysis

## Observation Room: Arrangement of observation sessions



2 minutes  
observation slots  
for each  
Participant



2 minutes  
observation slots  
for each  
Participant



Observers swap position after 30 minutes

# Naturalistic Observation

Study Design

Data Collection

Data Analysis

- Passive observation of participants over their shoulders
- Fly on the wall profile
- Questions by participants

Session# _____	
Time: _____	Activity: <input type="checkbox"/> familiarizing <input type="checkbox"/> reporting    Resource: <input type="checkbox"/> clone info <input type="checkbox"/> code <input type="checkbox"/> documentation
Subject #: _____	Notes: _____ _____ _____



# Self Reported Data

Study Design

Data Collection

Data Analysis

## Defect Identification Sheet:

- Self reported data
- 2 entries for each bug with time stamp and steps used in locating
- Possibility of a false positive

**Defect Identification Sheet – Bug 1**

**Defect 1**  
*Time Located:* \_\_\_\_\_  
*Location: File* \_\_\_\_\_ *Method* \_\_\_\_\_ *Lines* \_\_\_\_\_  
*Description of Defect:* \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
*What steps did you use to locate the defect?* \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
*How would you fix this defect?* \_\_\_\_\_

## Post observation questionnaire:

- Work-ex, experience with clones, experience with CC Finder
- Mostly Likert scale data
- Clone efficacy reported by participants as realized by them after the task

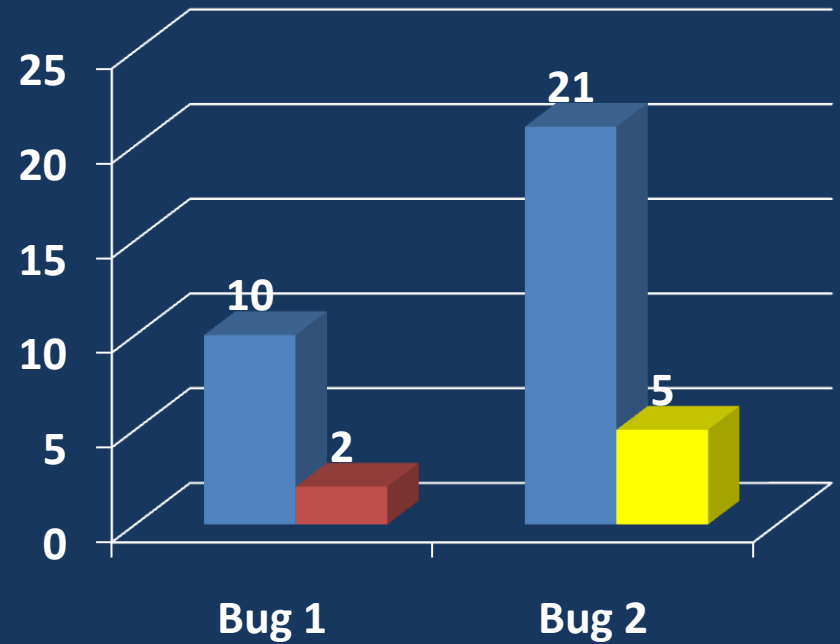
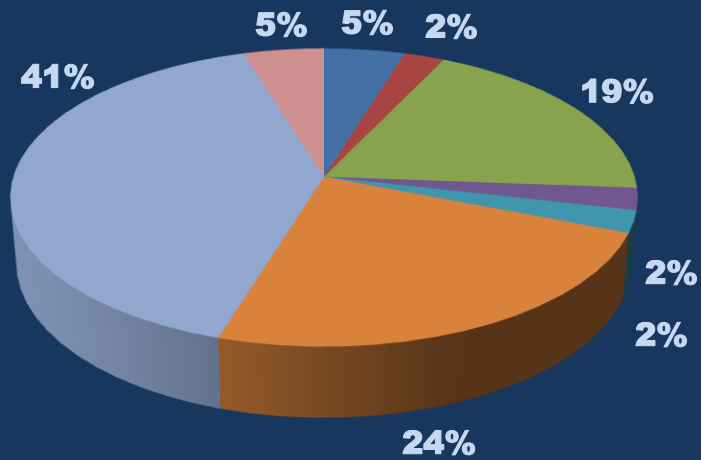
# Overview of Data

Study Design

Data Collection

Data Analysis

- All defects with no FP
- All defects with FP
- Both bugs without clone
- Both bugs with FP
- Bug2 & FP
- Bug2 only
- None
- None and FP



- Defect 1
- Clone
- False Positives

# Causality

Study Design

Data Collection

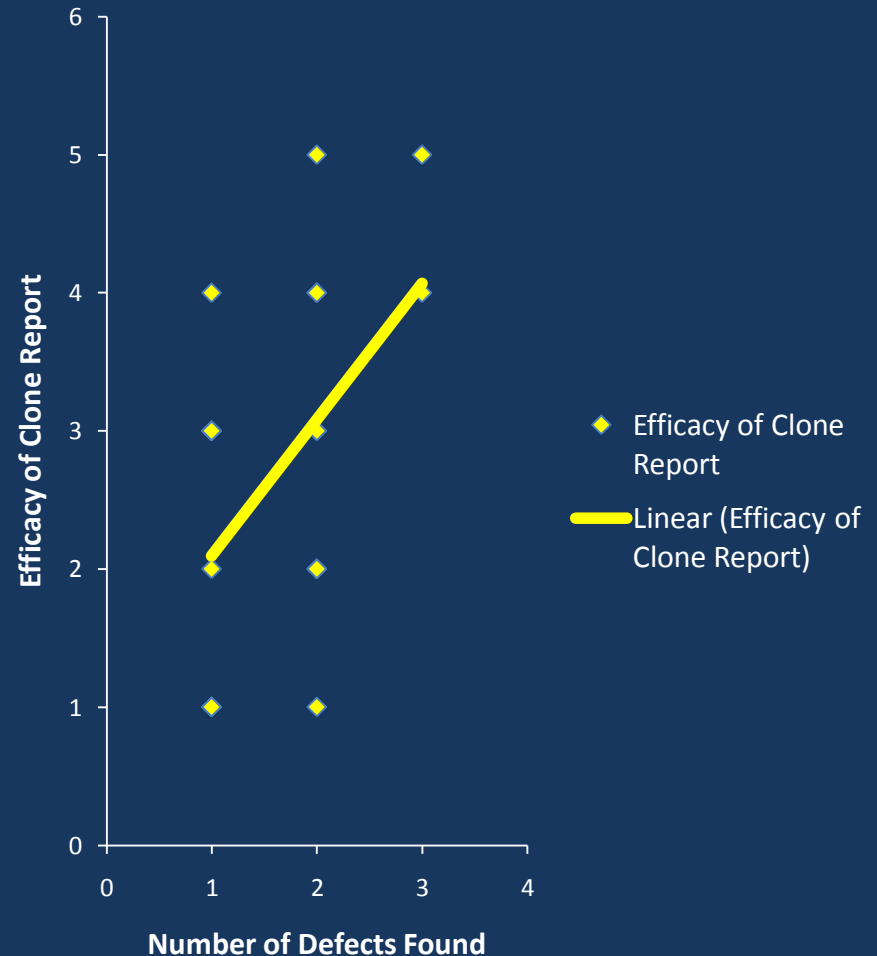
Data Analysis

More defects found → Clone report useful

No claim for causality between these two variables.

Correct Use of Clone report

Novice and Professional



# Correct vs Incorrect

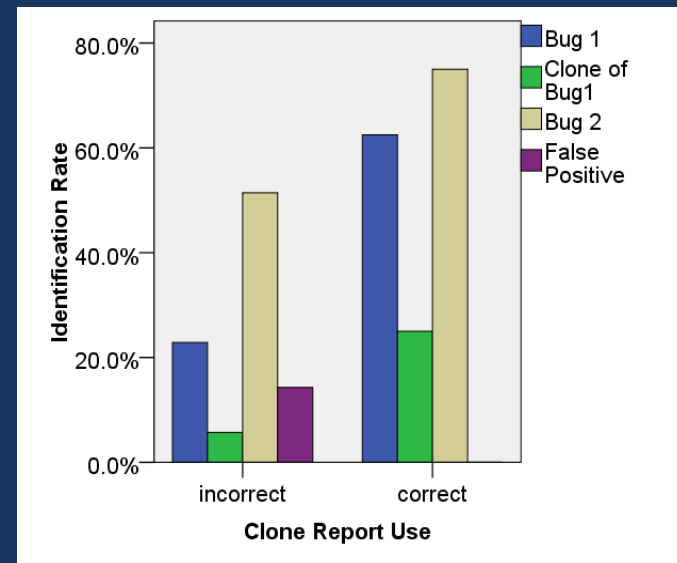
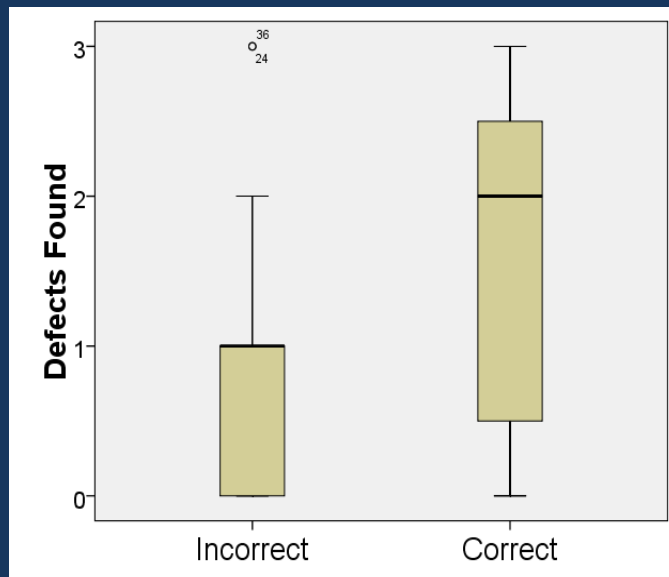
Study Design

Data Collection

Data Analysis

**Incorrect Use: Use of clone report prior to identifying a defect.**

The data showed that only 8 participants used the clone report correctly



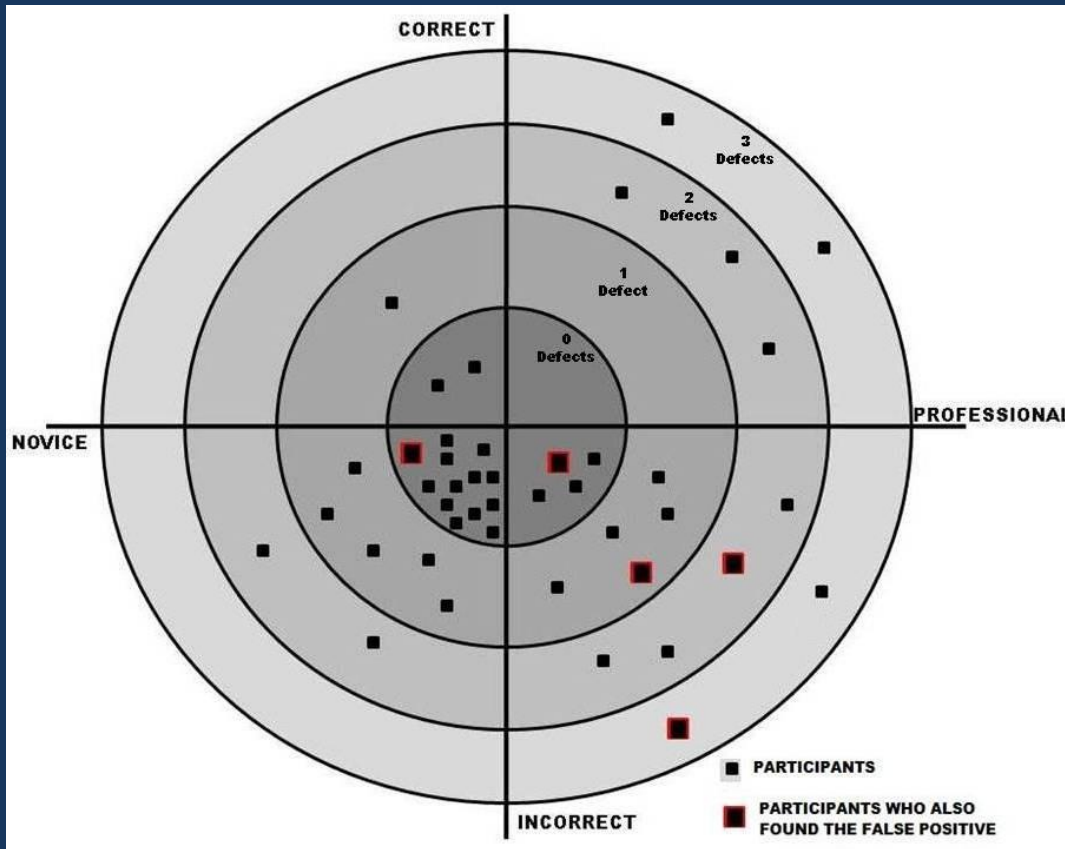
Participants who used the clone report correctly tended to identify more real defects and fewer false positives.

# Novice vs. Professional

Study Design

Data Collection

Data Analysis



Professionals identified more defects than the novices

None of the participants using the correct process, found False Positives.

The professionals also tended to use the clone report correctly

Possible reasons ???

Chi-Square test :

Count	Use of Clone Report		
	incorrect	correct	Total
Novice	20	3	23
Professional	15	5	20
Total	35	8	43

# Conclusions

**How developers use a clone report?**

- **Training needed for inexperienced developers for using the clone reports to advantage**
- **Relationship between correct use of clone report and effectiveness, yet not causal**
- **Clone report not supposed to be used for locating bugs....**

**A starting point for code clone related empirical studies.**

# Future Work

## Replications proposed:

- Control for clone detection training
- Innovation with clone groups:
  - A clone group of 8 clones but only 3 cause defects
  - Execute code
- False positives in more detail

# Thank You !!!

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Questions  
&  
Comments