Software Quality and Measurement

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When and Why Your Code Starts to Smell Bad

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Agenda

- Introduction
- Goal
- Study Design
- Analysis of Results
- Threats to Validity
- Conclusion and Lessons Learned

Introduction

- Management of Technical Debt
- Two ways to add a functionality:

One is quick to do but is messy

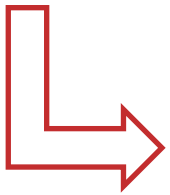
X

Cleaner design that will take longer

- Bad code smells

Bad Smells

- Relevance of code smells to developers
- Approaches and tools to detect them
- Side effects



Fault proneness, decrease of maintainability

What Do We Have Today?

- Tools don't consider circumstances
- Important to support developers in planning actions
- Common wisdom: maintenance activities and pressure to delivery the software

In This Paper...

- Large empirical study  200 projects
- Android, Apache and Eclipse
- Investigate WHEN code smells are introduced and WHY
- Analysis of code entities in change histories of projects

Large Study

- 0.5M commits were mined
- 9.164 of those identified as smell-introducing
- Results: quantitative/qualitative
- Often contradicting common wisdom

GOAL

- Analyze change history of projects with the purpose to find when and why smells are introduced

Study Design

Research Questions

- RQ1: When are code smells introduced?
  - To what extend common wisdom applies
  - Suddenly or gradually?
- RQ2: Why are code smells introduced?
  - Focus on the factors: commit goal, project status and developer status

Context Selection

- Change history of 200 projects hosted in Git repositories

Domain	#Projects	#Classes	KLOC	#Commits
Apache	100	4 - 5.052	1 – 1.031	207.997
Android	70	5 – 4.980	3 – 1.140	107.555
Eclipse	30	142 – 16.700	26 – 2.610	246.119
Overall	**200**	**-**	**-**	**579.671**

Domains

- Android: 70 open sources from f-droid
- Apache: 100 Java systems randomly selected from Apache website
- Eclipse: 30 randomly mined from GitHub

Domains

- Three main reasons:
  - Sizes: Android is smaller than the other ones
  - Architectures: Android mobile apps, Apache libraries and Eclipse plug-in
  - Developers team: Android has smaller teams

5 Types of Smells

- Blob Classes
- Class Data Should Be Private
- Complex Class
- Functional Decomposition
- Spaghetti Code

Data Extraction and Analysis

To Answer RQ1

- Analysis of repository r_i with tool *HistoryMiner* in order to find smell-introducing commits
- The tool checks each commit in chronological order and runs DECOR

DECOR

- High accuracy and efficient smell detector
- Rules based on internal quality metrics
- Our tool output: for each file f_j , the list of commits and if f_j was affected by a smell

Number of Commits

- For files affected by a smell: compute the number of commits until DECOR identify

- 2 scenarios:
  - One commit
  - After several commits

Number of Commits

- For 2nd scenario:
  - LOC, WMC, CBO, LCOM, NOA, NOM
- Compare their behavior in files based on a linear function

Metrics Comparison

- Linear function to approximate metrics distribution
- For files not affected: the first n commits (n = average)
- For affected files: from first commit until the commit identified by DECOR

To Answer RQ2

- Challenge: Identify the specific commit that introduced the smell
- Crucial to explain the reasons why the smell appeared

Smell-introducing Commit

- If it is the first commit 
- If after several commits 

- Results from RQ1 to select quality metrics

Smell-introducing Commit

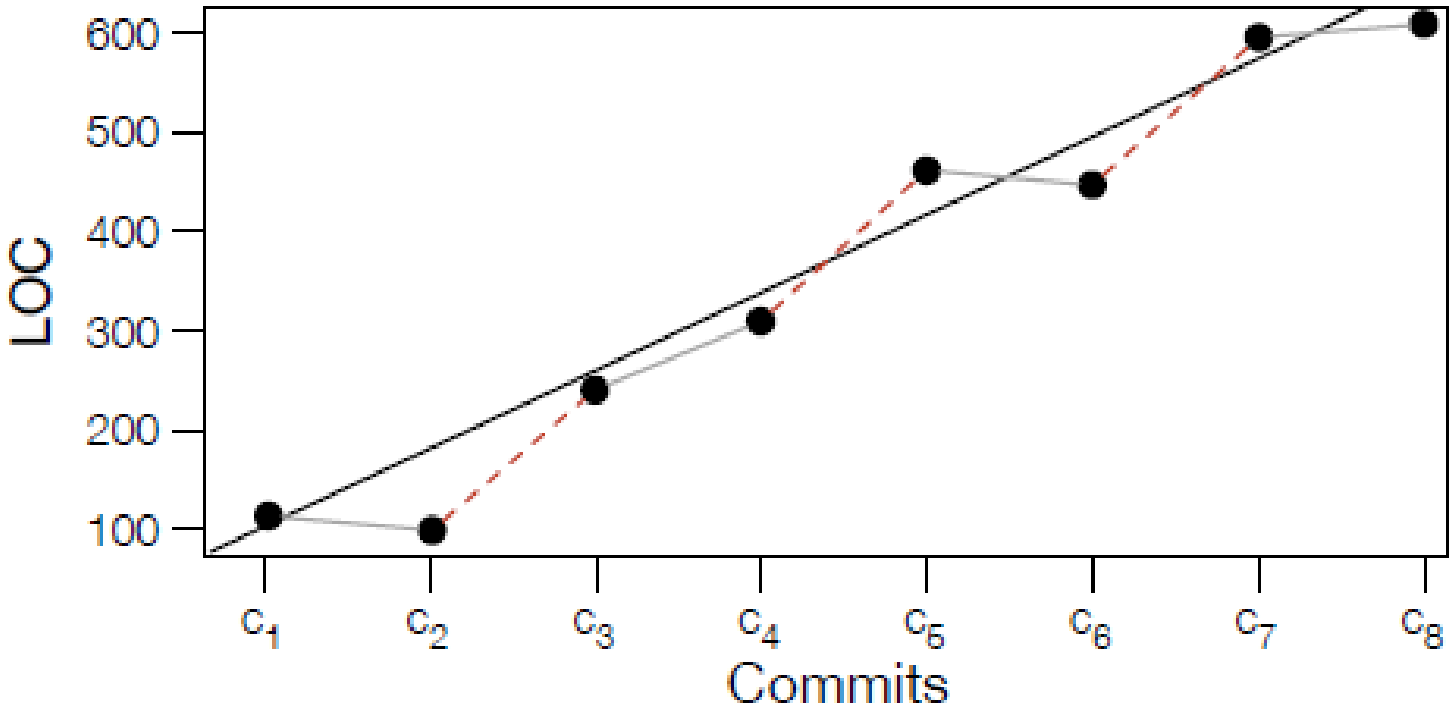


Fig. 1. Example of smell-introducing commit identification.

Smell-introducing Commit

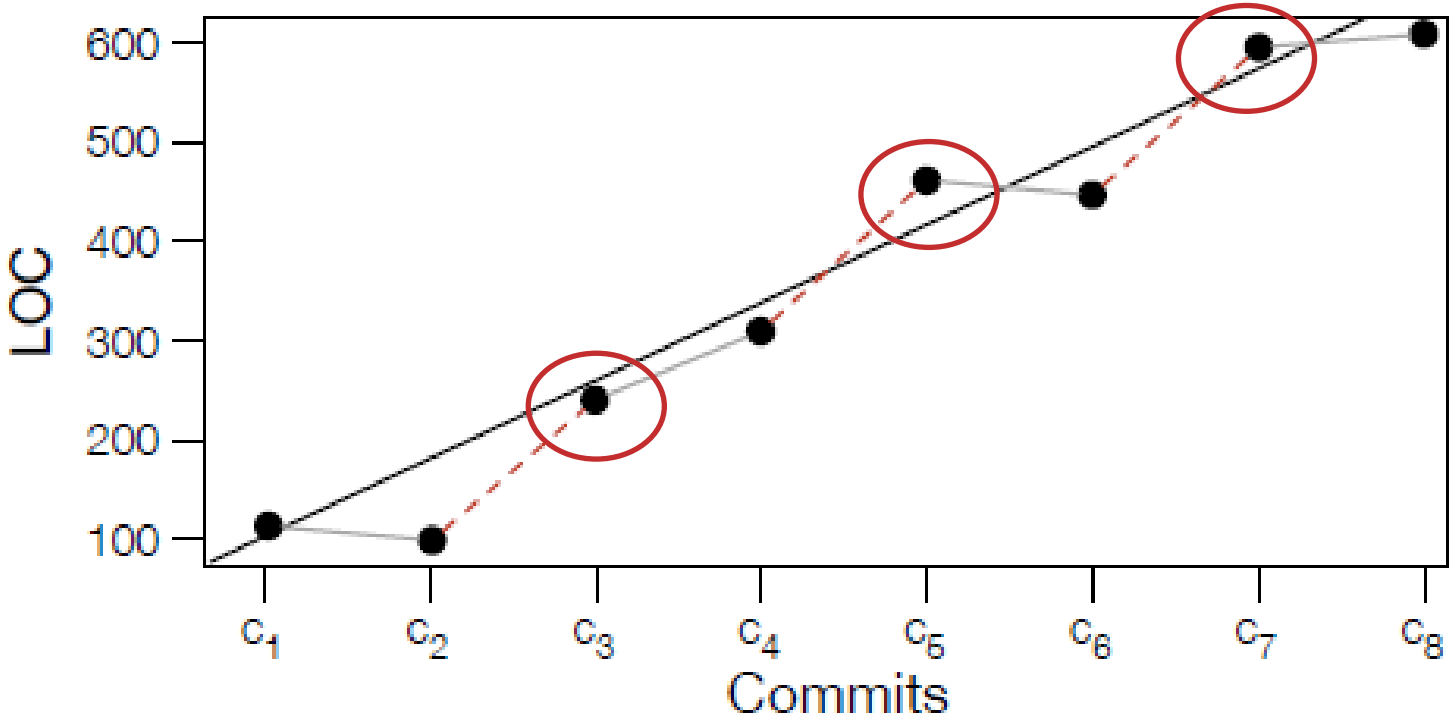


Fig. 1. Example of smell-introducing commit identification.

Smell-introducing Commit

- Overall, 9.164 smell-introducing commits in the 200 systems

Why smells were introduced?

- We assign tags to each commit

- Commit Goal: identify what the developer was doing

Bug Fixing, Enhancement,
New Feature, Refactoring

Why smells were introduced?

- Project Status: identify the stage of the project

Close to Release, Startup

Why smells were introduced?

- Developer Status: to identify how the developer was when smell was introduced

Workload, Ownership, Newcomer

Analysis of Results

- RQ1: Most of smells need one commit to manifest itself
- Contradicts the common wisdom

Analysis of Metrics

- For all smells, but Functional Decomposition, the affected files have higher slope

- When a smell is going to appear, the metric values increase very fastly

- LOC as main metric

Summary for RQ1

- Most of the smell instances are introduced when files are created
- Blob and Complex Class: smells manifest themselves after several changes performed on the file.
- Files that will become smelly exhibit specific trends for some quality metric values

Analysis of Results

- RQ2: analysis of percentage of smell-introducing commits in each tag

- Commit Goal
  - Enhancement operations (60% - 66%)
  - Refactoring (4% - 11%) $\longrightarrow$ quite unexpected

Project Status

- In the last month before release $\longrightarrow$ deadline pressure
- Considering project startup: many smells introduced a few months after start

Developer Status

- High workload influences negatively
- 55% of cases, high workload means introduction of smells
- Owner are responsible for most smells: against common wisdom

Summary for RQ2

- Smells are generally introduced when enhancing existing features or implementing new ones
- Last month before issuing a deadline
- Owners of the file are more prone to introduce smells

Threats to Validity

- Imprecision in measurements, but DECOR has high accuracy
- Cases of classes affected by many smells at the same time, but they represent 3% - 9% only

Conclusion and Lessons Learned

- This paper presented a large-scale empirical study to identify when and why smells are introduced
- Smells affect code since its creation → contradicts common wisdom

Conclusion and Lessons Learned

- Smells introduced when enhancing and add new features
- Owners are usually the responsible for introducing smells

OBRIGADO!