



Detecting Smelly Methods with Concern Metrics: An Empirical Study

Juliana Padilha
juliana.padilha@dcc.ufmg.br

Software Engineering Lab (LabSoft)
<http://labsoft.dcc.ufmg.br/>

Motivation

- Extension to **Journal of the Brazilian Computer Society (JBACS)**.



- Best paper in LAWASP'13 entitled like
 - **Detecting God Methods with Concern Metrics - An Exploratory Study**

Software Engineering Lab (LabSoft)
<http://labsoft.dcc.ufmg.br/>

Motivation

- Goals of software engineering is
 - Evaluate and control the software quality
- To assess the quality of software involves
 - Several factories
 - Maintainability
- Software metrics indicates the quality of a system

Software Engineering Lab (LabSoft)
<http://labsoft.dcc.ufmg.br/>

Our Study

- **Empirical Study**
 - Investigates the efficacy of concern metrics on the identification of two code smell
 - We used a set of metrics concern and traditional to detect smelly Methods

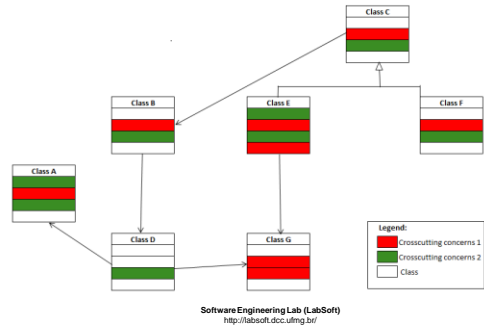
Software Engineering Lab (LabSoft)
<http://labsoft.dcc.ufmg.br/>

Separation of Concern

- **A concern is**
 - something you want to treat as conceptual unit modular
- Example of mechanisms used to separate concerns
 - Class
 - Methods

Software Engineering Lab (LabSoft)
<http://labssoft.dcc.ufmg.br/>

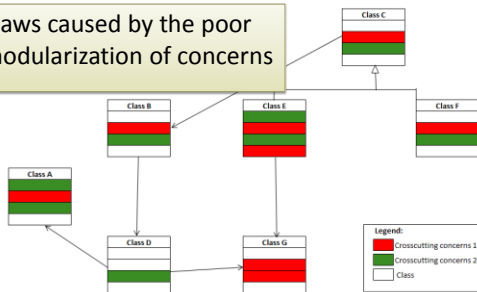
Scattering and Tangling



Software Engineering Lab (LabSoft)
<http://labssoft.dcc.ufmg.br/>

Scattering and Tangling

Flaws caused by the poor modularization of concerns



Software Engineering Lab (LabSoft)
<http://labssoft.dcc.ufmg.br/>

Goal Study

- Compare two metrics:
 - concern metrics x traditional metrics
- Detection two code smells
 - God Method
 - Feature Envy

Software Engineering Lab (LabSoft)
<http://labssoft.dcc.ufmg.br/>

What is God Method?

- Method that has grown too much
- It tends to centralize the functionality of a class
- In a different perspective:
 - it is a method that implements many concerns

Software Engineering Lab (LabSoft)
<http://labssoft.dcc.ufmg.br/>

What is Feature Envy?

- Occurs when a piece of code seems more interested in a class other than one it actually
- In a different perspective
 - Hence, the concern realized by misplaced method is probably located mainly in a different class

Software Engineering Lab (LabSoft)
<http://labssoft.dcc.ufmg.br/>

Target System

- **MobileMedia**
 - Concerns analyzed:
 - Sorting
 - Favorites
 - Persistence
 - Exception Handling
 - Security



Software Engineering Lab (LabSoft)
<http://labssoft.dcc.ufmg.br/>

Traditional Metrics

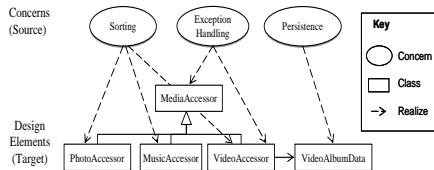
- **Metrics used in experiment**
 - Coupling between Objects (**CBO**)
 - McCabe Cyclomatic Complexity (**CYCLO**)
 - Lack of Cohesion in Methods (**LCOM**)
 - Lines of Code (**LOC**)
 - Number of Attributes (**NOA**)
 - Number of Methods (**NOM**)
 - Number of Parameters in Methods (**PAR**)
 - Weighted Methods per Class (**WMC**)

Software Engineering Lab (LabSoft)
<http://labssoft.dcc.ufmg.br/>

Concern Metrics

□ Concern metrics need mapping (relationship)

■ Concerns x Code



Software Engineering Lab (LabSoft)
http://labsoft.doc.ufmg.br/

Software Engineering Lab (LabSoft)
http://labsoft.doc.ufmg.br/

Concern Metrics

□ Metrics used in experiment

- Concern Diffusion over Attributes (CDA)
- Concern Diffusion over Operations (CDO)
- Concern Diffusions over LOC (CDLOC)
- Number of Concerns Lines of Code (LOCC)
- Number Concerns per Component (NCC)
- Number Concerns per Method (NCO)

Example CDLOC

```

public class AbstractController      concern switch ↷
    implements IController {
    private IController nextController;
    ...
    public void nextController(Command command) {      concern switch ↷
        if (handleCommand(command) == false)
            getNextController().handleCommand(command);
    }
    public IController getNextController() {...}
    public void setNextController(...) {...}          concern switch ↷
    }
  
```

CDLOC = 4

Software Engineering Lab (LabSoft)
http://labsoft.doc.ufmg.br/

Software Engineering Lab (LabSoft)
http://labsoft.doc.ufmg.br/

Study Settings

□ Participants

- 47 participants worked individually
 - From UFMG and UFBA
 - All analyzed two code smells
- Each participant worked with different metrics
 - Traditional metrics (Group A)
 - Concern metrics (Group B)
 - Hybrid metrics (Group C) - All Metrics

Study Settings

□ Experimental Tasks

- Training on the metrics and code smells
- The participant had access the metrics they were assigned them

□ Each participant

- Read the description of the MobileMedia design
- Identify the methods with code smells
- Register the time spent on each task
- Document which metrics they found useful

Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

God Method Reference List

Methods smelling God Method	
MainUIMidlet.startApp	MediaListController.showMediaList
AlbumController.handleCommand	MusicPlayController.handleCommand
MediaController.handleCommand	PhotoViewController.handleCommand
MediaController.showImage	

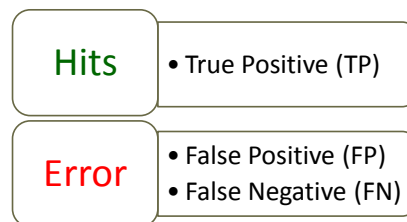
Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

Feature Envy Reference List

Methods smelling Feature Envy	
AlbumController.resetMediaData	BaseController.init
MediaListController.bubbleSort	MediaListaController.exchange

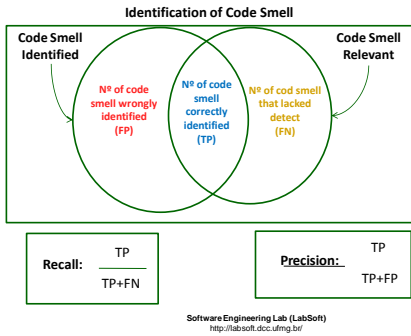
Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

Recall and Precision



Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

Recall and Precision



Research Questions

□ **RQ. Do concern metrics support of code smells in methods?**

- RQ1.** How accurate do concern metrics perform in comparison with traditional ones to detect code smells in methods?
- RQ2.** Is there a specific metric that accurately detect code smells in methods?
- RQ3.** Is there a combination of metrics that increase the accuracy of identifying codes smells in methods?

Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

Accuracy of the Concern Metrics

- **Main goal of this study is**
- To evaluate the effectiveness of concern metrics to detect code smells in methods
 - There are four concern metrics: **NCO**, **LOCC**, **NCC**, and **CDLOC** for God Methods
 - They seem helpful when used together with traditional metrics

Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

Analysis of Specific Metrics God Method

Metrics	LOC	CYCLO	NCO	LOCC	PAR	NCC	CDLOC
# Subjects who used	27	18	15	10	9	6	5
Average of recall (%)	64%	63%	53%	47%	63%	41%	46%

➔ Traditional metrics were considered useful by more 5 subjects: LOC, CYCLO and PAR

➔ Concern metrics were considered useful by 5 subjects or more: NCO, LOCC, NCC, and CDLOC

Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

Analysis of Specific Metrics Feature Envy

Metrics	PAR	LOCC	LCOM
# Subjects who used	10	10	7
Average of recall (%)	10%	5%	7%

➔ Traditional metrics were considered useful by more 5 subjects: PAR and LCOM

➔ Concern metrics were considered useful by 5 subjects or more: LOCC

Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

Combined Use of Metrics God Method

□ Metrics: LOC , CYCLO e NCO

■ Example

Participants	S1	S45	S47
Recall	71%	43%	57%
Precision	100%	38%	100%
Time	11min	9min	14min

Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

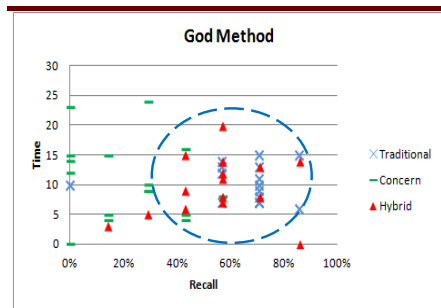
Combined Use of Metrics Feature Envy

- Participants had poor performance for detecting this code smell
- This analysis only participants who
 - Correctly identified at least one smell instance
 - Example

Participants	S4	S16
Recall	50%	25%
Metrics used	PAR and NOA	PAR and LCOM

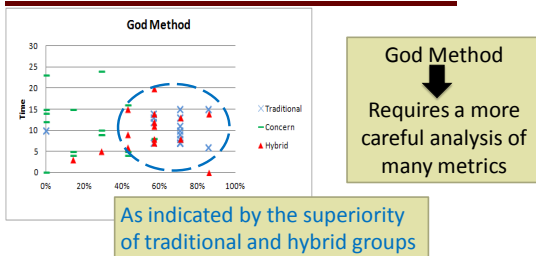
Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

Analysis of Time Efficiency God Method



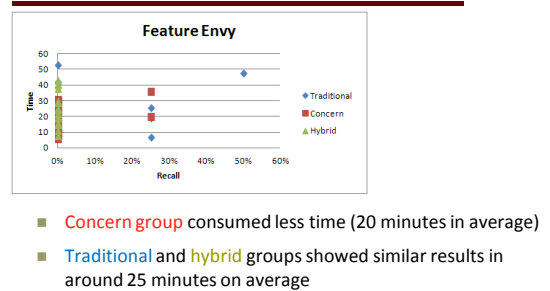
Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

Analysis of Time Efficiency God Method



Software Engineering Lab (LabSoft)
<http://labssoft.dcc.ufmg.br/>

Analysis of Time Efficiency Feature Envy



Software Engineering Lab (LabSoft)
<http://labssoft.dcc.ufmg.br/>

Threats to Validity

- The conclusions obtained here are restricted to
 - The involved metrics
 - Code smells
 - Systems

Software Engineering Lab (LabSoft)
<http://labssoft.dcc.ufmg.br/>

Conclusions

- Results indicated
 - Accuracy of each metric suite dependent on the adequacy of each metric
 - To capture the properties mentioned in the definition of code smell

Software Engineering Lab (LabSoft)
<http://labssoft.dcc.ufmg.br/>

Conclusions

- Concern metrics: **NCO**, **LOCC**, **NCC** and **CDLOC**
 - They are effective in helping detect God Method
 - However, when used together with other traditional metrics

Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

Conclusions

- However, none of the evaluated traditional and concern metrics can be considered helpful Feature Envy detection
- This result open up a road for Future Work
 - Create and/ or evaluate new metrics that better capture facets of the Feature Envy definition

Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

Work in Progress

- Apply statistical tests
 - **Test-t** → **RQ1.** How accurate do concern metrics perform in comparison with traditional ones to detect God Method and Feature Envy?
 - **Factorial Design**
 - To analyze whether the background of participants can explain results Feature Envy

Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

Software Engineering Lab (LabSoft)
http://labssoft.dcc.ufmg.br/

lab-soft
software engineering laboratory

Thank!

FAPEMIG
Fundação de Amparo à Pesquisa do Estado de Minas Gerais

