Effects of Model Composition Techniques on Effort and Affective States: A Controlled Experiment

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This talk…

- Why
- How
- What

Why…

Model composition…

…really important and hard

…error-prone

…time-consuming

…the literature fails to provide empirical evidence

Why…

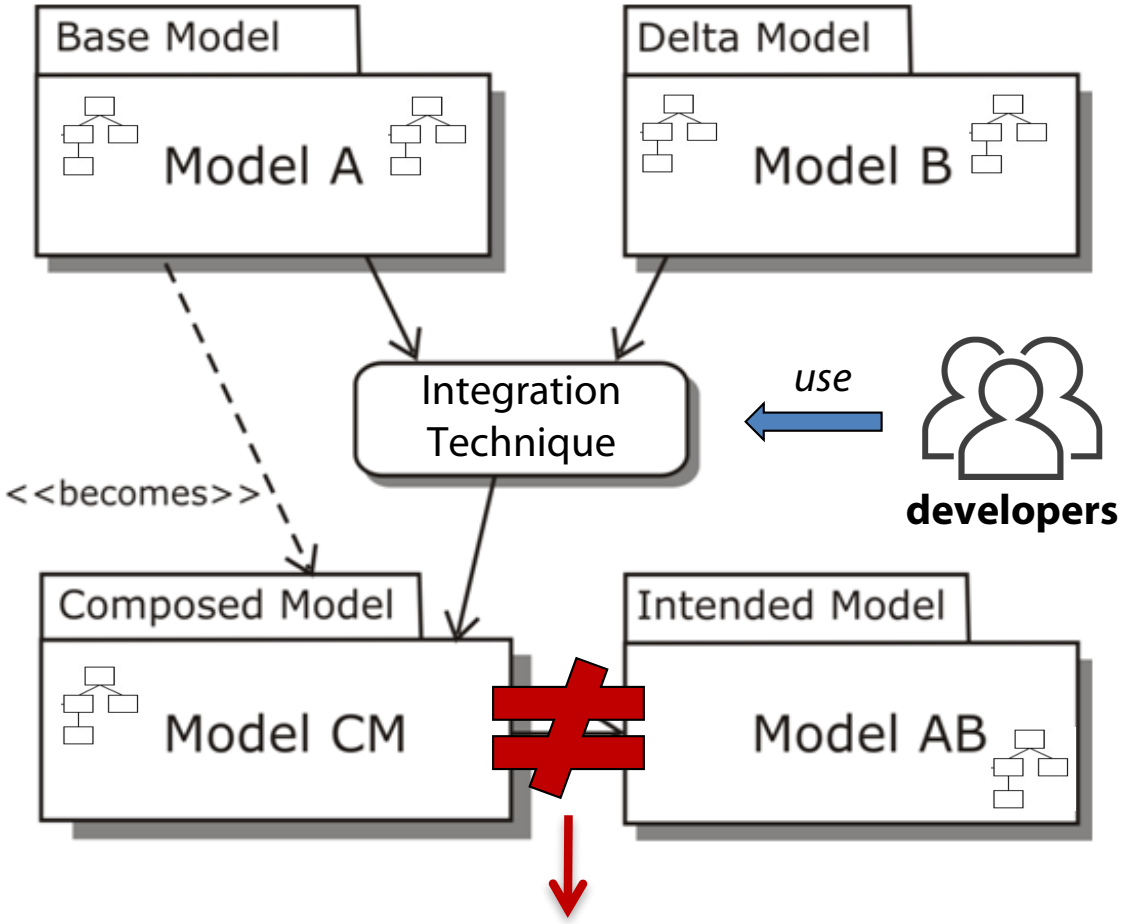
It is not clear to what extent

…composition techniques

…composition effort

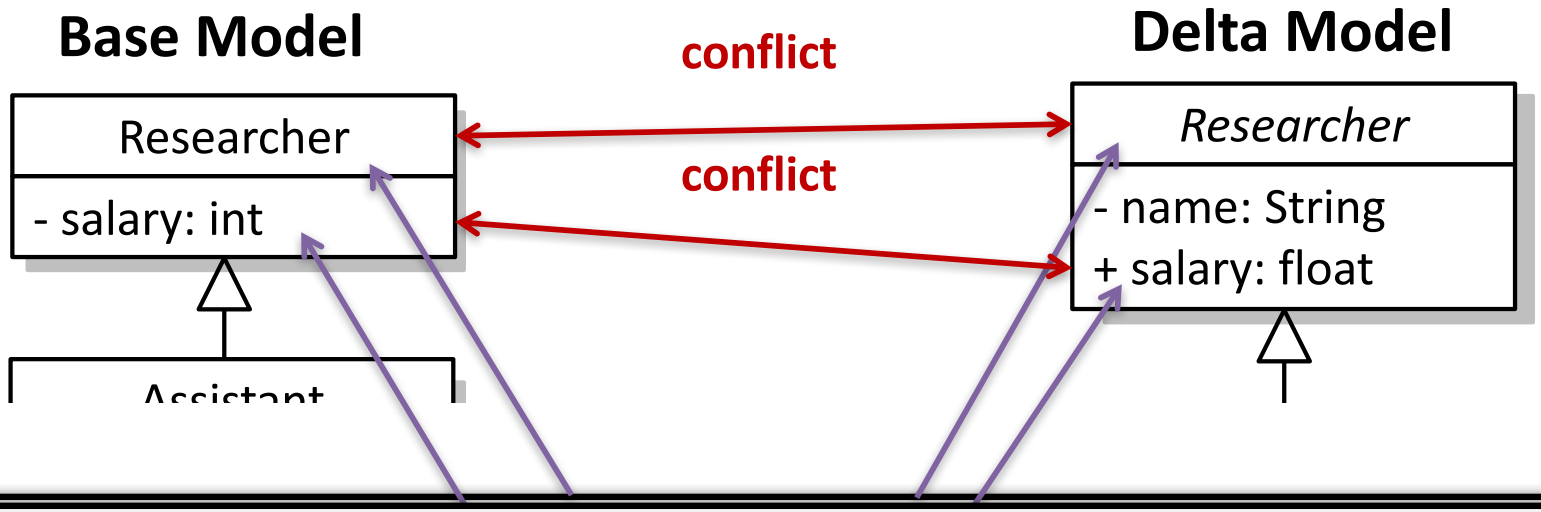
….affective states of software developers.

Introduction



There is a difference because
the input models conflict with each other in a some way.

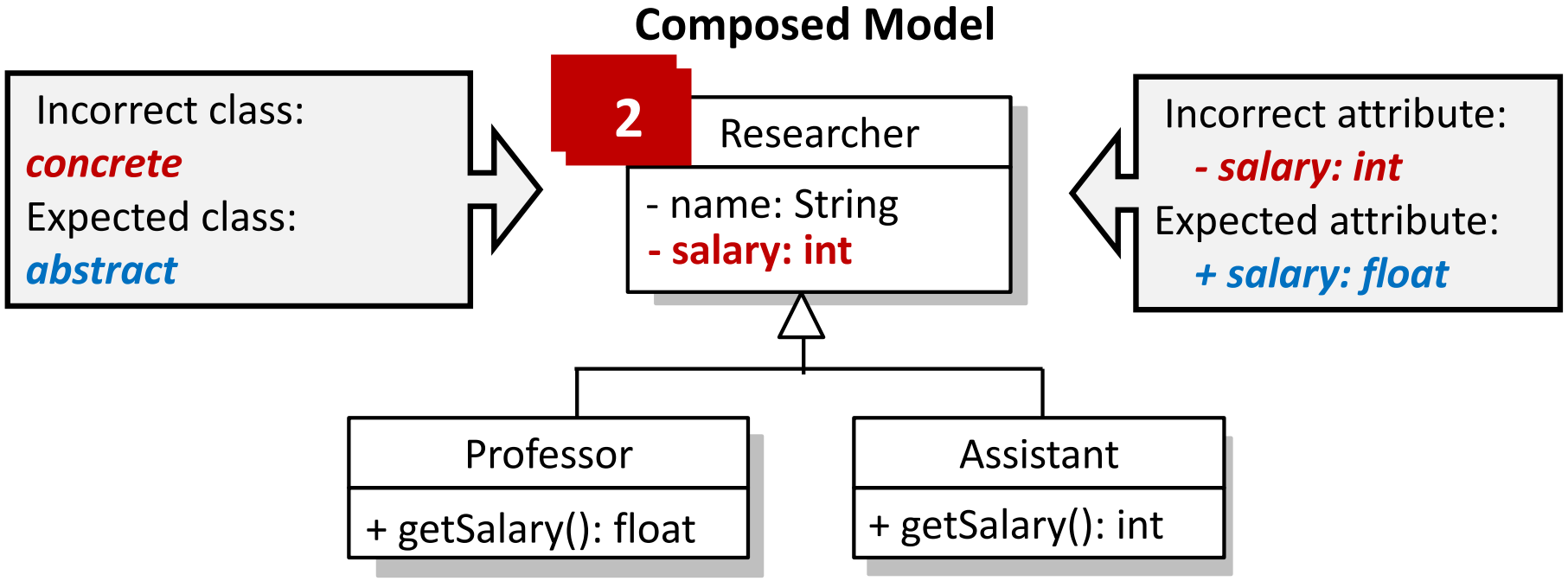
Example: applying the techniques



Attributes with equal names, but different types: INT vs FLOAT and

Developer needs to compose two input models.

Example: detecting inconsistencies

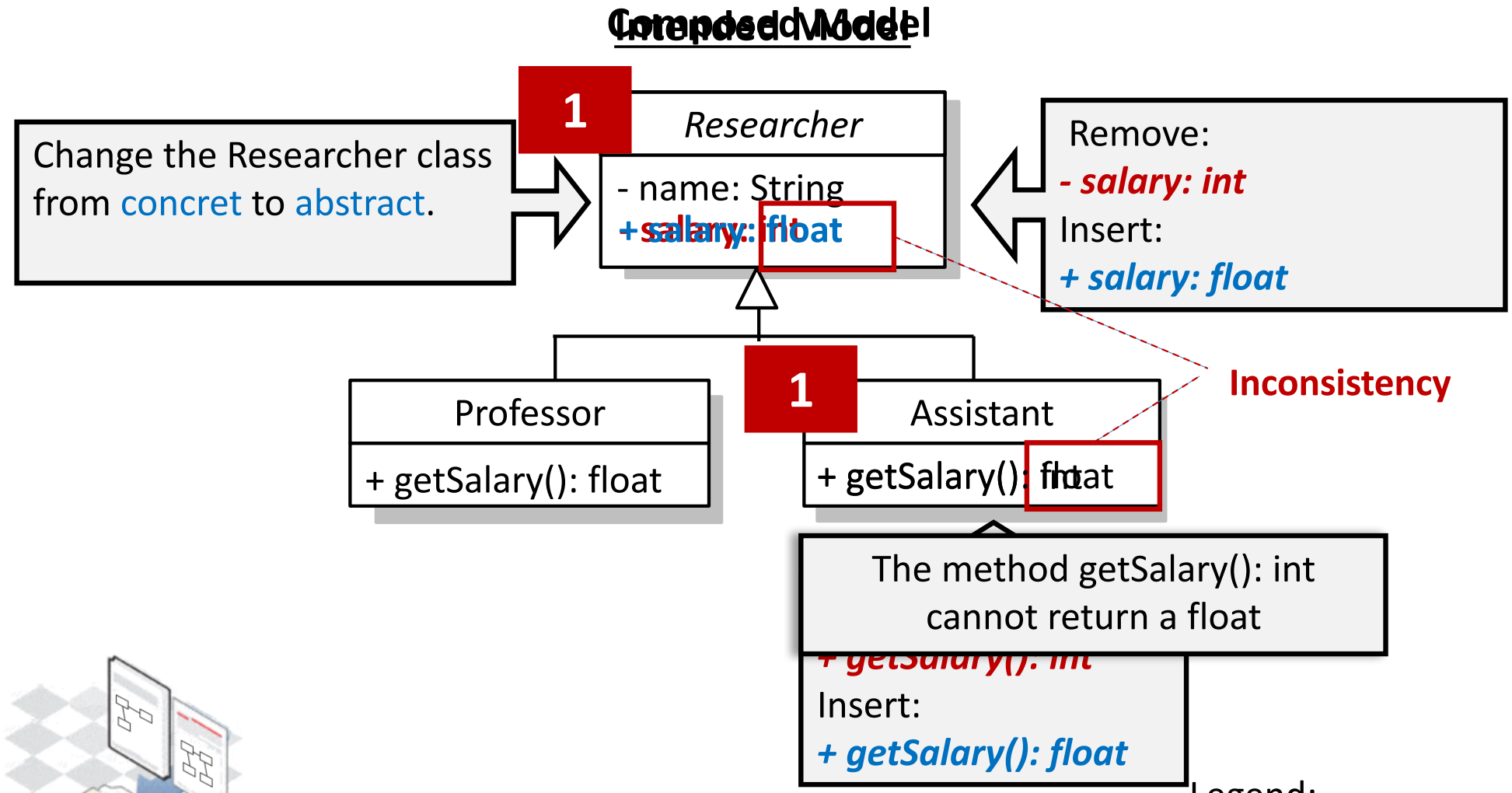


Legend:

Unexpected

Expected

Example: resolving inconsistency



Composition Techniques

- **Composition techniques:** Developers can compose design models using specification-based techniques, such as Epsilon, and heuristic-based composition techniques, such as IBM Rational Software Architecture, and traditional composition algorithms like override, merge and union.

Specification-based technique

Epsilon

Match Rule

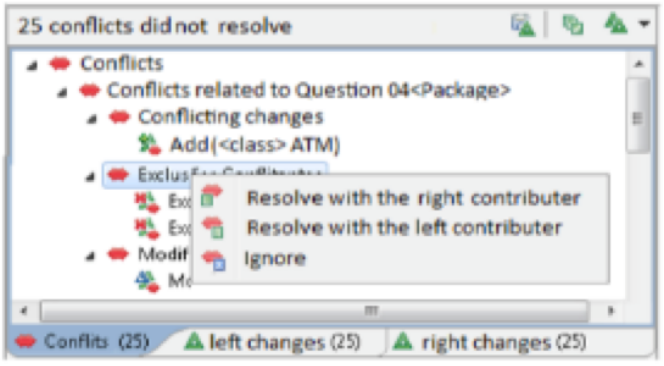
```
rule MatchClass
  match b : baseIClass
  with d : deltaIClass {
   compare {
     b.name = d.name
   }
}
```

Merge Rule

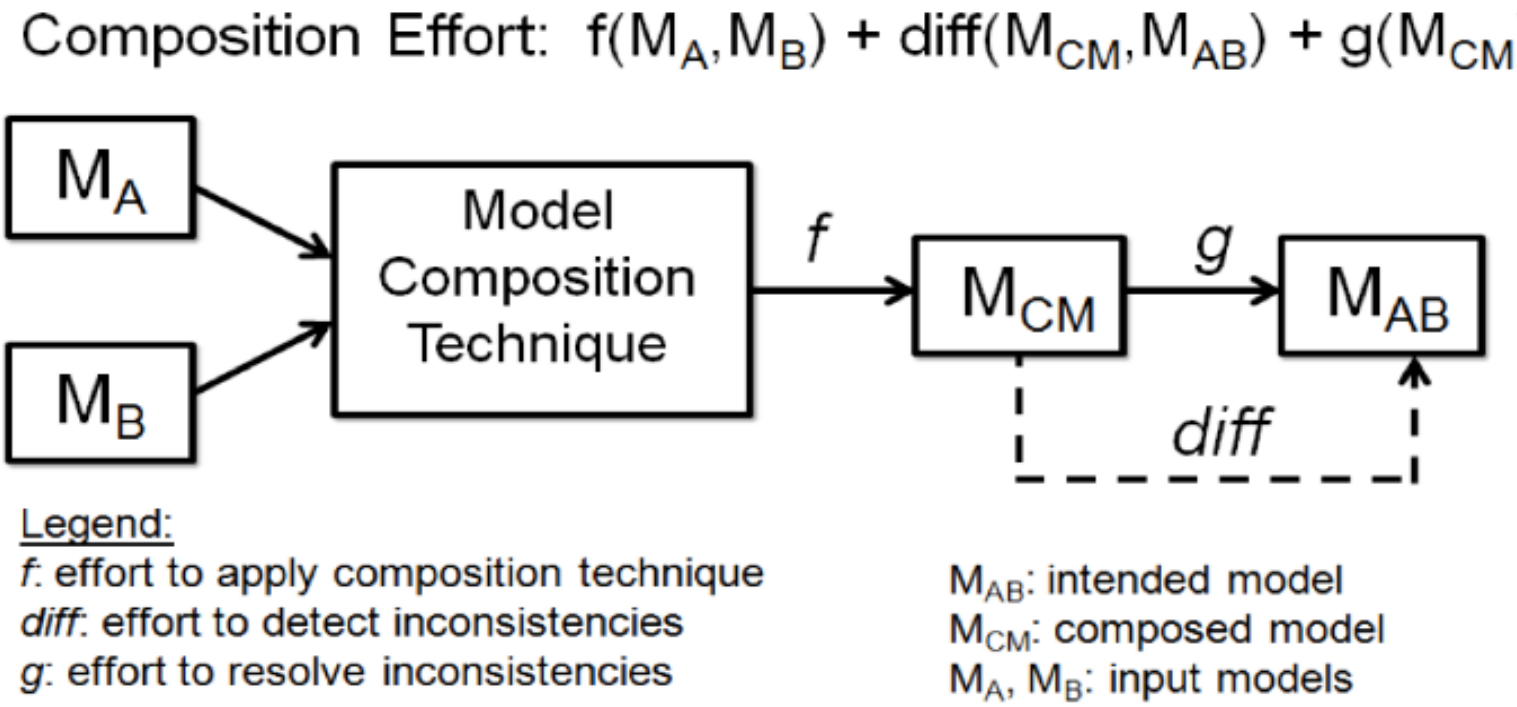
```
rule MergeClass
  merge b : baseIClass
  with d : deltaIClass
  into c : composedIClass {
  c.name := d.name;
  ....
}
```

Heuristic-based technique

Rational Software Architect



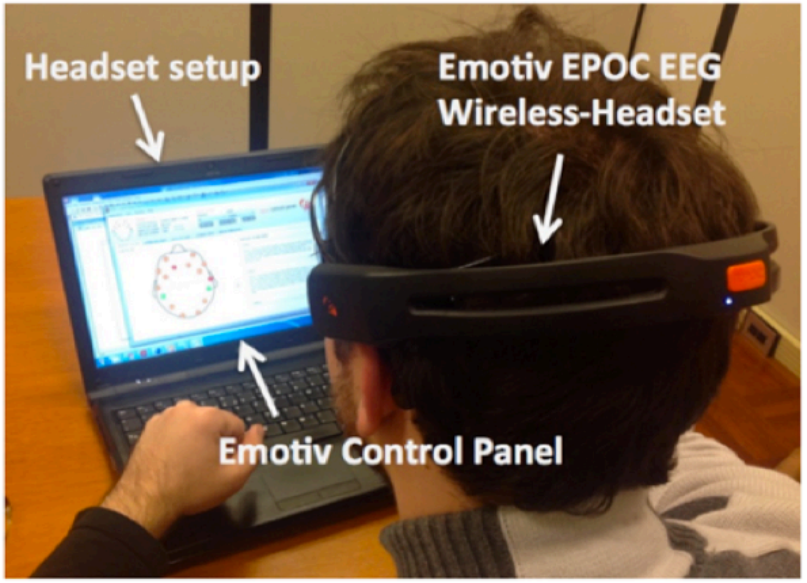
Effort to Compose Design Models



- **Composition Effort** is formed by:
  - the effort that the software developers invest to apply the composition techniques,
  - the effort to detect inconsistencies, and
  - the effort to resolve inconsistencies.

Affective States

- **Affective states:** Software developers have different types of affective states, such as engagement, frustration and excitement, that can be measured using wearable Electroencephalography (EEG).



Study Setup

Wearable EEG

In short…

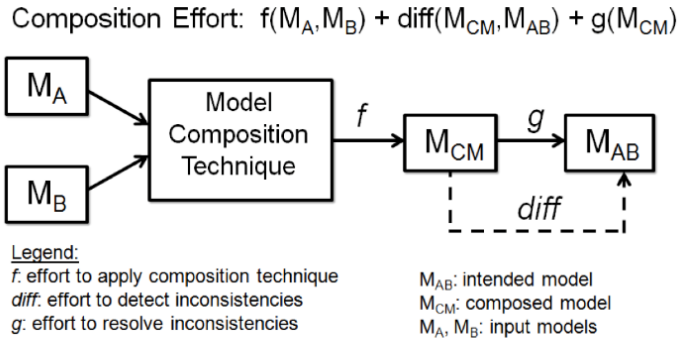
Composition Techniques

Epsilon

Match Rule	Merge Rule

rule MatchClass
match b : baseIClass
with d : deltaIClass {
compare {
b.name = d.name
}
}
	rule MergeClass
	merge b : baseIClass
	with d : deltaIClass
	into c : composedIClass {
	c.name := d.name;
	....
	}

Composition Tasks



Affective States

Nothing has been done to understand the impact of composition techniques:

…on the effort to perform composition tasks and

…on the affective states of software developers

How…

…performing a controlled experiment with realistic design models

…evaluating 18 composition scenarios

…three research questions were formulated and investigated

…following a well-known experimental process

…using wearable Electroencephalography with 14 channels.

Methodology

- Objective:

Analyze *composition techniques*
for the purpose of *investigating their effects*
with respect to *effort, correctness and affectivity*
from the perspective of *software developers*
in the context of *evolution of software design models*

- Model Composition Effort is equal to

effort to apply the model composition technique +

effort to detect the inconsistencies +

effort to resolve the inconsistencies

Methodology

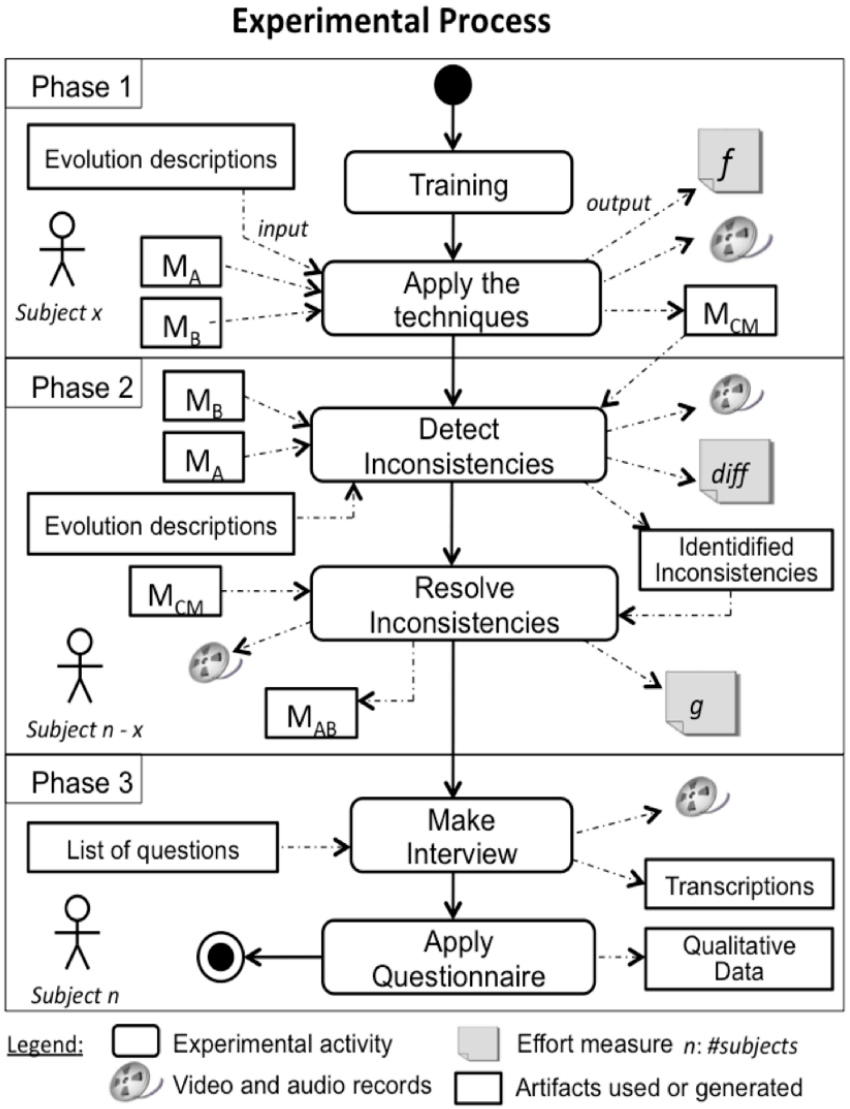
- Research questions:

RQ1: What is the relative effort of composing two input models using specification-based composition techniques with respect to heuristic-based composition techniques?

RQ2: Is the number of correctly composed models higher using specification-based techniques with respect to heuristic-based ones?

RQ3: Does the use of heuristic-based technique cause a higher effect on the developer's affectivity than specification-based technique?

Experimental Process



The experimental process has three phases:

Phase 1 – Training and Application:

- all participants were trained to ensure that they obtained the necessary familiarity with model integration techniques.
- Participants applied the composition techniques, Epsilon and Traditional Algorithms

Phase 2 – Detection and Resolution Effort:

- The participants detected and resolved inconsistencies using the composition techniques

Step 3 – Participant Data Collection

- Data related to participants were collected, such as age and level of experience, using a questionnaire.

What…

…our main findings considering

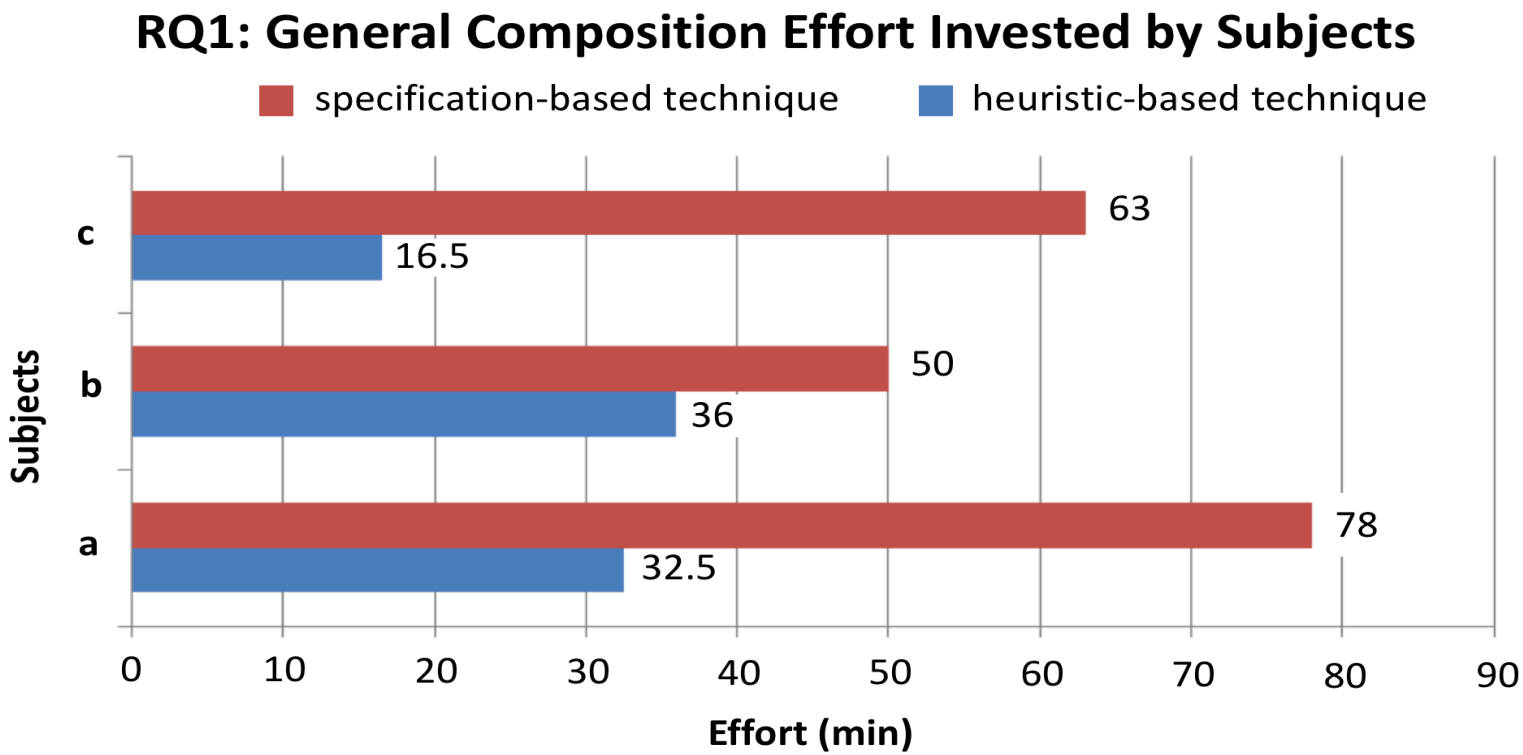
… general composition effort invested by subjects

… the number of correctly composed models

… general affectivity state of our participants

Study Results

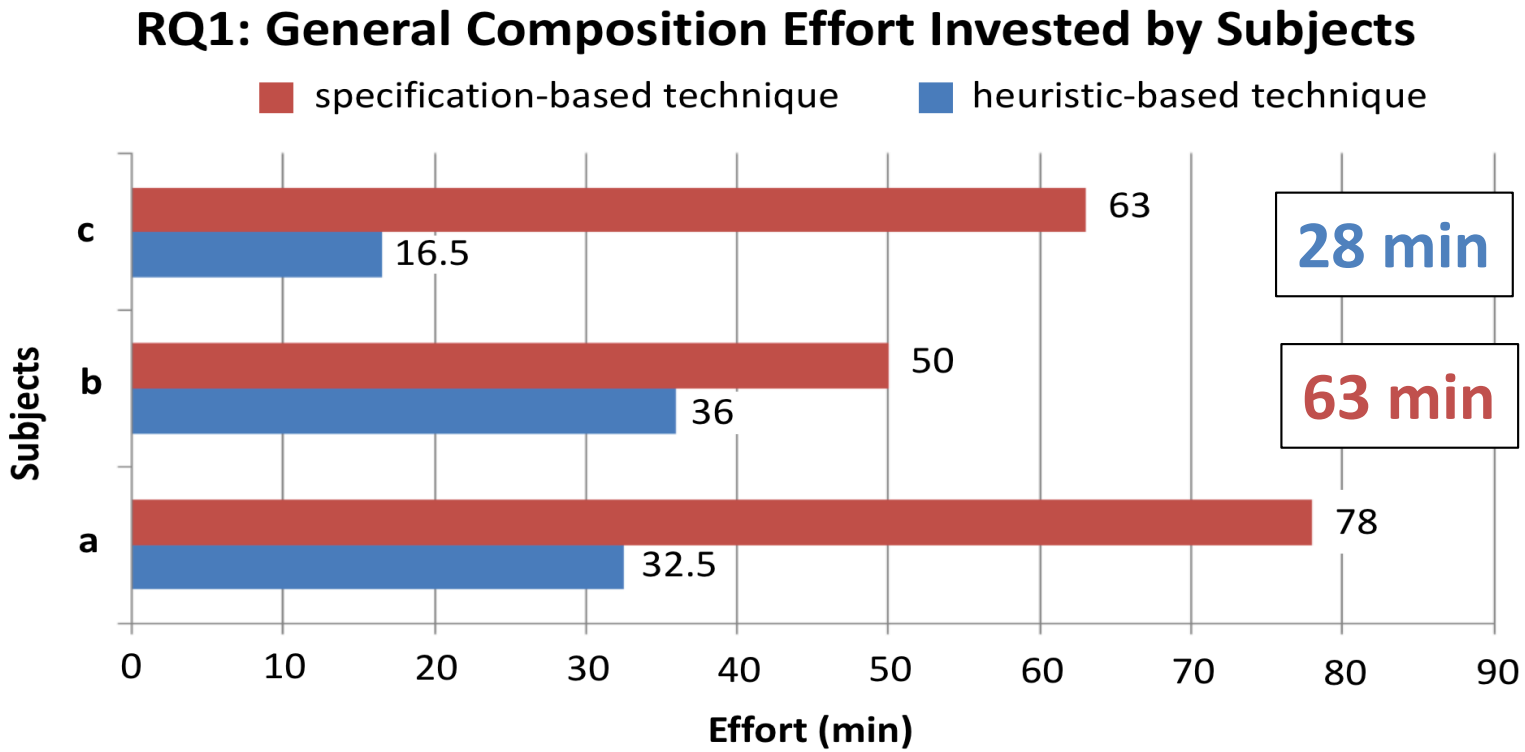
- **RQ1:** Composition and Effort



- **Specific finding 1:**
  Participants tend to invest more than twice effort to produce the output composed model using the specification-based technique.

Study Results

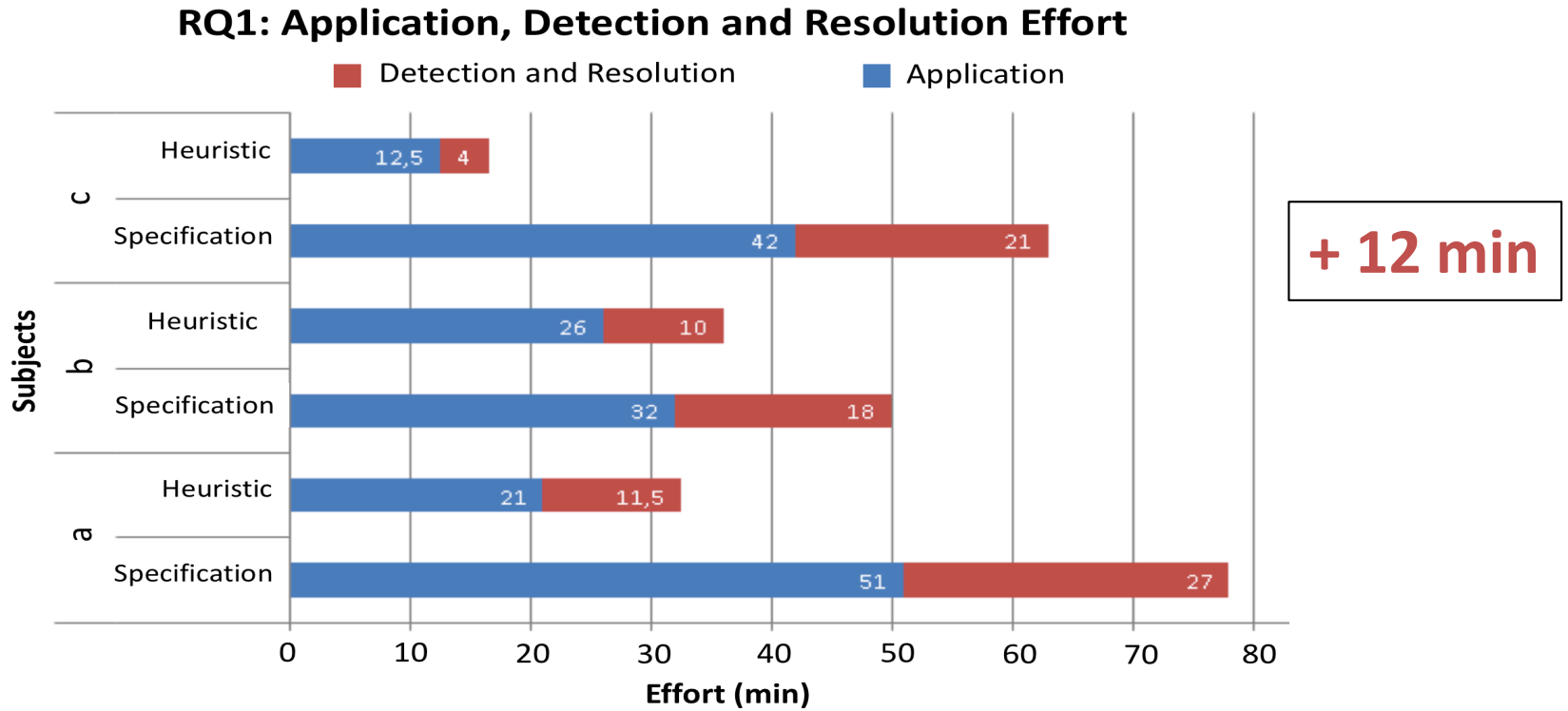
- **RQ1:** Composition and Effort



- **Specific finding 2:**
  On average, developers invested by about **28 min** to run the experimental tasks using a heuristic-based technique, compared to **63 min** using specification-based techniques.

Study Results

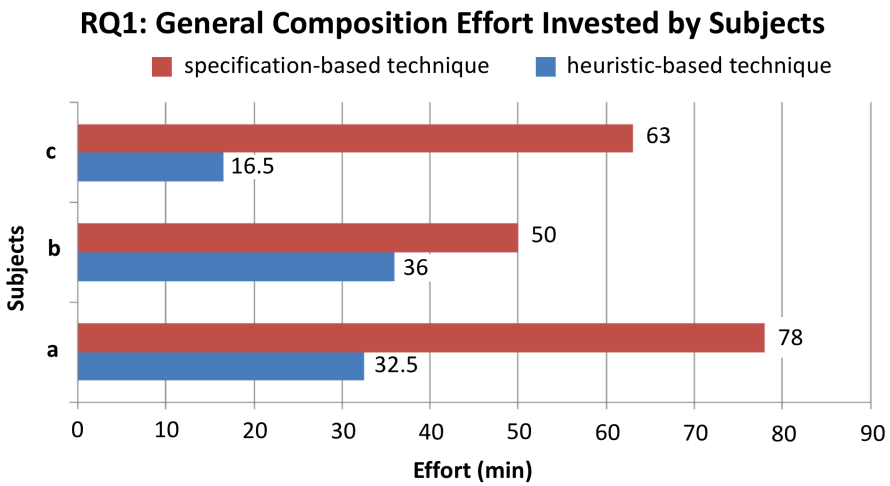
- **RQ1:** Composition and Effort

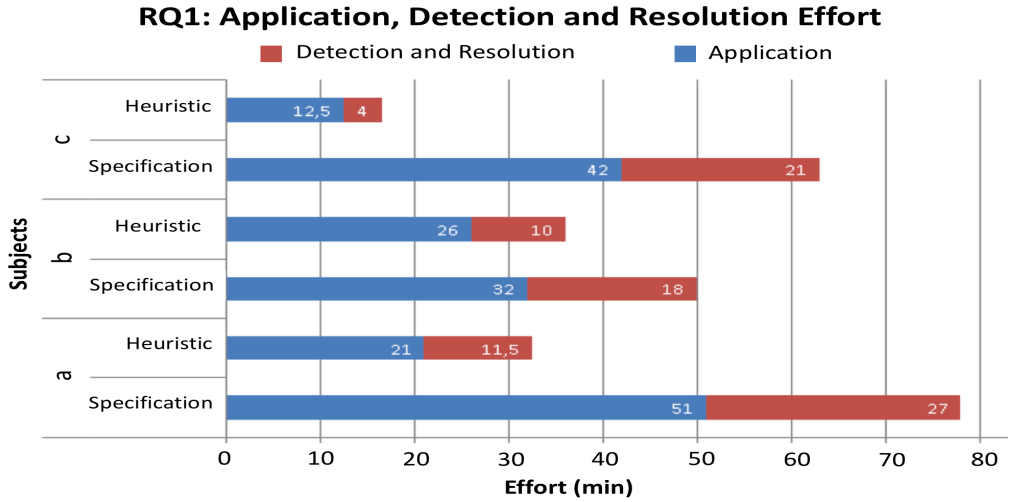


- **Specific finding 3:**
  The specification-based technique required, on average, 12 minutes longer to detect and resolve inconsistencies than the heuristic-based techniques.

Study Results

- **RQ1:** Composition and Effort

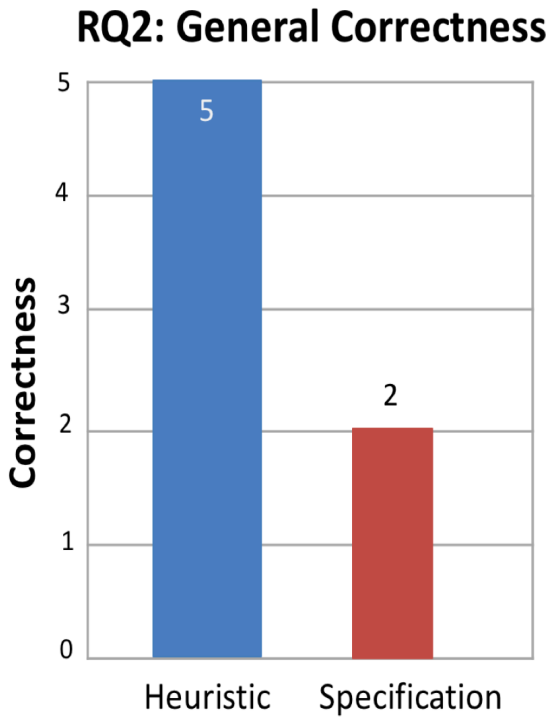




Conclusion of RQ1: Developers tend to invest more effort to combine two input models, detect and resolve inconsistencies using a specification-based technique, compared to a heuristic-based technique.

Study Results

- **RQ2:** Composition and Correctness

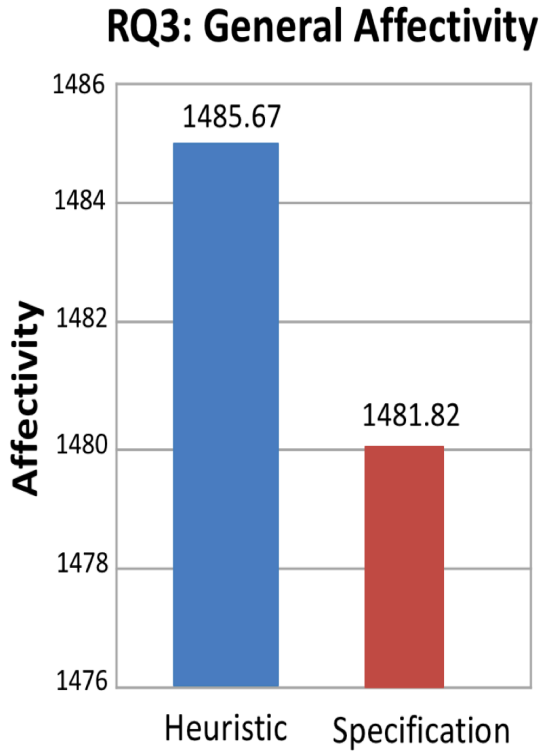


- **Expectation <u>Not Confirmed</u>:**
  Our initial expectation was that the number of correctly composed models might be improved using specification-based technique due to its flexibility to elaborate the composition rules. However, this expectation was not confirmed.

Conclusion of RQ2: Developers tend to produce a higher number of correctly composed models using heuristic-based technique, compared to specification-based technique.

Study Results

- **RQ3:** Composition and Affectivity



- **Finding 1:**
  Specification-based technique tends to cause a lower impact on the developers' affectivity, compared to heuristic-based technique.

Conclusion of RQ3: Specification-based technique tends to cause a lower impact on the affectivity of the developers, compared to heuristic-based technique.

Conclusion and Future Work

- **An initial empirical study was performed for:**
  - evaluating the effects of model composition techniques on the developers' effort and affective states
  - performing a pilot study to explore EEG in the context of model composition
- **Main finding:**
  - While the specification-based technique required a greater effort and produced a lower amount of correctly composed model, it caused a lower impact on affectivity.
- **Future work focuses on:**
  - Replicating this study with more participants, and
  - Exploring cognitive and emotional aspects of software developers.

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