Modelling the Quality Economics of Defect-Detection Techniques

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Introduction

Motivation

- Analytical software quality assurance (Reviews, Tests, ...), also called defect-detection techniques, is still the most important method to improve the quality of software
- The costs for those techniques is significant. Myers (1979) estimates that 50% of the total development costs can be attributed to testing. Jones (1987) states that 30–40% of the development costs are for quality assurance and defect removal. The *National Institute of Standards and Technology* (2002) even assigns 80% to the detection and removal of defects.
- There is a huge opportunity for cost savings in that area.

Problem

- This results in three questions:
  1. Which techniques should be used?
  2. In what sequence?
  3. With what effort for each technique?
- Ntafos (2001): "Cost is clearly a central factor in any realistic comparison but it is hard to measure, data are not easy to obtain, and little has been done to deal with it."
- Rai et al. (1998): "A better understanding of the costs and benefits of SQA and improvements to existing quantitative models should be useful to decision-makers."
- Boehm, keynote this morning

Overview

Introduction

Software Quality Economics

Running Example

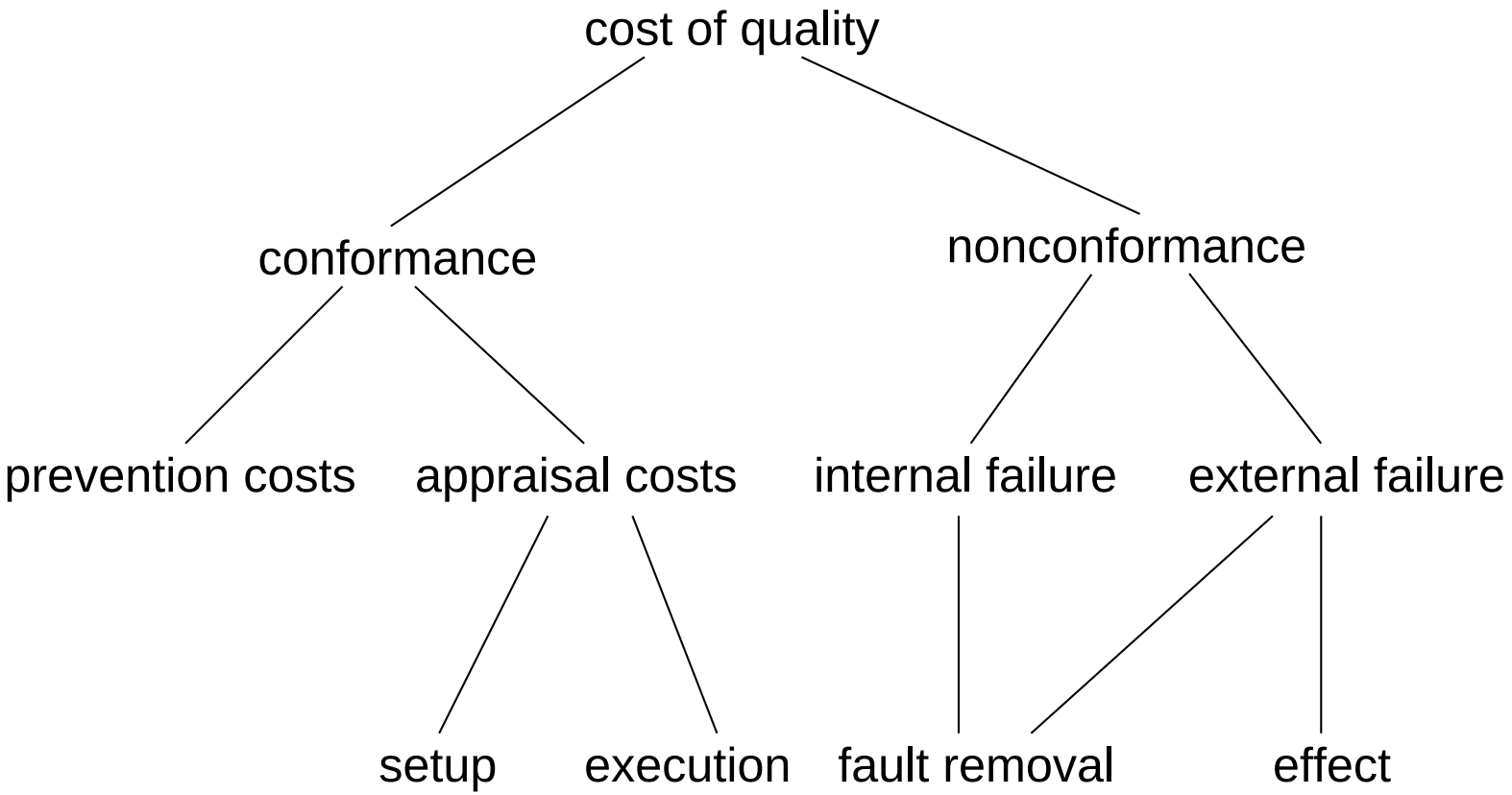
An Analytical Model

Conclusions

Software Quality Economics

Quality Economics

- Quality economics is the cost/benefit analysis w.r.t. quality
- The benefits are the saved costs



Constructive and Analytical QA

- Constructive quality assurance
  - Example: detailed architecture
  - Cause prevention costs
  - Prevent internal and external failure costs
- Analytical quality assurance
  - Defect-detection techniques: reviews, tests
  - Cause appraisal costs and internal failure costs
  - Prevent external failure costs

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- Focus on *analytical* QA in the following

Running Example

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- *How do you plan the quality assurance?*

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- *How probable is it that they occur at the customer?*

An Analytical Model

General

- For all types of defect-detection techniques
- Three components:
  - Direct costs d_A
  - Future costs t_A
  - Revenues / saved costs r_A
- Assumptions:
  - Found faults are perfectly removed
  - The effort for a technique can be freely varied
- Not covered:
  - Time to market
  - Net present value

Important Concepts

- By developing the software, a random number of faults is introduced
- (Fixed) setup and (variable) execution costs of techniques
- The difficulty function of Littlewood et al. (2000) denotes the difficulty for a specific technique to find a specific fault.
- We extend the function with the dimension *effort*
- Each fault has a probability of resulting in a failure in the field
- Defect removal costs for techniques and in the field

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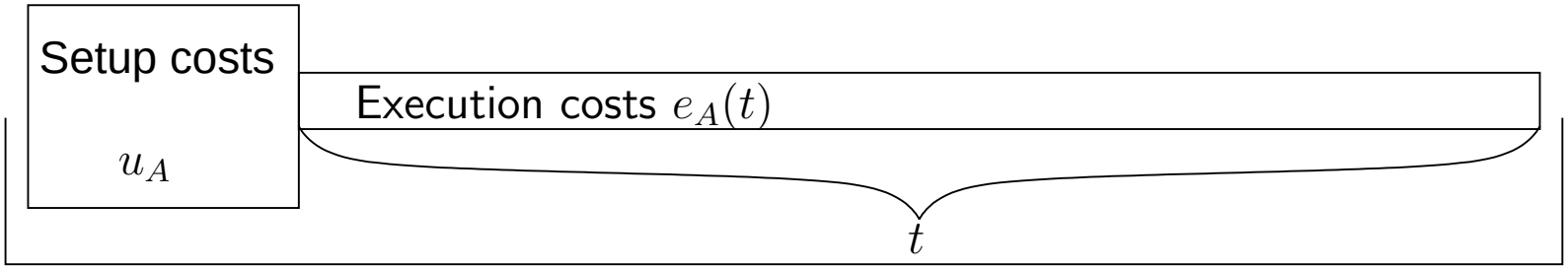

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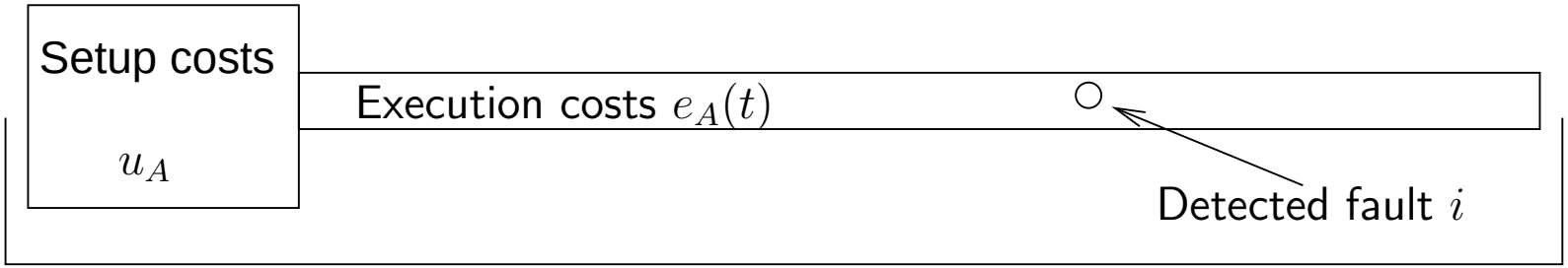

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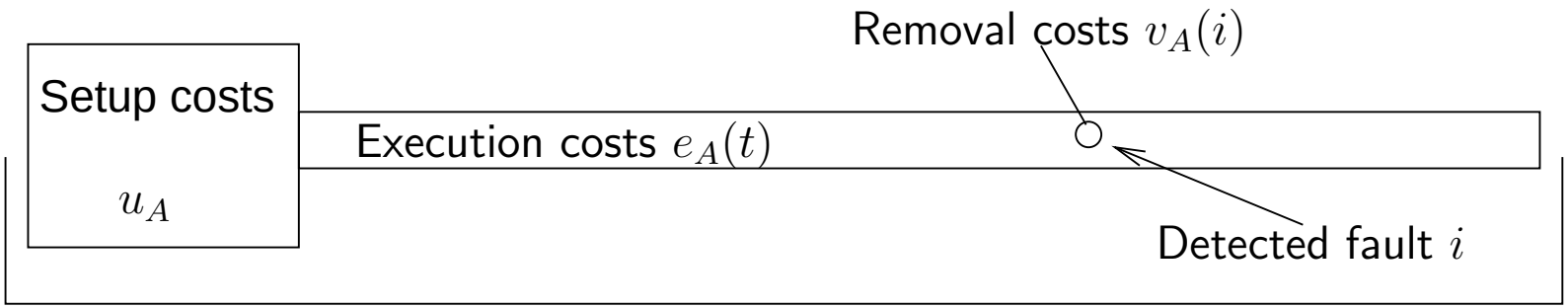

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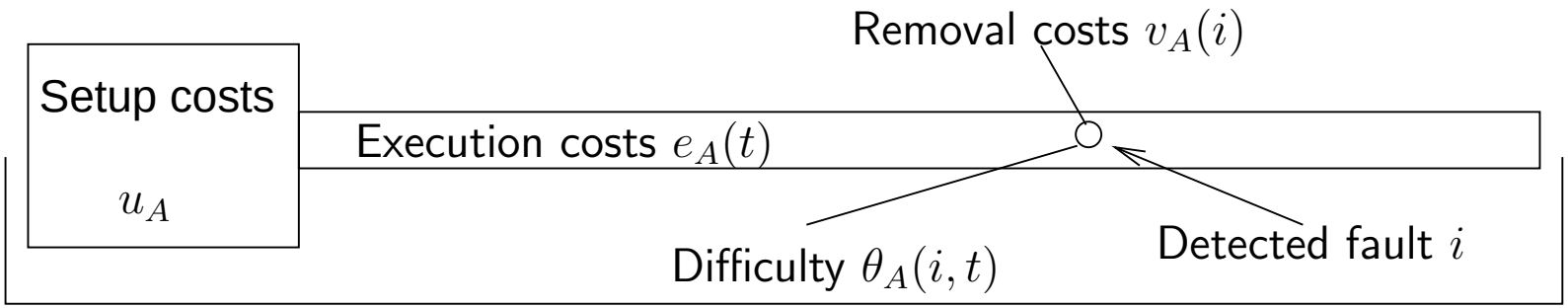

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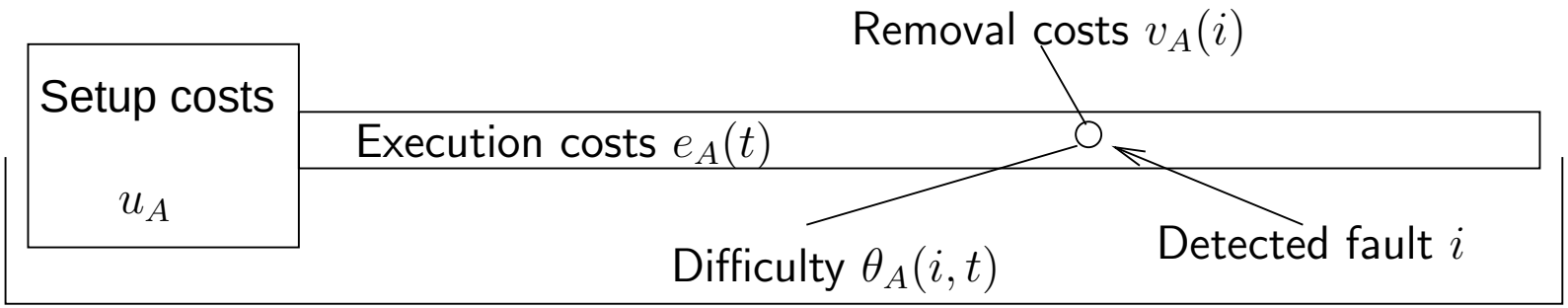

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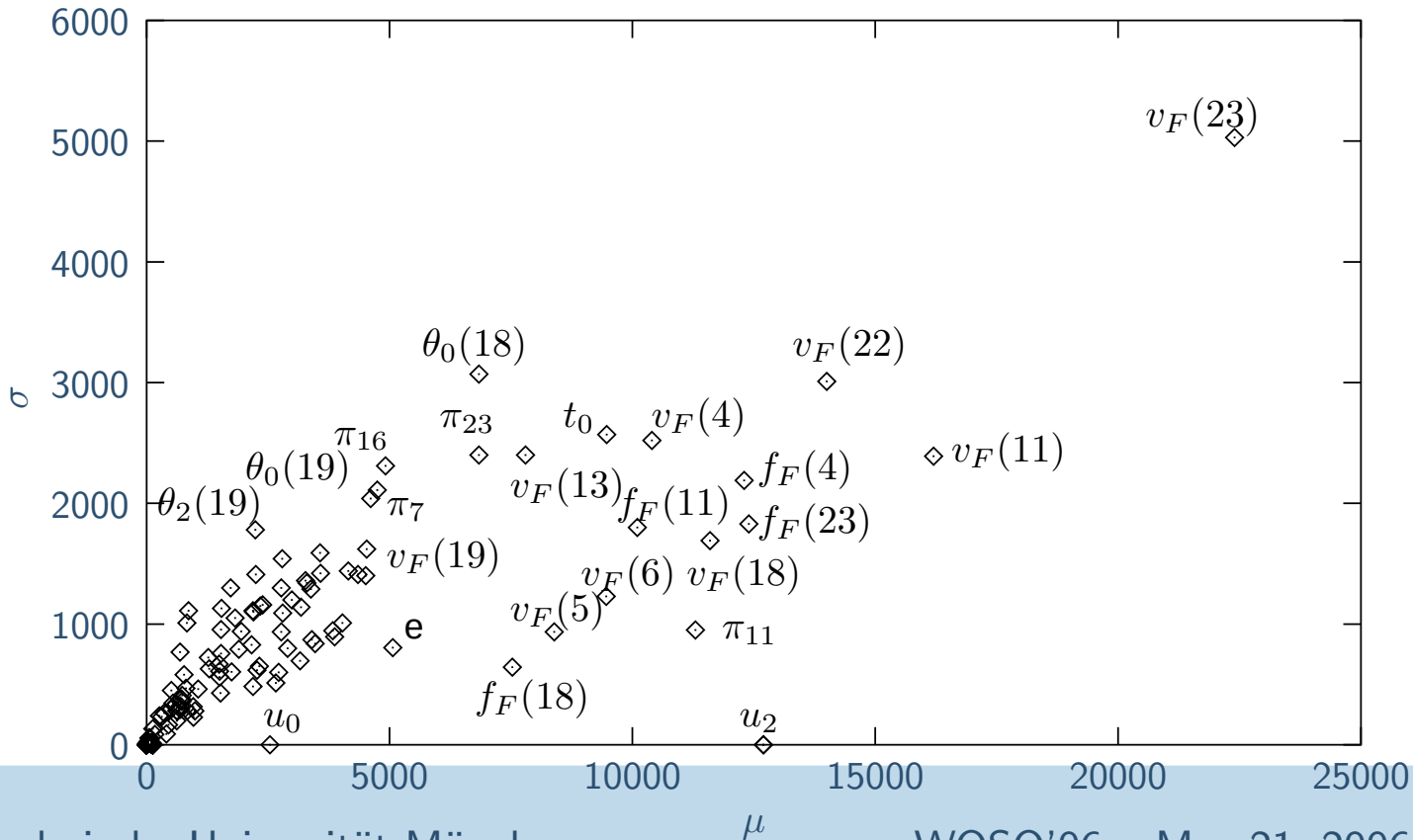
- $\theta_A(i,t)$ derived from Littlewood et al. (2000)

Usage

- Theoretical analysis of defect-detection techniques and improvements
  - Which parts of the model are affected by improvements?
  - How do different techniques differ?
  - What are the most important factors?
- Practical optimisation with simplified model
  - Grouping of defects by defect types
  - Collecting data in a company
  - Predicting for new project based on old data
  - Using optimisation methods

Sensitivity Analysis

- Using the example project on model-based testing of an automotive control unit in Pretschner et al. (2005)
- Removal costs have a strong influence on output variation
- Effect costs and failure probabilities
- Difficulty of the first technique



Conclusions

Summary

- Costs and benefits are a central factor in planning software quality assurance
- Models of those costs and benefits can help decision makers
- We propose an analytical model of the quality economics
- More detailed as common economical models
- But more general than specific inspection or reliability models
- Sensitivity analysis shows that the removal costs in the field, the effect costs, and the failure probability of the faults have the strongest effects on the output variation

Future work

- Evaluation of static analysis tools (bug finding tools) using the model with data from a company
- Evaluation of the predictive validity of the model
- Empirical research regarding the most important factors of the model