

Porantim: An Approach to Support the Combination and Selection of Model-Based Testing Techniques

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4th Workshop on the
Automation of Software Test (AST'09)
Vancouver - Canada





Agenda

- SW Technologies Selection: MBT Techniques
- MBT Techniques Selection Approach: *Porantim*
- The Computerized Infrastructure
- *Porantim* Evaluation: Experimental Study
- Future Works

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SW Technologies Selection

- Problem reported since 1991 when Basili & Rombach (SE 1991) proposed an approach for reusing of SW technologies
- Technologies selection task may influence the SW process effectiveness and SW quality (Vegas & Basili, ESE 2005)
- Software Technologies Selection Scenarios:
 1. Only 1 SW technology is enough (e.g.: modeling tool)
 2. More than 1 SW technology can be combined aiming at improving the results (e.g.: software testing techniques)



Selection of Testing Techniques

- Selection of more than 1 testing techniques:
 - [+] May increase testing coverage and software quality
 - [-] May increase the effort and cost for testing
 - [-] May require a larger testing team to use all techniques
- Testing techniques selection needs to be analyzed carefully based on software projects needs
- Characterization Schema (Vegas & Basili, ESE 2005)
 - Testing Techniques selection approach
 - It supports just the individual selection of testing techniques
 - It provides just a general characterization of testing techniques

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Selection of MBT Techniques

➤ Model-Based Testing:

- Automatic generation of test cases based on software models (Dalal *et al.*, ICSE 1999)
- It has specific characteristics when compared to other testing techniques subcategories (Dalal *et al.*, ICSE 1999)
 - It needs a software modeling activity before tests generation
 - It depends on the quality of Software Model
 - ...
- Its specific characteristics may influence on the selection of the MBT techniques for software projects

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Selection of MBT Techniques

Research Hypotheses

1. The specialization of the MBT techniques characterization is important for the selection process quality
2. It is necessary to provide a process guiding the selection of MBT techniques
3. Providing knowledge regarding MBT techniques adequacy for a software project would contribute for the selection process quality
4. Providing knowledge regarding the impact of combining more than 1 MBT techniques would contribute for the selection process quality

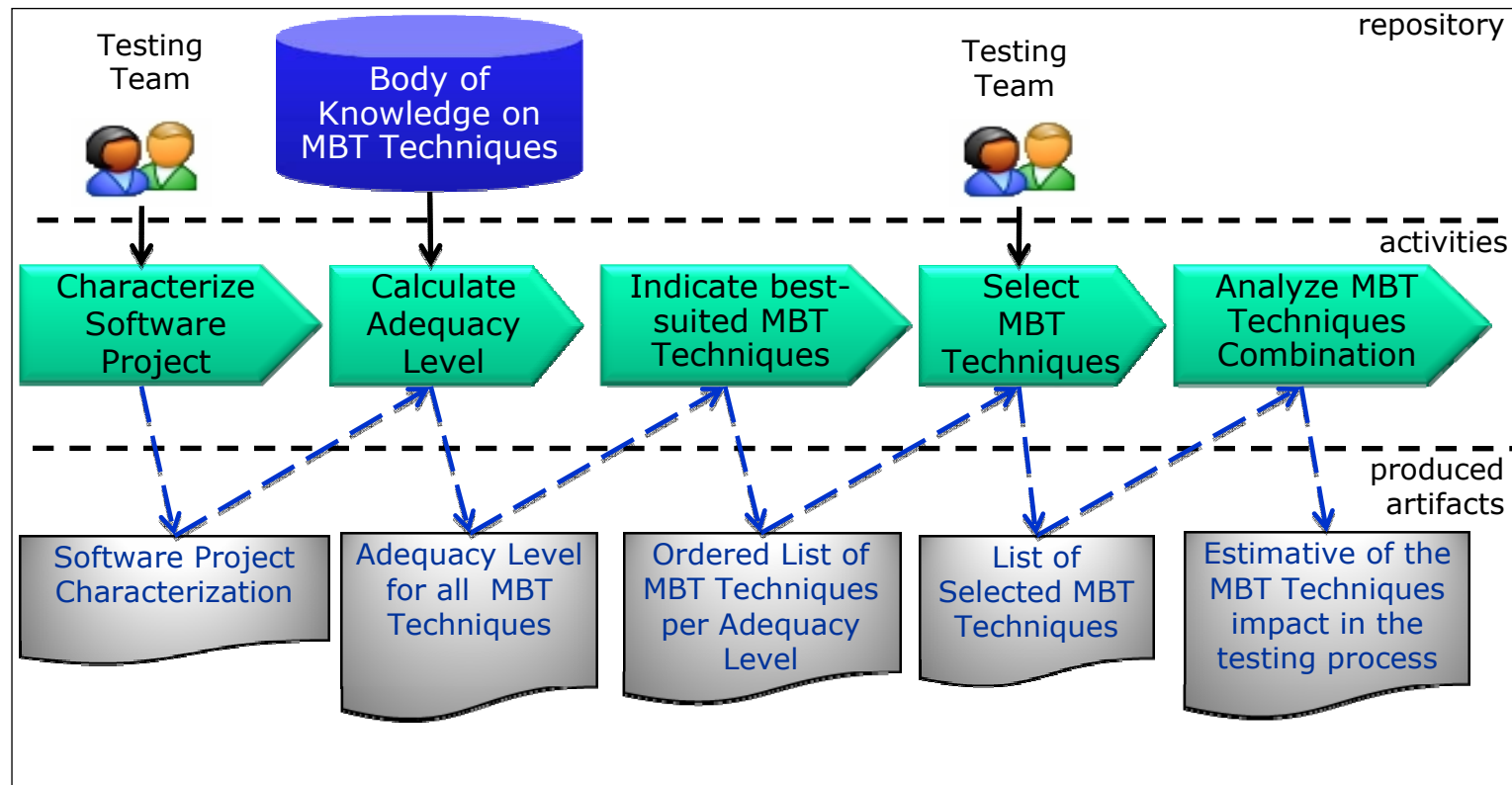


MBT Techniques Selection Approach: *Porantim*

- Evolution of *Characterization Schema*, based on:
 1. Body of Knowledge regarding MBT Techniques
 - o Inclusion of specific characterization attributes for MBT Techniques
 - o Definition of weights for each characterization attributes
 - o Results presented in AST'2008 (Dias-Neto & Travassos, 2008)
 2. Process of MBT Techniques Selection
 - o Explicit description of activities and artifacts/information to be executed/produced while selecting MBT techniques

MBT Techniques Selection Approach: *Porantim*

➤ MBT Techniques Selection Process



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MBT Techniques Selection Approach: *Porantim*

- Calculating Adequacy Level
 - Crossing characteristics of SW Project x MBT Techniques
 - These attributes are translated into numbers using some pre-defined rules (presented in the paper)
 - These values are represented using two vectors: 1 for the SW Project and 1 for the MBT technique
 - The *Euclidian Distance* is calculated between these two vectors
 - Adequacy Level (AL):
 - Number [0 – 100%] indicating how closer are the MBT technique characteristics when compared to the SW project characteristics
 - 0% → Low Adequacy between SW Project and Technique
 - 100% → High Adequacy between SW Project and Technique



MBT Techniques Selection Approach: *Porantim*

- Analyzing the combination of MBT Techniques
 - Goal: supporting an impact analysis of the selected MBT techniques regarding some testing process variables:
 - **Coverage of Software Project Requirements:** which testing requirements are attended by the selected MBT techniques
 - **Saved Modelling Effort:** which models required by MBT techniques are already available in the SW development process
 - **Human Resources:** which skills/capabilities required by the selected MBT Techniques are attended by the testing team
 - Output: indicator between [0 – 100%] estimating the impact of the selected MBT techniques in these variables
 - [0-25%] Very Low ; [25-50%] Low ; [50-75%] Medium ; [75-100%] High

The Computerized Infrastructure

➤ Extension of Maraká Infrastructure

- Maraká: Computerized infrastructure for testing planning and control (Dias-Neto & Travassos, SBES 2006)
 - <http://lens-ese.cos.ufrj.br/maraka>
- Porantim functionalities were included into the context of Maraká's "Testing Approaches Selection" activity

➤ Facilities:

- Step 1: Software Project Characterization
- Step 2: Selection of MBT Techniques
- Step 3: Combination of MBT Techniques

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The Computerized Infrastructure

➤ STEP 1: Software Project Characterization

1 SW Project Characterization	▶	2 Selection of MBT Techniques	▶	3 Combining MBT Techniques
Characteristics of the Software to be developed				
>> Execution Platform	Desktop - MS Windows			<input checked="" type="radio"/> Optional <input type="radio"/> Required
>> Development Paradigm:	Object-oriented			<input checked="" type="radio"/> Optional <input type="radio"/> Required
>> Programming Language:	Java			<input checked="" type="radio"/> Optional <input type="radio"/> Required
>> Models provided by the Development Process:	<input type="checkbox"/> Data Dictionary in OCL <input type="checkbox"/> EFSM - Extended Finite State Machine	<input checked="" type="checkbox"/> UML Class Diagram <input type="checkbox"/> UML Collaboration Diagram		<input checked="" type="radio"/> Optional <input type="radio"/> Required
>> Modeling Technology:	UML - Unified Modeling Language			<input checked="" type="radio"/> Optional <input type="radio"/> Required
Testing Requirements for the Software Project				
>> Testing Levels required:	<input type="checkbox"/> Acceptation Testing <input type="checkbox"/> Integration Testing <input type="checkbox"/> Regression Testing	<input type="checkbox"/> Stress Testing <input checked="" type="checkbox"/> System Testing <input type="checkbox"/> Unit Testing		<input checked="" type="radio"/> Optional <input type="radio"/> Required
>> Testing Types:	Functional			<input checked="" type="radio"/> Optional <input type="radio"/> Required
>> Quality Charateristics to be evaluated:	<input checked="" type="checkbox"/> Performance <input checked="" type="checkbox"/> Functionality	<input type="checkbox"/> Reliability <input type="checkbox"/> Security		<input checked="" type="radio"/> Optional <input type="radio"/> Required
>> Type of Failure to be revealed:	<input type="checkbox"/> Data File Error <input checked="" type="checkbox"/> Database Error	<input checked="" type="checkbox"/> Incorrect Logic in the Code <input checked="" type="checkbox"/> Interface Error		<input checked="" type="radio"/> Optional <input type="radio"/> Required
>> Cost estimated for test execution:	Low			
>> Tool required for testing:	Any tool			<input checked="" type="radio"/> Optional <input type="radio"/> Required

The Computerized Infrastructure

➤ STEP 2: Selection of MBT Techniques

1 SW Project Characterization 2 Selection of MBT Techniques 3 Combining MBT Techniques

MBT techniques best suited to the Software Project

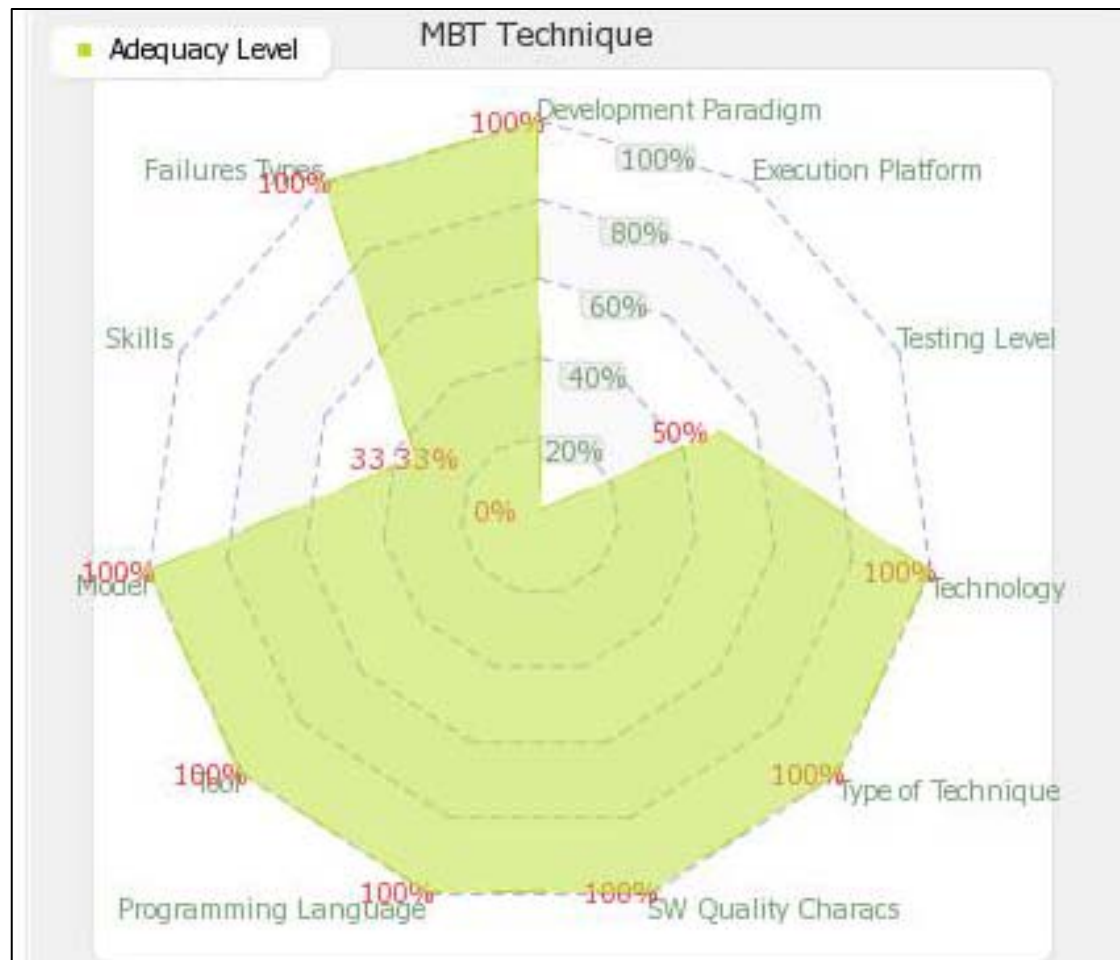
Select which MBT Techniques you intend to use in this Software Project.

	MBT Techniques	Category	Year	Authors	Type of Technique	Tool	Adequacy Level	Details
<input type="checkbox"/>	MBT Technique #2	A	2002	Briand and Labiche	Funcional	TOTEM	60.01 %	
<input checked="" type="checkbox"/>	MBT Technique #4	A	2000	Hartmann e Nagin	Funcional	AGEDIS	55.83 %	
<input checked="" type="checkbox"/>	MBT Technique #1	C	2000	Abdurazik and Offut	Estrutural	Plug-in for Rational Rose	50.68 %	
<input type="checkbox"/>	MBT Technique #5	C	1999	Kim et al	Estrutural	Not defined	42.74 %	
<input type="checkbox"/>	MBT Technique #11	D	1999	Chung et al.	Estrutural	No tool	13.89 %	

Navigation: Previous Activity, Save, Next Activity, Back, Help

The Computerized Infrastructure

- STEP 2: Selection of MBT Techniques
 - Spider/Radar chart: graphical visualization of adequacy level



The Computerized Infrastructure

➤ STEP 3: Combination of MBT Techniques

1 SW Project Characterization

2 Selection of MBT Techniques

3 Combining MBT Techniques

Análise da Combinação de Técnicas de TBM e seu impacto no Processo de Testes

MBT Techniques	Category	Year	Authors	Type of Technique	Tool	Adequacy Level	Details
MBT Technique #4	A	2000	Hartmann e Nagin	Funcional	AGEDIS	55.83 %	
MBT Technique #1	C	2000	Abdurazik and Offut	Estrutural	Plug-in for Rational Rose	50.68 %	

Gauge Charts analyzing the Combination of the selected MBT Techniques

Indicator of Coverage of Software Projects Requirements	Testing Level	Testing Requirements for the Software Project	Techniques Characteristics	
	SW Quality Characs	System Testing	System Testing	
	Failure Types	Functionality; Performance;	Functionality; Performance; Security;	
		Database Error; Incorrect Data Type; Incorrect Logic in the Code; Interface Error; Missing Code; Navigational Error;	Data File Error; Database Error; Exception Error; Incorrect Logic in the Code; Interface Error; Missing Code; Navigational Error; Shell Script Error;	

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Porantim's Evaluation: Experimental Study

➤ Goal:

- Analyzing three different approaches for the selection of MBT techniques
 - (CE) Characterization Schema (Vegas & Basili, ESE 2005)
 - (PI) *Porantim* Incomplete (CE + MBT attributes)
 - (PC) *Porantim* Complete (PI + adequacy level indicators)
- Aspects evaluated:
 - Completeness ; Effectiveness ; **Efficiency** ; Usability ; User satisfaction
- Aspect presented in AST: Efficiency
 - Metric: percent of adequate selections / selection time

Porantim's Evaluation: Experimental Study

➤ Results: Average Analysis

	% of adequate selection	Selection time	% of adequate selection / selection time
Selection Approach			
Characterization Schema	50.00%	65.50 min	0.78 (%/min)
<i>Porantim</i> incomplete	68.33%	58.10 min	1.28 (%/min)
<i>Porantim</i> complete	86.11%	45.25 min	1.89 (%/min)
Software Project			
Video	73.33%	54.30 min	1.51 (%/min)
Loan Arranjer	57.57%	53.64 min	1.21 (%/min)
Parking	68.33%	61.91 min	1.10 (%/min)
WLMS	60.60%	62.00 min	0.93 (%/min)

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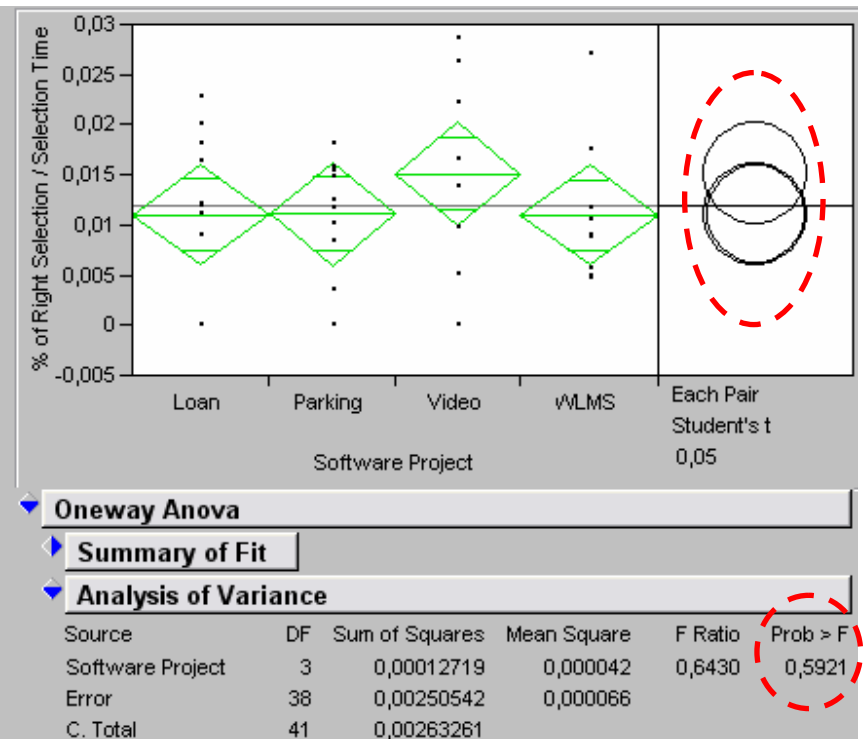
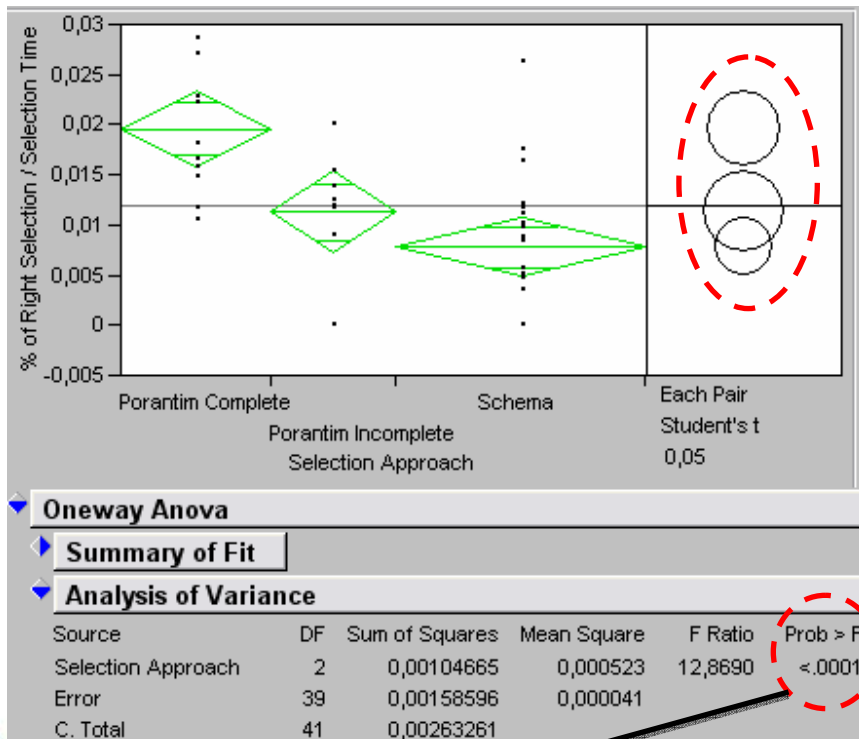
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Porantim's Evaluation: Experimental Study

➤ Results: Analysis of Variance ($\alpha = 0.05$)

- JMP 4.0 Tool



" p -value $< \alpha$ " → statistical significance

Porantim's Evaluation: Experimental Study

➤ Summary of the Results

Category	Variable	Which factor has influence?
Completeness	% of used Information during the selection	NONE
	Amount of missing information during the selection	NONE
Effectiveness	% of Adequate Choices	PORANTIM COMPLETE
Efficiency	Selection Time (in minutes)	PORANTIM COMPLETE
	% of Adequate Choices / % of used Information	PORANTIM COMPLETE
	% of Adequate Choices / Selection Time	PORANTIM COMPLETE
Usability	Amount of problems reported during the selection	NONE



Future Works

- Evaluating the computerized infrastructure supporting *Porantim* in the software industry
- Re-executing the systematic review on MBT techniques to update the body of knowledge regarding MBT techniques
- Conducting more experimental studies to evaluate the formulas used to estimate the impact of MBT techniques combination



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MBT Techniques Selection Approach: *Porantim*

- Analyzing MBT Techniques Combination
 - Coverage of Software Project Requirements
 - o Testing Levels:
 - Testing levels required by SW project?
 - Testing levels evaluated by MBT techniques?
 - o Software Quality Characteristics:
 - The SW quality characteristics required by SW project?
 - The SW quality characteristics evaluated by MBT techniques?
 - o Type of Detected Failures:
 - The type of failures to be revealed in the SW project?
 - The type of failures identified by MBT techniques?



MBT Techniques Selection Approach: *Porantim*

- Analyzing MBT Techniques Combination
 - Saved Modelling Efforts:
 - Which models are (not) provided by SW project?
 - Which models are (not) required by MBT techniques?

 - Saved Modelling Efforts:
 - Which skills have the testing team in the SW project?
 - Which skills are required to use the MBT techniques?



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