Technische Universität Braunschweig

Institut für Programmierung und Reaktive Systeme

Towards Incremental Model Slicing for SPL Regression Testing

Sascha Lity, Hauke Baller, Ina Schaefer, May 14th, 2015

Technische Universität Braunschweig

Motivation

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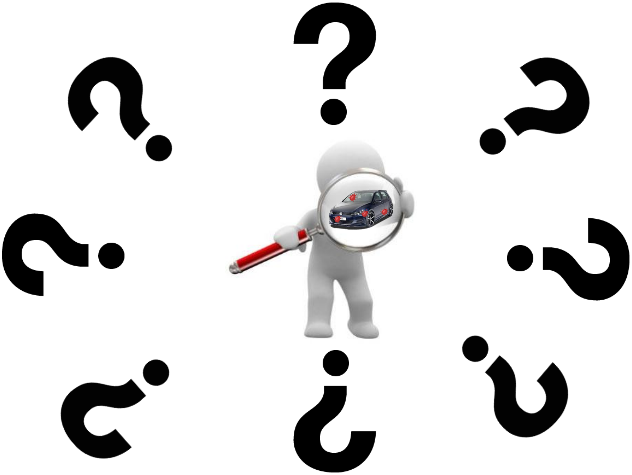

Motivation

Product-by-Product Testing

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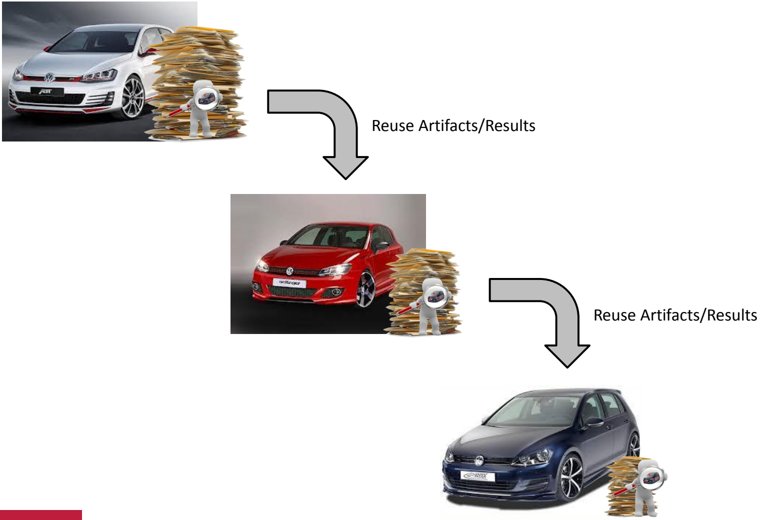
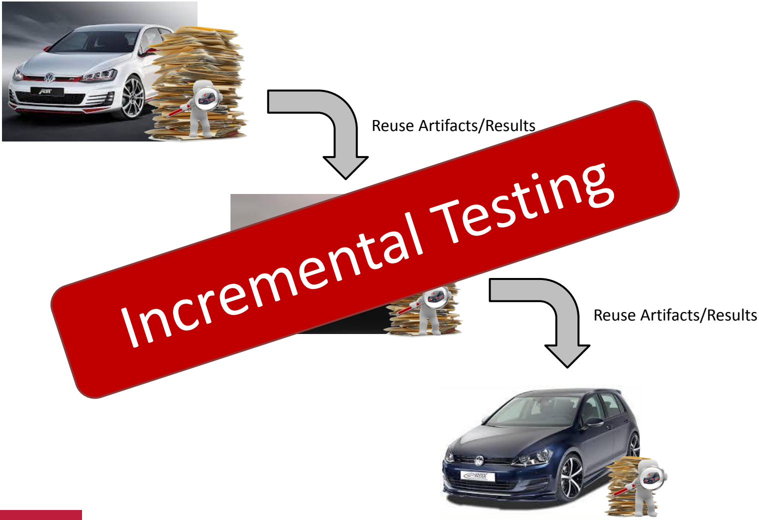


Product-by-Product Testing



Applying Regression Testing for SPLs

Regression testing allows for incremental SPL testing [TTK04, Eng10]

Regression Testing validates whether modified software behaves as intended, and modifications have not adversely impacted the software's quality. [Rot96]

- Software *version* testing vs. software *variant* testing?
- *Reuse* of test artifacts?
- *Incremental* SPL testing?
- *Retest* decision?

Applying Regression Testing for SPLs

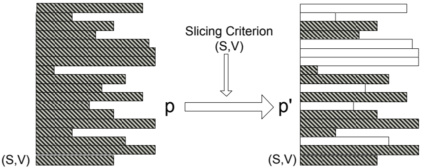
Regression testing allows for incremental SPL testing [TTK04, Eng10]

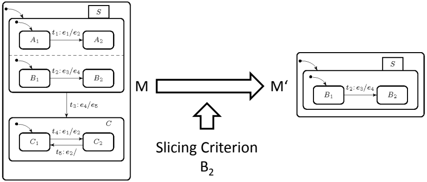
> *Regression Testing validates whether modified software behaves as intended, and modifications have not adversely impacted the software's quality.* [Rot96]

- Software *version* testing vs. software *variant* testing?
- *Reuse* of test artifacts? ⇒ Adaption of Delta Modeling [CHS15]
- *Incremental* SPL testing? ⇒ Delta-oriented [LSKL12, Loc12, $LLL^{+}14$]
- *Retest* decision? ⇒ Slicing [AHKL93, BH93, GHS92]

Program/Model Slicing

- Static program projection technique by Weiser [Wei81]
- Preserves syntax and semantics w.r.t. slicing criterion
- Based on control/data dependencies
- Model slicing [JWZC02, KLB12, ACH$^+$13] adapts concept for state-based models





Variability-aware Slicing [ACLF11, KLB12, KS14]

Conditioned Model Slicing of Feature-Annotated State Machines

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Slicing Feature Models

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Program Slicing in the Presence of Preprocessor Variability

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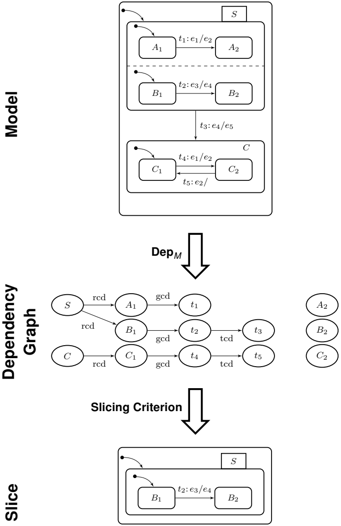
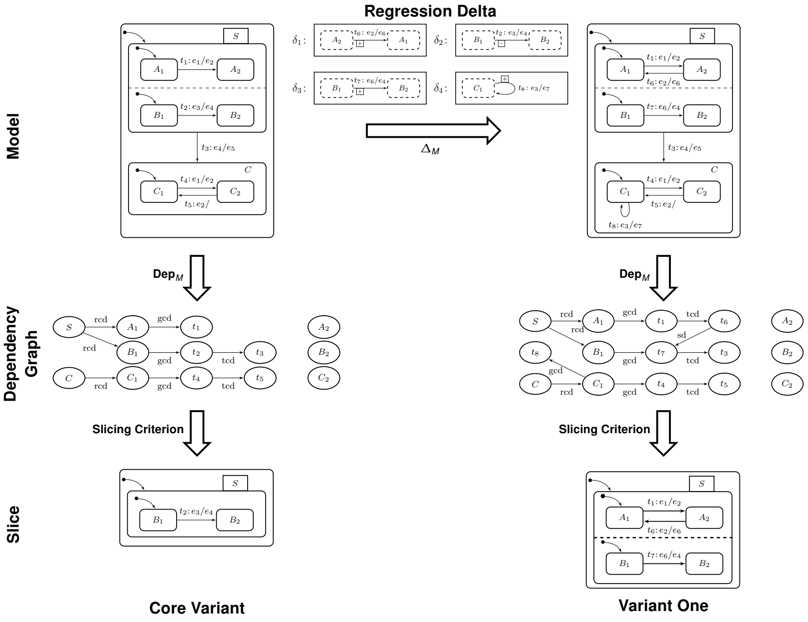


Core Variant

Lity, Baller, Schaefer: Towards Incremental Model Slicing for Delta-oriented SPLs, SANER'15 [LBS15]



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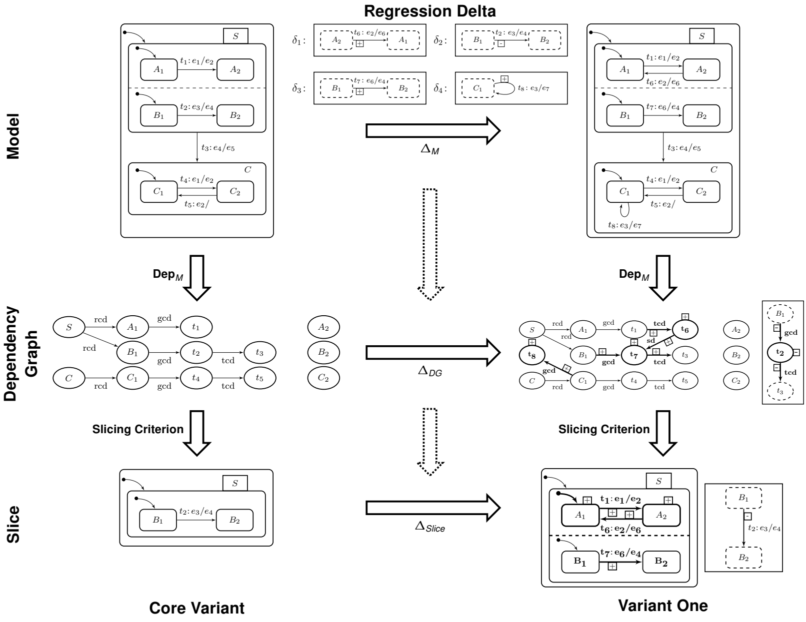

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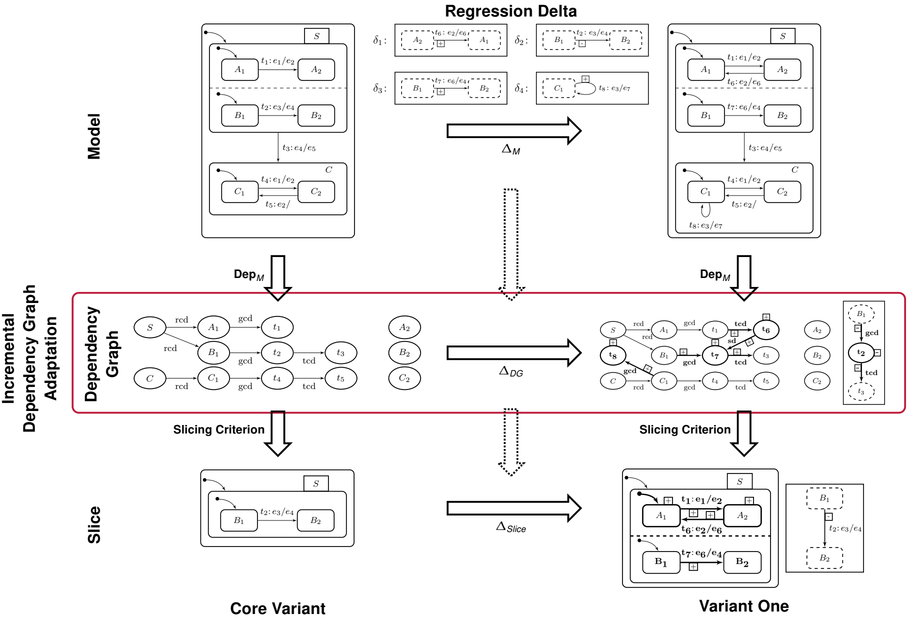

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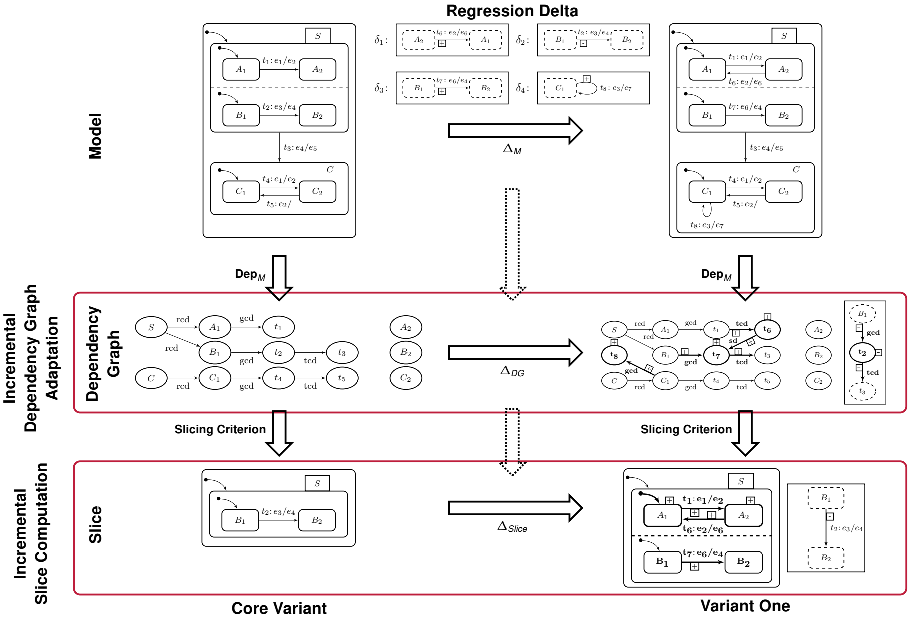


Lity, Baller, Schaefer: Towards Incremental Model Slicing for Delta-oriented SPLs, SANER'15 [LBS15]

Discussion

Dependence on Differences

- Number of model deltas
- Impact/Distributability of changes

Worst Case

- Distributed changes
- No effort reduction

Average Case

- Local changes
- Exploit commonality

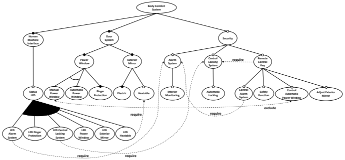
Benefits

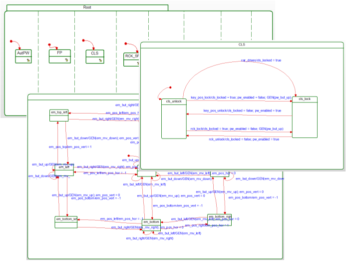
1. Effort reduction for dependency graph generation
2. Direct derivation of slice changes

Evaluation – BCS Case Study [LLLS12]

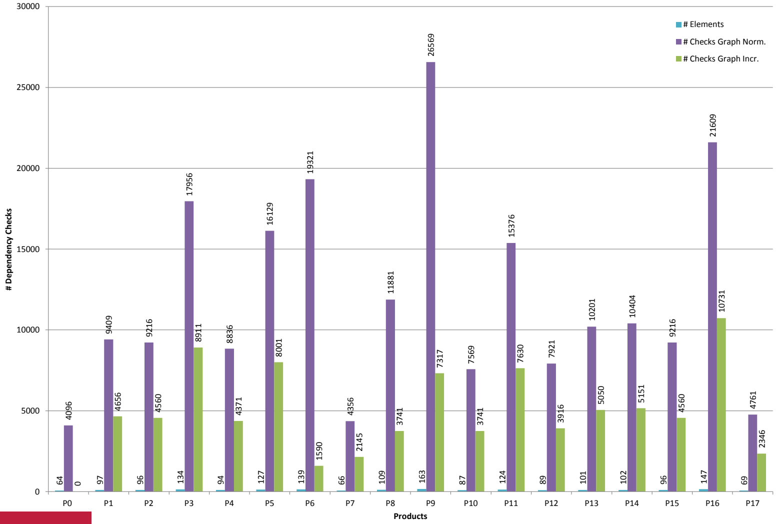
Body Comfort System

- 27 features ⇒ 11616 variants
- Sampling subset: 18 Products (incl. core) [OLZG11, LSKL12]
- Sampling result ⇒ Order
- Model size:
  - ∅ Elements: 106
  - ∅ States: 40
  - ∅ Transition: 66
  - ∅ Hierarchy Depth: 3

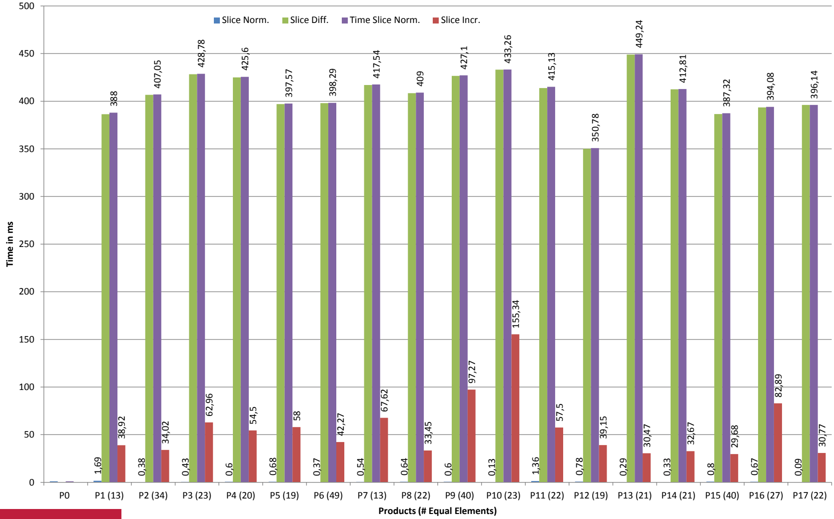




Evaluation – Dependency Graph (First Results)



Evaluation – Slicing and Model Diff (First Results)



First Idea – Retest Coverage Criterion

Slice differences indicate *retest potentials* based on the impact of model changes

- What are retest requirements/goals?
  - Elements corresponding to slice differences
  - Elements connected to those elements
- Applicable for selection and prioritization
  - (Pairwise) coverage of retest requirements/goals
  - Number of occurrences of a difference usable as weighting factor
  - Potential retest test case generation
- Retest requirements/goals refer only to retestable behavior
- Model parts not influenced by changes indicate behavior not to be retested

Conclusion & Future Work

Conclusion

- Regression Testing ⇒ Incremental SPL testing
- Incremental model slicing ⇒ Change impact analysis
- Slice differences ⇒ Retest potentials
- Retest decision ⇒ Retest coverage criterion

Future Work

- Comprehensive evaluation
- Extension of control and data dependency
- Extension & optimization of implementation
- Application for (evolution-aware) change impact analysis

Thank You for Your Attention! Any Questions?

IMoTEP

Integrated **Mo**del-based **T**esting of Continuously **E**volving Software **P**roduct Lines

Design For FUTURE
DFG priority programme 1593
Design For Future - Managed Software Evolution
DFG

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References I

Kelly Androutsopoulos, David Clark, Mark Harman, Jens Krinke, and Laurence Tratt.
State-based Model Slicing: A Survey.
ACM Comput. Surv., 45(4):53:1–53:36, August 2013.

Mathieu Acher, Philippe Collet, Philippe Lahire, and Robert B. France.
Slicing feature models.
In *ASE'11*, pages 424–427, 2011.

Hiralal Agrawal, Joseph R. Horgan, Edward W. Krauser, and Saul London.
Incremental regression testing.
In *Proceedings of the Conference on Software Maintenance*, ICSM '93, pages 348–357, Washington, DC, USA, 1993. IEEE Computer Society.

Samuel Bates and Susan Horwitz.
Incremental program testing using program dependence graphs.
In *Proceedings of the 20th ACM SIGPLAN-SIGACT Symposium on Principles of Programming Languages*, POPL '93, pages 384–396, New York, NY, USA, 1993. ACM.

References II

Dave Clarke, Michiel Helvensteijn, and Ina Schaefer.
Abstract Delta Modeling.
Mathematical Structures in Computer Science, 25(3):482–527, 2015.

Emelie Engström.
Exploring Regression testing and software product line testing - research and state of practice.
Lic dissertation, Lund University, May 2010.

R. Gupta, M.J. Harrold, and M.L. Soffa.
An approach to regression testing using slicing.
In *Software Maintenance, 1992. Proceerdings., Conference on*, pages 299–308, Nov 1992.

Wang Ji, Dong Wei, and Qi Zhi-Chang.
Slicing Hierarchical Automata for Model Checking UML Statecharts.
In *Formal Methods and Software Engineering*, pages 435–446. Springer, 2002.

Jochen Kamischke, Malte Lochau, and Hauke Baller.
Conditioned Model Slicing of Feature-Annotated State Machines.
In *FOSD'12*, pages 9–16, 2012.

References III

Frederik Kanning and Sandro Schulze.
Program Slicing in the Presence of Variability.
In *ICSME'14 - ERA Track*, 2014.

Sascha Lity, Hauke Baller, and Ina Schaefer.
Towards incremental model slicing for delta-oriented software product lines.
In *Software Analysis, Evolution and Reengineering (SANER), 2015 IEEE 22nd International Conference on*, pages 530–534, March 2015.

Malte Lochau, Sascha Lity, Remo Lachmann, Ina Schaefer, and Ursula Goltz.
Delta-oriented Model-based Integration Testing of Large-scale Systems.
Journal of Systems and Software, 91:63–84, 2014.

Sascha Lity, Remo Lachmann, Malte Lochau, and Ina Schaefer.
Delta-oriented Software Product Line Test Models - The Body Comfort System Case Study.
Technical Report 2012-07, Technische Universität Braunschweig, 2012.

References IV

Malte Lochau.
Model-Based Conformance Testing of Software Product Lines.
PhD thesis, Technische Universität Braunschweig, 2012.

Malte Lochau, Ina Schaefer, Jochen Kamischke, and Sascha Lity.
Incremental Model-Based Testing of Delta-Oriented Software Product Lines.
In *TAP'12*, pages 67–82. Springer, 2012.

S. Oster, M. Lochau, M. Zink, and M. Grechanik.
Pairwise Feature-Interaction Testing for SPLs: Potentials and Limitations.
In *FOSD'11*, 2011.

Alessandro Orso, Saurabh Sinha, and Mary Jean Harrold.
Incremental Slicing Based on Data-Dependences Types.
In *ICSM'01*, page 158, 2001.

Gregg Rothermel.
Efficient, Effective Regression Testing Using Safe Test Selection Techniques.
PhD thesis, Clemson University, May 1996.

References V

Antti Tevanlinna, Juha Taina, and Raine Kauppinen.
Product Family Testing: A Survey.
SIGSOFT Softw. Eng. Notes, 29(2):12–12, March 2004.

Heike Wehrheim.
Incremental Slicing.
In *Formal Methods and Software Engineering, ICFEM'06*, pages 514–528, 2006.

Mark Weiser.
Program slicing.
In *ICSE'81*, pages 439–449, 1981.