Closing Gaps between Capture and Replay: Model-based GUI Testing

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2015-10-19

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Intro

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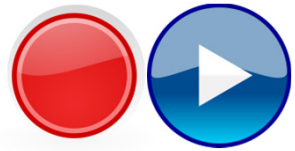
Motivation, Goal

- Generic way for testing software are GUI-tests
- Goal: development of GUI test method
- Combining existing methods:
  - Capture/Replay
  - Widget Trees
  - State Machines
  - Classification Tree Method
- Done so far: Concept and Implementation
- Pros/Cons of combination

Basics

Capture/Replay + Widget-Trees



Capture/Replay

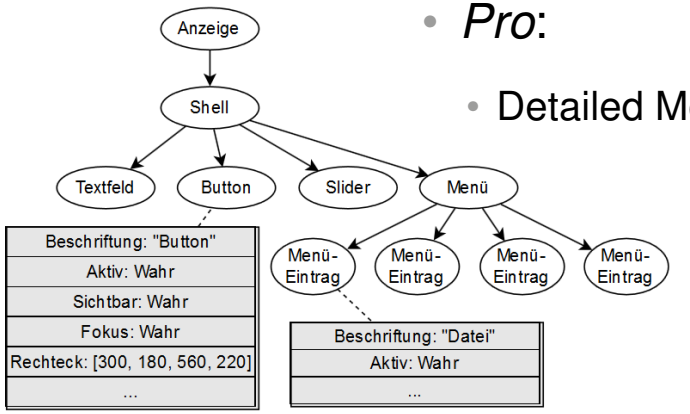
- Sequence of actions is captured and can be replayed
- *Pro*:
  - Intuitive Usability
  - Widespread

Con:
- High Maintenance Costs,
- Low Stability against Changes

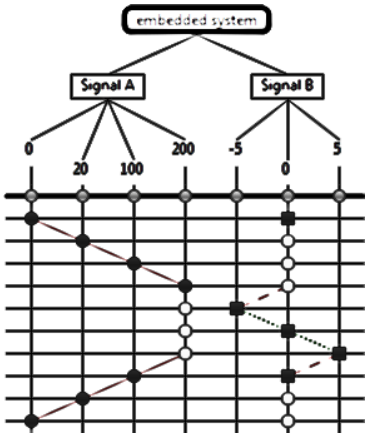
Widget Trees

- Describes a Widget-Hierarchy for a certain point in time
- *Pro*:
  - Detailed Modeling of GUI States

Con:
- Description of single state only



Classification Tree Method + State Machine

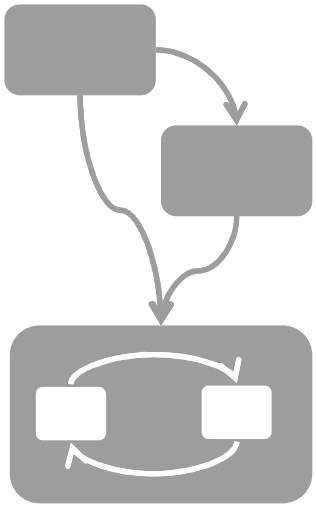


Classification Tree Method

- *Pro*:
  - Systematic Derivation of Test Cases
  - Established in Practice
  - Suitable for Functional Black Box Testing

Con:

- Can be Too Large for Complex Systems



State Machine

- *Pro* :
  - Modeling and Selection of System Behavior (Sequences)
  - Easy to Learn
  - Easy to Maintain

Con:

- Difficult Automated Construction

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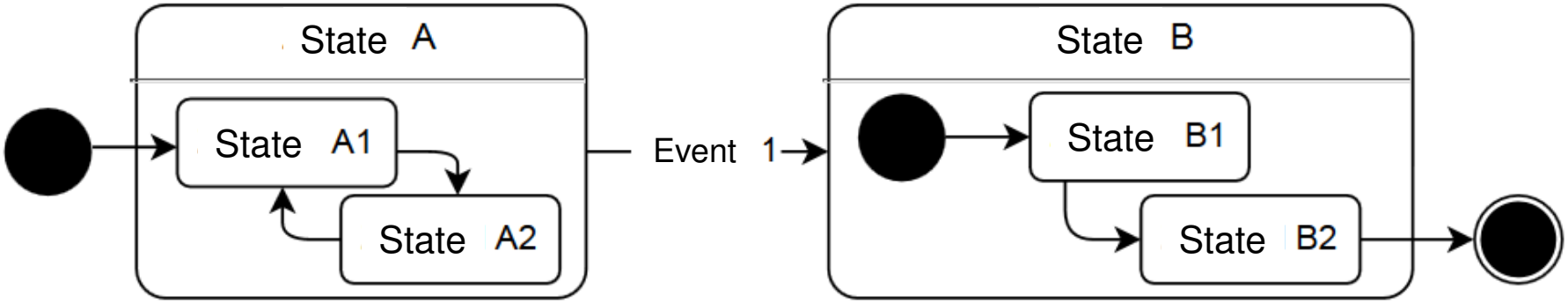
State Machine - Hierarchy

- Helps to structure and to keep clarity
- Describes XOR-Relation („*1-in-n*“)
  - *State A* ⇔ *State A1* **XOR** *State A2*



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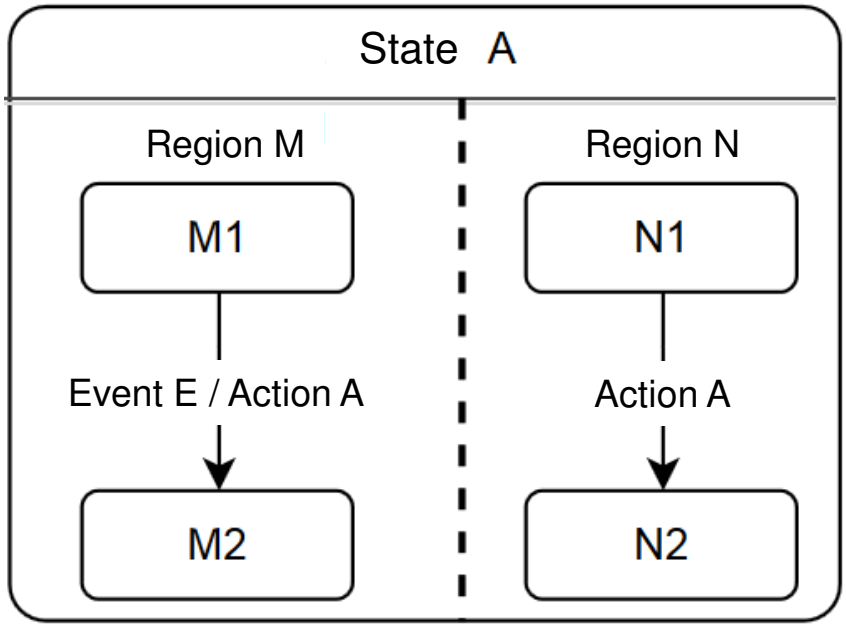
State Machine - Orthogonality

- AND-Relation
  - *State A ⇔ Region M* ***AND*** *Region N ⇔ (M1* ***XOR*** *M2)* ***AND*** *(N1* ***XOR*** *N1)*
- reduces complexity
  - Only N+M States required instead of N*M



Method + Realization

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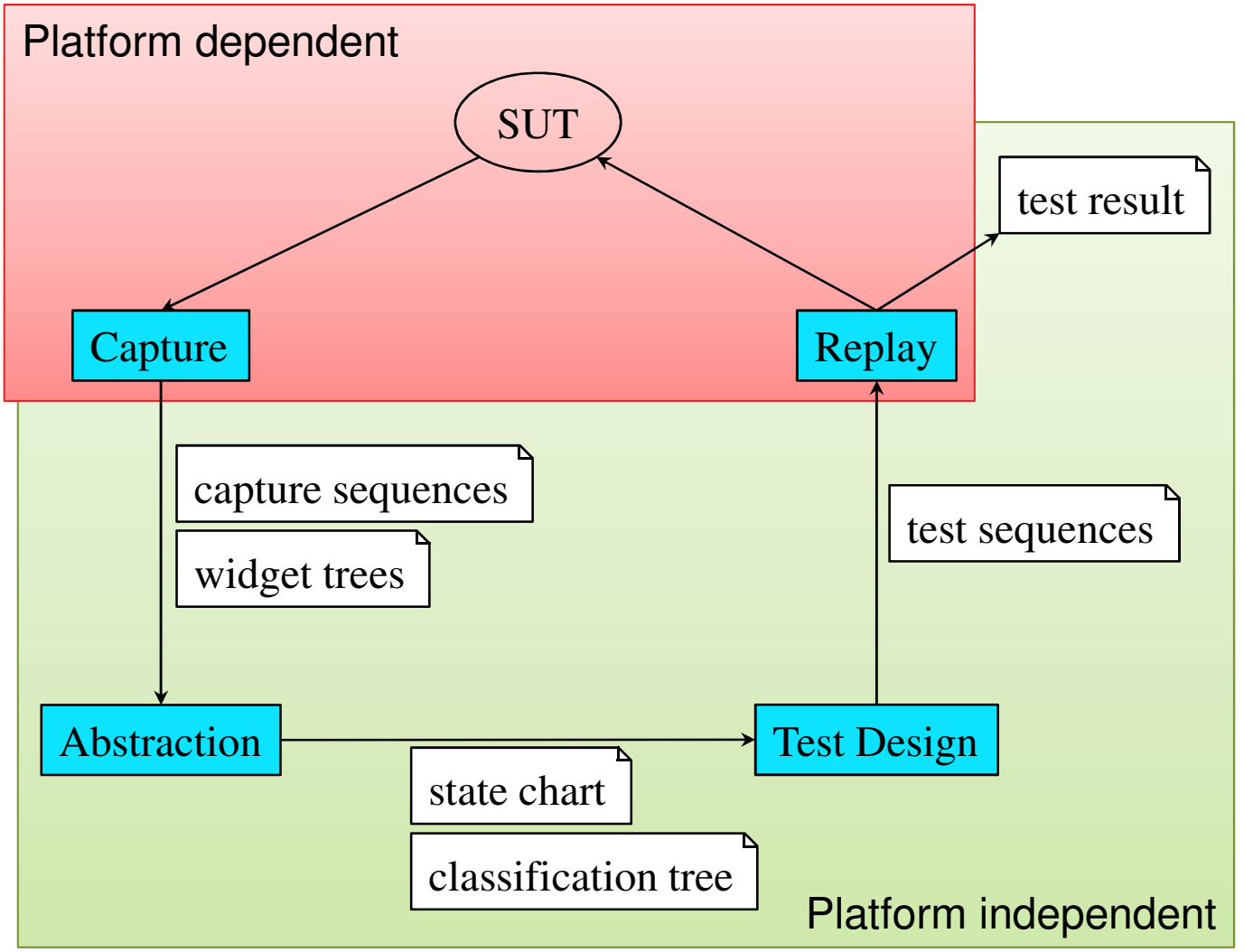
Overview

Borrowed from

Test*



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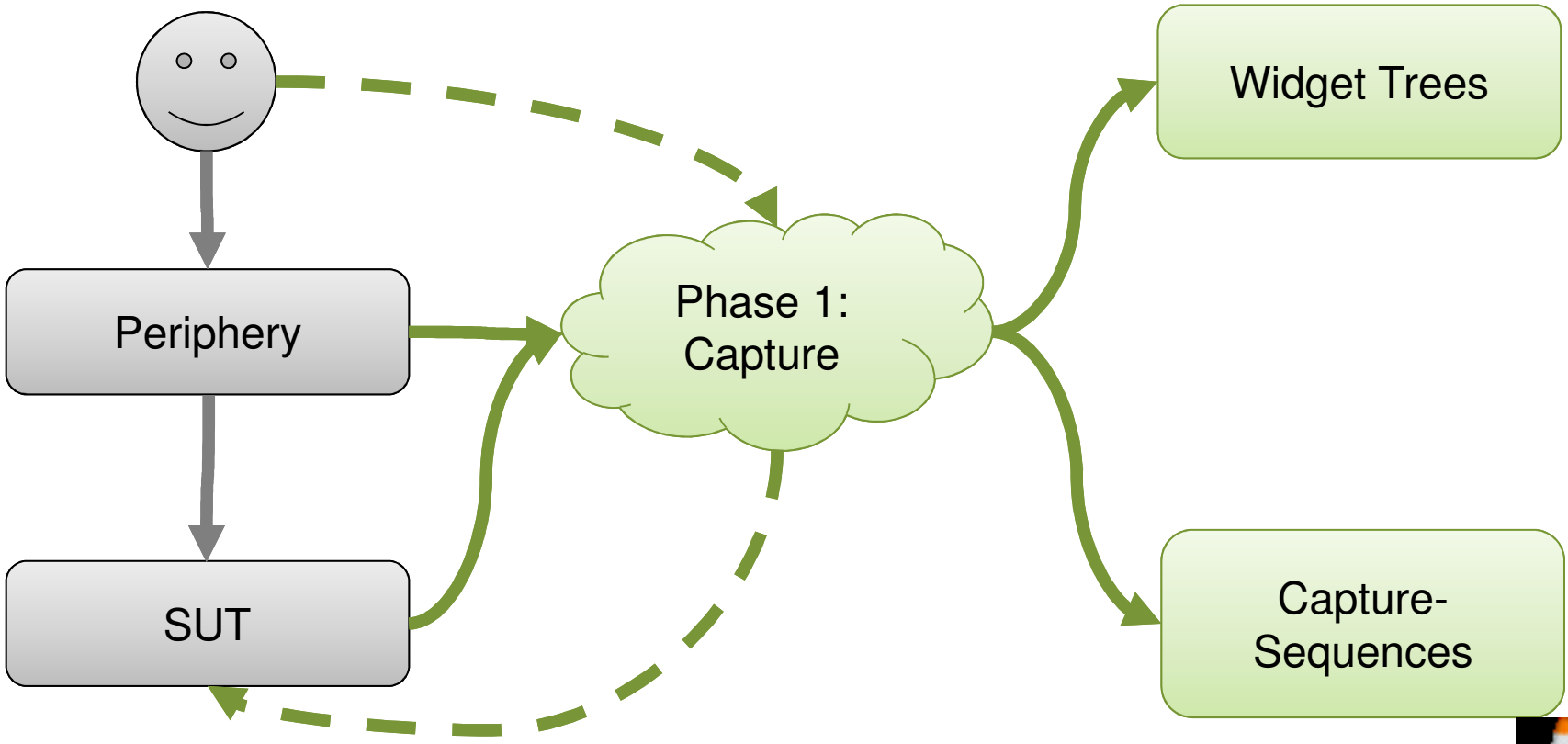
Phase 1: Capture



Phase1.avi

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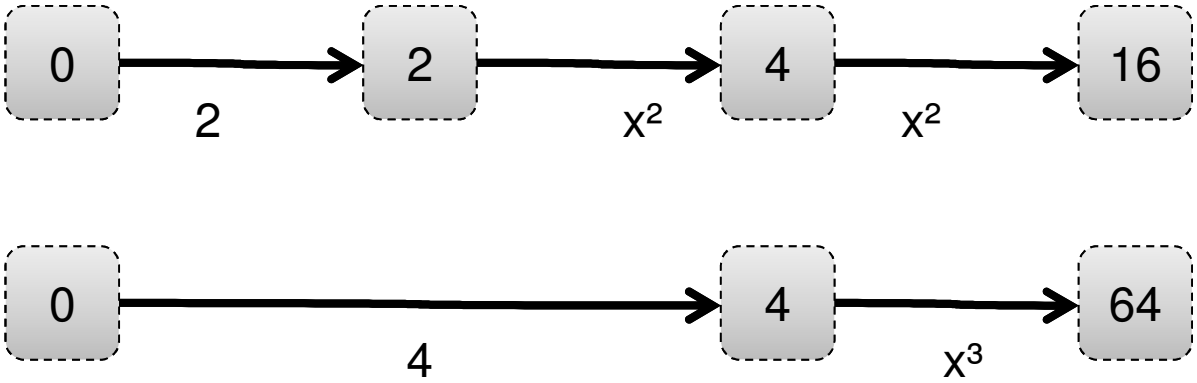
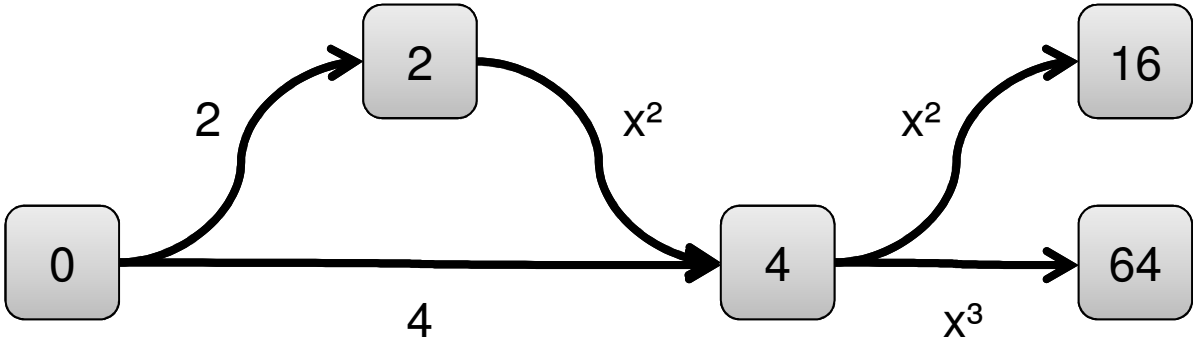
Phase 1: Capture - Artefacts

Capture-Sequences



GUI-Modell



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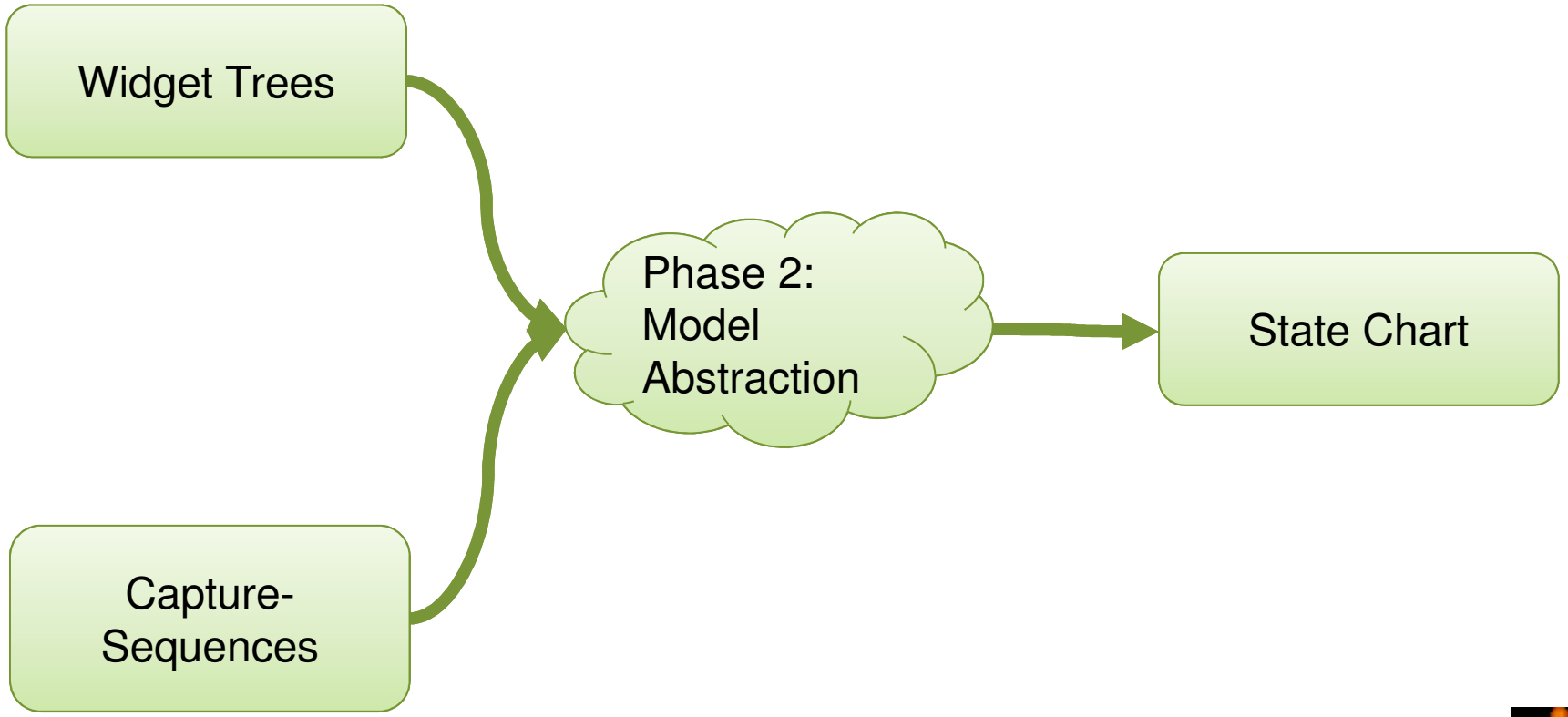
Phase 2: Model Abstraction



Phase2.avi

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Phase 2: Details

1. **Creation of Hierarchy**
2. **Creation of Orthogonality**
3. Inclusion of Sequences
4. Creation of Classification Tree

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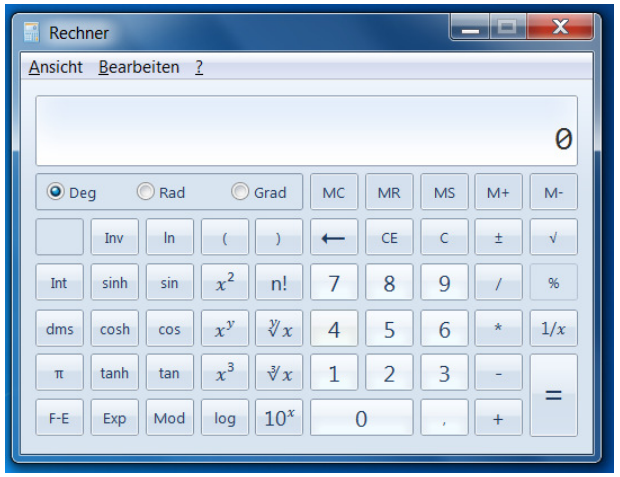
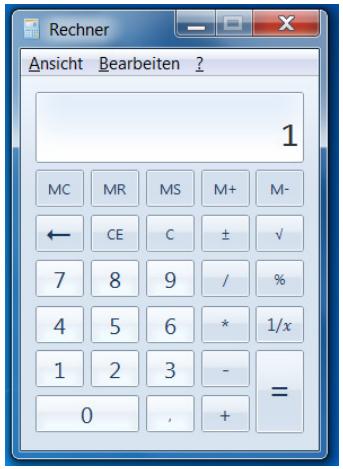
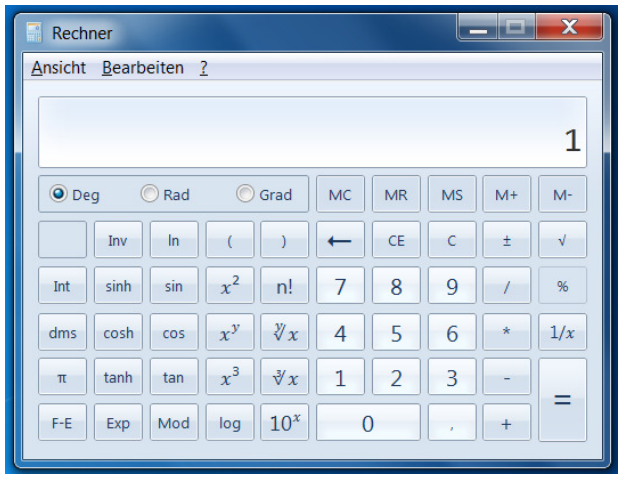
Phase 2: Creation of Hierarchy







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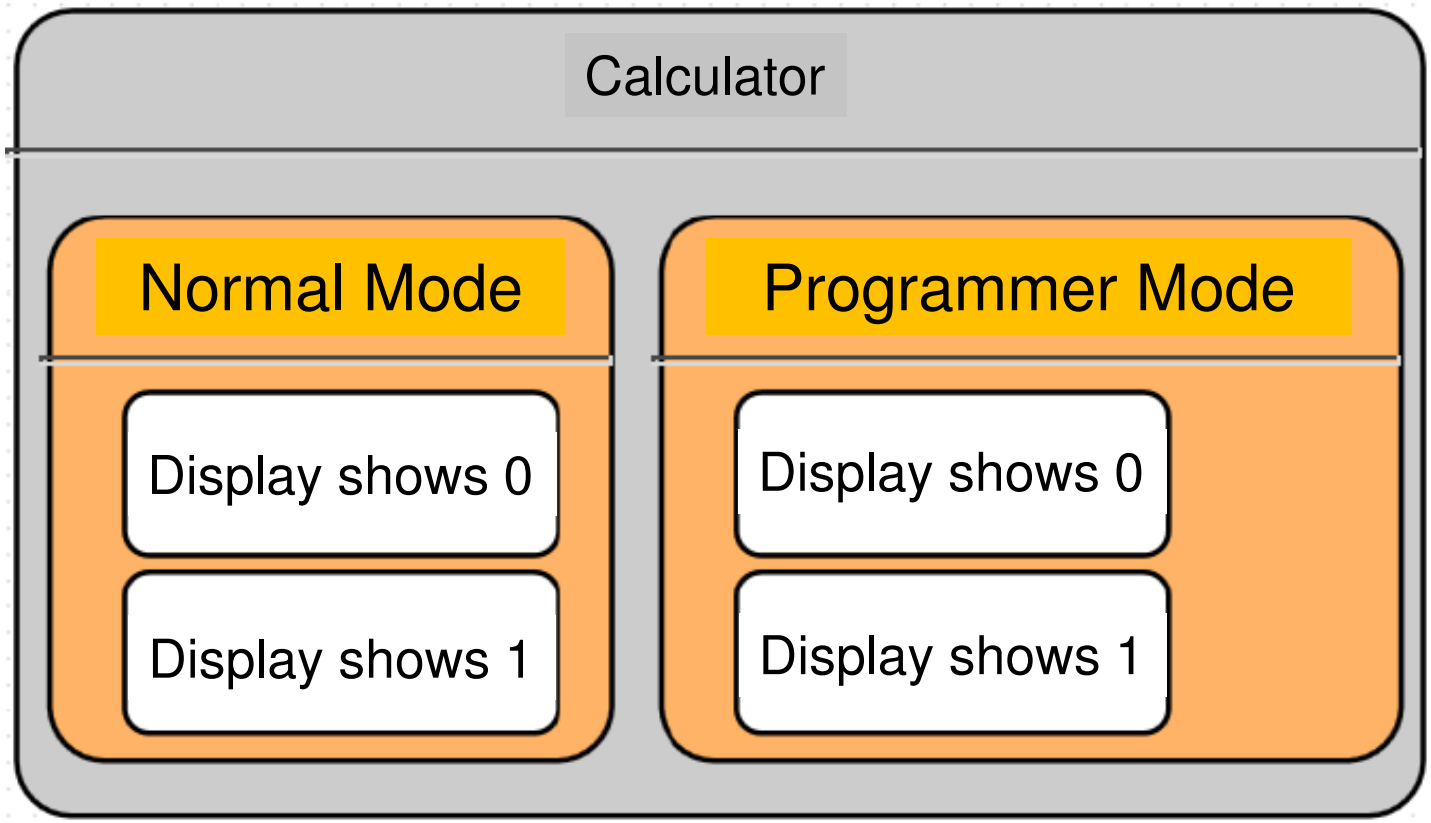
Phase 2: Creation of Hierarchy



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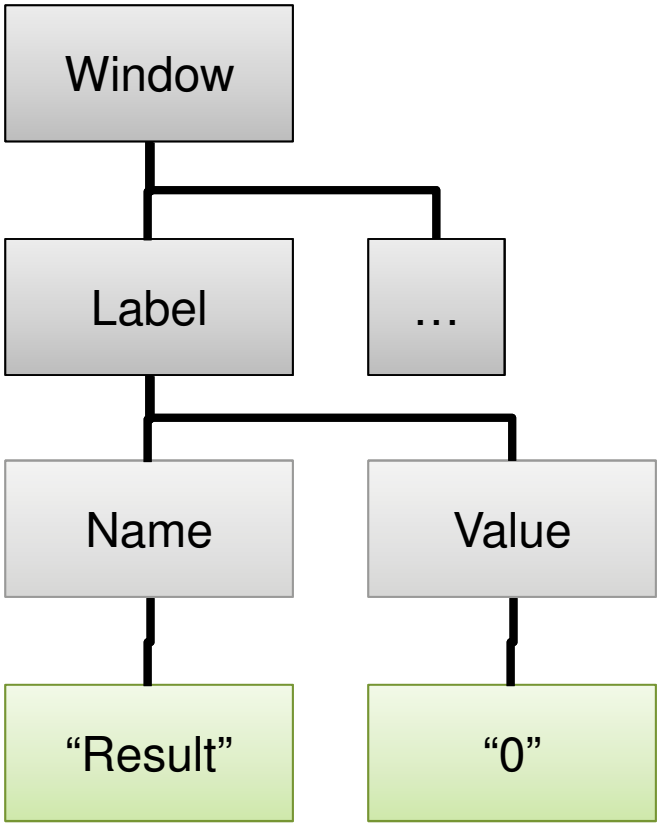
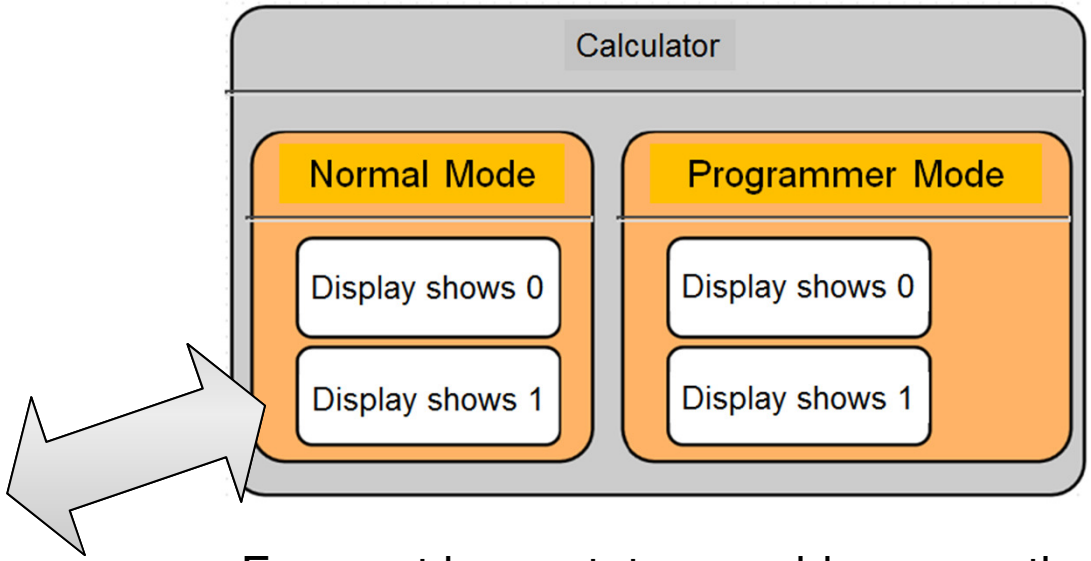
Phase 2: Creation of Hierarchy





For most inner state, consider properties.

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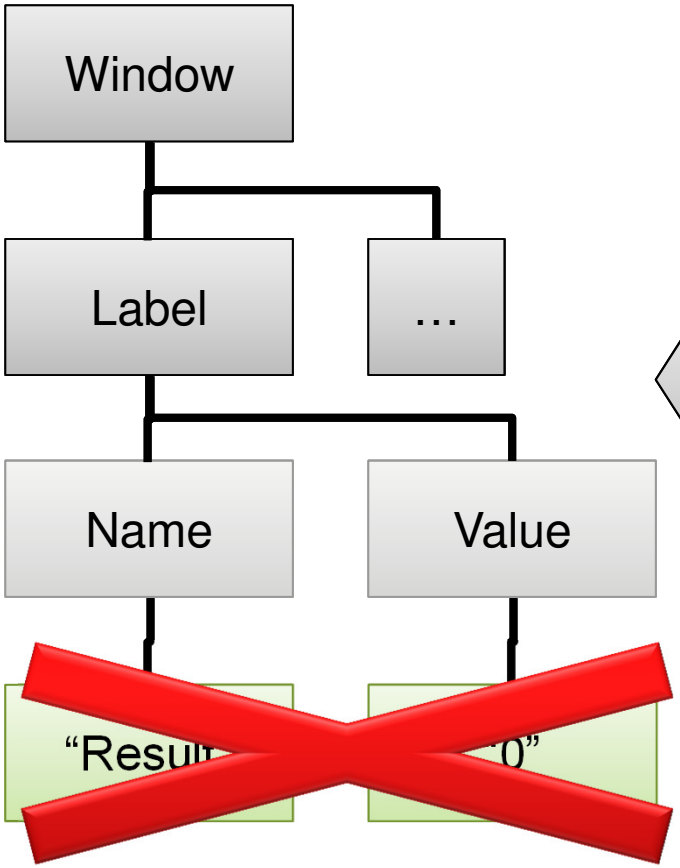
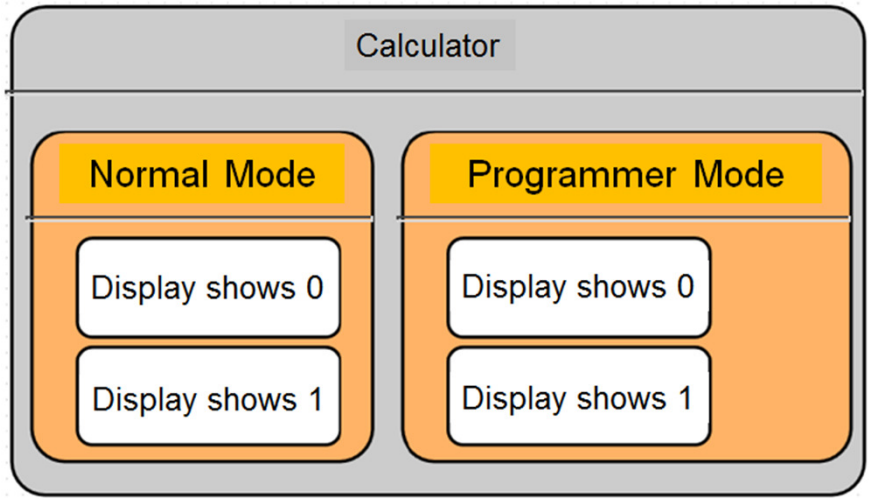
Phase 2: Creation of Hierarchy





Discard properties for grouping.

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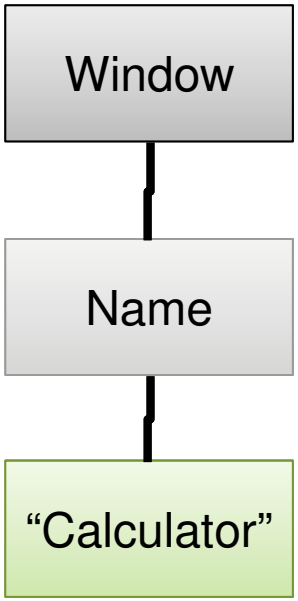
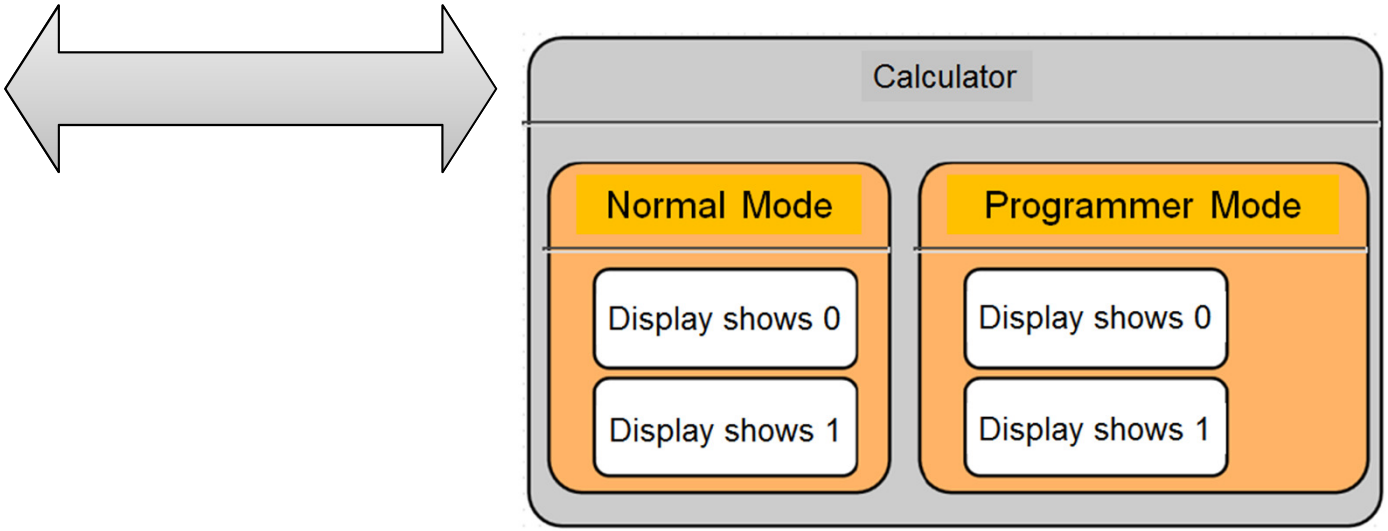
Phase 2: Creation of Hierarchy





Use Window Name for outer state.

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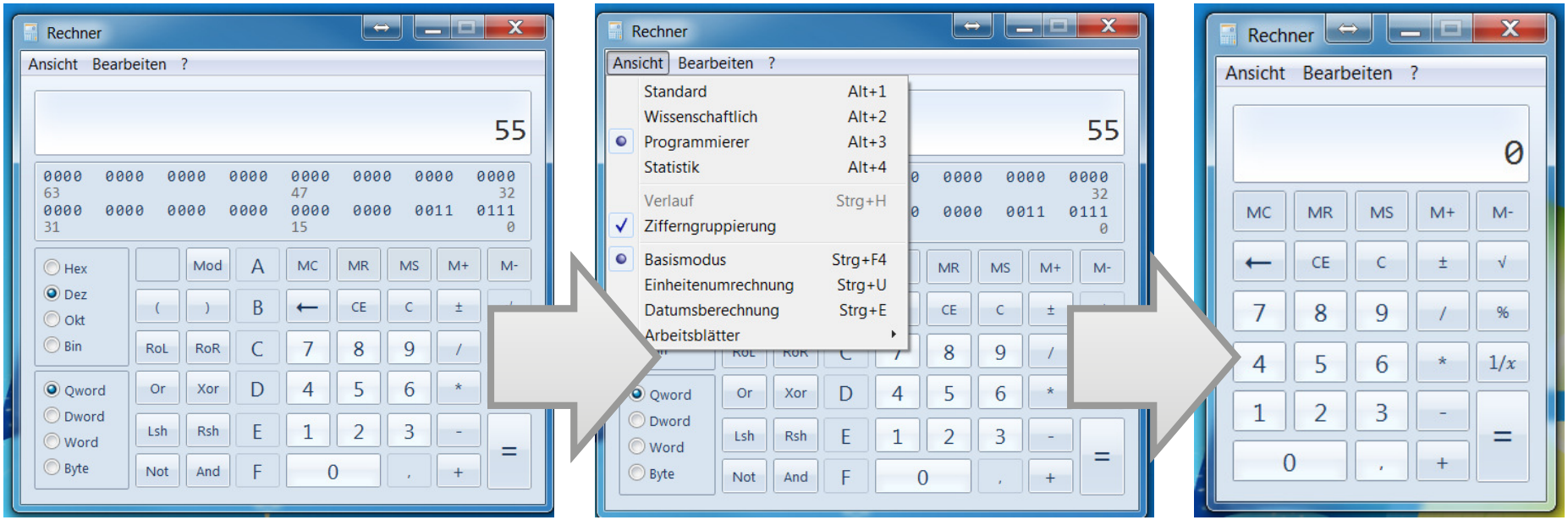
Phase 2: Creation of Orthogonality



Programmer Mode

Programmer-Mode
&
Menu

Normal Mode

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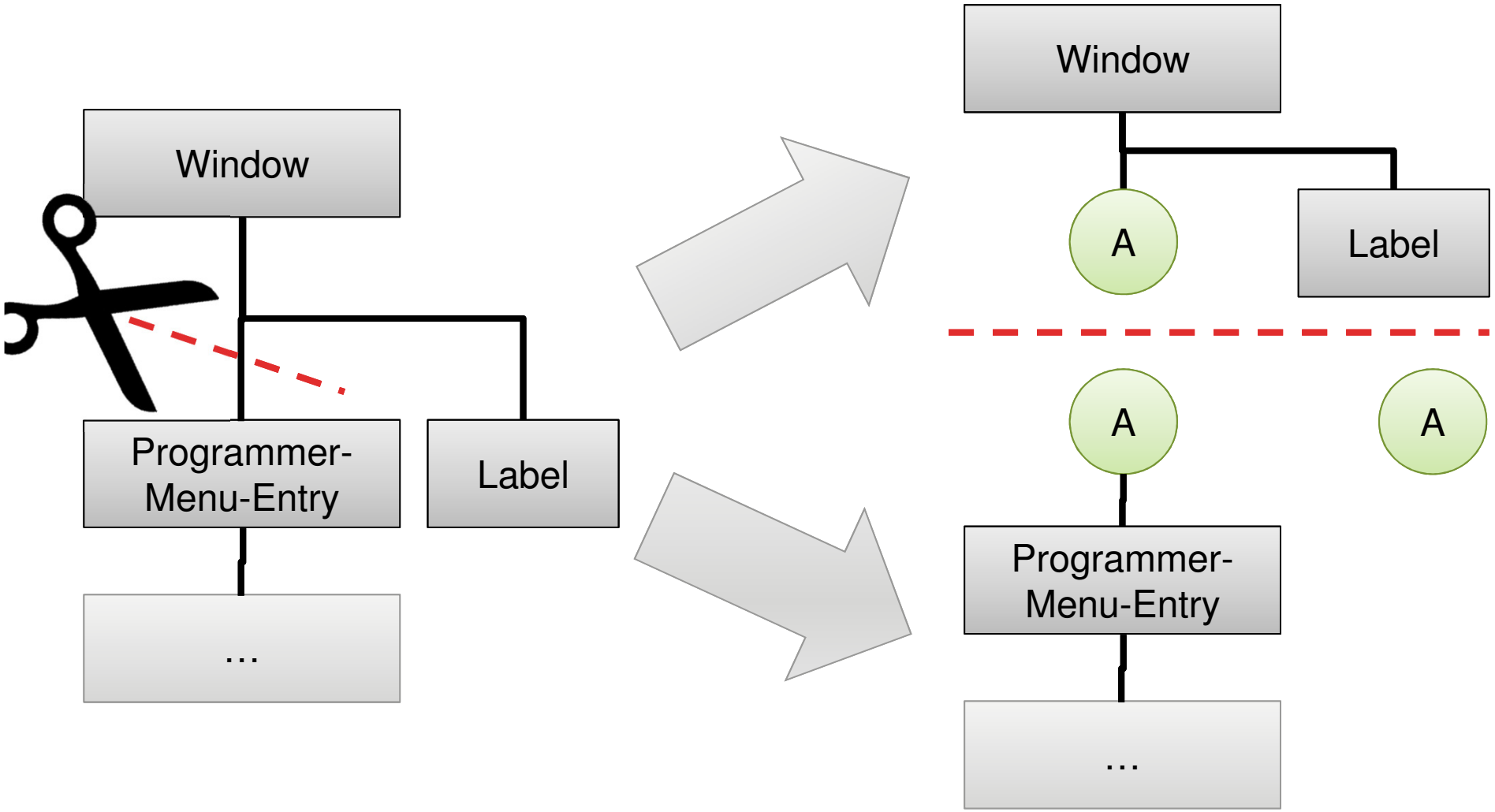
Phase 2: Creation of Orthogonality



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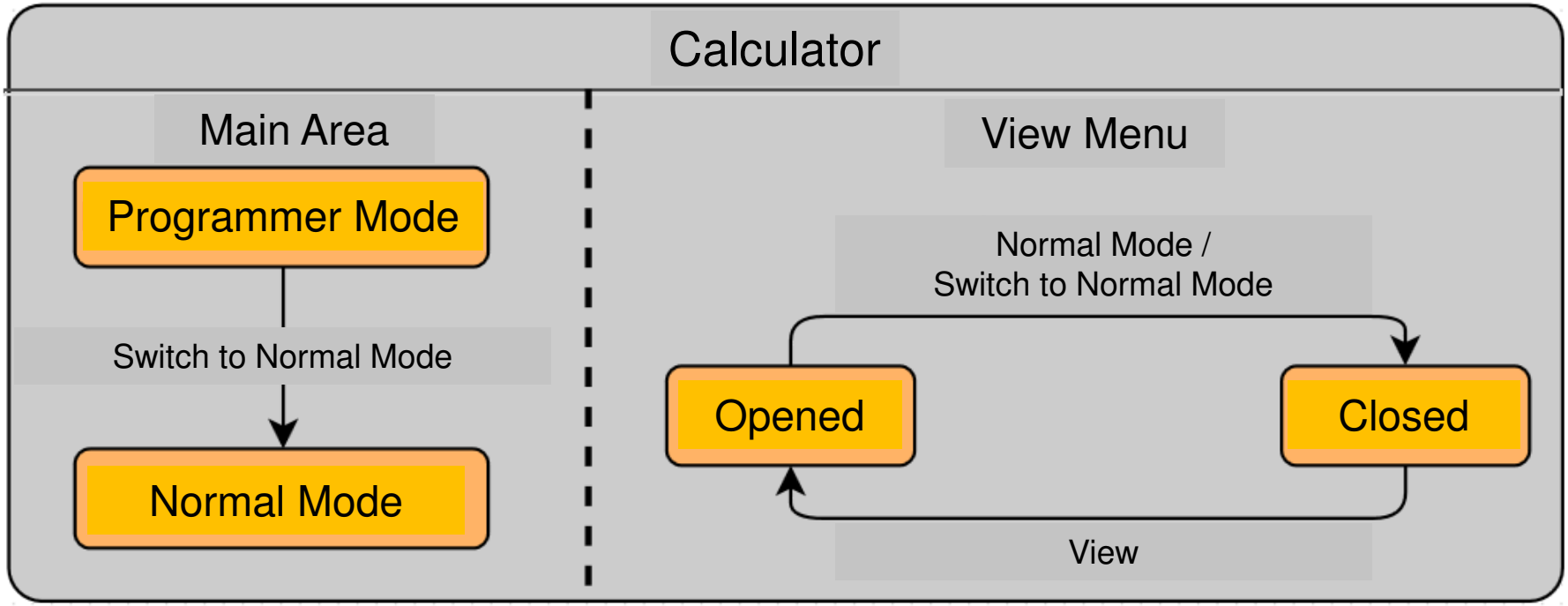
Phase 2: Creation of Orthogonality + Transitions



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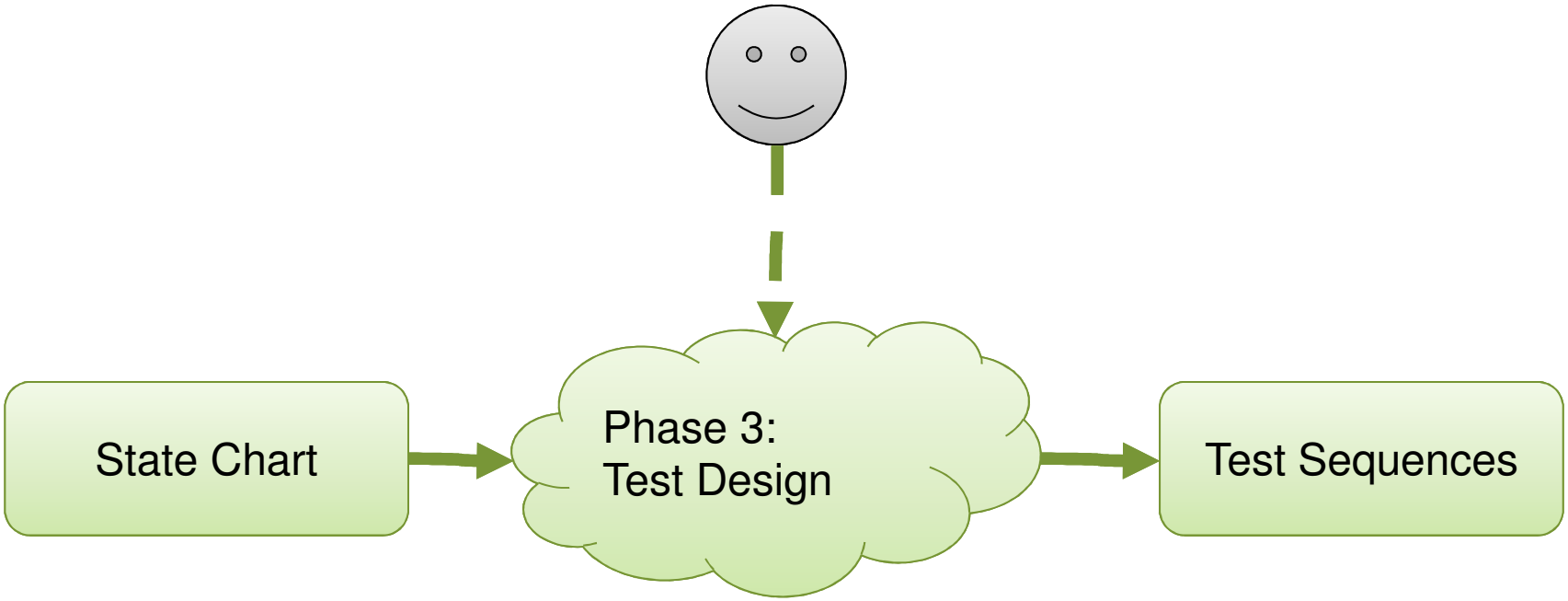
Phase 3: Test Design



Phase3-auto-gen.avi

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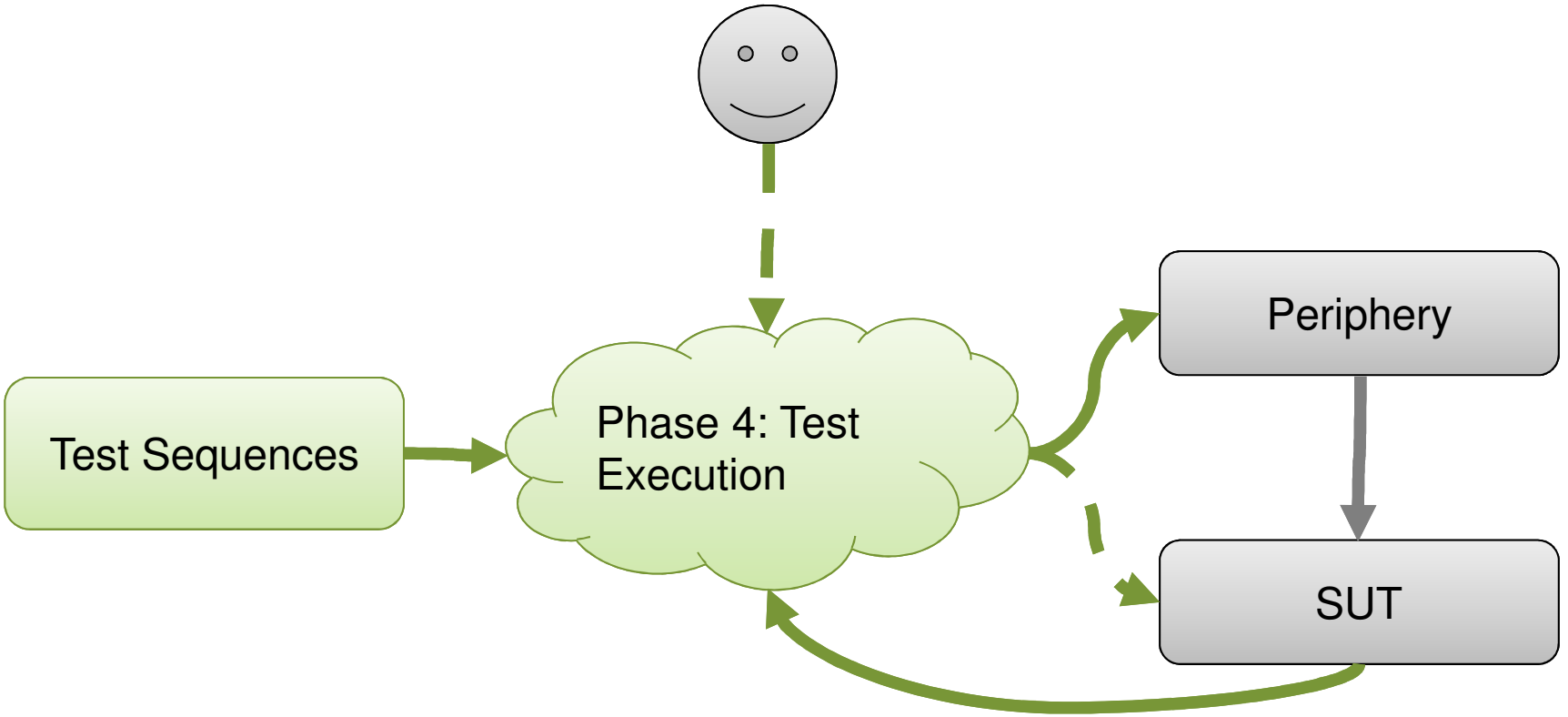
Phase 4: Test Execution (Replay)



Phase4-auto-gen.avi

Conclusion

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Conclusion

- Four methods successfully combined to GUI Test approach
- Prototype evaluation using Windows Calculator tutorial
- First hints on practicality of method
- Approach is feasible
  - productive use required additional effords
  - Currently: Limitation on left-clicks (mouse) and only some widget types
- Relevant results
  - No recognition of internal state changes
  - Some visible GUI elements are not part of widget trees

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Future Work

Substantiation

- Analyze missing Widget Tree Elements
- Complete Prototype
- Enhance modelling capabilities for human tester
- Evaluation using further SUTs

Continuation

- Regressions-Tests and test oracles
- Guards and Variables
- History-States
- Nguyen et al. [NgMT12] on Parametrization

Thank you!

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References

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- [KrWe12] KRUSE, PETER M. ; WEGENER, JOACHIM: Test Sequence Generation from Classification Trees. In: *2012 IEEE Fifth International Conference on Software Testing, Verification and Validation*. Montreal, QC : IEEE, 2012 — ISBN 978-0-7695-4670-4, S. 539–548
- [NgMT12] NGUYEN, CU D ; MARCHETTO, ALESSANDRO ; TONELLA, PAOLO: Combining Model-Based and Combinatorial Testing for Effective Test Case Generation. In: *Proceedings of the 2012 International Symposium on Software Testing and Analysis, ISSTA 2012*. New York, NY, USA, 2012 — ISBN 9781450314541, S. 100–110

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