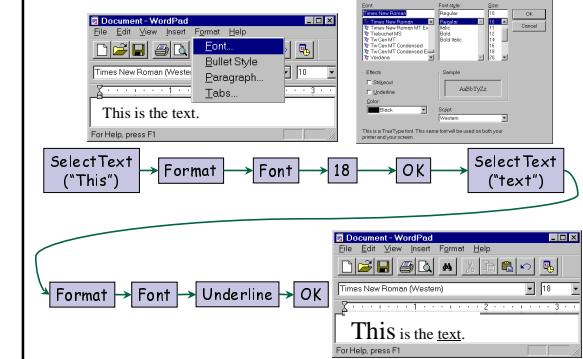


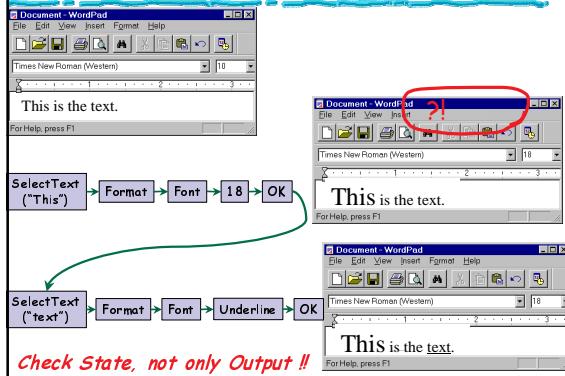
Automated Test Oracles for GUIs

Eighth International Symposium
on the Foundations of Software
Engineering, San Diego, CA,
Nov. 6-10, 2000.

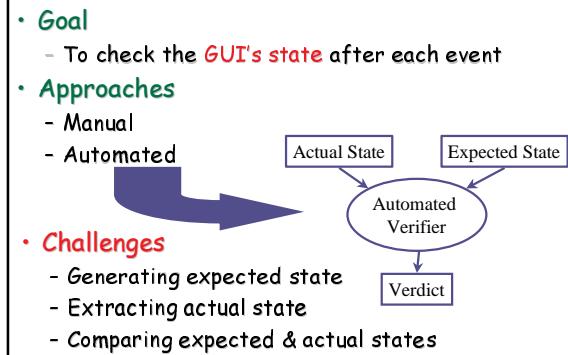
A Test Case for WordPad



What Is Correct Behavior



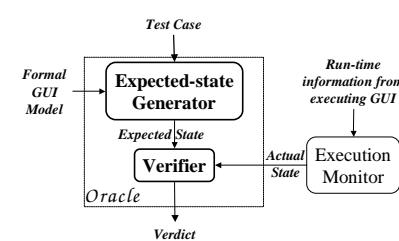
Research Focus



Outline

- Overview of GUI Oracle
- Generating Expected State
 - Modeling the GUI's State
 - Objects
 - Properties
 - Modeling the Events
- Obtaining Actual GUI's State
- Comparing Actual & Expected States
- Case Study: MS WordPad
- Concluding Remarks

Overview of GUI Oracle



Modeling the GUI

A GUI consists of Objects

Open

Look in:

<input type="checkbox"/> Music
<input type="checkbox"/> Recycled
<input checked="" type="checkbox"/> Share

File name: Open

Files of type: Word

Form

Window State	wsNormal
Width	1088
AutoScroll	TRUE

Label

Align	allNone
Caption	Files of type:
Color	cIBtnFace
Font	(tFont)

Button

Caption	Cancel
Enabled	TRUE
Visible	TRUE
Height	65

The screenshot shows the Delphi IDE's Object Inspector window. The selected object is 'Button1'. The properties listed include:

Properties	Events
Cancel	True
Caption	Cancel
Cursor	crDefault
Default	False
DragCursor	crDrag
DragMode	dmManual
Enabled	True
+Font	(TFont)
Height	65
HelpContext	0
Hint	
Left	8
ModelResult	mrNone
Name	Button1
ParentFont	False
ParentShowHint	True
PopupMenu	
ShowHint	False
TabOrder	0
TabStop	True
Tag	0
Top	8
Visible	True
Width	153

9

Determining Properties

- Manual Examination of GUI
- Specifications (Reduced Set)
 - GUI being tested
- Toolkit/Language (Complete Set)
 - All available properties

Now we know how to represent the GUI's state

The diagram illustrates a state transition in a word processor application. On the left, a window titled "Document - WordPad" shows the text "This is the text." A blue box labeled "SelectText ('This')" has an arrow pointing to the word "This". Below it, another blue box labeled "Event: e" also has an arrow pointing to the word "This". On the right, a second window titled "Document - WordPad" shows the text "This is the text." A blue box labeled "State: S_j" is positioned above the window. The word "This" is highlighted in red, indicating it is selected. A blue bracket on the far left groups the "SelectText" box and the "Event" box, while a blue bracket on the far right groups the "State" box and the second window.

11

Representing Events

- We define an event as:

$$\text{State}_j = [\text{State}_i, \text{event}]$$

- For example:

$$\text{State}_j = [\text{State}_i, \text{cut}]$$

- Need a compact representation

Operators

File Edit View Ins

Menu1

Cut Ctrl+X

Copy Ctrl+C

Paste Ctrl+V

Paste Special...

Clear Del

Menu2

Operator :: CUT

Preconditions:
isCurrent(Menu2).

Effects:

FORALL Obj in Objects
Selected(Obj) \Rightarrow

- ADD inClipboard(Obj)
- DEL onScreen(Obj)
- DEL Selected(Obj)

ADD isCurrent(Menu1)

DEL isCurrent(Menu2).

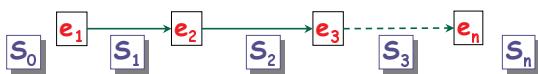
Obtaining next state

Deriving Expected State

- Given S_0 , the initial state,
- A sequence of events



- Obtain $S_1 = [S_0, e_1]$
- And $S_i = [S_{i-1}, e_i]$

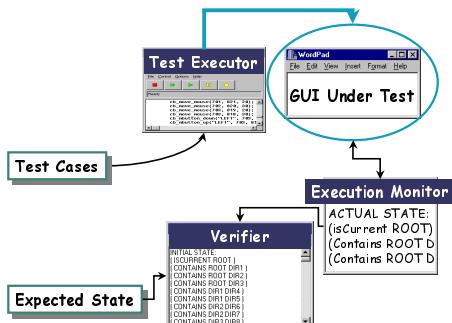


Obtaining Actual GUI's State

Execution Monitor

- Screen Scraping
 - Queries
 - Compatible with Expected State
 - Returns <Object, Property, Value>
- <Button1, "Caption", "Cancel">

Automated Execution



Comparing Actual and Expected States

Verifier

- Three Levels of Testing
 - Changed Property Set (*Operators*)
 - GUI Relevant Property Set (*Specifications*)
 - Complete Property Set (*Toolkit/Language*)
- Hybrid Approach
 - Use all 3

Case Study

- Purpose: Determine
 - Time to Derive Expected State
 - Time to Execute Monitor and Verifier
- Experimental Design
 - **GUI:** Our Version of MS WordPad (36 Modal Windows, 362 events)
 - **Test Cases:** Generated 290 Test Cases (6-56 events) using an AI Planner
 - **Hardware Platform:** 350 MHz Pentium based Machine, 256 MB RAM
 - **Properties:** Reduced Set
 - **Level of Testing:** GUI Relevant Property Set

Deriving Expected State

