Fraunhofer USA

Center for Experimental Software Engineering

Automated Visual GUI Testing for the Space Network

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Space Network

- Proprietary GUI running on OpenVMS
  - The system includes lots of screens
  - Developed in ADA, Fortran etc.
- Current testing practices
  - Create test cases & documentation
  - Manually issue commands and verify results
- Tedious work that should be automated…

SN Testing Challenges

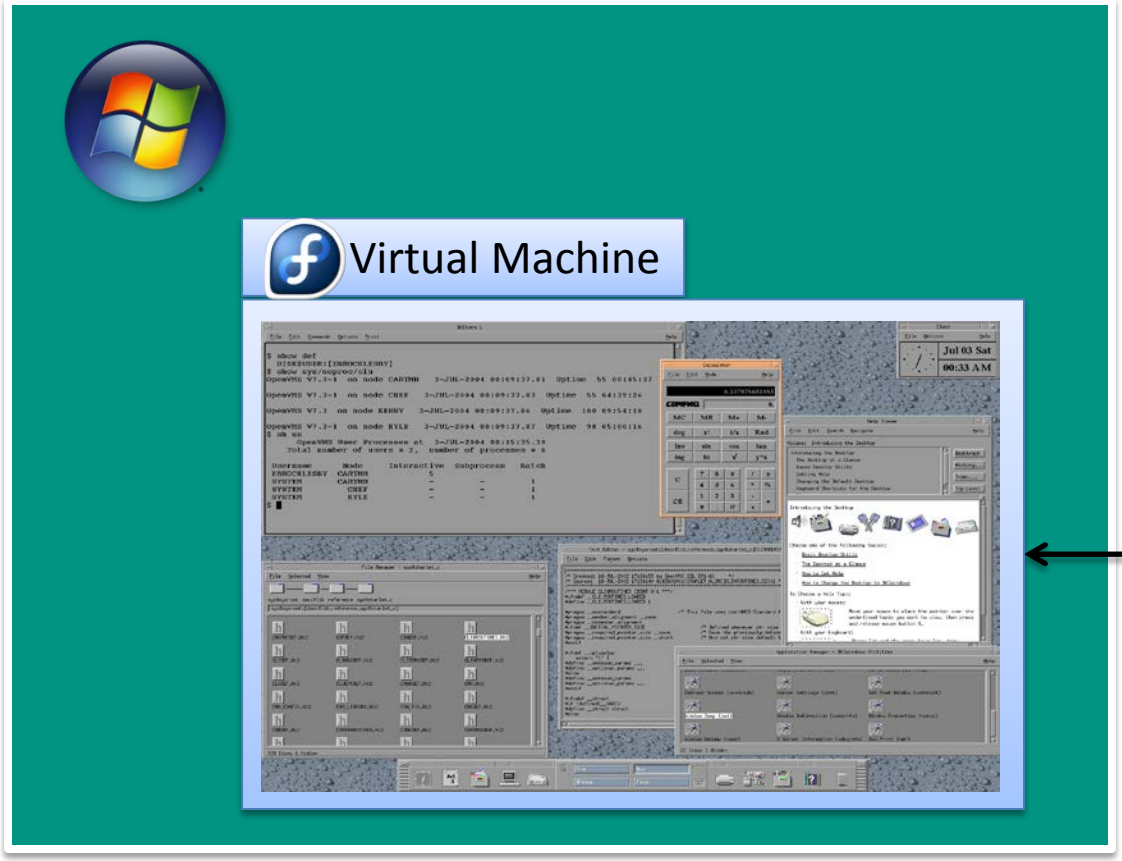
- OpenVMS does NOT have robust GUI testing frameworks
  - Cannot perform testing natively
- SN uses proprietary GUI libraries
  - Cannot port system to other platforms
- GUI libraries also depend on DECNet protocol
  - Difficult to transport GUI to other platforms

Platform Solution

- Transport GUI windows to Linux via X Server
  - Requires DECNet components for Linux
    - DECNet enabled Linux kernel and DECNet tools
    - Custom-compiled DECNet-enabled X Server
  - Fedora Core 6 Linux release with limited support
- Run DECNet-enabled Linux in a Virtual Machine on Windows
  - Finally access to modern GUI testing tools!

Platform Solution

- Transporting SN windows to a modern platform

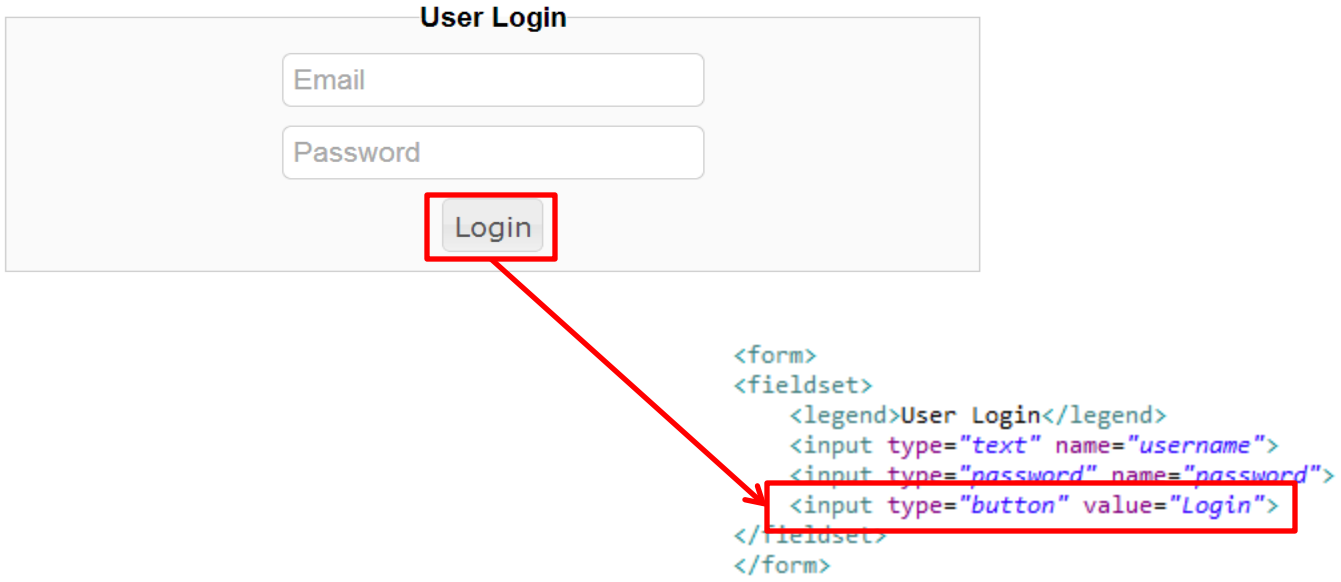


Alpha Server

DECNET
Protocol

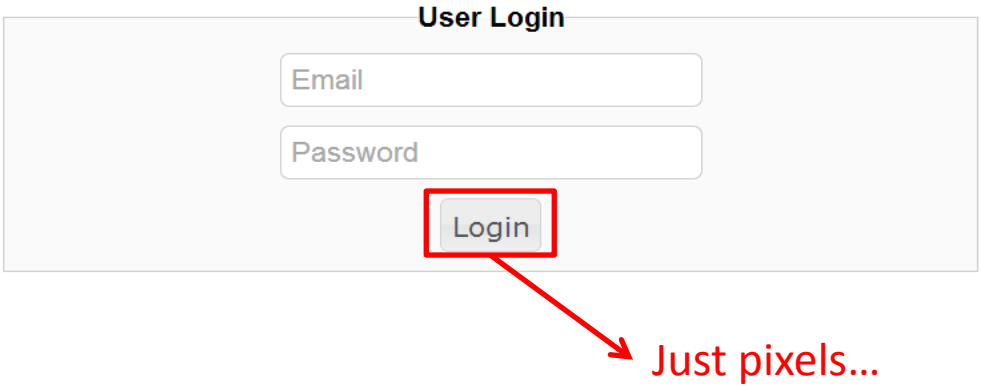
Reference-Based Testing Tools

- Most robust approach to GUI testing
  - E.g. Selenium for testing web applications
    - Examines underlying HTML code



However…

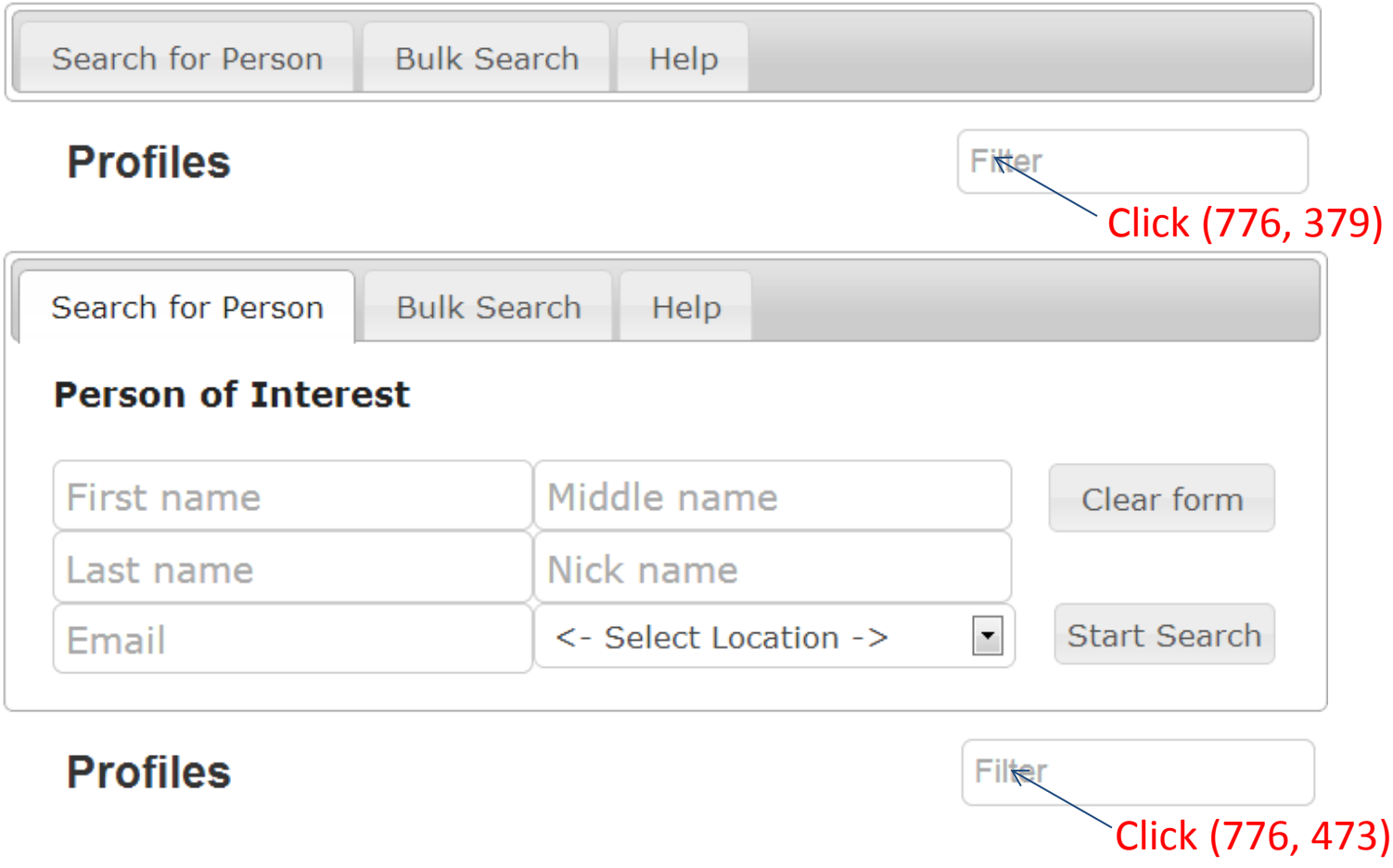
- X Server does NOT retain GUI information needed for meaningful testing



- Cannot use Reference-based tools for SN testing...

Record & Replay Testing Tools

- Should not use Record & Replay tools…



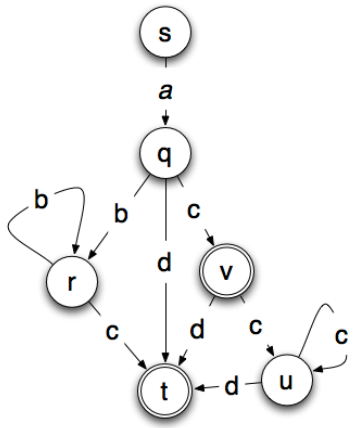
A Potential Solution

- A screenshot-based GUI automation tool named Sikuli
  - Searches for given patterns on the screen
  - Controls keyboard/mouse inputs
  - Some support for Optical Character Recognition (OCR)
- However, Sikuli NOT designed for testing
  - Automation scripts expressed in low-level interactions
    - Click, type, find…
  - Difficult to reuse test code
    - Scripting vs OO design

PiGuiT: Visual GUI Testing

- Platform-independent GUI Testing
  - Built on top of Sikuli's Java API
  - Works on all modern platforms with any GUIs technology
  - Designed to bring OO design to GUI testing
- Three-step approach to GUI testing
  - Define "model" for GUI under test
    - Details of GUI look and feel / interactions
  - Abstract higher level GUI logic
  - Create test cases using high level abstractions

PiGuiT Workflow

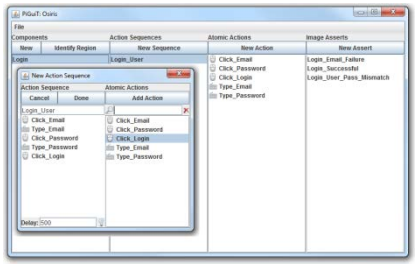


GUI Model

Custom API

testCreateScreenElem (0.512 s)
testAddPadding (0.547 s)
testCurrentState (2.745 s)
testExistsColor (0.510 s)
testFindPredictors (8.935 s)
testRightClick (6.957 s)
testSaveScreenElem (2.862 s)
testCaptureImage (4.171 s)
testCreateScreenElemFromList (0.514 s)
testDragDropElemToAnother (13.236 s)
testTypeWithShiftModifier (1.798 s)
testTypeWithSpecialKeys (5.850 s)
testRegionComparators (0.511 s)

Test Cases

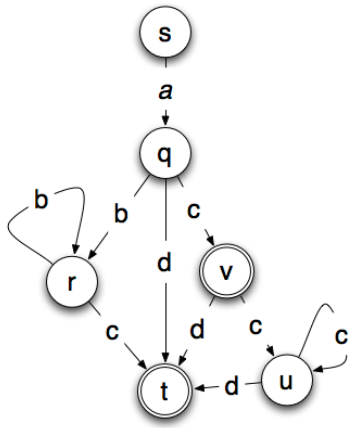


PiGuiT GUI

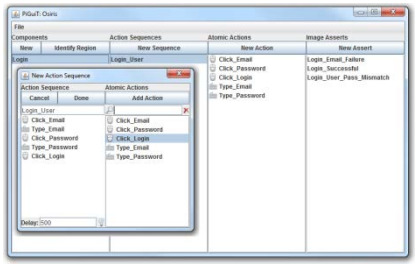
PiGuiT Core

Tester

PiGuiT Workflow

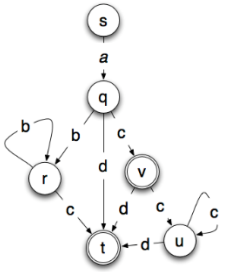


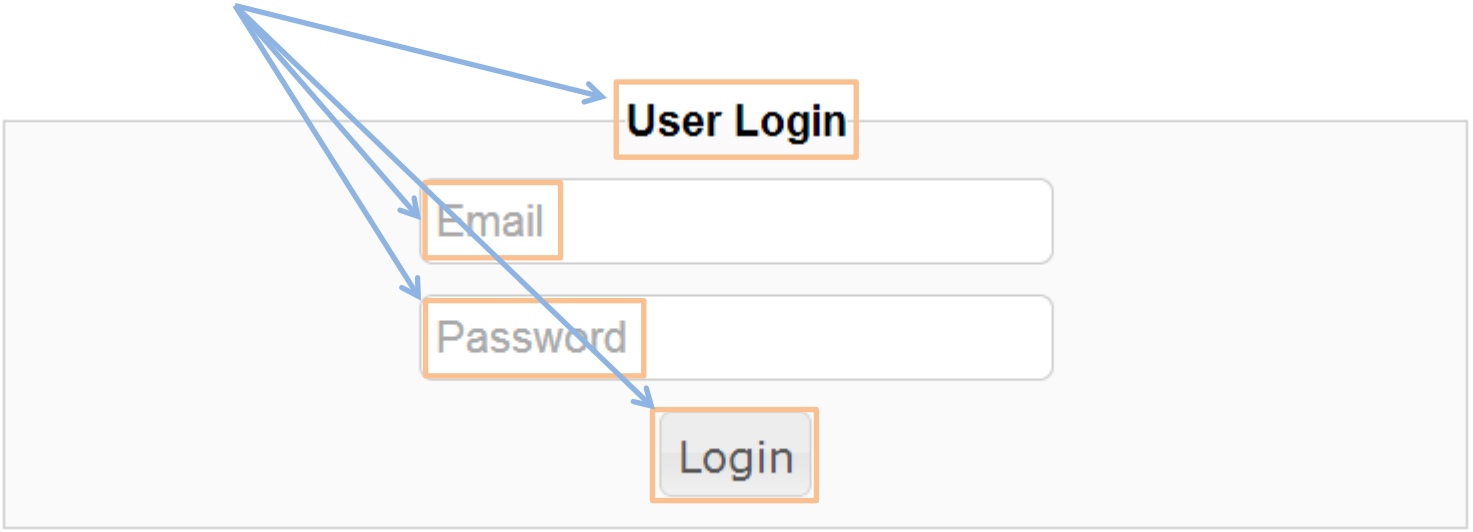
GUI Model



PiGuiT GUI

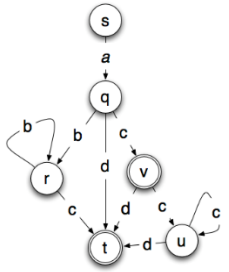
Predictors





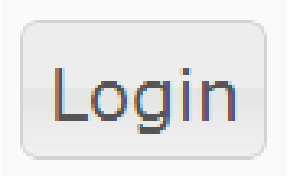
- Predictors are images that can be used to identify elements of GUI
  - Basically anything users can see on the screen
  - Used for GUI interactions and verification

Predictor States



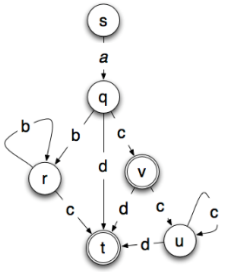
- Each predictor can have one or more states
  - Element may have several states that are displayed graphically

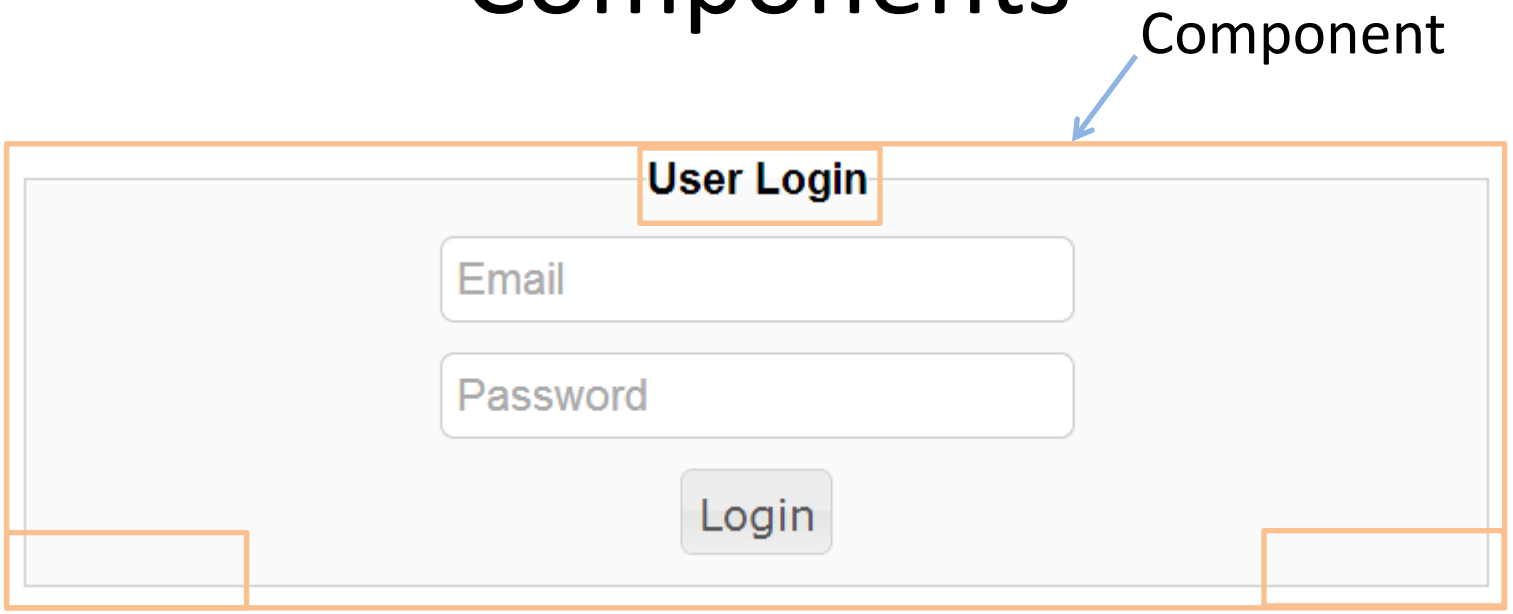
In Focus



Not in Focus

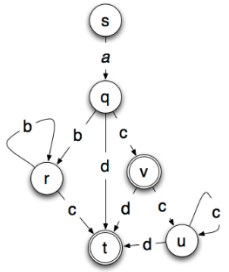
Components





- Components give logical structure to GUI elements
  - Can use one or more predictors to define component location/boundary

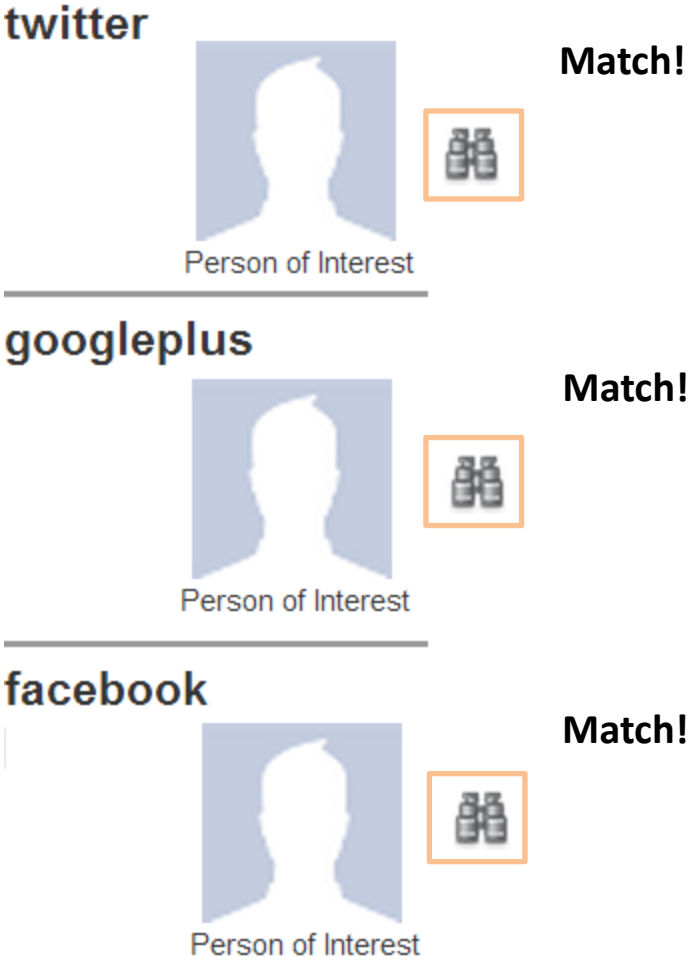
PiGuiT GUI: Component



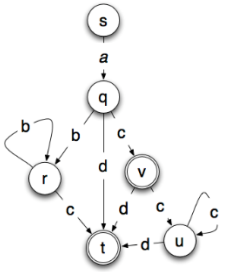
- What if a predictor is not unique?
  - E.g. view details of

    Person of Interest from

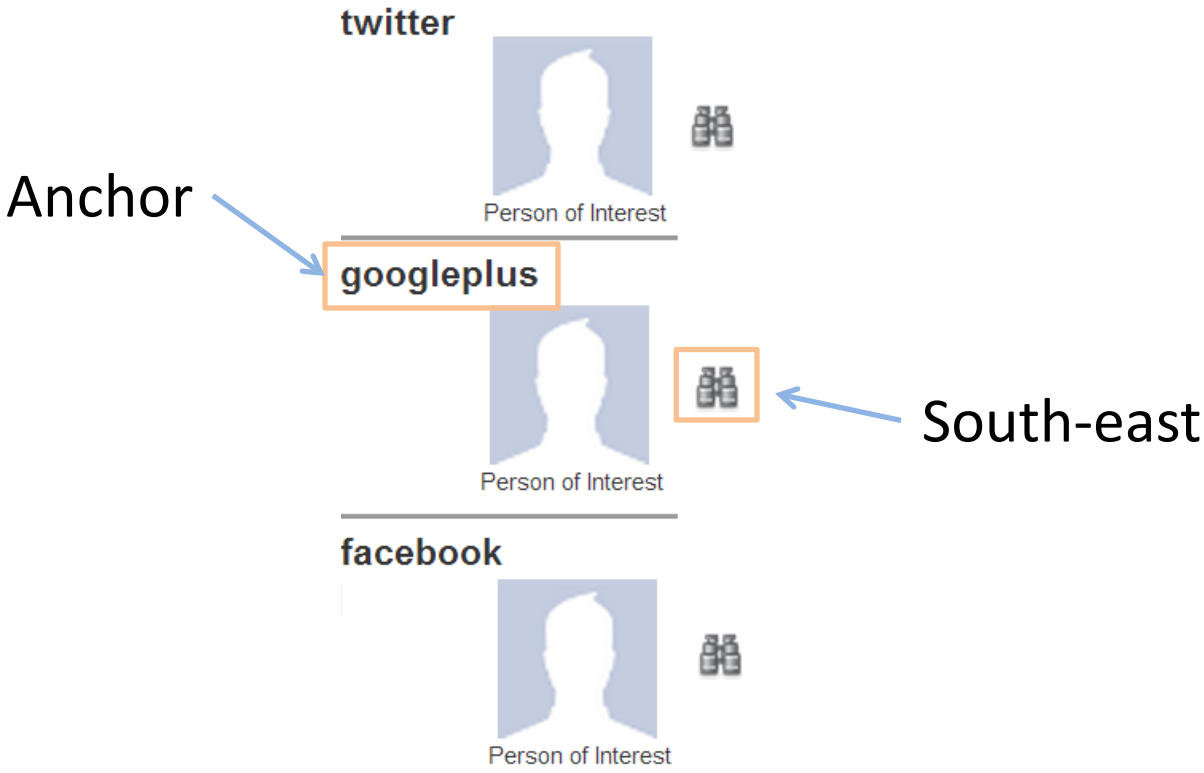
    “googleplus”



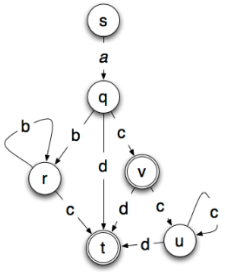
PiGuiT GUI: Component



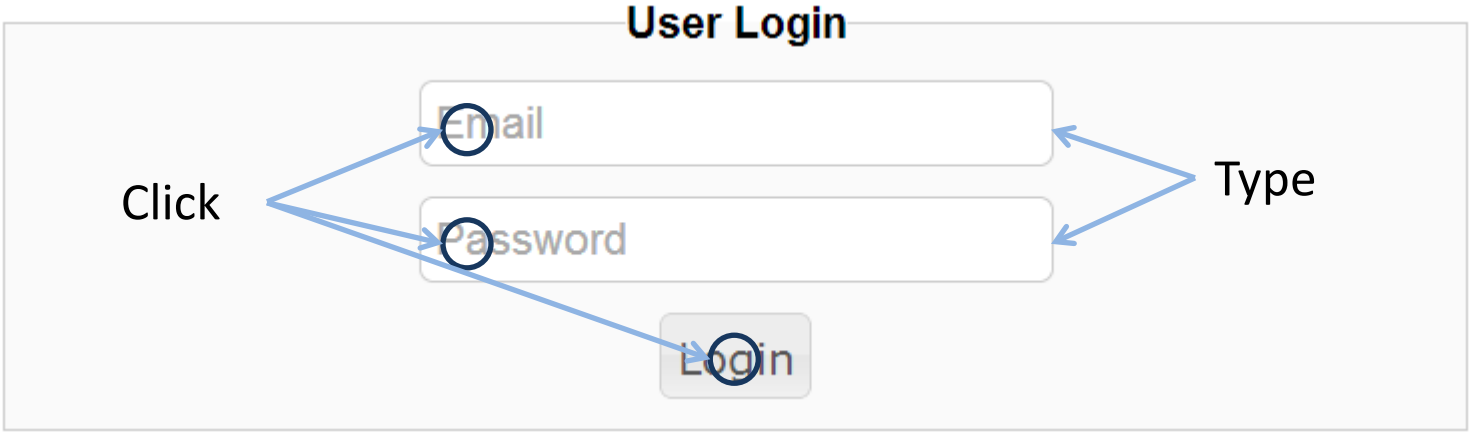
- Designate one predictor as the **anchor**
- Pick the **closest** predictor in **relative direction**



Actions

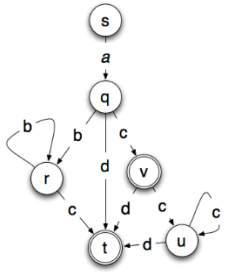


- A GUI event is represented as an action



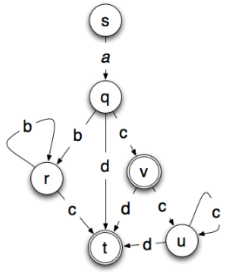
- Action types
  - Mouse clicks
  - Keyboard input

PiGuiT GUI: Actions

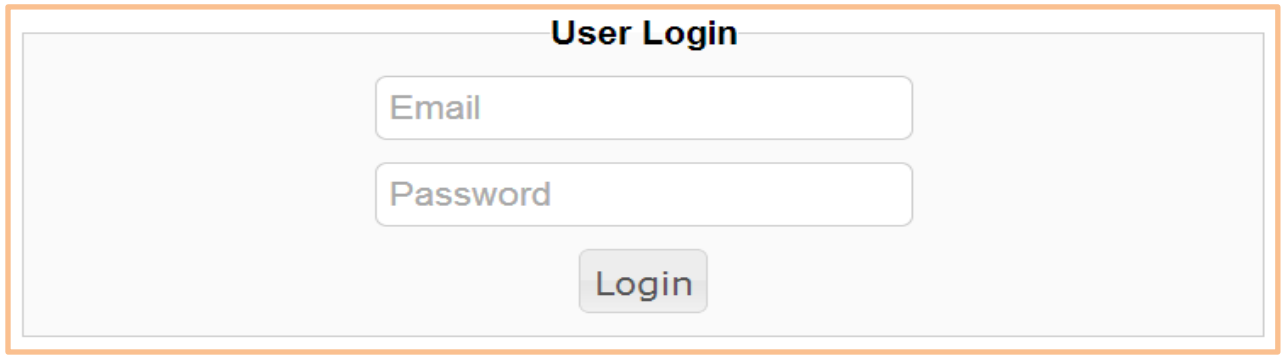


- Click Action
  - Left, right, double click on a predictor
  - Offset to the predictor
- Drag and Drop (or swipe)
- Type Action
  - Parameters: __<parameter>__
  - Special keys: enter / modifiers: e.g. shift
- Assert/wait action
  - Predictor exist / not exist
  - Wait until predictor appears

Action Sequences



- Logical grouping of a set of actions
  - Performed in a particular sequence in **the context of a component**



LoginComponent

sequence_Login_User()

1. Type TAB + TAB
2. Type email + TAB
3. Type password + ENTER

PiGuiT Workflow

Custom API

PiGuiT Core

Custom API

- PiGuiT
  - Component
  - Action sequence

OO Design
- Class
- Method

- Components encoded as classes

```
LoginComponent login = new LoginComponent();
```

- Action Sequences become their methods

```
login.sequence_Login_User(email, password);
```

PiGuiT Workflow

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Test Cases

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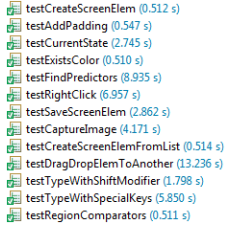


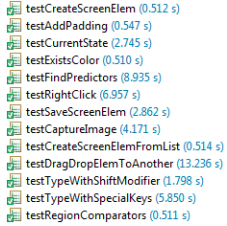
PiGuiT Login Test

- Test cases are written against high level logic
  - Test cases are shielded from GUI changes

```
@Test
public void testValidLogin() {
    LoginComponent login = new LoginComponent );

    login.sequence_Login_User(email, password);
    Assert(login.sequence_Login_Successful());
}
```

- Unless the fundamental functionalities of the software change, the test cases remain the same!



Leverage Java Good Practices

- Using JUnit framework to automate GUI test case execution
  - Setup() – brings up screen under test
  - Teardown() – resets screen if neccessary
  - Tests – independent, repeatable, self-contained
  - Asserts – verify predictors and component states

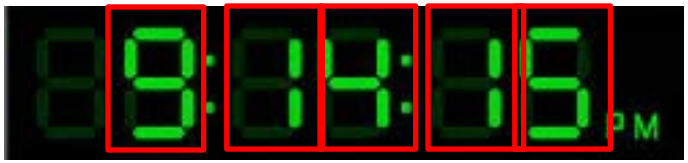
  - @BeforeClass/@AfterClass – run expensive setup/cleanup code
    - E.g. Sending all vectors before running SHOs

SN Testing Progress

- Deployed **configurable** initialization scripts for SN equipment
  - Tedious manual steps before every testing session
  - 20 – 30 minutes of tester effort saved
- Developed **extensible** test suite for regression testing
  - Submits and verifies Shos to test SN
    - Extend test suite by adding Shos to specified directories
  - 4 - 6 hours of testing runs overnight unattended

Lessons Learned

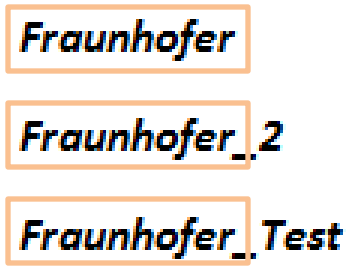
- SN fonts are especially difficult for OCR
  - Image recognition is more reliable



- SN GUI does NOT scale on resolution change
  - Aspect ratios change between GUI elements
  - Always maximize SN window on test machine

Lessons Learned

- Image string search == substrings search
  - Differentiate by adding space to the end of predictor



- Automated tests do not need to be perfect to be useful
  - Simplify assumptions
    - E.g. check for link state, no need to verify data rate
    - E.g. take down all equipment and reconfigure

Future Work

- Streamline API generation/jar import
- Improved logging for visual GUI testing
- Custom OCR solution for difficult fonts
- Knowledge transfer PiGuiT technology to NASA testers/developers

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