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Department of Computer Science

An Examination of the Run- time Performance of GUI Creation Frameworks

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Presentation Outline

- Introduction: importance of graphical user interfaces (GUIs)
- What is a GUI?
- Event handling latency and GUI manipulation event difficulty
- Overview of GUI creation frameworks: Swing and Thinlet
- Experimental design and justification
- Empirical results:
  - ➔ Event handling latency
  - ➔ CPU and memory consumption
- Related and future work
- Conclusion

Introduction

- Source code for GUIs: Past- 48%, Current- 60%
- GUI creation frameworks: correctness and performance
- Analysis of Java programs
  - Statically, at source code and bytecode levels
  - Dynamically, at bytecode level and on specific virtual machine(s)
- Our focus: performance of GUI creation frameworks for specific applications and Java virtual machines
- GUI toolkit showdown: Thinlet vs. Swing
- User-perceived performance for a case study application

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GUI Fundamentals

- A GUI is simply a set of widgets
- The state of the GUI is the state of all the widgets
- Our model ignores widget layout constraints
- Event handling latency: $L(E) = L_A(E) + L_G(E)$
- Difficulty of GUI manipulation event: $D(E) = D_A(E) + D_G(E)$
  - ➔ Formulation of $D_A(E)$ requires analysis of algorithms in the underlying application and JVM
  - ➔ Formulation of $D_G(E)$ requires understanding of the GUI widgets that are updated and added to the GUI

Comparing Swing and Thinlet

- ***Swing:***
  - Extension of AWT
  - Approximately 50 components
  - **Advantages:**
    - Lightweight – more efficient use of resources
    - Written in Java – cross-platform and very consistent look and feel
  - **Disadvantages:**
    - Inherent abstraction level
    - Excessive object creation

- ***Thinlet:***
  - Created by Robert Bajzat
  - Currently 22 components
  - **Advantages:**
    - Application Separation: GUI in XML and underlying code in Java
    - Relatively simple GUI development
  - **Disadvantages:**
    - Limited number of components
    - Limited threading model

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Visual Database Querying Tool

- Ideal candidate application - enables the variation of GUI manipulation event handling difficulty
- Difficulty was varied by changing table sizes to 25, 250, and 2500 tuples
- User can select tables, attributes, and comparison operators
- Query results displayed in the form of a table
- One version of the tool was developed with Swing and another with Thinlet
- Each tool uses the same Java Database Connectivity (JDBC) driver to connect to a PostreSQL database

Experiments

- Systems Used
    - Pentium III, 533 Mhz with 128 MB RAM
        - Debian/GNU Linux – JVM 1.4.1
        - Ms Windows NT – JVM 1.4.0
    - UltraSPARC-5 Sun4u, 366 Mhz with 128 MB RAM
        - Solaris 8 – JVM 1.4.1
- Five Distinct Experiments
    - Initial startup
    - Opening of Screens (Selection of tables, attributes, relational operators)
    - Viewing of final query results with 3 different table sizes

Latency Results: Overview

- Measured average event handling latency for single addition to textarea
- First four experiments measure event handling latency when table size is not a factor

Latency Time (ms)		
OS	Thinlet	Swing
Solaris	4	6.33
Linux	3.16	3.66
Windows	3.33	3.33

- • Fifth experiment varied the table sizes:
  - Thinlet outperforms Swing for smaller number of updates/adds
  - Swing outperforms Thinlet for larger number of updates/adds

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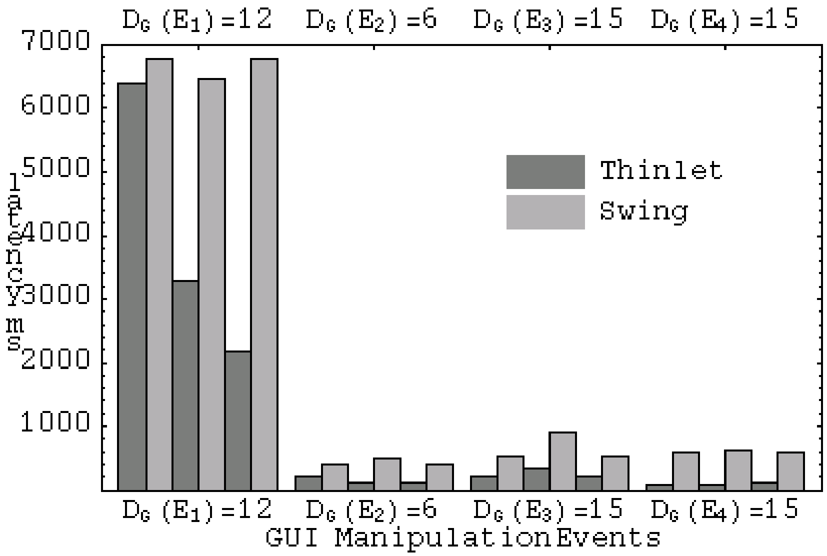
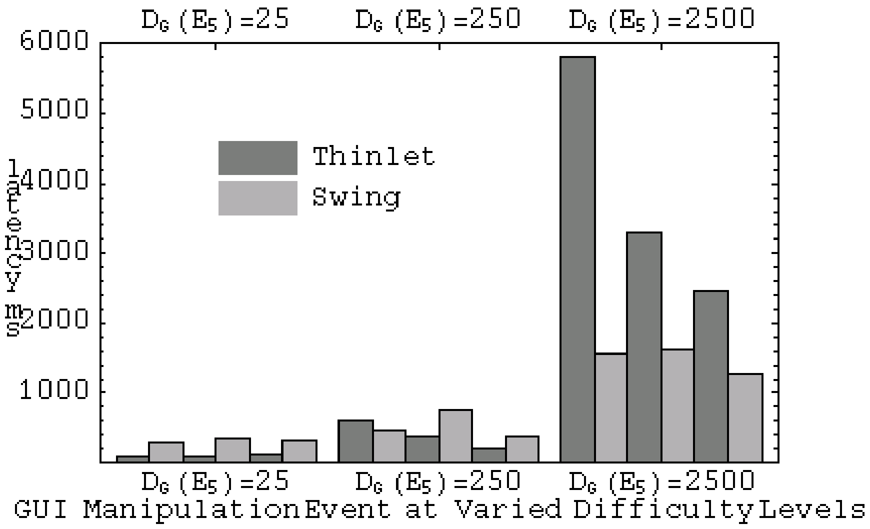
Latency Results: Graphs



(a)



(b)

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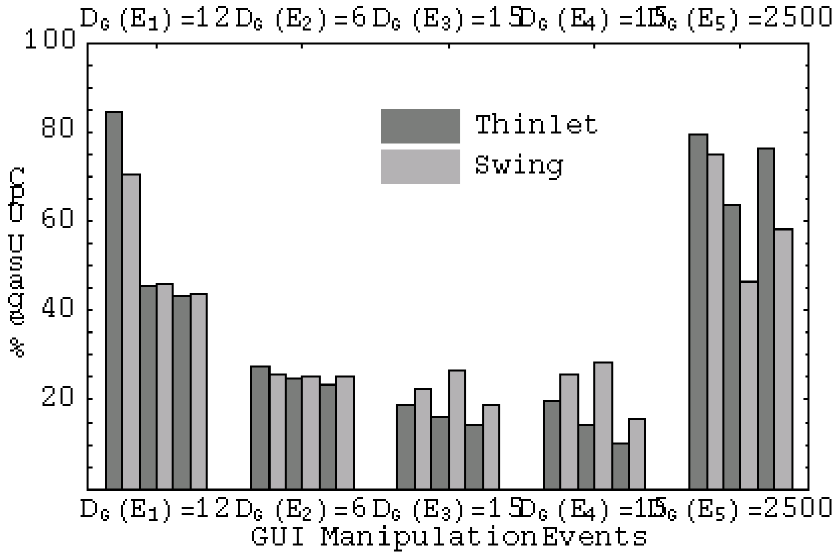
CPU and Memory Results

- Swing uses less CPU when rendering large amounts of data
- Memory usage consistent throughout applications with more use at startup and querying final results
- Memory usage for single addition to textarea

Memory Used (ms)		
OS	Thinlet	Swing
Solaris	392	992
Linux	312	748
Windows	334.66	846.66



Related and Future Work

- Related research:
  - Memon et al.: testing and analysis of programs with GUIs
  - Endo et al.: interactive system performance analysis
  - Horgan et al: Java - centric performance analysis
- Future research:
  - The impact of different JVM modes (HotSpot client, HotSpot server, interpreted) on user- perceived performance
  - Memory usage patterns for applications that use Swing and Thinlet
  - New case study applications
  - New Java GUI creation frameworks: Eclipse SWT, SWIXML
  - General methodology for GUI toolkit performance analysis

Conclusion

- Thinlet is better for less difficult GUI manipulation events
    - Easier to implement due to XML interface
    - Currently, only 22 widgets
    - Threading model needs to be improved
- Swing is better for more difficult GUI manipulation events
    - Harder to implement
    - Approximately 50 widgets in toolkit
- GUI toolkit choice depends of application being created for which to choose
- Our goal: to provide GUI- driven application developers with heuristics for chosing the appropriate GUI creation framework

Resources

- Java GUI Creation Framework Performance Research:
  - `http://cs.allegheny.edu/~gkapfham/research/jgp/`
- Java Performance Tuning (J. Shirazi):
  - `http://www.javaperformancetuning.com`
- Performance Documentation for Java HotSpot VM:
  - `http://java.sun.com/docs/hotspot/`
- Performance Documentation for Java Platform:
  - `http://java.sun.com/docs/performance/`
- S. Wilson and J. Kesselman. *Java Platform Performance: Stategies and Tactics*, Addison- Wesley, 2003.