



Computer Systems and Networks

ECPE 170 – Jeff Shafer – University of the Pacific

Performance Measurement

Lab Schedule

Activities

- **Today**
 - Background discussion
 - **Lab 4 – Performance Measurement**
- **Next Tuesday**
 - **Lab 4 – Performance Measurement**
- **Next Thursday**
 - **Lab 5 – Performance Optimization**

Assignments Due

- **Today**
 - **Prelab – Due now**
- **Sunday**
 - **Lab Report for Lab 3 due by 11:59pm**
 - **Includes programming project**

Person of the Day: Bill Joy



- Co-founder of **Sun Microsystems**
- Author of **vi text editor**
- Key contributor to original BSD Unix while a Berkeley grad student
 - First open-source OS with TCP/IP

Performance Measurement



Lab 4 Goals

1. Measure program **execution time**
2. Break down program execution time by **specific subroutines / lines** of code
3. Measure program **memory usage**
 - Heap and stack
4. Monitor program for **memory leaks**
 - Not really “performance”, but uses same tool

Performance Measurement

- **Why is it important to measure application performance *in detail*?**

Valgrind



<http://valgrind.org/>

Valgrind Features

- **Memcheck** module – Memory error detector
- Access 1 beyond the beginning / end of your array?
- Access un-initialized memory?
- Reading/writing memory after calling free()?
- Memory leak? (Lost pointer to a malloc() block)
- **Valgrind produces a report that identifies these errors**

Valgrind Features

- **Callgrind** module – Program profiler
- Callgraph shows you what function called what other functions
- How much CPU time does each function / code line consume?
- **Valgrind produces a report that summarizes CPU usage of your program**

Valgrind Features

- **Massif** module – Heap profiler
 - Optimize your program to use less memory (by identifying where memory is being used)
- **Helgrind** module – Threading profiler
 - Bugs in multi-threaded programs are especially difficult to find!
- ... and more modules ...

Valgrind Common Uses

- **Your program runs and suddenly segfaults**
 - Segfault means you accessed a memory address that doesn't exist for your program
- How do I find where this error is?
 - Valgrind can monitor your program and detect accesses outside of legit static variables and dynamic memory regions

Valgrind Common Uses

- **Your program gets slower and slower the longer it runs**
 - Memory leak? (Slowing running out of heap memory because you malloc() without ever calling free())
- **How do I find where this error is?**
 - Valgrind can monitor your program. It can't tell you where you *should* free it, but it will tell you where you originally called malloc(), or where the pointer was lost

Valgrind Behind-the-Scenes

- **Just-in time compiler**
 - Your program is re-compiled onto a virtual (simulated processor)
 - Another example of a virtual machine!
- Benefit – Valgrind can observe your program running at the (assembly) instruction level
- Drawback – Slow! (5x slower than normal)
 - *But it's still better than fixing bugs without a tool...*

Profiling Basics



Profiling Basics

- The next labs (4-7) will ask you to **measure application performance** by conducting experiments
 - Execution time
 - Processor usage
 - Memory usage

- **What system configuration do you think would be best in terms of producing the cleanest, most accurate, most reproducible results?**
 - Three choices to choose from...

jshafer@ecpe170: ~

jshafer@ecpe170:~\$

Program to Benchmark



ECPE 170

Terminal

jshafer@ecpe170: ~

```
jshafer@ecpe170:~$
```

Program to Benchmark

- DataNode modifications
- Good CV - Applic...le.pdf
- Trends Disk GPU N...k.xlsx
- Compile FreeBSD
- mount_nas
- Festival of Light_2008.ppt
- backup_mac_contacts



Terminal

```
jshafer@ecpe170: ~
jshafer@ecpe170:~$
```

Program to Benchmark

Downloads

chrome://downloads

Search downloads

Downloads [Open downloads folder](#) [Clear all](#)

Today
Sep 18, 2012

ubuntu-12.04.1-desktop-i386.iso 476 KB/s - 36.2 MB of 695 MB, 23 mins left
<http://releases.ubuntu.com//precise/ubuntu-12.04.1-desktop-i386.iso>
[Pause](#) [Cancel](#)

Sep 13, 2012

05-c-programming.pdf Removed
http://ecs-network.serv.pacific.edu/ecpe-170/slides/05cprogramming.pdf/at_do...
[Remove from list](#)

BIOS_Acor_7-10_A_A.zip Removed

iTunes

Alone in the Cosmos
Glint — Sound in Silence
0:19 -4:22

Alone in the Cosmos
Glint
Sound in Silence

ESPN: The Worldwide Leader

espn.go.com

EDITIONS: USA DEPORTES More

CITIES: BOSTON CHICAGO DALLAS LOS ANGELES NEW YORK

ESPN

Search

MLB Full Scoreboard Soccer WNBA NFL NCAAAF Cricket myScores All Scores

| | | | | | | | | |
|----------------|---------------|-----------------|----------------|-----------------|----------------|----------------|---------------|----------------|
| Bottom 9th | Top 8th | Top 7th | F/12 | Final | Final | F/10 | Final | Final |
| BAL 2 SEA 2 | COL 0 SF 4 | TEX 3 LAA 10 | MIN 6 CLE 5 | OAK 2 DET 12 | MIL 6 PIT 0 | ATL 3 MIA 4 | BOS 7 TB 5 | CIN 3 CHC 1 |

myESPN NFL MLB NBA NHL NCAA FB NCAA BB NASCAR SOCCER MORE SPORTS

TOP STORIES WATCH LIVE

ESPN ESPN2 ESPN3

HEADLINES MY HEADLINES SHARES

- Escobar banned 3 games for eye-black slur
- Falcons' Turner charged with DUI, speeding
- Ex-ref blasts Goodell | Sub refs under fire
- Late Ronaldo goal jolts City in thriller | Blog

Profiling Basics

- The best approach (directly booting Linux) may not be convenient to achieve for this class
- But you can ***definitely*** avoid the worst configuration!
- Keep your system **simple** when benchmarking