Mr. 305
Announcements

Extra credit: Code-a-thon was postponed to next Friday and Saturday (27th-28th)

I also forgot the answer key for the test at my apartment, but I have to come back later tonight so I will try to scan it then.
Please note that if you ever have any issue with anything regarding the class you can email me about it, I am generally pretty responsive.

New homework will be assigned at the end of this class so my inbox is ready.
Let’s go!
Performance

Last time we started on how to measure performance, we will continue that with...
CPI or cycles per instruction
CPI = # of CPU clock cycles/Instruction Count
This number gives us a way of comparing two different implementations of the same instruction set architecture
CPI

CPI is program dependent

- Not all instructions take the same number of cycles to complete
- Memory behavior also affects the CPI
Other useful CPI things

CPU time = Instruction Count \times CPI / Clock Rate

CPU Clock Cycles = \sum (CPI_i \times IC_i) \quad [i = 1 \text{ to } n]
## Example

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Program</th>
<th>Instruction Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>
Example

Compare the CPI of program 1 and 2. Which one is faster?
The performance equation

CPUtime = InstructionCount \times CPI \times ClockCycleTime

Separates the three key performance factors:
- Instructions, CPI, Clock rate

Can help evaluate design decisions
- If we see one of these terms change we know the effect on the performance
Example

A java application runs in 15 seconds. A new compiler requires 0.6 as many instructions as the the old compiler, but it increases the CPI by 1.1. Can we expect a speedup by using the new compiler?
Example

2 implementations with the same ISA (all instructions have same amount of cycles)
Comp. A has a cycle time of 250ps
Comp. B has a cycle time of 500ps
Comp. A has CPI of 2.0
Comp. B has a CPI of 1.2
Which is faster and by how much?
Amdahl’s Law

Used to find the maximum expected improvement to a system when part of it is improved
Used in parallel computing to predict speedup
Named after Gene Amdahl, presented in 1967
Amdahl’s Law

So if we improve something, our speedup is limited by the number of times our improvement is run.

It makes sense to try to speed up something we use a lot instead of something we use rarely.
The formula

Exec time after improvement =
(Exec time affected/Improvement) + Exec time unaffected
Example

Program runs in 100s, multiply operations responsible for 90s. I want a 5x overall speedup.

Speedup = OldTime/NewTime
Using MARS, I would like you to write a program that generates a random number (between 1-100). It will then ask the user to guess the number. It will continue to ask for input until the user inputs 15 numbers or guesses correctly. Once the exit condition is met, print out “Winner” or “Loser” and print the answer and all of the guessed numbers. Due March 27th