CSCI 2400: Computer Systems
Recitation Exercise 4 Solutions

(Dated: November 10, 2014)

1.
```
mov $10, %eax
NOP
NOP
NOP
add $2, %eax
mov $4, %ebx
mov $5, %ecx
NOP
NOP
add $1, %ebx
NOP
NOP
add $1, %ecx
NOP
NOP
NOP
add %ecx, %eax
NOP
NOP
NOP
add %ebx, %eax
```

2. (a) Latency = 420 ps and Throughput = 14.29 GIPS.
   (b) Latency = $C + NR$ ps and Throughput = $1000N/(C + NR)$ GIPS.
   (c) Condition: $N > C/R$.

3. This problem gives students a chance to examine machine code and perform a detailed analysis of its execution timing.
   (a) See Figure 1.
   (b) The critical path is formed by the addition operation updating variable sum. This puts a lower bound on the CPE equal to the latency of floating-point addition.
   (c) For integer data, the lower bound would be just 1.00. Some other resource constraint is limiting the performance.
   (d) The multiplication operations have longer latencies, but these are not part of a critical path of dependencies, and so they can just be pipelined through the multiplier.

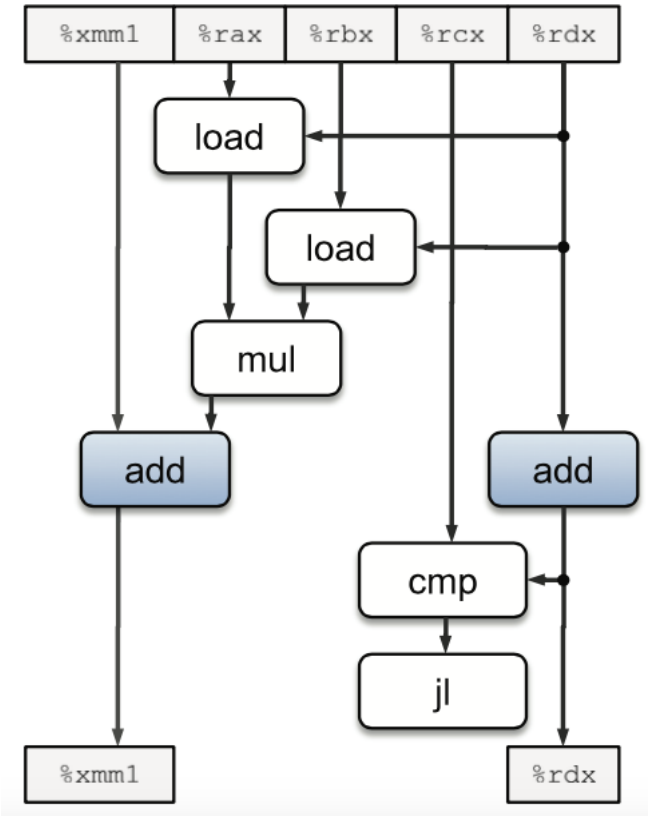

FIG. 1: Dataflow diagram