Homework2 Solutions
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Computer Architecture

2.5

a)

ALU Instr = 16bits
other instr. = 16+offset
Frequency of other instructions 26% + 12% + 10% + 4*1% = 52%
Frequency of ALU Instructions = 100% - 52% = 48%
Frequency of data reference instr. = 26% + 10% = 36%
Frequency of branch instr. = 12% + 4*1% = 16%

Assume a total of 100 instructions.
w/ 0 offset
Data ref.: 30.4 / 100 * 36 = 10.94
Branch: 0.1 / 100 * 16 = 0.16

w/8bit offset
Data ref: 71.6 / 100 * 36 10.94 = 14.83
Branch: 90.5 / 100 * 16 0.16 = 14.46

w/16bit offset
Data ref: 100/100 * 36 14.83 10.94 = 10.23
Branch: 99.5/100 * 16 14.46 0.16 = 1.3

w/24bit offset
Data ref.: 100/100 * 36 14.83 10.94 10.23 = 0
Branch: 100/100 * 16 99.5/100 * 16 = 16 * 0.5/100 = 0.08

Total Size

16 *(10.94 + 0.16) + (16+8) * (14.83 + 14.46) + (16 + 16) * (10.23 + 1.3) +
(16 + 24) * (0.08) + 16 (48) = 2020.72 / 100 = 20.21 Instructions on average

b)

Data ref. : 0offset = 10.94
total instr. = 48 + 11.66 + 0.8 = 59.74
total instr. w/8 offset = 29.29 + 11.66 + 0.8 = 40.97
total instr = 100.78 + 10.94 = 111.72
total bytes = 111.72 * 3 = 335.16
2020.72 / 8 = 252.86
ratio = 1.33

c)

offset 24
assume 100 instructions
(24+16) * (52) + 2(48) = 356
256/335.16 = 1.06

2.11

Avg gap/gcc	load = 25.8%	store = 11.75%	add=20.05
	load = 1.95%	mul = 0.75%	comp = 4.45
	load imm = 3.65%	cond brnch = 10.7%	cond mov = 4.45
	jmp = 0.75%	call = 1.1%	return 1.1%
	shift = 2.45%	and = 4.45%	or = 8.2%
	not = 1.95%	other = 2.5%	

ALU = 48.15%

LOAD/STORE = 37.55%

Cond Branch = 10.7 + 0.5 = 11.2%

Jmp = 2.95%

Number of clock cycles:
48.15 * 1 + 37.55 * 1.4 + 2.95 * 1.2 + 60/100 * 11.2 * 2 + 40/100 * 11.2 * 1.5 = 42.15 + 52.5 + 3.54 + 13.44 + 6.72 = 124.42

Effedctive CPI = 124.42 / 100 = 1.24

2.12

a)

LOAD 26%
Add 19%

% of LOAD written in new mode
26*0.1 = 2.6%

Number of ADD instructions decreased by 16.4
Instruction count of original = (100 2.6) / 100 97.4 / 100 = 0.974

b)

Total exec time of original
= 100 * CPI * clock
Total New execution = 97.4 * CPI * 1.05
ORG / NEW = 100 * 1 / 97.4 * 1.05 = 0.978
Improvement by 1.02