Your name: \_Lake Summers\_

Deriving Amdahl's law starting from the expression

execution\_time\_old

overall\_speedup = ------------------

execution\_time\_new

+----------+---------+

| 1-f | f | execution\_time\_old = T\*[ (1-f) + f ] = T

+----------+---------+

. . .

. . s . **s** is the speedup of a fraction **f** of

. . . program execution time

. . .

+----------+-----+

| 1-f | f/s | execution\_time\_new = T\*[ (1-f) + f/s ]

+----------+-----+

T 1

overall\_speedup = ----------------- = ---------------

T\*[ (1-f) + f/s ] [ (1-f) + f/s ]

law of diminishing returns

+--------+--------+

| .5 | .5 | time = .5 + .5 = 1

+--------+--------+

. . .

. . s . speedup of 1000 infinite speedup

. . .

+--------+-+

| | | time = .5 + .5/1000 = .505 .5 + 0 = .5

+--------+-+

overall speedup = 1/.505 1/.5

**>> overall\_speedup limited to 1/(1-f) <<**

1. What is the overall speedup in program execution time if an enhancement with a speedup of 8 is available and can be used to enhance 80% of the execution time? You should use Amdahl’s Law and give your answer as a fraction.

S = 8, f = .8

Overall Speedup = 1/[(1-.8)+ (.8/8)] = 3.33

2. Consider a vector computer in which vector mode can provide a speedup of 10. Using Amdahl's Law, what amount of vectorization is required for an overall speedup of 5? Solve the problem algebraically and express the answer as a reduced fraction rather than a decimal or a percentage.

S = 10, Overall Speedup = 5

5 = 1/[(1-f) + (f/10)] 🡪 1-f+(1/10)f = .2 🡪 -0.9f = -0.8 🡪 f= 8/9

Consider the following workload and execution characteristics:

|------------------------- 100 instructions --------------------------|

| | | | |

| 50 ALU ops | 20 loads | 10 stores| 20 branches |

| \* | \* | \* | \* |

| 1 cycle / ALU op| 2 cycles/ld | 3 cyc/st | 4 cycles / branch |

| = | = | = | = |

| 50 cycles | 40 cycles | 30 cycles| 80 cycles |

| | | | |

|------------------------- 200 clock cycles --------------------------|

Branches represent 20/100 of the instruction count (20%) but 80/200 of the cycle count (40%).

3. If the execution of branches is reduced to 2 cycles/branch, do you have enough information to determine how much faster the modified processor will be than the original processor:

1. Using the speedup ratio equation?

Old

|  |  |  |
| --- | --- | --- |
| Frac | IC | CPI |
| .5 | 1 | .5 |
| .2 | 2 | .4 |
| .1 | 3 | .3 |
| .2 | 4 | .8 |
|  | Avg = | 2.0 |

New

|  |  |  |
| --- | --- | --- |
| Frac | IC | CPI |
| .5 | 1 | .5 |
| .2 | 2 | .4 |
| .1 | 3 | .3 |
| .2 | 2 | .4 |
|  | Avg = | 1.6 |

2/1.6 = 1.25

1. Using Amdahl’s Law?

F=.4, s=2

1/[(1-.4)+(.4/2)]= 1/.8=1.25