Com S 321 **Homework 1** **Due: Thu, August 31, Midnight**
Fall 2017

1. If a computer A runs a program in 20 seconds and computer B runs the same program in 40 seconds, which of the following statements is true:

(a) Computer A is 50% faster than computer B.
(b) Computer A is 100% faster than computer B.

2. Suppose you are considering an improvement to a computer program. The improvement is applicable only to a fraction 35% of the program and the speedup of the improved fraction is 15. What is the overall speedup using Amdahl's Law?

3. Use Amdahl's Law to compute the overall speedup of the following options:

(a) Make 80% of a program run 20 times faster.
(b) Make 20% of a program run 80 times faster.
(c) Make 90% of a program run 10 times faster.
(d) Make 10% of a program run 90 times faster.

Which option gives the best overall speedup?

4. Use Amdahl's Law to compute the overall speedup of the following options:

(a) Make 80% of a program run 20 % faster.
(b) Make 20% of a program run 80 % faster.
(c) Make 90% of a program run 10 % faster.
(d) Make 10% of a program run 90 % faster.

Which option gives the best overall speedup?

5. You have a system that contains a special processor for doing floating-point operations. You have determined that 60% of your computations can use the floating-point processor. The speedup of the floating-point processor is 10.

(a) What is the overall speedup achieved by Amdahl's Law using the floating-point processor?

(b) What is the overall speedup achieved by Amdahl's Law if you modify the compiler so that 75% of the computations can use the floating-point processor?

(c) What fraction of the computations should be able to use the floating-point processor in order to achieve an overall speedup of 2.75?

6. You have a system that contains a special processor for doing floating-point operations. You have determined that 60% of your computations can use the floating-point processor. When a program uses the floating-point processor, it runs 30% faster than when it doesn't use it (so the speedup of the floating point processor is 1 + 30/100 = 1.3).

(a) What is the overall speedup by Amdahl's Law achieved by using the floating-point processor?

(b) In order to improve the speedup you are considering two options:

- Option 1: Modifying the compiler so that 70% of the computations can use the floating-point processor. Cost of this option is $50,000.
- Option 2: Modifying the floating-point processor so that when a program uses the floating-point processor it runs 100% faster than when it doesn't use it (so the speedup of the floating point processor is 1 + 100/100 = 2). Assume in this case that 50% of the computations can use the floating-point processor. Cost of this option is $53,000.

Which option (1 or 2) would you recommend? Justify your answer quantitatively by computing the [Cost/Overall_speedup] ratio for each option.

1 $\frac{40}{20} = 1 + \frac{N}{100}$, $N = 100$. Thus, Computer A is 100% faster than Computer B

(b)

2 $F = 0.35$, $S = 15$

$$O.S = \frac{1}{(1-F) + \frac{F}{S}} = \frac{1}{(1-0.35) + \frac{0.35}{15}} = 1.49$$

3 $\text{Amdahl's Law} = \frac{1}{(1-F)+(F/S)}$

(a) $F = 0.8$, $S = 20$

$$O.S = \frac{1}{(1-0.8)+(0.8/20)} = 4.17$$

(b) $F = 0.2$, $S = 80$

$$O.S = \frac{1}{(1-0.2)+(0.2/80)} = 1.25$$

(c) $F = 0.9$, $S = 10$

$$O.S = \frac{1}{(1-0.9)+(0.9/10)} = 5.26$$

(d) $F = 0.1$, $S = 90$

$$O.S = \frac{1}{(1-0.1)+(0.1/90)} = 1.11$$

- Option C gives the best overall speedup.

4 $\text{Amdah'ls Law} = \frac{1}{(1-F)+(F/S)}$

(a) $F = 0.8$, $S = 1.2$

$$O.S = \frac{1}{(1-0.8)+(0.8/1.2)} = 1.15$$

(b) $F = 0.2$, $S = 1.8$

$$O.S = \frac{1}{(1-0.2)+(0.2/1.8)} = 1.10$$

(c) $F = 0.9$, $S = 1.1$

$$O.S = \frac{1}{(1-0.9)+(0.9/1.1)} = 1.09$$

(d) $F = 0.1$, $S = 1.9$

$$OS = \frac{1}{(1-0.1)+(0.1/1.9)} = 1.05$$

- Option A gives the best overall speedup.

5 (a) $F = 0.6$, $S = 10$

$$O.S = \frac{1}{(1-0.6) + (0.6/10)} = 2.17$$

(b) $F = 0.75$, $S = 10$

$$O.S = \frac{1}{(1-0.75) + (0.75/10)} = 3.08$$

(c) F: Fraction of the computations.

$$2.75 = \frac{1}{(1-F) + (F/10)}$$

$F \approx 0.71 \approx 71\%$

6 (a) $F = 0.6$, $S = 1.3$

$$O.S = \frac{1}{(1-0.6) + (0.6/1.3)} = 1.16$$

(b) Option #1: $F = 0.7$, $S = 1.3$, Cost = 50,000

$$O.S = \frac{1}{(1-0.7) + (0.7/1.3)} = 1.20$$

$$\frac{Cost}{O.S} = \frac{50{,}000}{1.20} = \boxed{41{,}666.7}$$

Option #2: $F = 0.5$, $S = 2$, Cost = 53,000

$$O.S = \frac{1}{(1-0.5) + (0.5/2)} = 1.33$$

$$\frac{Cost}{O.S} = \frac{53{,}000}{1.33} = \boxed{39{,}849.6}$$

- I would recommend option 2 since it is lower in (cost/O.S)