

Computer Architecture Exercise 3

Consider the following SPEC CINT2017 results on two Intel CPUs:

CPU	Clock Rate	Cores	Parallel Compilation	CINT2017
Xeon 5160	3.0 GHZ	4	No	5.20
Intel Core i7-5960X	4.0 GHZ	6	Yes	8.98

1. Find the expected SPEC CINT2017 score for the Core i7 if its clock rate were 3.0 GHz.

$$8.98 * (3.0 \text{ GHZ} / 4.0 \text{ GHZ}) = \mathbf{6.735}$$

2. Find the speedup of the Core i7 relative to the Xeon 5160 if both run at 3.0 GHz.

$$\frac{\text{Core i7}}{\text{Xeon 5160}} = \frac{6.735}{5.2} = \mathbf{1.2951}$$

3. Assume that the compilation for the Core i7 uses all 6 cores, so that some proportion F_p of the program runs in parallel.

Assume that the Xeon 5160 (without parallel compilation) runs the program sequentially on one core.

From the speedup that was found in question 2, use the Amdahl equation

$$S = \frac{1}{1 - F_p + \frac{F_p}{N}}$$

to find F_p (the relative proportion of the program that the compiler was able to parallelize).

$$\text{We will find } F_p: S = \frac{1}{1 - F_p + \frac{F_p}{N}} \rightarrow 1 - F_p + \frac{F_p}{N} = \frac{1}{S} \rightarrow 1 - \frac{1}{S} = F_p - \frac{F_p}{N} \rightarrow 1 - \frac{1}{S} =$$

$$F_p \left(1 - \frac{1}{N}\right) \rightarrow F_p = \frac{1 - \frac{1}{S}}{1 - \frac{1}{N}}$$

Now, $N=8$ which is the number of cores that the processor used (divided into 8 programs that run concurrently), and $S=1.2951$ - according to the calculation of the improvement in q2. Therefore, we get:

$$F_p = \frac{1 - \frac{1}{1.2951}}{1 - \frac{1}{8}} = \frac{\frac{1.2951 - 1}{1.2951}}{\frac{8 - 1}{8}} = \frac{\frac{0.2951}{1.2951}}{\frac{7}{8}} = \frac{0.2278}{0.875} \approx 0.2603$$

The relative part of the software that the compiler found to run concurrently is \approx **26.03%**.

4. Find the expected score for the Core i7 on SPEC CINT2017 if it is possible to make a 30% improvement on 50% of the run time.

For $F_e = 0.5$ (The percentage of commands that can be run concurrently) And for $S_e = 1.3$ (The ratio of the improvement of the running time - since it is possible to improve by 30%, therefore we will accept that the percentage of improvement = 1.3). In total, we will get that the improvement is: $S = \frac{1}{1 - 0.5 + \frac{0.5}{1.3}} = \frac{1}{0.5 + \frac{0.5}{1.3}} = 1.13$

Therefore, the new score that the processor will get is $8.98 * 1.13 = \mathbf{10.1474}$.