CS 5220 Parallel Computing	**Aug 31 2015**

Preclass: Performance Analysis Basics

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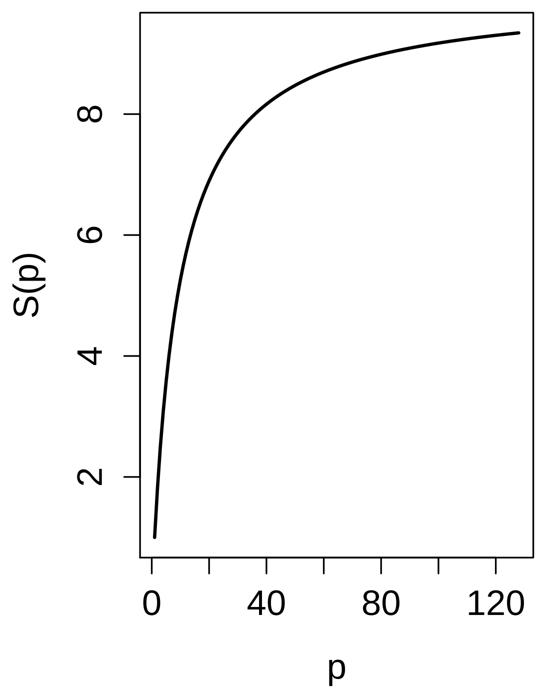
1. By Amdahl's Law, the speed up $S(p)$ satisfies

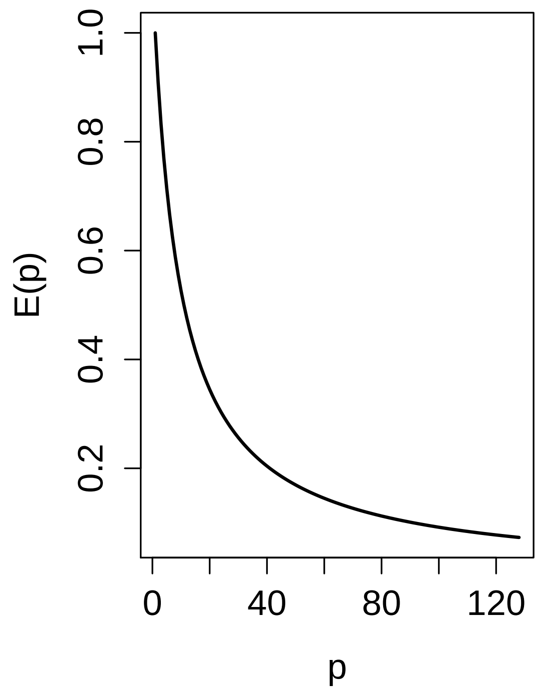
$$S(p) \leq \frac{1}{\alpha + (1-\alpha)/p} = \frac{p}{0.1p + 0.9}$$

and efficiency $E(p)$ by definition

$$E(p) = \frac{S(p)}{p} \leq \frac{1}{0.1p + 0.9}$$

Following please find the corresponding plots for both speedup $S(p)$ and efficiency $E(p)$.





2. Suppose there are n tasks. Then the total time needed for the work to be done is

$$T_{Total} = n\alpha + \tau$$

So the ratio is

$$\frac{n}{T_{Total}} = \frac{n}{n\alpha + \tau} = \frac{1}{\alpha + \tau/n} \to \frac{1}{\alpha} \quad \text{as } n \to \infty$$

3. (a) Tuning takes human time. If the human time is more expensive than the computation time saved, its not worth it.
   (b) Performance is often in tension with maintainability, generality, and other nice software design properties. If tuning for performance means making a mess of the code base, it may not be worth it.
   (c) Most codes have bottlenecks where the majority of the time is spent. It doesnt make sense to tune something that already takes little time.

4. From Intel product details we know that each Intel Xeon Phi coprocessor 5110P has 60 cores, each of which is running at 1.053GHz. So the double precision FLOPS for this coprocessor has peak

$$2\frac{FLOPS}{FMA}\times\left(\frac{512}{64}\right)\frac{FMA}{vectorFMA}\times 2\frac{vectorFMA}{cycle}\times 60cores\times 1.053\times 10^9\frac{cycles}{s} = 2021.76\times 10^9 FLOPS/s$$

   For a single Intel E5-2620 v3 with Turbo Boost, Intel product details show that it has 6 cores each of which has peak frequency 3.2GHz with turbo boost and each CPU is dual core. So each one has peak

$$16\frac{\text{FLOPS}}{cycle}\times 12 \text{ cores } \times 3.2GHz = 614.4GF/s$$

   So in total we have 8 nodes and 15 accelerators and the theoretical peak should be

$$8\times 614.4GF/s + 15\times 2021.76GF/s = 35241.45GF/s$$

5. My laptop is mid-2014 Apple macbook pro 15 inch version with 2.2GHz quad-core Intel Core i7 processor (Turbo Boost up to 3.4GHz).

$$2\frac{FLOPS}{FMA}\times(256/64)\frac{FMA}{vectorFMA}\times 2\frac{vectorFMAs}{cycle}\times 4cores\times 3.4\times 10^9 cycles/s = 2.176\times 10^{11} FLOPS/s$$