Assignment 1

Part 1

Solution provided in code and can be found in the zip file.

Part 2

The appropriate points are circled in red, representing the inter-node scaling at 20, 40, 60, and 80 processes. The other points from 1-20 processes are not appropriate for Amdahl's law fitting because within a socket all cores are competing for shared memory bandwidth, leading to saturation effects that create a bottleneck. This violates the model's assumption of scalable resources (Lecture 1, Slide 40). In order to fit Amdahl's law, we use inter-node scaling where intra-socket communication overhead is not the limiting factor. We define the first node (20 processes) as the scaling baseline.

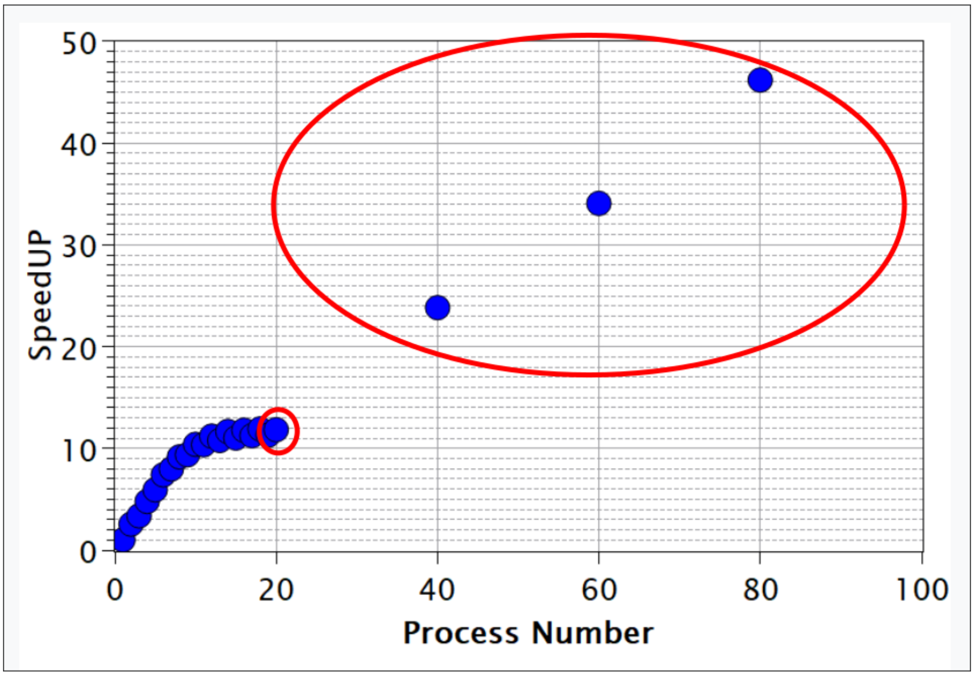

Figure 1: Appropriate data points shown in red circle

Serial fraction

Using the first node as our scaling baseline, we divide all speedup values by the speedup at 20 processes, resulting in the following rebased values. (Note: We now express parallelism in terms of nodes N, where 1 node equals 20 processes)

$$S(1) = \frac{12}{12} = 1 \tag{1}$$
$$S(2) = \frac{24}{12} = 2 \tag{2}$$
$$S(3) = \frac{34}{12} = \frac{17}{6} \tag{3}$$
$$S(4) = \frac{46}{12} = \frac{23}{6} \tag{4}$$
$$\tag{5}$$

We can now compute the serial fraction for $N = 4$ Nodes:

$$S(N) = \frac{1}{s + \frac{1-s}{N}} \tag{6}$$
$$\frac{23}{6} = \frac{1}{s + \frac{1-s}{4}} \tag{7}$$
$$s + \frac{1-s}{4} = \frac{6}{23} \tag{8}$$
$$4s + (1-s) = \frac{24}{23} \tag{9}$$
$$3s + 1 = \frac{24}{23} \tag{10}$$
$$3s = \frac{24-23}{23} \tag{11}$$
$$s = \frac{1}{23 \cdot 3} \approx 0.01449 \tag{12}$$

Therefore approximately 1.45% of the code is serial.