Sample Solution for Homework 1

Dining Philosophers (AMP, p. 16, 12 Points)

See Java source code for one possible solution to this problem.

Prisoners' Dilemma (AMP, p. 17, 7 Points)

When the prisoners discuss their strategy they elect a leader among themselves. All other prisoners are followers.
For the first part of the exercise, the prisoners follow the following protocol:

- The leader counts how many times he has entered the room and found the light switch turned off. If he finds it switched off for the Pth time, he announces that all prisoners have been in the room. Furthermore, each time he enters and finds the light switch off, he switches it on.
- Whenever a follower enters the room and finds the switch on for the first time, he turns it off. Otherwise he does nothing.

For the second part of the exercise, after electing a leader, the leader chooses an adjutant from the remaining $P-1$ followers (assume $P > 1$ since the case for $P = 1$ is trivial). The leader and all followers other than the adjutant execute the same protocol as in the first part. The adjutant does the following:

- When he enters the room and he has not yet visited the room twice with the switch on, he turns the switch off. Otherwise he does nothing.

Amdahl's Law (AMP, p. 18, 6 Points)

- $\lim_{n\to\infty}(\frac{1}{1-p+\frac{p}{n}}) = \lim_{n\to\infty}(\frac{1}{\frac{2}{5}+\frac{3}{5n}}) = \frac{5}{2} = 2.5$
- We have:
$$s_n = \frac{1}{\frac{3}{10}+\frac{7}{10n}} = \frac{10n}{3n+7}$$
Assume that the (normalized) running time of the original program on one processor was 1. Then the normalized running time of the improved program on one processor is:
$$t' = \frac{3}{10k} + \frac{7}{10}$$
Hence we have the new speedup
$$s'_n = \frac{t'}{\frac{3}{10k}+\frac{7}{10n}} = \frac{3n+7kn}{3n+7k}$$
Solving the equation $s'_n = 2s_n$ for k yields
$$k_n = \frac{51n-21}{21n-91}$$

Considering the limit case, we should aim for $k = \lim_{n \to \infty} k_n = \frac{51}{21} \approx 2.43$

- Find x such that
$$2\left(\frac{x}{3} + \frac{1-x}{n}\right) = x + \frac{1-x}{n}$$
Solving for x yields
$$x = \frac{3}{n+3}$$