

Dining Philosophers: Contention Levels

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Abstract

This report investigates how varying levels of eating time, thinking time, range of eating/thinking time, and food affect the level of contention for forks (time spent hungry). Level of contention is measured as a percentage of overall running time spent waiting for a fork. Overall running time is the sum of the time spent thinking, hungry, and eating. Experiments showed that increasing the time spent eating relative to thinking increased levels of contention logarithmically and that other variables like range of time and food have little correlation with levels of contention.

1 Experiment: Decreasing Eating/Thinking Ratio

1.1 Hypothesis

My hypothesis was that decreasing the eating to thinking ratio would also decrease the levels of contention. I hypothesized this because forks are withheld from other philosophers while eating and are made available while thinking, so less eating relative to thinking would increase the availability of forks overall.

1.2 Methodology

Eating and thinking time are set up in my program as constants. I set them both initially to 0.5, a range of 0.25. I have each philosopher thread set up to log overall contention levels (as defined in the abstract) upon termination. I run the program, and repeat the process after recompiling the program with the thinking time set to 1, 1.5, 2, ..., 5; this gives us the ratios 1, $\frac{1}{2}$, ..., $\frac{1}{10}$. I then log all of the contention levels for each of the philosophers in a spreadsheet.

1.3 Observations

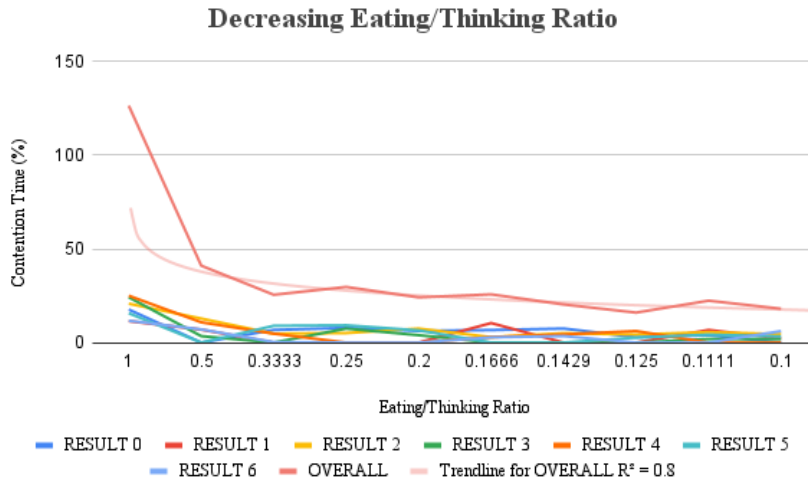


Figure 1: Contention with respect to Eat/Thinking.

1.4 Conclusions

There is a fairly strong inversely logarithmic relationship between decreasing the eating/thinking ratio with an R^2 value of 0.8. This confirms my initial hypothesis.

2 Experiment: Increasing Eating/Thinking Ratio

2.1 Hypothesis

My hypothesis was that increasing the eating to thinking ratio would also increase the levels of contention. I hypothesized this because forks are withheld from other philosophers while eating and are made available while thinking, so more eating relative to thinking would decrease the availability of forks overall.

2.2 Methodology

Eating and thinking time are set up in my program as constants. I set them both initially to 0.5, a range of 0.25. I have each philosopher thread set up to log overall contention levels (as defined in the abstract) upon termination. I run the program, and repeat the process after recompiling the program with the eating time set to 1, 1.5, 2, ..., 5; this gives us the ratios 1, 2, ..., 10. I then log all of the contention levels for each of the philosophers in a spreadsheet.

2.3 Observations

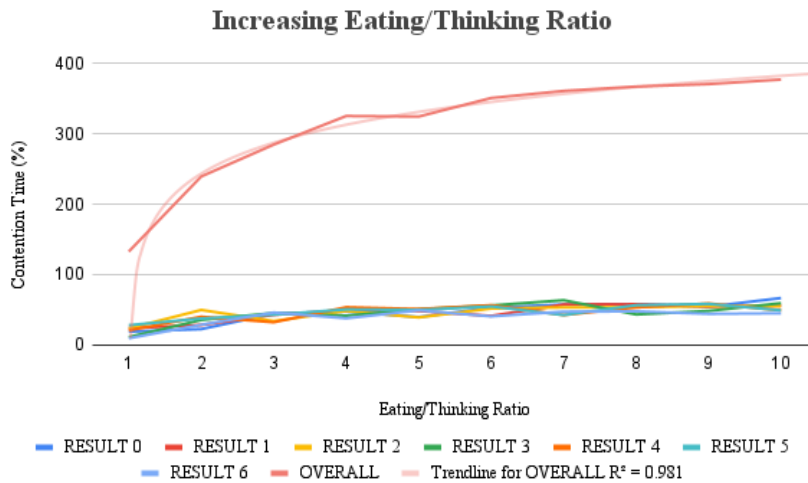


Figure 2: Contention with respect to Eat/Thinking.

2.4 Conclusions

There is a fairly strong logarithmic relationship between decreasing the eating/thinking ratio with an R^2 value of 0.981. This confirms my initial hypothesis.

3 Experiment: Increasing Range of Times

3.1 Hypothesis

My hypothesis was that increasing the range of times may affect the contention levels depending on the eating to thinking ratio. This is because on average, the time spent eating will be $eating + \frac{range}{2}$ and the time spent thinking will be $thinking + \frac{range}{2}$. If $eating \neq thinking$, then the ratio of eating time to thinking time may become dominated by a sufficiently large range and become 1.

3.2 Methodology

Eating/thinking time and range of time are each set up in my program as constants. I do 3 sets of trials, one where the eating/thinking ratio is 1 (0.5s, 0.5s), 2 (1s, 0.5s), 0.5 (0.5s, 1s). I have each philosopher thread set up to log overall contention levels (as defined in the abstract) upon termination. I run the program initially with the range being 0.25, and repeat the process after recompiling the program with the range set to 0.5, 1, 2, ..., 5. I then log all of the contention levels for each of the philosophers in a spreadsheet.

3.3 Observations

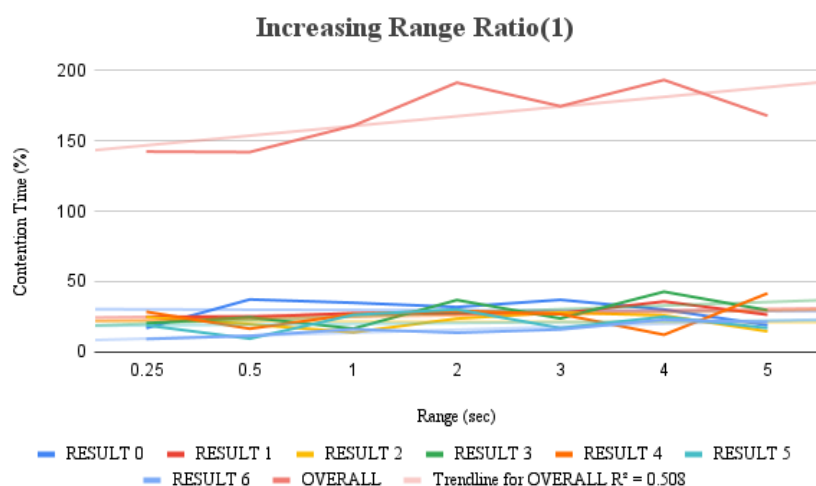


Figure 3: Contention with respect to Range (Eating/Thinking Ratio of 1).

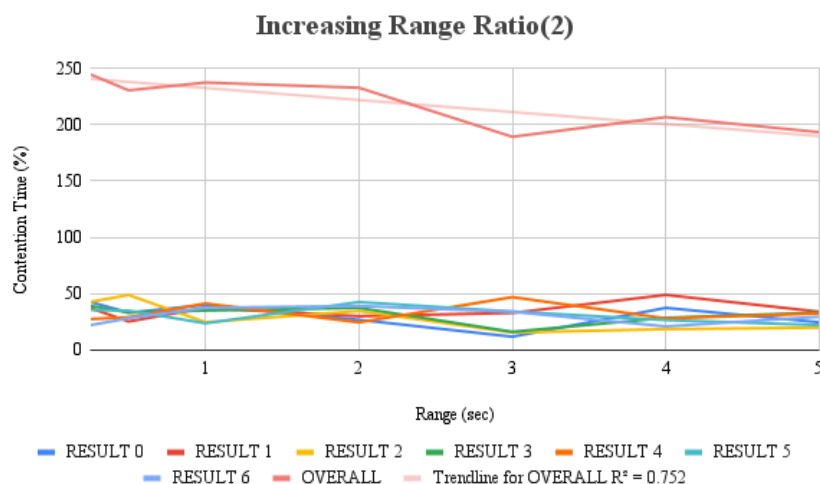


Figure 4: Contention with respect to Range (Eating/Thinking Ratio of 2).

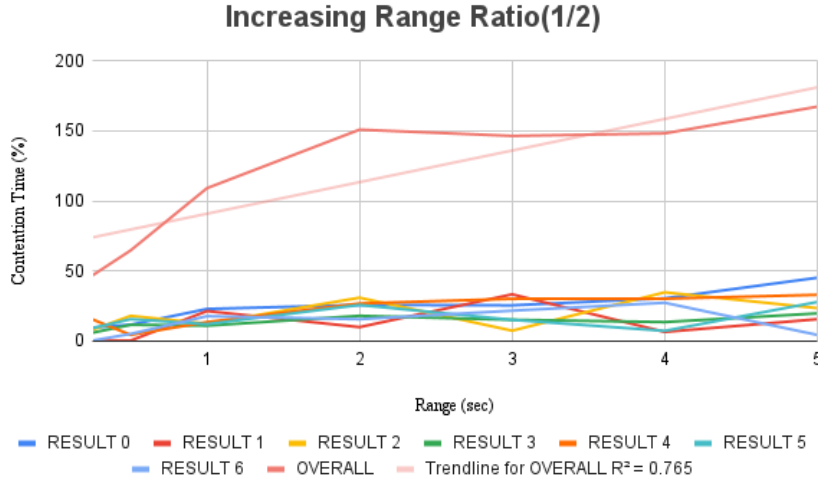


Figure 5: Contention with respect to Range (Eating/Thinking Ratio of $\frac{1}{2}$).

3.4 Conclusions

There is a weak amount of positive correlation with the ratio equalling 1 ($R^2 = 0.508$), but there is a stronger positive correlation ($R^2 = 0.765$) when the ratio is less than one and negative correlation ($R^2 = 0.752$) when the ratio is greater than one. This confirms my initial hypothesis.

4 Experiment: Decreasing Amount of Food

4.1 Hypothesis

My hypothesis was that decreasing the amount of food will not affect the contention time. This is because the amount of food does not affect the interaction between philosophers and only determines when the philosophers must terminate.

4.2 Methodology

Eating/thinking time, range of time, food amount are each set up in my program as constants. I have each philosopher thread set up to log overall contention levels (as defined in the abstract) upon termination. I run the program initially with the food being 50, and repeat the process after recompiling the program with the range set to 40, 30, ..., 10. I then log all of the contention levels for each of the philosophers in a spreadsheet.

4.3 Observations

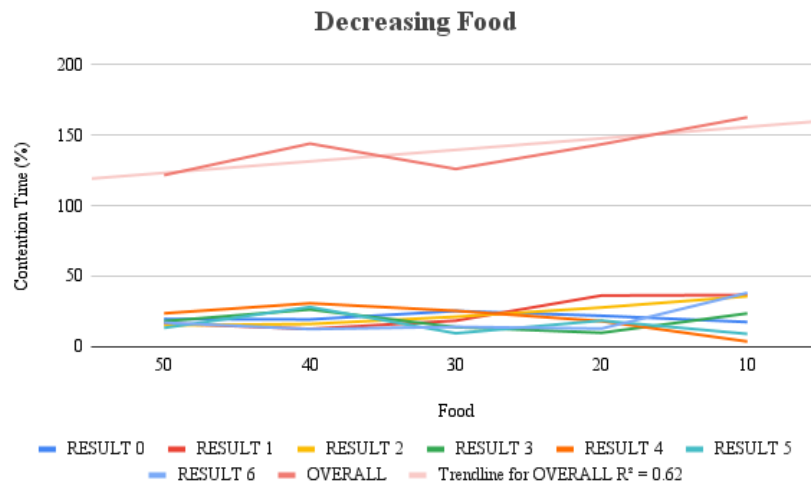


Figure 6: Contention with Respect to Amount of Food.

4.4 Conclusions

The positive correlation between food and contention time is fairly weak with an R^2 value of 0.62, and we can also see that variability between philosophers increases with decreasing amounts of food. This confirms my initial hypothesis.