Exercise 05

MPI Part II

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rworreby@student.ethz.ch

1. Parallel Scaling

For the strong scaling we calculate the speedup with the following formula:

$$S = \frac{T(1)}{T(P)} \tag{1}$$

We take as reference the speed of $T(P = 1)$ for the problem size $N = 1000$. In order to calculate the speedup of multiple nodes we therefore calculate $S_P = \frac{T(P=1,N=1000)}{T(P=P,N=1000)}$. We choose the four values to plot as $P = 1, 4, 9, 16$. The result can be seen in Figure 3.
For the weak scaling we calculate the efficiency with the following formula:

$$\eta_W = \frac{T(1)}{T(P)} \tag{2}$$

Note that for the $T(P)$ the workload is $P * W(1)$, where $W(1)$ is the workload of $T(1)$. We take as reference the speed of $T(P = 1)$ for the problem size $N = 500$, which has a workload W of $N^2 = 500^2$. In order to calculate the efficiency of multiple nodes we therefore calculate $\eta_W = \frac{T(P=1,N=500)}{T(P=P,W=P*W(1))}$. We choose the four values to plot as $P = 1, 4, 9, 16$. Calculating for example $P = 4$, we have $W(P = 4) = 4 * W(P = 1) = 4 * 500^2 = 1000^2$. Plugging the result into the equation before this yields the following:

$$\eta_W(P = 4) = \frac{T(P = 1, N = 500, W = 500^2)}{T(P = 4, N = 1000, W = 4 * W(1))} = \frac{T(P = 1, N = 500, W = 500^2)}{T(P = 4, N = 1000, W = 1000^2)} \tag{3}$$

The result can be seen in Figure 4.

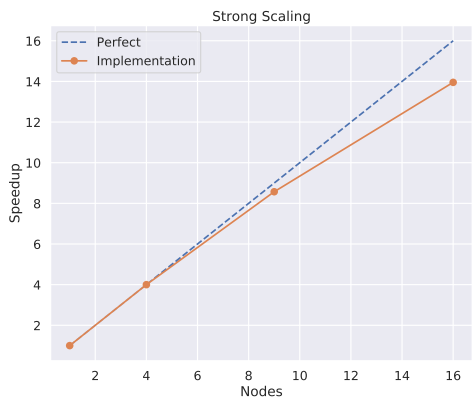

Figure 1: Strong scaling plot for $N = 1000$ and four different P values.

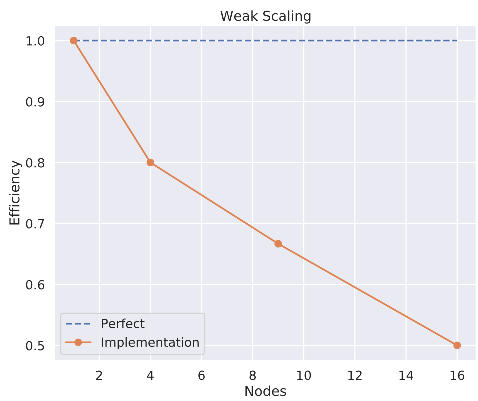

Figure 2: Weak scaling plot for reference workload $P = 1, N = 500$.

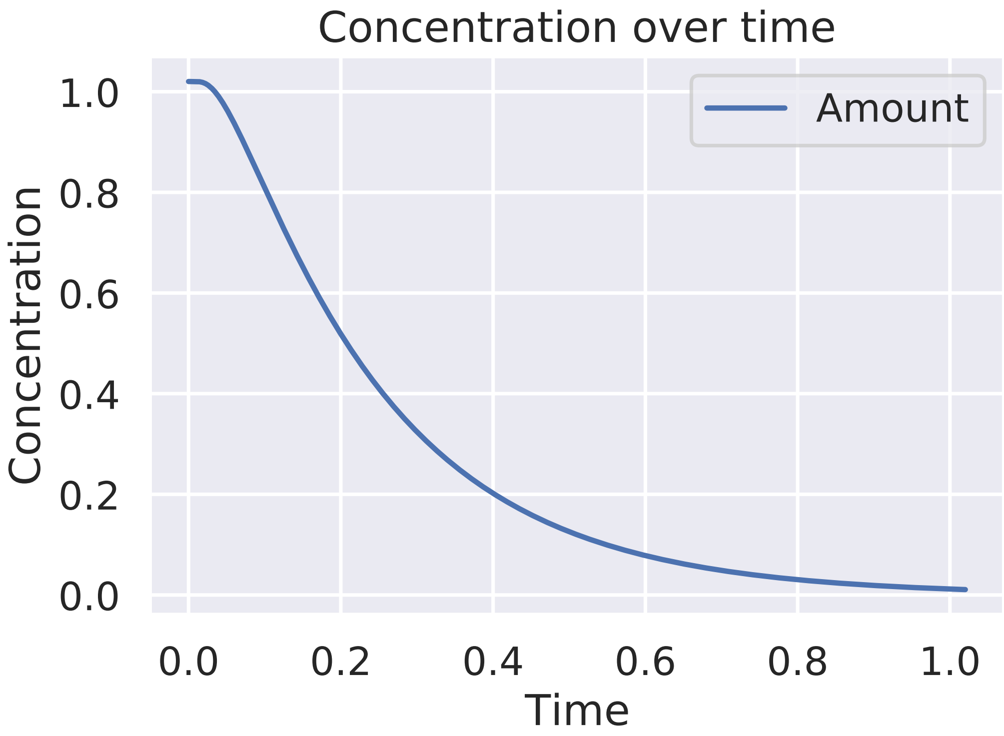

Figure 3: Total concentration (substance) over time for the diffusion equation. Parameters: $D = 1, L = 2, N = 100$.

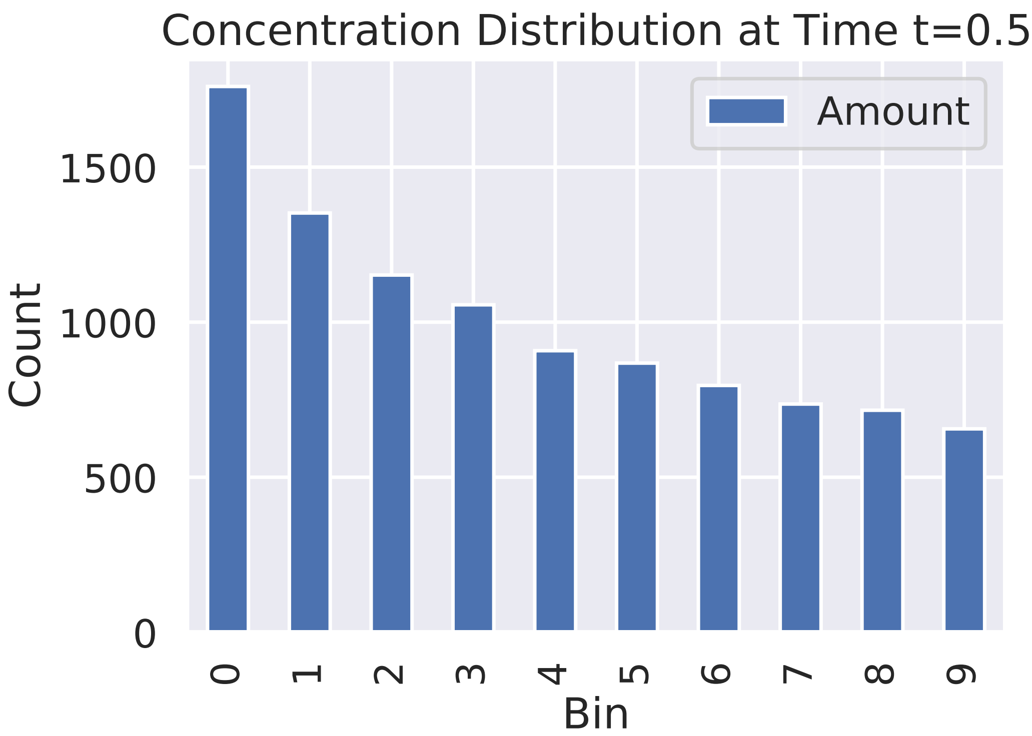

Figure 4: Distribution of concentration (substance) at time $t = 0.5$ for the diffusion equation. Parameters: $D = 1, L = 2, N = 100$.