

# Example solution Sheet 3, Task 2

December 22, 2023

## 1 Reproduction of analytical solution

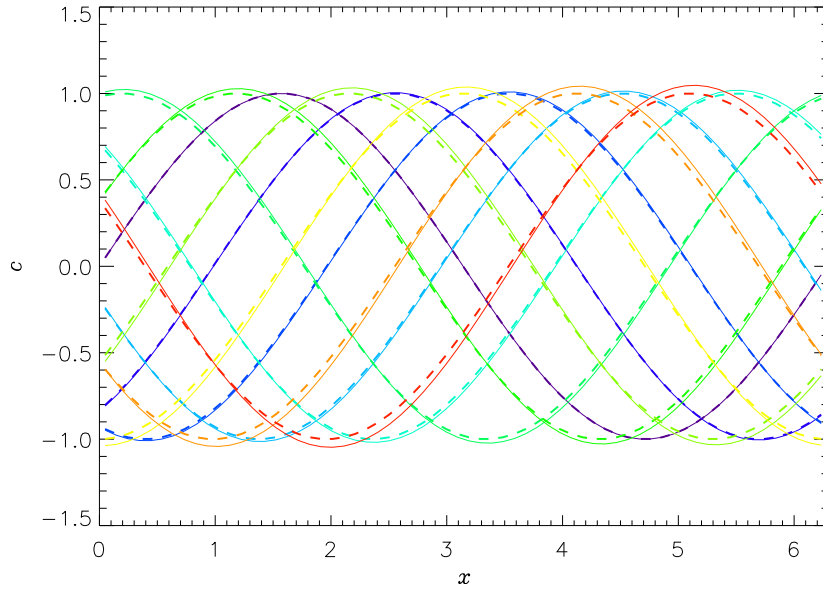


Figure 1: Numerical solution (solid lines) compared to analytical solution (dashed lines) for the advected concentration wave. Initial condition:  $c = \sin(x)$ , advective velocity:  $\mathbf{u} = [1, 0]$ , timestep: 0.009817, grid resolution:  $64 \times 64$ , integration time: 1000 timesteps = 9.817, number of processes: 4 ( $2 \times 2$ ). Time is indicated by color: start at dark lila, end at red, time progress  $\rightarrow$  blue  $\rightarrow$  green  $\rightarrow$  yellow  $\rightarrow$  red in steps of 0.9817.

## 2 Computation – communication concurrency tests

Again 4 ( $2 \times 2$ ) processes were used but different grid resolutions, 100 integration timesteps. Elapsed time per integration step in seconds, averaged over all processes.

### MPI\_Rget, 1 node:

	$1024 \times 1024$	$2048 \times 2048$	$4096 \times 4096$
comput. & communic.	0.005628	0.022218	0.091953
only computation	0.005535	0.022130	0.091777
only communication	0.000009	0.000010	0.000015

Table 1:  $\mathbf{u} = [1, 0]$

	$1024 \times 1024$	$2048 \times 2048$	$4096 \times 4096$
comput. & communic.	0.014319	0.057546	0.266096
only computation	0.008199	0.032834	0.136144
only communication	0.000036	0.000057	0.000145

Table 2:  $\mathbf{u} = [1, 1]$

### MPI\_Get, 1 node:

	$1024 \times 1024$	$2048 \times 2048$	$4096 \times 4096$
comput. & communic.	0.005582	0.022729	0.094449
only computation	0.005635	0.022922	0.092634
only communication	0.000011	0.000012	0.000022

Table 3:  $\mathbf{u} = [1, 0]$

	$1024 \times 1024$	$2048 \times 2048$	$4096 \times 4096$
comput. & communic.	0.008330	0.033166	0.137238
only computation	0.008212	0.032869	0.136508
only communication	0.000027	0.000042	0.000098

Table 4:  $\mathbf{u} = [1, 1]$

**MPI\_Rget, 2 nodes:**

	$1024 \times 1024$	$2048 \times 2048$	$4096 \times 4096$
comput. & communic.	0.005570	0.022262	0.092393
only computation	0.005954	0.022194	0.091782
only communication	0.000010	0.000012	0.000016

Table 5:  $\mathbf{u} = [1, 0]$ 

	$1024 \times 1024$	$2048 \times 2048$	$4096 \times 4096$
comput. & communic.	0.016271	0.064787	0.271212
only computation	0.008209	0.032802	0.136501
only communication	0.000035	0.000062	0.000123

Table 6:  $\mathbf{u} = [1, 1]$ **MPI\_Get, 2 nodes:**

	$1024 \times 1024$	$2048 \times 2048$	$4096 \times 4096$
comput. & communic.	0.005593	0.022453	0.119186
only computation	0.005534	0.022144	0.091971
only communication	0.000021	0.000024	0.000026

Table 7:  $\mathbf{u} = [1, 0]$ 

	$1024 \times 1024$	$2048 \times 2048$	$4096 \times 4096$
comput. & communic.	0.008249	0.032733	0.135766
only computation	0.008235	0.032770	0.147043
only communication	0.000034	0.000055	0.000107

Table 8:  $\mathbf{u} = [1, 1]$ 

In all, the measurements are not conclusive. Hiding of the communication seems not possible, except for some cases with MPI\_Get, 1 node,  $\mathbf{u} = [1, 0]$ , MPI\_Get, 2 nodes,  $\mathbf{u} = [1, 1]$ . Most likely, the comparison is in a way unfair as “only computation” has no synchronisation, whereas the two other regimes have.