Verteilte Systeme

Übung 1

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Aufgabe 1.2)

```
#include <mpi.h>
#include <stdio.h>
#include <assert.h>
#include <stdlib.h>

/* First argument should be the number of elements in array */
int main (int argc, char *argv[]){
	int numprocs;
	int workers;
	int myid;

	int* array;
	int* buf;
	int i = 0;
	int res = 0;
	MPI_Request req1;
	MPI_Request req2;

	/* Initialize MPI */
	MPI_Init(&argc,&argv);
	MPI_Comm_size(MPI_COMM_WORLD, &numprocs);
	MPI_Comm_rank(MPI_COMM_WORLD, &myid);

	/*Quit if we only have one process */
	assert(numprocs > 1);
	workers = numprocs - 1;

	/* We fail if no input available */
	assert(argc > 1);
	/* Convert input to number */
	int n = atoi(argv[1]);
	assert(n > 0);

	/* Size of a normal chunk and size of remainder */
	int chunksize = n/workers;
	int rem = n%workers;


	/* Process 0 creates array, and sends it to the remaining processes */
	if(myid == 0){
		/* Create Array with 1s */
		printf("Creating Array with size %i\nWill send this array to %i
processes\n", n, workers);
		array = malloc(n * sizeof(int*));
		for (i = 0; i < n; i++)
			array[i] = 1;

		int offset = 0;
		/* Send to other processes*/
		for(i = 1; i <= workers; i++){
			int count = chunksize + (rem-- > 0 ? 1 : 0);
			/* Send number of elements */
			MPI_Isend(&count,1, MPI_INT, i, 1, MPI_COMM_WORLD, &req1);
			/* Send actual elements */
			MPI_Isend(array+offset, count, MPI_INT, i, 2, MPI_COMM_WORLD, &req2);
			printf("Sending %i elements to worker %i\n", count, i);
			offset += count;
		}
```

```
            printf("Sending done. Now receiving...\n");

            /* Receive sums from workers */
            int sum = 0;
            int totalsum = 0;
            for(i = 1; i <= workers; i++){
                  res = MPI_Recv(&sum, 1, MPI_INT, i, 1, MPI_COMM_WORLD,
MPI_STATUS_IGNORE);
                  assert(res == MPI_SUCCESS);
                  printf("Sum received => sum: %i\n",sum);
                  totalsum += sum;
            }

            printf("The total sum is: %i\n", totalsum);
            assert(totalsum == n);

      /* Other processes sum up received array elements */
      }else{
            /* Receive number of elements */
            int count = 0;
            res = MPI_Recv(&count, 1, MPI_INT, 0, 1, MPI_COMM_WORLD,
MPI_STATUS_IGNORE);
            assert(res == MPI_SUCCESS);

            buf = malloc(count*sizeof(int*));

            /* Receive actual elements */
            res = MPI_Recv(buf, count, MPI_INT, 0, 2, MPI_COMM_WORLD,
MPI_STATUS_IGNORE);
            assert(res == MPI_SUCCESS);

            int sum = 0;
            for(i = 0; i < count; i++)
                  sum += buf[i];

            //printf("Sum calculated by process %i => sum: %i\n",myid,sum);

            /* Send sum to master */
            res = MPI_Send(&sum, 1, MPI_INT, 0, 1, MPI_COMM_WORLD);
            assert(res == MPI_SUCCESS);
      }

      MPI_Finalize();
      return 0;
}
```

Testläufe für verschiedene Arraygrößen und 1..8 Prozesse, generiert mit folgenden Bashscript:

```
#!/bin/bash
mpicc main.c -o main
for k in 1 10 32 128 666 10000
do
      echo "++++++++++++++++++++++++";
      #echo "Now using array size $k";
      for i in {1..8}
      do
            echo "--------------------------------------";
            echo "Array size is $k. Using $i processes";
            echo "--------------------------------------";
          mpirun -n $i main $k
      done
      echo "++++++++++++++++++++++++";
      echo "";
done
```

```
------------------------------------
Array size is 1. Using 1 processes
------------------------------------
main: main.c:25: main: Assertion `numprocs > 1' failed.
[tywyn:17311] *** Process received signal ***
[tywyn:17311] Signal: Aborted (6)
[tywyn:17311] Signal code:  (-6)
[tywyn:17311] [ 0] /lib/libpthread.so.0(+0xeff0) [0x7f37d12f0ff0]
[tywyn:17311] [ 1] /lib/libc.so.6(gsignal+0x35) [0x7f37d0fb21b5]
[tywyn:17311] [ 2] /lib/libc.so.6(abort+0x180) [0x7f37d0fb4fc0]
[tywyn:17311] [ 3] /lib/libc.so.6(__assert_fail+0xf1) [0x7f37d0fab301]
[tywyn:17311] [ 4] main(main+0x7d) [0x400c41]
[tywyn:17311] [ 5] /lib/libc.so.6(__libc_start_main+0xfd) [0x7f37d0f9ec8d]
[tywyn:17311] [ 6] main() [0x400b09]
[tywyn:17311] *** End of error message ***
-------------------------------------------
------------------------------
mpirun noticed that process rank 0 with PID 17311 on node tywyn exited on signal 6 (Aborted).
-------------------------------------------
------------------------------
------------------------------------
Array size is 1. Using 2 processes
------------------------------------
Creating Array with size 1
Will send this array to 1 processes
Sending 1 elements to worker 1
Sending done. Now receiving...
Sum received => sum: 1
The total sum is: 1
------------------------------------
Array size is 1. Using 3 processes
------------------------------------
Creating Array with size 1
Will send this array to 2 processes
Sending 1 elements to worker 1
Sending 0 elements to worker 2
Sending done. Now receiving...
Sum received => sum: 1
Sum received => sum: 0
The total sum is: 1
------------------------------------
Array size is 1. Using 4 processes
------------------------------------
Creating Array with size 1
Will send this array to 3 processes
Sending 1 elements to worker 1
Sending 0 elements to worker 2
Sending 0 elements to worker 3
Sending done. Now receiving...
Sum received => sum: 1
Sum received => sum: 0
Sum received => sum: 0
The total sum is: 1
------------------------------------
Array size is 1. Using 5 processes
------------------------------------
Creating Array with size 1
Will send this array to 4 processes
Sending 1 elements to worker 1
Sending 0 elements to worker 2
Sending 0 elements to worker 3
Sending 0 elements to worker 4
Sending done. Now receiving...
Sum received => sum: 1
Sum received => sum: 0
Sum received => sum: 0
Sum received => sum: 0
The total sum is: 1
------------------------------------
Array size is 1. Using 6 processes
------------------------------------
Creating Array with size 1
Will send this array to 5 processes
Sending 1 elements to worker 1
Sending 0 elements to worker 2
Sending 0 elements to worker 3
Sending 0 elements to worker 4
Sending 0 elements to worker 5
Sending done. Now receiving...
Sum received => sum: 1
Sum received => sum: 0
Sum received => sum: 0
Sum received => sum: 0
Sum received => sum: 0
The total sum is: 1
------------------------------------
Array size is 1. Using 7 processes
------------------------------------
Creating Array with size 1
Will send this array to 6 processes
Sending 1 elements to worker 1
Sending 0 elements to worker 2
Sending 0 elements to worker 3
Sending 0 elements to worker 4
Sending 0 elements to worker 5
Sending 0 elements to worker 6
Sending done. Now receiving...
Sum received => sum: 1
Sum received => sum: 0
Sum received => sum: 0
Sum received => sum: 0
Sum received => sum: 0
The total sum is: 1
------------------------------------
Array size is 1. Using 8 processes
------------------------------------
Creating Array with size 1
Will send this array to 7 processes
Sending 1 elements to worker 1
Sending 0 elements to worker 2
Sending 0 elements to worker 3
Sending 0 elements to worker 4
Sending 0 elements to worker 5
Sending 0 elements to worker 6
Sending 0 elements to worker 7
Sending done. Now receiving...
Sum received => sum: 1
Sum received => sum: 0
Sum received => sum: 0
Sum received => sum: 0
Sum received => sum: 0
Sum received => sum: 0
Sum received => sum: 0
```

```
The total sum is: 1
++++++++++++++++++++++
++++++++++++++++++++++
--------------------------------------
Array size is 10. Using 1 processes
--------------------------------------
main: main.c:25: main: Assertion `numprocs > 1' failed.
[tywyn:17357] *** Process received signal ***
[tywyn:17357] Signal: Aborted (6)
[tywyn:17357] Signal code:  (-6)
[tywyn:17357] [ 0] /lib/libpthread.so.0(+0xeff0) [0x7f6bac64aff0]
[tywyn:17357] [ 1] /lib/libc.so.6(gsignal+0x35) [0x7f6bac30c1b5]
[tywyn:17357] [ 2] /lib/libc.so.6(abort+0x180) [0x7f6bac30efc0]
[tywyn:17357] [ 3] /lib/libc.so.6(__assert_fail+0xf1) [0x7f6bac305301]
[tywyn:17357] [ 4] main(main+0x7d) [0x400c41]
[tywyn:17357] [ 5] /lib/libc.so.6(__libc_start_main+0xfd) [0x7f6bac2f8c8d]
[tywyn:17357] [ 6] main() [0x400b09]
[tywyn:17357] *** End of error message ***
-------------------------------------------------------
------------------------------
mpirun noticed that process rank 0 with PID 17357 on node tywyn exited on signal 6 (Aborted).
-------------------------------------------------------
------------------------------
--------------------------------------
Array size is 10. Using 2 processes
--------------------------------------
Creating Array with size 10
Will send this array to 1 processes
Sending 10 elements to worker 1
Sending done. Now receiving...
Sum received => sum: 10
The total sum is: 10
--------------------------------------
Array size is 10. Using 3 processes
--------------------------------------
Creating Array with size 10
Will send this array to 2 processes
Sending 5 elements to worker 1
Sending 5 elements to worker 2
Sending done. Now receiving...
Sum received => sum: 5
Sum received => sum: 5
The total sum is: 10
--------------------------------------
Array size is 10. Using 4 processes
--------------------------------------
Creating Array with size 10
Will send this array to 3 processes
Sending 4 elements to worker 1
Sending 3 elements to worker 2
Sending 3 elements to worker 3
Sending done. Now receiving...
Sum received => sum: 4
Sum received => sum: 3
Sum received => sum: 3
The total sum is: 10
--------------------------------------
Array size is 10. Using 5 processes
--------------------------------------
Creating Array with size 10
Will send this array to 4 processes
Sending 3 elements to worker 1
Sending 3 elements to worker 2
Sending 2 elements to worker 3
Sending 2 elements to worker 4
Sending done. Now receiving...
Sum received => sum: 3
Sum received => sum: 3
Sum received => sum: 2
Sum received => sum: 2
The total sum is: 10
--------------------------------------
Array size is 10. Using 6 processes
--------------------------------------
Creating Array with size 10
Will send this array to 5 processes
Sending 2 elements to worker 1
Sending 2 elements to worker 2
Sending 2 elements to worker 3
Sending 2 elements to worker 4
Sending 2 elements to worker 5
Sending done. Now receiving...
Sum received => sum: 2
Sum received => sum: 2
Sum received => sum: 2
Sum received => sum: 2
Sum received => sum: 2
The total sum is: 10
--------------------------------------
Array size is 10. Using 7 processes
--------------------------------------
Creating Array with size 10
Will send this array to 6 processes
Sending 2 elements to worker 1
Sending 2 elements to worker 2
Sending 2 elements to worker 3
Sending 2 elements to worker 4
Sending 1 elements to worker 5
Sending 1 elements to worker 6
Sending done. Now receiving...
Sum received => sum: 2
Sum received => sum: 2
Sum received => sum: 2
Sum received => sum: 2
Sum received => sum: 1
Sum received => sum: 1
The total sum is: 10
--------------------------------------
Array size is 10. Using 8 processes
--------------------------------------
Creating Array with size 10
Will send this array to 7 processes
Sending 2 elements to worker 1
Sending 2 elements to worker 2
Sending 2 elements to worker 3
Sending 1 elements to worker 4
Sending 1 elements to worker 5
Sending 1 elements to worker 6
Sending 1 elements to worker 7
Sending done. Now receiving...
Sum received => sum: 2
Sum received => sum: 2
Sum received => sum: 2
```

```
Sum received => sum: 1
Sum received => sum: 1
Sum received => sum: 1
Sum received => sum: 1
The total sum is: 10
++++++++++++++++++++++

++++++++++++++++++++++
------------------------------------
Array size is 32. Using 1 processes
------------------------------------
main: main.c:25: main: Assertion `numprocs > 1' failed.
[tywyn:17403] *** Process received signal ***
[tywyn:17403] Signal: Aborted (6)
[tywyn:17403] Signal code:  (-6)
[tywyn:17403] [ 0] /lib/libpthread.so.0(+0xeff0) [0x7fd3a7fdeff0]
[tywyn:17403] [ 1] /lib/libc.so.6(gsignal+0x35) [0x7fd3a7ca01b5]
[tywyn:17403] [ 2] /lib/libc.so.6(abort+0x180) [0x7fd3a7ca2fc0]
[tywyn:17403] [ 3] /lib/libc.so.6(__assert_fail+0xf1) [0x7fd3a7c99301]
[tywyn:17403] [ 4] main(main+0x7d) [0x400c41]
[tywyn:17403] [ 5] /lib/libc.so.6(__libc_start_main+0xfd) [0x7fd3a7c8cc8d]
[tywyn:17403] [ 6] main() [0x400b09]
[tywyn:17403] *** End of error message ***
-------------------------------------------
------------------------------
mpirun noticed that process rank 0 with PID 17403 on node tywyn exited on signal 6 (Aborted).
-------------------------------------------
------------------------------
------------------------------------
Array size is 32. Using 2 processes
------------------------------------
Creating Array with size 32
Will send this array to 1 processes
Sending 32 elements to worker 1
Sending done. Now receiving...
Sum received => sum: 32
The total sum is: 32
------------------------------------
Array size is 32. Using 3 processes
------------------------------------
Creating Array with size 32
Will send this array to 2 processes
Sending 16 elements to worker 1
Sending 16 elements to worker 2
Sending done. Now receiving...
Sum received => sum: 16
Sum received => sum: 16
The total sum is: 32
------------------------------------
Array size is 32. Using 4 processes
------------------------------------
Creating Array with size 32
Will send this array to 3 processes
Sending 11 elements to worker 1
Sending 11 elements to worker 2
Sending 10 elements to worker 3
Sending done. Now receiving...
Sum received => sum: 11
Sum received => sum: 11
Sum received => sum: 10
The total sum is: 32
------------------------------------
Array size is 32. Using 5 processes
------------------------------------
Creating Array with size 32
Will send this array to 4 processes
Sending 8 elements to worker 1
Sending 8 elements to worker 2
Sending 8 elements to worker 3
Sending 8 elements to worker 4
Sending done. Now receiving...
Sum received => sum: 8
Sum received => sum: 8
Sum received => sum: 8
Sum received => sum: 8
The total sum is: 32
------------------------------------
Array size is 32. Using 6 processes
------------------------------------
Creating Array with size 32
Will send this array to 5 processes
Sending 7 elements to worker 1
Sending 7 elements to worker 2
Sending 6 elements to worker 3
Sending 6 elements to worker 4
Sending 6 elements to worker 5
Sending done. Now receiving...
Sum received => sum: 7
Sum received => sum: 7
Sum received => sum: 6
Sum received => sum: 6
Sum received => sum: 6
The total sum is: 32
------------------------------------
Array size is 32. Using 7 processes
------------------------------------
Creating Array with size 32
Will send this array to 6 processes
Sending 6 elements to worker 1
Sending 6 elements to worker 2
Sending 5 elements to worker 3
Sending 5 elements to worker 4
Sending 5 elements to worker 5
Sending 5 elements to worker 6
Sending done. Now receiving...
Sum received => sum: 6
Sum received => sum: 6
Sum received => sum: 5
Sum received => sum: 5
Sum received => sum: 5
Sum received => sum: 5
The total sum is: 32
------------------------------------
Array size is 32. Using 8 processes
------------------------------------
Creating Array with size 32
Will send this array to 7 processes
Sending 5 elements to worker 1
Sending 5 elements to worker 2
Sending 5 elements to worker 3
Sending 5 elements to worker 4
Sending 4 elements to worker 5
Sending 4 elements to worker 6
Sending 4 elements to worker 7
```

```
Sending done. Now receiving...
Sum received => sum: 5
Sum received => sum: 5
Sum received => sum: 5
Sum received => sum: 5
Sum received => sum: 4
Sum received => sum: 4
Sum received => sum: 4
The total sum is: 32
++++++++++++++++++++++

++++++++++++++++++++++
--------------------------------------
Array size is 128. Using 1 processes
--------------------------------------
main: main.c:25: main: Assertion `numprocs >
1' failed.
[tywyn:17448] *** Process received signal
***
[tywyn:17448] Signal: Aborted (6)
[tywyn:17448] Signal code:  (-6)
[tywyn:17448] [ 0]
/lib/libpthread.so.0(+0xeff0)
[0x7fc750494ff0]
[tywyn:17448] [ 1]
/lib/libc.so.6(gsignal+0x35)
[0x7fc7501561b5]
[tywyn:17448] [ 2]
/lib/libc.so.6(abort+0x180) [0x7fc750158fc0]
[tywyn:17448] [ 3]
/lib/libc.so.6(__assert_fail+0xf1)
[0x7fc75014f301]
[tywyn:17448] [ 4] main(main+0x7d)
[0x400c41]
[tywyn:17448] [ 5]
/lib/libc.so.6(__libc_start_main+0xfd)
[0x7fc750142c8d]
[tywyn:17448] [ 6] main() [0x400b09]
[tywyn:17448] *** End of error message ***
-------------------------------------------
------------------------------
mpirun noticed that process rank 0 with PID
17448 on node tywyn exited on signal 6
(Aborted).
-------------------------------------------
------------------------------
--------------------------------------
Array size is 128. Using 2 processes
--------------------------------------
Creating Array with size 128
Will send this array to 1 processes
Sending 128 elements to worker 1
Sending done. Now receiving...
Sum received => sum: 128
The total sum is: 128
--------------------------------------
Array size is 128. Using 3 processes
--------------------------------------
Creating Array with size 128
Will send this array to 2 processes
Sending 64 elements to worker 1
Sending 64 elements to worker 2
Sending done. Now receiving...
Sum received => sum: 64
Sum received => sum: 64
The total sum is: 128
--------------------------------------
Array size is 128. Using 4 processes
--------------------------------------
Creating Array with size 128
Will send this array to 3 processes
Sending 43 elements to worker 1
Sending 43 elements to worker 2
Sending 42 elements to worker 3
Sending done. Now receiving...
Sum received => sum: 43
Sum received => sum: 43
Sum received => sum: 42
The total sum is: 128
--------------------------------------
Array size is 128. Using 5 processes
--------------------------------------
Creating Array with size 128
Will send this array to 4 processes
Sending 32 elements to worker 1
Sending 32 elements to worker 2
Sending 32 elements to worker 3
Sending 32 elements to worker 4
Sending done. Now receiving...
Sum received => sum: 32
Sum received => sum: 32
Sum received => sum: 32
Sum received => sum: 32
The total sum is: 128
--------------------------------------
Array size is 128. Using 6 processes
--------------------------------------
Creating Array with size 128
Will send this array to 5 processes
Sending 26 elements to worker 1
Sending 26 elements to worker 2
Sending 26 elements to worker 3
Sending 25 elements to worker 4
Sending 25 elements to worker 5
Sending done. Now receiving...
Sum received => sum: 26
Sum received => sum: 26
Sum received => sum: 26
Sum received => sum: 25
Sum received => sum: 25
The total sum is: 128
--------------------------------------
Array size is 128. Using 7 processes
--------------------------------------
Creating Array with size 128
Will send this array to 6 processes
Sending 22 elements to worker 1
Sending 22 elements to worker 2
Sending 21 elements to worker 3
Sending 21 elements to worker 4
Sending 21 elements to worker 5
Sending 21 elements to worker 6
Sending done. Now receiving...
Sum received => sum: 22
Sum received => sum: 22
Sum received => sum: 21
Sum received => sum: 21
Sum received => sum: 21
Sum received => sum: 21
The total sum is: 128
--------------------------------------
Array size is 128. Using 8 processes
--------------------------------------
Creating Array with size 128
Will send this array to 7 processes
Sending 19 elements to worker 1
Sending 19 elements to worker 2
Sending 18 elements to worker 3
```

```
Sending 18 elements to worker 4
Sending 18 elements to worker 5
Sending 18 elements to worker 6
Sending 18 elements to worker 7
Sending done. Now receiving...
Sum received => sum: 19
Sum received => sum: 19
Sum received => sum: 18
Sum received => sum: 18
Sum received => sum: 18
Sum received => sum: 18
Sum received => sum: 18
The total sum is: 128
++++++++++++++++++++++

++++++++++++++++++++++
--------------------------------------
Array size is 666. Using 1 processes
--------------------------------------
main: main.c:25: main: Assertion `numprocs >
1' failed.
[tywyn:17492] *** Process received signal
***
[tywyn:17492] Signal: Aborted (6)
[tywyn:17492] Signal code:  (-6)
[tywyn:17492] [ 0]
/lib/libpthread.so.0(+0xeff0)
[0x7f4062bd5ff0]
[tywyn:17492] [ 1]
/lib/libc.so.6(gsignal+0x35)
[0x7f40628971b5]
[tywyn:17492] [ 2]
/lib/libc.so.6(abort+0x180) [0x7f4062899fc0]
[tywyn:17492] [ 3]
/lib/libc.so.6(__assert_fail+0xf1)
[0x7f4062890301]
[tywyn:17492] [ 4] main(main+0x7d)
[0x400c41]
[tywyn:17492] [ 5]
/lib/libc.so.6(__libc_start_main+0xfd)
[0x7f4062883c8d]
[tywyn:17492] [ 6] main() [0x400b09]
[tywyn:17492] *** End of error message ***
-------------------------------------------
-----------------------------
mpirun noticed that process rank 0 with PID
17492 on node tywyn exited on signal 6
(Aborted).
-------------------------------------------
-----------------------------
--------------------------------------
Array size is 666. Using 2 processes
--------------------------------------
Creating Array with size 666
Will send this array to 1 processes
Sending 666 elements to worker 1
Sending done. Now receiving...
Sum received => sum: 666
The total sum is: 666
--------------------------------------
Array size is 666. Using 3 processes
--------------------------------------
Creating Array with size 666
Will send this array to 2 processes
Sending 333 elements to worker 1
Sending 333 elements to worker 2
Sending done. Now receiving...
Sum received => sum: 333
Sum received => sum: 333
The total sum is: 666
--------------------------------------
Array size is 666. Using 4 processes
--------------------------------------
Creating Array with size 666
Will send this array to 3 processes
Sending 222 elements to worker 1
Sending 222 elements to worker 2
Sending 222 elements to worker 3
Sending done. Now receiving...
Sum received => sum: 222
Sum received => sum: 222
Sum received => sum: 222
The total sum is: 666
--------------------------------------
Array size is 666. Using 5 processes
--------------------------------------
Creating Array with size 666
Will send this array to 4 processes
Sending 167 elements to worker 1
Sending 167 elements to worker 2
Sending 166 elements to worker 3
Sending 166 elements to worker 4
Sending done. Now receiving...
Sum received => sum: 167
Sum received => sum: 167
Sum received => sum: 166
Sum received => sum: 166
The total sum is: 666
--------------------------------------
Array size is 666. Using 6 processes
--------------------------------------
Creating Array with size 666
Will send this array to 5 processes
Sending 134 elements to worker 1
Sending 133 elements to worker 2
Sending 133 elements to worker 3
Sending 133 elements to worker 4
Sending 133 elements to worker 5
Sending done. Now receiving...
Sum received => sum: 134
Sum received => sum: 133
Sum received => sum: 133
Sum received => sum: 133
Sum received => sum: 133
The total sum is: 666
--------------------------------------
Array size is 666. Using 7 processes
--------------------------------------
Creating Array with size 666
Will send this array to 6 processes
Sending 111 elements to worker 1
Sending 111 elements to worker 2
Sending 111 elements to worker 3
Sending 111 elements to worker 4
Sending 111 elements to worker 5
Sending 111 elements to worker 6
Sending done. Now receiving...
Sum received => sum: 111
Sum received => sum: 111
Sum received => sum: 111
Sum received => sum: 111
Sum received => sum: 111
Sum received => sum: 111
The total sum is: 666
--------------------------------------
Array size is 666. Using 8 processes
--------------------------------------
Creating Array with size 666
```

```
Will send this array to 7 processes
Sending 96 elements to worker 1
Sending 95 elements to worker 2
Sending 95 elements to worker 3
Sending 95 elements to worker 4
Sending 95 elements to worker 5
Sending 95 elements to worker 6
Sending 95 elements to worker 7
Sending done. Now receiving...
Sum received => sum: 96
Sum received => sum: 95
Sum received => sum: 95
Sum received => sum: 95
Sum received => sum: 95
Sum received => sum: 95
Sum received => sum: 95
The total sum is: 666
++++++++++++++++++++++

++++++++++++++++++++++
--------------------------------------
Array size is 10000. Using 1 processes
--------------------------------------
main: main.c:25: main: Assertion `numprocs > 1' failed.
[tywyn:17536] *** Process received signal ***
[tywyn:17536] Signal: Aborted (6)
[tywyn:17536] Signal code:  (-6)
[tywyn:17536] [ 0] /lib/libpthread.so.0(+0xeff0) [0x7f0998173ff0]
[tywyn:17536] [ 1] /lib/libc.so.6(gsignal+0x35) [0x7f0997e351b5]
[tywyn:17536] [ 2] /lib/libc.so.6(abort+0x180) [0x7f0997e37fc0]
[tywyn:17536] [ 3] /lib/libc.so.6(__assert_fail+0xf1) [0x7f0997e2e301]
[tywyn:17536] [ 4] main(main+0x7d) [0x400c41]
[tywyn:17536] [ 5] /lib/libc.so.6(__libc_start_main+0xfd) [0x7f0997e21c8d]
[tywyn:17536] [ 6] main() [0x400b09]
[tywyn:17536] *** End of error message ***
-------------------------------------------
------------------------------
mpirun noticed that process rank 0 with PID 17536 on node tywyn exited on signal 6 (Aborted).
-------------------------------------------
------------------------------
--------------------------------------
Array size is 10000. Using 2 processes
--------------------------------------
Creating Array with size 10000
Will send this array to 1 processes
Sending 10000 elements to worker 1
Sending done. Now receiving...
Sum received => sum: 10000
The total sum is: 10000
--------------------------------------
Array size is 10000. Using 3 processes
--------------------------------------
Creating Array with size 10000
Will send this array to 2 processes
Sending 5000 elements to worker 1
Sending 5000 elements to worker 2
Sending done. Now receiving...
Sum received => sum: 5000
Sum received => sum: 5000
The total sum is: 10000
--------------------------------------
Array size is 10000. Using 4 processes
--------------------------------------
Creating Array with size 10000
Will send this array to 3 processes
Sending 3334 elements to worker 1
Sending 3333 elements to worker 2
Sending 3333 elements to worker 3
Sending done. Now receiving...
Sum received => sum: 3334
Sum received => sum: 3333
Sum received => sum: 3333
The total sum is: 10000
--------------------------------------
Array size is 10000. Using 5 processes
--------------------------------------
Creating Array with size 10000
Will send this array to 4 processes
Sending 2500 elements to worker 1
Sending 2500 elements to worker 2
Sending 2500 elements to worker 3
Sending 2500 elements to worker 4
Sending done. Now receiving...
Sum received => sum: 2500
Sum received => sum: 2500
Sum received => sum: 2500
Sum received => sum: 2500
The total sum is: 10000
--------------------------------------
Array size is 10000. Using 6 processes
--------------------------------------
Creating Array with size 10000
Will send this array to 5 processes
Sending 2000 elements to worker 1
Sending 2000 elements to worker 2
Sending 2000 elements to worker 3
Sending 2000 elements to worker 4
Sending 2000 elements to worker 5
Sending done. Now receiving...
Sum received => sum: 2000
Sum received => sum: 2000
Sum received => sum: 2000
Sum received => sum: 2000
Sum received => sum: 2000
The total sum is: 10000
--------------------------------------
Array size is 10000. Using 7 processes
--------------------------------------
Creating Array with size 10000
Will send this array to 6 processes
Sending 1667 elements to worker 1
Sending 1667 elements to worker 2
Sending 1667 elements to worker 3
Sending 1667 elements to worker 4
Sending 1666 elements to worker 5
Sending 1666 elements to worker 6
Sending done. Now receiving...
Sum received => sum: 1667
Sum received => sum: 1667
Sum received => sum: 1667
Sum received => sum: 1667
Sum received => sum: 1666
Sum received => sum: 1666
The total sum is: 10000
```

```
-----------------------------------
Array size is 10000. Using 8 processes
-----------------------------------
Creating Array with size 10000
Will send this array to 7 processes
Sending 1429 elements to worker 1
Sending 1429 elements to worker 2
Sending 1429 elements to worker 3
Sending 1429 elements to worker 4
Sending 1428 elements to worker 5
Sending 1428 elements to worker 6
Sending 1428 elements to worker 7
Sending done. Now receiving...
```

```
Sum received => sum: 1429
Sum received => sum: 1429
Sum received => sum: 1429
Sum received => sum: 1429
Sum received => sum: 1428
Sum received => sum: 1428
Sum received => sum: 1428
The total sum is: 10000
++++++++++++++++++++++++
```

Aufgabe 1.3)

Dense Linear Algebra, da wir auf einem Vector (Array) arbeiten und eine algebraische Operation ausführen.

Aufgabe 1.4)

a): Das Programm ist unter Multiple Instruction Multiple Data (MIMD) einzuordnen. Es gibt multiple Instruktionen, weil der Master und die Worker unterschiedlichen Programmcode ausführen. Mehrere Daten gib es, weil alle Worker auf verschiedenen Datenteilen arbeiten.

b): Eine andere Möglichkeit wäre, per Schleife über das Array zu iterieren und die Summe in einer Variable zu speichern. Das würde SISD entsprechen, da es nur einen Instruktionsstrom und einen Datenstrom gibt.