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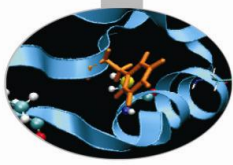
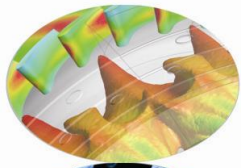
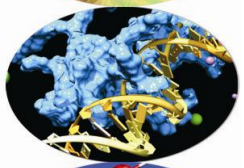
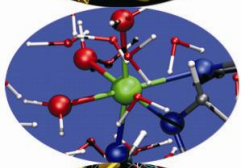
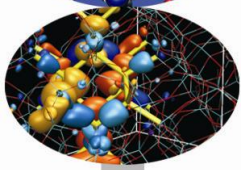
SuperComputing Applications and Innovation



Debugging - Exercises

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18/02/2013

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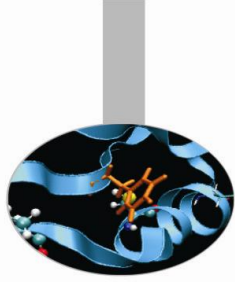
Integral of sin(x)



- The serial program (pi_trapez_bug.f90 , pi_trapez_bug.c) computes the integral of sin(x) from 0 to π using the trapezoidal rule.

Compiling and running we obtain the following wrong result

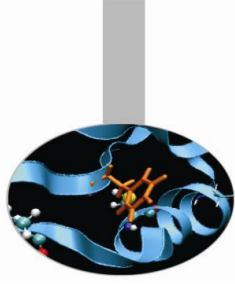
```
 i   x    f(x)  int(f(x))
 1  0.00  1.00  0.00
 2  0.00  1.00  0.00
 3  0.00  1.00  0.00
 4  0.00  1.00  0.00
 5  0.00  1.00  0.00
 6  0.00  1.00  0.00
 7  0.00  1.00  0.00
 8  0.00  1.00  0.00
 9  0.00  1.00  0.00
10  0.00  1.00  0.00
11  3.14 -1.00  0.00
```

Correct result should be like that

```
 i  x  f(x)  int(f(x))
 1 0.00 1.00  0.00
 2 0.31 0.95  0.31
 3 0.63 0.81  0.58
 4 0.94 0.59  0.80
 5 1.26 0.31  0.94
 6 1.57 0.00  0.99
 7 1.88 -0.31 0.94
 8 2.20 -0.59 0.80
 9 2.51 -0.81 0.58
10 2.83 -0.95 0.31
11 3.14 -1.00 0.00
```

Use GDB debugger to find out and resolve the error

Integral of sin(x)



Hints

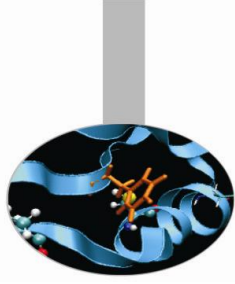
Remember to compile using the “–g” flag

Run the debugger with : gdb executable_name

During the debugging phase control the values of variables “i,nm, pi, x2”.

Source code : `pi_trapez_bug.c`

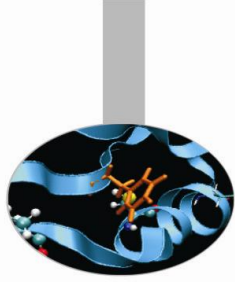
GDB Attach mode



- The serial program (trial_bug.f90 , trial_bug.c) executes some simple operations on array x and y.

- The code compiles correctly but crashes during execution.
- Debug the application using gdb in attach mode
- **Hints :**
  - Insert in the source code the lines of code contained in slide 29 of debugger theory and follow the procedure explained in that slide.
  - Control arrays operations with a watch command with a conditional clause

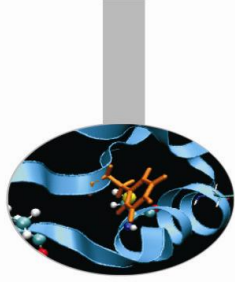
Fibonacci



- The serial program (fib_bug.f90 , fib_bug.c) computes Fibonacci numbers.
- The code compiles correctly but crashes during execution and contains several bugs inside.

1. Execute the code, execution produces a core dump.
2. Use gdb with the core file to try to find out the reason why the program exited.
3. Check the reason why the program exited using gdb in the classic way.

MPI message excange



The following sample program executes a message passing between two processes, extra processes are ignored.

During message passing something goes wrong and the program hangs.

Use the GDB debugger to try to find out and solve the bug.

Hints :

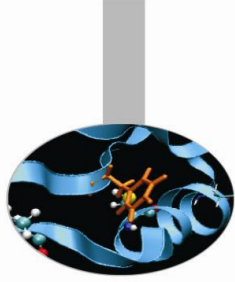
Remember to compile using the “–g” flag

Run the program with “`mpirun -np 2 xterm -e gdb executable_name`”

During the debugging phase control that the parameters of the functions “MPI_send” “MPI_Recv” match.

Source code : `mpi_send_recv_bug.c`

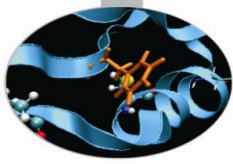
MPI sum



- The following sample program executes in parallel the sum of the elements of an array using domain decomposition. The master process initializes the array and sends to the other processes their own part to compute their partial sum.
- Once the partial sums are completed it's computed the final sum using a reduction operation.
- The result for final sum is wrong.
  - Use the GDB debugger to try to find out and resolve the bug.
  - The number of MPI tasks when running the application must be divisible by 4.
- Hints :
  - Remember to compile using the "–g" flag
  - During the debugging phase control if the portion of the array is correctly passed and received among master and slaves and if the ruction operation is correct.

- **Source code : `mpi_sum_bug.c`**

MPI heat2D



This example is based on a simplified two-dimensional heat equation domain decomposition. The initial temperature is computed to be high in the middle of the domain and zero at the boundaries.

The grid is decomposed by the master process and then distributed by rows to the worker processes. At each time step, worker processes must exchange border data with neighbors. Upon completion of all time steps, the worker processes return their result to the master process.

Two data files are produced: an initial data set and a final data set.

An X graphic of these two states displays after all calculations have completed.

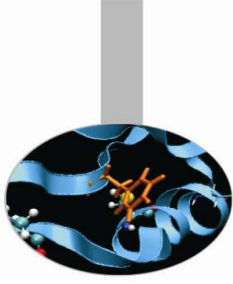
At the end of simulation something goes wrong and the program crashes.

Use the GDB debugger to try to find out and resolve the bug.

The number of MPI tasks when running the application must be divisible by 4.

Source code : `mpi_heat2D_bug.c draw_heat2D.c`

MPI heat2D



Hints :

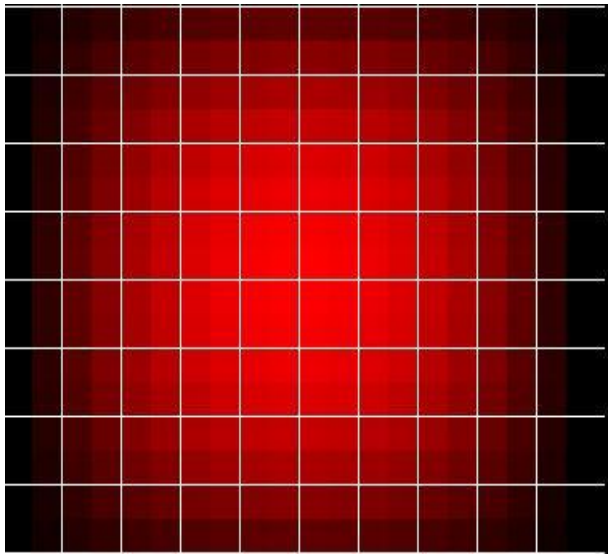
Compile the program this way:

```
mpicc -g -o mpi_heat_2D_bug mpi_heat_2D_bug.c draw_heat2D.c -lX11
```

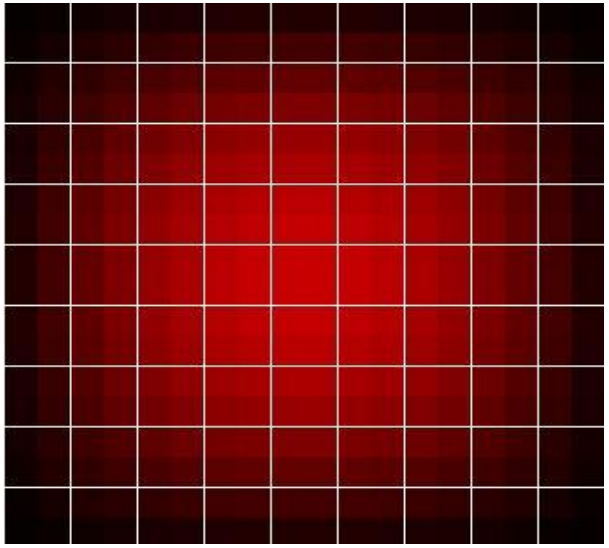
Run the program with: `mpirun -np 4 xterm -e gdb executable_name`

During the debugging phase run the code without inserting breakpoints and look at behavior and messages of MPI processes during finalization phase.

Once you have solved this bug run again the code and check if the images of initial and final step correspond to the following ones.

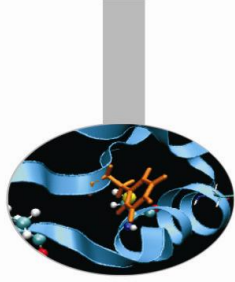


Initial state



Final state

MPI heat2D



Unfortunately images don’t match.

Hints :

- Check the calls to MPI_Send and MPI_Recv from master and slave processes
- Check if the data of the 2D grid are correctly excanged