Introduction to MPI: Lecture 4

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Learning MPI by Examples: Part III

Blocking and non-blocking communications

Learning MPI by Examples: Part III

- Previous parallel programming with MPI blocking Send/Receive, which means
  - process 1 (or processes other than 0) is ready for receiving message from process 0. Once it is ready, it deserve for receiving. If process 0 doesn't send a message, the process 1 is idle and waiting for receiving the message
  - it is not synchronous communication, which means sender would send message until it receives confirmation from receiver

Learning MPI by Examples: Part III

- blocking communication should be avoid
- The use of non-blocking communication can be used to provide dramatic improvements in the performance of message passing programs
- Use MPI_Isend() and MPI_Irecv()
  - I stands for immediate
- Use MPI_Wait() to complete the non-blocking communication

Learning MPI by Examples: Part III

- Parallel programming with MPI non blocking Send/Receive
  - do not make processes idle
  - Using the following MPI functions
    - MPI_Init and MPI_Finalize
    - MPI_Comm_rank
    - MPI_Comm_size
    - MPI_Irecv
    - MPI_Isend
    - MPI_Wait()

Learning MPI by Examples: Part III

- MPI _ISend() syntax:

```
int MPI_ISend (        void* buffer              /*in */,
                       int count                 /* in */,
                       MPI_Datatypes              /*in */,
                       int dest                  /*in*/,
                       int tag                    /*in*/,
                       MPI_Comm comm             /*in*/
                       MPI_Request* request      /*out */)
```

Learning MPI by Examples: Part III

- MPI _IRecv() syntax:

```
int MPI_IRecv (        void* buffer              /*in */,
                       int count                 /* in */,
                       MPI_Datatypes              /*in */,
                       int source                /*in*/,
                       int tag                    /*in*/,
                       MPI_Comm comm             /*in*/
                       MPI_Request* request      /*out */)
```

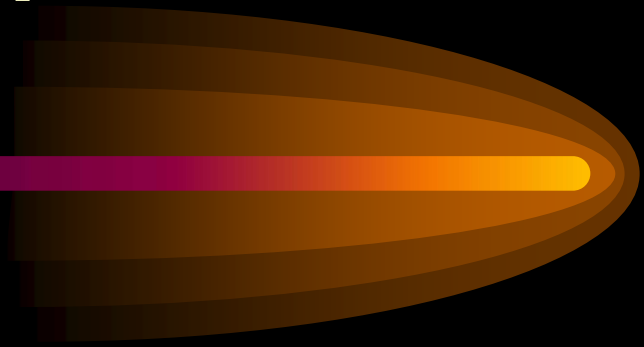
```
/* nbtrap.c -- Parallel Trapezoidal Rule, nonblocking
 * sending
 * Input: None.
 * Output:  Estimate of the integral from a to b of f(x)
 *    using the trapezoidal rule and n trapezoids.
 *
 * Algorithm:
 *    1.  Each process calculates "its" interval of
 *        integration.
 *    2.  Each process estimates the integral of f(x)
 *        over its interval using the trapezoidal rule.
 *    3a. Each process != 0 sends its integral to process 0.
 *    3b. Process 0 sums the calculations received from
 *        the individual processes and prints the result.
 *
 *
```

```
Notes:
 *    1.  f(x), a, b, and n are all hardwired.
 *    2.  The number of processes (p) should evenly divide
 *        the number of trapezoids (n = 1024)
 *
 */
#include <stdio.h>

/* We'll be using MPI routines, definitions, etc. */
#include "mpi.h"


main(int argc, char** argv)
{
    int         my_rank;   /* My process rank           */
    int         p;         /* The number of processes   */
    float       a = 0.0;   /* Left endpoint             */
```

```
 float       b = 1.0;   /* Right endpoint           */
   int         n = 1024;  /* Number of trapezoidsi
                             in each subintegrals     */
   float       h;         /* Trapezoid base length    */

/* local_a and local_b are the bounds
   for each integration performed in individual process */

   float       local_a;   /* Left endpoint my process  */
   float       local_b;   /* Right endpoint my process */
   float       local_h;   /* trapezoid base length for
                             each subintegral */
   float       integral;  /* Integral over my interval */
   float       total;     /* Total integral            */
   int         source;    /* Process sending integral  */
   int         dest = 0;  /* All messages go to 0      */
   int         tag = 0;
```

```
MPI_Status  status;
  MPI_Request send_req;

/* Trap function prototype. Trap function is used to calculate
  local integral   */

  float Trap(float local_a, float local_b, int local_n);

  /* Let the system do what it needs to start up MPI */
  MPI_Init(&argc, &argv);

  /* Get my process rank */
  MPI_Comm_rank(MPI_COMM_WORLD, &my_rank);

  /* Find out how many processes are being used */
  MPI_Comm_size(MPI_COMM_WORLD, &p);
```

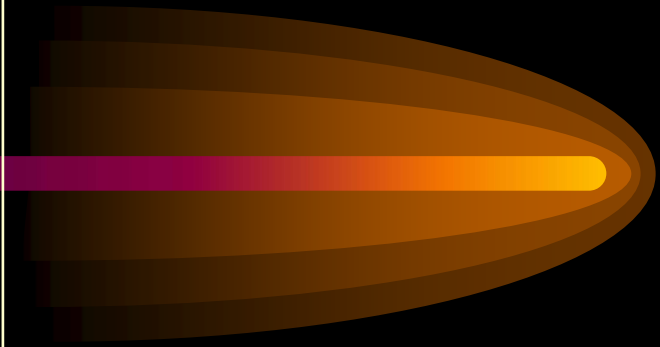
```
h = (b-a)/n;    /* h is the same for all processes */
 local_h = h/p;  /* So is the number of trapezoids */

 local_a = a + my_rank*local_h*n;
 local_b = local_a + local_h*n;
 integral = Trap(local_a, local_b, n);

 if (my_rank == 0)
 {
 /* Add up the integrals calculated by each process */
   total = integral;   /* this is the intergal calculated by process 0 */
   for (source = 1; source < p; source++)
   {
     MPI_Recv(&integral, 1, MPI_FLOAT, source, tag,
           MPI_COMM_WORLD, &status);
     total = total + integral;
   }
 }
```



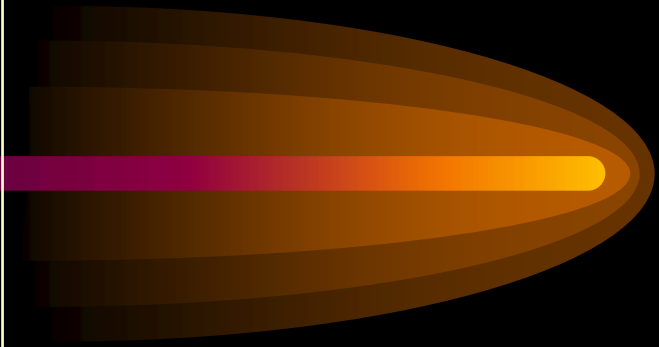
```
    else
    {
      printf("The intergal calculated from  process %d is %f\n",my_rank,i
);
    /*  MPI_Send(&integral, 1, MPI_FLOAT, dest, tag, MPI_COMM_W
    */
      MPI_Isend(&integral, 1, MPI_FLOAT, dest, tag, MPI_COMM_WO
      MPI_Wait(&send_req, &status);
    }

    /* Print the result */
    if (my_rank == 0)
    {
      printf("With n = %d trapezoids, our estimate\n", n);
      printf("of the integral from %f to %f = %f\n",a,b,total);
    }
```

```
    /* Shut down MPI */
    MPI_Finalize();
}


float Trap (
          float  local_a   /* in */,
          float  local_b   /* in */,
          int    local_n   /* in */)
{

    float integral;   /* Store result in integral  */
    float x;
    int i;
    float local_h;

    float f(float x); /* function we're integrating */
```

```
    local_h=(local_b-local_a)/local_n;

    integral = (f(local_a) + f(local_b))/2.0;
    x = local_a;
    for (i = 1; i <= local_n-1; i++)
    {
        x = x + local_h;
        integral = integral + f(x);
    }
    integral = integral*local_h;
    return integral;
}
```



```
    float f(float x)
{
   float return_val;
   /* Calculate f(x). */
   /* Store calculation in return_val. */
   return_val = x*x;
   return return_val;
} /* f */
```



Learning MPI by Examples: Part II

- Example of parallel programming using non blocking Sending

```
 mpirun -np 8 a.out
The intergal calculated from  process 4 is 0.039714
The intergal calculated from  process 5 is 0.059245
The intergal calculated from  process 7 is 0.110026
The intergal calculated from  process 2 is 0.012370
The intergal calculated from  process 3 is 0.024089
The intergal calculated from  process 1 is 0.004557
The intergal calculated from  process 6 is 0.082682
With n = 1024 trapezoids, our estimate
of the integral from 0.000000 to 1.000000 = 0.333333
```