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1RV17CS125

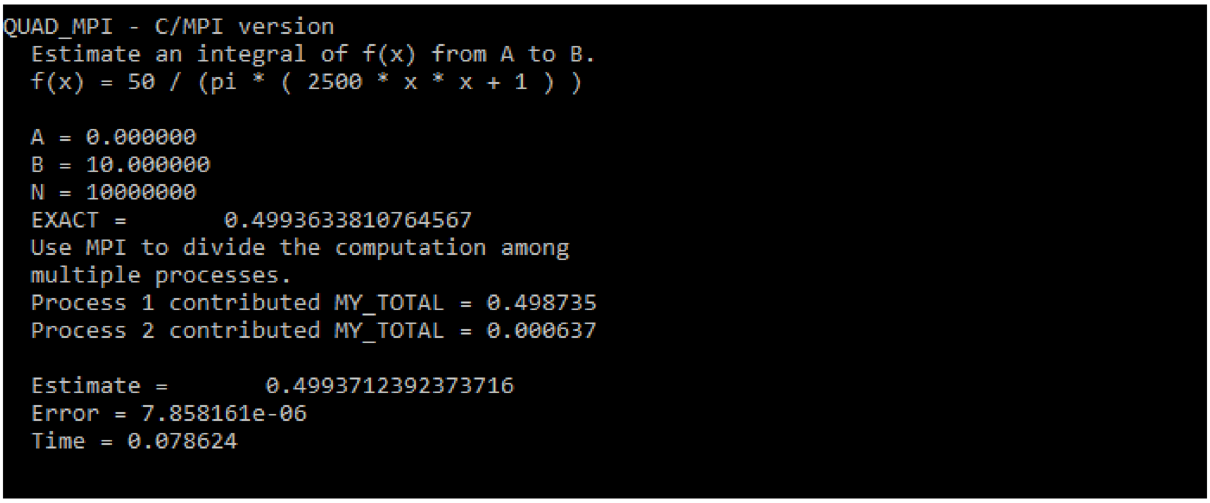
7^{TH} CSE C2, PADP

PROGRAM 8

CODE:

```
# include <math.h>
# include <mpi.h>
# include <stdio.h>
# include <stdlib.h>
# include <time.h>

int main ( int argc, char *argv[] );
double f ( double x );
void timestamp ( );

int main ( int argc, char *argv[] )
{
  double a;
  double b;
  double error;
  double exact;
  int i;
  int master = 0;
  double my_a;
  double my_b;
  int my_id;
  int my_n;
  double my_total;
  int n;
  int p;
  int p_num;
  int source;
  MPI_Status status;
  int tag;
  int target;
  double total;
  double wtime;
  double x;

  a =  0.0;
  b = 10.0;
  n = 10000000;
  exact = 0.49936338107645674464;
/* Initialize MPI.*/
  MPI_Init ( &argc, &argv );
/*  Get this processor's ID.*/
  MPI_Comm_rank ( MPI_COMM_WORLD, &my_id );
/* Get the number of processes.*/
  MPI_Comm_size ( MPI_COMM_WORLD, &p_num );

  if ( my_id == master )
  {
/* We want N to be the total number of evaluations.
  If necessary, we adjust N to be divisible by the number of processes.*/
    my_n = n / ( p_num - 1 );
    n = ( p_num - 1 ) * my_n;

    wtime = MPI_Wtime ( );

    //timestamp ( );//Prints the current time
    //printf ( "\n" );
    printf ( "QUAD_MPI - C/MPI version\n" );
    printf ( "  Estimate an integral of f(x) from A to B.\n" );
    printf ( "  f(x) = 50 / (pi * ( 2500 * x * x + 1 ) )\n" );
    printf ( "\n" );
    printf ( "  A = %f\n", a );
    printf ( "  B = %f\n", b );
    printf ( "  N = %d\n", n );
    printf ( "  EXACT = %24.16f\n", exact );
    //printf ( "\n" );
    printf ( "  Use MPI to divide the computation among\n" );
    printf ( "  multiple processes.\n" );
  }
  source = master;
  MPI_Bcast ( &my_n, 1, MPI_INT, source, MPI_COMM_WORLD );
/* Process 0 assigns each process a subinterval of [A,B].*/
  if ( my_id == master )
  {
    for ( p = 1; p <= p_num - 1; p++ )
    {
      my_a = ( ( double ) ( p_num - p     ) * a
             + ( double ) (         p - 1 ) * b )
             / ( double ) ( p_num     - 1 );

      target = p;
      tag = 1;
      MPI_Send ( &my_a, 1, MPI_DOUBLE, target, tag, MPI_COMM_WORLD );

      my_b = ( ( double ) ( p_num - p - 1 ) * a
             + ( double ) (         p     ) * b )
             / ( double ) ( p_num     - 1 );
      target = p;
      tag = 2;
      MPI_Send ( &my_b, 1, MPI_DOUBLE, target, tag, MPI_COMM_WORLD );
    }
total = 0.0;
    my_total = 0.0;
  }
/*Processes receive MY_A, MY_B, and compute their part of the integral.*/
  else
  {
    source = master;
    tag = 1;
    MPI_Recv ( &my_a, 1, MPI_DOUBLE, source, tag, MPI_COMM_WORLD, &status );

    source = master;
    tag = 2;
    MPI_Recv ( &my_b, 1, MPI_DOUBLE, source, tag, MPI_COMM_WORLD, &status );

    my_total = 0.0;
    for ( i = 1; i <= my_n; i++ )
    {
      x = ( ( double ) ( my_n - i     ) * my_a
          + ( double ) (        i - 1 ) * my_b )
          / ( double ) ( my_n     - 1 );
      my_total = my_total + f ( x );
    }

    my_total = ( my_b - my_a ) * my_total / ( double ) ( my_n );

    printf ( "  Process %d contributed MY_TOTAL = %f\n", my_id, my_total );
  }
/*Each process sends its value to the master process.*/
  MPI_Reduce ( &my_total, &total, 1, MPI_DOUBLE, MPI_SUM, master, MPI_COMM_WORLD );
/* Compute the weighted estimate.*/
  if ( my_id == master )
  {
    error = fabs ( total - exact );
    wtime = MPI_Wtime ( ) - wtime;

    printf ( "\n" );
    printf ( "  Estimate = %24.16f\n", total );
    printf ( "  Error = %e\n", error );
    printf ( "  Time = %f\n\n", wtime );
  }
/*
  Terminate MPI.
*/
  MPI_Finalize ( );
/*
  Terminate.
*/
  if ( my_id == master )
{
    printf ( "\n" );
    printf ( "QUAD_MPI:" );
    printf ( "  Normal end of execution.\n" );
    //printf ( "\n" );
    //timestamp ( );//Prints the current time
  }

  return 0;
}

double f ( double x )
{
  double pi;
  double value;
  pi = 3.141592653589793;
  value = 50.0 / ( pi * ( 2500.0 * x * x + 1.0 ) );

  return value;
}

void timestamp ( void )

{
# define TIME_SIZE 40

  static char time_buffer[TIME_SIZE];
  const struct tm *tm;
  time_t now;

  now = time ( NULL );
  tm = localtime ( &now );

  strftime ( time_buffer, TIME_SIZE, "%d %B %Y %I:%M:%S %p", tm );

  printf ( "%s\n", time_buffer );

  return;
# undef TIME_SIZE
}
```

OUTPUT:



```
QUAD_MPI - C/MPI version
  Estimate an integral of f(x) from A to B.
  f(x) = 50 / (pi * ( 2500 * x * x + 1 ) )

  A = 0.000000
  B = 10.000000
  N = 10000000
  EXACT =       0.4993633810764567
  Use MPI to divide the computation among
  multiple processes.
  Process 1 contributed MY_TOTAL = 0.498735
  Process 2 contributed MY_TOTAL = 0.000637

  Estimate =       0.4993712392373716
  Error = 7.858161e-06
  Time = 0.078624
```