COMP 605: Introduction to Parallel Computing HW 2: Distributed Memory Programming with the Message Passing Interface

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$$\pi = \frac{\textit{Circumference of a Circle}}{\textit{Diameter of a Circle}}$$

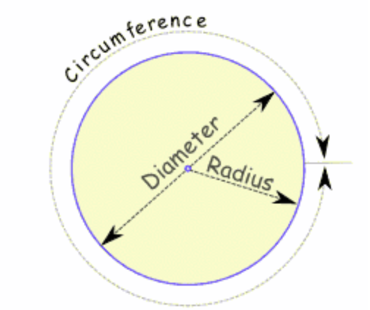
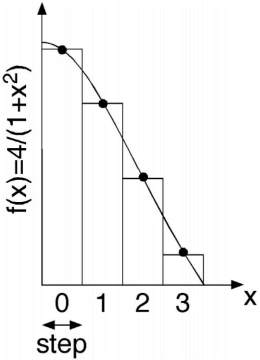


Image Source: `http://www.mathsisfun.com/numbers/pi.html`

Homework #1, Problem #1: Using Numerical Integration to Estimate π

- Integral representation for π
  $\int_0^1 dx \frac{4}{1+x^2} = pi$
- Discretize the problem:
  $\Delta = 1/N : step = 1/N_{areas}$
  $x_i = (i + 0.5)\Delta(i = 0, \ldots, N_{areas} - 1)$
  $\sum_{i=0}^{N-1} \frac{4}{1+x_i^2}\Delta \cong \pi$



π Formulae: `http://en.wikipedia.org/wiki/Approximations_of_pi`
Image: `http://cacs.usc.edu/education/cs596/mpi-pi.pdf`

Homework #1, Problem #1: Using Numerical Integration to Estimate π

```
#include <stdio.h>
#define NAREA 10000000
void main() {
    int i; double step,x,sum=0.0,pi;
    step = 1.0/NAREA;
    for (i=0; i<NAREA; i++) {
        x = (i+0.5)*step;
        sum += 4.0/(1.0+x*x);
     }
    pi = sum*step;
    printf(PI = %f\n,pi);
}
```

Homework #1, Problem #1: Using Numerical Integration to Estimate π

- Use the method of *numerical integration* to estimate the value for π
- Note: the Numerical Integration is used to solve *any* function $f(x)$
- Design and write a parallel version to estimate π using the formula above or another approach. Explain how your formula works.
  - See the *Trap* example discussed in Pachecho 2011, Ch 3.
  - You can use point-to-point or collective communications.
  - You must run jobs on the queue.
  - Vary the number of areas used: $N_{areas} = 10^n$, where $n = 1, 2, 3,$
  - Vary the number of PEs: $np = [1, 2, 4, 8, 16]$
  - Time the job runs.

Homework #2, Problem #1: Using Numerical Integration to Estimate π

What to Report/Turn in:

- Estimate π to the limits of a double precision number on the student cluster
- Calculate the value for π and the error of your estimate as a function of the number or areas used
- Calculate the value for π and the error of your estimate as a function of the number or areas used
- Relevant tables of your test data
- Plot the error as a function of the number of processors and number of points.
- Plot the runtime as a function of the number of processors and number of points.
- A copy of your code (single spaced, two column format is OK).
- Reference key sources of information (Pacheco, lectures, Web,).

Homework #2, Problem #2: Calculating Prime Numbers

Sieve of Eratosthenes: Basic Algorithm

- A prime number is a natural number which has exactly two distinct natural number divisors: 1 and itself.
- To find all the prime numbers less than or equal to a given integer n by Eratosthenes' method:
  - Create list of consecutive integers from 2 through n: (2, 3, 4, ..., n).
  - Initially, let p equal 2, the first prime number.
  - Starting from p, enumerate its multiples by counting to n in increments of p, and mark them in the list (these will be 2p, 3p, 4p, etc.; the p itself should not be marked).
  - Find the first number greater than p in the list that is not marked. If there was no such number, stop. Otherwise, let p now equal this new number (which is the next prime), and repeat from step 3.
  - When the algorithm terminates, all the numbers in the list that are not marked are prime.

Homework #2, Problem #2: Calculating Prime Numbers

- Due: 03/2/17
- Calculate the number of prime numbers that exist within a defined range
- Use the Sieve of Eratosthenes approach:
  `http://en.wikipedia.org/wiki/Sieve_of_Eratosthenes`
  - Consider different data distributions – try cyclic distribution.
  - You can use point-to-point or collective communications.
  - You must run jobs on the queue.
  - Vary the value for: $N_{areas} = 10^n$, where $n = 1, 2, 3,$
  - Determine N_{max} that can be run on tuckoo.
  - Vary the number of PEs: $np = [1, 2, 4, 8, 16]$
  - Time the job runs

Homework #2, Problem #2: Calculating Prime Numbers

What to Report/Turn in:

- Explain the value you obtained for N_{max} and why it occurred.
- Plot the runtime as a function of the number of processors and number of primes.
- A copy of your code (single spaced, two column format is OK).
- Reference key sources of information (Pacheco, lectures, Web,).