PRACE Course: Intermediate MPI

Day 1

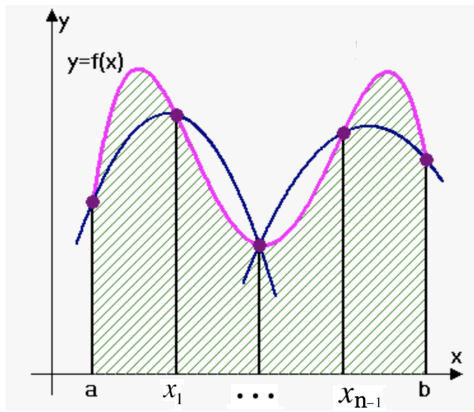
9/11/2022

1 Extra: Simpson's Rule

Computing the area under the curve of $f(x)$ where $x \in [a,b]$ can be done using the Simpson's rule:

$$\int_a^b f(x)dx \sim \frac{h}{3}(f(x_0) + 4\sum_{i=1,3,\cdots}^{n-1} f(x_i) + 2\sum_{i=2,4,\cdots}^{n-2} f(x_i) + f(x_n))$$

where $x_0 = a$, $x_n = b$ and $h = \frac{b-a}{n}$ with $n-1$ equidistant points between a and b.



The interval $[a,b]$ is partitioned into the set $\{a = x_0, x_1, x_2, ..., x_{n-1}, b = x_n\}$ so that there are n sub-intervals of equal width h where n is an even number. The shaded area bounded by the parabolas is approximately equal to the area bounded by $y = f(x)$.

Find the integral of $f(x) = \sin(x) * sin(x)$ from $0 \rightarrow 90$. Compare with the actual result: $\int_0^{90} sin^2(x) = \pi/4$.

The serial code is given (simpson_serial.c / simpson_serial.f90). Parallelise using MPI as follows.

1. Process 0 reads in a, b, and n, and sends them to all other processes.
2. The interval [a, b] is distributed among processes. Each process calculates its sub-interval: $[a_{local}, b_{local}]$ which is split up into n_{local} sub-intervals of width h_{local}.
3. Calculate the values of $sin^2(x)$ where x is in radians in the range $[a_{local}, b_{local}]$ every h_{local} degrees. The value of the pts and the value of the function at these pts as arrays. Use the provided function (or subroutine) to convert degrees to radians.
4. Each process applies Simpson's function over its local interval divided into local sub-intervals.
5. Local approximated areas found by each process are summed at process 0 to a final estimation value.
6. Compare the approximated area with the exact value of integral with different number of processes.