3$\underline{^{d}}$Programming Task

Definite integral calculation

The Computational Problem

Calculate the value of a definite integral with precision **ε**:

$$J(A, B) = \int_A^B f(x)dx$$

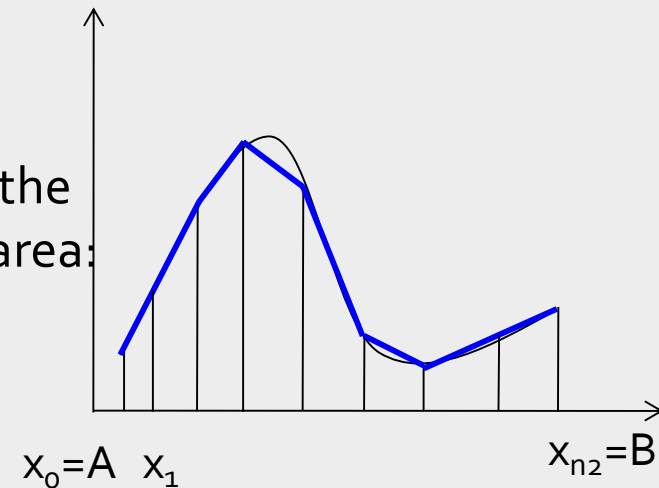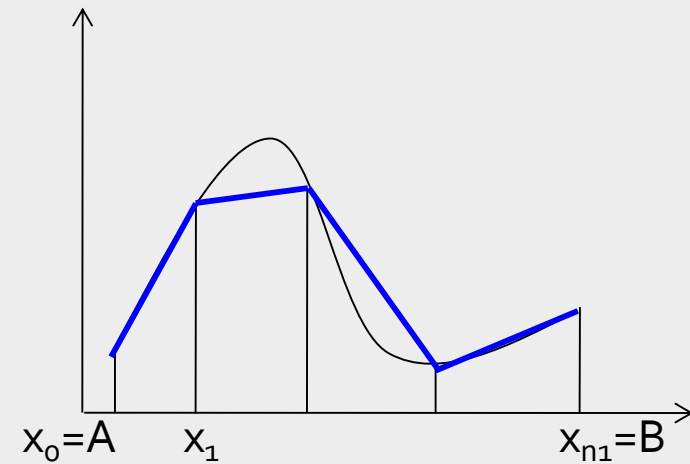Consider there is uniform grid on [A,B] region with $n+1$ points:

$$x_i = A + \frac{B - A}{n}i, \quad i = 0, \cdots, n$$

The **trapezoidal rule** is a technique for approximating the definite integral by approximating the region under the graph of the function as a trapezoid and calculating its area:

$$J_n(A, B) = \frac{B - A}{n}\left(\frac{f(x_0)}{2} + \sum_{i=1}^{n-1} f(x_i) + \frac{f(x_n)}{2} \right)$$

ε precision :

$$\left| J_{n1} - J_{n2} \right| \leq \varepsilon \left| J_{n2} \right| \qquad n_2 > n_1$$

$x_0=A \quad x_1 \qquad\qquad\qquad x_{n1}=B$

$x_0=A \quad x_1 \qquad\qquad\qquad x_{n2}=B$

The Computational Problem

$$f(x) = \frac{1}{x^2} \sin^2\left(\frac{1}{x}\right), \quad 0 < A << 1$$

$$J(A,B) = \int_A^B \frac{1}{x^2} \sin^2\left(\frac{1}{x}\right) dx = -\frac{1}{2x} + \frac{1}{4}\sin\left(\frac{2}{x}\right)\Big|_A^B$$

$$J(A,B) = \frac{1}{4}\left(2\frac{B-A}{AB} + \sin\left(\frac{2}{B}\right) - \sin\left(\frac{2}{A}\right)\right)$$

A	B	Npoints	eps real	time, c
0.00001	0.0001		-2.77E-11	
0.0001	0.001		1.90E-10	
0.001	0.01		2.05E-11	
0.01	0.1		-2.22E-12	
0.1	1		8.67E-11	
1	10		-6.00E-11	
10	100		-6.30E-11	

1. Choose precision **ε**
2. Calculate integral with different **A** and **B** values from the table
3. Calculate execution time of serial program
4. Write a parallel program with:
   a. atomic
   b. Critical sections
   c. Locks
   d. reduction
5. Count speedup with different thread number
6. Fill the table (for each point of 4a-4d)