

# Exercise sheet

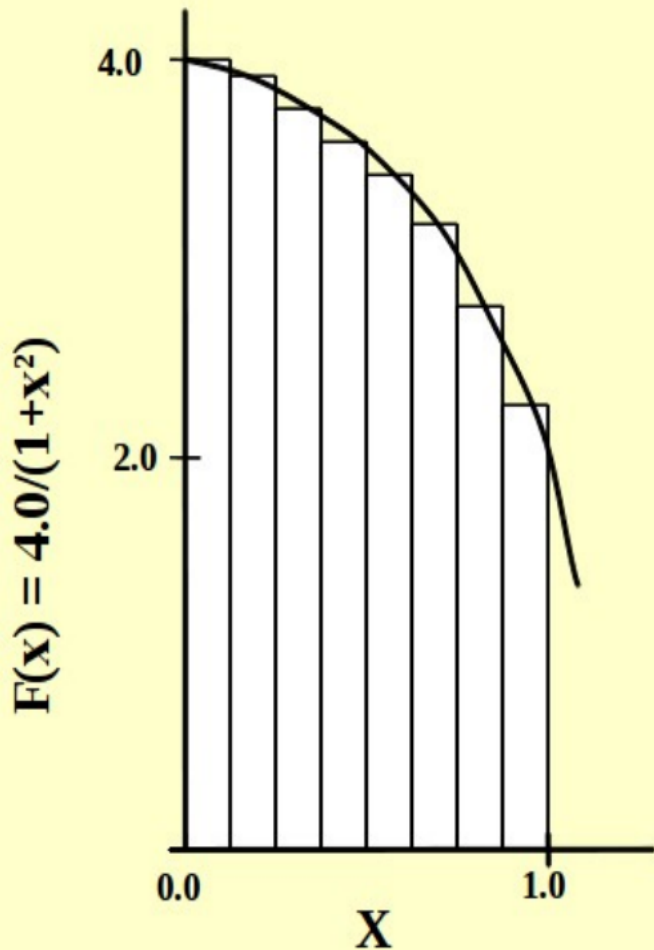
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Supplementary material for the exercises is provided in  
[OSM2018/day4/supplementary\\_material](#)

# 1. Compute Pi with finite differences



Mathematically, we know that:

$$\int_0^1 \frac{4.0}{(1+x^2)} dx = \pi$$

We can approximate the integral as a sum of rectangles:

$$\sum_{i=0}^N F(x_i) \Delta x \approx \pi$$

Where each rectangle has width  $\Delta x$  and height  $F(x_i)$  at the middle of interval  $i$ .

# 1. Hybrid computaton of Pi

1. go to OSM2018/day4/supplementary\_material

> **cd OSM\_Lab/day4/supplementary\_material**

2. Have a look at the source code in Fortran/CPP that compute Pi  
OpenMP parallel.

3. Make the code hybrid parallel by adding MPI.

4. write a makefile that compiles the code in hybrid.

5. run the code with a slurm file in hybrid mode. Experiment with the  
settings/distribution of MPI processes and OpenMP threads.

→ **2 MPI processes & 10 OMP threads, 4 MPI & 5 Openmp, ...**

## 2. Scaling test – Discrete State DP

Go to the massively parallelized DSDP code (set  $nk = 36,000$  – a big number)

/project2/osmlab/DP\_MultComms

- perform a fully-fledged hybrid scaling test.
- 1 thread, 1 MPI process.
- 1 node, 1 MPI process – max. threads/node (hybrid – comm not split).
- 5 nodes (comm split).
- 10 nodes (comm split).
- 20 nodes (comm split).

(see how much you can request – be careful with the wall time requested)

→ **all on MIDWAY – please use the slurm file that allows for hybrid jobs.**

- **Generate scaling plots, normalized to**
  - a) one CPU.**
  - b) one Node.**

## 4. Hybridize the options pricer

- Can you parallelize BS.cpp (both option flavours) in hybrid (mixed OpenMP/MPI)?
- If yes, perform a scaling experiment
  - 1 thread per process/ 1 MPI
  - 8 threads per process/ 1 MPI
  - 8 threads per process/ 2 MPI
  - 8 threads per process/ 4 MPI
  - 8 threads per process/ 8 MPI
- Vary the number of MC samples and generate scaling plots.
- How do the number of MC samples influence scalability?