rank 0 | rank 1 | rank 2 | rank 3

Read data x, N

Let other processors know how many points was read (N)

Compute N_loc = N/nproc

Compute N_loc = N/irank

Compute N_loc = N/irank

Compute N_loc = N/irank

Send each process a piece x_loc of data array x (each gets N_loc elements of x)

Compute
$$\mu_{loc} = \sum_{i=0}^{N_{loc}-1} x_i^{loc}$$

Compute global sum $\mu = \sum \mu_{loc}$ and make sure all processes know the result

Compute $\mu := \mu/N$

Compute
$$\sigma_{loc} = \sum_{i=0}^{N_{loc}-1} (x_i^{loc} - \mu)^2$$

Compute global sum $\sigma = \sum \sigma_{loc}$ and store in on rank 0

Compute $\sigma := \sqrt{\dfrac{\sigma}{N}}$
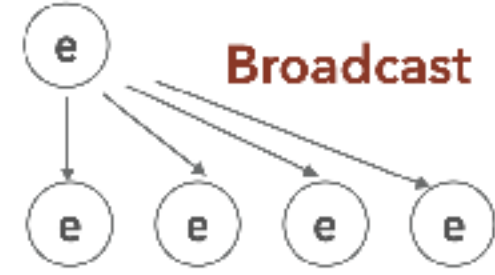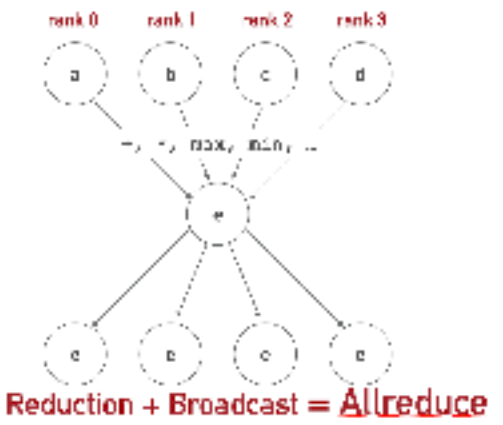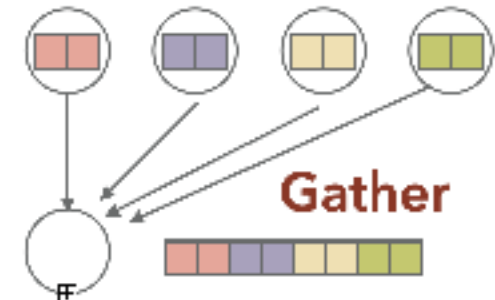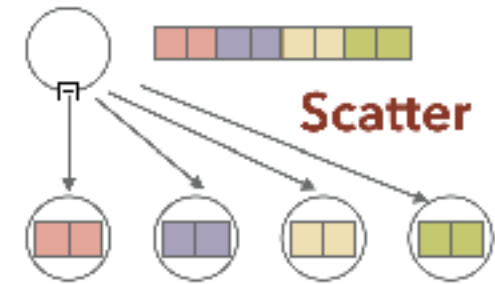
Broadcast

Gather

Allreduce

Reduction

Reduction

Broadcast

Scatter

Gather

Scatter

Allgather

Reduction

Broadcast

Reduction + Broadcast = Allreduce

Gather

Scatter

Gather + Scatter = Allgather