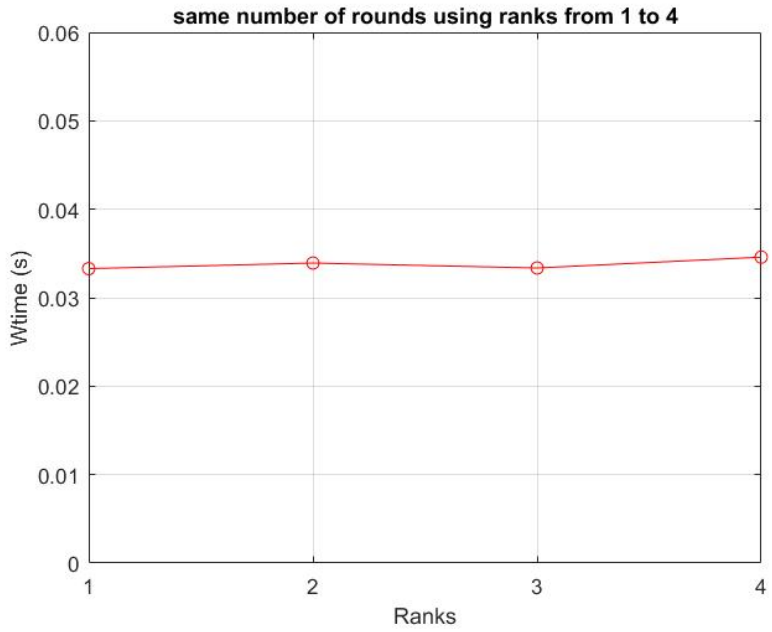
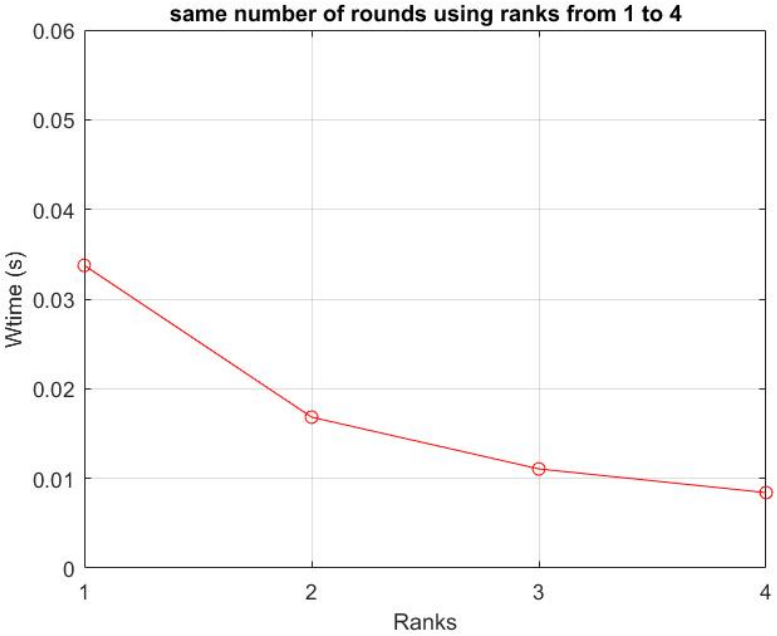
1. please see the attached code.

2. The total runtime of ranks used from 1 to 4 is almost the same, because every processor does the same amount of work in this case.



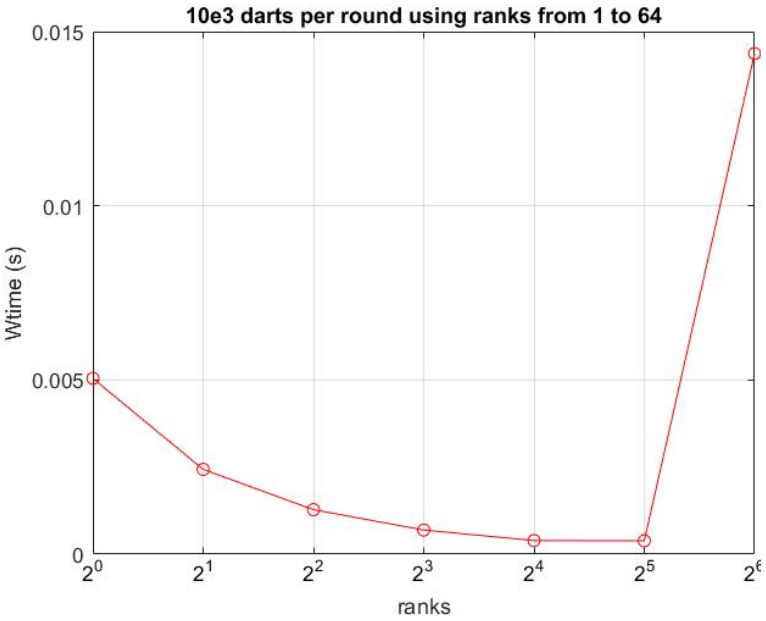
Darts = 10000 Rounds = 100.

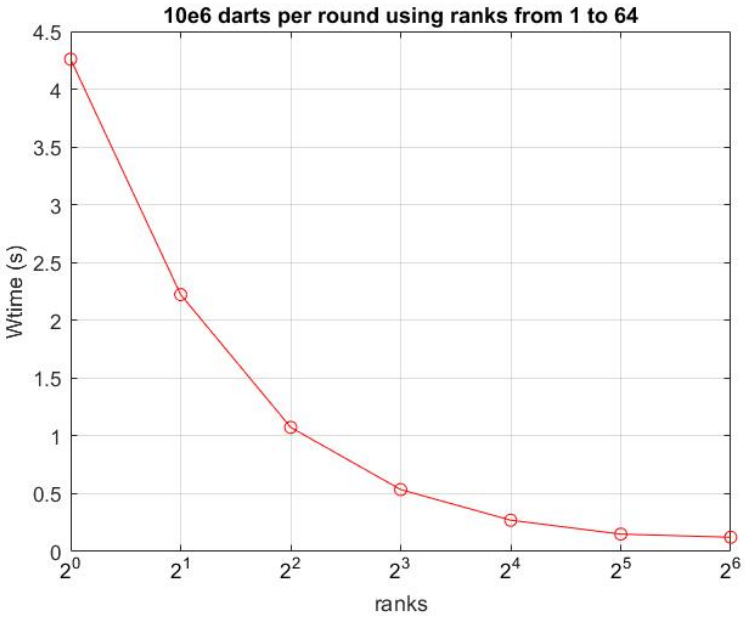
3. As the number of ranks increase, the total run time decreases. Because now the amount of work is fixed and it is distributed to different processors.

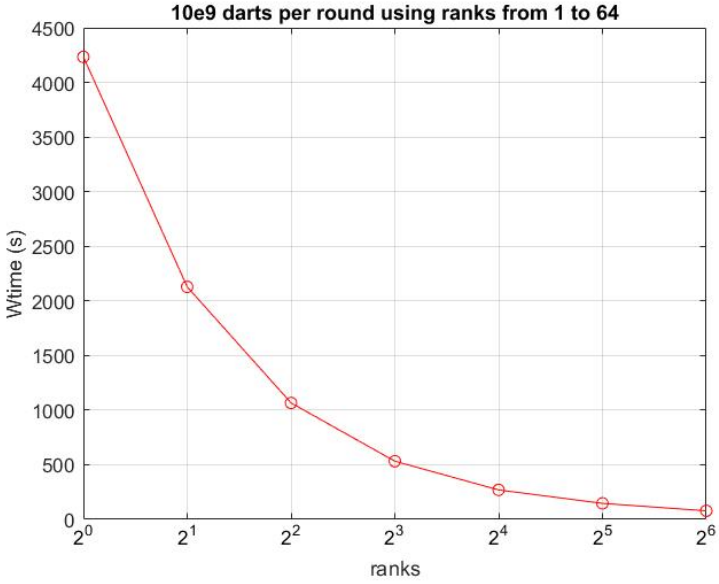


Darts = 10000 Rounds = 100.

4.







The total runtime will decrease as the number of processors increase except for the case, drats = 10e3, ranks from 2^5 to 2^6. Since our nodes have 40 processors within them, ranks below 40 you don't need to worry about the communication between nodes. But when the number of processors is over 40, for example 64, the latency cannot be ignored. For the darts = 10e6 and 10e9, as the time spent on operation is long enough, the latency can be hidden.

Goup: 4

Goup number: Alex Mckim, Robert Branson, Danqi Qu