Task 4 Extended Task

Reasons and Rationale

The original approach used individual send and receive operations for each neighbour, which involved multiple communication steps. This leads to high overhead due to frequent context switching and synchronization delays. By using non-blocking send (MPI\_Isend) and receive (MPI\_Irecv) operations in conjunction, we can initiate communication with all neighbors simultaneously and then wait for all communications to complete with MPI\_Waitall. This approach reduces the total communication time by overlapping the communication of multiple messages and minimizing waiting periods to improve performance. Moreover, sending and receiving messages individually cause excessive network overhead and latency. To counter this, aggregating messages into a single communication operation reduces the number of network transactions and the associated overhead. This means that fewer and larger messages are sent over the network which is more efficient than sending many small messages. This aggregation helps in reducing network congestion and improves communication efficiency.

Additionally, by ensuring that file operations are performed efficiently and only when necessary, the program minimizes I/O overhead because frequent file operations when handling a large number of logs can slow down the program. For instance, writing to a log file only when there are matching primes avoids unnecessary file operations and reduces the impact on performance. Efficient file handling ensures that the program can scale better with the number of processes and the volume of data. Besides that, the program avoids redundant processing by streamlining operations and focusing on necessary calculations. For example, generating and comparing primes in a more direct manner ensures that the program consumes fewer resources. These improvements collectively enhance the MPI program's efficiency by reducing communication overhead, improving network performance and minimizing computational and I/O bottlenecks.