IPC Assignment 1 Question 2

Following are the benefits of loop interchange:
- Allows us to change the level at which there is dependence in the loops.
- After interchange of loops, all the loops above the level to which the new dependence holds, can be parallelized.

Examples taken in code to demonstrate it, result and observation:
1. Small two dimensional matrix: initial dependence at level 1
→ after loop interchange and before loop interchange time remains same, as matrix is smaller, no significant change observed. Both took less than 1 second.

2. Big one dimensional arrays, flow dependence at level 1
 → time before loop interchange: 3 seconds
→ time after loop interchange: 0 seconds
→ this happened because due to loop interchange, dependence was moved to level 2 and new outer loop was parallelized.

3. Big two dimensional matrix: initial dependence at level 1
→ time taken before loop interchange: 27 seconds
 → time taken after loop interchange: 3 seconds (using 12 cores on my laptop)
→ this happened because due to loop interchange, dependence was moved to level 2 and new outer loop was parallelized. But some part of fastening of process can also be attributed to change in access of matrix element.(row major ↔ column major)

Given the limited memory capacity to run program and test compiler optimization, there was not a big improvement observed, but following are the observation for compiler optimization options:

1. o0 to disable optimizations : above observations

2. -o1 to perform level-1 optimizations - No changes observed from o0

3. -o2 to perform level-2 optimizations.
- For second example: before loop interchange: 2 seconds, after: 0
- For third example: before loop interchange: 25 seconds, after: 3

4. -o3 to perform level-3 optimizations.
- For second example: before loop interchange: 2 seconds, after: 0
- For third example: before loop interchange: 23 seconds, after: 2

5. -os to optimize for size.
- For second example: before loop interchange: 2 seconds, after: 0
- For third example: before loop interchange: 21 seconds, after: 2

6. -ofast to perform level-3 optimizations plus disregard strict standards compliance.
- For second example: before loop interchange: 1 seconds, after: 0
- For third example: before loop interchange: 16 seconds, after: 1