# **Assignment 2a Report**

### 1. Results from the multithreaded counter program

Thread number	1	100	1000	10000
Final counter value	10	1000	10000	100000
Time taken(ms)	0	4	27	278

# 2. Results from the collection 1 program

Time taken to add elements to Vector (ms)	3
Time taken to add 100k elements to ArrayList (ms)	1

# 3. Results from the collection 2 program

Thread number	1	100
Time taken to add elements to HashTable (ms)	7	10
Time taken to add elements to HashMap (ms)	4	14
Time taken to add elements to ConcurrentHashMap (ms)	22	15

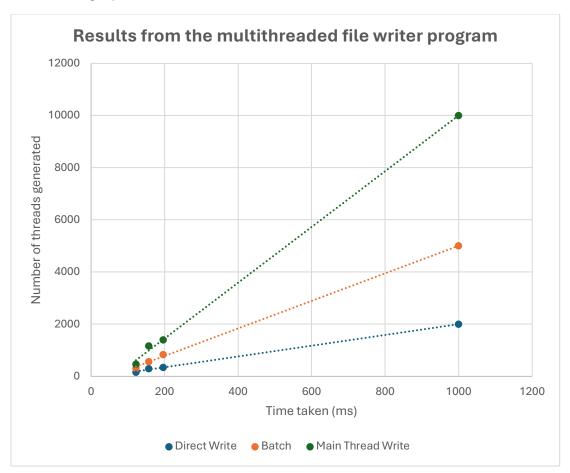
# 4. Results from the multithreaded file writer program

This program runs with 1000, 2000, 5000, and 10,000 threads, and implements three approaches to writing to a file using multiple threads:

- 1. direct write in each thread
- 2. bath write after thread completion
- 3. main thread write

Number of threads generated	1000	2000	5000	1000
				0
Time taken for Approach 1 (Direct Write) (ms)	157	291	561	1165
Time taken for Approach 2 (Batch Write) (ms)	122	155	306	468
Time taken for Approach 3 (Main Thread Write) (ms)	196	348	828	1395

### Below is a graph on the results:



#### Insights and takeaways:

#### 1. Performance aspect:

- Main thread write took the longest time to write to the file. It may be that this
  approach accumulates data in memory and writes all at once, resulting in a
  significant overhead.
- Direct write was faster than main thread write, may due to the frequent input output operations
- Batch write was the fastest, as it writes data in batches after all threads have completed their tasks. This approach reduces the overhead of frequent I/O operations, and synchronization overhead.

#### 2. Scalability:

- Main thread suffers the most as the number of threads increases due to the large amount of data stored in memory and synchronization overhead during collection.
- Direct write also suffers as the number of threads increases, but not as much as main thread write.
- Batch write is the most scalable approach, as it writes data in batches after all threads have completed their tasks.

### Alternative implementations:

- 1. Only one thread writes to the file while the threads are generating the strings.
- 2. Write data in an ascending timestamp order

### Results from the alternative implementation:

- Producer Threads: Time taken = 1169 ms
- Consumer Thread: Time taken = 2591 ms
- Total Time (Producer + Consumer): Time taken = 2591 ms

#### Pros and Cons of the alternative implementation:

- Pros:
  - The PriorityBlockingQueue ensures ascending timestamp order.
  - The generation and writing processes are independent.
  - Only one writer ensures thread safety
- Cons:
  - One single writer may become a bottleneck when the number of threads increases.
  - The use of PriorityBlockingQueue requires additional memory and adds complexity, which may introduce overhead.