HIGH PERFORMANCE COMPUTING

LAB ASSIGNMENT – 03

BATCH – 04

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LOAD BALANCING WITH IRREGULAR WORKLOADS

LOAD BALANCING WITH IRREGULAR WORKLOADS USING PARALLEL EXECUTION

Aim:

To study load balancing issues in parallel programs by simulating irregular workloads and analyzing execution time variations using Numba's parallel execution model.

JUST FOR THE REFERENCE PURPOSE IM KEEPING THE CODE BELOW

```
import numpy as np
import time
from numba import njit, prange


@njit(parallel=True)
def process_images(work):
    result = 0.0
    for i in prange(len(work)):
        tmp = 0.0
        # Variable workload per iteration
        for j in range(work[i]):
            tmp += j * 0.000001
        result += tmp
    return result


if __name__ == "__main__":


    # Simulate irregular workloads (e.g., different image sizes)
    np.random.seed(42)
    work = np.random.randint(1000, 10000, size=1000)
```

```
# Warm-up run (Numba JIT compilation)
process_images(work)

runs = 5
times = []

for i in range(runs):
    start = time.time()
    result = process_images(work)
    end = time.time()

    exec_time = end - start
    times.append(exec_time)

    print(f"Run {i+1}: Execution Time = {exec_time:.4f} seconds")

print("\nFinal Result:", result)
print("Average Execution Time:", sum(times) / runs)
```

CPU – GOOGLE COLAB (OUTPUT)

```
Run 1: Execution Time = 0.0130 seconds
Run 2: Execution Time = 0.0093 seconds
Run 3: Execution Time = 0.0119 seconds
Run 4: Execution Time = 0.0083 seconds
Run 5: Execution Time = 0.0109 seconds

Final Result: 18851.291027000007
Average Execution Time: 0.010648250579833984
```

KEY OBSERVATIONS

- **Execution time varies slightly across runs due to irregular workloads**
- **Some parallel threads finish earlier, while others take longer**
- **CPU cores are not uniformly utilized**
- **Performance does not scale linearly due to load imbalance**

WHY LOAD IMBALANCE OCCURS

- **Each iteration performs a different amount of work**
- **Static scheduling distributes iterations evenly, not workload**
- **Larger tasks delay completion of certain threads**

----------THANKYOU----------