Operating Systems Laboratory (CS39002)

Assignment - 3

Shared Memory Management

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Design of the strategy to optimize re-computation of shortest paths

1. **Naïve Approach:** Whenever new nodes get added by the producer, each consumer re-calculates the shortest paths considering all the nodes assigned to it as source.

   Algorithm:

```
int dist[n/10][n]                          // n = |V|
for (u = consumer_id; u < n; u += 10)      // consumer_id ~ [0, 9]
      dijkstra(u, dist)
```

   Time Complexity: $\left(\frac{|V|}{10}\right) * |E| \, log(|V|)$

2. **Optimized Approach:** Whenever new nodes get added by the producer, each consumer calculates the shortest paths considering only the newly added nodes as source and store result in **`dist1`**. Then the distance between a node **u** assigned the consumer and any other node **v** is updated if,

$$dist[u][v] \succ dist1[u][new\_node] + dist1[new\_node][v]$$

   Algorithm:

```
int dist1[k][n];     // k = new nodes added by the producer

// use new nodes as the source when applying Dijkstra
for (u = 0; u < k; i++)
      dijkstra(u, dist1);

// update old dist matrix using the above condition
for (u = consumer_id; u < n; u += 10)
      for (v = 0; v < n; v++)
          for (i = 0; i < k; i++)
          {
             if (dist[u][v] > dist1[i][u] + dist1[i][v])
                 dist[u][v] = dist1[i][u] + dist1[i][v];
          }
```

   Time Complexity: $\left(\frac{|V|}{10}\right) * (|V|) * k + k * |E| \, log(|V|)$

3. **Improvement:** During each iteration of a consumer process the optimized algorithm will run, for $\left(\frac{|V|}{10}\right) * (|V|) * k + k * |E| \, log(|V|)$ iterations and the naïve algorithm will run for $\left(\frac{|V|}{10}\right) * |E| \, log(|V|)$ iterations. For the given dataset the optimized algorithm will decrease the running time almost **13 times**.

$$improvement = \frac{\left(\frac{|V|}{10}\right) * |E| \, log(|V|)}{\left(\frac{|V|}{10}\right) * (|V|) * k + k * |E| \, log(|V|)} = \frac{404 * 88234 * log(4039)}{404 * 4039 * 20 + 2 * 88234 * log(4039)} = 13$$