**Offline 1**

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**Runtime analysis of BFS on graphs.**

**Data:**

**Adjacency Matrix representation: (in microseconds):**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **-** | **|V|** | **5|V|** | **10|V|** | **50|V|** | **100|V|** | **500|V|** | **1000|V|** | **(|V|2-|V|)/10** | **(|V|2-|V|)/2** |
| **1000** | 1818 | 3250 | 3410 | 4057 | 5120 | - | - | 4999 | 2828 |
| **2000** | 6594 | 16785 | 12270 | 14012 | 16064 | 33400 | - | 20024 | 11236 |
| **4000** | 31197 | 43616 | 44096 | 46833 | 51338 | 88599 | 131812 | 76750 | 43752 |
| **8000** | 85015 | 151911 | 151419 | 157949 | 164770 | 253844 | 327644 | 282392 | 165614 |
| **16000** | 335982 | 612914 | 649340 | 659446 | 636267 | 766591 | 988151 | 1211390 | 709701 |

**Adjacency List representation: (in microseconds):**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **-** | **|V|** | **5|V|** | **10|V|** | **50|V|** | **100|V|** | **500|V|** | **1000|V|** | **(|V|2-|V|)/10** | **(|V|2-|V|)/2** |
| **1000** | 37 | 146 | 212 | 864 | 1631 | - | - | 1807 | 7565 |
| **2000** | 116 | 333 | 422 | 1768 | 3355 | 15281 | - | 6242 | 32506 |
| **4000** | 157 | 576 | 839 | 3573 | 7610 | 31090 | 58796 | 24395 | 113941 |
| **8000** | 452 | 1278 | 2241 | 7621 | 13324 | 62727 | 120664 | 109920 | 448381 |
| **16000** | 1284 | 3288 | 4486 | 14526 | 27441 | 122432 | 272834 | 388833 | 1855630 |

**Question Answers:**

1. **What is the impact on runtime if we keep |V| unchanged and double |E| for adjacency list? Why is it so?**

Answer:

In adjacency list, the runtime complexity of BFS is O(V+E), So if we double |E| then, it will become the dominating term and runtime will approximately double, as seen from the data.

1. **What is the impact on runtime if we keep |E| unchanged and double |V| for adjacency list? Why is it so?**

Answer:

Since the complexity is O(V+E), so the runtime will increase provided that |E| is not dominating over |V|. If |E| is too large, this will have no impact

1. **What is the impact on runtime if we keep |V| unchanged and double |E| for adjacency matrix? Why is it so?**

Answer:

In adjacency matrix representation, the complexity of BFS is O(V2+E). And in general, |E| < |V|2. So increasing |E| will have ignorable effect, unless E is very large and around V2

1. **What is the impact on runtime if we keep |E| unchanged and double |V| for adjacency matrix? Why is it so?**

Answer:

As the complexity is O(V2+E), so the runtime will approximately quadruple. |E| is always dominated by |V|2 , so changing |V| will have a big effect.

1. **For the same |E| and |V|, why are the runtimes for adjacency list and adjacency matrix representation different? Which one is higher and why?**

Answer:

Adjacency list uses time O(V+E) while adjacency matrix uses O(V2+E). So in general adjacency matrix takes more time. But as the graph becomes dense, the runtime of both become approximately equal.