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| --- | --- | --- |
| **Title *(English)*** | OSPF(bare bone)  Phase 2 : OSPF communication | |
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| **Field** | Computer science and Engineering | |
| **Program** | Artificial intelligence science | |
| **Instructor** | **Dr. Mohamed Amir** | |
| **This part for the instructor: Notice** | | **Degree** |
| **Date of Submission** |  | |

***Section one: A brief introduction about the OSPF protocol***

The Open Shortest Path First (OSPF) protocol is a widely used routing protocol within a single administrative domain (like an autonomous system) for Internet Protocol (IP) networks. It's known for its:

* Speed and Scalability: OSPF quickly adapts to network changes and efficiently scales for large networks.
* Reliability: It uses a link-state routing approach, where routers share their complete network topology information, enabling fast and reliable routing decisions.
* Security: OSPF supports authentication to prevent unauthorized routing updates.

Here's a breakdown of the key elements you mentioned:

LSA Types:

* LSA Type 1 (Router LSA): Advertises a router's information like its router ID, network masks, and directly connected networks. This helps other routers build the overall network topology.
* LSA Type 2 (Network LSA): Advertises detailed information about directly connected networks, including subnet masks, router IDs, and metric costs. This enables routers to calculate the shortest paths to specific destinations.
* LSA Type 3 (Summary LSA): Summarizes a group of networks within an area, reducing the amount of routing information flooded across the network. This improves efficiency and scalability.

LSU (Link-State Update): A packet containing one or more LSAs. Routers send LSUs to their neighbors to share their network topology information.

LSBD (Link-State Database): A collection of all LSAs received by a router. Each router builds and maintains its own LSBD based on the information it receives from its neighbors. This database is used to calculate the shortest paths to any destination within the network.

Additional Points:

* OSPF also uses other LSA types like Type 5 (Autonomous System LSA) and Type 7 (Intra-area Prefix LSA), but these are less common and mainly used for advanced configurations.
* The LSAs and LSBD work together to enable OSPF routers to dynamically calculate the shortest paths to any destination, leading to efficient and reliable routing within a network.

***Section Two: result section***

Vertex Distance Path

0 6 [3, 0]

1 7 [3, 0, 1]

2 3 [3, 2]

3 0 [3]

LSA received and stored in LSDB of Router 20: {'link\_state\_id': '10-20', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 30: {'link\_state\_id': '10-20', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 40: {'link\_state\_id': '10-20', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 20: {'link\_state\_id': '10-30', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 30: {'link\_state\_id': '10-30', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 40: {'link\_state\_id': '10-30', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 20: {'link\_state\_id': '10-40', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 30: {'link\_state\_id': '10-40', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 40: {'link\_state\_id': '10-40', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 10: {'link\_state\_id': '20-10', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 30: {'link\_state\_id': '20-10', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 40: {'link\_state\_id': '20-10', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 10: {'link\_state\_id': '20-30', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 30: {'link\_state\_id': '20-30', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 40: {'link\_state\_id': '20-30', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 10: {'link\_state\_id': '30-10', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 20: {'link\_state\_id': '30-10', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 40: {'link\_state\_id': '30-10', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 10: {'link\_state\_id': '30-20', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 20: {'link\_state\_id': '30-20', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 40: {'link\_state\_id': '30-20', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 10: {'link\_state\_id': '30-40', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 20: {'link\_state\_id': '30-40', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 40: {'link\_state\_id': '30-40', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 10: {'link\_state\_id': '40-10', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 20: {'link\_state\_id': '40-10', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 30: {'link\_state\_id': '40-10', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 10: {'link\_state\_id': '40-30', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 20: {'link\_state\_id': '40-30', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

LSA received and stored in LSDB of Router 30: {'link\_state\_id': '40-30', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

LSDB of Router 10:

Link State ID: 10-20 | LSA: {'link\_state\_id': '10-20', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 10-30 | LSA: {'link\_state\_id': '10-30', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 10-40 | LSA: {'link\_state\_id': '10-40', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 20-10 | LSA: {'link\_state\_id': '20-10', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 20-30 | LSA: {'link\_state\_id': '20-30', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 30-10 | LSA: {'link\_state\_id': '30-10', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 30-20 | LSA: {'link\_state\_id': '30-20', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 30-40 | LSA: {'link\_state\_id': '30-40', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 40-10 | LSA: {'link\_state\_id': '40-10', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 40-30 | LSA: {'link\_state\_id': '40-30', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

LSDB of Router 20:

Link State ID: 10-20 | LSA: {'link\_state\_id': '10-20', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 10-30 | LSA: {'link\_state\_id': '10-30', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 10-40 | LSA: {'link\_state\_id': '10-40', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 20-10 | LSA: {'link\_state\_id': '20-10', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 20-30 | LSA: {'link\_state\_id': '20-30', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 30-10 | LSA: {'link\_state\_id': '30-10', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 30-20 | LSA: {'link\_state\_id': '30-20', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 30-40 | LSA: {'link\_state\_id': '30-40', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 40-10 | LSA: {'link\_state\_id': '40-10', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 40-30 | LSA: {'link\_state\_id': '40-30', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

LSDB of Router 30:

Link State ID: 10-20 | LSA: {'link\_state\_id': '10-20', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 10-30 | LSA: {'link\_state\_id': '10-30', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 10-40 | LSA: {'link\_state\_id': '10-40', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 20-10 | LSA: {'link\_state\_id': '20-10', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 20-30 | LSA: {'link\_state\_id': '20-30', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 30-10 | LSA: {'link\_state\_id': '30-10', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 30-20 | LSA: {'link\_state\_id': '30-20', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 30-40 | LSA: {'link\_state\_id': '30-40', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 40-10 | LSA: {'link\_state\_id': '40-10', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 40-30 | LSA: {'link\_state\_id': '40-30', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

LSDB of Router 40:

Link State ID: 10-20 | LSA: {'link\_state\_id': '10-20', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 10-30 | LSA: {'link\_state\_id': '10-30', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 10-40 | LSA: {'link\_state\_id': '10-40', 'sequence\_number': 1001, 'advertising\_router': '10', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 20-10 | LSA: {'link\_state\_id': '20-10', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 1, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 20-30 | LSA: {'link\_state\_id': '20-30', 'sequence\_number': 2001, 'advertising\_router': '20', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 30-10 | LSA: {'link\_state\_id': '30-10', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 4, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 30-20 | LSA: {'link\_state\_id': '30-20', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 5, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 30-40 | LSA: {'link\_state\_id': '30-40', 'sequence\_number': 3001, 'advertising\_router': '30', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 40-10 | LSA: {'link\_state\_id': '40-10', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 6, 'timestamp': '2024-01-09 09:24:13'}

Link State ID: 40-30 | LSA: {'link\_state\_id': '40-30', 'sequence\_number': 4001, 'advertising\_router': '40', 'link\_cost': 3, 'timestamp': '2024-01-09 09:24:13'}

Forwarding Table for Router A:

Cost to reach Router 20: 1, the next stop is router: ['10', '20']

Cost to reach Router 30: 4, the next stop is router: ['10', '30']

Cost to reach Router 40: 6, the next stop is router: ['10', '40']

Forwarding Table for Router B:

Cost to reach Router 10: 1, the next stop is router: ['20', '10']

Cost to reach Router 30: 5, the next stop is router: ['20', '30']

Cost to reach Router 40: 7, the next stop is router: ['20', '10', '40']

Forwarding Table for Router C:

Cost to reach Router 10: 4, the next stop is router: ['30', '10']

Cost to reach Router 20: 5, the next stop is router: ['30', '20']

Cost to reach Router 40: 3, the next stop is router: ['30', '40']

Forwarding Table for Router D:

Cost to reach Router 10: 6, the next stop is router:['40', '10']

Cost to reach Router 20: 7, the next stop is router:['40', '10', '20']

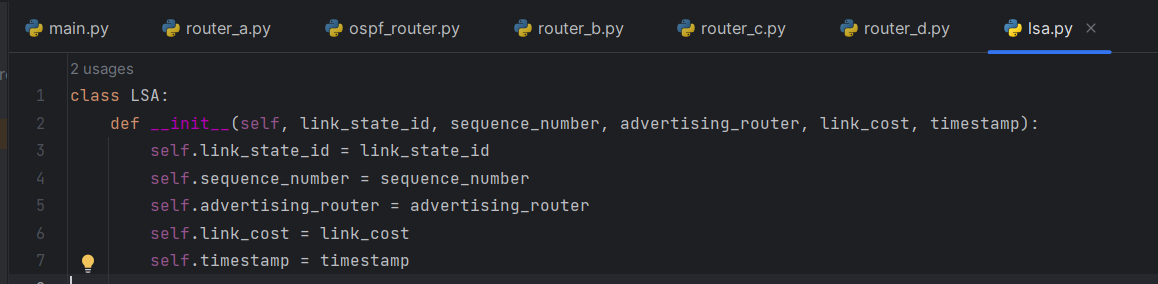
Cost to reach Router 30: 3, the next stop is router:['40', '30']

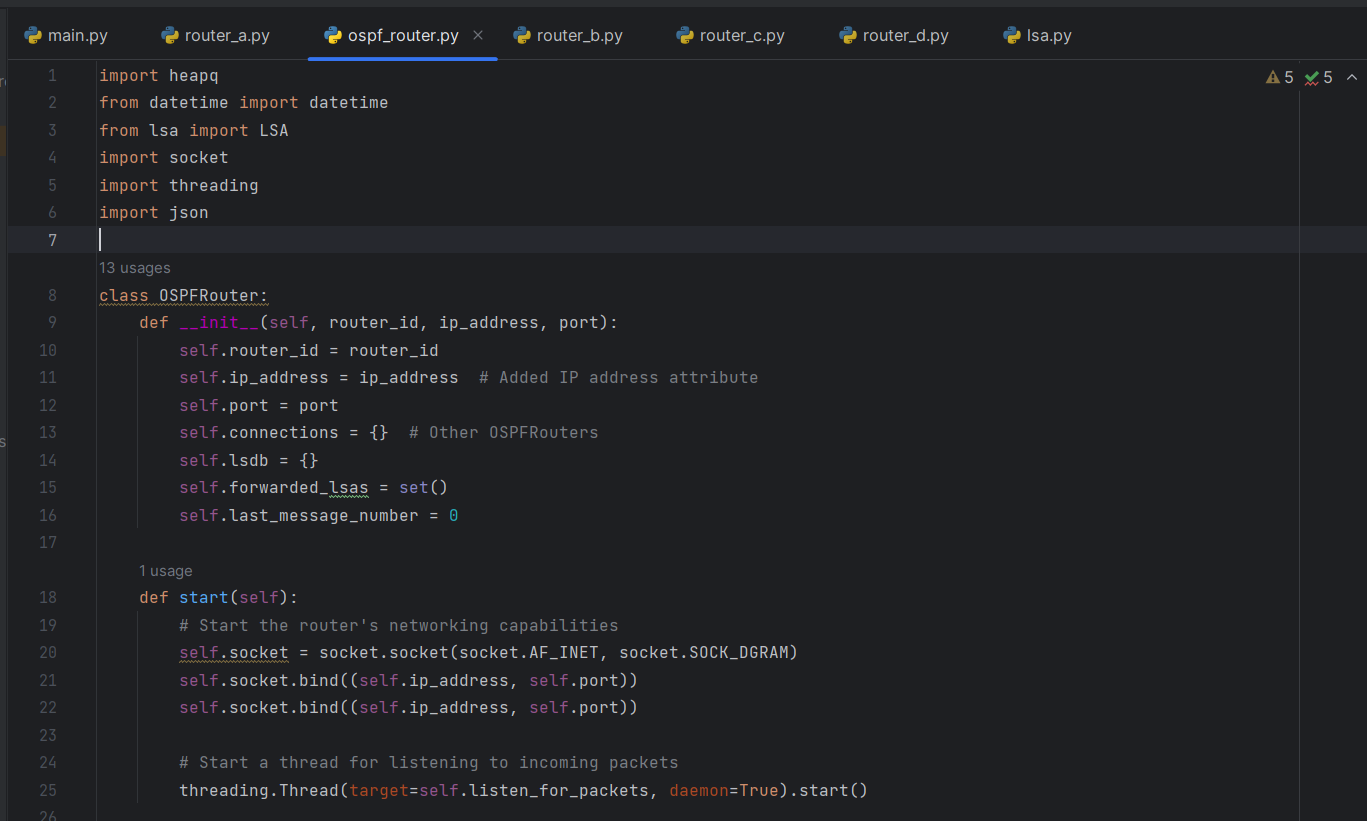
Process finished with exit code 0

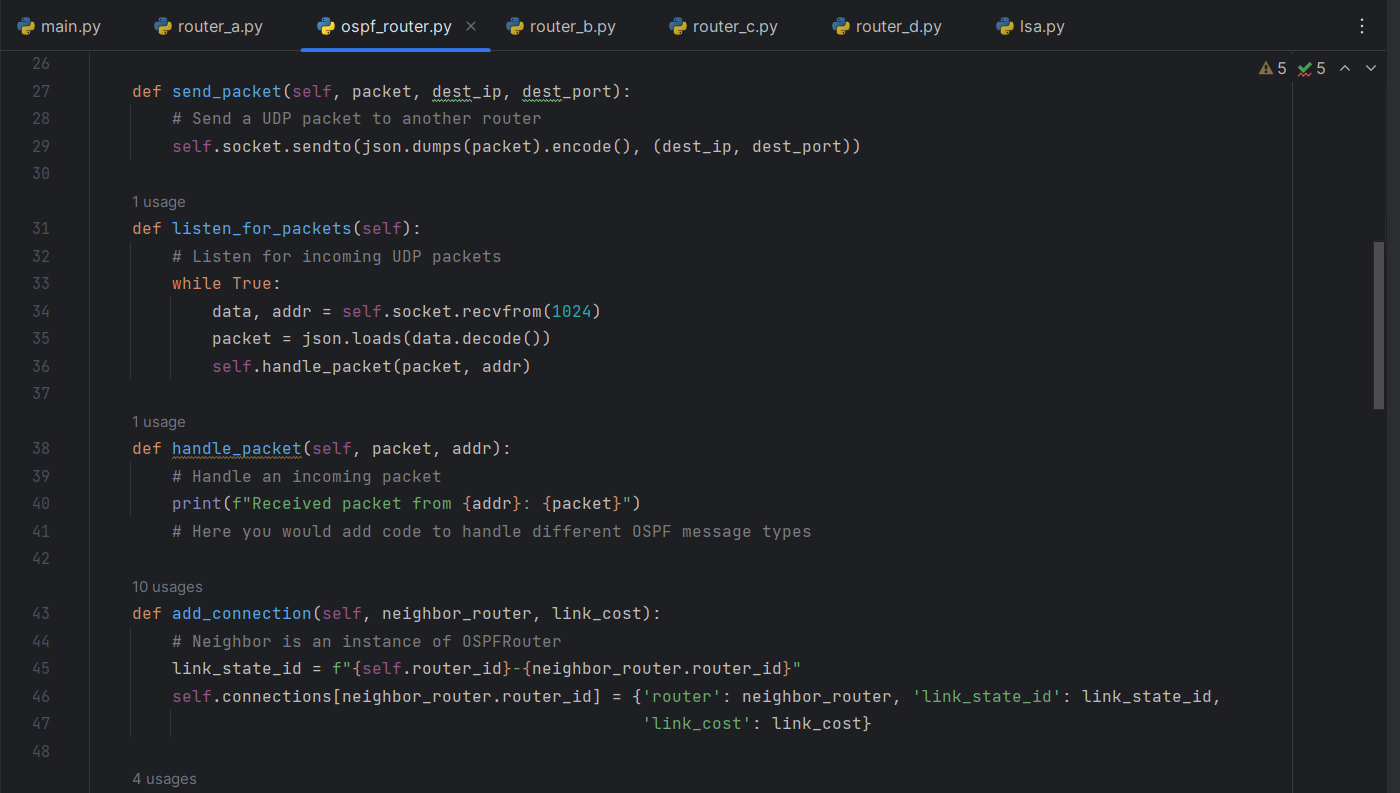
***Comment:***

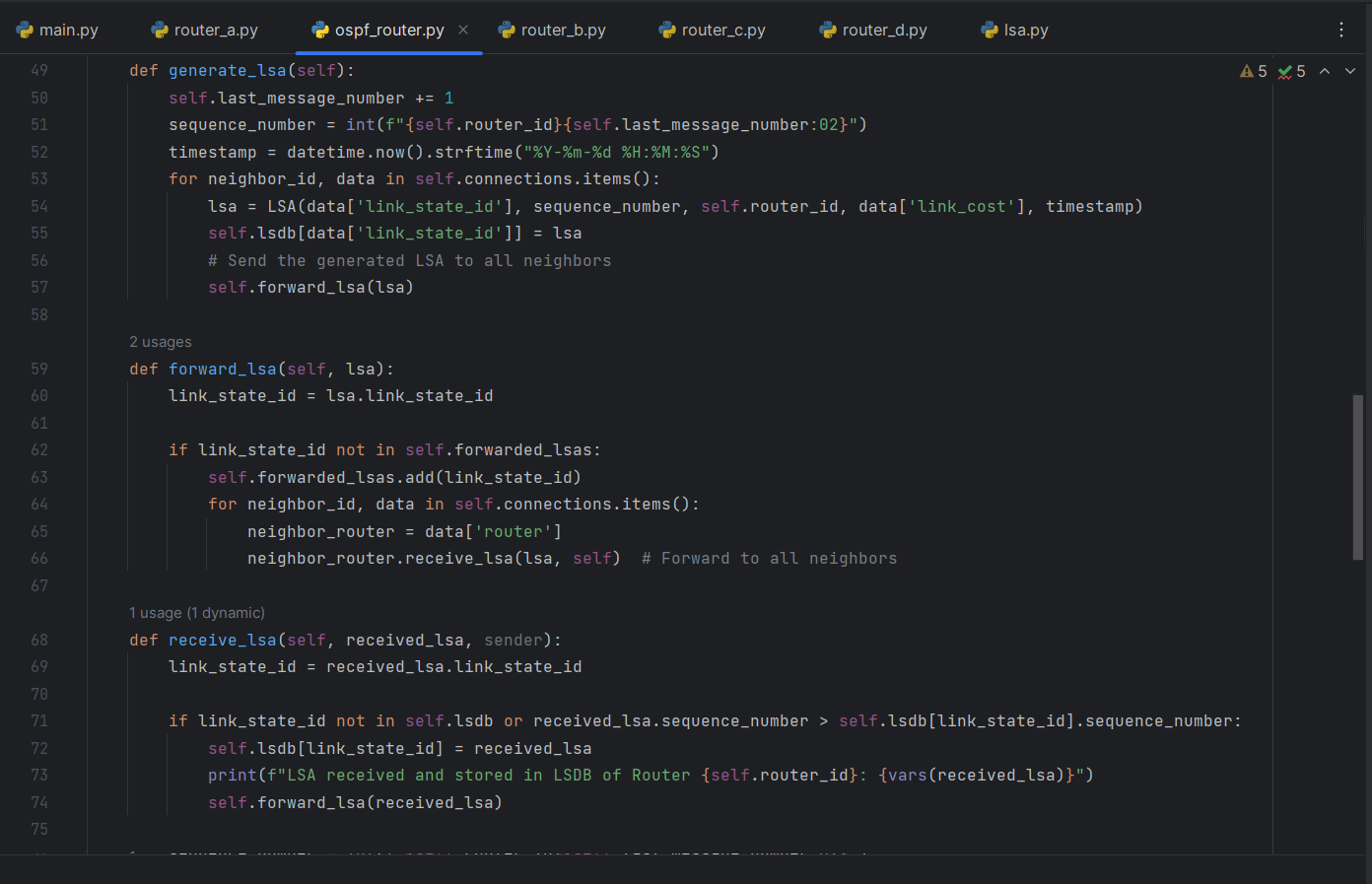
1. **LSA Generation and Sharing:**
   * Routers are creating and sharing LSAs (Link State Advertisements) with each other. This is like each router sending out a little message to tell its neighbors about the other routers it knows, how to reach them, and how "expensive" it is to get there (the cost).
2. **Link State Database (LSDB):**
   * Every router is receiving LSAs and keeping a record of them in something called the LSDB. You can think of the LSDB as a router's address book where it keeps the most up-to-date information about how to reach other routers.
3. **Sequence Numbers:**
   * Each LSA has a sequence number, kind of like a version number, that helps routers figure out which information is the newest and should be used.
4. **Forwarding Table Computation:**
   * Based on the LSAs, each router calculates the best (shortest and cheapest) paths to all the other routers. This is like planning out the best route on a map using the most recent information you have.
5. **Consistency in Timing:**
   * The timestamps in the LSAs are all the same, which suggests that these LSAs were processed at the same time during the simulation.
6. **Network Map Accuracy:**
   * The output shows that the routers' understanding of the network matches the connections you set up. For example, Router A knows it's directly connected to Routers B, C, and D, and it knows the "cost" to reach them.

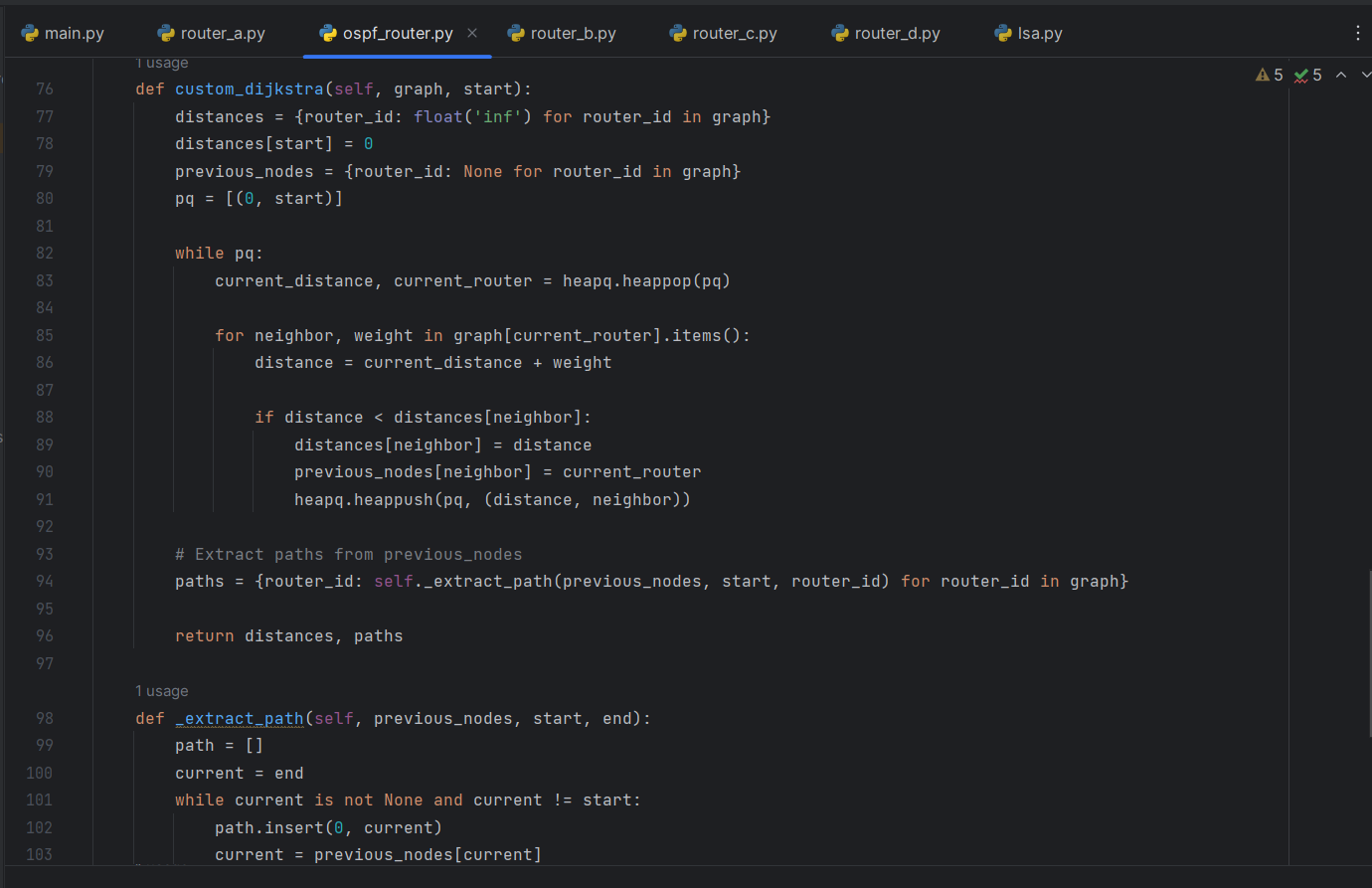
***Appendix section:***

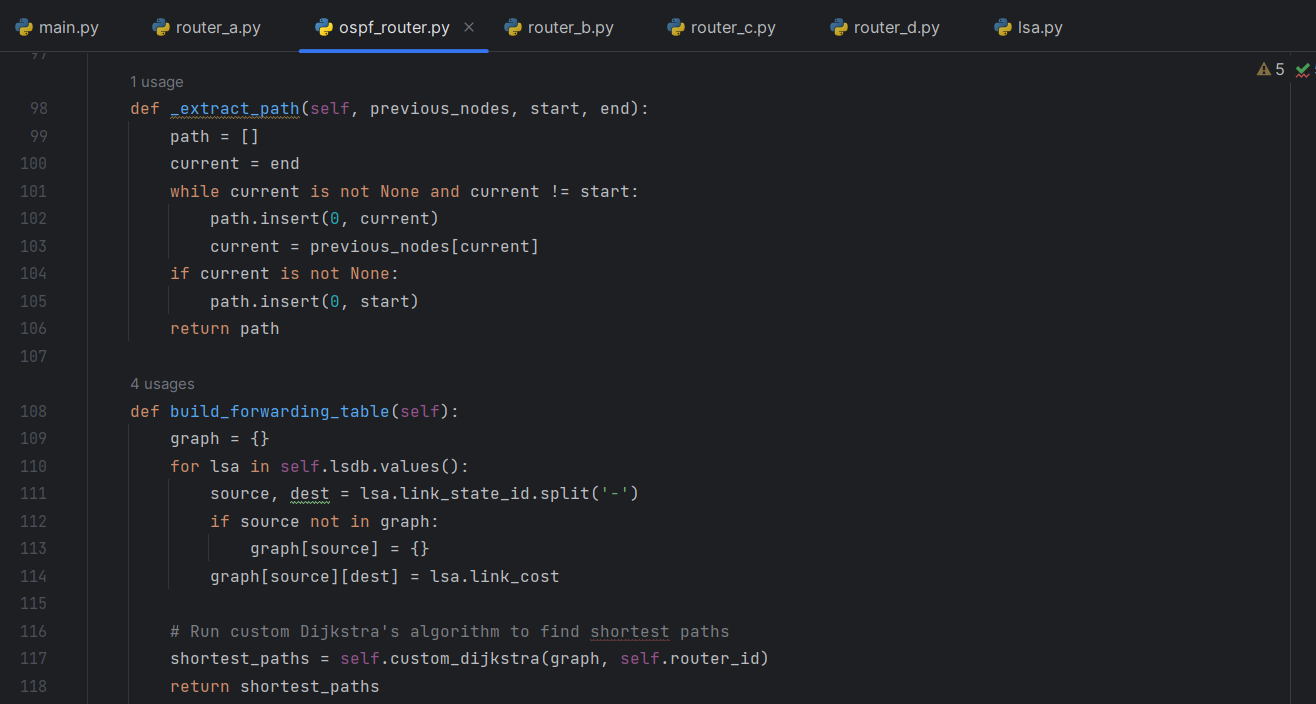
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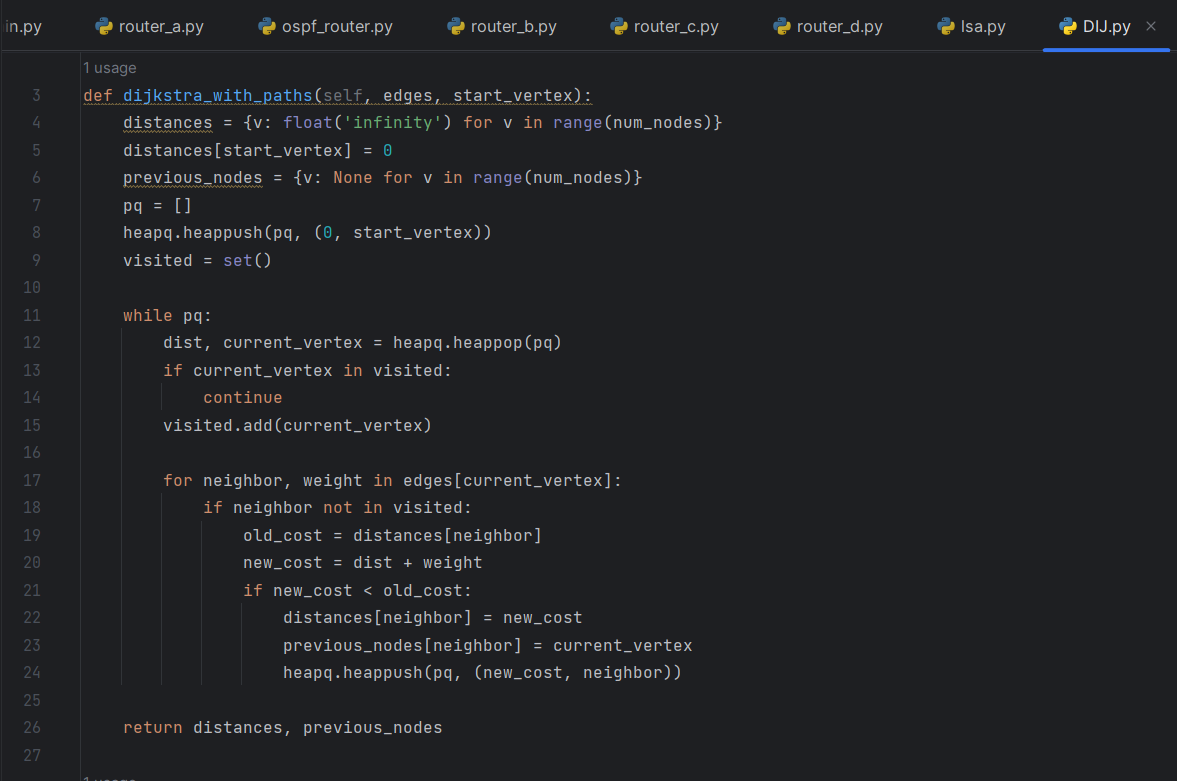
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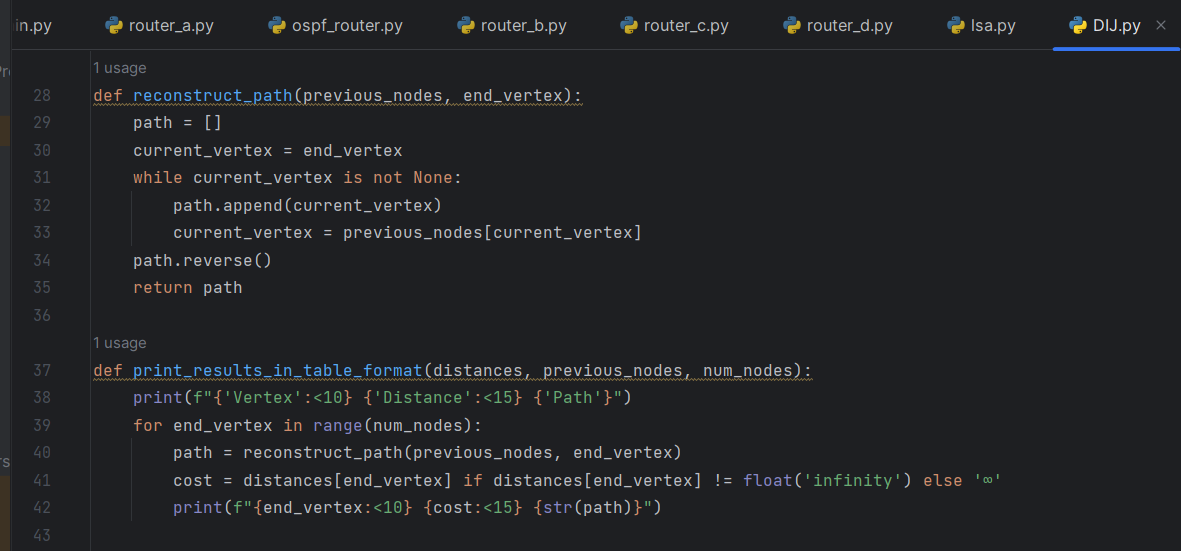
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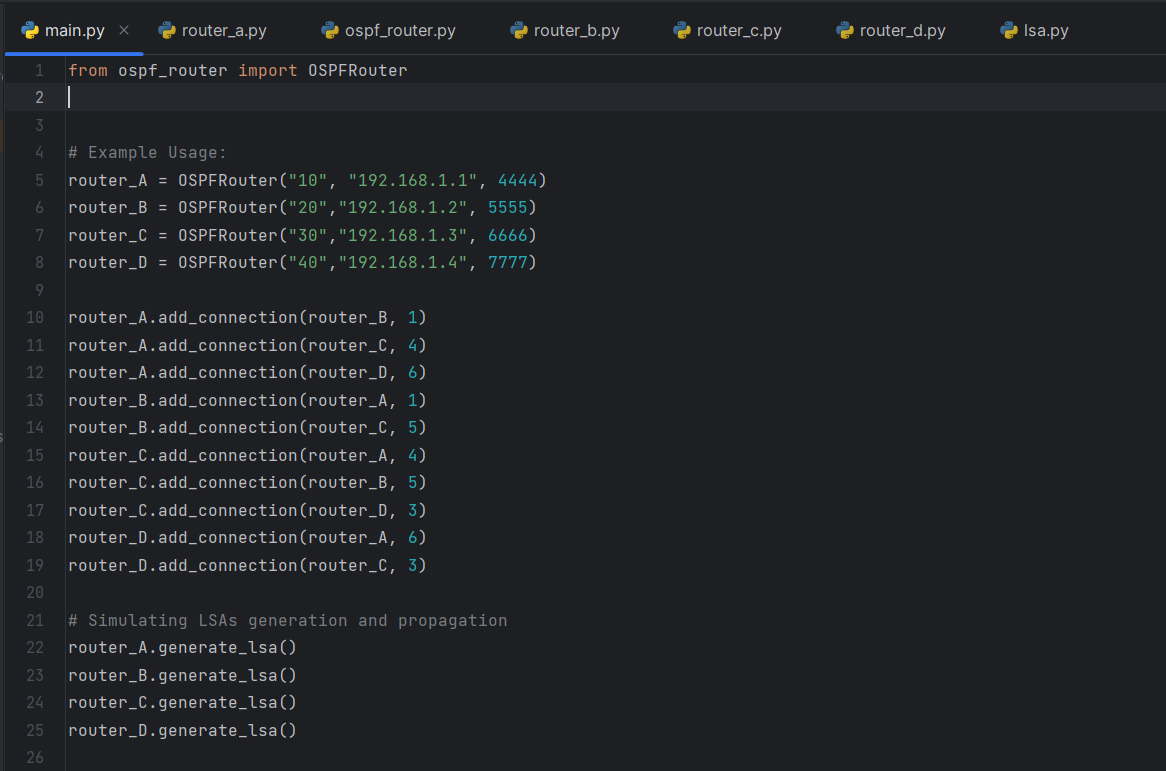
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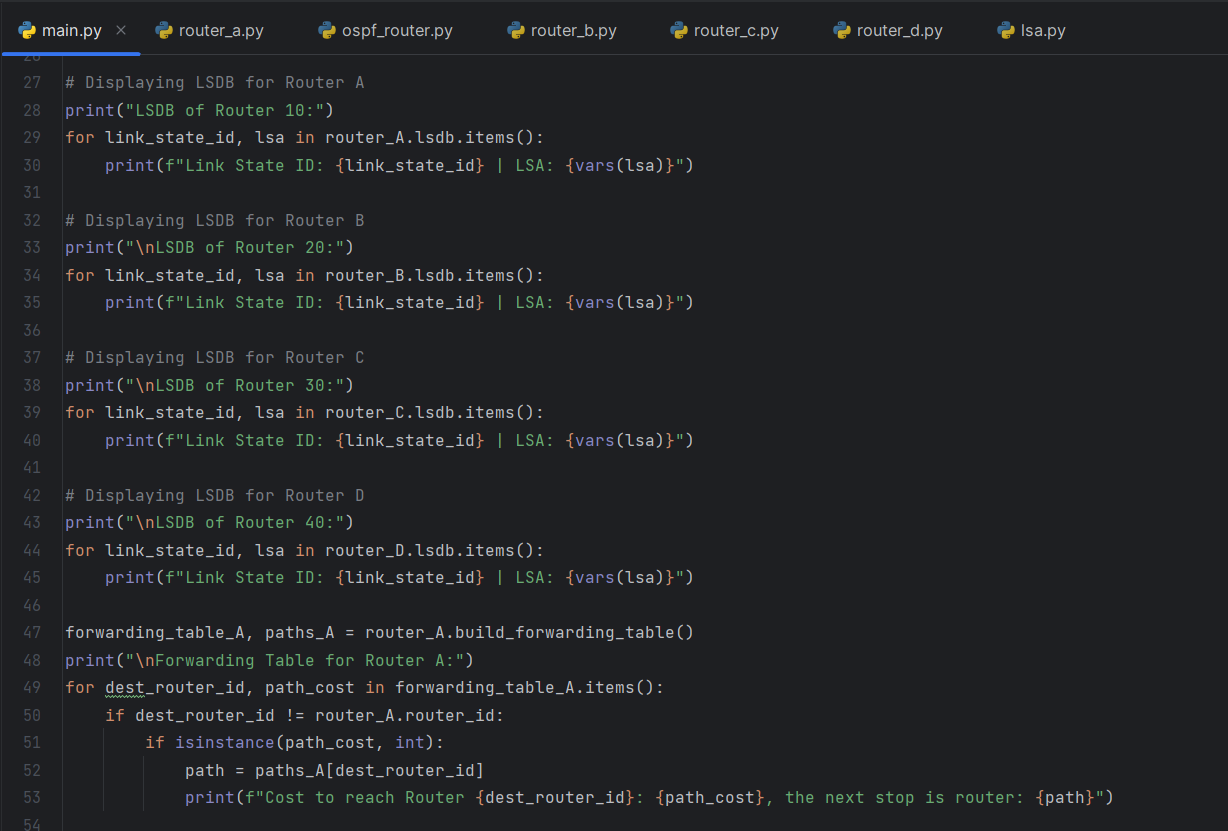
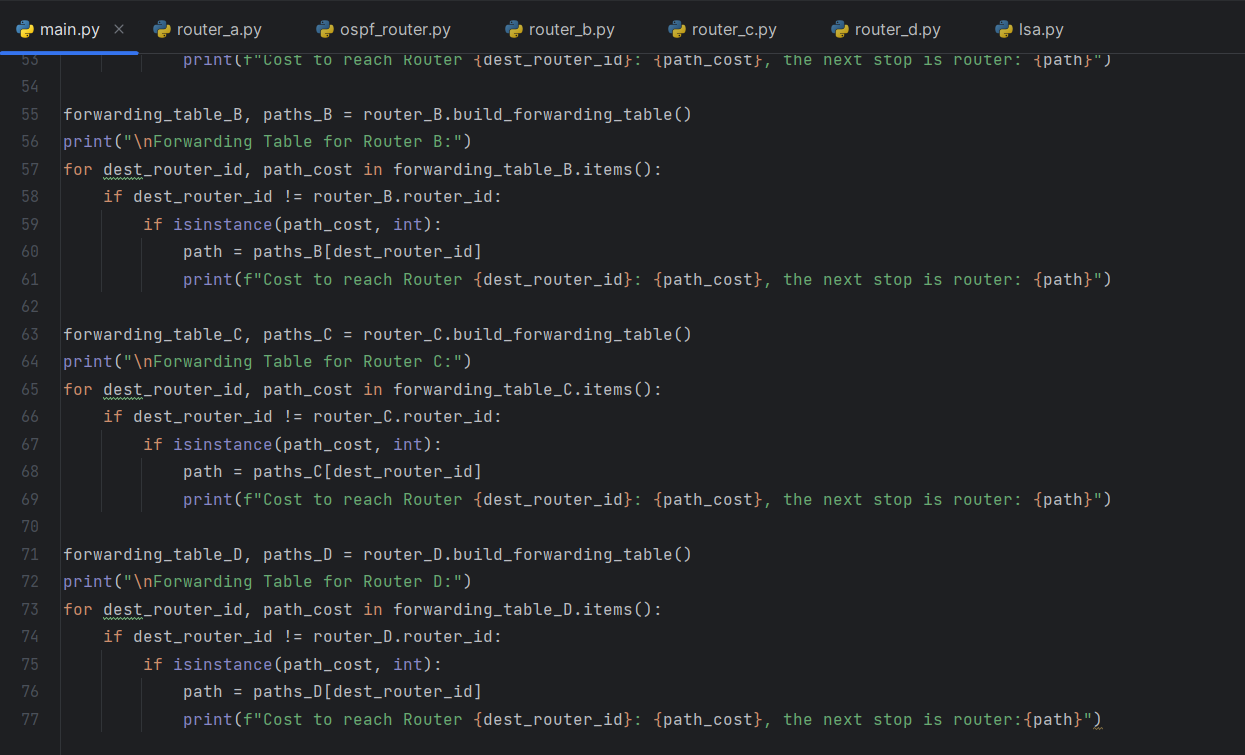
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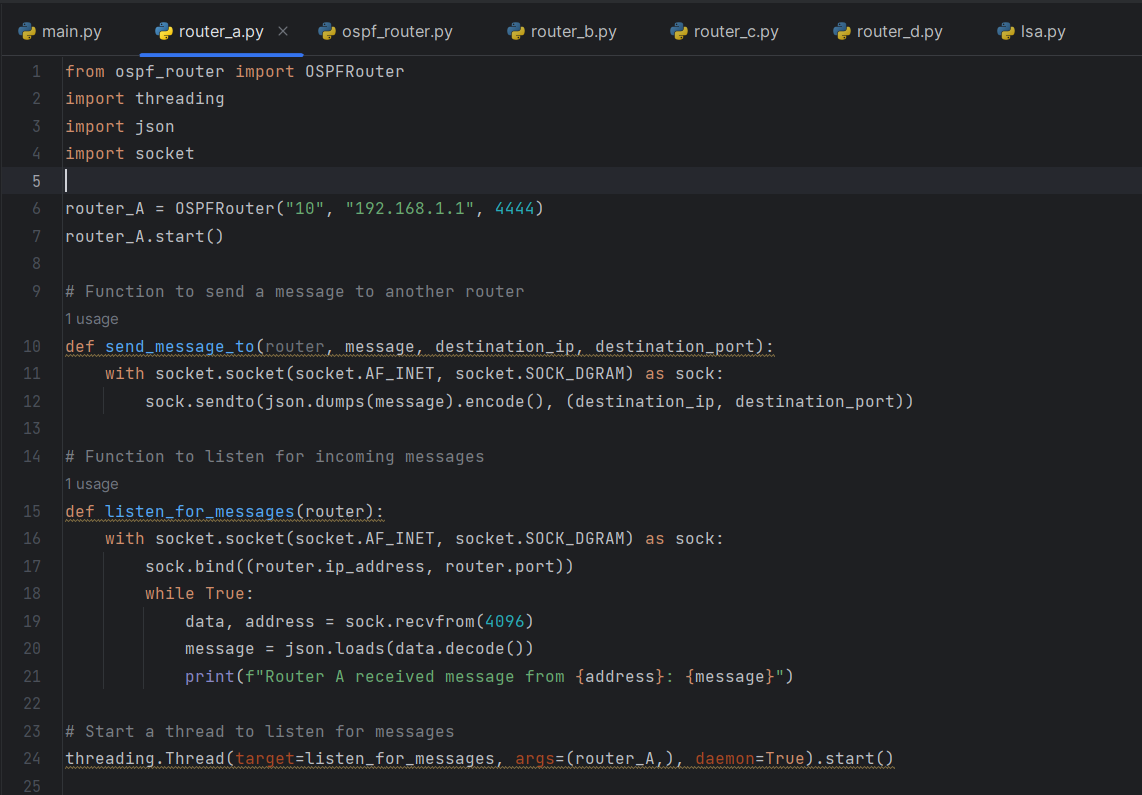
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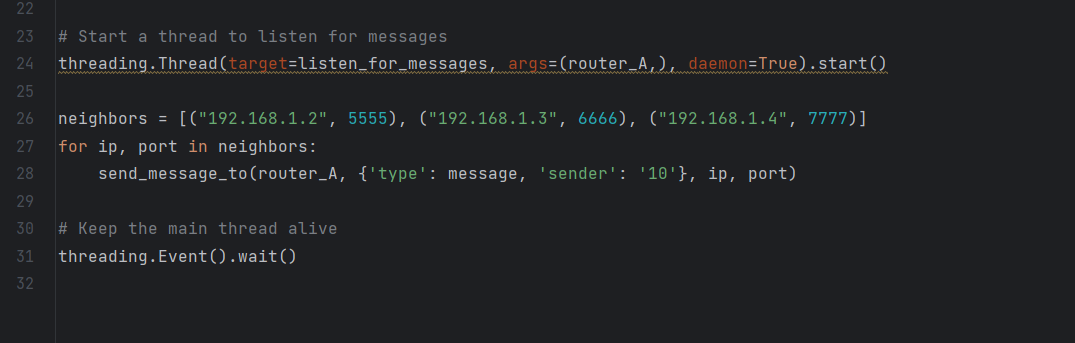
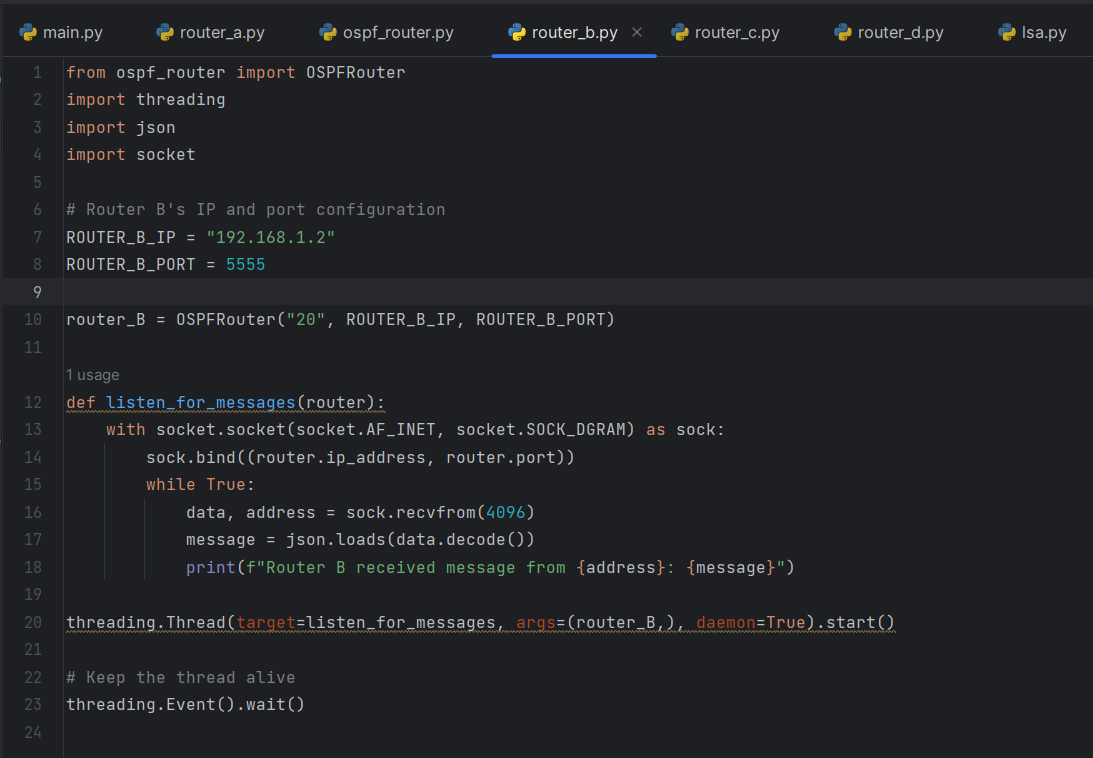
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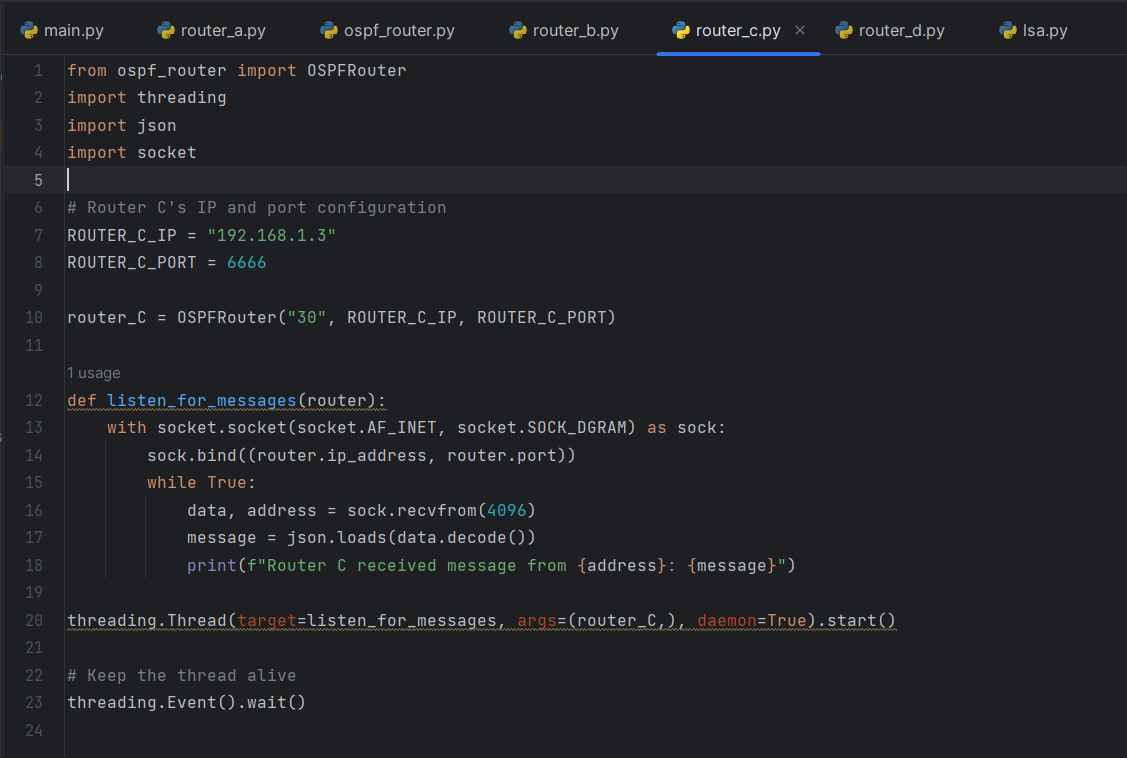
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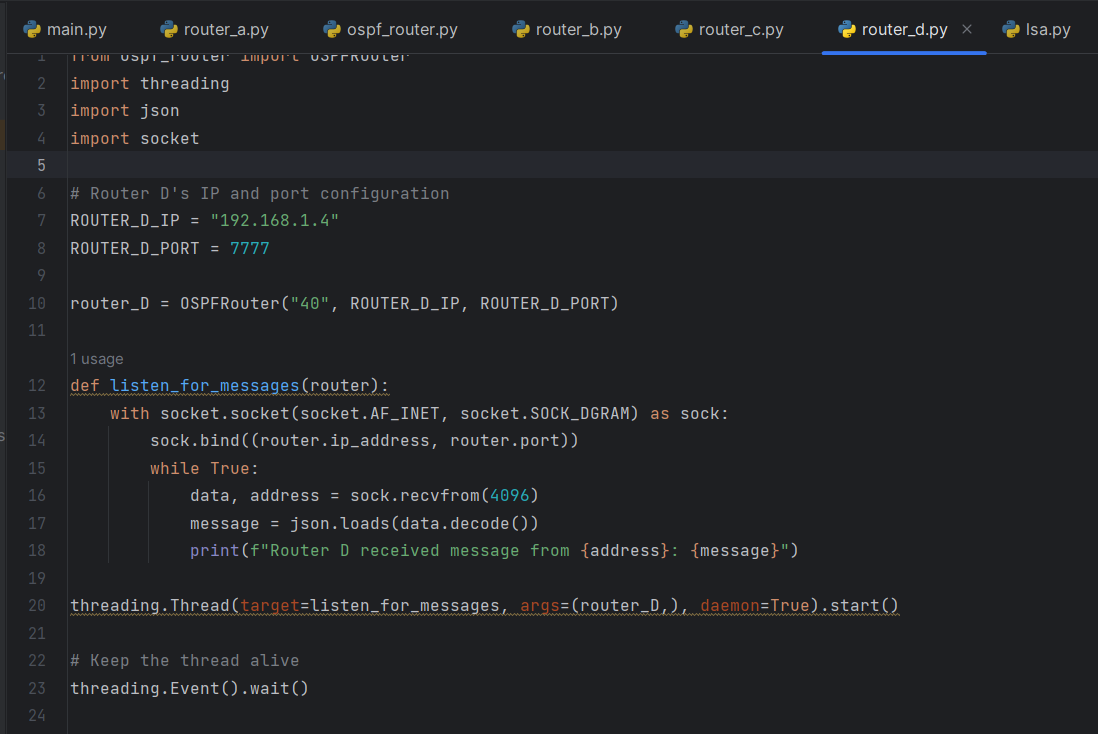
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