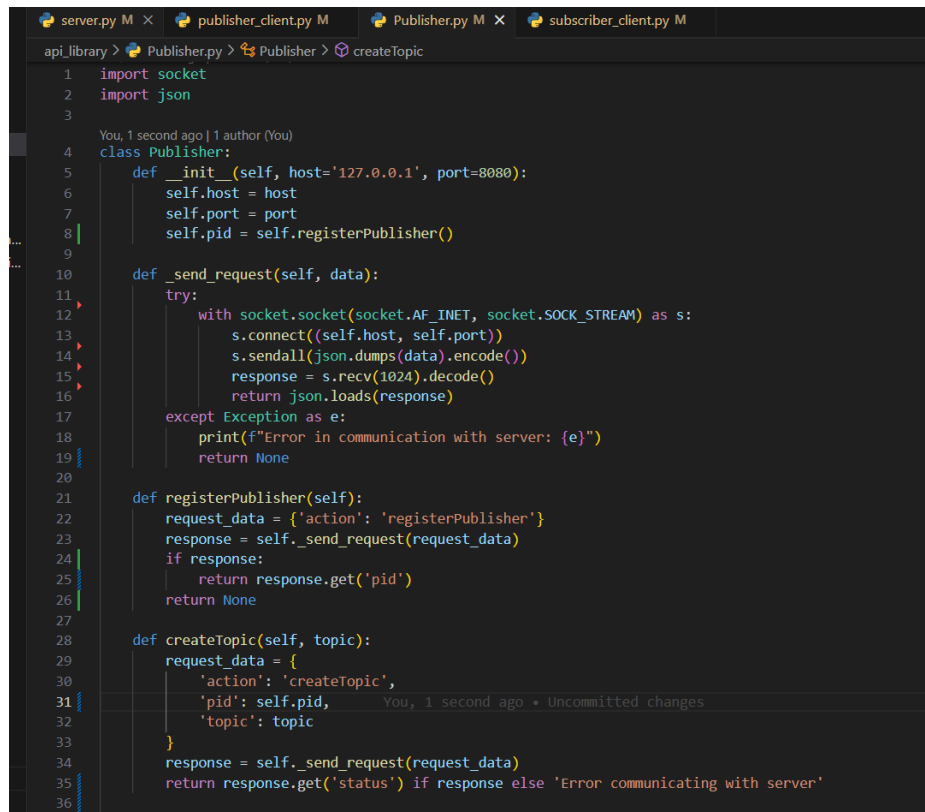


# ASSIGNMENT 1 DOCUMENTATION – KUNAL RAJPUT – A20540912

## PART 1 – Creating Publisher and Subscriber API Libraries:

### Publisher.py

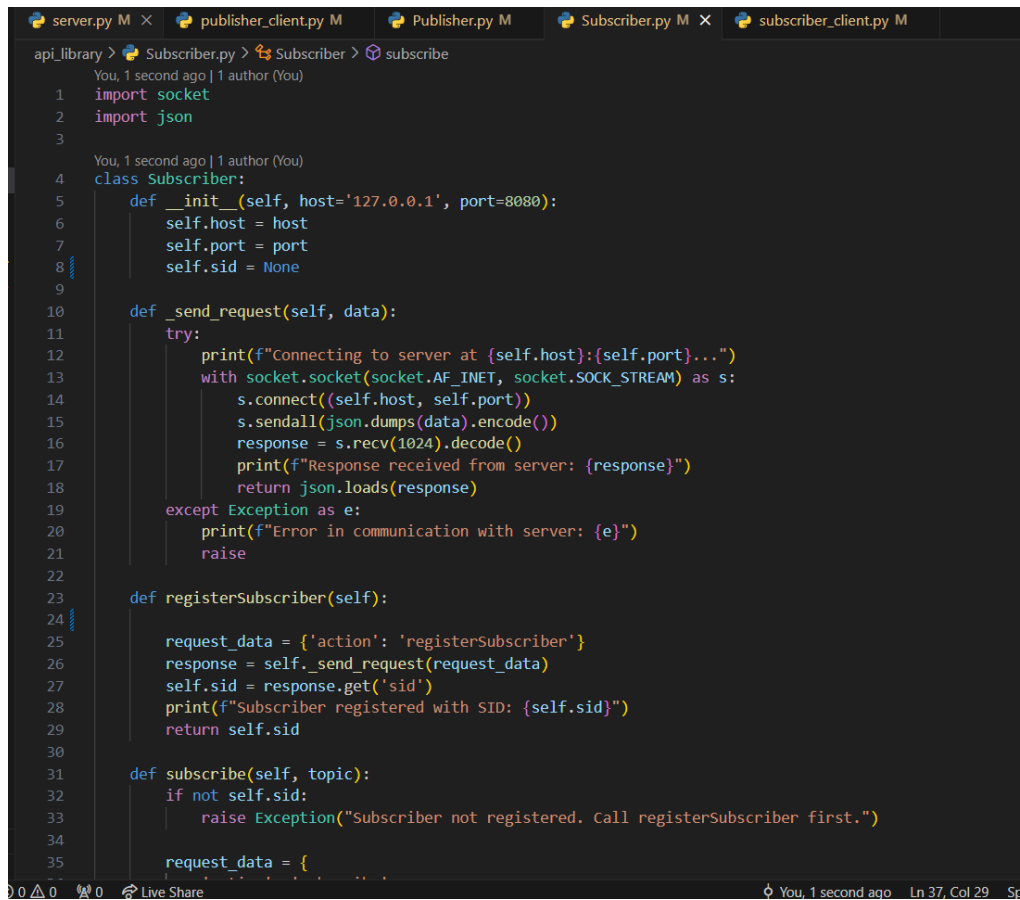


```
1 import socket
2 import json
3
4 class Publisher:
5     def __init__(self, host='127.0.0.1', port=8080):
6         self.host = host
7         self.port = port
8         self.pid = self.registerPublisher()
9
10    def _send_request(self, data):
11        try:
12            with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
13                s.connect((self.host, self.port))
14                s.sendall(json.dumps(data).encode())
15                response = s.recv(1024).decode()
16                return json.loads(response)
17        except Exception as e:
18            print(f"Error in communication with server: {e}")
19            return None
20
21    def registerPublisher(self):
22        request_data = {'action': 'registerPublisher'}
23        response = self._send_request(request_data)
24        if response:
25            return response.get('pid')
26        return None
27
28    def createTopic(self, topic):
29        request_data = {
30            'action': 'createTopic',
31            'pid': self.pid,
32            'topic': topic
33        }
34        response = self._send_request(request_data)
35        return response.get('status') if response else 'Error communicating with server'
```

### Publisher Functions

- **registerPublisher():**
  - This function registers a client as a publisher and returns a unique PID (Publisher ID). This ID will be used to identify the publisher in further operations.
- **createTopic(PID, String topic):**
  - The publisher creates a new topic using its PID. Think of a topic as a channel for distributing messages (e.g., "Sports", "News").
- **deleteTopic(PID, String topic):**
  - The publisher can delete a topic it created, preventing further messages from being published to that topic.
- **send(PID, String topic, String message):**
  - This function sends a message from the publisher (PID) to all subscribers of the specified topic.

## Subscriber.py



```
api_library > Subscriber.py > Subscriber > subscribe
You, 1 second ago | 1 author (You)
1 import socket
2 import json
3
4 class Subscriber:
5     def __init__(self, host='127.0.0.1', port=8080):
6         self.host = host
7         self.port = port
8         self.sid = None
9
10    def _send_request(self, data):
11        try:
12            print(f"Connecting to server at {self.host}:{self.port}...")
13            with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
14                s.connect((self.host, self.port))
15                s.sendall(json.dumps(data).encode())
16                response = s.recv(1024).decode()
17                print(f"Response received from server: {response}")
18                return json.loads(response)
19        except Exception as e:
20            print(f"Error in communication with server: {e}")
21            raise
22
23    def registerSubscriber(self):
24
25        request_data = {'action': 'registerSubscriber'}
26        response = self._send_request(request_data)
27        self.sid = response.get('sid')
28        print(f"Subscriber registered with SID: {self.sid}")
29        return self.sid
30
31    def subscribe(self, topic):
32        if not self.sid:
33            raise Exception("Subscriber not registered. Call registerSubscriber first.")
34
35        request_data = {
```

## Subscriber Functions

- **registerSubscriber():**
  - Registers a client as a subscriber and returns a unique SID (Subscriber ID). This ID is used to interact with topics and receive messages.
- **subscribe(SID, String topic):**
  - Subscribes the client to a specific topic. The subscriber will be able to pull messages from that topic after subscription.
- **pull(SID, String topic):**
  - Allows a subscriber to retrieve new messages from a topic. Only new, unread messages are returned, not the entire history. Once the message is pulled, it's removed from the buffer for that subscriber.

## Part 2 – Creating the Server (Message Broker):

```
server.py M X
server.py > handle_client_connection
You, 3 minutes ago | 1 author (You)
1 import socket
2 import threading
3 import json
4
5 # Data structures to hold publishers, subscribers, topics, and messages
6 publishers = {}
7 subscribers = {}
8 topics = {}
9 topic_messages = {}
10 message_locks = threading.Lock()
11 subscriber_views = {} # Track how many subscribers have pulled messages for each topic
12
13 def handle_client_connection(client_socket):
14     request = client_socket.recv(1024).decode()
15     request_data = json.loads(request)
16     action = request_data.get('action')
17
18     if action == 'registerPublisher':
19         pid = len(publishers) + 1
20         publishers[pid] = client_socket.getpeername()
21         response = {'pid': pid}
22         client_socket.sendall(json.dumps(response).encode())
23
24     elif action == 'registerSubscriber':
25         sid = len(subscribers) + 1
26         subscribers[sid] = {'address': client_socket.getpeername(), 'subscriptions': set()}
27         response = {'sid': sid}
28         client_socket.sendall(json.dumps(response).encode())
29
30     elif action == 'createTopic':
31         pid = request_data.get('pid')
32         topic = request_data.get('topic')
33         if topic not in topics:
34             topics[topic] = pid
35             topic_messages[topic] = []
36             subscriber_views[topic] = 0 # Initialize views count for the topic
```

The **server** manages all the topics and messages. It has the following responsibilities:

- **Handling Client Connections:** Accepts connections from both publishers and subscribers.
- **Message Buffers:** For each topic, it stores messages until all subscribers have pulled them. Once all subscribers read a message, it is garbage collected (deleted).
- **Routing Messages:** The server needs to ensure messages from a publisher get delivered to all subscribed clients.

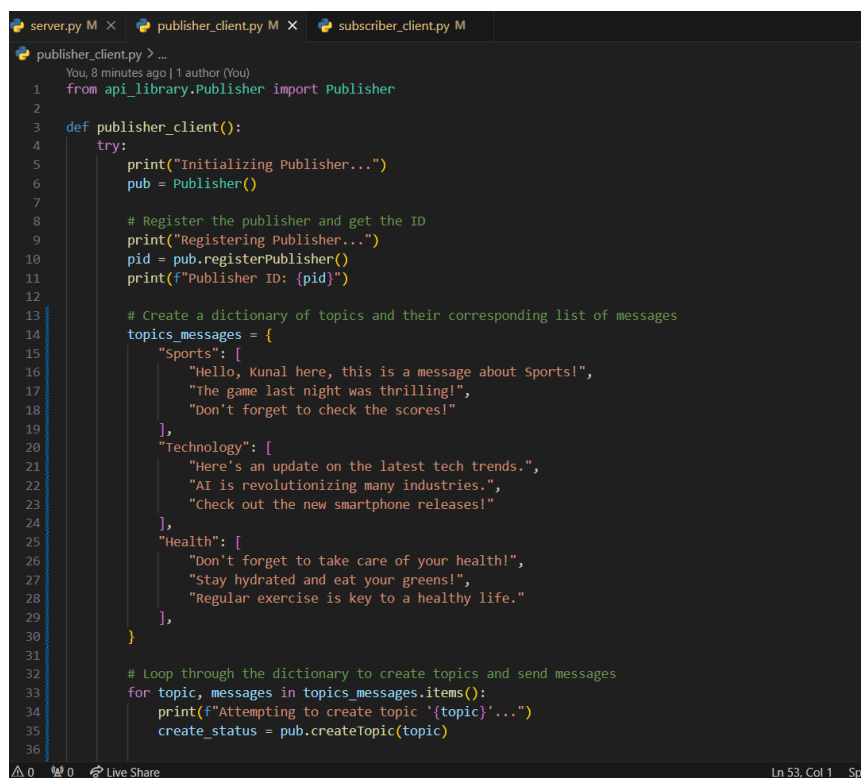
## PART 2 -

### EVALUATION PART 1

1. "Start by connecting one pair of publisher and subscriber to the server. Ensure you can perform all commands properly and both client and server can support its respective requirements aforementioned."

Creating a **publisher\_client** and **subscriber\_client** pair:

**publisher\_client.py** –

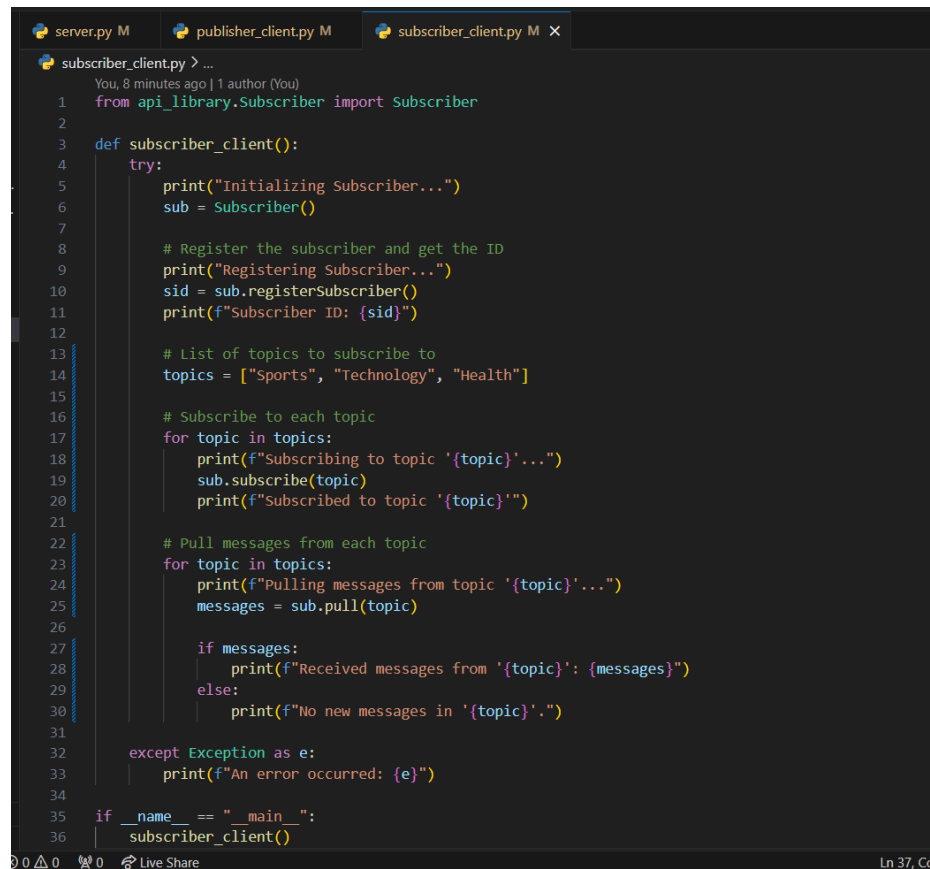


```
server.py M × publisher_client.py M × subscriber_client.py M
publisher_client.py > ...
You, 8 minutes ago | 1 author (You)
1 from api_library.Publisher import Publisher
2
3 def publisher_client():
4     try:
5         print("Initializing Publisher...")
6         pub = Publisher()
7
8         # Register the publisher and get the ID
9         print("Registering Publisher...")
10        pid = pub.registerPublisher()
11        print(f"Publisher ID: {pid}")
12
13        # Create a dictionary of topics and their corresponding list of messages
14        topics_messages = {
15            "Sports": [
16                "Hello, Kunal here, this is a message about Sports!",
17                "The game last night was thrilling!",
18                "Don't forget to check the scores!"
19            ],
20            "Technology": [
21                "Here's an update on the latest tech trends.",
22                "AI is revolutionizing many industries.",
23                "Check out the new smartphone releases!"
24            ],
25            "Health": [
26                "Don't forget to take care of your health!",
27                "Stay hydrated and eat your greens!",
28                "Regular exercise is key to a healthy life."
29            ],
30        }
31
32        # Loop through the dictionary to create topics and send messages
33        for topic, messages in topics_messages.items():
34            print(f"Attempting to create topic '{topic}'...")
35            create_status = pub.createTopic(topic)
36
Ln 53, Col 1 Sp
```

### **Key Components:**

1. **Initialization:** Creates an instance of the Publisher class.
2. **Registration:** Registers the publisher and retrieves its ID.
3. **Topics and Messages:** Defines a dictionary where each topic is associated with a list of messages.
4. **Loop Through Topics:** For each topic:
  - Creates the topic if it doesn't exist.
  - Sends all associated messages to the topic.

## subscriber\_client.py –

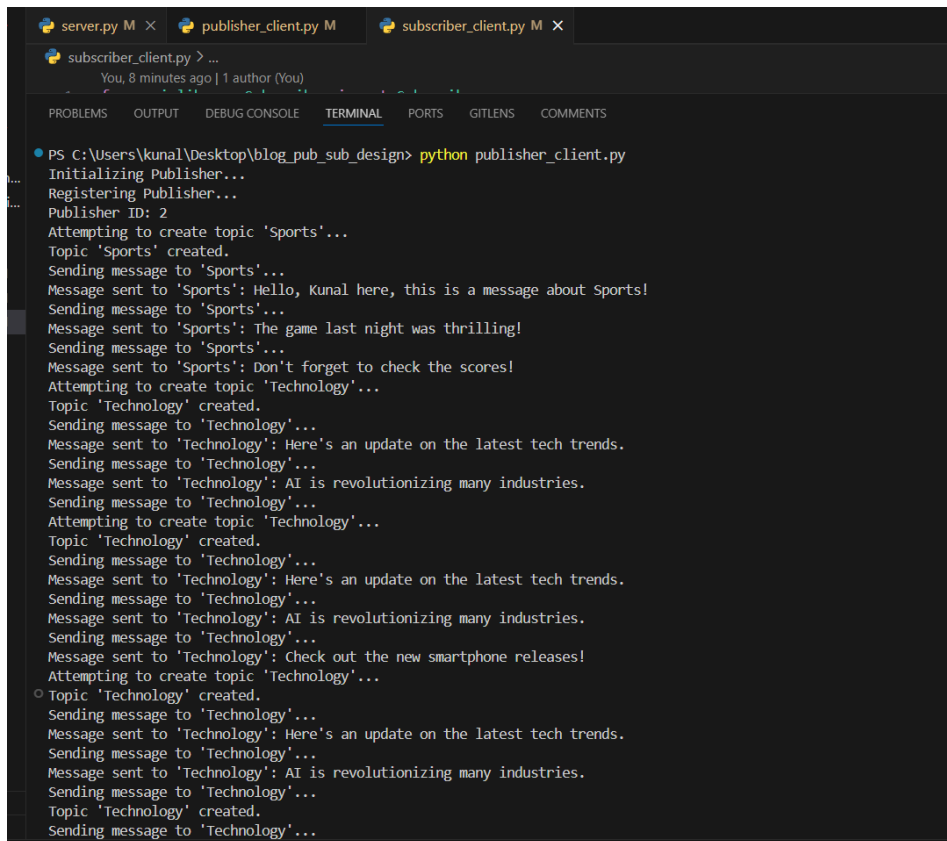


```
server.py M publisher_client.py M subscriber_client.py M X
subscriber_client.py > ...
You, 8 minutes ago | 1 author (You)
1 from api_library.Subscriber import Subscriber
2
3 def subscriber_client():
4     try:
5         print("Initializing Subscriber...")
6         sub = Subscriber()
7
8         # Register the subscriber and get the ID
9         print("Registering Subscriber...")
10        sid = sub.registerSubscriber()
11        print(f"Subscriber ID: {sid}")
12
13        # List of topics to subscribe to
14        topics = ["Sports", "Technology", "Health"]
15
16        # Subscribe to each topic
17        for topic in topics:
18            print(f"Subscribing to topic '{topic}'...")
19            sub.subscribe(topic)
20            print(f"Subscribed to topic '{topic}'")
21
22        # Pull messages from each topic
23        for topic in topics:
24            print(f"Pulling messages from topic '{topic}'...")
25            messages = sub.pull(topic)
26
27            if messages:
28                print(f"Received messages from '{topic}': {messages}")
29            else:
30                print(f"No new messages in '{topic}'.")
31
32        except Exception as e:
33            print(f"An error occurred: {e}")
34
35 if __name__ == "__main__":
36     subscriber_client()
```

### Key Components:

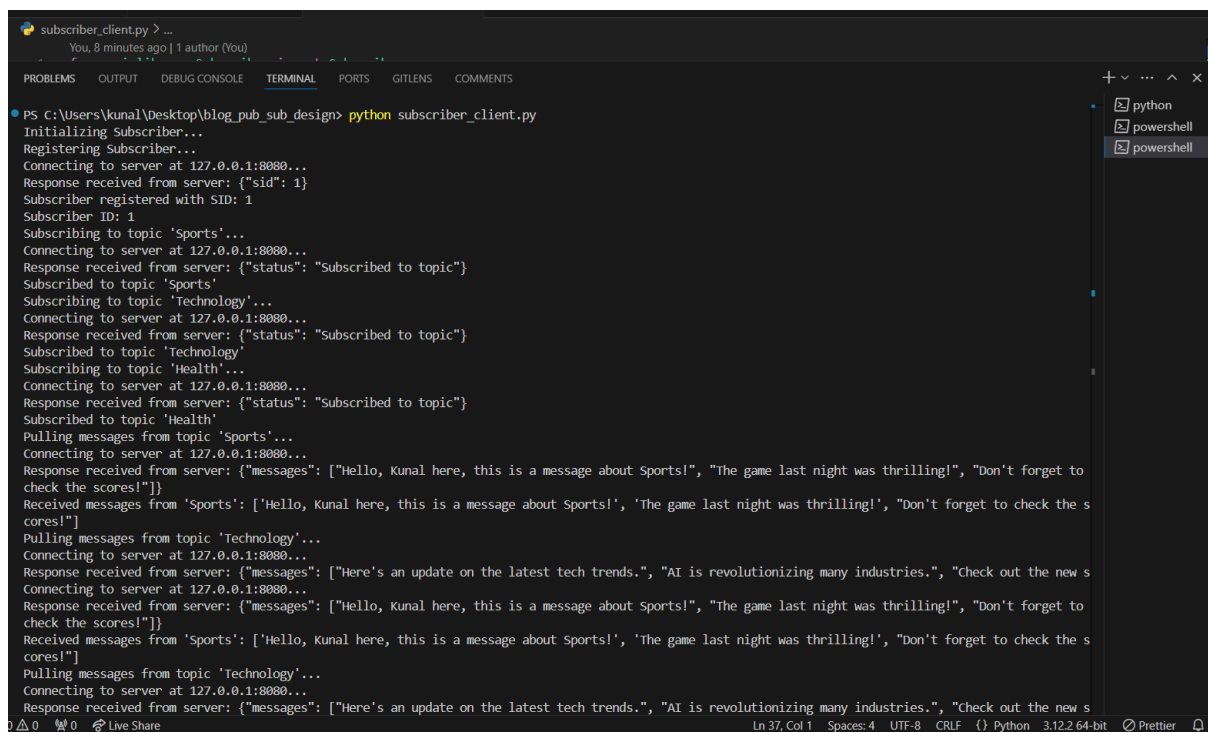
1. **Initialization:** Creates an instance of the Subscriber class.
2. **Registration:** Registers the subscriber and retrieves its ID.
3. **Topics List:** Defines a list of topics to subscribe to.
4. **Subscription Loop:** Subscribes to each topic in the list.
5. **Message Pulling Loop:** For each subscribed topic:
  - Pulls and displays messages.

Now, first we run the server. Once the server starts listening, we then run this publisher\_client.py file that registers a publisher, created 3 topics, and sends messages to all the topics on the server. These topics will be temporarily stored on the message buffer (currently the internal memory) until all the subscribers view the messages.



```
server.py M x publisher_client.py M subscriber_client.py M x
subscriber_client.py > ...
You, 8 minutes ago | 1 author (You)
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS GITLENS COMMENTS
• PS C:\Users\kunal\Desktop\blog_pub_sub_design> python publisher_client.py
Initializing Publisher...
Registering Publisher...
Publisher ID: 2
Attempting to create topic 'Sports'...
Topic 'Sports' created.
Sending message to 'Sports'...
Message sent to 'Sports': Hello, Kunal here, this is a message about Sports!
Sending message to 'Sports'...
Message sent to 'Sports': The game last night was thrilling!
Sending message to 'Sports'...
Message sent to 'Sports': Don't forget to check the scores!
Attempting to create topic 'Technology'...
Topic 'Technology' created.
Sending message to 'Technology'...
Message sent to 'Technology': Here's an update on the latest tech trends.
Sending message to 'Technology'...
Message sent to 'Technology': AI is revolutionizing many industries.
Sending message to 'Technology'...
Attempting to create topic 'Technology'...
Topic 'Technology' created.
Sending message to 'Technology'...
Message sent to 'Technology': Here's an update on the latest tech trends.
Sending message to 'Technology'...
Message sent to 'Technology': AI is revolutionizing many industries.
Sending message to 'Technology'...
Message sent to 'Technology': Check out the new smartphone releases!
Attempting to create topic 'Technology'...
Topic 'Technology' created.
Sending message to 'Technology'...
Message sent to 'Technology': Here's an update on the latest tech trends.
Sending message to 'Technology'...
Message sent to 'Technology': AI is revolutionizing many industries.
Sending message to 'Technology'...
Topic 'Technology' created.
Sending message to 'Technology'...
```

Once we call the publisher client api, we then run the subscriber\_client.py on another terminal where we subscribe to these topics and pull these messages as demonstrated below:



```
subscriber_client.py > ...
You, 8 minutes ago | 1 author (You)
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS GITLENS COMMENTS
• PS C:\Users\kunal\Desktop\blog_pub_sub_design> python subscriber_client.py
Initializing Subscriber...
Registering Subscriber...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"sid": 1}
Subscriber registered with SID: 1
Subscriber ID: 1
Subscribing to topic 'Sports'...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"status": "Subscribed to topic"}
Subscribed to topic 'Sports'
Subscribing to topic 'Technology'...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"status": "Subscribed to topic"}
Subscribed to topic 'Technology'
Subscribing to topic 'Health'...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"status": "Subscribed to topic"}
Subscribed to topic 'Health'
Pulling messages from topic 'Sports'...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"messages": ["Hello, Kunal here, this is a message about Sports!", "The game last night was thrilling!", "Don't forget to check the scores!"]}
Received messages from 'Sports': ['Hello, Kunal here, this is a message about Sports!', 'The game last night was thrilling!', "Don't forget to check the s
cores!"]
Pulling messages from topic 'Technology'...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"messages": ["Here's an update on the latest tech trends.", "AI is revolutionizing many industries.", "Check out the new s
"]}
Connecting to server at 127.0.0.1:8080...
Response received from server: {"messages": ["Hello, Kunal here, this is a message about Sports!", "The game last night was thrilling!", "Don't forget to check the s
cores!"]}
Received messages from 'Sports': ['Hello, Kunal here, this is a message about Sports!', 'The game last night was thrilling!', "Don't forget to check the s
cores!"]
Pulling messages from topic 'Technology'...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"messages": ["Here's an update on the latest tech trends.", "AI is revolutionizing many industries.", "Check out the new s
"]}
Ln 37, Col 1 Spaces: 4 UTF-8 CRLF {} Python 3.12.2 64-bit Prettier
```

So, now so far, we have 4 API calls implemented –

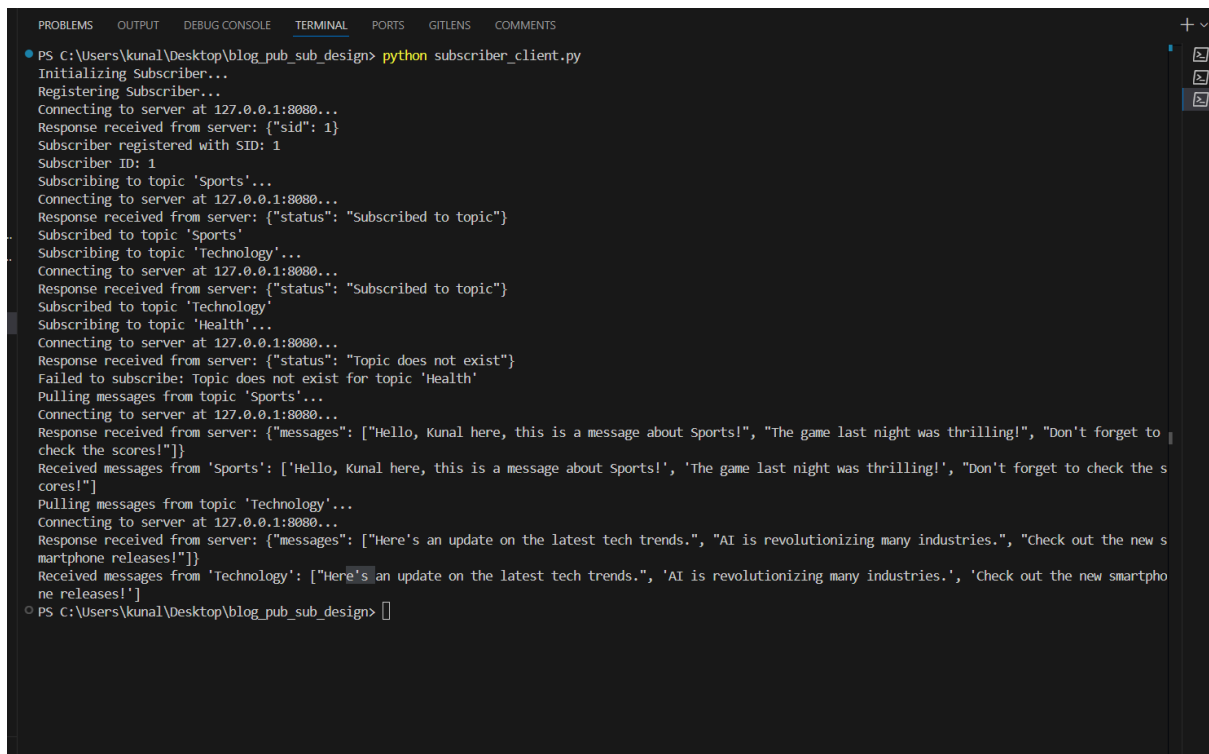
- **createTopic()**
- **send()**
- **subscribe()**
- **pull()**

Now let's check for the 5<sup>th</sup>, **deleteTopic()** api call, this should be simple.

Now when we run the publisher\_client.py file and here we deleted “Health” -

We get –

And now after deleting the topic from topics list by the Publisher, and when we try to subscribe it, our code successfully displays “Failed to subscribe: Topic does not exist for exist”:



```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS GIT LENS COMMENTS
PS C:\Users\kunal\Desktop\blog_pub_sub_design> python subscriber_client.py
Initializing Subscriber...
Registering Subscriber...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"sid": 1}
Subscriber registered with SID: 1
Subscriber ID: 1
Subscribing to topic 'Sports'...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"status": "Subscribed to topic"}
Subscribed to topic 'Sports'
Subscribing to topic 'Technology'...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"status": "Subscribed to topic"}
Subscribed to topic 'Technology'
Subscribing to topic 'Health'...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"status": "Topic does not exist"}
Failed to subscribe: Topic does not exist for topic 'Health'
Pulling messages from topic 'Sports'...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"messages": ["Hello, Kunal here, this is a message about Sports!", "The game last night was thrilling!", "Don't forget to check the scores!"]}
Received messages from 'Sports': ['Hello, Kunal here, this is a message about Sports!', 'The game last night was thrilling!', "Don't forget to check the scores!"]
Pulling messages from topic 'Technology'...
Connecting to server at 127.0.0.1:8080...
Response received from server: {"messages": ["Here's an update on the latest tech trends.", "AI is revolutionizing many industries.", "Check out the new smartphone releases!"]}
Received messages from 'Technology': ["Here's an update on the latest tech trends.", 'AI is revolutionizing many industries.', 'Check out the new smartphone releases!']
PS C:\Users\kunal\Desktop\blog_pub_sub_design>
```

**SO NOW WE HAVE SUCCESSFULLY IMPLEMENTED ALL 5 APIs WITH ALL THE APPROPRIATE CONDITIONS.**

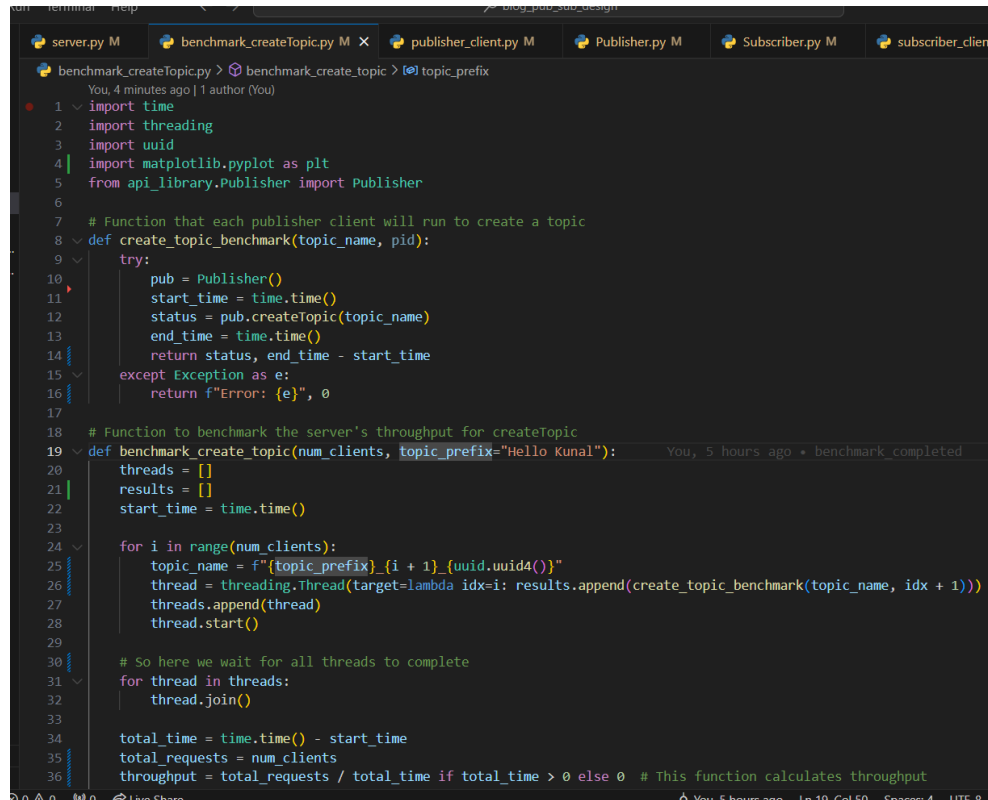


## EVALUATION PART 2

2. Starting with one client program, use it to benchmark server's throughput for createTopic(...). Keep increasing the number of client programs until you find the maximum throughput. **ALONG WITH MANUAL PAGES FOR ALL THE APIS**

1) createTopic() api.

First, we create the "benchmark\_createTopic.py" code:



```
1 import time
2 import threading
3 import uuid
4 import matplotlib.pyplot as plt
5 from api_library.Publisher import Publisher
6
7 # Function that each publisher client will run to create a topic
8 def create_topic_benchmark(topic_name, pid):
9     try:
10         pub = Publisher()
11         start_time = time.time()
12         status = pub.createTopic(topic_name)
13         end_time = time.time()
14         return status, end_time - start_time
15     except Exception as e:
16         return f"Error: {e}", 0
17
18 # Function to benchmark the server's throughput for createTopic
19 def benchmark_create_topic(num_clients, topic_prefix="Hello Kunal"):
20     threads = []
21     results = []
22     start_time = time.time()
23
24     for i in range(num_clients):
25         topic_name = f"{topic_prefix}_{i + 1}_{uuid.uuid4()}"
26         thread = threading.Thread(target=lambda idx=i: results.append(create_topic_benchmark(topic_name, idx + 1)))
27         threads.append(thread)
28         thread.start()
29
30     # So here we wait for all threads to complete
31     for thread in threads:
32         thread.join()
33
34     total_time = time.time() - start_time
35     total_requests = num_clients
36     throughput = total_requests / total_time if total_time > 0 else 0 # This function calculates throughput
```

Description of the code:

**Setup:** The code imports necessary libraries, including threading for concurrent execution, time for measuring durations, uuid for generating unique topic names, and matplotlib for plotting the results.

**Creating Topics:** It defines a function (create\_topic\_benchmark) that simulates a publisher client creating a topic on a server. This function measures the time taken to create the topic and returns the result along with the time elapsed.

**Benchmarking Throughput:** The main benchmarking function (benchmark\_create\_topic):

- Initializes a set number of threads (clients) to create topics concurrently.
- Each thread calls the topic creation function, collects the results, and measures the total time taken for all threads to complete.
- It calculates the throughput (number of topics created per second) based on the total time taken and the number of clients.

**Progressive Testing:** The code progressively increases the number of clients (from 1 to 1000, doubling each time) to evaluate how the server handles different loads.

**Output Results:** After each run, it prints a summary of the benchmark results, including total time taken, average time per client, throughput, and the number of successful topic creations.

**Visualization:** Finally, it plots a graph showing the relationship between the number of clients and the throughput to visualize how performance changes with increasing load.

Here's the output:

```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS GITLENS COMMENTS

Benchmark completed with 16 clients.
Total time for 16 clients to create topics: 0.5117 seconds
Average time per client: 0.0320 seconds
Maximum throughput: 31.27 topics/second
Successful topic creations: 16/16

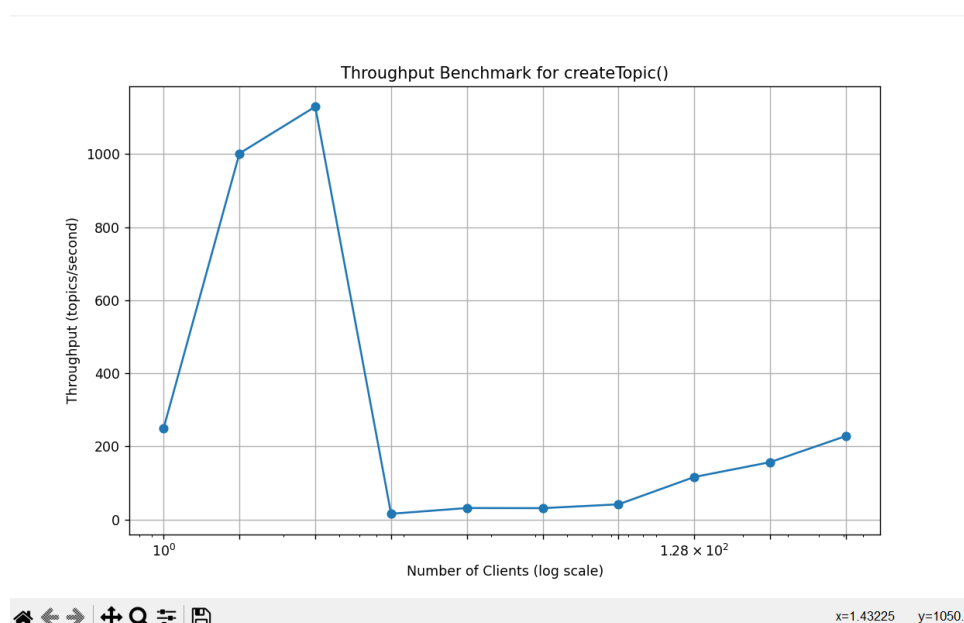
Benchmark completed with 32 clients.
Total time for 32 clients to create topics: 1.0334 seconds
Average time per client: 0.0323 seconds
Maximum throughput: 30.97 topics/second
Successful topic creations: 32/32

Benchmark completed with 64 clients.
Total time for 64 clients to create topics: 1.5457 seconds
Average time per client: 0.0242 seconds
Maximum throughput: 41.41 topics/second
Successful topic creations: 64/64

Benchmark completed with 128 clients.
Total time for 128 clients to create topics: 1.1013 seconds
Average time per client: 0.0086 seconds
Maximum throughput: 116.23 topics/second
Successful topic creations: 128/128

Benchmark completed with 256 clients.
Total time for 256 clients to create topics: 1.6326 seconds
Average time per client: 0.0064 seconds
Maximum throughput: 156.81 topics/second
Successful topic creations: 256/256

Benchmark completed with 512 clients.
Total time for 512 clients to create topics: 2.2421 seconds
Average time per client: 0.0044 seconds
Maximum throughput: 228.35 topics/second
Successful topic creations: 512/512
```



Repeating Step 2 for all the other APIs:

## 2) deleteTopic() api.

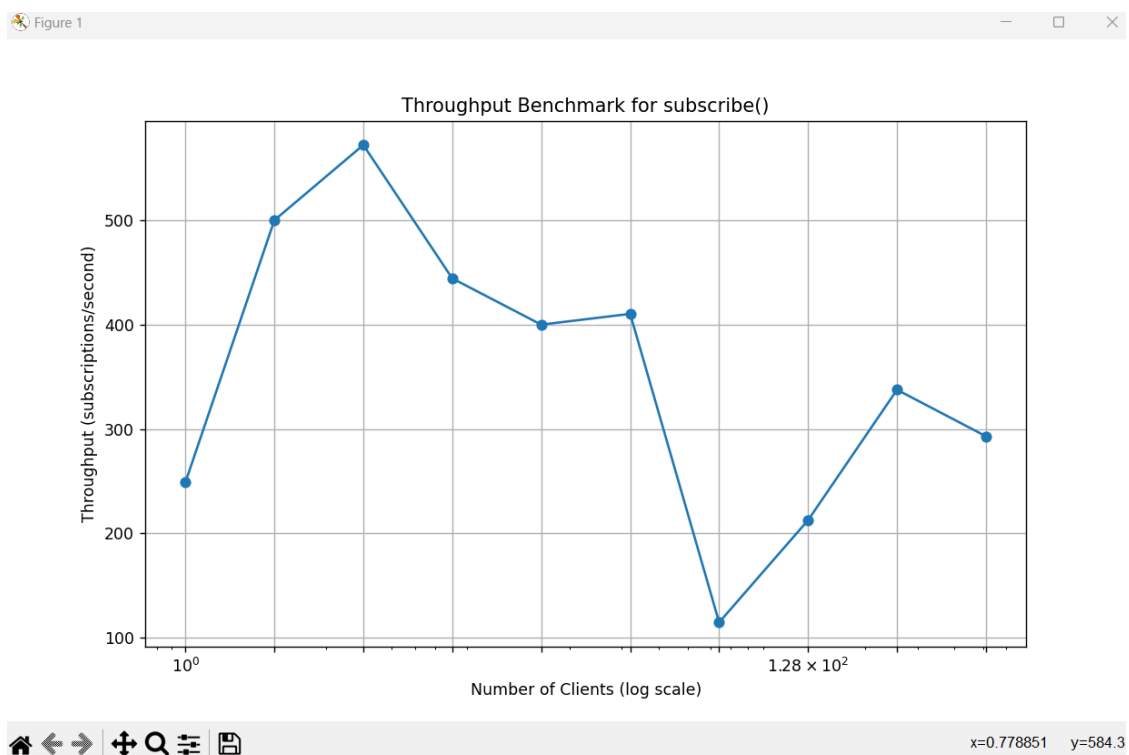
After successfully creating all the topics, and concurrently deleting them, my server started crashing for few of the test cases. Here is the output with throughput. And the chart.

```
server.py  benchmark_createTopic.py  benchmark_subscribe.py  benchmark_send.py  benchmark_deleteTopic.py M X
benchmark_deleteTopic.py > ...
You, 2 seconds ago | 1 author (You)
1 import time
2 import threading
3 from api_library.Publisher import Publisher
4 import matplotlib.pyplot as plt
5
6 # Function to create a topic once
7 def create_topic_benchmark(topic_name):
8     try:
9         # ...
10
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```

### 3) benchmark subscribe.py:

```
server.py  benchmark_createTopic.py  benchmark_subscribe.py M X  benchmark_send.py  benchmark_delete

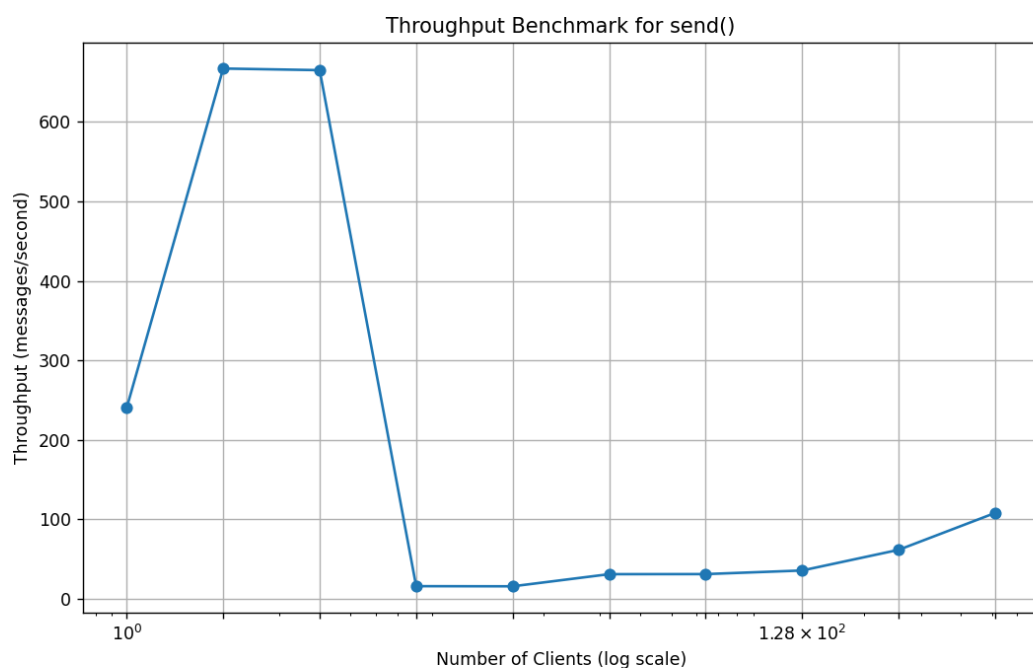
benchmark_subscribe.py > subscribe_benchmark
You, 1 second ago | 1 author (You)
1 import time
2 import threading
3 from api_library.Publisher import Publisher
4 from api_library.Subscriber import Subscriber
5 import matplotlib.pyplot as plt
6
7 def create_topic_benchmark(topic_name):
8     try:
9         pub = Publisher()
10        pub.registerPublisher()
11        start_time = time.time()
12        status = pub.createTopic(topic_name)
13        end_time = time.time()
14        print(f"Topic '{topic_name}' created in {end_time - start_time:.4f} seconds")
15        return status, end_time - start_time
16    except Exception as e:
17        print(f"Error creating topic: {e}")
18        return f"Error: {e}", 0
19
20 def subscribe_benchmark(topic_name, sid):
21     try:
22         sub = Subscriber()
23         sub.registerSubscriber()
24         start_time = time.time()
25         status = sub.subscribe(topic_name)
26         end_time = time.time()
27         return status, end_time - start_time
28    except Exception as e:
29        return f"Error: {e}", 0
30
31 def benchmark_subscribe(num_clients, topic_name="Hello Kunal"):
32
33
34     create_status, _ = create_topic_benchmark(topic_name)
35     if "Error" in create_status:
36         print("Error creating the topic. Aborting benchmark.")
```



#### 4) benchmark send():

Here we create the topic once, and then send multiple messages on the same topic to test the benchmark.

```
server.py benchmark_createTopic.py benchmark_subscribe.py M benchmark_send.py M X benchmark_deleteTopic.py
benchmark_send.py > ...
You, 2 minutes ago | 1 author (You)
1 import time
2 import threading
3 import uuid
4 from api_library.Publisher import Publisher
5 import matplotlib.pyplot as plt
6
7
8 def create_topic_once(topic_name):
9     try:
10         pub = Publisher()
11         pub.registerPublisher()
12         start_time = time.time()
13         status = pub.createTopic(topic_name)
14         end_time = time.time()
15         print(f"Topic '{topic_name}' created in {end_time - start_time:.4f} seconds")
16         return status, end_time - start_time
17     except Exception as e:
18         print(f"Error creating topic: {e}")
19         return f"Error: {e}", 0
20
21 def send_benchmark(topic_name, message, pid):
22     try:
23         pub = Publisher()
24         pub.registerPublisher()
25         start_time = time.time()
26         status = pub.send(topic_name, message)
27         end_time = time.time()
28         return status, end_time - start_time
29     except Exception as e:
30         return f"Error: {e}", 0
31
32 def benchmark_send(num_clients, topic_name="Hello Kunal"):
33     create_status, _ = create_topic_once(topic_name)
34     if "Error" in create_status:
35         print("Error creating the topic. Aborting benchmark.")
```



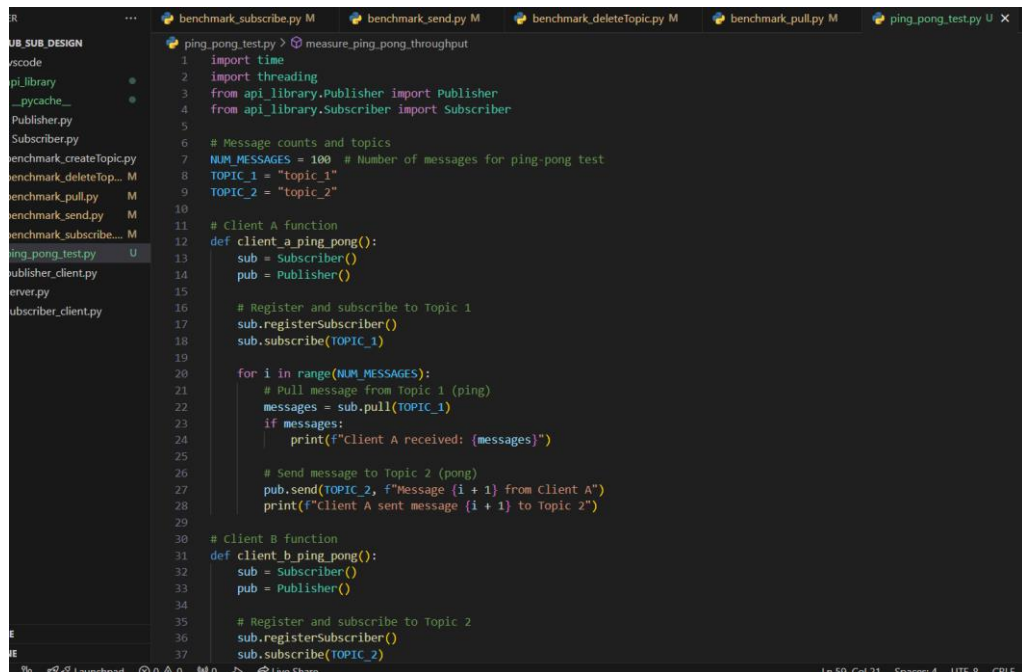
## 5) benchmark\_pull()

```
benchmark_createTopic.py  benchmark_subscribe.py M  benchmark_send.py M  benchmark_deleteTopic.py M  benchmark_pull.py
You, 53 seconds ago | 1 author (You)
1  import time
2  import threading
3  from api_library.Subscriber import Subscriber
4  import matplotlib as plt
5
6  def pull_benchmark(topic_name, sid):
7      try:
8          sub = Subscriber()
9          sub.registerSubscriber()
10         start_time = time.time()
11         messages = sub.pull(topic_name)
12         end_time = time.time()
13         return messages, end_time - start_time
14     except Exception as e:
15         return f"Error: {e}", 0
16
17  def benchmark_pull(num_clients, topic_name="Hello Kunal"):
18      threads = []
19      results = []
20      start_time = time.time()
21
22      for i in range(num_clients):
23          thread = threading.Thread(target=lambda idx=i: results.append(pull_benchmark(topic_name, idx + 1)))
24          threads.append(thread)
25          thread.start()
26
27      for thread in threads:
28          thread.join()
29
30      total_time = time.time() - start_time
31      total_requests = num_clients
32      throughput = total_requests / total_time if total_time > 0 else 0
33
34      success_count = sum(1 for result in results if "Error" not in result[0])
35      print(f"\nBenchmark completed with {num_clients} clients.")
36      print(f"Total time for {num_clients} clients to pull messages: {total_time:.4f} seconds")
```

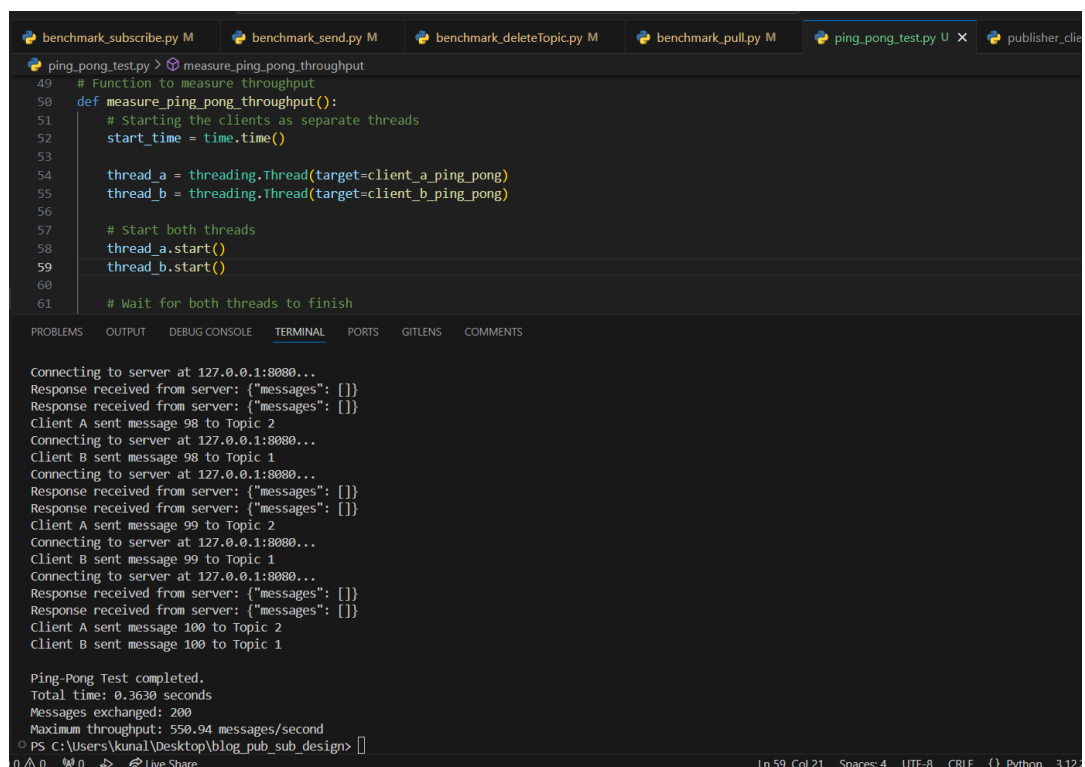
Live Share You, 26 minutes ago • update 3 Ln 24, Col 31 Spaces: 4 UTF-8

## PING PONG TEST FILE:

Here we got throughput of 550 messages/second.



```
1 import time
2 import threading
3 from api_library.Publisher import Publisher
4 from api_library.Subscriber import Subscriber
5
6 # Message counts and topics
7 NUM_MESSAGES = 100 # Number of messages for ping-pong test
8 TOPIC_1 = "topic_1"
9 TOPIC_2 = "topic_2"
10
11 # Client A function
12 def client_a_ping_pong():
13     sub = Subscriber()
14     pub = Publisher()
15
16     # Register and subscribe to Topic 1
17     sub.registerSubscriber()
18     sub.subscribe(TOPIC_1)
19
20     for i in range(NUM_MESSAGES):
21         # Pull message from Topic 1 (ping)
22         messages = sub.pull(TOPIC_1)
23         if messages:
24             print(f"Client A received: {messages}")
25
26         # Send message to Topic 2 (pong)
27         pub.send(TOPIC_2, f"Message {i + 1} from Client A")
28         print(f"Client A sent message {i + 1} to Topic 2")
29
30 # Client B function
31 def client_b_ping_pong():
32     sub = Subscriber()
33     pub = Publisher()
34
35     # Register and subscribe to Topic 2
36     sub.registerSubscriber()
37     sub.subscribe(TOPIC_2)
```



```
49 # Function to measure throughput
50 def measure_ping_pong_throughput():
51     # Starting the clients as separate threads
52     start_time = time.time()
53
54     thread_a = threading.Thread(target=client_a_ping_pong)
55     thread_b = threading.Thread(target=client_b_ping_pong)
56
57     # Start both threads
58     thread_a.start()
59     thread_b.start()
60
61     # Wait for both threads to finish
```

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS GITLENS COMMENTS

Connecting to server at 127.0.0.1:8080...  
Response received from server: {"messages": []}  
Client A sent message 98 to Topic 2  
Connecting to server at 127.0.0.1:8080...  
Client B sent message 98 to Topic 1  
Connecting to server at 127.0.0.1:8080...  
Response received from server: {"messages": []}  
Response received from server: {"messages": []}  
Client A sent message 99 to Topic 2  
Connecting to server at 127.0.0.1:8080...  
Client B sent message 99 to Topic 1  
Connecting to server at 127.0.0.1:8080...  
Response received from server: {"messages": []}  
Response received from server: {"messages": []}  
Client A sent message 100 to Topic 2  
Client B sent message 100 to Topic 1

Ping-Pong Test completed.  
Total time: 0.3630 seconds  
Messages exchanged: 200  
Maximum throughput: 550.94 messages/second

PS C:\Users\kunal\Desktop\blog\_pub\_sub\_design>

# DETAILED DESIGN OF THE CODE

## 1. Purpose of the Code

The main purpose of this code is to implement and test a **Publisher-Subscriber** system in which:

- **Publishers** can create topics and send messages to those topics.
- **Subscribers** can subscribe to topics and receive messages from those topics.

The goal of this system is to facilitate message exchange between multiple clients, where one or more publishers can publish messages to specific topics, and multiple subscribers can subscribe to these topics and receive the published messages.

## 2. Publisher and Subscriber Interaction

This system follows the **Publish-Subscribe Model**, where:

- A **Publisher** creates a topic and sends messages to that topic.
- A **Subscriber** subscribes to a topic to receive messages from it.

## 3. Publisher Class Overview

The Publisher class is responsible for allowing a client to register as a publisher, create topics, and send messages to those topics.

### Key Methods of the Publisher Class:

1. **registerPublisher():**
  - Registers the client as a publisher with the server.
  - The client must be registered as a publisher before interacting with any topics (i.e., creating topics or sending messages).
2. **createTopic(topic\_name):**
  - Creates a new topic with the given topic\_name.
  - After creation, publishers can send messages to this topic.
  - This step ensures that a valid topic exists before sending any messages.
3. **send(topic\_name, message):**
  - Sends a message to the specified topic\_name.
  - All subscribers that are subscribed to this topic will receive the message.



## **4. Subscriber Class Overview**

The Subscriber class is responsible for registering a client as a subscriber and subscribing to topics in order to receive messages.

### **Key Methods of the Subscriber Class:**

1. **registerSubscriber():**
  - Registers the client as a subscriber with the server.
  - The client must be registered as a subscriber before subscribing to topics.
2. **subscribe(topic\_name):**
  - Subscribes the client to a specified topic\_name.
  - Once subscribed, the client can receive messages published to this topic.

## **5. Server Interaction**

The Publisher and Subscriber classes interact with the server using APIs like:

- **registerPublisher():** Registers a publisher with the server.
- **registerSubscriber():** Registers a subscriber with the server.
- **createTopic(topic\_name):** Instructs the server to create a new topic.
- **send(topic\_name, message):** Sends a message to a specific topic on the server.
- **subscribe(topic\_name):** Informs the server that the client wants to subscribe to a specific topic.

### **Server Architecture:**

The server must maintain:

- **A list of topics:** Each topic is associated with a list of subscribers.
- **Message buffers:** For each topic, the server can store messages that can be distributed to the subscribers.

When a message is sent to a topic:

- The server places the message in the message queue for that topic.
- The message is delivered to all clients that are subscribed to that topic.

## **6. Message Flow in the Publish-Subscribe System**

Let's break down the flow of how messages are published and subscribed to in this system:

1. **Publisher Workflow:**
  - The publisher first registers itself using registerPublisher().

- It creates a topic using `createTopic()`.
- The publisher then sends messages to that topic using `send()`.
- 2. **Subscriber Workflow:**
  - The subscriber registers itself using `registerSubscriber()`.
  - The subscriber subscribes to a topic using `subscribe()`.
  - Once subscribed, the subscriber can receive any message published to that topic.
- 3. **Message Distribution:**
  - The server manages the topics and subscribers.
  - When a message is sent to a topic, the server pushes the message to all the subscribers that are registered to the topic.

## **7. Multithreading for Simultaneous Clients**

To simulate multiple clients publishing or subscribing to a topic simultaneously, the code uses **threads**.

- **Threading** allows multiple clients (publishers or subscribers) to perform actions (e.g., sending messages or subscribing to a topic) concurrently.
- This is important when benchmarking performance, as it allows us to simulate a real-world scenario where multiple clients are interacting with the server at the same time.

## **8. Threading Example**

In the benchmarking code, multiple threads are created using the `threading.Thread` class, and each thread simulates a client (either publisher or subscriber) interacting with the server.

For example:

```
for i in range(num_clients):
```

```
    thread = threading.Thread(target=lambda idx=i:
results.append(subscribe_benchmark(topic_name, idx + 1)))
```

```
    threads.append(thread)
```

```
thread.start()
```

- A new thread is created for each client using `threading.Thread()`.
- Each thread runs the `subscribe_benchmark()` function, which simulates a client subscribing to a topic.