

Nikhil Mhatre:1002122555	Question 1 –Python Question 2 -Python Question 3 -Python Client
Imtiaz Bin Rahim: 1002076394	Question 1 -Java Question 2 -Java Question 3 –Java Client

How gRPC works ?

**Define service:** Create a .proto file with service definitions.

**Generate code:** Use the gRPC compiler to generate server and client code.

**Implement server:** Write the logic for the defined methods in your preferred language.

**Invoke client:** Use the generated client code to make remote procedure calls to the server.

## Question1

### Python

#### Setting Up

##### Installing gRPC

```

nikhilmhatre@NIKHILs-MBP ~ % git clone https://github.com/ghost9933/gRPC.git
Cloning into 'gRPC'...
remote: Enumerating objects: 3, done.
remote: Counting objects: 100% (3/3), done.
remote: Total 3 (delta 0), reused 0 (delta 0), pack-reused 0 (from 0)
Receiving objects: 100% (3/3), done.
nikhilmhatre@NIKHILs-MBP ~ % cd gRPC
nikhilmhatre@NIKHILs-MBP gRPC % ls -l
total 8
-rw-r--r--  1 nikhilmhatre  staff   6 Oct  9 02:14 README.md
nikhilmhatre@NIKHILs-MBP gRPC % date; whoami;
Wed Oct  9 02:15:58 CDT 2024
nikhilmhatre
nikhilmhatre@NIKHILs-MBP gRPC % python -m pip install --upgrade pip
zsh: command not found: python
nikhilmhatre@NIKHILs-MBP gRPC % python3 -m pip install --upgrade pip
Requirement already satisfied: pip in /Library/Frameworks/Python.framework/Versions/3.12/lib/python3.12/site-packages (24.2)
nikhilmhatre@NIKHILs-MBP gRPC % python -m pip install grpcio
zsh: command not found: python
nikhilmhatre@NIKHILs-MBP gRPC % python3 -m pip install grpcio
Collecting grpcio
  Downloading grpcio-1.66.2-cp312-cp312-macosx_10_9_universal2.whl.metadata (3.9 kB)
Downloading grpcio-1.66.2-cp312-cp312-macosx_10_9_universal2.whl (10.8 MB)
    |-----| 10.8/10.8 MB 36.9 MB/s eta 0:00:00
Installing collected packages: grpcio
Successfully installed grpcio-1.66.2
nikhilmhatre@NIKHILs-MBP gRPC % >

```

```

nikhilmhatre@NIKHILs-MBP gRPC % date; whoami;
Wed Oct  9 02:20:12 CDT 2024
nikhilmhatre
nikhilmhatre@NIKHILs-MBP gRPC % python -m pip install grpcio-tools
zsh: command not found: python
nikhilmhatre@NIKHILs-MBP gRPC % date; whoami;
Wed Oct  9 02:20:24 CDT 2024
nikhilmhatre
nikhilmhatre@NIKHILs-MBP gRPC % python3 -m pip install grpcio-tools
Collecting grpcio-tools
  Downloading grpcio_tools-1.66.2-cp312-cp312-macosx_10_9_universal2.whl.metadata (5.3 kB)

```

## Cloned tutorial

```

Successfully installed grpcio-tools-1.66.2 protobuf-5.28.2 setuptools-75.1.0
nikhilmhatre@NIKHILs-MBP gRPC % date; whoami;
Wed Oct  9 02:21:54 CDT 2024
nikhilmhatre
nikhilmhatre@NIKHILs-MBP gRPC % git clone -b v1.66.0 --depth 1 --shallow-submodules https://github.com/grpc/grpc
Cloning into 'grpc'...
remote: Enumerating objects: 13626, done.
remote: Counting objects: 100% (13626/13626), done.
remote: Compressing objects: 100% (8578/8578), done.
remote: Total 13626 (delta 4674), reused 9813 (delta 3626), pack-reused 0 (from 0)
Receiving objects: 100% (13626/13626), 19.57 MiB | 2.72 MiB/s, done.
Resolving deltas: 100% (4674/4674), done.
Note: switching to '13cecab1c4f45902197a9f8fe4e787eb9c4d4db1'.
You are in 'detached HEAD' state. You can look around, make experimental
changes and commit them, and you can discard any commits you make in this
state without impacting any branches by switching back to a branch.
If you want to create a new branch to retain commits you create, you may
do so (now or later) by using -c with the switch command. Example:
git switch -c <new-branch-name>
To undo this operation with:
git switch -
Turn off this advice by setting config variable advice.detachedHead to false
Updating files: 100% (12448/12448), done.
nikhilmhatre@NIKHILs-MBP gRPC %
nikhilmhatre@NIKHILs-MBP gRPC % cd grpc/examples/python/helloworld
nikhilmhatre@NIKHILs-MBP helloworld %

```

## Quick Start Tutorial

## Client

```
C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld> python greeter_client.py
C:\Users\Nikhil\AppData\Local\Programs\Python\Python313\Lib\site-packages\google\protobuf\runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at helloworld.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
Will try to greet world ...
Greeter client received: Hello, you!

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld> python greeter_client.py
C:\Users\Nikhil\AppData\Local\Programs\Python\Python313\Lib\site-packages\google\protobuf\runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at helloworld.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
Will try to greet world ...
Greeter client received: Hello, you!

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld> echo %date% %time% & whoami
09-10-2024 3:00:41.81
ghost\nikhil
```

```
Will try to greet world ...
Greeter client received: Hello, you!
@ghost9933 → .../grpc/examples/python/helloworld (master) $ cd grpc/examples/python/helloworld
bash: cd: grpc/examples/python/helloworld: No such file or directory
@ghost9933 → .../grpc/examples/python/helloworld (master) $ python greeter_client.py
/usr/local/python/3.12.1/lib/python3.12/site-packages/google/protobuf/runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at helloworld.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
Will try to greet world ...
Greeter client received: Hello, you!
```

## Server:

```
KeyboardInterrupt
^C
C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld> echo %date% %time% & whoami
09-10-2024 3:02:30.55
ghost\nikhil

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld> python greeter_server.py
C:\Users\Nikhil\AppData\Local\Programs\Python\Python313\Lib\site-packages\google\protobuf\runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at helloworld.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
Server started, listening on 50051
```

```
@ghost9933 → .../grpc/examples/python/helloworld (master) $
python greeter_server.py
/usr/local/python/3.12.1/lib/python3.12/site-packages/google/protobuf/runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at helloworld.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
Server started, listening on 50051
```

## Adding Methods

```
syntax = "proto3";

option java_package = "ex.grpc";
option objc_class_prefix = "HSW";

package hellostreamingworld;

// The greeting service definition.
service MultiGreeter {
    // Sends multiple greetings
    rpc sayHello (HelloRequest) returns (stream HelloReply) {}
    // Sends another greeting
    rpc SayHelloAgain (HelloRequest) returns (HelloReply) {}
}

// The request message containing the user's name and how many greetings
// they want.
message HelloRequest {
    string name = 1;
    string num_greetings = 2;
}

// A response message containing a greeting
message HelloReply {
    string message = 1;
}

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld>python -m grpc_tools.protoc -I../protos --python_out=. --pyi_out=. --grpc_python_out=. ../protos/helloworld.proto

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld>whoami
ghost\nikhil

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld>date
The current date is: 09-10-2024
```

## Modifying the server code

# limitations under the License.

"""The Python implementation of the GRPC helloworld.Greeter server."""

from concurrent import futures

import logging

import grpc

import helloworld\_pb2

import helloworld\_pb2\_grpc

You, 5 seconds ago | 3 authors (You and others)

class Greeter(helloworld\_pb2\_grpc.GreeterServicer):

def SayHello(self, request, context):

return helloworld\_pb2>HelloReply(message="Hello, %s!" % request.name)

def SayHelloAgain(self, request, context):

return helloworld\_pb2>HelloReply(message=f"Hello again, {request.name}!")

You, 1 second ago • Uncommi

def serve():

port = "50051"

server = grpc.server(futures.ThreadPoolExecutor(max\_workers=10))

helloworld\_pb2\_grpc.add\_GreeterServicer\_to\_server(Greeter(), server)

server.add\_insecure\_port(":::" + port)

server.start()

print("Server started, listening on " + port)

server.wait\_for\_termination()

if \_\_name\_\_ == "\_\_main\_\_":

logging.basicConfig()

serve()

## Updating the server

```
"""The Python implementation of the GRPC helloworld.Greeter client."""

from __future__ import print_function

import logging

import grpc
import helloworld_pb2
import helloworld_pb2_grpc

def run():
    # NOTE(gRPC Python Team): .close() is possible on a channel and should be
    # used in circumstances in which the with statement does not fit the needs
    # of the code.
    print("Will try to greet world ...")
    with grpc.insecure_channel("localhost:50051") as channel:
        stub = helloworld_pb2_grpc.GreeterStub(channel)
        response = stub.SayHello(helloworld_pb2.HelloRequest(name='you'))
        print("Greeter client received: " + response.message)
        response = stub.SayHelloAgain(helloworld_pb2.HelloRequest(name='you'))
        print("Greeter client received: " + response.message)

if __name__ == "__main__":
    logging.basicConfig()
    run()
```

## Starting the server

```
C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld>date /t & whoami
09-10-2024
ghost\nikhil

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld>python greeter_server.py
C:\Users\Nikhil\AppData\Local\Programs\Python\Python313\Lib\site-packages\google\protobuf\runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at helloworld.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
Server started, listening on 50051
```

## Running the client

```
C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld>whoami & date /t
ghost\nikhil
09-10-2024

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld>python greeter_client.py
C:\Users\Nikhil\AppData\Local\Programs\Python\Python313\Lib\site-packages\google\protobuf\runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at helloworld.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
Will try to greet world ...
Greeter client received: Hello, nikhil nxm2555!
Greeter client received: Hello again, Nikhil nxm2555!

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\grpc\examples\python\helloworld>python greeter_client.py
C:\Users\Nikhil\AppData\Local\Programs\Python\Python313\Lib\site-packages\google\protobuf\runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at helloworld.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
Will try to greet world ...
Greeter client received: Hello, nikhil nxm2555!
Greeter client received: Hello again, Nikhil nxm2555!
```

## Basics

### Setting up the project files

```
C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\base_tutorial>whoami & date /t
ghost\nikhil
09-10-2024

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\base_tutorial>git clone -b v1.66.0 --depth 1 --shallow-submodules https://github.com/grpc/grpc
Cloning into 'grpc'...
remote: Enumerating objects: 13626, done.
remote: Counting objects: 100% (13626/13626), done.
remote: Compressing objects: 100% (8578/8578), done.
remote: Total 13626 (delta 4674), reused 9813 (delta 3626), pack-reused 0 (from 0)Receiving objects: 100% (13626/13626),
Receiving objects: 100% (13626/13626), 19.57 MiB | 1.93 MiB/s, done.

Resolving deltas: 100% (4674/4674), done.
Note: switching to '13cecab1c4f45902197a9f8fe4e787eb9c4d4db1'.
```

### generate the Python stub code:

```
C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\base_tutorial\grpc\examples\python\route_guide> python -m grpc_tools.protoc -I../../protos --python_out=. --pyi_out=. --grpc_python_out=. ../../protos/route_guide.proto

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\base_tutorial\grpc\examples\python\route_guide>whoami & date /t
ghost\nikhil
09-10-2024
```

### Server

```
C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\base_tutorial\grpc\examples\python\route_guide>whoami & date /t
ghost\nikhil
09-10-2024

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\base_tutorial\grpc\examples\python\route_guide>python route_guide_server.py
C:\Users\Nikhil\AppData\Local\Programs\Python\Python313\Lib\site-packages\google\protobuf\runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at route_guide.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
```

### Client



Java:

Setting Up:

1. Clone Java gRPC repository

```
imtiazevan@Imtiazs-Air temp % date;whoami;git clone -b v1.67.1 --depth 1 https://github.com/grpc/grpc-java
Mon Oct 21 21:48:13 CDT 2024
imtiazevan
Cloning into 'grpc-java'...
remote: Enumerating objects: 3156, done.
remote: Counting objects: 100% (3156/3156), done.
remote: Compressing objects: 100% (2157/2157), done.
remote: Total 3156 (delta 629), reused 1698 (delta 231), pack-reused 0 (from 0)
Receiving objects: 100% (3156/3156), 3.59 MiB | 9.37 MiB/s, done.
Resolving deltas: 100% (629/629), done.
Note: switching to '24085103b926559659ecd3941a3308479876f084'.
```



## 2. Build using gradle

```
imtiazevan@Imtiazs-Air examples % date;whoami;./gradlew installDist
Mon Oct 21 21:50:32 CDT 2024
imtiazevan

> Task :compileJava
Note: /Users/imtiazevan/Desktop/Projects/temp/grpc-java/examples/src/main/java/io/grpc/examples/customloadbalance/CustomLoadBalanceClient.java uses unchecked or unsafe operations.
Note: Recompile with -Xlint:unchecked for details.

BUILD SUCCESSFUL in 6s
40 actionable tasks: 40 executed
```

## 3. Run Server

```
imtiazevan@Imtiazs-Air examples % date;whoami;./build/install/examples/bin/hello-world-server
Mon Oct 21 21:51:38 CDT 2024
imtiazevan
Oct 21, 2024 9:51:44 PM io.grpc.examples.helloworld.HelloWorldServer start
INFO: Server started, listening on 50051
```

## 4. Run Client

```
imtiazevan@Imtiazs-MacBook-Air examples % date;whoami;./build/install/examples/bin/hello-world-client
Mon Oct 21 21:52:53 CDT 2024
imtiazevan
Oct 21, 2024 9:52:54 PM io.grpc.examples.helloworld.HelloWorldClient greet
INFO: Will try to greet world ...
Oct 21, 2024 9:52:59 PM io.grpc.examples.helloworld.HelloWorldClient greet
INFO: Greeting: Hello world
```

## Update The App:

Update proto file:

```
// The greeting service definition.
service Greeter {
  // Sends a greeting
  rpc SayHello (HelloRequest) returns (HelloReply) {}

  rpc SayHelloAgain (HelloRequest) returns (HelloReply) {}
}
```

Update server file:

```
@Override
public void sayHelloAgain(HelloRequest req, StreamObserver<HelloReply> responseObserver) {
    // Generate another greeting message for the new method.
    HelloReply reply = HelloReply.newBuilder().setMessage("Hello again " + req.getName()).build();

    // Send the reply back to the client.
    responseObserver.onNext(reply);

    // Indicate that no further messages will be sent to the client.
    responseObserver.onCompleted();
}
```

Update client file:

```
// Client-side logic for interacting with the gRPC service.
public void greet(String name) {
    // Log a message indicating the intention to greet a user.
    logger.info("Will try to greet " + name + " ...");

    // Creating a request with the user's name.
    HelloRequest request = HelloRequest.newBuilder().setName(name).build();
    HelloReply response;
    try {
        // Call the original method on the server.
        response = blockingStub.sayHello(request);
    } catch (StatusRuntimeException e) {
        // Log a warning if the RPC fails.
        logger.log(Level.WARNING, "RPC failed: {0}", e.getStatus());
        return;
    }

    // Log the response from the original method.
    logger.info("Greeting: " + response.getMessage());

    try {
        // Call the new method on the server.
        response = blockingStub.sayHelloAgain(request);
    } catch (StatusRuntimeException e) {
        // Log a warning if the RPC fails.
        logger.log(Level.WARNING, "RPC failed: {0}", e.getStatus());
        return;
    }

    // Log the response from the new method.
    logger.info("Greeting: " + response.getMessage());
}
```

Build and Run:

```
Mon Oct 21 22:59:08 CDT 2024
imtiazevan
Oct 21, 2024 10:59:09 PM io.grpc.examples.helloworld.HelloWorldClient greet
INFO: Will try to greet world ...
Oct 21, 2024 10:59:14 PM io.grpc.examples.helloworld.HelloWorldClient greet
INFO: Greeting: Hello world
Oct 21, 2024 10:59:14 PM io.grpc.examples.helloworld.HelloWorldClient greet
INFO: Greeting: Hello again world
```

## Question 2

Python:

### Step 1

writing the proto buff script to define the required interfaces for the communication between the server and client

```
syntax = "proto3";

package todo;

service TodoService {
    rpc CreateTodo (TodoRequest) returns (TodoResponse);
    rpc DeleteTodo (TodoId) returns (TodoResponse);
    rpc UpdateTodo (TodoRequest) returns (TodoResponse);
    rpc ListTodos (Empty) returns (TodoListResponse);
}

message TodoItem {
    string id = 1;
    string title = 2;
    bool completed = 3;
}

message TodoRequest {
    TodoItem item = 1;
}

message TodoId {
    string id = 1;
}

message TodoResponse {
```

```

    string message = 1;
    TodoItem item = 2; // Optional: return the item in the response
}

message Empty {}

message TodoListResponse {
    repeated TodoItem items = 1;
}

```

```

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\sharingStub>whoami & date /t
ghost\nikhil
13-10-2024

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\sharingStub>python -m grpc_tools.protoc -I. --python_out=. --grpc_pyton_out=. main.proto

```

Creating the stub codes using the proto definition for our todo app

Client code:

```

import grpc
import main_pb2
import main_pb2_grpc

def print_todos(todos):
    """Utility function to print all todos."""
    print("Current Todos:")
    for item in todos:
        print(f"{item.id}: {item.title} (Completed: {item.completed})")

def run():
    with grpc.insecure_channel('localhost:50051') as channel:
        stub = main_pb2_grpc.TODOServiceStub(channel)

        while True:

```

```

print("\nOptions:")
print("1. Create Todo")
print("2. List Todos")
print("3. Update Todo")
print("4. Delete Todo")
print("5. Exit")

choice = input("Choose an option (1-5): ")

if choice == '1':
    title = input("Enter the title of the Todo item: ")
    response =
stub.CreateTodo(main_pb2.TodoRequest(item=main_pb2.TodoItem(title=title)))
    print(response.message)

elif choice == '2':
    response = stub.ListTodos(main_pb2.Empty())
    print_todos(response.items)

elif choice == '3':
    todo_id = input("Enter the ID of the Todo item to update: ")
    title = input("Enter the new title of the Todo item: ")
    completed = input("Is the Todo item completed? (yes/no): ")
    completed = True if completed.lower() == 'yes' else False
    response =
stub.UpdateTodo(main_pb2.TodoRequest(item=main_pb2.TodoItem(id=todo_id, title=title,
completed=completed)))
    print(response.message)

elif choice == '4':
    todo_id = input("Enter the ID of the Todo item to delete: ")
    response = stub.DeleteTodo(main_pb2.TodoId(id=todo_id))
    print(response.message)

elif choice == '5':
    print("Exiting...")
    break

```

```

        else:
            print("Invalid option, please try again.")

if __name__ == '__main__':
    run()

```

Server Code:

```

import grpc
from concurrent import futures
import time
import main_pb2
import main_pb2_grpc

class TodoService(main_pb2_grpc.TodoServiceServicer):
    def __init__(self):
        self.todos = {} # In-memory database for todo items

    def CreateTodo(self, request, context):

        todo_id = str(len(self.todos) + 1)
        todo_item = main_pb2.TodoItem(id=todo_id, title=request.item.title, completed=False)
        self.todos[todo_id] = todo_item
        print('request recived to create',request.item.id,request.item)
        return main_pb2.TodoResponse(message="Todo created successfully", item=todo_item)

    def DeleteTodo(self, request, context):
        print('request recived to delete',request.id)
        if request.id in self.todos:
            del self.todos[request.id]
            return main_pb2.TodoResponse(message="Todo deleted successfully")

```

```

        return main_pb2.TODOResponse(message="Todo not found")

    def UpdateTodo(self, request, context):
        print('request recived to update',request.item.id,request.item)
        if request.item.id in self.todos:
            self.todos[request.item.id] = request.item
            return main_pb2.TODOResponse(message="Todo updated successfully",
item=request.item)
        return main_pb2.TODOResponse(message="Todo not found")

    def ListTodos(self, request, context):

        items = list(self.todos.values())
        print('seding this data to client',items)
        return main_pb2.TODOListResponse(items=items)

def serve():
    server = grpc.server(futures.ThreadPoolExecutor(max_workers=10))
    main_pb2_grpc.add_TODOServiceServicer_to_server(TODOService(), server)
    server.add_insecure_port('[::]:50051')
    server.start()
    print("gRPC server started, listening on port 50051")
    print("Server started at port 50051.")
    try:
        while True:
            time.sleep(86400) # Keep the server running for a day
    except KeyboardInterrupt:
        print('TODO server stopping')
        server.stop(0)

if __name__ == '__main__':
    print('starting TODO server')
    serve()

```



## Step 2:

Starting the server:

```
C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\sharingStub>whoami & date /t
ghost\nikhil
13-10-2024

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\sharingStub>python server.py
C:\Users\Nikhil\AppData\Local\Programs\Python\Python313\Lib\site-packages\google\protobuf\runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at main.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
starting TODO server
gRPC server started, listening on port 50051
Server started at port 50051.
|
```

## Step 3:

Starting the client:

```
C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\sharingStub>whoami & date /t
ghost\nikhil
13-10-2024

C:\Users\Nikhil\Desktop\MS\DistributedSystems\gRPC\sharingStub>python client.py
C:\Users\Nikhil\AppData\Local\Programs\Python\Python313\Lib\site-packages\google\protobuf\runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at main.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(

Options:
1. Create Todo
2. List Todos
3. Update Todo
4. Delete Todo
5. Exit
Choose an option (1-5): |
```

## Step 4: Test the code

### Using the client side

```
C:\Users\Nikhil\Desktop\MS\ Distributed Systems\gRPC\sharingStub>cmd & date /t
ghost\Nikhil
15-10-2024

C:\Users\Nikhil\Desktop\MS\ Distributed Systems\gRPC\sharingStub>python client.py
C:\Users\Nikhil\AppData\Local\Programs\Python\Python313\Lib\site-packages\google\protobuf\runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.26.2 at main.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(

Options:
1. Create Todo
2. List Todos
3. Update Todo
4. Delete Todo
5. Exit
Choose an option (1-5): 1
Enter the title of the Todo item: create a sample grpc application
Todo created successfully

Options:
1. Create Todo
2. List Todos
3. Update Todo
4. Delete Todo
5. Exit
Choose an option (1-5): 1
Enter the title of the Todo item: Create a multi threaded client and server API for a pet adoption service
Todo created successfully

Options:
1. Create Todo
2. List Todos
3. Update Todo
4. Delete Todo
5. Exit
Choose an option (1-5): 2
Current Todos:
1: create a sample grpc application (Completed: False)
2: Create a multi threaded client and server API for a pet adoption service (Completed: False)

Options:
1. Create Todo
2. List Todos
3. Update Todo
4. Delete Todo
5. Exit
Choose an option (1-5): 3
Enter the ID of the Todo item to update: 1
Enter the new title of the Todo item: Sample gRPC application
Is the Todo item completed? (yes/no): yes
Todo updated successfully

Options:
1. Create Todo
2. List Todos
3. Update Todo
4. Delete Todo
5. Exit
Choose an option (1-5): 2
Current Todos:
1: Sample gRPC application (Completed: True)
2: Create a multi threaded client and server API for a pet adoption service (Completed: False)

Options:
1. Create Todo
2. List Todos
3. Update Todo
4. Delete Todo
5. Exit
Choose an option (1-5): 4
Enter the ID of the Todo item to delete: 1
Todo deleted successfully

Options:
1. Create Todo
2. List Todos
3. Update Todo
4. Delete Todo
5. Exit
Choose an option (1-5): 2
Current Todos:
2: Create a multi threaded client and server API for a pet adoption service (Completed: False)

Options:
1. Create Todo
2. List Todos
3. Update Todo
4. Delete Todo
5. Exit
Choose an option (1-5): 5
Exiting...
```

### Debugging updates on the server side

```
C:\Users\Nikhil\Desktop\MS\ Distributed Systems\gRPC\sharingStub>cmd & date /t
ghost\Nikhil
15-10-2024

C:\Users\Nikhil\Desktop\MS\ Distributed Systems\gRPC\sharingStub>python server.py
C:\Users\Nikhil\AppData\Local\Programs\Python\Python313\Lib\site-packages\google\protobuf\runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the run
time version 5.26.2 at main.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(

starting TODO server
gRPC server started, listening on port 50051
Server started at port 50051.
request recived to create title: "create a sample grpc application"

request recived to create title: "Create a multi threaded client and server API for a pet adoption service"

seding this data to client [id: "1"
title: "create a sample grpc application"
, id: "2"
title: "Create a multi threaded client and server API for a pet adoption service"
]
request recived to update 1 id: "1"
title: "Sample gRPC application"
completed: true

seding this data to client [id: "1"
title: "Sample gRPC application"
completed: true
, id: "2"
title: "Create a multi threaded client and server API for a pet adoption service"
]
request recived to delete 1
seding this data to client [id: "2"
title: "Create a multi threaded client and server API for a pet adoption service"
]
[]
```

# JAVA:

## Step 1: Generate stub using proto file

```
Grpc-Java > grpc-java > examples > src > main > proto > petadoption.proto
1  syntax = "proto3";
2
3  option java_multiple_files = true;
4  option java_package = "io.grpc.examples.petadoption"; // Change this to your desired package
5  option java_outer_classname = "PetAdoptionProto";    // Name for the generated outer class
6
7  package petadoption;
8
9  // The Pet Adoption service definition.
10 service PetAdoptionService {
11     //Greet the client
12     rpc greet (GreetRequest) returns (GreetResponse);
13 }
14
15 message GreetRequest {
16     string name = 1;
17 }
18
19 message GreetResponse {
20     string message = 1;
21 }
```

## Step 2: build and run server

```
imtiazevan@Imtiazs-MacBook-Air examples % date;whoami;./build/install/examples/bin/pet-adoption-server
Mon Oct 21 22:09:23 CDT 2024
imtiazevan
Server started on port 8080
Handling greet client on thread: pool-1-thread-1
```

Step 3: Run Client and send system username to server for a customized greeting message

```
private void greet(String name)
{
    GreetRequest request = GreetRequest.newBuilder().setName(name).build();
    GreetResponse response = client.greet(request);
    System.out.println(response.getMessage());
}
```

```
// Call the greet function
String username = System.getProperty("user.name");
client.greet(username);
```

```
imtiazdevan@Imtiazs-MacBook-Air examples % date;whoami;./build/install/examples/bin/pet-adoption-client
Mon Oct 21 22:09:39 CDT 2024
imtiazdevan
Hello, imtiazdevan! Welcome to the Pet Adoption Service.
imtiazdevan@Imtiazs-MacBook-Air examples %
```

## Question 3:

### The Proto file

use the proto file to generate the stubs for java and python

Used the below command to generate the python stub

```
python -m grpc_tools.protoc -I. --python_out=. --grpc_python_out=. Petadoption.proto
```

For java modify build.gradle to generate the java stub code

```
C:\Users\Wikhil\Downloads\CSE-5306-Assignment-2(Team-28)\Grpc-Java\grpc-java-docker-compose up --build
time="2024-10-21T19:05:54.05-08" level="warning" msg="C:\Users\Wikhil\Downloads\CSE-5306-Assignment-2(Team-28)\Grpc-Java\grpc-java\docker-compose.yml: the attribute 'version' is obsolete, it will be ignored, please remove it to avoid potential confusion"
[+] Building 8.0s (12/12) FINISHED
docker:desktop-linux
=> [grpc-service internal] load build definition from Dockerfile 0.1s
=> transferring dockerfile: 497B 0.0s
=> [grpc-service internal] load metadata for docker.io/library/openjdk:8-jdk-alpine 1.2s
=> [grpc-service auth] library/openjdk:pull token for registry-1.docker.io 0.0s
=> [grpc-service internal] load dockerignore 0.0s
=> transferring context: 2B 0.0s
=> [grpc-service 1/5] FROM docker.io/library/openjdk:8-jdk-alpine@sha256:9d792824d6f2d33462f281713f932b58cb9de94 5.7s
=> resolve docker.io/library/openjdk:8-jdk-alpine@sha256:9d792824d6f2d33462f281713f932b58cb9de94@sha256:9d792824d6f2d33462f281713f932b58cb9de94 0.0s
=> sha256:9d792824d6f2d33462f281713f932b58cb9de94@sha256:24164a0f2283343547b3 1.64kB / 1.64kB 0.0s
=> sha256:44b3cea369c9473527e266275ccee85c71a81f20fc5076f6ebb5a13f19815dce71 947B / 947B 0.0s
=> sha256:a3562a0b991a80cfe8172847c8be6dbf6e46340b759c2b782f8bb8e453342717 3.40kB / 3.40kB 0.0s
=> sha256:e7c96db7181be991f19a9fb6975cd8bd73c65f4a2681348e6a1a1a2192a5f10 2.76MB / 2.76MB 0.3s
=> sha256:f910a506b6c1dbec7667278356f95ae2bf2bae6224dbec76cad4f3664b2 238B / 238B 0.0s
=> sha256:c22741a0e2786e9101b08f7611f9ab8019e368dc1e325d3c284a8ca33397 70.73MB / 70.73MB 4.2s
=> extracting sha256:e7c96db7181be991f19a9fb6975cd8bd73c65f4a2681348e6a1a1a2192a5f10 0.0s
=> extracting sha256:f910a506b6c1dbec7667278356f95ae2bf2bae6224dbec76cad4f3664b2 0.0s
=> extracting sha256:c22741a0e2786e9101b08f7611f9ab8019e368dc1e325d3c284a8ca33397 0.7s
=> [grpc-service internal] load build context 0.0s
=> transferring context: 23.79MB 0.6s
=> [grpc-service 2/5] WORKDIR /app 0.1s
=> [grpc-service 3/5] COPY examples/build/install/examples/lib/ /app/lib/ 0.1s
=> [grpc-service 4/5] COPY examples/build/install/examples/bin/ /app/bin/ 0.0s
=> [grpc-service 5/5] RUN chmod +x /app/bin/pet-adoption-server 0.6s
=> [grpc-service] exporting to image 0.1s
=> exporting layers 0.1s
=> writing image sha256:8253b7332aaf669f1ebcf9529ba208d73d73d1b40457e85ac19153bc0a54a6 0.0s
=> naming to docker.io/library/grpc-java:latest 0.0s
=> [grpc-service] resolving provenance for metadata file 0.0s
[+] Running 2/2
✔Network grpc-java_default Created 0.2s
✔Container grpc-java-grpc-service-1 Created 0.1s
Attaching to grpc-service-1

=> [grpc-service] resolving provenance for metadata file 0.0s
[+] Running 2/2
✔Network grpc-java_default Created 0.2s
✔Container grpc-java-grpc-service-1 Created 0.1s
Attaching to grpc-service-1

grpc-service-1 | Server started on port 8080
grpc-service-1 | Handling registerPet on thread: pool-1-thread-1
grpc-service-1 | Handling registerPet on thread: pool-1-thread-2
grpc-service-1 | Handling registerPet on thread: pool-1-thread-3
grpc-service-1 | Handling registerPet on thread: pool-1-thread-4
grpc-service-1 | Handling registerPet on thread: pool-1-thread-5
grpc-service-1 | Handling registerPet on thread: pool-1-thread-6
grpc-service-1 | Handling registerPet on thread: pool-1-thread-7
grpc-service-1 | Handling searchPet on thread: pool-1-thread-8
grpc-service-1 | Handling searchPet on thread: pool-1-thread-9
grpc-service-1 | Handling searchPet on thread: pool-1-thread-10
grpc-service-1 | Handling registerPet on thread: pool-1-thread-1
grpc-service-1 | Handling registerPet on thread: pool-1-thread-2
grpc-service-1 | Handling registerPet on thread: pool-1-thread-3
grpc-service-1 | Handling registerPet on thread: pool-1-thread-4
grpc-service-1 | Handling searchPet on thread: pool-1-thread-5
grpc-service-1 | Handling searchPet on thread: pool-1-thread-6
grpc-service-1 | Handling searchPet on thread: pool-1-thread-7
grpc-service-1 | Handling searchPet on thread: pool-1-thread-8
grpc-service-1 | Handling searchPet on thread: pool-1-thread-9
```

# The Client: implemented in Python

```
C:\Users\Nikhil\Downloads\CSE-5306-Assignment-2(Team-28)\CSE-5306-Assignment-2(Team-28)>cd Grpc-python\gRPC\PetAdoption\client
C:\Users\Nikhil\Downloads\CSE-5306-Assignment-2(Team-28)\CSE-5306-Assignment-2(Team-28)\Grpc-python\gRPC\PetAdoption\client>docker-compose run client bash
time="2024-10-21T19:07:09-05:00" level=warning msg="C:\\Users\\Nikhil\\Downloads\\CSE-5306-Assignment-2(Team-28)\\CSE-5306-Assignment-2(Team-28)\\Grpc-python\\gRPC\\PetAdoption\\cl
ient\\docker-compose.yml: the attribute 'version' is obsolete, it will be ignored, please remove it to avoid potential confusion"
[*] Building 7.1s (12/12) FINISHED
=> [client internal] load build definition from Dockerfile                                docker:desktop-linux 0.0s
=> => transferring dockerfile: 359B                                                    0.0s
=> [client internal] load metadata for docker.io/library/python:3.9-slim                0.5s
=> [client auth] library/python:pull token for registry-1.docker.io                    0.0s
=> [client internal] load .dockerignore                                                0.0s
=> => transferring context: 2B                                                         0.0s
=> [client 1/5] FROM docker.io/library/python:3.9-slim@sha256:7a9cd42706c174cdc578880ab9ae3b6551323a7ddbc2a89ad 0.0s
=> [client internal] load build context                                                0.2s
=> => transferring context: 7.87MB                                                    0.1s
=> CACHED [client 2/5] WORKDIR /App                                                    0.0s
=> [client 3/5] COPY requirements.txt requirements.txt                                0.0s
=> [client 4/5] RUN pip install --no-cache-dir -r requirements.txt                    6.1s
=> [client 5/5] COPY . .                                                              0.0s
=> [client] exporting to image                                                         0.1s
=> => exporting layers                                                                0.1s
=> => writing image sha256:e06513383c2638fa44a6e22f1cc438ac4511d58dd70c296c8db29598ca45c72a 0.0s
=> => naming to docker.io/library/client-client                                       0.0s
=> [client] resolving provenance for metadata file                                     0.0s
root@docker-desktop:/app# python test.py & python client.py
[1] 7
/usr/local/lib/python3.9/site-packages/google/protobuf/runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at petadoption.
proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
/usr/local/lib/python3.9/site-packages/google/protobuf/runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at petadoption.
proto. Please avoid checked-in Protobuf gencode that can be obsolete.
```

```
/usr/local/lib/python3.9/site-packages/google/protobuf/runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at petadoption.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
/usr/local/lib/python3.9/site-packages/google/protobuf/runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at petadoption.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
Connecting to server at: 127.0.0.1:8080
Connecting to server at: 127.0.0.1:8080
Connecting to server at: 127.0.0.1:8080
Building dataset...

Menu:
1. Register a Pet
2. Search for a Pet
5. Exit
Choose an option (1-5): Registering Buddy: Pet registered successfully
Registering Charlie: Pet registered successfully
Registering Daisy: Pet registered successfully
Registering Max: Pet registered successfully
Registering Bella: Pet registered successfully
Registering Lucy: Pet registered successfully
Dataset built successfully.

Testing pet registration...
Passed test_register_pet: Pet registered successfully

Testing pet search by name...
Passed test_search_pet: Found 1 pet(s) with name 'Buddy'.

Testing pet search by gender...
Passed test_search_by_gender: Found 3 female pet(s).

Testing pet search by age...
Passed test_search_by_age: Found pets with age '3': ['Charlie']

Testing pet search by breed...
Passed test_search_by_breed: Found pets with breed 'Beagle': ['Charlie', 'Lucy']

Testing registering multiple pets...
Registered Molly: Pet registered successfully
Registered Oscar: Pet registered successfully
Registered Lola: Pet registered successfully
Passed test_register_multiple_pets.

Verified search for Molly: Found 1 pet(s).
Verified search for Oscar: Found 1 pet(s).
Verified search for Lola: Found 1 pet(s).
Passed verification for test_register_multiple_pets.

Testing pet search with multiple criteria...
Passed test_search_with_multiple_criteria: Found 1 pet(s) matching 'Buddy' and 'Labrador'.

All functional tests passed successfully.

Invalid choice. Please try again.
```



C:\Windows\System32\cmd.e X + v

```
Testing pet search by age...
Passed test_search_by_age: Found pets with age '3': ['Charlie']

Testing pet search by breed...
Passed test_search_by_breed: Found pets with breed 'Beagle': ['Charlie', 'Lucy']

Testing registering multiple pets...
Registered Molly: Pet registered successfully
Registered Oscar: Pet registered successfully
Registered Lola: Pet registered successfully
Passed test_register_multiple_pets.

Verified search for Molly: Found 1 pet(s).
Verified search for Oscar: Found 1 pet(s).
Verified search for Lola: Found 1 pet(s).
Passed verification for test_register_multiple_pets.

Testing pet search with multiple criteria...
Passed test_search_with_multiple_criteria: Found 1 pet(s) matching 'Buddy' and 'Labrador'.

All functional tests passed successfully.

Invalid choice. Please try again.

Menu:
1. Register a Pet
2. Search for a Pet
5. Exit
Choose an option (1-5): |
```

```

Testing pet search by breed...
Passed test_search_by_breed: Found pets with breed 'Beagle': ['Charlie', 'Lucy']

Testing registering multiple pets..
Registered Molly: Pet registered successfully
Registered Oscar: Pet registered successfully
Registered Lola: Pet registered successfully
Passed test_register_multiple_pets.

Verified search for Molly: Found 1 pet(s).
Verified search for Oscar: Found 1 pet(s).
Verified search for Lola: Found 1 pet(s).
Passed verification for test_register_multiple_pets.

Testing pet search with multiple criteria...
Passed test_search_with_multiple_criteria: Found 1 pet(s) matching 'Buddy' and 'Labrador'.

All functional tests passed successfully.

Invalid choice. Please try again.

Menu:
1. Register a Pet
2. Search for a Pet
5. Exit
Choose an option (1-5): "CTraceback (most recent call last):
  File "/app/client.py", line 108, in <module>
    run()
  File "/app/client.py", line 71, in run
    choice = input("Choose an option (1-5): ")
KeyboardInterrupt

[1]+  Done                  python test.py
root@docker-desktop:/app# whoami & date \t
[1] 52
date: invalid date 't'
root@docker-desktop:/app# root
^C
[1]+  Done                  whoami
root@docker-desktop:/app# exit
exit

C:\Users\Nikhil\Downloads\CSE-5306-Assignment-2(Team-28)\CSE-5306-Assignment-2(Team-28)\Grpc-python\gRPC\PetAdoption\client>whoami & date /t
ghost\nikhil
The system cannot accept the date entered.
Enter the new date: (dd-mm-yy)
C:\Users\Nikhil\Downloads\CSE-5306-Assignment-2(Team-28)\CSE-5306-Assignment-2(Team-28)\Grpc-python\gRPC\PetAdoption\client>whoami & date /t
ghost\nikhil
21-10-2024

```

## Testing the client

```

C:\Users\Nikhil\Desktop\VS\ Distributed Systems\gRPC\PetAdoption>whoami & date /t
ghost\nikhil
21-10-2024

C:\Users\Nikhil\Desktop\VS\ Distributed Systems\gRPC\PetAdoption>docker-compose exec client bash
line 2:2024-10-21T02:00:45.00Z level=warning msg=C:\Users\Nikhil\Desktop\VS\ Distributed Systems\gRPC\PetAdoption\docker-compose.yaml: the attribute 'version' is obsolete, it will be ignored, please remove it to avoid potential confusion"
root@ghost:~/client$ ./app.py
./usr/local/lib/python3.9/site-packages/google/protobuf/runtime_version.py:112: UserWarning: Protobuf gencode version 5.27.2 is older than the runtime version 5.28.2 at petadoption.proto. Please avoid checked-in Protobuf gencode that can be obsolete.
  warnings.warn(
Client running at IP: None
Connecting to server at: server:50051
Client running at IP: None
Connecting to server at: server:50051

Menu:
1. Register a Pet
2. Search for a Pet
5. Exit
Choose an option (1-5): 2
Enter pet name, gender, age, or breed to search: Male
Matching pets:
ID: 8c6b2ad-f459-45f6-a2ad-a971533f9576, Name: Buddy, Gender: Male, Age: 2, Breed: Labrador
Picture (base64): /9j/4AAQSkZJRgABAQAAQABQIAQICGEMRbGp2aATUwAAAAA...
ID: 67829039-a748-42a9-a8d2-3cd67ab4d21, Name: Charlie, Gender: Male, Age: 3, Breed: Beagle
Picture (base64): /9j/4AAQSkZJRgABAQAAQABQIAQICGEMRbGp2aATUwAAAAA...
ID: a3ab0d77-ae0f-4e5a-82ab-dcf4b0abab0, Name: Rex, Gender: Male, Age: 4, Breed: Golden Retriever
Picture (base64): /9j/4AAQSkZJRgABAQAAQABQIAQICGEMRbGp2aATUwAAAAA...
ID: 69a80ab3-1e4e-4a0b-a5c8-f212f7, Name: Boddy, Gender: Male, Age: 4, Breed: Boxer
Picture (base64): /9j/4AAQSkZJRgABAQAAQABQIAQICGEMRbGp2aATUwAAAAA...
ID: 1c1500e-8009-4773-ae5e-1cd41b2309, Name: Oscar, Gender: Male, Age: 5, Breed: Terrier
Picture (base64): /9j/4AAQSkZJRgABAQAAQABQIAQICGEMRbGp2aATUwAAAAA...

Menu:
1. Register a Pet
2. Search for a Pet
5. Exit
Choose an option (1-5): 2
Enter pet name, gender, age, or breed to search: female
Matching pets:
ID: 9353186f-6227-4688-a5de-a57d97c5b4d5, Name: Daisy, Gender: Female, Age: 5, Breed: Poodle
Picture (base64): /9j/4AAQSkZJRgABAQAAQABQIAQICGEMRbGp2aATUwAAAAA...
ID: 47480309-18a7-4edc-9b3c-74dc-09b4c778, Name: Bella, Gender: Female, Age: 1, Breed: Shih Tzu
Picture (base64): /9j/4AAQSkZJRgABAQAAQABQIAQICGEMRbGp2aATUwAAAAA...
ID: e8f7b777-111e-452b-b83d-4234e4234e, Name: Lucy, Gender: Female, Age: 7, Breed: Beagle
Picture (base64): /9j/4AAQSkZJRgABAQAAQABQIAQICGEMRbGp2aATUwAAAAA...
ID: 28f272a8-17d2-40c3-4769-22ad7c718f00, Name: Molly, Gender: Female, Age: 3, Breed: Bulldog
Picture (base64): /9j/4AAQSkZJRgABAQAAQABQIAQICGEMRbGp2aATUwAAAAA...
ID: d65ff5c6-5baf-4773-ae5e-1cd41b2309, Name: Lola, Gender: Female, Age: 2, Breed: Pomeranian
Picture (base64): /9j/4AAQSkZJRgABAQAAQABQIAQICGEMRbGp2aATUwAAAAA...

Menu:
1. Register a Pet
2. Search for a Pet
5. Exit
Choose an option (1-5): |

```

## Question 4: Testing

The script tests the core functionalities of a gRPC-based pet adoption system by registering pets and searching for them based on various criteria.

- **Connect to Server:** Establishes a gRPC connection to the pet adoption server.
- **Build Dataset:** Registers a predefined list of pets to set up the testing environment.



- **Run Tests:** Executes each test function sequentially to verify registration and search functionalities.
- **Report Results:** Outputs the status of each test and summarizes any failures.

### Initial Dataset Registration (build\_dataset)

- **Registered Pets:**

- Buddy (Male, 2, Labrador)
- Charlie (Male, 3, Beagle)
- Daisy (Female, 5, Poodle)
- Max (Male, 4, Golden Retriever)
- Bella (Female, 1, Shih Tzu)
- Lucy (Female, 7, Beagle)

#### 1. test\_register\_pet

Verifies that a new pet can be successfully registered with all required details.

- **Registers:** Rocky (Male, 4, Boxer)
- **Verification:** Confirms Rocky is successfully registered.

#### 2. test\_search\_pet

Ensures that searching for a pet by name returns the correct pet(s).

- **Searches for:** Buddy
- **Expected Result:** Buddy should be found among the registered pets.

#### 3. test\_search\_by\_gender

Checks that searching by gender retrieves only pets of the specified gender.

- **Searches for:** Female
- **Expected Count:** 3 female pets (Daisy, Bella, Lucy)
- **Verification:** Ensures only female pets are returned and count is as expected.

#### 4. test\_search\_by\_age

Validates that searching by age returns pets matching the specified age.

- **Searches for:** Age 3
- **Expected Pet:** Charlie
- **Verification:** Confirms Charlie is retrieved when searching by age.

#### 5. test\_search\_by\_breed

Confirms that searching by breed retrieves all pets of the specified breed.

- **Searches for:** Beagle
- **Expected Pets:** Charlie and Lucy
- **Verification:** Ensures both Beagle breeds are returned

6. test\_register\_multiple\_pets

Tests the registration of multiple pets and verifies their availability in searches.

- **Registers:** Molly (Female, 3, Bulldog), Oscar (Male, 5, Terrier), Lola (Female, 2, Pomeranian)
- **Verification:** Confirms each newly registered pet can be searched and found.

7. test\_search\_with\_multiple\_criteria

Ensures that searching with multiple criteria returns the correct pet(s) matching all criteria.

- **Searches for:** "Buddy Labrador"
- **Expected Pet:** Buddy matching both name and breed
- **Verification:** Ensures multi-criteria search returns the correct pet.