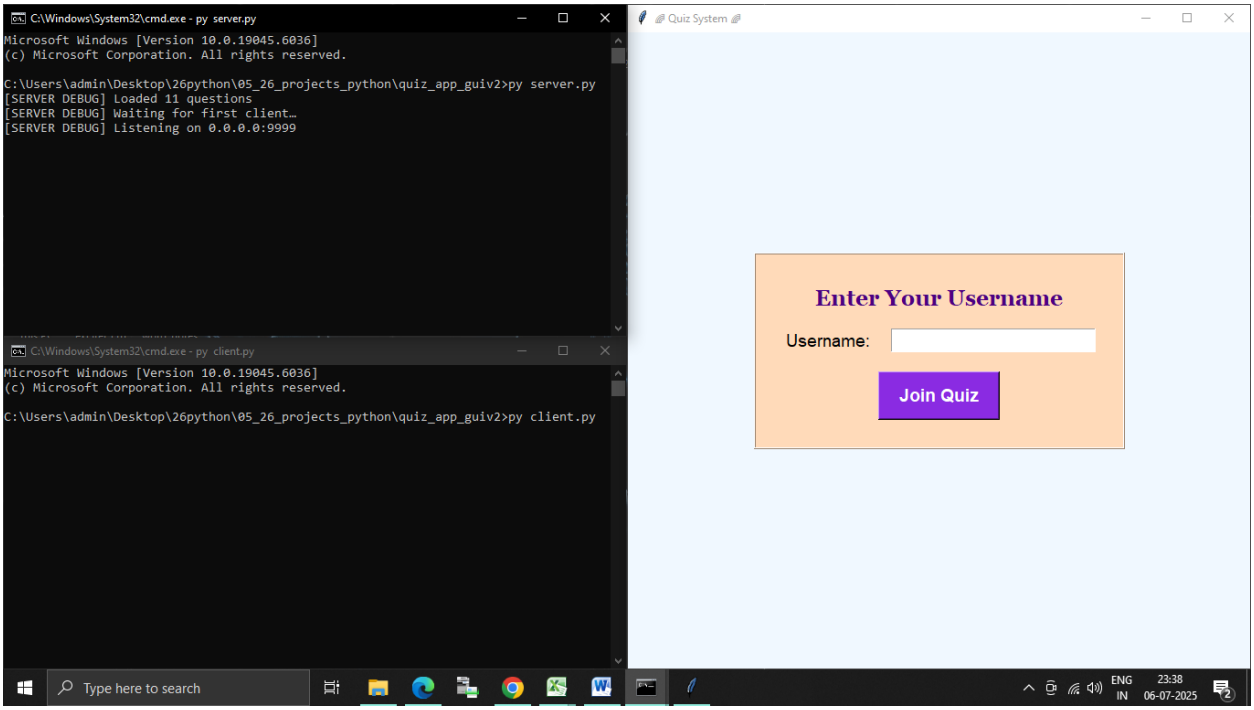
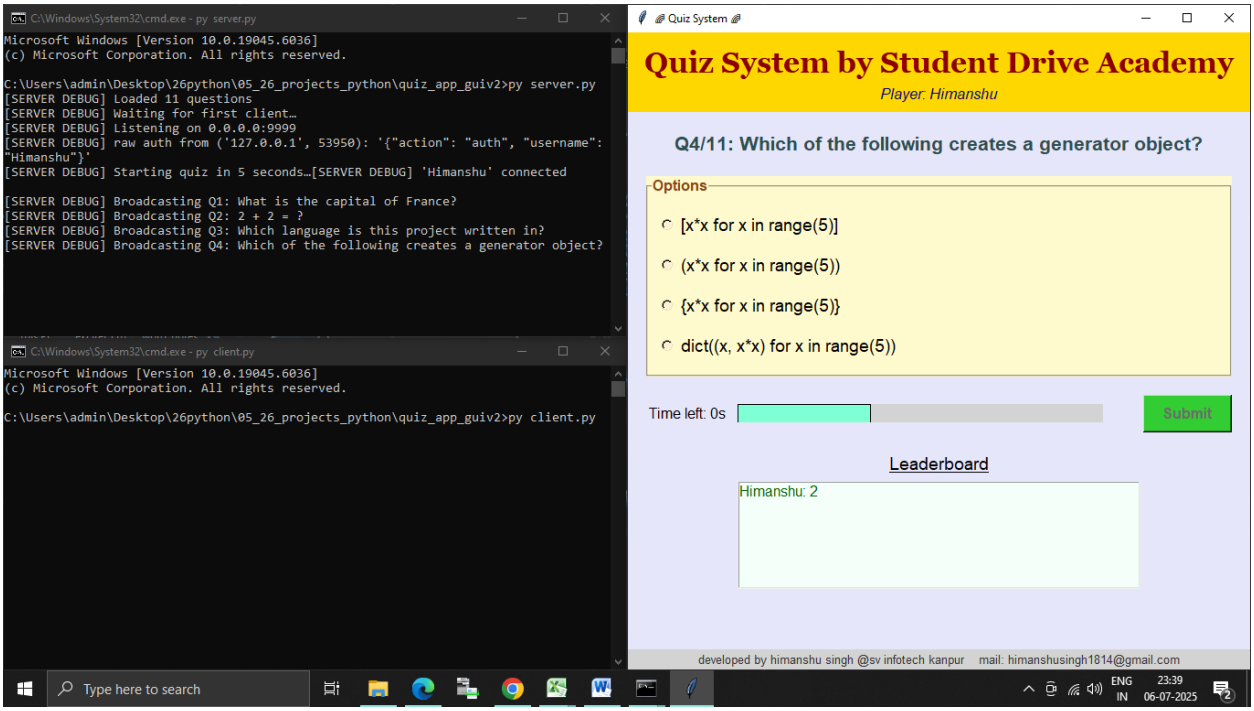
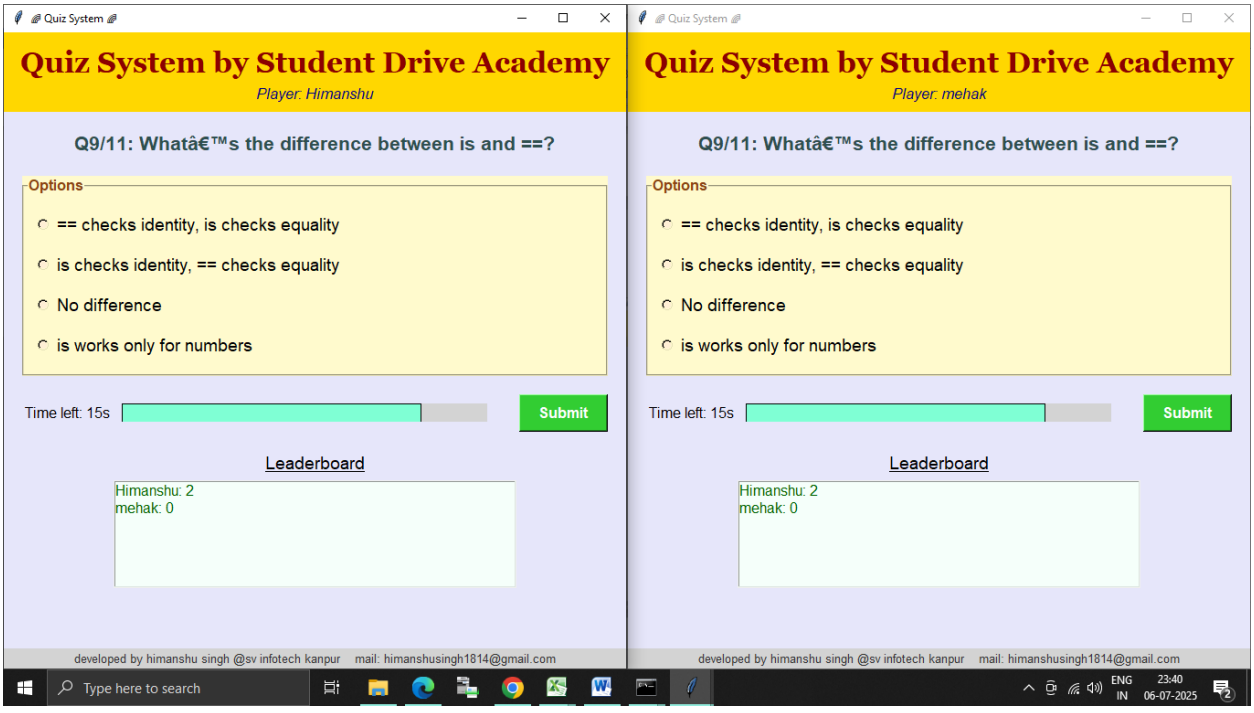
NETWORK PROGRAMMNG IN PYTHON

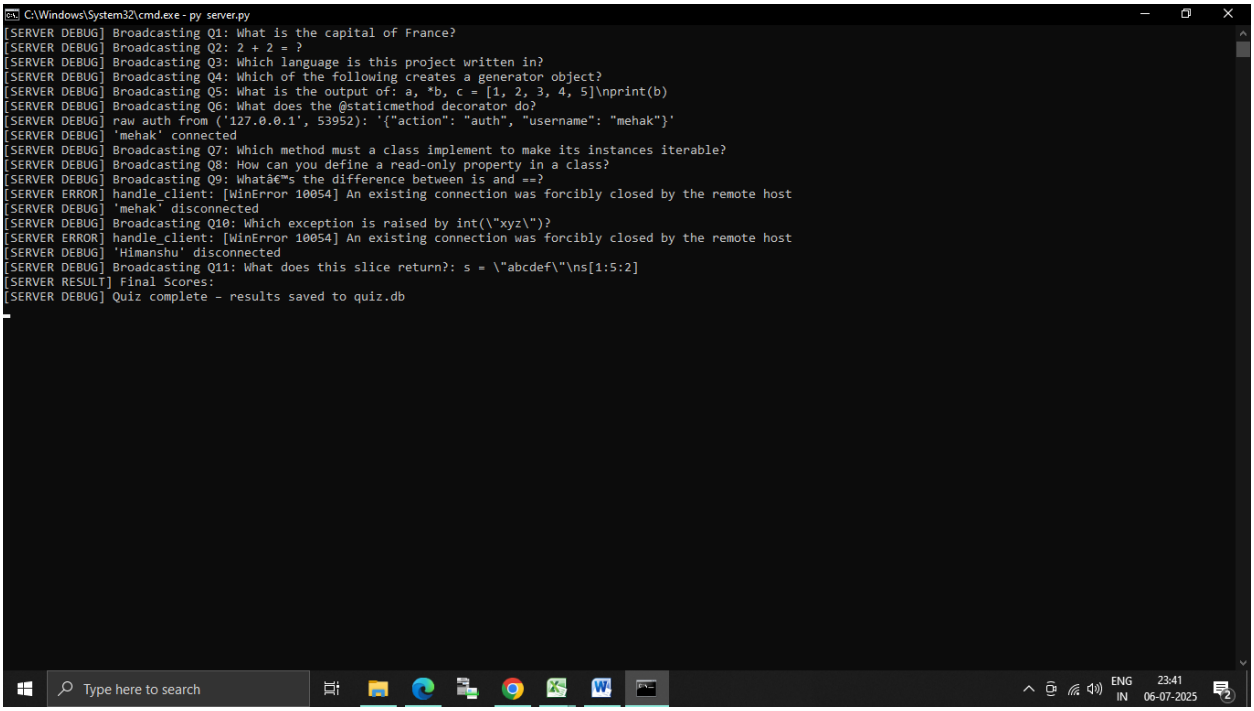
SOCKET PROGRAMMING IN PYTHON

PROJECT QUIZ SYSTEM IN PYTHON (MULLTIPLE CLIENT)




C:\Windows\System32\cmd.exe - py server.py
Microsoft Windows [Version 10.0.19045.6036]
(c) Microsoft Corporation. All rights reserved.
C:\Users\admin\Desktop\26python\05_26_projects_python\quiz_app_guiv2>py server.py
[SERVER DEBUG] Loaded 11 questions
[SERVER DEBUG] Waiting for first client…
[SERVER DEBUG] Listening on 0.0.0.0:9999
[SERVER DEBUG] raw auth from ('127.0.0.1', 53950): '{"action": "auth", "username": "Himanshu"}'
[SERVER DEBUG] Starting quiz in 5 seconds…[SERVER DEBUG] 'Himanshu' connected
[SERVER DEBUG] Broadcasting Q1: What is the capital of France?
[SERVER DEBUG] Broadcasting Q2: 2 + 2 = ?
[SERVER DEBUG] Broadcasting Q3: Which language is this project written in?
[SERVER DEBUG] Broadcasting Q4: Which of the following creates a generator object?
C:\Windows\System32\cmd.exe - py client.py
Microsoft Windows [Version 10.0.19045.6036]
(c) Microsoft Corporation. All rights reserved.
C:\Users\admin\Desktop\26python\05_26_projects_python\quiz_app_guiv2>py client.py
Quiz System
Quiz System by Student Drive Academy
Player: Himanshu
Q4/11: Which of the following creates a generator object?
Options
[x*x for x in range(5)]
(x*x for x in range(5))
{x*x for x in range(5)}
dict((x, x*x) for x in range(5))
Time left: 0s
Submit
Leaderboard
Himanshu: 2
developed by himanshu singh @sv infotech kanpur mail: himanshusingh1814@gmail.com
Type here to search
ENG
IN
23:39
06-07-2025


Quiz System
Quiz System by Student Drive Academy
Player: Himanshu
Q9/11: Whatâ€™s the difference between is and ==?
Options
== checks identity, is checks equality
is checks identity, == checks equality
No difference
is works only for numbers
Time left: 15s
Submit
Leaderboard
Himanshu: 2
mehak: 0
developed by himanshu singh @sv infotech kanpur mail: himanshusingh1814@gmail.com
Quiz System
Quiz System by Student Drive Academy
Player: mehak
Q9/11: Whatâ€™s the difference between is and ==?
Options
== checks identity, is checks equality
is checks identity, == checks equality
No difference
is works only for numbers
Time left: 15s
Submit
Leaderboard
Himanshu: 2
mehak: 0
developed by himanshu singh @sv infotech kanpur mail: himanshusingh1814@gmail.com
Type here to search
ENG
IN
23:40
06-07-2025



Source code:

py server.py

```
import socket

import threading

import json

import sqlite3

import time

from datetime import datetime


HOST, PORT = '0.0.0.0', 9999


# 1) Load quiz data immediately

with open('questions.json','r') as f:

    questions = json.load(f)
```

```
print(f"[SERVER DEBUG] Loaded {len(questions)} questions")


# 2) Track connected clients
clients = []           # each is {'conn','username','score','event','last_ans'}
clients_lock = threading.Lock()
client_connected = threading.Event()


# 3) SQLite persistence
db  = sqlite3.connect('quiz.db', check_same_thread=False)
cur = db.cursor()
cur.execute('''
  CREATE TABLE IF NOT EXISTS results (
    id       INTEGER PRIMARY KEY,
    username  TEXT,
    score     INTEGER,
    taken_at  TEXT
  )
''')
db.commit()


def broadcast(msg: dict):
    data = (json.dumps(msg) + '\n').encode()
    with clients_lock:
        for c in clients:
            try:
```

```
            c['conn'].sendall(data)
        except Exception as e:
            print(f"[SERVER ERROR] to {c['username']}: {e}")


def handle_client(conn, addr):
    f = conn.makefile('r')
    username = None
    try:
        # first message must be auth
        line = f.readline().strip()
        print(f"[SERVER DEBUG] raw auth from {addr}: {repr(line)}")
        req = json.loads(line)
        if req.get('action')!='auth':
            conn.close(); return


        username = req.get('username') or f"guest_{addr[1]}"
        client = {
            'conn': conn,
            'username': username,
            'score': 0,
            'event': threading.Event(),
            'last_ans': None
        }
        with clients_lock:
            clients.append(client)
```

```
            client_connected.set()
        conn.sendall(b'{"status":"ok"}\n')
        print(f"[SERVER DEBUG] '{username}' connected")

        # then accept answer messages
        for line in f:
            msg = json.loads(line)
            if msg.get('action')=='answer':
                client['last_ans'] = (msg['question_index'], msg['choice'])
                client['event'].set()

    except Exception as e:
        print(f"[SERVER ERROR] handle_client: {e}")
    finally:
        conn.close()
        with clients_lock:
            clients[:] = [c for c in clients if c['conn'] is not conn]
        print(f"[SERVER DEBUG] '{username}' disconnected")

def quiz_manager():
    # wait for someone to join
    print("[SERVER DEBUG] Waiting for first client…")
    client_connected.wait()

    # give a 5s buffer to join more clients
```

```
print("[SERVER DEBUG] Starting quiz in 5 seconds…")
time.sleep(5)

total = len(questions)
for qi, q in enumerate(questions):
    # clear previous answers
    with clients_lock:
        for c in clients:
            c['event'].clear()
            c['last_ans'] = None

    # broadcast question
    print(f"[SERVER DEBUG] Broadcasting Q{qi+1}: {q['question']}")
    broadcast({
        'action':         'question',
        'question_index':  qi,
        'total_questions': total,
        'question':        q['question'],
        'options':         q['options'],
        'time_limit':      q.get('time_limit', 20)
    })

    # wait up to time_limit or until all answered
    deadline = time.time() + q.get('time_limit', 20)
    while time.time() < deadline:
```

```
        with clients_lock:
            if all(c['event'].is_set() for c in clients):
                break
        time.sleep(0.1)

    # score the answers
    with clients_lock:
        for c in clients:
            ans = c['last_ans']
            if ans and ans[0] == qi and ans[1] == q['answer']:
                c['score'] += 1

    # broadcast interim leaderboard
    board = sorted([(c['username'], c['score']) for c in clients],
                   key=lambda x: -x[1])
    broadcast({'action':'leaderboard','scores':board})

# final results → broadcast + persist + console print
final = [(c['username'], c['score']) for c in clients]
broadcast({'action':'final','scores': final})

print("[SERVER RESULT] Final Scores:")
for user, score in final:
    print(f"  • {user}: {score}")
    cur.execute(
```

```
            "INSERT INTO results(username,score,taken_at) VALUES(?,?,?)",
            (user, score, datetime.now().isoformat())
        )
    db.commit()
    print("[SERVER DEBUG] Quiz complete – results saved to quiz.db")


def start_server():
    threading.Thread(target=quiz_manager, daemon=True).start()
    srv = socket.socket()
    srv.bind((HOST, PORT))
    srv.listen()
    print(f"[SERVER DEBUG] Listening on {HOST}:{PORT}")
    while True:
        conn, addr = srv.accept()
        threading.Thread(target=handle_client,
                         args=(conn, addr),
                         daemon=True).start()


if __name__=='__main__':
    start_server()
```

py client.py

```
import socket
import json
import threading
import tkinter as tk
from tkinter import messagebox

HOST, PORT = '127.0.0.1', 9999

class QuizClientApp:
    def __init__(self, root):
        self.root = root
        root.title("□ Quiz System □")

        # — Window size & center —
        win_w, win_h = 900, 740
        scr_w = root.winfo_screenwidth()
        scr_h = root.winfo_screenheight()
        x = (scr_w - win_w) // 2
        y = (scr_h - win_h) // 2
        root.geometry(f"{win_w}x{win_h}+{x}+{y}")
        root.configure(bg='#F0F8FF')  # AliceBlue

        self.build_login()
```

```
def build_login(self):
    self.login_frame = tk.Frame(self.root,
                            bg='#FFDAB9',  # PeachPuff
                            bd=2, relief='ridge',
                            padx=30, pady=30)
    self.login_frame.place(relx=0.5, rely=0.5, anchor='c')

    tk.Label(self.login_frame,
             text="Enter Your Username",
             font=('Georgia', 18, 'bold'),
             bg='#FFDAB9', fg='#4B0082')\
      .grid(row=0, column=0, columnspan=2, pady=(0,15))

    tk.Label(self.login_frame,
             text="Username:",
             font=('Arial', 14),
             bg='#FFDAB9')\
      .grid(row=1, column=0, sticky='e', padx=(0,10))
    self.username_entry = tk.Entry(self.login_frame,
                                   font=('Arial', 14))
    self.username_entry.grid(row=1, column=1, padx=(10,0))
    self.username_entry.focus()

    tk.Button(self.login_frame,
```

```
            text="Join Quiz",
            font=('Arial', 14, 'bold'),
            bg='#8A2BE2', fg='white',
            activebackground='#4B0082',
            padx=15, pady=8,
            command=self.on_join)\
        .grid(row=2, column=0, columnspan=2, pady=(20,0))

def on_join(self):
    self.username = self.username_entry.get().strip()
    if not self.username:
        messagebox.showwarning("Input Error", "Please enter a username.")
        return

    # Remove login, build full UI
    self.login_frame.destroy()
    self.build_banner()
    self.build_quiz_frame()
    self.build_footer()
    self.connect_to_server()

def build_banner(self):
    # Top banner
    self.banner = tk.Frame(self.root, bg='#FFD700', height=80)  # Gold
    self.banner.pack(fill='x')
```

```
    tk.Label(self.banner,
             text="Quiz System by Student Drive Academy",
             font=('Georgia', 24, 'bold'),
             bg='#FFD700', fg='#8B0000')\
      .pack(pady=(10,0))
    # Username display
    tk.Label(self.banner,
             text=f"Player: {self.username}",
             font=('Arial', 12, 'italic'),
             bg='#FFD700', fg='#000080')\
      .pack(pady=(0,8))

def build_quiz_frame(self):
    # Main quiz area
    self.quiz_frame = tk.Frame(self.root,
                               bg='#E6E6FA',  # Lavender
                               padx=20, pady=20)
    self.quiz_frame.pack(fill='both', expand=True)

    # Question label
    self.question_lbl = tk.Label(self.quiz_frame,
                                 text="",
                                 font=('Arial', 16, 'bold'),
                                 wraplength=800,
                                 justify='left',
```

```
                        bg='#E6E6FA',
                        fg='#2F4F4F')
    self.question_lbl.pack(pady=(0,20))

    # Options
    opts_frame = tk.LabelFrame(self.quiz_frame,
                        text="Options",
                        font=('Arial', 12, 'bold'),
                        bg='#FFFACD',  # LemonChiffon
                        fg='#8B4513',  # SaddleBrown
                        padx=10, pady=10)
    opts_frame.pack(fill='x', pady=(0,20))
    self.radio_var = tk.IntVar(value=-1)
    self.opts = []
    for i in range(4):
        rb = tk.Radiobutton(opts_frame,
                        text="",
                        variable=self.radio_var,
                        value=i,
                        font=('Arial', 14),
                        bg='#FFFACD',
                        activebackground='#FAFAD2',
                        selectcolor='#FFEFD5')
        rb.pack(anchor='w', pady=5)
        self.opts.append(rb)
```

```
# Controls (timer, progress, submit)
ctrl = tk.Frame(self.quiz_frame, bg='#E6E6FA')
ctrl.pack(fill='x', pady=(0,20))
self.timer_lbl = tk.Label(ctrl,
                          text="Time left: --",
                          font=('Arial', 12),
                          bg='#E6E6FA')
self.timer_lbl.pack(side='left')
# Progress bar (canvas)
self.prog_canvas = tk.Canvas(ctrl,
                             width=400, height=20,
                             bg='#D3D3D3',
                             highlightthickness=0)
self.prog_canvas.pack(side='left', padx=10)
self.prog_bar = self.prog_canvas.create_rectangle(
    0,0,0,20, fill='#7FFFD4')  # Aquamarine
# Submit button
self.submit_btn = tk.Button(ctrl,
                            text="Submit",
                            font=('Arial', 12, 'bold'),
                            bg='#32CD32', fg='white',
                            activebackground='#228B22',
                            state='disabled',
                            padx=15, pady=5,
```

```
                        command=self.on_submit)
    self.submit_btn.pack(side='right')


    # Leaderboard
    tk.Label(self.quiz_frame,
            text="Leaderboard",
            font=('Arial', 14, 'underline'),
            bg='#E6E6FA')\
      .pack()
    self.lb = tk.Listbox(self.quiz_frame,
                         font=('Arial', 12),
                         bg='#F5FFFA',  # MintCream
                         fg='#006400',  # DarkGreen
                         height=6)
    self.lb.pack(fill='x', padx=100, pady=(5,0))


def build_footer(self):
    # Bottom footer
    self.footer = tk.Label(self.root,
                           text=("developed by himanshu singh @sv infotech kanpur    "
                                 "mail: himanshusingh1814@gmail.com"),
                           font=('Arial', 10),
                           bg='#D3D3D3',
                           fg='#333333')
    self.footer.pack(side='bottom', fill='x')
```

```
def connect_to_server(self):
    self.sock = socket.socket()
    try:
        self.sock.connect((HOST, PORT))
        self.sock_file = self.sock.makefile('r')
        self.send({'action':'auth','username':self.username})
        resp = json.loads(self.sock_file.readline())
        if resp.get('status')!='ok':
            raise RuntimeError(resp.get('msg','Auth failed'))
    except Exception as e:
        messagebox.showerror("Connection Error", str(e))
        self.root.destroy()
        return
    threading.Thread(target=self.listen, daemon=True).start()

def send(self, msg):
    self.sock.sendall((json.dumps(msg)+'\n').encode())

def listen(self):
    for line in self.sock_file:
        m = json.loads(line.strip())
        act = m.get('action')
        if act=='question':
            self.root.after(0, lambda msg=m: self.on_question(msg))
```

```
            elif act=='leaderboard':
                self.root.after(0, lambda msg=m: self.on_leaderboard(msg))
            elif act=='final':
                self.root.after(0, lambda msg=m: self.on_final(msg))
                break
        self.sock.close()

    def on_question(self, m):
        self.current = m
        idx, tot = m['question_index'], m['total_questions']
        self.question_lbl.config(text=f"Q{idx+1}/{tot}: {m['question']}")
        for i, opt in enumerate(m['options']):
            self.opts[i].config(text=opt)
        self.radio_var.set(-1)
        self.submit_btn.config(state='normal')
        # reset & start timer/progress
        self.time_left = m.get('time_limit',20)
        self.update_progress()
        self.countdown()

    def update_progress(self):
        idx, tot = self.current['question_index'], self.current['total_questions']
        width = 400 * (idx+1)/tot
        self.prog_canvas.coords(self.prog_bar, 0,0, width,20)
```

```
def countdown(self):
    if self.time_left >= 0:
        self.timer_lbl.config(text=f"Time left: {self.time_left}s")
        self.time_left -= 1
        self.root.after(1000, self.countdown)
    else:
        self.submit_btn.config(state='disabled')


def on_submit(self):
    choice = self.radio_var.get()
    if choice<0:
        messagebox.showwarning("No Selection", "Please pick an option.")
        return
    self.send({
        'action':'answer',
        'question_index': self.current['question_index'],
        'choice': choice
    })
    self.submit_btn.config(state='disabled')


def on_leaderboard(self, m):
    self.lb.delete(0, 'end')
    for user, sc in m.get('scores', []):
        self.lb.insert('end', f"{user}: {sc}")
```

```
    def on_final(self, m):
        final = m.get('scores', [])
        your = next((s for u,s in final if u==self.username), None)
        board = "\n".join(f"{u}: {s}" for u,s in final)
        messagebox.showinfo("Quiz Over",
            f"Your score: {your}\n\nFinal leaderboard:\n{board}")
        self.root.destroy()


if __name__ == '__main__':
    root = tk.Tk()
    app = QuizClientApp(root)
    root.mainloop()
```

py admin_client.py

```
import sys, socket, json


if len(sys.argv)!=2:
    print("Usage: python admin_client.py questions.json")
    sys.exit(1)


with open(sys.argv[1],'r') as f:
    questions = json.load(f)


HOST, PORT = '127.0.0.1', 9999
ADMIN_PASS     = 'supersecret'


sock = socket.socket()
sock.connect((HOST, PORT))
f = sock.makefile('r')


# Authenticate as admin
sock.sendall((json.dumps({
    'action':'auth','role':'admin','password':ADMIN_PASS
})+'\n').encode())
print("Auth:", json.loads(f.readline()))


# Load questions
sock.sendall((json.dumps({
```

```
    'action':'load','questions': questions
})+'\n').encode())
print("Load:", json.loads(f.readline()))


# Start quiz
sock.sendall((json.dumps({
    'action':'start'
})+'\n').encode())
print("Start:", json.loads(f.readline()))


sock.close()
```

questions.json

```
[
 {
  "question": "What is the capital of France?",
  "options": ["Paris", "London", "Berlin", "Madrid"],
  "answer": 0,
  "time_limit": 15
 },
 {
  "question": "2 + 2 = ?",
  "options": ["3", "4", "5", "2"],
  "answer": 1,
  "time_limit": 10
 },
 {
  "question": "Which language is this project written in?",
  "options": ["Java", "C++", "Python", "Ruby"],
  "answer": 2,
  "time_limit": 12
 },
 {
  "question": "Which of the following creates a generator object?",
  "options": [
   "[x*x for x in range(5)]",
   "(x*x for x in range(5))",
```

```
    "{x*x for x in range(5)}",
    "dict((x, x*x) for x in range(5))"
  ],
  "answer": 1,
  "time_limit": 15
},
{
  "question": "What is the output of: a, *b, c = [1, 2, 3, 4, 5]\\nprint(b)",
  "options": ["[1, 2, 3, 4]", "[2, 3, 4]", "(2, 3, 4)", "([2, 3, 4],)"],
  "answer": 1,
  "time_limit": 15
},
{
  "question": "What does the @staticmethod decorator do?",
  "options": [
    "Binds method to the class, not the instance",
    "Allows method to access instance data",
    "Automatically converts method to class method",
    "Makes method run in a separate thread"
  ],
  "answer": 0,
  "time_limit": 15
},
{
  "question": "Which method must a class implement to make its instances iterable?",
```

```
  "options": ["__getitem__", "__iter__", "__call__", "__next__"],
  "answer": 1,
  "time_limit": 15
},
{
  "question": "How can you define a read-only property in a class?",
  "options": [
    "Use @property without a setter",
    "Define __get__ only in a descriptor",
    "Use readonly keyword",
    "Both A and B"
  ],
  "answer": 3,
  "time_limit": 15
},
{
  "question": "What’s the difference between is and ==?",
  "options": [
    "== checks identity, is checks equality",
    "is checks identity, == checks equality",
    "No difference",
    "is works only for numbers"
  ],
  "answer": 1,
  "time_limit": 15
```

```
 },
 {
  "question": "Which exception is raised by int(\\\"xyz\\\")?",
  "options": ["ValueError", "TypeError", "SyntaxError", "KeyError"],
  "answer": 0,
  "time_limit": 15
 },
 {
  "question": "What does this slice return?: s = \\\"abcdef\\\"\\ns[1:5:2]",
  "options": ["bdf", "bd", "ace", "bcde"],
  "answer": 1,
  "time_limit": 15
 }
]
```

quiz.db will initiate automatically

first run **py server.py**

then **py client.py** in other terminal

1. What Is Network Programming?

At its heart, **network programming** means writing code that lets one computer talk to another over a network. You'll deal with:

- **Protocols** (rules for formatting and exchanging data): TCP, UDP, HTTP, etc.
- **Client–Server architecture**: one side listens ("server") and one side connects ("client").
- **Sockets**: the programming abstraction that represents an endpoint for sending/receiving data.

---

2. Prerequisites

- Python 3.x installed
- Basic familiarity with Python syntax
- (Optional) Command-line comfort

---

3. The Python `socket` Module

Python's builtin `socket` module gives you low-level access to the BSD socket API.

```
import socket
```

Key classes/functions:

- `socket.socket(family, type)` — create a socket object
- `bind(address)` — attach a server socket to a local address (host, port)
- `listen(backlog)` — start listening for connections (TCP only)
- `accept()` — accept an incoming TCP connection
- `connect(address)` — initiate a connection from a client
- `send()` / `recv()` — send and receive bytes
- `sendto()` / `recvfrom()` — send/receive with a specified address (UDP)
- `close()` — close the socket

---

4. A Simple TCP Echo Server & Client

4.1 TCP Server

```
# tcp_echo_server.py
import socket

HOST = '127.0.0.1'  # localhost
PORT = 65432        # arbitrary non-privileged port

with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as serv:
    serv.bind((HOST, PORT))
    serv.listen()  # backlog defaults to a reasonable value
    print(f"Server listening on {HOST}:{PORT}")
    conn, addr = serv.accept()  # wait for a client
    with conn:
        print('Connected by', addr)
        while True:
            data = conn.recv(1024)  # receive up to 1024 bytes
            if not data:
                break
            conn.sendall(data)      # echo it back
```

4.2 TCP Client

```
# tcp_echo_client.py
import socket

HOST = '127.0.0.1'
PORT = 65432

with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as sock:
    sock.connect((HOST, PORT))
    for msg in [b'Hello', b'World', b'!']:
        print(f"Sending: {msg!r}")
        sock.sendall(msg)
        data = sock.recv(1024)
        print(f"Received: {data!r}")
```

Run the server first (`python tcp_echo_server.py`), then the client.

---

5. UDP “Echo” Server & Client

UDP is connection-less and doesn’t guarantee delivery.

5.1 UDP Server

```
# udp_echo_server.py
import socket

HOST, PORT = '127.0.0.1', 65433

with socket.socket(socket.AF_INET, socket.SOCK_DGRAM) as serv:
    serv.bind((HOST, PORT))
    print(f"UDP server on {HOST}:{PORT}")
    while True:
        data, addr = serv.recvfrom(1024)
        print(f"Received {data!r} from {addr}")
        serv.sendto(data, addr)  # echo back
```

5.2 UDP Client

```
# udp_echo_client.py
import socket

HOST, PORT = '127.0.0.1', 65433

with socket.socket(socket.AF_INET, socket.SOCK_DGRAM) as sock:
    for msg in [b'Foo', b'Bar']:
        sock.sendto(msg, (HOST, PORT))
        data, _ = sock.recvfrom(1024)
        print(f"Echoed back: {data!r}")
```

---

6. Handling Multiple Clients

A single-threaded server handles one client at a time. To support many clients:

1. **Threading**: spawn a new `threading.Thread` for each connection.
2. **`selectors` module**: multiplex many sockets in a single thread (more scalable).

6.1 Threaded TCP Server (overview)

```
import socket, threading

def handle_client(conn, addr):
    with conn:
        print('Client', addr)
        while True:
            data = conn.recv(1024)
            if not data: break
            conn.sendall(data)

with socket.socket() as serv:
    serv.bind(('0.0.0.0', 65432))
    serv.listen()
    while True:
        conn, addr = serv.accept()
        threading.Thread(target=handle_client, args=(conn, addr),
daemon=True).start()
```

---

7. Higher-Level Helpers

7.1 `socketserver` Module

The `socketserver` module provides classes to simplify servers:

```
from socketserver import ThreadingTCPServer, StreamRequestHandler

class EchoHandler(StreamRequestHandler):
    def handle(self):
        for line in self.rfile:
            self.wfile.write(line)

if __name__ == '__main__':
    with ThreadingTCPServer(('0.0.0.0', 9999), EchoHandler) as server:
        server.serve_forever()
```

7.2 `asyncio` & Async IO

Modern async approach (Python 3.7+):

```
import asyncio

async def handle_echo(reader, writer):
    data = await reader.read(100)
    writer.write(data)
    await writer.drain()
    writer.close()

async def main():
    server = await asyncio.start_server(handle_echo, '127.0.0.1', 8888)
    async with server:
        await server.serve_forever()

asyncio.run(main())
```

---

8. Practical Tips & Next Steps

- **Keep data small** (chunk sizes of 1 KB–4 KB often work well).
- **Handle exceptions** (`ConnectionResetError`, timeouts).
- **Use timeouts** with `sock.settimeout()` to avoid hangs.
- **Security**: never trust incoming data; sanitize and validate.
- **Explore higher-level protocols**: HTTP with `requests`/`aiohttp`, FTP with `ftplib`, email with `smtplib`/`imaplib`.
- **Learn packet-level** programming with `scapy` for advanced network tasks.

Summary

1. Learn basic **socket API**: `socket()`, `bind()`, `listen()`, `accept()`, `connect()`, `send()`/`recv()`.
2. Practice both **TCP** and **UDP** echo servers/clients.
3. Scale to multiple clients with **threads** or **selectors**.
4. Try the **socketserver** and **asyncio** libraries for cleaner code.
5. Move on to real-world protocols (HTTP, FTP, SMTP) and packet crafting.

With these fundamentals, you'll have the building blocks to create chat servers, file transfer tools, custom network services—and understand how any networked application under the hood moves bytes around. Happy coding

EXAMPLE:

Below is a pair of Python scripts—for the server and the client—that together implement a simple, production-quality, CLI-based chat system. They support multiple clients, clean startup/shutdown, logging, argument parsing, and basic error handling.

---

server.py

```
#!/usr/bin/env python3
"""
server.py

A multi-client chat server. Accepts TCP connections, broadcasts messages
from any client to all others, and handles clean shutdown on SIGINT/SIGTERM.
"""

import argparse
import logging
import signal
import socket
import sys
import threading
from typing import List, Tuple

logging.basicConfig(
    level=logging.INFO,
    format='[%(asctime)s] %(levelname)s: %(message)s',
    datefmt='%Y-%m-%d %H:%M:%S'
)

class ChatServer:
    def __init__(self, host: str, port: int):
        self.address: Tuple[str, int] = (host, port)
        self.server_socket = socket.socket(socket.AF_INET,
socket.SOCK_STREAM)
        self.server_socket.setsockopt(socket.SOL_SOCKET, socket.SO_REUSEADDR,
1)
        self.clients: List[socket.socket] = []
        self.clients_lock = threading.Lock()
        self.running = False

    def start(self) -> None:
        """Bind, listen, and start accepting clients."""
        self.server_socket.bind(self.address)
        self.server_socket.listen()
        self.running = True
        logging.info(f"Chat server listening on
{self.address[0]}:{self.address[1]}")
        signal.signal(signal.SIGINT, self._shutdown_signal)
        signal.signal(signal.SIGTERM, self._shutdown_signal)
        try:
```

```
            while self.running:
                conn, addr = self.server_socket.accept()
                logging.info(f"Connection from {addr}")
                with self.clients_lock:
                    self.clients.append(conn)
                threading.Thread(
                    target=self._handle_client,
                    args=(conn, addr),
                    daemon=True
                ).start()
        finally:
            self._cleanup()

    def _handle_client(self, conn: socket.socket, addr: Tuple[str, int]) ->
None:
        """Receive messages from one client and broadcast them."""
        try:
            with conn:
                while True:
                    data = conn.recv(1024)
                    if not data:
                        break
                    message = f"{addr[0]}:{addr[1]}> {data.decode().strip()}"
                    logging.info(f"Broadcasting: {message}")
                    self._broadcast(message, exclude=conn)
        except ConnectionResetError:
            logging.warning(f"Connection lost from {addr}")
        finally:
            with self.clients_lock:
                if conn in self.clients:
                    self.clients.remove(conn)
            logging.info(f"Client {addr} disconnected")

    def _broadcast(self, message: str, exclude: socket.socket) -> None:
        """Send message to all clients except the sender."""
        with self.clients_lock:
            for client in list(self.clients):
                if client is not exclude:
                    try:
                        client.sendall((message + "\n").encode())
                    except Exception:
                        logging.exception("Error sending to client,
removing")
                        self.clients.remove(client)

    def _shutdown_signal(self, signum, frame) -> None:
        """Signal handler to stop the server loop."""
        logging.info(f"Shutdown signal ({signum}) received")
        self.running = False

    def _cleanup(self) -> None:
        """Close all client connections and the server socket."""
        logging.info("Shutting down server, closing connections")
        with self.clients_lock:
            for client in self.clients:
                try:
                    client.shutdown(socket.SHUT_RDWR)
```

```
                    client.close()
                except Exception:
                    pass
            self.clients.clear()
        self.server_socket.close()
        logging.info("Server shutdown complete")

def parse_args() -> argparse.Namespace:
    parser = argparse.ArgumentParser(description="Multi-client chat server")
    parser.add_argument(
        "--host", "-H",
        default="0.0.0.0",
        help="Interface to bind (default: all interfaces)"
    )
    parser.add_argument(
        "--port", "-p",
        type=int,
        default=5000,
        help="Port number to listen on (default: 5000)"
    )
    return parser.parse_args()

def main() -> None:
    args = parse_args()
    server = ChatServer(args.host, args.port)
    server.start()

if __name__ == "__main__":
    main()
```

---

client.py

```
#!/usr/bin/env python3
"""
client.py

A CLI chat client. Connects to the chat server, reads user input from stdin,
sends it, and concurrently listens for incoming messages to display.
"""

import argparse
import logging
import socket
import sys
import threading
from typing import Tuple

logging.basicConfig(
    level=logging.INFO,
    format='[%(asctime)s] %(levelname)s: %(message)s',
    datefmt='%Y-%m-%d %H:%M:%S'
)

def receive_messages(sock: socket.socket) -> None:
```

```
    """Continuously read from the socket and print to stdout."""
    try:
        while True:
            data = sock.recv(1024)
            if not data:
                logging.info("Server closed the connection")
                break
            print(data.decode(), end='')
    except Exception:
        logging.exception("Error receiving data")
    finally:
        sock.close()
        sys.exit(0)

def parse_args() -> argparse.Namespace:
    parser = argparse.ArgumentParser(description="CLI chat client")
    parser.add_argument(
        "host",
        help="Server hostname or IP address"
    )
    parser.add_argument(
        "port",
        type=int,
        help="Server port number"
    )
    return parser.parse_args()

def main() -> None:
    args = parse_args()
    server_addr: Tuple[str, int] = (args.host, args.port)
    sock = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
    try:
        sock.connect(server_addr)
    except Exception as e:
        logging.error(f"Could not connect to {server_addr}: {e}")
        sys.exit(1)

    logging.info(f"Connected to chat server at {server_addr}")
    threading.Thread(target=receive_messages, args=(sock,),
daemon=True).start()

    try:
        for line in sys.stdin:
            message = line.strip()
            if message.lower() == "/quit":
                break
            sock.sendall((message + "\n").encode())
    except KeyboardInterrupt:
        logging.info("Interrupted by user")
    finally:
        logging.info("Closing connection")
        sock.close()

if __name__ == "__main__":
    main()
```

How to Use

1. **Start the server** on a machine (or container) accessible to clients:

   ```
   bash
   CopyEdit
   python3 server.py --host 0.0.0.0 --port 5000
   ```

2. **Run one or more clients** from any terminal:

   ```
   bash
   CopyEdit
   python3 client.py 192.168.1.100 5000
   ```

3. **Chat** by typing messages and pressing Enter.
   - Incoming messages appear with the sender's IP and port.
   - To exit the client, type `/quit` or press Ctrl+C.

Production-Level Features

- **Argument parsing** via `argparse`
- **Structured logging** (timestamps, levels)
- **Graceful shutdown** with signal handling (server) and clean client exit
- **Thread-based concurrency** to support multiple clients
- **Error handling** around network operations

You can extend this further by adding user nicknames, authentication, encryption (TLS), or a GUI—but this foundation gives you a robust, maintainable CLI chat application ready for production use.