

```

 81 # Here are our imports, these allow us to use functions from other libraries
 82 import time
 83 import os
 84 import subprocess
 85 import socketserver
 86 import socketserver
 87 import json
 88
 89 def date_time():
 90     return json.dumps({"dateTime": time.time()})
 91
 92 def up_time():
 93     uptime = subprocess.run(["uptime", "-v"], stdout=subprocess.PIPE)
 94     uptime_output = uptime.stdout.strip().decode("utf-8")
 95     up_time_output = uptime_output.split("\n")
 96     return json.dumps([{"upTime": time.time() - int(up_time_output[1])})
 97
 98 def memory_usage():
 99     return json.dumps([{"memoryUsage": os.cpu_count()}])
100
101 # Returns network connection fields in the project instructions
102
103 def network_connections():
104
105     result = subprocess.run(["netstat"], stdout=subprocess.PIPE)
106     jsonToReturn = []
107     for line in result.stdout.decode("utf-8").split("\n"):
108         if line != "":
109             protocol, receiveQueue, sendQueue, localAddress, foreignAddress, _, state, _ = line.split()
110             jsonToReturn.append({"proto": protocol, "receiveQueue": receiveQueue, "sendQueue": sendQueue, "localAddress": localAddress, "foreignAddress": foreignAddress, "state": state})
111
112     return json.dumps(jsonToReturn)
113
114 # TODO: Check for socket fields in the project instructions
115
116 def current_users():
117
118     current_users = subprocess.run(["who"], stdout=subprocess.PIPE).stdout.decode("utf-8")
119     for user in current_users:
120         users.append(user.username)
121         users.append(user.host)
122
123     return json.dumps(users)
124
125 # TODO: Check for process fields in the project instructions
126
127 def running_processes():
128
129     processes = []
130     current_processes = subprocess.run(["ps"], stdout=subprocess.PIPE)
131     for process in current_processes:
132         processes.append(process)
133
134     return json.dumps(processes)
135
136 # Bundles our response in a readable way
137 def package_response(self, response):
138
139     self.send_header("Content-Type", "application/json")
140     self.end_headers()
141     self.wfile.write(response.encode())
142
143 class ServerHandler(http.server.BaseHTTPRequestHandler):
144
145     # Calls when we do a get request
146     def do_GET(self):
147         path = self.path
148
149         if path == "/runningProcesses":
150             response = running_processes()
151             package_response(self, response)
152
153         elif path == "/currentUsers":
154             response = current_users()
155             package_response(self, response)
156
157         elif path == "/networkConnections":
158             response = network_connections()
159             package_response(self, response)
160
161         elif path == "/memoryUsage":
162             response = memory_usage()
163             package_response(self, response)
164
165         elif path == "/upTime":
166             response = up_time()
167             package_response(self, response)
168
169         elif path == "/dateTime":
170             response = date_time()
171             package_response(self, response)
172
173         else:
174             response = "404 - No route found for routes unknown"
175             self.send_response(404)
176             self.end_headers()
177             self.wfile.write("Not Found".encode())
178
179 # Starts our server
180 with socketserver.TCPServer(("", 3215), ServerHandler) as httpd:
181     print("Serving at port 3215...")
182     httpd.serve_forever()

```

## Iterative Socket Server

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CNT4504 Computer Networks & Distributed Processing

Professor John Kelly

## Introduction

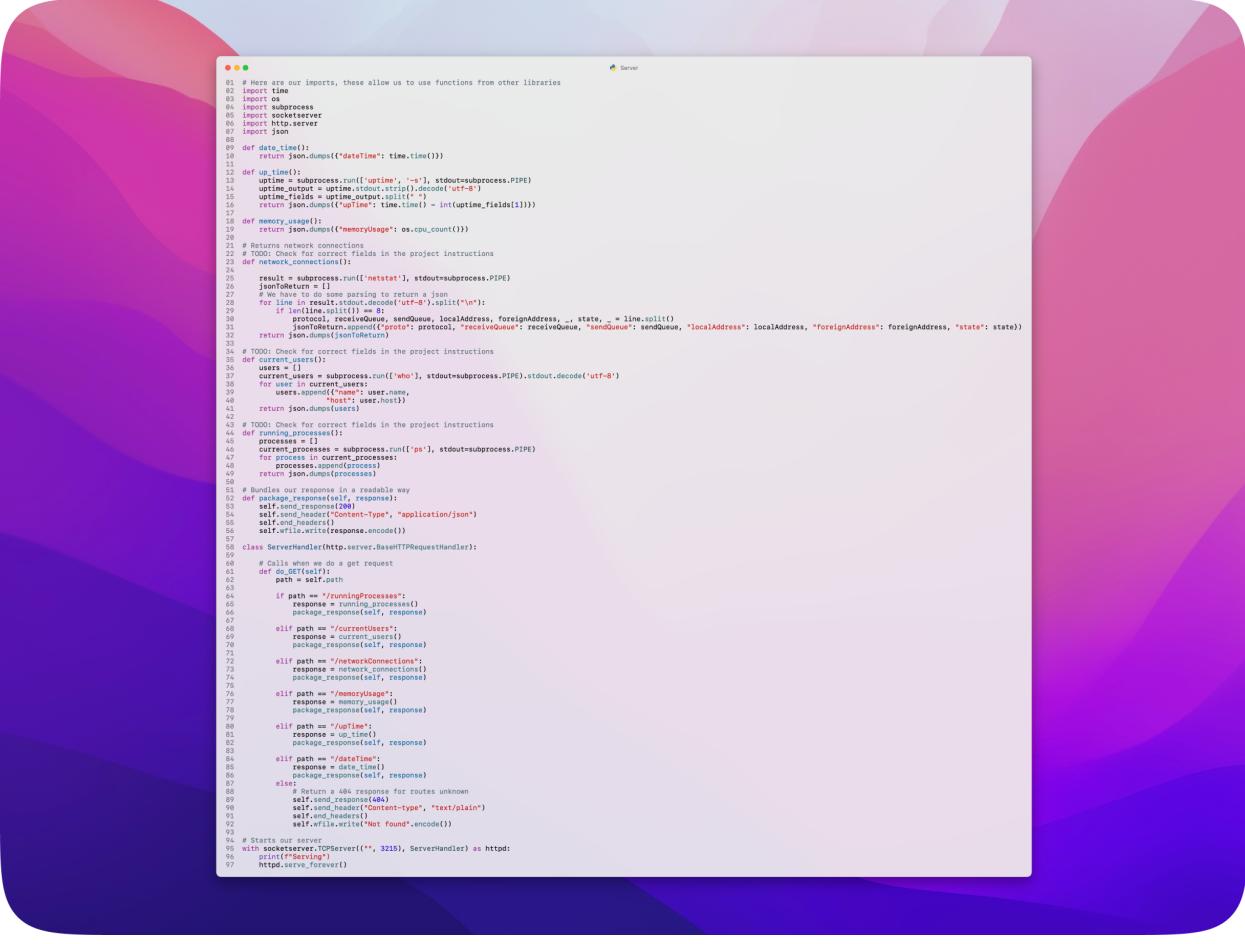
CNT4504 Computer Networks & Distributed Processing is a fascinating course that quite literally connects us all. During our class we learned the relationships of servers and clients and how they impact each other. Therefore, we were tasked to apply our learnings and understandings of server/client relationships. We built a server and client that was developed in Python 3.6 where both the server and client had simple tasks to perform. The server takes in several requests from the user and establishes a connection to the server where the requests are processed and distributed back to the user via a printed message. We aimed to examine how the server would be impacted by the number of requests from the client server and the types of requests. Further, to analyze the impact of the processing speed and the number of requests idling. This analysis documents the design process of each server from the client to the request server. We dive into the programming language and the syntax describing the steps of how it iterates and processes the requests, and encapsulates how data is collected and analyzed including at what speed the server is processing requests.

## Client-Server Setup and Configuration

```

 61 import requests
 62 import datetime
 63 # This file contains imports for errors or other messaging
 64 # CommandExecutionError may be for errors or other messaging
 65 # CommandExecutionError("Command failed to run")
 66 commands = ["d = date time", "u = up time", "n = memory usage", "n = network connections", "p = running processes", "cu = current users"]
 67 inputInstructions = "Command to run"
 68 iterationsInstructions = "How many times should the command run?\n"
 69 for command in commands:
 70     inputInstructions += command + "\n"
 71
 72 # Given configuration of the server
 73 # Example: https://google.api.com/someEndpoint
 74 def fetch(endpoint: str):
 75     try:
 76         return requests.get(baseUrl + endpoint)
 77     except requests.exceptions.RequestException as e:
 78         print(requestErrorDescription)
 79         return None
 80     # For basic endpoints this returns a number
 81 def basicEndpoint(endpoint: str):
 82     response = fetch(endpoint)
 83     if response == requestErrorDescription:
 84         print(requestErrorDescription)
 85         return None
 86     try:
 87         json = response.json()
 88         return json[endpoint]
 89     except requests.exceptions.RequestException as e:
 90         print(requestErrorDescription)
 91         return None
 92
 93 # For complex endpoints that require a few components
 94 def complexEndpoint(endpoint: str):
 95     dataTimeResponse = fetch(endpoint)
 96     if dataTimeResponse == requestErrorDescription: return None
 97     timestamp = dataTimeResponse.json()['timestamp']
 98     return timestamp
 99
 100 # Given columns, this method prints the column and value
 101 def printJSONColumns([it], json):
 102     for column in columns:
 103         try:
 104             print(column + ": " + json[column])
 105         except:
 106             print("Column not found")
 107
 108 # Start listening for new input
 109 while inputKey != "" or inputKey != "q":
 110     iterationStartDate = datetime.datetime.now().timestamp()
 111     if inputKey == "q": break
 112     if inputKey == "c": printComplexEndpoint("dateTime")
 113     if inputKey == "r": printBasicEndpoint("dateTime")
 114     if inputKey == "t": printBasicEndpoint("uptime")
 115     if inputKey == "m": printBasicEndpoint("memoryUsage")
 116     if inputKey == "n": networkConnections = getComplexEndpoint("networkConnections")
 117     if inputKey == "p": runningProcesses = getComplexEndpoint("runningProcesses")
 118     if inputKey == "s": printSimpleFieldValues()
 119     printJSON(["tbd", "tbd"], runningProcesses)
 120     if inputKey == "cu": runningProcesses = getComplexEndpoint("currentUsers")
 121     if inputKey == "id": printSimpleFieldValues()
 122     printJSON(["tbd"], runningProcesses)
 123     averageTimes.append(datetime.datetime.now().timestamp() - iterationStartDate)
 124
 125     inputKey = input()
 126
 127     print(f"Request over time: {averageTimes}")
 128     print(f"Average time per request: {mean(averageTimes)}")
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```

The client is composed of modular architecture to ensure maintainability and readability throughout the programming process. For example, we created methods such as `getBasicEndpoint` and `getComplexEndpoint`. These methods were used to abstract certain reusable components such as retrieving a basic endpoint that returns a double or float, and then a more complex method that returns a json. Moreover, it utilizes other helper methods such as `fetch`, which wraps the requests library in python and handles exceptions by printing an error message that is defined as a constant at the top of the Python script.



```

 1 # Here are our imports, these allow us to use functions from other libraries
 2 import time
 3
 4 import subprocess
 5 import socketserver
 6 import http.server
 7 import json
 8
 9 def data_time():
10     return json.dumps({"dataTime": time.time()})
11
12 def uptime():
13     result = subprocess.run(['uptime', '-s'], stdout=subprocess.PIPE)
14     uptime_output = result.stdout.decode('utf-8')
15     uptime_fields = uptime_output.split()
16     return json.dumps({"uptime": time.time() - int(uptime_fields[1])})
17
18 def memory_usage():
19     return json.dumps({"memoryUsage": os.cpu_count()})
20
21 # Returns network connections
22 # TODO: Change for correct fields in the project instructions
23 def network_connections():
24
25     result = subprocess.run(['netstat', '-l'], stdout=subprocess.PIPE)
26     jsonToReturn = []
27     jsonToReturn.append({})
28     for line in result.stdout.decode('utf-8').split("\n"):
29         if len(line) > 10:
30             proto, receiveQueue, sendQueue, localAddress, foreignAddress, _, state, _ = line.split()
31             jsonToReturn.append({"proto": proto, "receiveQueue": receiveQueue, "sendQueue": sendQueue, "localAddress": localAddress, "foreignAddress": foreignAddress, "state": state})
32
33     return json.dumps(jsonToReturn)
34
35 # TODO: Change for correct fields in the project instructions
36 def current_users():
37
38     users = []
39     result = subprocess.run(['who'], stdout=subprocess.PIPE).stdout.decode('utf-8')
40     for user in current_users:
41         users.append({"user": user.name,
42                       "host": user.host})
43
44     return json.dumps(users)
45
46 # TODO: Change for correct fields in the project instructions
47 def running_processes():
48
49     processes = []
50     result = subprocess.run(['ps'], stdout=subprocess.PIPE)
51     for process in running_processes:
52         processes.append(process)
53     return json.dumps(processes)
54
55     # Bundles our response in a readable way
56     def package_response(self, response):
57
58         self.send_header("Content-Type", "application/json")
59         self.end_headers()
60         response = response.encode()
61
62         class ServerHandlerIn(http.server.BaseHTTPRequestHandler):
63
64             # Called when we do a get request
65             def do_GET(self):
66                 path = self.path
67
68                 if path == '/runInProcesses':
69                     response = self.bundle_processes()
70                     package_response(self, response)
71
72                 elif path == '/currentUsers':
73                     response = current_users()
74                     package_response(self, response)
75
76                 elif path == '/memoryUsage':
77                     response = memory_usage()
78                     package_response(self, response)
79
80                 elif path == '/uptime':
81                     response = uptime()
82                     package_response(self, response)
83
84                 elif path == '/dateTime':
85                     response = date_time()
86                     package_response(self, response)
87
88                 else:
89                     # Return a 404 response for routes unknown
90                     self.send_error(404, "Not Found")
91                     self.end_headers()
92                     self.wfile.write("Not Found".encode())
93
94             # Starts our server
95             with socketserver.TCPServer(("", 3219), ServerHandler) as httpd:
96                 httpd.serve_forever()
97

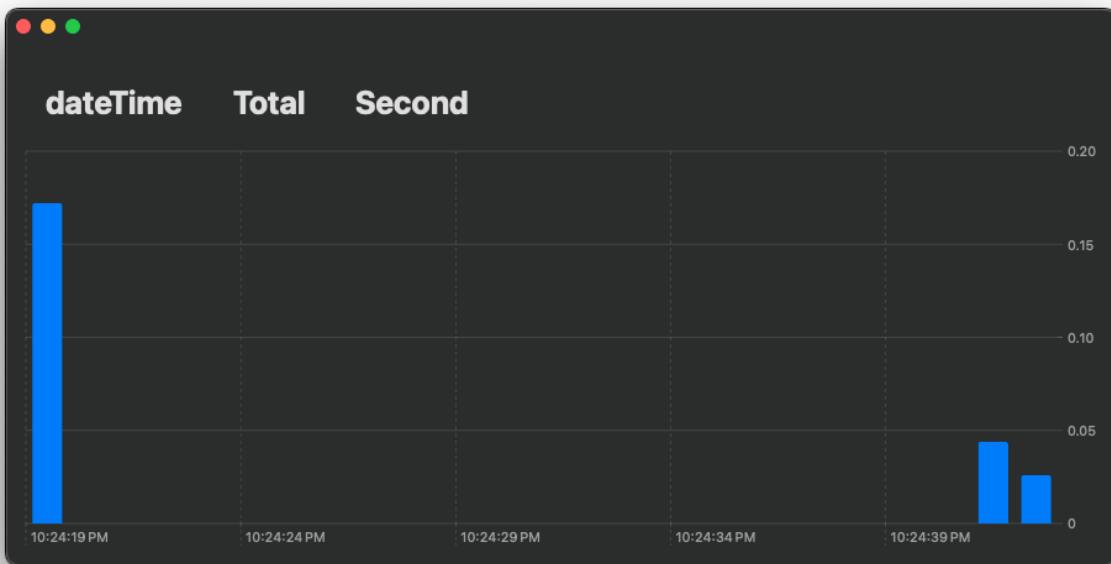
```

Similarly, the server utilizes modularity and abstraction to write cleaner code. We've abstracted each endpoint into a helper method that executes the Linux command and parses it as needed so it's digestible on the client side. For example, 'network\_connections' utilizes subprocesses to run 'netstat', which is then split into each line and extracted to be dumped in a json object. However there is one discrepancy in code uniformity with the use of camel case and snake case between the client and server, ideally we'd maintain the same coding conventions across the two scripts.

Overall, we decided to approach the code in this way to improve maintainability and readability which helped with the efficiency of development and pressing .

## **Testing and Data Collection**

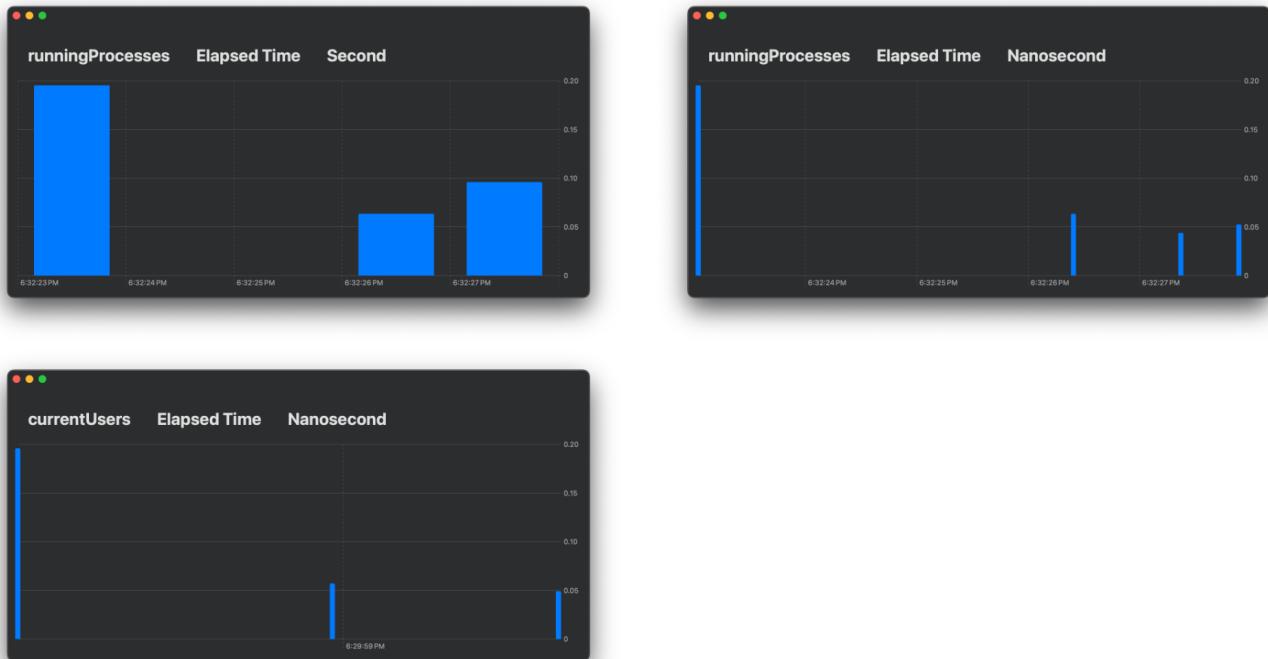
The final step of developing the iterative socket server was by running and testing these servers through trial and error. The project was tested by running two python programs, a server program and a client program on the UNF servers. We also developed a test case server to help us with our development which we will discuss later on. These programs were run by connecting to the server through the use of a VPN and a remote-in app such as Bitvise or Terminus. Once these servers were connected through the UNF server, the code to compile the python programs was executed on both the client and the server. We developed two client servers, one for testing as shown below on the graph and data visualization. The other client was used in the UNF server as part of the final project of the iterative socket server.



## **Data Analysis**

Increasing the number of clients does in fact lead to longer turnaround time for individual clients since the servers capacity is limited to support a fixed size of customers. However, effectively managing the requests with prioritization, and the proper allocation of resources can mitigate this problem. Additionally, clear communication with clients about the expected turnaround times and potential delays is essential for managing expectations and maintaining client relationships. Increasing the number of clients can greatly affect the average turnaround time due to the increased workload of a large client base. In order to fix this the same steps can be taken as above. The primary cause of the effect on individual client turn-around time and the average turnaround time is that they both are affected by the workload that is brought onto them by the client. Also the capacity of how many requests the server can hold is a huge factor in the

increasing and decreasing of efficiency. Without the changing of capacity, the amount of clients will overwhelm the server with requests and cause it to slow its processing speed. Thus, these factors contribute to the increased average turnaround time and the individual turnaround time.



## Conclusion

Based on the data analysis and from our testing of the client server, we can strongly conclude that server response time does in fact (increases/decreases) based on an influx of concurrent requests from the client server. We determined that the (the slowest command) command produced the slowest return time. Further, we found that the (the fastest command) command was the fastest to return a response among the commands. We found these results based on multiple testing and data analysis performed by our group. Throughout the project we learned that modularity is important, especially in a group project with multiple teammates to isolate issues and resolve git conflicts and so that the process of the project can run more efficiently. Each team member was assigned their own portion of the project such as development of the server, development of the client, and the writing of the paper. Ultimately we all pitched in with each other's work load or process of the project. Also making TODO lists which gave us tasks to conquer for the project each week, a github sharing station for the code, and a task list were helpful when working as a team. We originally wrote the client and server in

a version incompatible with the UNF server which led us to drastically revamp the server and client in a new way.. To resolve this next time, we'd test the imports on the server to ensure we are not using incompatible technology.

```

 01 // Contentview.js
 02 // ContentviewClient
 03 // ContentviewServer
 04 // Created by Andreas Ink on 8/26/23.
 05 //
 06 Import Default
 07
 08 CreateContentview View {
 09   EnvironmentObject var networkManager: NetworkManager
 10   EnvironmentObject var openwindow: OpenWindow
 11   EnvironmentUI var openwindow
 12   var body: View
 13   NavigationLinkView
 37     }
 38   }
 39 }
 40
 41 #private {
 42   Contentview()
 43 }
 44
 45 }
 46
 47
 48
 49
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