CSE 344 SYSTEM PROGRAMMING

FINAL PROJECT REPORT

MURAT BEYAZ

151044004

Problem Definition: In this project our problem is that we have a data set in directory structure. This data set holds real estate transactions in it. Our purpose is creating a system that includes 1 servant multiple clients and multiple servants to extract and return the number of transactions specified with some properties like city, date and type...etc.

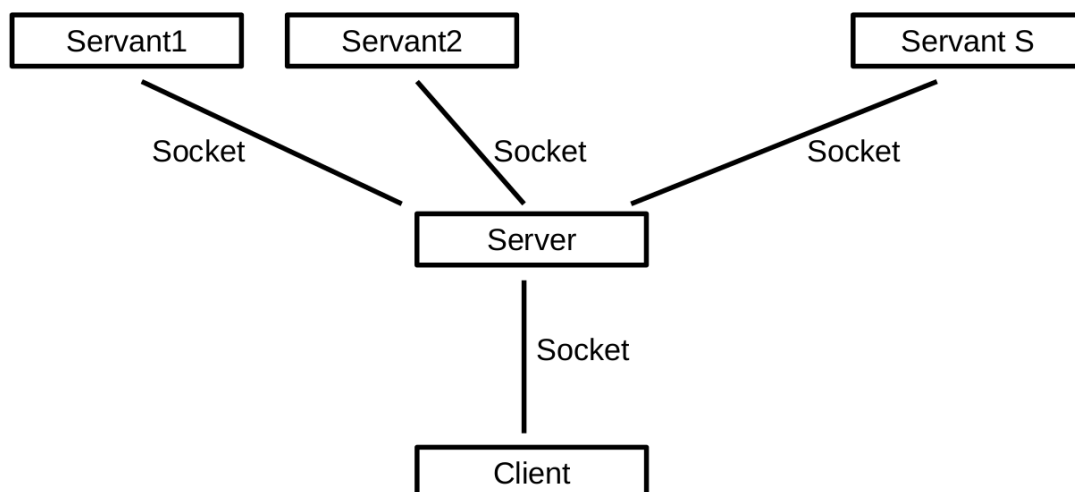**The Dataset:** The dataset will be in the form of a directory structure as below:

directory/
directory/ADANA/
directory/ADANA/05-05-2026

As you can see dataset contains cities as directories in it and there are several number of ASCII files named with date of transactions and files contain transactions in it.

Each file's content start with transaction id, type, street, surface and price following it. Sample record is shown below.

661 TARLA DEMİRYOLU 1000 1500000

The Application: There are 3 programs to be developed as mentioned above. Server, servant and client are the programs that we will develop. The client make requests to the server through sockets and server will respond via information acquired from servants. Structure of the application is shown below.

The Servants: Servants are getting requests from server, checking the dataset for the query and returns the number of transactions found in dataset that satisfies the criteria of the query.

All communication between server and servants will be made through socket. So that servant processes takes port number and ip address of the server via command line argument.

./servant -d directoryPath -c 10_19 -r IP -p PORT

The command shown above is for running a servant process. Arguments are:
    directoryPath: Path to dataset directory
    10-19: is the responsibility range of the servant in dataset
    IP: is the IP address of server
    PORT : is the port number that server is listening.

When a servant process runs finds it's PID via /proc file. Reads */proc/*self and finds it's PID. Then opens a socket port for itself to communicate. While opening socket port number is given as 0 so that system gives the first available port number to the process.

Servant starts to read dataset part which it is responsible for. The chosen data structure for it is map like array. I am keeping indexes of each city record starts and when a request arrives servant searches that part of the records. Records are kept in a special structure that shown below:

```
/*
    record object that saves the informations of the record lines.
    city : City of the record.
    type : Type of the record. TARLA, DUKKAN... etc.
    id : ID of the record.
    province : Street of the record.
    field_size : Size of the field in meter square type.
    day : Day of record
    month : Month of record
    year : Year of record
*/
typedef struct record{
    char city[256];
    char type[256];
    int id;
    char province[256];
    int field_size;
    int price;
    int day;
    int month;
    int year;
} record;
```

After reading that sends it's PID, port number that it will listen and starting and ending cities of it's responsibility area to server. Sample message is shown below:

S-PID-PORT-Start City-End City-End

The S character at the beginning of the message allows server to know that request came from a servant so server can evaluate it specifically.

After sending the message servant starts to listen it's dedicated port. For each new request comes from server it creates a new thread and let's it to handle request.

While servant doing this process it prints information about it to stdout. Sample shown below:

Servant 20288: loaded dataset, cities ARTVIN-BITLIS
Servant 20288: listening at port 58907

The Server: The server takes two arguments for it's purposes.

./server -p PORT -t numberOfThreads

PORT: is the port number it will listen.
NumberOfThreads : is the number of threads that will handle incoming requests from client or server.

The server will wait on it's port listening. If a request comes from a client server adds it to the queue of jobs and if there is an available thread signals the monitor to wake a thread up in the pool and handles the request.

```
/*
    Thread job object that holds the socket fd of the requester client thread.
*/
struct jobQueue{
    int socketFd;
};
```

The code snippet above shows the job that a thread will handle. It contains the socket file descriptor and the thread which gets the job from the queue reads from that socket file descriptor. These jobs kept in a queue and queue operations are made under the protection of mutexes. So that we can avoid the race condition of threads over the queue.

If the request came from a servant, server parses the message and creates a servant object to hold informations about servants. Servant object structure is shown below:

```
/*
    Servant object. Holds informations about servants.
    pid : PID of the servant process.
    port : Port number that given servant process listens.
    start : Starting city which the servant process is responsible for.
    end : Ending city which the servant process is responsible for.
*/
struct Servant{
    int pid;
    int port;
    char start[256];
    char end[256];
};
```

These servants are kept in an array.

Thread that handles the client request sends it's request to appropriate servant and waits for the response from it. Returns the response of the servant to client.

The Client: The client process takes port number and IP address of the server. Also takes a path to request file as an argument.

Each row in request file contains a query that will directed to server. Client process will created a thread for each query. Threads will wait until all the threads are created. This is a synchronization problem and solved by a monitor. Threads wait at randezvous point until all threads arrives. When the last thread arrives signals the threads that are waiting. This way threads sends their requests to server at the same time.

The client threads start to wait for responses from server/servants. By the time client process is waiting for all threads to accomplish it's job and not terminates directly.

NOTE: The explanations of the funtions and variables used in these programs are in their header files. Functions are explained in numpydoc format. First explains the job of the function then explains the parameters and return value.

TEST

Test 1:

Number of servants: 3
Server thread pool size: 5
Number of requests: 10

Script to run the application is shown below:

```bash
#!/bin/bash

PORT=33000

./server -p $PORT -t 5 &
sleep 1
./servant -d dataset -c 1-27 -r 127.0.0.1 -p $PORT &
./servant -d dataset -c 28-54 -r 127.0.0.1 -p $PORT &
./servant -d dataset -c 55-81 -r 127.0.0.1 -p $PORT &
sleep 3
./client -r requestFile -q $PORT -s 127.0.0.1
```

Request file is shown below:

```
transactionCount TARLA 01-01-2073 30-12-2074 ADANA
transactionCount MERA 03-02-2018 09-11-2050
transactionCount DUKKAN 20-04-2000 23-01-2031  KILIS
transactionCount BAG 01-12-2004 27-09-2089 ADIYAMAN
transactionCount FIDANLIK 02-09-2016 12-09-2081 BALIKESIR

transactionCount BAHCE 02-03-2005 17-01-2084
transactionCount FABRIKA 22-07-2004 11-05-2072 ANKARA
transactionCount AMBAR 28-01-2044 13-09-2050 AKSARAY
transactionCount VILLA 22-04-2049 20-03-2061
transactionCount IMALATHANE 04-06-2004 11-11-2011 ISPARTA
```

Output of the test is shown below:

```
mrtbyz@mrtbyz:~/Desktop/FİNAL/linked_list$ bash script.sh
Servant 13023: loaded dataset, cities EDIRNE-KUTAHYA
Servant 13023: listening at port 47163
Mon Jun 13 12:37:26 2022
 Servant 13023: present at port 47163 handling cities EDIRNE-KUTAHYA
Servant 13022: loaded dataset, cities ADANA-DUZCE
Servant 13022: listening at port 41263
Servant 13024: loaded dataset, cities MALATYA-ZONGULDAK
Mon Jun 13 12:37:26 2022
 Servant 13022: present at port 41263 handling cities ADANA-DUZCE
Servant 13024: listening at port 51911
Mon Jun 13 12:37:26 2022
 Servant 13024: present at port 51911 handling cities MALATYA-ZONGULDAK
I have loaded 10 requests and I'm creating 10 threads.
Client-Thread-0: Thread-0 has been created.
Client-Thread-1: Thread-1 has been created.
Client-Thread-2: Thread-2 has been created.
Client-Thread-3: Thread-3 has been created.
Client-Thread-4: Thread-4 has been created.
Client-Thread-5: Thread-5 has been created.
Client-Thread-6: Thread-6 has been created.
Client-Thread-7: Thread-7 has been created.
Client-Thread-8: Thread-8 has been created.
Client-Thread-9: Thread-9 has been created.
Client-Thread-9: I am requesting transactionCount IMALATHANE 04-06-2004 11-11-2011 ISPARTA
Client-Thread-0: I am requesting transactionCount TARLA 01-01-2073 30-12-2074 ADANA
Client-Thread-1: I am requesting transactionCount MERA 03-02-2018 09-11-2050
Client-Thread-2: I am requesting transactionCount DUKKAN 20-04-2000 23-01-2031  KILIS
Client-Thread-3: I am requesting transactionCount BAG 01-12-2004 27-09-2089 ADIYAMAN
Client-Thread-4: I am requesting transactionCount FIDANLIK 02-09-2016 12-09-2081 BALIKESIR
Client-Thread-5: I am requesting transactionCount BAHCE 02-03-2005 17-01-2084
Client-Thread-6: I am requesting transactionCount FABRIKA 22-07-2004 11-05-2072 ANKARA
Mon Jun 13 12:37:29 2022
 Request arrived transactionCount TARLA 01-01-2073 30-12-2074 ADANA
Mon Jun 13 12:37:29 2022
 Contacting servant 13022
Mon Jun 13 12:37:29 2022
 Request arrived transactionCount MERA 03-02-2018 09-11-2050
Client-Thread-7: I am requesting transactionCount AMBAR 28-01-2044 13-09-2050 AKSARAY
Mon Jun 13 12:37:29 2022
 Contacting ALL servants
Client-Thread-8: I am requesting transactionCount VILLA 22-04-2049 20-03-2061
Mon Jun 13 12:37:29 2022
 Contacting servant 13023
Mon Jun 13 12:37:29 2022
 Request arrived transactionCount DUKKAN 20-04-2000 23-01-2031  KILIS
Mon Jun 13 12:37:29 2022
 Request arrived transactionCount IMALATHANE 04-06-2004 11-11-2011 ISPARTA
```

```
Mon Jun 13 12:37:29 2022
 Response received: 44 forwarded to client.
Mon Jun 13 12:37:29 2022
 Request arrived transactionCount BAG 01-12-2004 27-09-2089 ADIYAMAN
Mon Jun 13 12:37:29 2022
 Contacting servant 13023
Mon Jun 13 12:37:29 2022
 Contacting servant 13023
Mon Jun 13 12:37:29 2022
 Contacting servant 13022
Mon Jun 13 12:37:29 2022
 Response received: 3 forwarded to client.
Mon Jun 13 12:37:29 2022
 Request arrived transactionCount FIDANLIK 02-09-2016 12-09-2081 BALIKESIR
Mon Jun 13 12:37:29 2022
 Response received: 66 forwarded to client.
Mon Jun 13 12:37:29 2022
 Response received: 1 forwarded to client.
Mon Jun 13 12:37:29 2022
 Contacting servant 13024
Mon Jun 13 12:37:29 2022
 Contacting servant 13022
Client-Thread-0: The server's response to transactionCount TARLA 01-01-2073 30-12-2074 ADANA  is 3
Mon Jun 13 12:37:29 2022
 Request arrived transactionCount BAHCE 02-03-2005 17-01-2084
Mon Jun 13 12:37:29 2022
 Contacting ALL servants
Mon Jun 13 12:37:29 2022
Client-Thread-0: Terminating.
 Response received: 5 forwarded to client.
Mon Jun 13 12:37:29 2022
 Response received: 48 forwarded to client.
Mon Jun 13 12:37:29 2022
 Request arrived transactionCount FABRIKA 22-07-2004 11-05-2072 ANKARA
Mon Jun 13 12:37:29 2022
 Request arrived transactionCount AMBAR 28-01-2044 13-09-2050 AKSARAY
Mon Jun 13 12:37:29 2022
 Contacting servant 13022
Mon Jun 13 12:37:29 2022
 Contacting servant 13022
Client-Thread-2: The server's response to transactionCount DUKKAN 20-04-2000 23-01-2031  KILIS is 1
Client-Thread-1: The server's response to transactionCount MERA 03-02-2018 09-11-2050  is 158
Client-Thread-1: Terminating.
Client-Thread-3: The server's response to transactionCount BAG 01-12-2004 27-09-2089 ADIYAMAN is 5
Client-Thread-3: Terminating.
Client-Thread-2: Terminating.
Mon Jun 13 12:37:29 2022
 Contacting servant 13023
Mon Jun 13 12:37:29 2022
 Contacting servant 13022
Mon Jun 13 12:37:29 2022
 Response received: 4 forwarded to client.
Mon Jun 13 12:37:29 2022
Client-Thread-9: The server's response to transactionCount IMALATHANE 04-06-2004 11-11-2011 ISPARTA is 4
Client-Thread-9: Terminating.
 Request arrived transactionCount VILLA 22-04-2049 20-03-2061
Mon Jun 13 12:37:29 2022
 Contacting ALL servants
Mon Jun 13 12:37:29 2022
 Response received: 0 forwarded to client.
Mon Jun 13 12:37:29 2022
 Contacting servant 13023
Client-Thread-7: The server's response to transactionCount AMBAR 28-01-2044 13-09-2050 AKSARAY is 0
Client-Thread-7: Terminating.
Mon Jun 13 12:37:29 2022
 Response received: 4 forwarded to client.
Mon Jun 13 12:37:29 2022
 Response received: 107 forwarded to client.
Client-Thread-6: The server's response to transactionCount FABRIKA 22-07-2004 11-05-2072 ANKARA is 4
Client-Thread-6: Terminating.
Mon Jun 13 12:37:29 2022
 Contacting servant 13022
Mon Jun 13 12:37:29 2022
 Response received: 3 forwarded to client.
Mon Jun 13 12:37:29 2022
 Response received: 6 forwarded to client.
Client-Thread-4: The server's response to transactionCount FIDANLIK 02-09-2016 12-09-2081 BALIKESIR is 3
Client-Thread-4: Terminating.
Mon Jun 13 12:37:29 2022
 Contacting servant 13022
Mon Jun 13 12:37:29 2022
 Response received: 118 forwarded to client.
Mon Jun 13 12:37:29 2022
 Contacting servant 13024
Mon Jun 13 12:37:29 2022
 Response received: 6 forwarded to client.
Mon Jun 13 12:37:29 2022
 Contacting servant 13024
Mon Jun 13 12:37:29 2022
 Response received: 118 forwarded to client.
Client-Thread-5: The server's response to transactionCount BAHCE 02-03-2005 17-01-2084 is 343
Client-Thread-5: Terminating.
Mon Jun 13 12:37:29 2022
 Response received: 17 forwarded to client.
Client-Thread-8: The server's response to transactionCount VILLA 22-04-2049 20-03-2061 is 29
Client-Thread-8: Terminating.
Client: All threads are terminated, goodbye.
```

Before and after of SIGINT signal sent to server process:

```
mrtbyz@mrtbyz:~/Desktop/FINAL/linked_list$ ps -aux | grep ./server
mrtbyz     13015  0.0  0.0 371444   748 pts/0    Sl   12:37   0:00 ./server -p 33000 -t 5
mrtbyz     13054  0.0  0.0  11784   660 pts/1    S+   12:37   0:00 grep --color=auto ./server
mrtbyz@mrtbyz:~/Desktop/FINAL/linked_list$ ps -aux | grep ./servant
mrtbyz     13022  0.0  0.0  70420  3976 pts/0    S    12:37   0:00 ./servant -d dataset -c 1-27 -r 127.0.0.1 -p 33000
mrtbyz     13023  0.0  0.0  45832  4120 pts/0    S    12:37   0:00 ./servant -d dataset -c 28-54 -r 127.0.0.1 -p 33000
mrtbyz     13024  0.0  0.0  29440  4076 pts/0    S    12:37   0:00 ./servant -d dataset -c 55-81 -r 127.0.0.1 -p 33000
mrtbyz     13056  0.0  0.0  11784   720 pts/1    S+   12:37   0:00 grep --color=auto ./servant
mrtbyz@mrtbyz:~/Desktop/FINAL/linked_list$ sudo kill -2 13015
[sudo] password for mrtbyz:
mrtbyz@mrtbyz:~/Desktop/FINAL/linked_list$ ps -aux | grep ./servant
mrtbyz     14094  0.0  0.0  11784   716 pts/1    S+   12:58   0:00 grep --color=auto ./servant
mrtbyz@mrtbyz:~/Desktop/FINAL/linked_list$
```

Result after SIGINT:

```
mrtbyz@mrtbyz:~/Desktop/FINAL/linked_list$ Mon Jun 13 12:37:56 2022
 SIGINT has been reveived. I handled a total of 10 requests. Goodbye.
Servant 13022: termination message has been received. I handled a total of 8 requests.Goodbye.
Servant 13023: termination message has been received. I handled a total of 5 requests.Goodbye.
Servant 13024: termination message has been received. I handled a total of 3 requests.Goodbye.
```

Test 2:

Number of servants: 9
Server thread pool size: 5
Number of requests: 10

Script to run the application is shown below:

```bash
1   #!/bin/bash
2
3   PORT=33000
4
5   ./server -p $PORT -t 5 &
6   sleep 1
7   ./servant -d dataset -c 1-9 -r 127.0.0.1 -p $PORT &
8   ./servant -d dataset -c 10-18 -r 127.0.0.1 -p $PORT &
9   ./servant -d dataset -c 19-27 -r 127.0.0.1 -p $PORT &
10  ./servant -d dataset -c 28-36 -r 127.0.0.1 -p $PORT &
11  ./servant -d dataset -c 37-45 -r 127.0.0.1 -p $PORT &
12  ./servant -d dataset -c 46-54 -r 127.0.0.1 -p $PORT &
13  ./servant -d dataset -c 55-63 -r 127.0.0.1 -p $PORT &
14  ./servant -d dataset -c 64-72 -r 127.0.0.1 -p $PORT &
15  ./servant -d dataset -c 73-81 -r 127.0.0.1 -p $PORT &
16  sleep 3
17  ./client -r requestFile -q $PORT -s 127.0.0.1
18
19
```

Request file is shown below:

```
1    transactionCount TARLA 01-01-2073 30-12-2074 ADANA
2    transactionCount MERA 03-02-2018 09-11-2050
3    transactionCount DUKKAN 20-04-2000 23-01-2031  KILIS
4    transactionCount BAG 01-12-2004 27-09-2089 ADIYAMAN
5    transactionCount FIDANLIK 02-09-2016 12-09-2081 BALIKESIR
6
7    transactionCount BAHCE 02-03-2005 17-01-2084
8    transactionCount FABRIKA 22-07-2004 11-05-2072 ANKARA
9    transactionCount AMBAR 28-01-2044 13-09-2050 AKSARAY
10   transactionCount VILLA 22-04-2049 20-03-2061
11   transactionCount IMALATHANE 04-06-2004 11-11-2011 ISPARTA
12   |
13
14
15
```

Output of the test is shown below:

```
mrtbyz@mrtbyz:~/Desktop/FINAL/linked_list$ bash script.sh
Servant 14241: loaded dataset, cities ARTVIN-BITLIS
Servant 14241: listening at port 49249
Mon Jun 13 12:59:48 2022
 Servant 14241: present at port 49249 handling cities ARTVIN-BITLIS
Servant 14240: loaded dataset, cities ADANA-ARDAHAN
Servant 14240: listening at port 40867
Mon Jun 13 12:59:48 2022
 Servant 14240: present at port 40867 handling cities ADANA-ARDAHAN
Servant 14243: loaded dataset, cities EDIRNE-HAKKARI
Servant 14243: listening at port 38913
Servant 14247: loaded dataset, cities OSMANIYE-SIVAS
Servant 14247: listening at port 52991
Mon Jun 13 12:59:48 2022
 Servant 14247: present at port 52991 handling cities OSMANIYE-SIVAS
Servant 14244: loaded dataset, cities HATAY-KARS
Servant 14244: listening at port 40919
Mon Jun 13 12:59:48 2022
Servant 14245: loaded dataset, cities KASTAMONU-KUTAHYA
Servant 14245: listening at port 36055
Servant 14246: loaded dataset, cities MALATYA-ORDU
Servant 14246: listening at port 51811
Servant 14248: loaded dataset, cities TEKIRDAG-ZONGULDAK
Servant 14248: listening at port 36007
 Servant 14244: present at port 40919 handling cities HATAY-KARS
Mon Jun 13 12:59:48 2022
 Servant 14243: present at port 38913 handling cities EDIRNE-HAKKARI
Mon Jun 13 12:59:48 2022
 Servant 14245: present at port 36055 handling cities KASTAMONU-KUTAHYA
Mon Jun 13 12:59:48 2022
 Servant 14246: present at port 51811 handling cities MALATYA-ORDU
Mon Jun 13 12:59:48 2022
 Servant 14248: present at port 36007 handling cities TEKIRDAG-ZONGULDAK
Servant 14242: loaded dataset, cities BOLU-DUZCE
Servant 14242: listening at port 58625
Mon Jun 13 12:59:48 2022
 Servant 14242: present at port 58625 handling cities BOLU-DUZCE
I have loaded 10 requests and I'm creating 10 threads.
Client-Thread-0: Thread-0 has been created.
Client-Thread-1: Thread-1 has been created.
Client-Thread-2: Thread-2 has been created.
Client-Thread-3: Thread-3 has been created.
Client-Thread-4: Thread-4 has been created.
Client-Thread-5: Thread-5 has been created.
Client-Thread-6: Thread-6 has been created.
Client-Thread-7: Thread-7 has been created.
Client-Thread-8: Thread-8 has been created.
Client-Thread-9: Thread-9 has been created.
```

```
Client-Thread-9: Thread-9 has been created.
Client-Thread-9: I am requesting transactionCount IMALATHANE 04-06-2004 11-11-2011 ISPARTA
Client-Thread-0: I am requesting transactionCount TARLA 01-01-2073 30-12-2074 ADANA
Client-Thread-1: I am requesting transactionCount MERA 03-02-2018 09-11-2050
Client-Thread-2: I am requesting transactionCount DUKKAN 20-04-2000 23-01-2031  KILIS
Client-Thread-3: I am requesting transactionCount BAG 01-12-2004 27-09-2089 ADIYAMAN
Client-Thread-4: I am requesting transactionCount FIDANLIK 02-09-2016 12-09-2081 BALIKESIR
Client-Thread-5: I am requesting transactionCount BAHCE 02-03-2005 17-01-2084
Mon Jun 13 12:59:51 2022
 Request arrived transactionCount MERA 03-02-2018 09-11-2050
Mon Jun 13 12:59:51 2022
 Contacting ALL servants
Client-Thread-6: I am requesting transactionCount FABRIKA 22-07-2004 11-05-2072 ANKARA
Mon Jun 13 12:59:51 2022
 Request arrived transactionCount TARLA 01-01-2073 30-12-2074 ADANA
Mon Jun 13 12:59:51 2022
 Request arrived transactionCount IMALATHANE 04-06-2004 11-11-2011 ISPARTA
Mon Jun 13 12:59:51 2022
 Contacting servant 14240
Mon Jun 13 12:59:51 2022
 Request arrived transactionCount BAG 01-12-2004 27-09-2089 ADIYAMAN
Mon Jun 13 12:59:51 2022
 Contacting servant 14244
Mon Jun 13 12:59:51 2022
 Contacting servant 14240
Mon Jun 13 12:59:51 2022
Client-Thread-7: I am requesting transactionCount AMBAR 28-01-2044 13-09-2050 AKSARAY
 Request arrived transactionCount DUKKAN 20-04-2000 23-01-2031  KILIS
Mon Jun 13 12:59:51 2022
 Contacting servant 14241
Client-Thread-8: I am requesting transactionCount VILLA 22-04-2049 20-03-2061
Mon Jun 13 12:59:51 2022
 Contacting servant 14245
Mon Jun 13 12:59:51 2022
 Response received: 5 forwarded to client.
Mon Jun 13 12:59:51 2022
 Response received: 3 forwarded to client.
Client-Thread-3: The server's response to transactionCount BAG 01-12-2004 27-09-2089 ADIYAMAN is 5
Mon Jun 13 12:59:51 2022
 Response received: 4 forwarded to client.
Mon Jun 13 12:59:51 2022
 Response received: 1 forwarded to client.
Mon Jun 13 12:59:51 2022
 Request arrived transactionCount FABRIKA 22-07-2004 11-05-2072 ANKARA
Mon Jun 13 12:59:51 2022
 Request arrived transactionCount AMBAR 28-01-2044 13-09-2050 AKSARAY
```

```
Mon Jun 13 12:59:51 2022
 Request arrived transactionCount AMBAR 28-01-2044 13-09-2050 AKSARAY
Mon Jun 13 12:59:51 2022
 Contacting servant 14240
Client-Thread-3: Terminating.
Mon Jun 13 12:59:51 2022
 Contacting servant 14240
Client-Thread-9: The server's response to transactionCount IMALATHANE 04-06-2004 11-11-2011 ISPARTA is 4
Client-Thread-9: Terminating.
Mon Jun 13 12:59:51 2022
Client-Thread-0: The server's response to transactionCount TARLA 01-01-2073 30-12-2074 ADANA  is 3
Client-Thread-0: Terminating.
 Response received: 23 forwarded to client.
Client-Thread-2: The server's response to transactionCount DUKKAN 20-04-2000 23-01-2031  KILIS is 1
Client-Thread-2: Terminating.
Mon Jun 13 12:59:51 2022
 Request arrived transactionCount FIDANLIK 02-09-2016 12-09-2081 BALIKESIR
Mon Jun 13 12:59:51 2022
 Contacting servant 14240
Mon Jun 13 12:59:51 2022
 Response received: 4 forwarded to client.
Mon Jun 13 12:59:51 2022
 Response received: 25 forwarded to client.
Client-Thread-6: The server's response to transactionCount FABRIKA 22-07-2004 11-05-2072 ANKARA is 4
Client-Thread-6: Terminating.
Mon Jun 13 12:59:51 2022
 Response received: 0 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14247
Mon Jun 13 12:59:51 2022
 Request arrived transactionCount VILLA 22-04-2049 20-03-2061
Client-Thread-7: The server's response to transactionCount AMBAR 28-01-2044 13-09-2050 AKSARAY is 0
Client-Thread-7: Terminating.
Mon Jun 13 12:59:51 2022
 Request arrived transactionCount BAHCE 02-03-2005 17-01-2084
Mon Jun 13 12:59:51 2022
 Contacting ALL servants
Mon Jun 13 12:59:51 2022
 Response received: 23 forwarded to client.
```

```
Mon Jun 13 12:59:51 2022
 Contacting servant 14241
Mon Jun 13 12:59:51 2022
 Contacting ALL servants
Mon Jun 13 12:59:51 2022
 Contacting servant 14241
Mon Jun 13 12:59:51 2022
 Contacting servant 14241
Mon Jun 13 12:59:51 2022
 Contacting servant 14244
Mon Jun 13 12:59:51 2022
 Response received: 3 forwarded to client.
Mon Jun 13 12:59:51 2022
 Response received: 0 forwarded to client.
Client-Thread-4: The server's response to transactionCount FIDANLIK 02-09-2016 12-09-2081 BALIKESIR is 3
Client-Thread-4: Terminating.
Mon Jun 13 12:59:51 2022
 Response received: 9 forwarded to client.
Mon Jun 13 12:59:51 2022
 Response received: 35 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14243
Mon Jun 13 12:59:51 2022
 Contacting servant 14240
Mon Jun 13 12:59:51 2022
 Contacting servant 14240
Mon Jun 13 12:59:51 2022
 Response received: 20 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14245
Mon Jun 13 12:59:51 2022
 Response received: 4 forwarded to client.
Mon Jun 13 12:59:51 2022
 Response received: 39 forwarded to client.
Mon Jun 13 12:59:51 2022
 Response received: 15 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14247
Mon Jun 13 12:59:51 2022
 Contacting servant 14246
Mon Jun 13 12:59:51 2022
 Response received: 6 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14244
Mon Jun 13 12:59:51 2022
 Response received: 13 forwarded to client.
```

```
Mon Jun 13 12:59:51 2022
 Contacting servant 14247
Mon Jun 13 12:59:51 2022
 Contacting servant 14248
Mon Jun 13 12:59:51 2022
 Response received: 1 forwarded to client.
Mon Jun 13 12:59:51 2022
 Response received: 12 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14243
Mon Jun 13 12:59:51 2022
 Response received: 39 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14244
Mon Jun 13 12:59:51 2022
 Contacting servant 14242
Mon Jun 13 12:59:51 2022
 Response received: 2 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14245
Mon Jun 13 12:59:51 2022
 Response received: 18 forwarded to client.
Mon Jun 13 12:59:51 2022
 Response received: 37 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14243
Client-Thread-1: The server's response to transactionCount MERA 03-02-2018 09-11-2050  is 158
Client-Thread-1: Terminating.
Mon Jun 13 12:59:51 2022
 Response received: 3 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14246
Mon Jun 13 12:59:51 2022
 Response received: 38 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14245
Mon Jun 13 12:59:51 2022
 Response received: 5 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14248
Mon Jun 13 12:59:51 2022
 Response received: 32 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14246
Mon Jun 13 12:59:51 2022
 Response received: 35 forwarded to client.
Mon Jun 13 12:59:51 2022
 Response received: 6 forwarded to client.
```

```
Mon Jun 13 12:59:51 2022
 Contacting servant 14248
Mon Jun 13 12:59:51 2022
 Contacting servant 14242
Mon Jun 13 12:59:51 2022
 Response received: 44 forwarded to client.
Mon Jun 13 12:59:51 2022
 Contacting servant 14242
Mon Jun 13 12:59:51 2022
 Response received: 2 forwarded to client.
Mon Jun 13 12:59:51 2022
 Response received: 44 forwarded to client.
Client-Thread-5: The server's response to transactionCount BAHCE 02-03-2005 17-01-2084 is 343
Client-Thread-5: Terminating.
Client-Thread-8: The server's response to transactionCount VILLA 22-04-2049 20-03-2061 is 29
Client-Thread-8: Terminating.
Client: All threads are terminated, goodbye.
```

Before and after of SIGINT signal sent to server process:

```
mrtbyz@mrtbyz:~/Desktop/FİNAL/linked_list$ ps -aux | grep ./server
mrtbyz    14233  0.1  0.0 371444   684 pts/0   Sl   12:59   0:00 ./server -p 33000 -t 5
mrtbyz    14296  0.0  0.0  11784   724 pts/1   S+   12:59   0:00 grep --color=auto ./server
mrtbyz@mrtbyz:~/Desktop/FİNAL/linked_list$ ps -aux | grep ./servant
mrtbyz    14240  0.0  0.0  60832  2808 pts/0   S    12:59   0:00 ./servant -d dataset -c 1-9 -r 127.0.0.1 -p 33000
mrtbyz    14241  0.0  0.0  36244  2808 pts/0   S    12:59   0:00 ./servant -d dataset -c 10-18 -r 127.0.0.1 -p 33000
mrtbyz    14242  0.0  0.0  28048  2580 pts/0   S    12:59   0:00 ./servant -d dataset -c 19-27 -r 127.0.0.1 -p 33000
mrtbyz    14243  0.0  0.0  28048  2704 pts/0   S    12:59   0:00 ./servant -d dataset -c 28-36 -r 127.0.0.1 -p 33000
mrtbyz    14244  0.0  0.0  36244  2792 pts/0   S    12:59   0:00 ./servant -d dataset -c 37-45 -r 127.0.0.1 -p 33000
mrtbyz    14245  0.0  0.0  36244  2704 pts/0   S    12:59   0:00 ./servant -d dataset -c 46-54 -r 127.0.0.1 -p 33000
mrtbyz    14246  0.0  0.0  28048  2792 pts/0   S    12:59   0:00 ./servant -d dataset -c 55-63 -r 127.0.0.1 -p 33000
mrtbyz    14247  0.0  0.0  28048  2788 pts/0   S    12:59   0:00 ./servant -d dataset -c 64-72 -r 127.0.0.1 -p 33000
mrtbyz    14248  0.0  0.0  28048  2656 pts/0   S    12:59   0:00 ./servant -d dataset -c 73-81 -r 127.0.0.1 -p 33000
mrtbyz    14298  0.0  0.0  11784   716 pts/1   S+   12:59   0:00 grep --color=auto ./servant
mrtbyz@mrtbyz:~/Desktop/FİNAL/linked_list$ sudo kill -2 14233
[sudo] password for mrtbyz:
mrtbyz@mrtbyz:~/Desktop/FİNAL/linked_list$ ps -aux | grep ./servant
mrtbyz    14313  0.0  0.0  11784   716 pts/1   S+   13:00   0:00 grep --color=auto ./servant
mrtbyz@mrtbyz:~/Desktop/FİNAL/linked_list$ ps -aux | grep ./server
mrtbyz    14315  0.0  0.0  11784   648 pts/1   S+   13:00   0:00 grep --color=auto ./server
mrtbyz@mrtbyz:~/Desktop/FİNAL/linked_list$
```

Result after SIGINT:

```
mrtbyz@mrtbyz:~/Desktop/FINAL/linked_list$ Mon Jun 13 13:00:12 2022
 SIGINT has been reveived. I handled a total of 10 requests. Goodbye.
Servant 14241: termination message has been received. I handled a total of 4 requests.Goodbye.
Servant 14246: termination message has been received. I handled a total of 3 requests.Goodbye.
Servant 14248: termination message has been received. I handled a total of 3 requests.Goodbye.
Servant 14240: termination message has been received. I handled a total of 7 requests.Goodbye.
Servant 14244: termination message has been received. I handled a total of 4 requests.Goodbye.
Servant 14243: termination message has been received. I handled a total of 3 requests.Goodbye.
Servant 14242: termination message has been received. I handled a total of 3 requests.Goodbye.
Servant 14247: termination message has been received. I handled a total of 3 requests.Goodbye.
Servant 14245: termination message has been received. I handled a total of 4 requests.Goodbye.
```

Test 3:
Missing argument test.

```
mrtbyz@mrtbyz:~/Desktop/FİNAL/linked_list$ ./server -p 33000 -t
Usage : Missing argument
mrtbyz@mrtbyz:~/Desktop/FİNAL/linked_list$ ./server -p -t 5
Usage : Missing argument
mrtbyz@mrtbyz:~/Desktop/FİNAL/linked_list$ ./servant -d
Usage : Missing argument
mrtbyz@mrtbyz:~/Desktop/FİNAL/linked_list$ ./client -r
Usage : Missing argument
mrtbyz@mrtbyz:~/Desktop/FİNAL/linked_list$
```