

DISTRIBUTED SYSTEMS



ΠΑΝΕΠΙΣΤΗΜΙΟ
ΔΥΤΙΚΗΣ ΑΤΤΙΚΗΣ
UNIVERSITY OF WEST ATTICA

DEPARTMENT OF INFORMATION AND COMPUTER ENGINEERING

PROJECT 1 RPC

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STUDENT PHOTO:



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Brief Report

rpc_server.c

O concurrent rpc server receives the following data

- A real number r
- Two integer vectors X, Y of length n

and performs the following 3 calculations :

1. The inner product of the two vectors X * Y (returns an integer)
2. The average of each vector: E x , E y (returns an array of 2 real numbers)
3. The product r * (X + Y) (returns a vector of real numbers of length n)

It returns the results to rpc client (rpc_client.c) which called the corresponding rpc routine.

rpc_client.c

The rpc client connects via TCP AF_INET socket with a socket client (socket_client.c) and it works in parallel and as a socket server. It receives the data from the socket client , calls the corresponding rpc routine according to the option sent to it, receives the results from the rpc server and finally sends them to the socket client .

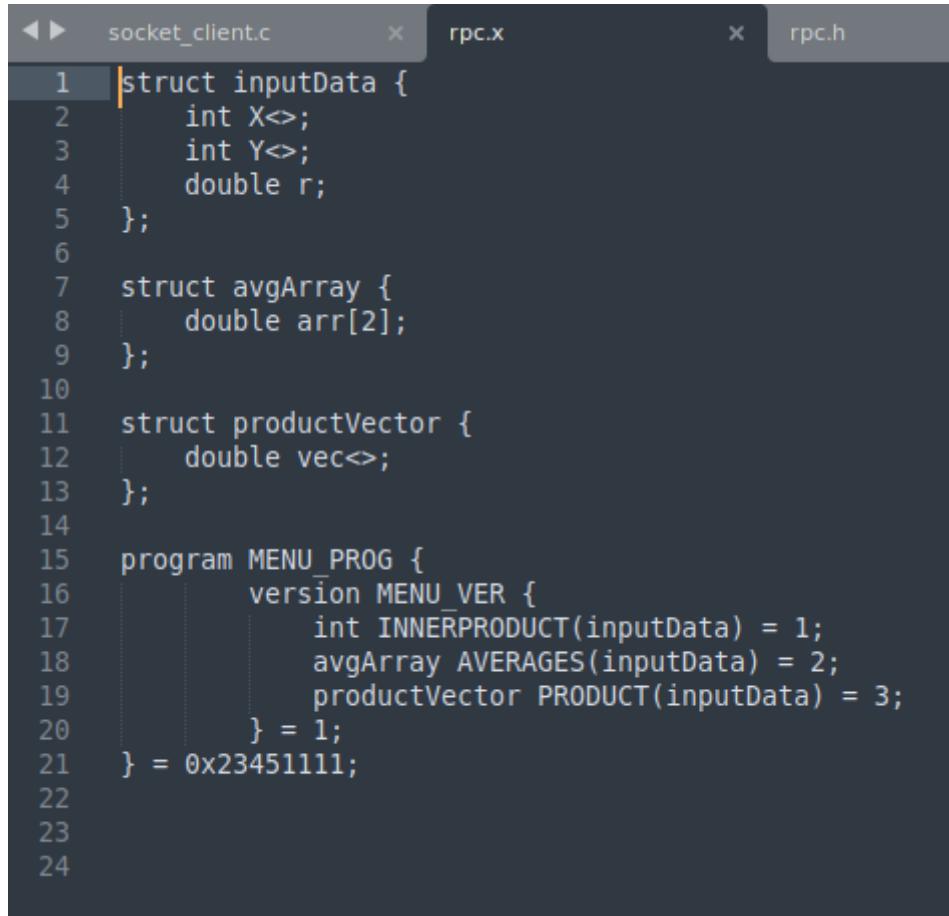
socket_client.c

The socket client does application for login via TCP AF_INET socket with the socket server that it works in parallel and as rpc client (rpc_client.c). Enters the data, sends it to socket server , which calls the corresponding rpc routine from an rpc server (rpc_server.c). Finally, the socket client receives the results from the socket server and prints them to the output .

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Create the rpc files and compile commands

To create the rpc files we defined the required interface file (' rpc . x ').



```
1 struct inputData {
2     int X<>;
3     int Y<>;
4     double r;
5 };
6
7 struct avgArray {
8     double arr[2];
9 };
10
11 struct productVector {
12     double vec<>;
13 };
14
15 program MENU_PROG {
16     version MENU_VER {
17         int INNERPRODUCT(inputData) = 1;
18         avgArray AVERAGES(inputData) = 2;
19         productVector PRODUCT(inputData) = 3;
20     } = 1;
21 } = 0x23451111;
```

Figure 1. The interface file “ rpc . x ” for rpc communication

struct inputData

“ inputData ” structure contains the input data structures of all 3 rpc routines, i.e., the vector of integers X with its size (X <> makes a structure with 2 members, the size of X and the vector X), the vector of integers Y with its magnitude (the same applies to Y <>) and the actual value r .

struct avgArray

The avgArray structure contains the data structure that the 2nd will ^{return} rpc routine (average of each vector), that is, a static array of 2 real numbers whose 1st ^{position} will contain the average value of the vector X and the 2nd ^{position} will contain the average value of the vector Y .

struct productVector

The " productVector " structure contains the data structure that the 3rd will ^{return} rpc routine (the product r * (X + Y)), i.e., a dynamic array of N reals where each position will contain the product r * (X [i] + Y [i]), where i is a position index of an array.

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program MENU – PROG

This program contains the version MENU _ VER which contains the rpc routines that rpc client can call rpc server to execute.

The command to create ready-made program templates for rpc client and rpc server is as follows

```
rpcgen -a -C rpc.x
```

With her implementation her command were created the files rpc.h (Figure 2), Makefile (Figure 3), rpc_client.c, rpc_server.c, rpc_clnt.c, rpc_svc.c and rpc_xdr.c

Figure 2. The rpc.h file

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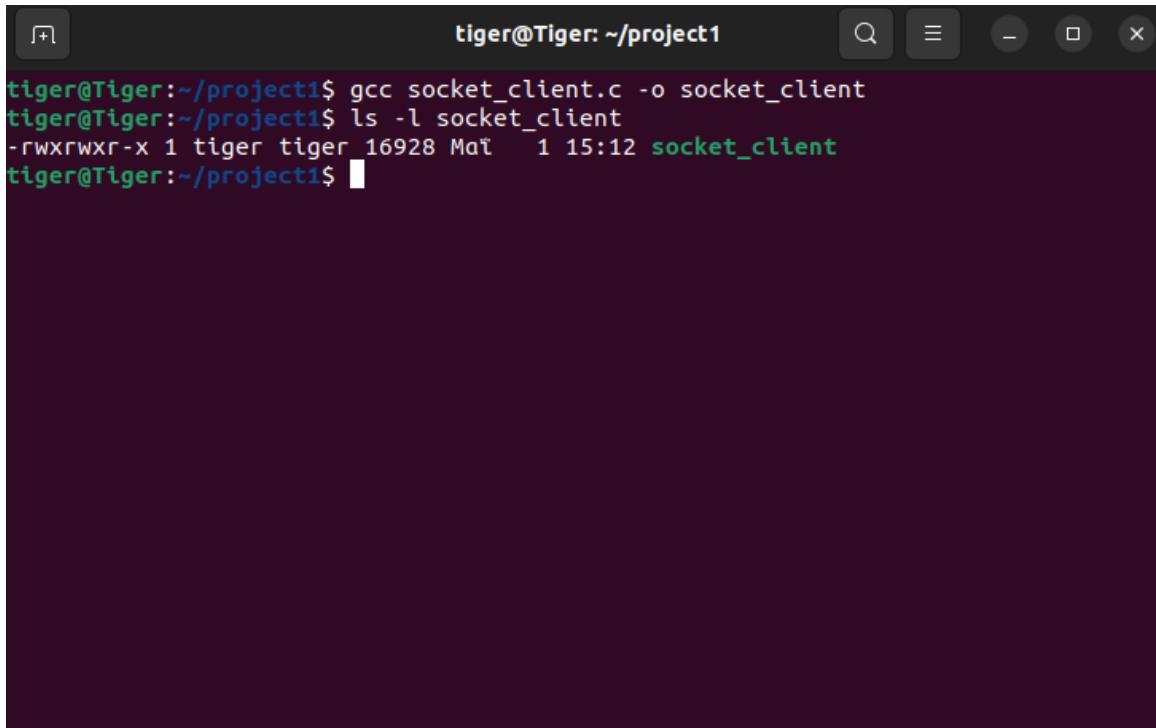
```
socket_client.c      x | rpc.x           x | rpc.h           x | rpc_client.c      x | rpc_server.c      x | Makefile
1 | # This is a template Makefile generated by rpcgen
2 |
3 | # Parameters
4 |
5 | CLIENT = rpc_client
6 | SERVER = rpc_server
7 |
8 | SOURCES_CLNT.c =
9 | SOURCES_CLNT.h =
10 | SOURCES_SVC.c =
11 | SOURCES_SVC.h =
12 | SOURCES.x = rpc.x
13 |
14 | TARGETS_SVC.c = rpc_svc.c rpc_server.c rpc_xdr.c
15 | TARGETS_CLNT.c = rpc_clnt.c rpc_client.c rpc_xdr.c
16 | TARGETS = rpc.h rpc_xdr.c rpc_clnt.c rpc_svc.c rpc_client.c rpc_server.c
17 |
18 | OBJECTS_CLNT = $(SOURCES_CLNT.c:%.c=%.o) $(TARGETS_CLNT.c:%.c=%.o)
19 | OBJECTS_SVC = $(SOURCES_SVC.c:%.c=%.o) $(TARGETS_SVC.c:%.c=%.o)
20 | # Compiler flags
21 |
22 | CFLAGS += -g -DRPC_SVC_FG -I/usr/include/tirpc
23 | LDLIBS += -lndl -ltirpc
24 | RPCGENFLAGS = -C
25 |
26 | # Targets
27 |
28 | all : $(CLIENT) $(SERVER)
29 |
30 | $(TARGETS) : $(SOURCES.x)
31 |   rpcgen $(RPCGENFLAGS) $(SOURCES.x)
32 |
33 | $(OBJECTS_CLNT) : $(SOURCES_CLNT.c) $(SOURCES_CLNT.h) $(TARGETS_CLNT.c)
34 |
35 | $(OBJECTS_SVC) : $(SOURCES_SVC.c) $(SOURCES_SVC.h) $(TARGETS_SVC.c)
36 |
37 | $(CLIENT) : $(OBJECTS_CLNT)
38 |   $(LINK.c) -o $(CLIENT) $(OBJECTS_CLNT) $(LDLIBS)
39 |
40 | $(SERVER) : $(OBJECTS_SVC)
41 |   $(LINK.c) -o $(SERVER) $(OBJECTS_SVC) $(LDLIBS)
42 |
43 | clean:
44 |   $(RM) core $(TARGETS) $(OBJECTS_CLNT) $(OBJECTS_SVC) $(CLIENT) $(SERVER)
45 |
46 |
47 |
```

Figure 3. The Makefile file

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socket code client is

```
gcc socket_client.c -o socket_client
```



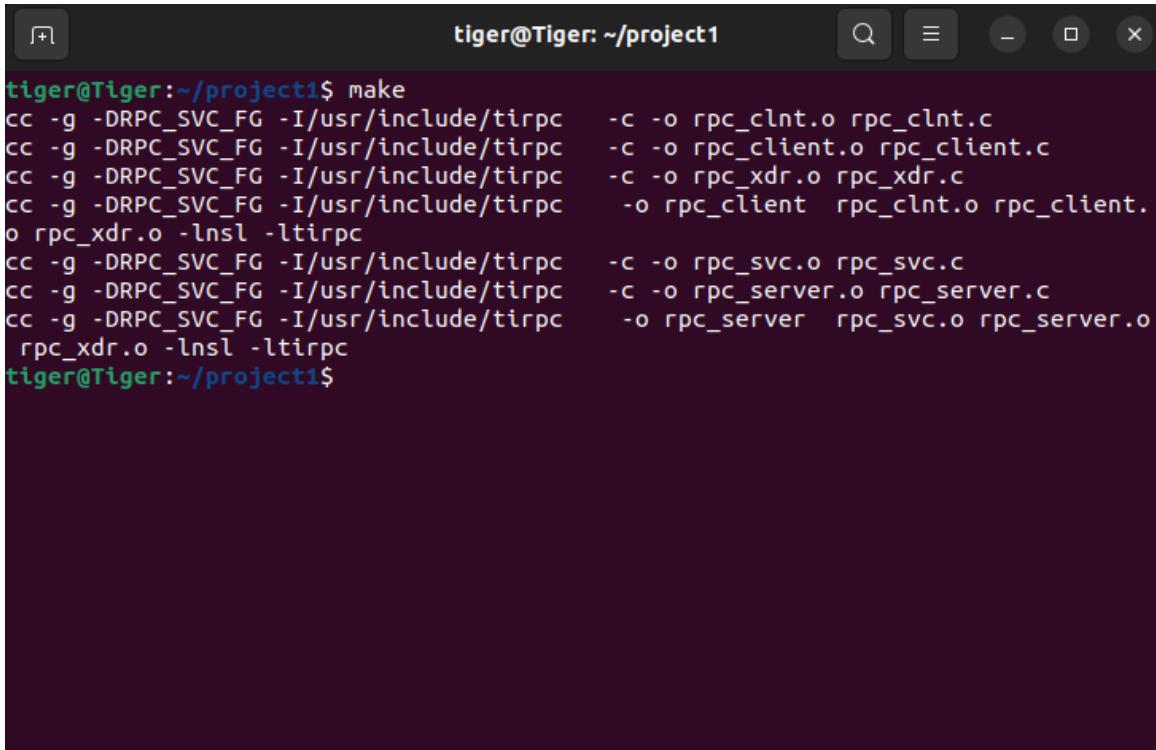
A terminal window titled "tiger@Tiger: ~/project1". The user runs the command "gcc socket_client.c -o socket_client". The output shows the file was compiled successfully into an executable named "socket_client". The file has permissions "-rwxrwxr-x" and was created by "tiger" on "16928 Mař 1 15:12".

```
tiger@Tiger:~/project1$ gcc socket_client.c -o socket_client
tiger@Tiger:~/project1$ ls -l socket_client
-rwxrwxr-x 1 tiger tiger 16928 Mař 1 15:12 socket_client
tiger@Tiger:~/project1$
```

Figure 4. Compiling socket _ client . c

The compile command for rpc _ *. c files are

```
make
```



A terminal window titled "tiger@Tiger: ~/project1". The user runs the command "make". The output shows the compilation of several C files: "rpc_clnt.c", "rpc_client.c", "rpc_xdr.c", "rpc_client.o", "rpc_clnt.o", "rpc_client.o", "rpc_svc.c", "rpc_server.c", and "rpc_server.o". The compilation process involves multiple "cc" commands with various flags and source files.

```
tiger@Tiger:~/project1$ make
cc -g -DRPC_SVC_FG -I/usr/include/tirpc -c -o rpc_clnt.o rpc_clnt.c
cc -g -DRPC_SVC_FG -I/usr/include/tirpc -c -o rpc_client.o rpc_client.c
cc -g -DRPC_SVC_FG -I/usr/include/tirpc -c -o rpc_xdr.o rpc_xdr.c
cc -g -DRPC_SVC_FG -I/usr/include/tirpc -o rpc_client rpc_clnt.o rpc_client.o rpc_xdr.o -lnsl -ltirpc
cc -g -DRPC_SVC_FG -I/usr/include/tirpc -c -o rpc_svc.o rpc_svc.c
cc -g -DRPC_SVC_FG -I/usr/include/tirpc -c -o rpc_server.o rpc_server.c
cc -g -DRPC_SVC_FG -I/usr/include/tirpc -o rpc_server rpc_svc.o rpc_server.o
tiger@Tiger:~/project1$
```

Figure 5. Compilation of rpc _ *. c files

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Execution of the programs

Socket clients: 1

Servers On

tiger@Tiger:~/project1\$./socket_server 7455 localhost
tiger@Tiger:~/project1\$./rpc_server 7455 localhost
tiger@Tiger:~/project1\$./socket_client 7455 localhost

Connection

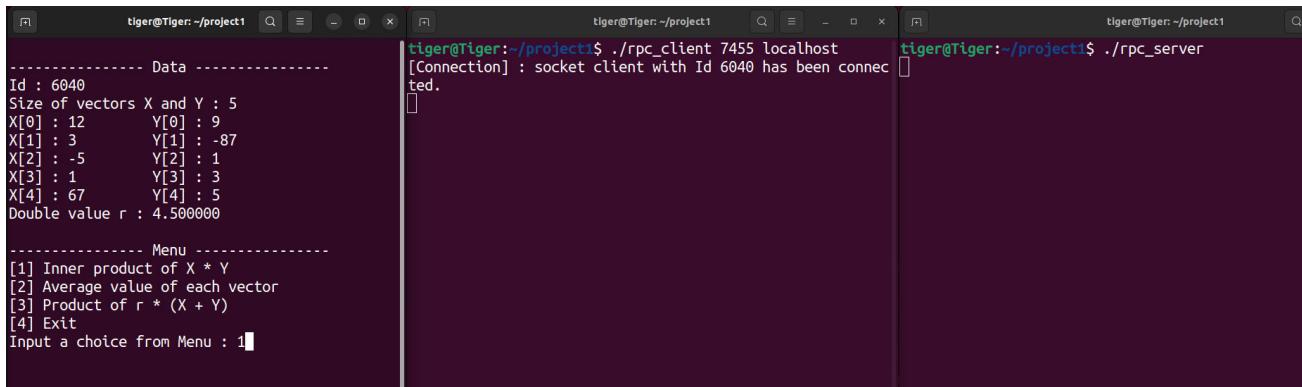
tiger@Tiger:~/project1\$./socket_client 7455 localhost
[6040] : connected to socket server.
Input the size of vectors X and Y :
tiger@Tiger:~/project1\$./rpc_client 7455 localhost
[Connection] : socket client with Id 6040 has been connected.
tiger@Tiger:~/project1\$./rpc_server

Input Data

tiger@Tiger:~/project1\$./socket_client 7455 localhost
[6040] : connected to socket server.
Input the size of vectors X and Y : 5
Input the 5 elements of vector X
X[0] : 12
X[1] : 3
X[2] : -5
X[3] : 1
X[4] : 67
Input the 5 elements of vector Y
Y[0] : 9
Y[1] : -87
Y[2] : 1
Y[3] : 3
Y[4] : 5
Input a value "r" of double range : 4.5
tiger@Tiger:~/project1\$./rpc_client 7455 localhost
[Connection] : socket client with Id 6040 has been connected.
tiger@Tiger:~/project1\$./rpc_server

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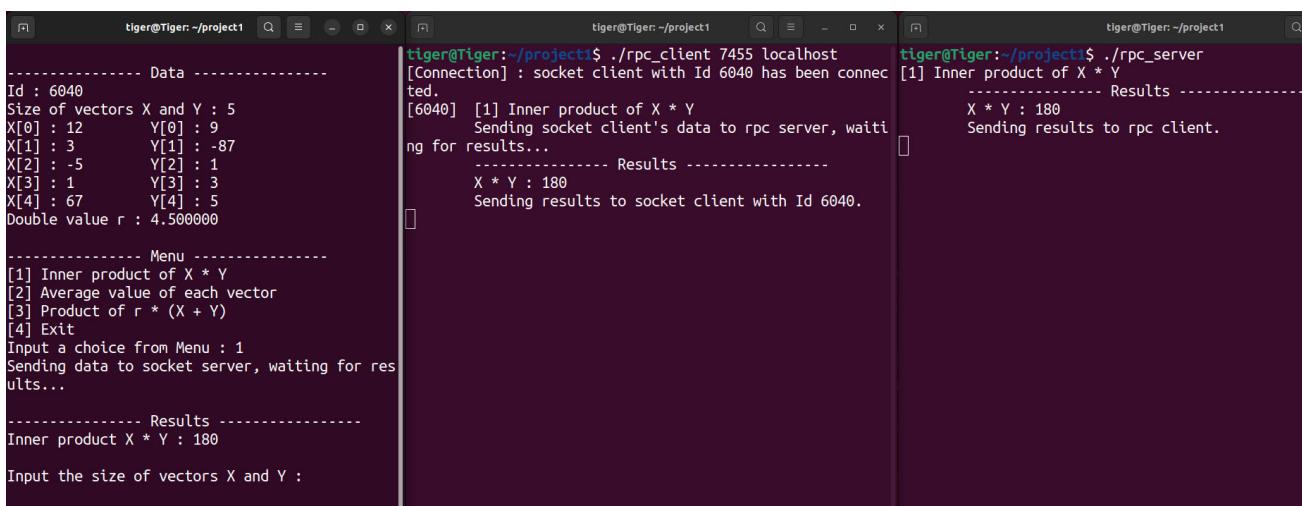
1st Choice



```
tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6040 has been connected.
```

```
tiger@Tiger:~/project1$ ./rpc_server
```

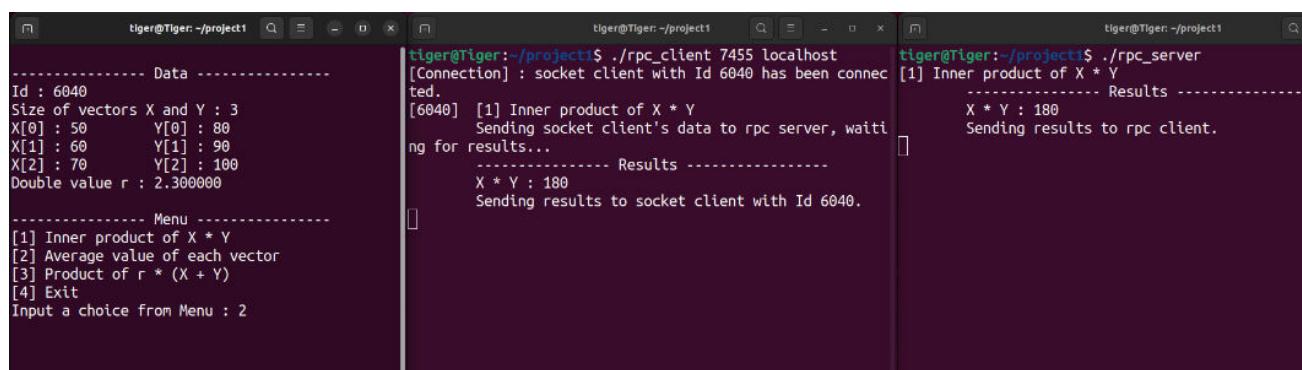
1st Choice Results



```
tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6040 has been connected.
[6040] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
```

```
tiger@Tiger:~/project1$ ./rpc_server
[1] Inner product of X * Y
----- Results -----
X * Y : 180
Sending results to rpc client.
```

2nd Choice



```
tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6040 has been connected.
[6040] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
```

```
tiger@Tiger:~/project1$ ./rpc_server
[1] Inner product of X * Y
----- Results -----
X * Y : 180
Sending results to rpc client.
```

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2nd Choice Results

```

tiger@Tiger:~/project1$ ./rpc_client
----- Data -----
Id : 6040
Size of vectors X and Y : 3
X[0] : 50      Y[0] : 80
X[1] : 60      Y[1] : 90
X[2] : 70      Y[2] : 100
Double value r : 2.300000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 2
Sending data to socket server, waiting for results...
----- Results -----
Average value of vector X : 60.000000
Average value of vector Y : 90.000000

Input the size of vectors X and Y :

```

```

tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6040 has been connected.
[6040] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      X * Y : 180
      Sending results to socket client with Id 6040.
[6040] [2] Average value of each vector
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      Average value of X : 60.000000
      Average value of Y : 90.000000
      Sending results to socket client with Id 6040.

```

```

tiger@Tiger:~/project1$ ./rpc_server
[1] Inner product of X * Y
----- Results -----
X * Y : 180
Sending results to rpc client.
[2] Average value of each vector
----- Results -----
Average value of X : 60.000000
Average value of Y : 90.000000
Sending results to rpc client.

```

3rd Choice

```

tiger@Tiger:~/project1$ ./rpc_client
----- Data -----
Id : 6040
Size of vectors X and Y : 6
X[0] : 1      Y[0] : 0
X[1] : -5     Y[1] : -10
X[2] : 4      Y[2] : 6
X[3] : 34     Y[3] : 2
X[4] : 10     Y[4] : 79
X[5] : 2      Y[5] : 810
Double value r : 5.500000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 3

```

```

tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6040 has been connected.
[6040] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      X * Y : 180
      Sending results to socket client with Id 6040.
[6040] [2] Average value of each vector
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      Average value of X : 60.000000
      Average value of Y : 90.000000
      Sending results to socket client with Id 6040.

```

```

tiger@Tiger:~/project1$ ./rpc_server
[1] Inner product of X * Y
----- Results -----
X * Y : 180
Sending results to rpc client.
[2] Average value of each vector
----- Results -----
Average value of X : 60.000000
Average value of Y : 90.000000
Sending results to rpc client.

```

3rd Choice Results

```

tiger@Tiger:~/project1$ ./rpc_client
----- Data -----
Id : 6040
Size of vectors X and Y : 6
X[0] : 1      Y[0] : 0
X[1] : -5     Y[1] : -10
X[2] : 4      Y[2] : 6
X[3] : 34     Y[3] : 2
X[4] : 10     Y[4] : 79
X[5] : 2      Y[5] : 810
Double value r : 5.500000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 3
Sending data to socket server, waiting for results...
----- Results -----
r * (X + Y)[0] : 5.500000
r * (X + Y)[1] : -82.500000
r * (X + Y)[2] : 55.000000
r * (X + Y)[3] : 198.000000
r * (X + Y)[4] : 489.500000
r * (X + Y)[5] : 4466.000000

Input the size of vectors X and Y :

```

```

tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6040 has been connected.
[6040] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      X * Y : 180
      Sending results to socket client with Id 6040.
[6040] [2] Average value of each vector
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      Average value of X : 60.000000
      Average value of Y : 90.000000
      Sending results to socket client with Id 6040.
[6040] [3] Product of r * (X + Y)
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      r * (X + Y)[0] : 5.500000
      r * (X + Y)[1] : -82.500000
      r * (X + Y)[2] : 55.000000
      r * (X + Y)[3] : 198.000000
      r * (X + Y)[4] : 489.500000
      r * (X + Y)[5] : 4466.000000
      Sending results to socket client with Id 6040.

```

```

tiger@Tiger:~/project1$ ./rpc_server
[1] Inner product of X * Y
----- Results -----
X * Y : 180
Sending results to rpc client.
[2] Average value of each vector
----- Results -----
Average value of X : 60.000000
Average value of Y : 90.000000
Sending results to rpc client.
[3] Product of r * (X + Y)
----- Results -----
r * (X + Y)[0] : 5.500000
r * (X + Y)[1] : -82.500000
r * (X + Y)[2] : 55.000000
r * (X + Y)[3] : 198.000000
r * (X + Y)[4] : 489.500000
r * (X + Y)[5] : 4466.000000
Sending results to rpc client.

```

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4th Choice

```
tiger@Tiger: ~/project1$ ./rpc_client 7455 localhost
----- Data -----
Id : 6040
Size of vectors X and Y : 1
X[0] : 1      Y[0] : 1
Double value r : 1.100000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 4
```

```
tiger@Tiger: ~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6040 has been connected.
[6040] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      X * Y : 180
      Sending results to socket client with Id 6040.
[6040] [2] Average value of each vector
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      Average value of X : 60.000000
      Average value of Y : 90.000000
      Sending results to socket client with Id 6040.
[6040] [3] Product of r * (X + Y)
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      r * (X + Y)[0] : 5.500000
      r * (X + Y)[1] : -82.500000
      r * (X + Y)[2] : 55.000000
      r * (X + Y)[3] : 198.000000
      r * (X + Y)[4] : 489.500000
      r * (X + Y)[5] : 4466.000000
      Sending results to socket client with Id 6040.
```

```
tiger@Tiger: ~/project1$ ./rpc_server
[1] Inner product of X * Y
----- Results -----
X * Y : 180
Sending results to rpc client.
[2] Average value of each vector
----- Results -----
Average value of X : 60.000000
Average value of Y : 90.000000
Sending results to rpc client.
[3] Product of r * (X + Y)
----- Results -----
r * (X + Y)[0] : 5.500000
r * (X + Y)[1] : -82.500000
r * (X + Y)[2] : 55.000000
r * (X + Y)[3] : 198.000000
r * (X + Y)[4] : 489.500000
r * (X + Y)[5] : 4466.000000
Sending results to rpc client.
```

4th Choice Results

```
tiger@Tiger: ~/project1$ ./rpc_client 7455 localhost
----- Data -----
Id : 6040
Size of vectors X and Y : 1
X[0] : 1      Y[0] : 1
Double value r : 1.100000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 4
tiger@Tiger:~/project1$
```

```
tiger@Tiger: ~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6040 has been connected.
[6040] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      X * Y : 180
      Sending results to socket client with Id 6040.
[6040] [2] Average value of each vector
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      Average value of X : 60.000000
      Average value of Y : 90.000000
      Sending results to socket client with Id 6040.
[6040] [3] Product of r * (X + Y)
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      r * (X + Y)[0] : 5.500000
      r * (X + Y)[1] : -82.500000
      r * (X + Y)[2] : 55.000000
      r * (X + Y)[3] : 198.000000
      r * (X + Y)[4] : 489.500000
      r * (X + Y)[5] : 4466.000000
      Sending results to socket client with Id 6040.
[6040] [4] Exit
[Disconnection] : socket client with Id 6040 has been disconnected.
```

```
tiger@Tiger: ~/project1$ ./rpc_server
[1] Inner product of X * Y
----- Results -----
X * Y : 180
Sending results to rpc client.
[2] Average value of each vector
----- Results -----
Average value of X : 60.000000
Average value of Y : 90.000000
Sending results to rpc client.
[3] Product of r * (X + Y)
----- Results -----
r * (X + Y)[0] : 5.500000
r * (X + Y)[1] : -82.500000
r * (X + Y)[2] : 55.000000
r * (X + Y)[3] : 198.000000
r * (X + Y)[4] : 489.500000
r * (X + Y)[5] : 4466.000000
Sending results to rpc client.
```

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Socket clients: 2

Servers On

The image shows four terminal windows side-by-side. The top row contains three windows: the left one runs `tiger@Tiger:~/project1$./socket_client 7455 localhost`, the middle one runs `tiger@Tiger:~/project1$./rpc_client 7455 localhost`, and the right one runs `tiger@Tiger:~/project1$./rpc_server`. The bottom row contains two windows, both running `tiger@Tiger:~/project1$./socket_client 7455 localhost`.

Connection

The image shows four terminal windows side-by-side. The top row contains three windows: the left one runs `tiger@Tiger:~/project1$./socket_client 7455 localhost` and receives the message "[6088] : connected to socket server.", the middle one runs `tiger@Tiger:~/project1$./rpc_client 7455 localhost` and receives the messages "[Connection] : socket client with Id 6088 has been connected." and "[Connection] : socket client with Id 6090 has been connected.", and the right one runs `tiger@Tiger:~/project1$./rpc_server`. The bottom row contains two windows, both running `tiger@Tiger:~/project1$./socket_client 7455 localhost` and receiving the message "[6090] : connected to socket server.", followed by "Input the size of vectors X and Y :".

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1st Choice Results

The image shows three terminal windows running on a Linux system (Ubuntu 14.04 LTS). The left window displays the client application's menu and data input. The middle window shows the client connecting to the server and sending data. The right window shows the server receiving the data and calculating the result.

```
tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6088 has been connected.
[Connection] : socket client with Id 6090 has been connected.
[6088] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      X * Y : 130
      Sending results to socket client with Id 6088.

tiger@Tiger:~/project1$ ./rpc_server
[1] Inner product of X * Y
----- Results -----
X * Y : 130
Sending results to rpc client.

tiger@Tiger:~/project1$ ./socket_client 7455 localhost
[6090] : connected to socket server.
Input the size of vectors X and Y : 5
```

2nd Choice Results

The image shows three terminal windows running on a Windows 10 system. The left window displays the client application's menu and data input. The middle window shows the client connecting to the server and sending data. The right window shows the server receiving the data and calculating the result.

```
tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6088 has been connected.
[Connection] : socket client with Id 6090 has been connected.
[6088] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      X * Y : 130
      Sending results to socket client with Id 6088.

tiger@Tiger:~/project1$ ./rpc_server
[1] Inner product of X * Y
----- Results -----
X * Y : 130
Sending results to rpc client.

tiger@Tiger:~/project1$ ./socket_client 7455 localhost
[6090] : connected to socket server.
Input the size of vectors X and Y : 3
```

Activate Windows
Go to Settings to activate Windows.

DISTRIBUTED SYSTEMS

3rd Choice Results

```
tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6088 has been connected.
[Connection] : socket client with Id 6090 has been connected.
[6088] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      X * Y : 130
      Sending results to socket client with Id 6088.
[6090] [2] Average value of each vector
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      Average value of X : 14.000000
      Average value of Y : 20.000000
      Sending results to socket client with Id 6090.
[6088] [3] Product of r * (X + Y)
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      r * (X + Y)[0] : 4400.000000
      r * (X + Y)[1] : 6600.000000
      Sending results to socket client with Id 6088.

Input the size of vectors X and Y :
----- Data -----
Id : 6090
Size of vectors X and Y : 3
X[0] : 12      Y[0] : 18
X[1] : 14      Y[1] : 20
X[2] : 16      Y[2] : 22
Double value r : 4.500000

----- Data -----
tiger@Tiger:~/project1$ ./rpc_server
[1] Inner product of X * Y
      ----- Results -----
      X * Y : 130
      Sending results to rpc client.
[2] Average value of each vector
      ----- Results -----
      Average value of X : 14.000000
      Average value of Y : 20.000000
      Sending results to rpc client.
[3] Product of r * (X + Y)
      ----- Results -----
      r * (X + Y)[0] : 4400.000000
      r * (X + Y)[1] : 6600.000000
      Sending results to rpc client.
```

4th Choice Results

```
tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6088 has been connected.
[Connection] : socket client with Id 6090 has been connected.
[6088] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      X * Y : 130
      Sending results to socket client with Id 6088.
[6090] [2] Average value of each vector
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      Average value of X : 14.000000
      Average value of Y : 20.000000
      Sending results to socket client with Id 6090.
[6088] [3] Product of r * (X + Y)
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      r * (X + Y)[0] : 4400.000000
      r * (X + Y)[1] : 6600.000000
      Sending results to socket client with Id 6088.

[6090] [4] Exit
[Disconnection] : socket client with Id 6090 has been disconnected.

----- Data -----
Id : 6090
Size of vectors X and Y : 1
X[0] : 1      Y[0] : 1
Double value r : 3.200000

----- Data -----
tiger@Tiger:~/project1$ ./rpc_server
[1] Inner product of X * Y
      ----- Results -----
      X * Y : 130
      Sending results to rpc client.
[2] Average value of each vector
      ----- Results -----
      Average value of X : 14.000000
      Average value of Y : 20.000000
      Sending results to rpc client.
[3] Product of r * (X + Y)
      ----- Results -----
      r * (X + Y)[0] : 4400.000000
      r * (X + Y)[1] : 6600.000000
      Sending results to rpc client.
```

DISTRIBUTED SYSTEMS

New Connection

The image shows three terminal windows illustrating a distributed system architecture. The left window shows a client interacting with a socket server. The middle window shows a client interacting with an RPC server. The right window shows the RPC server processing requests from multiple clients.

```
tiger@Tiger:~/project1$ ./socket_client 7455 localhost
[6108] : connected to socket server.
Input the size of vectors X and Y : 2
Id : 6088
Size of vectors X and Y : 2
X[0] : 200      Y[0] : 600
X[1] : 400      Y[1] : 800
Double value r : 5.500000

tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6088 has been connected.
[Connection] : socket client with Id 6090 has been connected.
[6088] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      X * Y : 130
      Sending results to socket client with Id 6088.
[6090] [2] Average value of each vector
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      Average value of X : 14.000000
      Average value of Y : 20.000000
      Sending results to socket client with Id 6090.
[6088] [3] Product of r * (X + Y)
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      r * (X + Y)[0] : 4400.000000
      r * (X + Y)[1] : 6600.000000
      Sending results to socket client with Id 6088.
[6090] [4] Exit
[Disconnection] : socket client with Id 6090 has been disconnected.
[Connection] : socket client with Id 6108 has been connected.

tiger@Tiger:~/project1$ ./rpc_server
[1] Inner product of X * Y
      ----- Results -----
      X * Y : 130
      Sending results to rpc client.
[2] Average value of each vector
      ----- Results -----
      Average value of X : 14.000000
      Average value of Y : 20.000000
      Sending results to rpc client.
[3] Product of r * (X + Y)
      ----- Results -----
      r * (X + Y)[0] : 4400.000000
      r * (X + Y)[1] : 6600.000000
      Sending results to rpc client.
```

Socket clients: 4

Servers On

The image shows four terminal windows. Three windows on the left show clients connecting to a single RPC server. The rightmost window shows the RPC server running.

```
tiger@Tiger:~/project1$ ./socket_client 7455 localhost
tiger@Tiger:~/project1$ ./socket_client 7455 localhost
tiger@Tiger:~/project1$ ./socket_client 7455 localhost
tiger@Tiger:~/project1$ ./socket_client 7455 localhost
tiger@Tiger:~/project1$ ./rpc_server
```

Activate Windows
Go to Settings to activate Windows.

DISTRIBUTED SYSTEMS

Connection

The image shows four terminal windows side-by-side. The top-left window shows a socket client connection with ID 6166. The top-right window shows a socket client connection with ID 6168. The bottom-left window shows a socket client connection with ID 6170. The bottom-right window shows an RPC server running.

```
tiger@Tiger:~/project1$ ./socket_client 7455 localhost
[6166] : connected to socket server.
Input the size of vectors X and Y : []
tiger@Tiger:~/project1$ ./socket_client 7455 localhost
[6170] : connected to socket server.
Input the size of vectors X and Y : []
tiger@Tiger:~/project1$ ./socket_client 7455 localhost
[6168] : connected to socket server.
Input the size of vectors X and Y : []
tiger@Tiger:~/project1$ ./rpc_server
tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6166 has been connected.
[Connection] : socket client with Id 6168 has been connected.
[Connection] : socket client with Id 6170 has been connected.
[Connection] : socket client with Id 6172 has been connected.
```

Input Data

The image shows four terminal windows side-by-side. The top-left window shows vector data for ID 6166. The top-right window shows vector data for ID 6170. The bottom-left window shows vector data for ID 6168. The bottom-right window shows an RPC server running.

```
tiger@Tiger:~/project1$ ./socket_client 7455 localhost
----- Data -----
Id : 6166
Size of vectors X and Y : 5
X[0] : 1      Y[0] : 6
X[1] : 2      Y[1] : 7
X[2] : 3      Y[2] : 8
X[3] : 4      Y[3] : 9
X[4] : 5      Y[4] : 10
Double value r : 4.500000
----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 1
tiger@Tiger:~/project1$ ./socket_client 7455 localhost
----- Data -----
Id : 6170
Size of vectors X and Y : 1
X[0] : 1      Y[0] : 2
Double value r : 3.200000
----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 4
tiger@Tiger:~/project1$ ./socket_client 7455 localhost
----- Data -----
Id : 6168
Size of vectors X and Y : 3
X[0] : 12     Y[0] : 12
X[1] : 80     Y[1] : 5
X[2] : -4     Y[2] : 67
Double value r : 7.800000
----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 2
tiger@Tiger:~/project1$ ./rpc_server
tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6166 has been connected.
[Connection] : socket client with Id 6168 has been connected.
[Connection] : socket client with Id 6170 has been connected.
[Connection] : socket client with Id 6172 has been connected.
```

Activate Windows
Go to Settings to activate Windows.

DISTRIBUTED SYSTEMS

1st Choice Results

```
tiger@Tiger:~/project1
```

----- Data -----
Id : 6166
Size of vectors X and Y : 5
X[0] : 1 Y[0] : 6
X[1] : 2 Y[1] : 7
X[2] : 3 Y[2] : 8
X[3] : 4 Y[3] : 9
X[4] : 5 Y[4] : 10
Double value r : 4.500000
----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 1
Sending data to socket server, waiting for results...
----- Results -----
Inner product X * Y : 130
Input the size of vectors X and Y :
X[0] : 80 Y[0] : 5
X[1] : -4 Y[1] : 67
Double value r : 7.800000
----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 2

```
tiger@Tiger:~/project1
```

----- Data -----
d : 6170
Size of vectors X and Y : 1
X[0] : 1 Y[0] : 2
Double value r : 3.200000
----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 4

```
tiger@Tiger:~/project1
```

[Connection] : socket client with Id 6166 has been connected.
[Connection] : socket client with Id 6168 has been connected.
[Connection] : socket client with Id 6170 has been connected.
[Connection] : socket client with Id 6172 has been connected.
[6166] [1] Inner product of X * Y
Sending socket client's data to rpc server, waiting for results...
----- Results -----
X * Y : 130
Sending results to socket client with Id 6166.

```
tiger@Tiger:~/project1
```

----- Data -----
Id : 6172
Size of vectors X and Y : 4
X[0] : 1 Y[0] : 45
X[1] : 24 Y[1] : 9
X[2] : -6 Y[2] : 1
X[3] : 12 Y[3] : 3
Double value r : 6.900000
----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 3

```
tiger@Tiger:~/project1
```

[1] Inner product of X * Y
----- Results -----
X * Y : 130
Sending results to rpc client.

```
tiger@Tiger:~/project1
```

2nd Choice Results

```
tiger@Tiger:~/project1
```

----- Data -----
Id : 6166
Size of vectors X and Y : 5
X[0] : 1 Y[0] : 6
X[1] : 2 Y[1] : 7
X[2] : 3 Y[2] : 8
X[3] : 4 Y[3] : 9
X[4] : 5 Y[4] : 10
Double value r : 4.500000

----- Menu -----
1] Inner product of X * Y
2] Average value of each vector
3] Product of r * (X + Y)
4] Exit
Input a choice from Menu : 4

```
tiger@Tiger:~/project1
```

----- Data -----
Id : 6170
Size of vectors X and Y : 1
X[0] : 1 Y[0] : 2
Double value r : 3.200000

----- Menu -----
1] Inner product of X * Y
2] Average value of each vector
3] Product of r * (X + Y)
4] Exit
Input a choice from Menu : 4

```
tiger@Tiger:~/project1
```

----- Data -----
Id : 6168
Size of vectors X and Y : 3
X[0] : 12 Y[0] : 12
X[1] : 80 Y[1] : 5
X[2] : -4 Y[2] : 67
Double value r : 7.800000

----- Menu -----
1] Inner product of X * Y
2] Average value of each vector
3] Product of r * (X + Y)
4] Exit
Input a choice from Menu : 2
Sending data to socket server, waiting for results...

----- Results -----
Average value of vector X : 29.000000
Average value of vector Y : 28.000000

```
tiger@Tiger:~/project1
```

----- Data -----
Id : 6172
Size of vectors X and Y : 4
X[0] : 1 Y[0] : 45
X[1] : 24 Y[1] : 9
X[2] : -6 Y[2] : 1
X[3] : 12 Y[3] : 3
Double value r : 6.900000

----- Menu -----
1] Inner product of X * Y
2] Average value of each vector
3] Product of r * (X + Y)
4] Exit
Input a choice from Menu : 3

```
tiger@Tiger:~/project1
```

[Connection] : socket client with Id 6170 has been connected.
[Connection] : socket client with Id 6172 has been connected.
[6166] [1] Inner product of X * Y
 Sending socket client's data to rpc server, waiting for results...
----- Results -----
X * Y : 130
Sending results to socket client with Id 6166.
[6168] [2] Average value of each vector
 Sending socket client's data to rpc server, waiting for results...
----- Results -----
Average value of X : 29.000000
Average value of Y : 28.000000
Sending results to socket client with Id 6168.

```
tiger@Tiger:~/project1
```

tiger@Tiger:~/project1\$./rpc_server
[1] Inner product of X * Y
----- Results -----
X * Y : 130
Sending results to rpc client.
[2] Average value of each vector
----- Results -----
Average value of X : 29.000000
Average value of Y : 28.000000
Sending results to rpc client.

```
tiger@Tiger:~/project1
```

Activate Windows
Go to Settings to activate Windows.

DISTRIBUTED SYSTEMS

3rd Choice Results

```
tiger@Tiger:~/project1
```

----- Data -----
Id : 6166
Size of vectors X and Y : 5
X[0] : 1 Y[0] : 6
X[1] : 2 Y[1] : 7
X[2] : 3 Y[2] : 8
X[3] : 4 Y[3] : 9
X[4] : 5 Y[4] : 10
Double value r : 4.500000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit

```
tiger@Tiger:~/project1
```

----- Data -----
Id : 6170
Size of vectors X and Y : 1
X[0] : 1 Y[0] : 2
Double value r : 3.200000

----- Menu -----
tiger@Tiger:~/project1

----- Data -----
Id : 6172
Size of vectors X and Y : 4
X[0] : 1 Y[0] : 45
X[1] : 24 Y[1] : 9
X[2] : -6 Y[2] : 1
X[3] : 12 Y[3] : 3
Double value r : 6.900000

```
tiger@Tiger:~/project1
```

----- Data -----
Id : 6168
Size of vectors X and Y : 3
X[0] : 12 Y[0] : 12
X[1] : 80 Y[1] : 5
X[2] : -4 Y[2] : 67
Double value r : 7.800000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 3
Sending data to socket server, waiting for results.
..

----- Results -----
r * (X + Y)[0] : 317.400000
r * (X + Y)[1] : 227.700000
r * (X + Y)[2] : -34.500000
r * (X + Y)[3] : 103.500000

```
tiger@Tiger:~/project1
```

Sending results to socket client with Id 6166.
[2] Average value of each vector
Sending socket client's data to rpc server, waiting for results...
----- Results -----
Average value of X : 29.000000
Average value of Y : 28.000000
Sending results to socket client with Id 6168.
[3] Product of r * (X + Y)
Sending socket client's data to rpc server, waiting for results...
----- Results -----
r * (X + Y)[0] : 317.400000
r * (X + Y)[1] : 227.700000
r * (X + Y)[2] : -34.500000
r * (X + Y)[3] : 103.500000
Sending results to socket client with Id 6172.

```
tiger@Tiger:~/project1
```

X * Y : 130
Sending results to rpc client.
[2] Average value of each vector
----- Results -----
Average value of X : 29.000000
Average value of Y : 28.000000
Sending results to rpc client.
[3] Product of r * (X + Y)
----- Results -----
r * (X + Y)[0] : 317.400000
r * (X + Y)[1] : 227.700000
r * (X + Y)[2] : -34.500000
r * (X + Y)[3] : 103.500000
Windows
Sending results to rpc client.

4th Choice Results

```
tiger@Tiger: ~/project1
```

----- Data -----
Id : 6166
Size of vectors X and Y : 5
X[0] : 1 Y[0] : 6
X[1] : 2 Y[1] : 7
X[2] : 3 Y[2] : 8
X[3] : 4 Y[3] : 9
X[4] : 5 Y[4] : 10
Double value r : 4.500000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit

```
tiger@Tiger: ~/project1
```

----- Data -----
Id : 6170
Size of vectors X and Y : 1
X[0] : 1 Y[0] : 2
Double value r : 3.200000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 4

```
tiger@Tiger: ~/project1$
```

```
tiger@Tiger: ~/project1
```

----- Data -----
Id : 6168
Size of vectors X and Y : 3
X[0] : 12 Y[0] : 12
X[1] : 80 Y[1] : 5
X[2] : -4 Y[2] : 67
Double value r : 7.800000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 2

Sending data to socket server, waiting for results

```
tiger@Tiger: ~/project1
```

----- Data -----
Id : 6172
Size of vectors X and Y : 1
X[0] : 1 Y[0] : 2
Double value r : 3.200000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 3

Sending data to socket server, waiting for results.

..

```
tiger@Tiger: ~/project1
```

----- Results -----
 $r * (X + Y)[0] : 317.400000$
 $r * (X + Y)[1] : 227.700000$
 $r * (X + Y)[2] : -34.500000$
 $r * (X + Y)[3] : 103.500000$

----- Results -----
Average value of X : 29.000000
Average value of Y : 28.000000

Sending results to socket client with Id 6168.

6172] [3] Product of r * (X + Y)

Sending socket client's data to rpc server, waiting for results...

```
tiger@Tiger: ~/project1$
```

```
tiger@Tiger: ~/project1
```

----- Results -----
Average value of X : 29.000000
Average value of Y : 28.000000

Sending results to socket client with Id 6170.

6170] [4] Exit

Disconnection] : socket client with Id 6170 has been connected.

```
tiger@Tiger: ~/project1
```

X * Y : 130
Sending results to rpc client.

[2] Average value of each vector

----- Results -----
Average value of X : 29.000000
Average value of Y : 28.000000

Sending results to rpc client.

[3] Product of r * (X + Y)

----- Results -----
 $r * (X + Y)[0] : 317.400000$
 $r * (X + Y)[1] : 227.700000$
 $r * (X + Y)[2] : -34.500000$
 $r * (X + Y)[3] : 103.500000$

----- Results -----
Average value of X : 29.000000
Average value of Y : 28.000000

Sending results to rpc client.

6170] [4] Exit

Disconnection] : socket client with Id 6170 has been connected.

```
tiger@Tiger: ~/project1
```

X * Y : 130
Sending results to rpc client.

[2] Average value of each vector

----- Results -----
Average value of X : 29.000000
Average value of Y : 28.000000

Sending results to rpc client.

[3] Product of r * (X + Y)

----- Results -----
 $r * (X + Y)[0] : 317.400000$
 $r * (X + Y)[1] : 227.700000$
 $r * (X + Y)[2] : -34.500000$
 $r * (X + Y)[3] : 103.500000$

----- Results -----
Average value of X : 29.000000
Average value of Y : 28.000000

Sending results to rpc client.

6170] [4] Exit

Disconnection] : socket client with Id 6170 has been connected.

```
tiger@Tiger: ~/project1
```

DISTRIBUTED SYSTEMS

Disconnection

The image shows six terminal windows from a Linux environment, each displaying a different part of a distributed system's state or log output. The windows are arranged in two columns of three.

- Top Left Window:** Shows "Data" and "Menu" sections. "Data" includes "Id : 6166", "Size of vectors X and Y : 1", "X[0] : 1", "Y[0] : 1", and "Double value r : 3.200000". "Menu" includes options [1] Inner product of X * Y, [2] Average value of each vector, [3] Product of r * (X + Y), and [4] Exit. The prompt is "Input a choice from Menu : 4".
- Top Middle Window:** Shows "Data" and "Menu" sections. "Data" includes "Id : 6170", "Size of vectors X and Y : 1", "X[0] : 1", "Y[0] : 2", and "Double value r : 3.200000". "Menu" includes options [1] Inner product of X * Y, [2] Average value of each vector, [3] Product of r * (X + Y), and [4] Exit. The prompt is "Input a choice from Menu : 4".
- Top Right Window:** Shows "Data" and "Menu" sections. "Data" includes "r * (X + Y)[0] : 317.400000", "r * (X + Y)[1] : 227.700000", "r * (X + Y)[2] : -34.500000", and "r * (X + Y)[3] : 103.500000". "Menu" includes options [1] Inner product of X * Y, [2] Average value of each vector, [3] Product of r * (X + Y), and [4] Exit. The prompt is "Input a choice from Menu : 4".
- Bottom Left Window:** Shows "Data" and "Menu" sections. "Data" includes "Id : 6168", "Size of vectors X and Y : 1", "X[0] : 1", "Y[0] : 1", and "Double value r : 3.200000". "Menu" includes options [1] Inner product of X * Y, [2] Average value of each vector, [3] Product of r * (X + Y), and [4] Exit. The prompt is "Input a choice from Menu : 4".
- Bottom Middle Window:** Shows "Data" and "Menu" sections. "Data" includes "Id : 6172", "Size of vectors X and Y : 1", "X[0] : 1", "Y[0] : 1", and "Double value r : 1.000000". "Menu" includes options [1] Inner product of X * Y, [2] Average value of each vector, [3] Product of r * (X + Y), and [4] Exit. The prompt is "Input a choice from Menu : 4".
- Bottom Right Window:** Shows "Results" and "Menu" sections. "Results" include "Average value of X : 29.000000" and "Average value of Y : 28.000000". "Menu" includes options [1] Inner product of X * Y, [2] Average value of each vector, [3] Product of r * (X + Y), and [4] Exit. The prompt is "Input a choice from Menu : 4".

Logs in the windows indicate socket and RPC client connections, as well as disconnection events. For example, the top right window shows sending results to a socket client with Id 6170 and disconnecting it. The bottom right window shows sending results to an RPC client and activating Windows.

DISTRIBUTED SYSTEMS

Verification of results

[1] Inner Product X * Y

```
tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6040 has been connected.
[6040] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      X * Y : 180
      Sending results to socket client with Id 6040.

----- Data -----
Id : 6040
Size of vectors X and Y : 5
X[0] : 12      Y[0] : 9
X[1] : 3       Y[1] : -87
X[2] : -5      Y[2] : 1
X[3] : 1       Y[3] : 3
X[4] : 67      Y[4] : 5
Double value r : 4.500000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 1
Sending data to socket server, waiting for results...

----- Results -----
Inner product X * Y : 180

Input the size of vectors X and Y :
```

vector	a
a ₁	12
a ₂	3
a ₃	-5
a ₄	1
a ₅	67

vector	b
b ₁	9
b ₂	-87
b ₃	1
b ₄	3
b ₅	5

Execute **Clear** **Store/Read** **Print** **14digit** ▾

vector product	
	product
inner product c	180
outer product c	no answer

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[2] Mean value of the two vectors

```
tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
[Connection] : socket client with Id 6040 has been connected.
[6040] [1] Inner product of X * Y
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      X * Y : 180
      Sending results to rpc client.
[6040] [2] Average value of each vector
      Sending socket client's data to rpc server, waiting for results...
      ----- Results -----
      Average value of X : 60.000000
      Average value of Y : 90.000000
      Sending results to rpc client.

tiger@Tiger:~/project1$ ./rpc_server
[1] Inner product of X * Y
      ----- Results -----
      X * Y : 180
      Sending results to rpc client.
[2] Average value of each vector
      ----- Results -----
      Average value of X : 60.000000
      Average value of Y : 90.000000
      Sending results to rpc client.

----- Data -----
Id : 6040
Size of vectors X and Y : 3
X[0] : 50      Y[0] : 80
X[1] : 60      Y[1] : 90
X[2] : 70      Y[2] : 100
Double value r : 2.300000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 2
Sending data to socket server, waiting for results...

----- Results -----
Average value of vector X : 60.000000
Average value of vector Y : 90.000000

Input the size of vectors X and Y :
```

Average Calculator

Please provide numbers separated by a comma to calculate the average of the numbers.

Result

Average: **60**

$$\begin{aligned}\text{Average} &= \frac{\text{Sum}}{\text{Count}} \\ &= \frac{180}{3} \\ &= 60\end{aligned}$$

Sum	180
Count	3
Median	60
Geometric Mean	59.439219527631
Largest	70
Smallest	50
Range	20

50, 60, 70

Calculate  **Clear**

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Average Calculator

Please provide numbers separated by a comma to calculate the average of the numbers.

Result

Average: **90**

$$\begin{aligned}\text{Average} &= \frac{\text{Sum}}{\text{Count}} \\ &= \frac{270}{3} \\ &= 90\end{aligned}$$

Sum	270
Count	3
Median	90
Geometric Mean	89.628094931143
Largest	100
Smallest	80
Range	20

80, 90, 100

Calculate  **Clear**

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[3] Product $r * (X + Y)$

```
tiger@Tiger:~/project1
```

----- Data -----
Id : 6040
Size of vectors X and Y : 6
X[0] : 1 Y[0] : 0
X[1] : -5 Y[1] : -10
X[2] : 4 Y[2] : 6
X[3] : 34 Y[3] : 2
X[4] : 10 Y[4] : 79
X[5] : 2 Y[5] : 810
Double value r : 5.500000

----- Menu -----
[1] Inner product of X * Y
[2] Average value of each vector
[3] Product of r * (X + Y)
[4] Exit
Input a choice from Menu : 3
Sending data to socket server, waiting for results...

----- Results -----
r * (X + Y)[0] : 5.500000
r * (X + Y)[1] : -82.500000
r * (X + Y)[2] : 55.000000
r * (X + Y)[3] : 198.000000
r * (X + Y)[4] : 489.500000
r * (X + Y)[5] : 4466.000000

Input the size of vectors X and Y : 6

```
tiger@Tiger:~/project1$ ./rpc_client 7455 localhost
```

[Connection] : socket client with Id 6040 has been connected.
[6040] [1] Inner product of X * Y
Sending socket client's data to rpc server, waiting for results...
----- Results -----
X * Y : 180
Sending results to socket client with Id 6040.

```
tiger@Tiger:~/project1$ ./rpc_server
```

[1] Inner product of X * Y
----- Results -----
X * Y : 180
Sending results to rpc client.
[2] Average value of each vector
----- Results -----
Average value of X : 60.000000
Average value of Y : 90.000000
Sending results to rpc client.
[3] Product of r * (X + Y)
----- Results -----
r * (X + Y)[0] : 5.500000
r * (X + Y)[1] : -82.500000
r * (X + Y)[2] : 55.000000
r * (X + Y)[3] : 198.000000
r * (X + Y)[4] : 489.500000
r * (X + Y)[5] : 4466.000000
Sending results to rpc client.

<p>Matrix A Input</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;">row</td> <td style="width: 50%; padding: 5px;">column</td> </tr> <tr> <td style="padding: 5px; text-align: center;">6</td> <td style="padding: 5px; text-align: center;">\times 1</td> </tr> <tr> <td style="padding: 5px; text-align: center;">1</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">-5</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">4</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">34</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">10</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">2</td> <td></td> </tr> </table> <div style="margin-top: 10px;"> <input type="button" value="Clear"/> <input type="button" value="All 0"/> <input type="button" value="All 1"/> <input type="button" value="Random"/> <input type="button" value="Transpose"/> <input type="button" value="Power of 2"/> <input type="button" value="Determinant"/> <input type="button" value="Inverse"/> <input type="button" value="x 3"/> </div> <div style="margin-top: 10px; background-color: #ccc; padding: 5px; display: flex; justify-content: space-around;"> A + B A - B AB A \leftrightarrow B </div>	row	column	6	\times 1	1		-5		4		34		10		2		<p>Matrix B Input</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;">row</td> <td style="width: 50%; padding: 5px;">column</td> </tr> <tr> <td style="padding: 5px; text-align: center;">6</td> <td style="padding: 5px; text-align: center;">\times 1</td> </tr> <tr> <td style="padding: 5px; text-align: center;">0</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">-10</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">6</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">2</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">79</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">810</td> <td></td> </tr> </table> <div style="margin-top: 10px;"> <input type="button" value="Clear"/> <input type="button" value="All 0"/> <input type="button" value="All 1"/> <input type="button" value="Random"/> <input type="button" value="Transpose"/> <input type="button" value="Power of 2"/> <input type="button" value="Determinant"/> <input type="button" value="Inverse"/> <input type="button" value="x 3"/> </div>	row	column	6	\times 1	0		-10		6		2		79		810		<p>Matrix A Input</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;">row</td> <td style="width: 50%; padding: 5px;">column</td> </tr> <tr> <td style="padding: 5px; text-align: center;">6</td> <td style="padding: 5px; text-align: center;">\times 1</td> </tr> <tr> <td style="padding: 5px; text-align: center;">1</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">-15</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">10</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">36</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">89</td> <td></td> </tr> <tr> <td style="padding: 5px; text-align: center;">812</td> <td></td> </tr> </table> <div style="margin-top: 10px;"> <input type="button" value="Clear"/> <input type="button" value="All 0"/> <input type="button" value="All 1"/> <input type="button" value="Random"/> <input type="button" value="Transpose"/> <input type="button" value="Power of 2"/> <input type="button" value="Determinant"/> <input type="button" value="Inverse"/> <input type="button" value="x 5.5"/> </div> <div style="margin-top: 10px; background-color: #ccc; padding: 5px; display: flex; justify-content: space-around;"> A + B A - B </div>	row	column	6	\times 1	1		-15		10		36		89		812	
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Thank you for your attention.

