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Lab 2 Networks

Question 1

1. Implement a port scanner using socket programming. The port scanner checks a number of ports (for instance, from 1 to 1026) to see if they are open (a server is listening on that port number) or closed (a server is not listening on that port number)

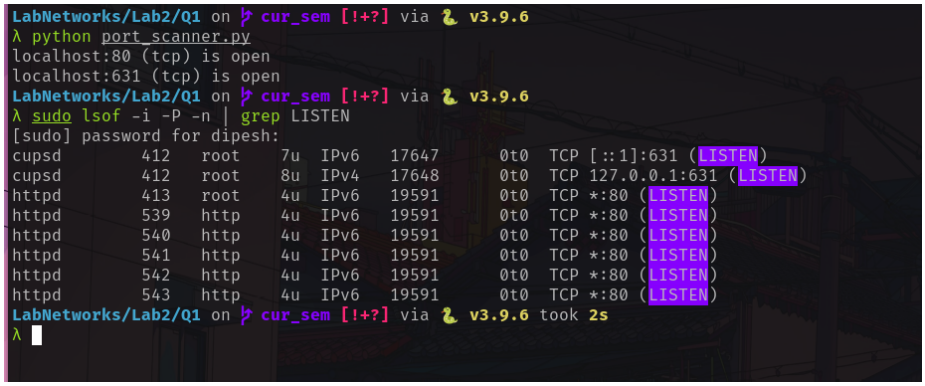
Code

- port_scanner.py

```
import socket,sys

def main():
    start =  1
    end = 1026

    addr = 'localhost'
    if len(sys.argv)>1 :
        addr = sys.argv[1]

    for port in range(start,end+1):
        try:
            sock = socket.socket(socket.AF_INET,socket.SOCK_STREAM)
            sock.settimeout(1)
            res = sock.connect_ex((addr,port))
            if(res==0):
                print("{}:{} (tcp) is open".format(addr,port))
            sock.close()
        except:
            continue
main()
```

Output

- I'm checking all the open ports of localhost. I ran the port_scanner.py and it showed 80 and 631 are open. After running a command to see all the ports open on my system, We can confirm that they are indeed 80 and 631.



Question 2

2. Implement the following using TCP socket:
When the server receives a message from a client, it simply converts the message by using following rule
" If a character is a letter or a digit, it will be replaced with the next character in the character set, except that Z will be replaced by A, z by a and 9 by 0. Thus i becomes j, C becomes D, p becomes q and so on. Any character other than a letter or a digit will be replaced by a period(.)"
and sends back the same to the client. This sending and receiving message should be done repeatedly until client and server send BYEBYE message.

Code

- server.cpp

```
#include <algorithm>
#include <arpa/inet.h>
#include <iostream>
#include <netdb.h>
#include <netinet/in.h>
#include <numeric>
#include <optional>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/socket.h>
#include <sys/types.h>
```

```cpp
#include <unistd.h>
using namespace std;

void HANDLE_SEND_RECV_ERRORS(int st) {
  if (st == -1) {
    perror("Error in send()/recv()");
    exit(254);
  } else if ((st) == 0) {
    perror("Connection is closed because send/recv returned 0");
    exit(255);
  }
}

void die_with_error(const char *message, int err_code = 1) {
  perror(message);
  exit(err_code);
}

struct addrinfo *addr_setup(const char *address, const char *port_no) {
  struct addrinfo hints, *result;

  memset(&hints, 0, sizeof(hints));
  hints.ai_addr = AF_UNSPEC;
  hints.ai_socktype = SOCK_STREAM;
  hints.ai_flags = AI_PASSIVE;

  int status = getaddrinfo(address, port_no, &hints, &result);
  if (status != 0)
    die_with_error("getaddrinfo");
  return result;
}

int setup_socket(struct addrinfo *result) {
  int yes = 1;
  int sock_fd =
      socket(result->ai_family, result->ai_socktype, result->ai_protocol);
  if (sock_fd < 0)
    die_with_error("socket()");
  if (setsockopt(sock_fd, SOL_SOCKET, SO_REUSEADDR | SO_REUSEPORT | SO_LINGER,
                 &yes, sizeof(yes)) < 0)
    die_with_error("setsockopt");
  if (bind(sock_fd, result->ai_addr, result->ai_addrlen) < 0)
    die_with_error("bind()");
  return sock_fd;
}
```

```
pair<int, struct sockaddr_storage> accept_connection(int sock_fd) {
  struct sockaddr_storage addr;
  socklen_t len = sizeof(addr);
  int client_fd = accept(sock_fd, (struct sockaddr *)&addr, &len);
  if (client_fd == -1)
    die_with_error("accept()");
  return {client_fd, addr};
}

void transform_buffer(string &s) {
  auto transformer = [](char c) {
    if (!isalnum(c))
      return '.';
    c += 1;
    if (c == 'z' + 1)
      c = 'a';
    else if (c == 'Z' + 1)
      c = 'A';
    else if (c == '9' + 1)
      c = '0';
    return c;
  };

  transform(s.begin(), s.end(), s.begin(), transformer);
}

void send_message(int conn, const string &message) {
  int sz = message.size();
  int htonl_sz = htonl(sz);

  int st = send(conn, &htonl_sz, sizeof(int), 0);
  HANDLE_SEND_RECV_ERRORS(st);

  st = send(conn, message.c_str(), sz, 0);
  HANDLE_SEND_RECV_ERRORS(st);
}

void handle_connection(int conn) {
  while (true) {
    int sz;
    int status = recv(conn, &sz, 4, 0);
    HANDLE_SEND_RECV_ERRORS(status);
    sz = ntohl(sz);

    char *buf = new char[sz + 1];
    status = recv(conn, buf, sz, 0);
```

```
    HANDLE_SEND_RECV_ERRORS(status);
    buf[status] = '\0';

    string buffer(buf);
    cout << "Received : " << buffer << endl;
    delete[] buf;

    if (buffer == "BYEBYE") {
      send_message(conn, "BYEBYE");
      cout << "Sent : BYEBYE" << endl;
      break;
    } else {
      transform_buffer(buffer);
      send_message(conn, buffer);
      cout << "Sent : " << buffer << endl;
    }
  }
}

int main() {
  struct addrinfo *result = addr_setup(NULL, "5000");
  int sock_fd = setup_socket(result);
  freeaddrinfo(result);

  listen(sock_fd, 10);

  auto [conn, addr] = accept_connection(sock_fd);
  handle_connection(conn);

  close(conn);
  close(sock_fd);
}
```

- client.cpp

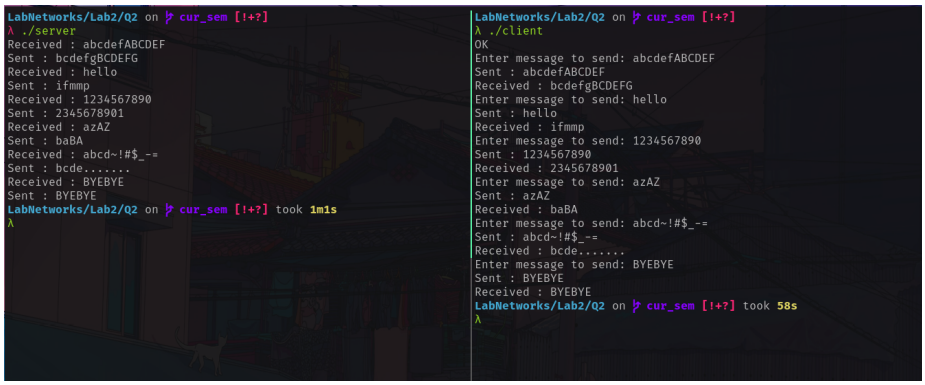
```
#include <arpa/inet.h>
#include <iostream>
#include <netdb.h>
#include <netinet/in.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/socket.h>
#include <sys/types.h>
#include <unistd.h>

using namespace std;
```

```
void HANDLE_SEND_RECV_ERRORS(int st) {
  if (st == -1) {
    perror("Error in send()/recv()");
    exit(254);
  } else if ((st) == 0) {
    perror("Connection is closed because send/recv returned 0");
    exit(255);
  }
}

void die_with_error(const char *message, int err_code = 1) {
  perror(message);
  exit(err_code);
}

struct addrinfo *addr_setup(const char *address, const char *port_no) {
  struct addrinfo hints, *result;

  memset(&hints, 0, sizeof(hints));
  hints.ai_addr = AF_UNSPEC;
  hints.ai_socktype = SOCK_STREAM;
  hints.ai_flags = AI_PASSIVE;

  int status = getaddrinfo(address, port_no, &hints, &result);
  if (status != 0)
    die_with_error("getaddrinfo()");
  cout << "OK\n";
  return result;
}

int setup_client_socket(struct addrinfo *result) {
  int yes = 1;
  int sock_fd =
      socket(result->ai_family, result->ai_socktype, result->ai_protocol);
  if (sock_fd < 0)
    die_with_error("socket()");
  if (setsockopt(sock_fd, SOL_SOCKET, SO_REUSEADDR | SO_REUSEPORT | SO_LINGER,
                 &yes, sizeof(yes)) < 0)

    die_with_error("setsockopt");

  if (connect(sock_fd, result->ai_addr, result->ai_addrlen) < 0)
    die_with_error("bind()");
  return sock_fd;
}
```

```
void send_message(int conn, const string &message) {
  int sz = message.size();
  int htonl_sz = htonl(sz);

  int st = send(conn, &htonl_sz, sizeof(int), 0);
  HANDLE_SEND_RECV_ERRORS(st);

  st = send(conn, message.c_str(), sz, 0);
  HANDLE_SEND_RECV_ERRORS(st);
}

string receive_message(int conn) {
  int sz;
  int status = recv(conn, &sz, 4, 0);
  HANDLE_SEND_RECV_ERRORS(status);
  sz = ntohl(sz);

  char *buf = new char[sz + 1];
  status = recv(conn, buf, sz, 0);
  HANDLE_SEND_RECV_ERRORS(status);
  buf[status] = '\0';

  string buffer(buf);
  cout << "Received : " << buffer << endl;
  delete[] buf;
  return buffer;
}

void handle_connection(int conn) {
  while (true) {
    string message;
    cout << "Enter message to send: ";
    cin >> message;
    cout.flush();

    send_message(conn, message);
    cout << "Sent : " << message << endl;

    string buffer = receive_message(conn);

    if (message == "BYEBYE" && buffer == "BYEBYE") {
      break;
    }
  }
}
```

```c
int main() {
  struct addrinfo *result = addr_setup(NULL, "5000");
  int sock_fd = setup_client_socket(result);
  freeaddrinfo(result);
  handle_connection(sock_fd);
  close(sock_fd);
  return 0;
}
```

Output



Question 3

3. Assume that there two servers, A and B, which store a 10MB file that is split into 10 parts. Client 1 requests the file to server A which replies to client 1 with 5 chunks of the requested file, which are randomly selected. Later on, client 1 identifies the missing chunks and it requests the missing chunks (and only them) to server B. Moreover, the Client 1 can request 1 piece of chunk at the same. Once all the chunks are received, Client 1 sends the THANKS message to both of the servers.

Code

- file_splitter.h

```c
#include <algorithm>
#include <fstream>
#include <iostream>
#include <iterator>
#include <map>
#include <numeric>
#include <queue>
#include <set>
#include <sstream>
```

```cpp
#include <stack>
#include <string>
#include <string_view>
#include <unordered_map>
#include <unordered_set>
#include <vector>

using namespace std;

struct file_chunk {
  size_t sz;
  size_t chunk_no;
  string buf;
  file_chunk() {}
  file_chunk(size_t _sz, size_t _chunk_no, string _buf)
      : sz(_sz), chunk_no(_chunk_no), buf(_buf) {}
};

array<file_chunk, 10> splitter(const char *name) {
  fstream fp(name);
  stringstream strm;
  copy(istreambuf_iterator<char>(fp), istreambuf_iterator<char>(),
       ostreambuf_iterator<char>(strm));
  fp.close();
  string buffer = strm.str();

  int filesize = buffer.size();
  int one_chunk_size = filesize / 10;

  array<file_chunk, 10> chunks;

  auto it = buffer.begin();
  string tmp;
  for (int i = 0; i < 9; i++) {
    copy(it, it + one_chunk_size, back_inserter(tmp));
    it += one_chunk_size;
    chunks[i] = file_chunk(one_chunk_size, i, move(tmp));
  }
  copy(it, buffer.end(), back_inserter(tmp));
  chunks[9] = file_chunk(distance(it, buffer.end()), 9, move(tmp));
  return chunks;
}
```

- server_A.cpp

```cpp
#include "file_splitter.h"
#include <arpa/inet.h>
```

```cpp
#include <iostream>
#include <netdb.h>
#include <netinet/in.h>
#include <optional>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/socket.h>
#include <sys/types.h>
#include <unistd.h>

void HANDLE_SEND_RECV_ERRORS(int st) {
  if (st == -1) {
    perror("Error in send()/recv()");
    exit(254);
  } else if ((st) == 0) {
    perror("Connection is closed because send/recv returned 0");
    exit(255);
  }
}

void die_with_error(const char *message, int err_code = 1) {
  perror(message);
  exit(err_code);
}

struct addrinfo *addr_setup(const char *address, const char *port_no) {
  struct addrinfo hints, *result;

  memset(&hints, 0, sizeof(hints));
  hints.ai_addr = AF_UNSPEC;
  hints.ai_socktype = SOCK_STREAM;
  hints.ai_flags = AI_PASSIVE;

  int status = getaddrinfo(address, port_no, &hints, &result);
  if (status != 0)
    die_with_error("getaddrinfo");
  return result;
}

int setup_socket(struct addrinfo *result) {
  int yes = 1;
  int sock_fd =
      socket(result->ai_family, result->ai_socktype, result->ai_protocol);
  if (sock_fd < 0)
    die_with_error("socket()");
```

```
  if (setsockopt(sock_fd, SOL_SOCKET, SO_REUSEADDR | SO_REUSEPORT | SO_LINGER,
                 &yes, sizeof(yes)) < 0)
    die_with_error("setsockopt");
  if (bind(sock_fd, result->ai_addr, result->ai_addrlen) < 0)
    die_with_error("bind()");
  return sock_fd;
}

pair<int, struct sockaddr_storage> accept_connection(int sock_fd) {
  struct sockaddr_storage addr;
  socklen_t len = sizeof(addr);
  int client_fd = accept(sock_fd, (struct sockaddr *)&addr, &len);
  if (client_fd == -1)
    die_with_error("accept()");
  return {client_fd, addr};
}

vector<int> get_five_random_nums(int mod) {
  srand(time(NULL));
  vector<int> nums(10);
  iota(nums.begin(), nums.end(), 0);
  random_shuffle(nums.begin(), nums.end());
  return vector<int>(nums.begin(), nums.begin() + 5);
}

void send_file_chunk(int conn, const file_chunk &chunk) {
  cout << endl << chunk.chunk_no << ":" << chunk.sz << endl;
  int size = chunk.sz;
  int chunk_id = chunk.chunk_no;
  int big_endian_sz = htonl(size);
  int big_endian_id = htonl(chunk_id);
  int status;

  status = send(conn, (void *)&big_endian_sz, sizeof(int), 0);
  cout << "sent size for " << chunk.chunk_no << ":" << status << endl;
  HANDLE_SEND_RECV_ERRORS(status);
  status = send(conn, (void *)&big_endian_id, sizeof(int), 0);
  cout << "sent id for " << chunk.chunk_no << ":" << status << endl;
  HANDLE_SEND_RECV_ERRORS(status);

  int total_sent = 0;
  const char *buf = chunk.buf.c_str();
  while (total_sent != size) {
    int bytes_sent =
        send(conn, (void *)(buf + total_sent), size - total_sent, 0);
    HANDLE_SEND_RECV_ERRORS(bytes_sent);
```

```
    cout << bytes_sent << ':' << total_sent << ' ';
    total_sent += bytes_sent;
  }
  cout << endl;
}

void handle_connection(int conn) {
  array<file_chunk, 10> file_chunks = splitter("./large_file.txt");
  auto five_random_chunk_no = get_five_random_nums(10);
  for (int id : five_random_chunk_no)
    cout << id << ' ' << file_chunks[id].buf.size() << '\n';
  for (int id : five_random_chunk_no) {
    // cout << id << '\n';
    send_file_chunk(conn, file_chunks[id]);
  }
}

int main() {
  int sock_fd;
  struct addrinfo *result = addr_setup(NULL, "3000");
  sock_fd = setup_socket(result);
  freeaddrinfo(result);
  listen(sock_fd, 10);

  auto [conn, addr] = accept_connection(sock_fd);
  handle_connection(conn);

  close(sock_fd);
}
```

```cpp
#include "file_splitter.h"
#include <arpa/inet.h>
#include <iostream>
#include <netdb.h>
#include <netinet/in.h>
#include <optional>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <sys/socket.h>
#include <sys/types.h>
#include <unistd.h>

void HANDLE_SEND_RECV_ERRORS(int st) {
  if (st == -1) {
```

```
    perror("Error in send()/recv()");
    exit(254);
  } else if ((st) == 0) {
    perror("Connection is closed because send/recv returned 0");
    exit(255);
  }
}

void die_with_error(const char *message, int err_code = 1) {
  perror(message);
  exit(err_code);
}

struct addrinfo *addr_setup(const char *address, const char *port_no) {
  struct addrinfo hints, *result;

  memset(&hints, 0, sizeof(hints));
  hints.ai_addr = AF_UNSPEC;
  hints.ai_socktype = SOCK_STREAM;
  hints.ai_flags = AI_PASSIVE;

  int status = getaddrinfo(address, port_no, &hints, &result);
  if (status != 0)
    die_with_error("getaddrinfo");
  return result;
}

int setup_socket(struct addrinfo *result) {
  int yes = 1;
  int sock_fd =
      socket(result->ai_family, result->ai_socktype, result->ai_protocol);
  if (sock_fd < 0)
    die_with_error("socket()");
  if (setsockopt(sock_fd, SOL_SOCKET, SO_REUSEADDR | SO_REUSEPORT | SO_LINGER,
                 &yes, sizeof(yes)) < 0)
    die_with_error("setsockopt");
  if (bind(sock_fd, result->ai_addr, result->ai_addrlen) < 0)
    die_with_error("bind()");
  return sock_fd;
}

pair<int, struct sockaddr_storage> accept_connection(int sock_fd) {
  struct sockaddr_storage addr;
  socklen_t len = sizeof(addr);
  int client_fd = accept(sock_fd, (struct sockaddr *)&addr, &len);
  if (client_fd == -1)
```

```
    die_with_error("accept()");
  return {client_fd, addr};
}

void send_file_chunk(int conn, const file_chunk &chunk) {
  cout << endl << chunk.chunk_no << ":" << chunk.sz << endl;
  int size = chunk.sz;
  int chunk_id = chunk.chunk_no;
  int big_endian_sz = htonl(size);
  int big_endian_id = htonl(chunk_id);
  int status;

  status = send(conn, (void *)&big_endian_sz, sizeof(int), 0);
  cout << "sent size for " << chunk.chunk_no << ":" << status << endl;
  HANDLE_SEND_RECV_ERRORS(status);
  status = send(conn, (void *)&big_endian_id, sizeof(int), 0);
  cout << "sent id for " << chunk.chunk_no << ":" << status << endl;
  HANDLE_SEND_RECV_ERRORS(status);

  int total_sent = 0;
  const char *buf = chunk.buf.c_str();
  while (total_sent != size) {
    int bytes_sent =
        send(conn, (void *)(buf + total_sent), size - total_sent, 0);
    HANDLE_SEND_RECV_ERRORS(bytes_sent);
    cout << bytes_sent << ':' << total_sent << ' ';
    total_sent += bytes_sent;
  }
  cout << endl;
}

void handle_connection(int conn) {
  array<file_chunk, 10> file_chunks = splitter("./large_file.txt");

  // ill keep taking requests always
  for (int i = 0; i < 5; i++) {
    int id;
    recv(conn, &id, sizeof(id), 0);
    id = ntohl(id);
    send_file_chunk(conn, file_chunks[id]);
  }
  char buf[100];
  int bytes_recvd = recv(conn, buf, 100, 0);
  buf[bytes_recvd] = 0;
  HANDLE_SEND_RECV_ERRORS(bytes_recvd);
  if (string(buf) == "THANKS") {
```

```
    cout << "Received : " << buf << '\n';
    return;
  } else {
    cerr << "Errorrrrr" << endl;
    exit(255);
  }
}

int main() {
  int sock_fd;
  struct addrinfo *result = addr_setup(NULL, "4000");
  sock_fd = setup_socket(result);
  freeaddrinfo(result);
  listen(sock_fd, 10);

  auto [conn, addr] = accept_connection(sock_fd);
  handle_connection(conn);

  close(sock_fd);
}
```

- client.py

```
import socket
import sys
port = 3000
if(len( sys.argv )>=2):
    port = int(sys.argv[1])

def recv_data(sock , sz:int):
    recvd = 0
    BUF_SIZE=4096
    buffer = ''
    while((sz-recvd)>BUF_SIZE):
        x = sock.recv(BUF_SIZE)
        buffer+= x.decode()
        recvd= len(buffer)
    x = sock.recv(sz-recvd)
    buffer+=x.decode()
    return buffer



with socket.socket(socket.AF_INET,socket.SOCK_STREAM) as sock:
    sock.setsockopt(socket.SOL_SOCKET, socket.SO_REUSEADDR | socket.SO_REUSEPORT | socket.SO
    sock.connect(('localhost',port))
    print(sock.getpeername())
```

```
recvd_already =  set()
for i in range(5):
    sz = int.from_bytes(sock.recv(4),byteorder='big')
    id = int.from_bytes(sock.recv(4),byteorder='big')
    recvd_already.add(id)
    print(sz,id)
    open( "file{}.txt".format(id),"w" ).write(recv_data(sock,sz))
sock.close()


not_recvd =  set(range(0,10)) -  recvd_already
sock2 =  socket.socket(socket.AF_INET,socket.SOCK_STREAM)
sock2.setsockopt(socket.SOL_SOCKET, socket.SO_REUSEADDR | socket.SO_REUSEPORT | socket.S
sock2.connect(('localhost',4000))

for id in not_recvd:
    sock2.send(id.to_bytes(4,byteorder='big'))
    sz = int.from_bytes(sock2.recv(4),byteorder='big')
    id = int.from_bytes(sock2.recv(4),byteorder='big')
    recvd_already.add(id)
    print(sz,id)
    open( "file{}.txt".format(id),"w" ).write(recv_data(sock2,sz))
sock2.send("THANKS".encode())
sock2.close()
```

Output