Redes de Computadores

Computer Networks

Lab 08

TPC-3

Streaming mJPEG over RTP

(TPC3 – Redes de Computadores 2024/2025)

TPC-3 Streaming mJPEG over RTP

- **Goal:** To implement a streaming video server and a client (as a C/S application) that coordinate their actions through a TCP socket and that exchange data using the Real-time Transfer Protocol (RTP)
- Note: In this work we will ignore the possibility of UDP datagram loss.

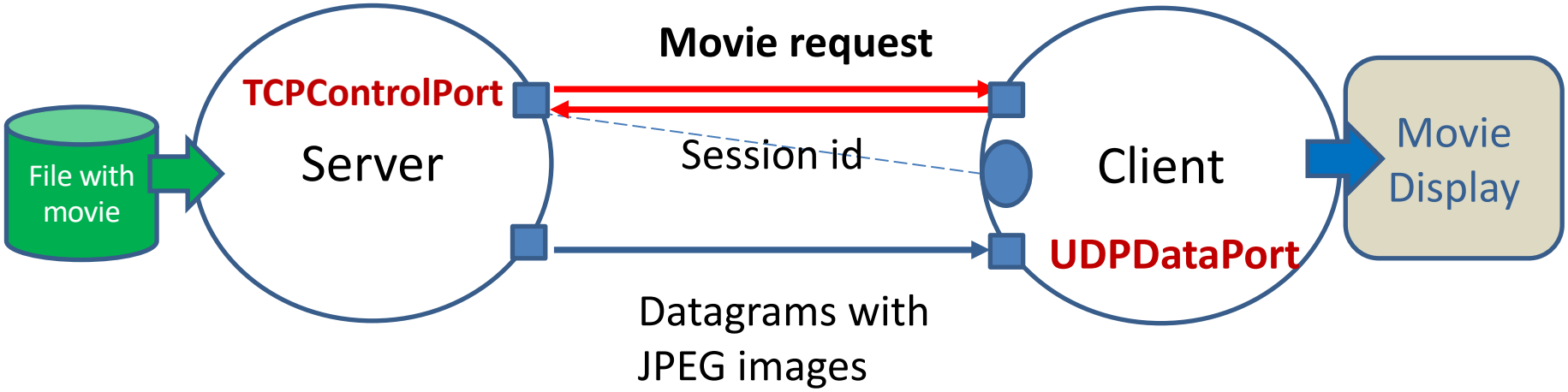
- In summary, the intended application is composed by two processes: **Server** and **Client**

Client and Server

- **Server (Server.py):** that stores video files in its disk and sends their contents in RTP packets
- **Client (Client.py) :** ask for a given file (video) and, in case of success, will receive the RTP packets and play the file displayed in a window (Player) using the **TkInter software**.

Movie Display

Generic Architecture



How the video will be displayed

- The video to be displayed is composed by a sequence of isolated JPEG Images;
- This format is close to MJPEG (Multiple JPEG).
- For the TPC you have a file that you will use to test
  - File called *movie.mpeg* : It is in a proprietary format.
  - It is a binary file with a sequence of parts, where each part is composed by:

    5 bytes codifying an integer NB

    The codification of the JPEG image itself contained in NB bytes

Server Action (and Server Arguments)

The server must be started with the command:

`python3 Server.py TCPControlPort`

where *TCPControlPort* is the port,

where the server expects a video request (from the client)

Client Action (and Client arguments)

The client with be stated with the command

```
python3 Client.py hostname TCPControlPort
UDPDataPort fileName
```

Where:

(***hostname, TCPControlPort***) defines the location of the server's TCP endpoint

UDPDataPort is the UDP port where the client will receive the datagrams containing the video

filename is the name of the file in the server containing the video that will be played.

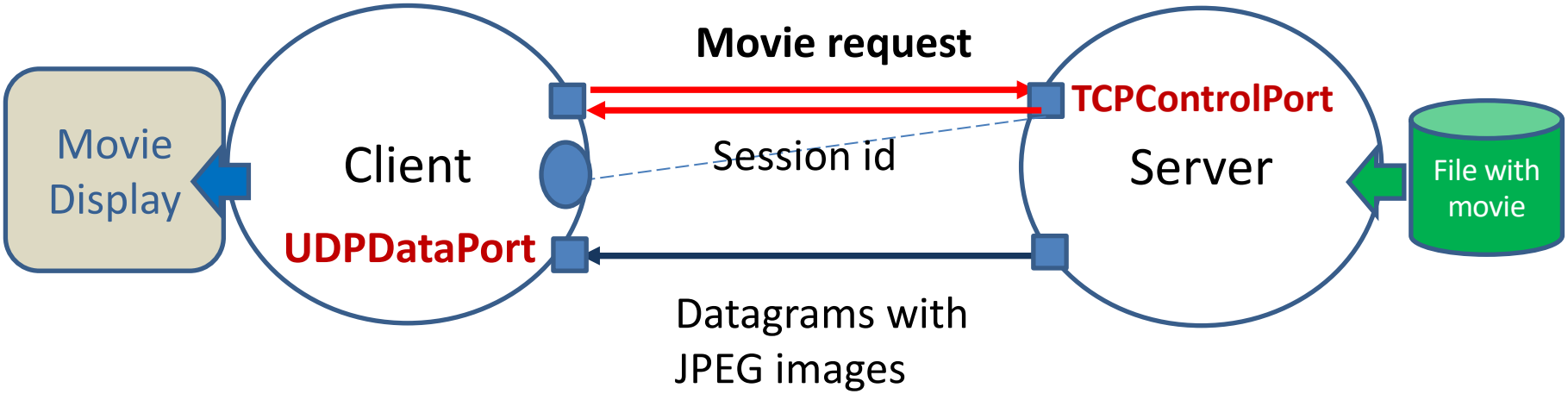
Generic Architecture

```
Server:
python3 Server.py TCPControlPort
```


```
Client:
python3 Client.py hostname TCPControlPort UDPDataPort fileName
```

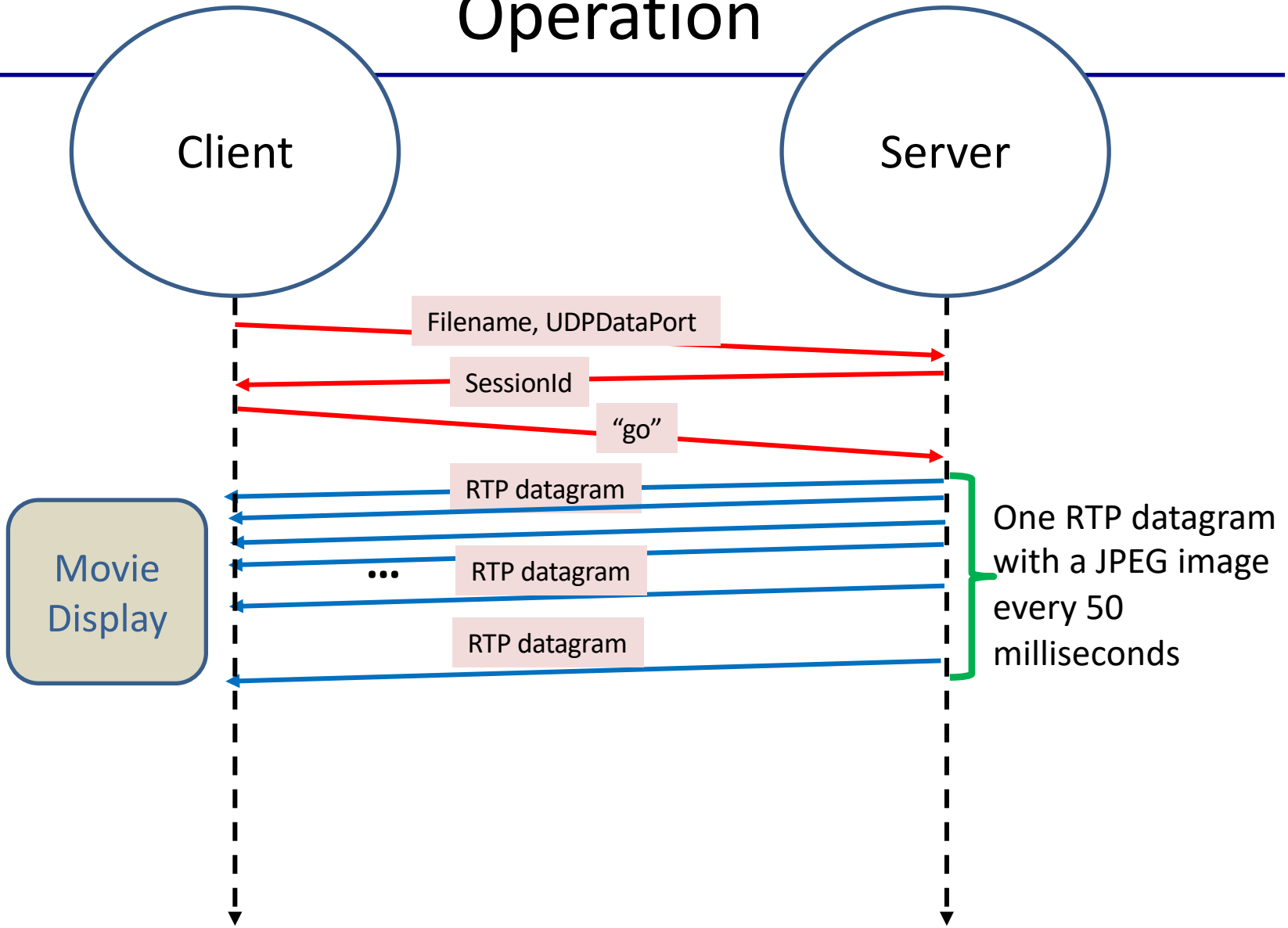
Generic Architecture

```
Server:
python3 Server.py TCPControlPort
```




```
Client:
python3 Client.py hostname TCPControlPort UDPDataPort fileName
```

Operation

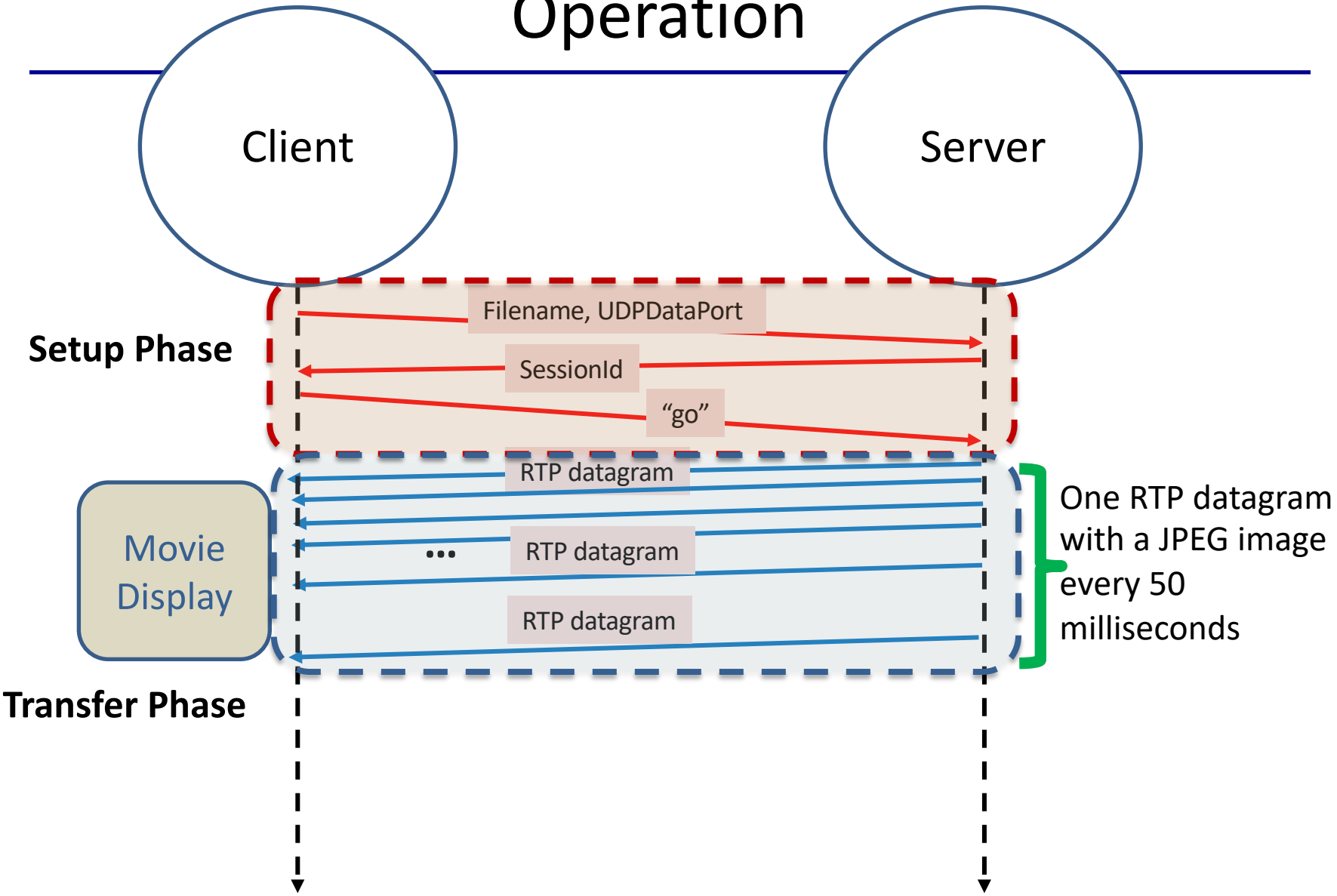

Client
Server
Filename, UDPDataPort
SessionId
“go”
RTP datagram
RTP datagram
RTP datagram
Movie Display
One RTP datagram with a JPEG image every 50 milliseconds

To Display the Video (Client Side)

The video is sent to be displayed in two phases:

1. **Setup Phase**
2. **Transfer Phase**

Operation


Client
Server
Setup Phase
Filename, UDPDataPort
SessionId
"go"
RTP datagram
RTP datagram
RTP datagram
Movie Display
Transfer Phase
One RTP datagram with a JPEG image every 50 milliseconds

Setup Phase

1. **Setup**

   The client connects to the **TCPControlPort** and **sends a message with `filename, UDPDataPort`**, where f*ilename* is a string and *`UDPDataPort`* is an integer.

   If the sender has the file, it will answer with a message `with a` **`SessionID`** `that is a random number;`

   otherwise it will reply with a **`SessionId of -1.`**

   Client replies with a message containing the string ***"Go"*** authorizing the server to start the sending of the movie.

Transfer Phase

2. Transfer – The sender will send the file in several UDP Datagrams.

Each UDP datagram contains:

- A RTP Header described below
- A JPEG file

The datagrams are sent at rate of **20 datagrams per second.**

The RTP Protocol

RTP packet header

bit offset	0-1	2	3	4-7	8	9-15	16-31
0	Version	P	X	CC	M	PT	Sequence Number
32	Timestamp						
64	SSRC identifier						

RTP Version	2
Padding(P) extension(X), number of contributing sources (CC) marker(M)	0 0 0 0
Payload type (PT)	26 (MJPEG)
Sequence number	Starts at 1 and is incremented each time an image is sent
Timestamp	Use time stamp of Python's time module
SRSC Identifier	The SessionID obtained in Setup phase should be inserted here

Client Processing RTP Packets

The client should perform the following checks in the RTP header:

- If the contents of **RTP Version**, **P, X., CC, M, PT** are the values expected
- If the sequence number is OK; this means that it should be greater than the last sequence number received
- If the Timestamp is reasonable
- If the SRSC value is the SessionId

To see in the TPC-3 Statement (document)

- See examples on how to set and check individual bits or groups of bits.
- Note that in the RTP packet header format smaller bit-numbers refer to higher order bits, that is, bit number 0 of a byte is 2^7 and bit number 7 is 1 (or 2^0). In the examples below, the bit numbers refer to the numbers in the above diagram.
- Because the header-field of the RtpPacket class is of type byte array, you will need to set the header one byte at a time, that is, in groups of 8 bits. The first byte has bits 0-7, the second byte has bits 8-15, and so on.
- To set bit number n in variable mybyte of type byte: mybyte = mybyte | 1 << (7 - n)
- To set bits n and n + 1 to the value of foo in variable mybyte: mybyte = mybyte | foo << (7 - n) . Note that foo must have a value that can be expressed with 2 bits, that is, 0, 1, 2, or 3.
- To copy a 16-bit integer foo into 2 bytes, b1 and b2: b1 = (foo >> 8) & 0xFF b2 = foo & 0xFF. After this, b1 will have the 8 high-order bits of foo and b2 will have the 8 low-order bits of foo. You can copy a 32-bit integer into 4 bytes in a similar way.

Example

- Suppose we want to fill in the first byte of the **RTP packet header** with V=2, P=0, X=0 , CC = 3. In binary this would correspond to the following table

Bits 7,6	Bit 5	Bit 4	Bits 3- 0
1 0	0	0	0 0 1 1
V = 2	P = 0	X = 0	CC = 3

Your Mission in TPC-3

Se the given (incomplete code) for:
Client.py
Server.py

To Do ...

Your task is **to complete the code of two Python programs called *Client.py* and *Server.*py**. Analyze the code files available in clip. You must complete the code.

- ***Client.py*** Must fill the blanks corresponding to:

  Verification of RTP header contents as above.
  Writing the payload of the datagram in a temporary file

- **Sender.py** Must fill the blanks corresponding to the loop that:

  Fills an UDP datagram with:
  - The RTP Header
  - The payload that contains a JPEG file

  Sends the datagram

Notes …

- Probably you must install the Pillow Package for Python
- Ex: `python3 –m pip install Pillow`

- If you ry to run the give Client.py nd you find the error ….

```
$ python3 Client.py
Traceback (most recent call last):
File "Client.py", line 3, in <module>
    from PIL import Image, ImageTk
ModuleNotFoundError: No module named 'PIL'
```

TPC-3 Delivery

- The delivery should be done **before 11:00 on November 13, 2024**.
- The submission has two parts:
  - A Google form containing the identification of the students that submit the work and questions about the functionality of the code
  - The code developed will be uploaded through Moodle
- Details will be sent later (but similar to TPC-1 and TPC-2)