200 points. Individual Work Only. Due March 23, 2023 before 12:30 PM.

1. Objective

Design and implement a multi-threaded client-server program using publish-subscribe pattern for communication between the client and server programs.

2. Description

Modify the socket-based client/server program developed in Homework-1 to use publish-subscribe pattern of communications. Use ZeroMQ library described in the textbook. The book provides examples in Python, you can find links to Java examples in the Resources section of this document.

3. Guidelines/Hints

Review the publish-subscribe pattern example in the textbook (Note 4.10) and review the documentation for ZeroMQ APIs. First run the example programs provided, you have to download and install ZeroMQ and any other dependencies it may have. Once you are able to successfully compile and run the example programs then you can work on your homework assignment.

4. Graduate Students Only (Bonus for Undergraduates)

Write a short essay (at least 500 words) comparing sockets-based communication with MPI communication.

5. Working Environment

You can develop and test the client and server programs on any machine that you have access to. You may be required to demonstrate the working program to the instructor to get full credits for this assignment.

6. Feedback Questions (answer to these questions has no impact on your grade)

1) Was this homework too difficult, or too easy?
2) Was the assignment fun or challenging?
3) Was there something that was unclear?
4) Was the homework too long for the given amount of time?
5) What did you learn from this homework?

7. Submission Instructions

List ALL the references you used in this homework as well as test cases used to test your programs. This includes any classes that you used that you did not write and any help you received from any other sources. Use appropriate class name and include comments to indicate various operations performed by the program. Your program must have the following header information within comments:

```
/*
        Name:
        Section: CS 491 or CS 591
        Homework #:
*/
```

Make a directory CS591/homework3 and then two separate directories one for the server (server) and one for the client program (client). Include a README.md file in the homework2 directory that provides the instructions for executing the client and server programs.

Create a github repository (say, Spring2023_CS691_HW3) and upload your source files to the github repository. Make sure that you have created a **private repository/project** (click on visibility to be private). Add pvbangalore@ua.edu as a collaborator to this project.

Create a tar/zip file (only tar and zip are accepted, all other file formats will not be considered) of the homework1 directory using the following filename format: <crimsonId>-cs491-hw3.tar or <crimsonId>-cs591-hw3.zip. Upload the tar/zip file that includes the source code and instructions for executing the programs and a separate Word/PDF document for the typed solution to short answer questions and the feedback questions. In the comment section of the homework submission, include the link to your github repository for this homework.

8. Late Submissions

Submissions must be made on the due date before the beginning of the class. Any submissions received after the due date will receive a score of 0 for this homework.

9. Resources

1. ZeroMQ Website: https://zeromq.org/
2. JeroMQ – Java binding for ZeroMQ: https://zeromq.org/languages/java/
3. Pyzmq – Python ZeroMQ: https://zeromq.org/languages/python/
4. ZeroMQ Guide: https://zguide.zeromq.org/