IN.5022 — Concurrent and Distributed Computing

Series 1

Due date: 28.09.2023, 12:00, on Moodle

First of all…

Subscribe to the course on *Moodle*: https://moodle.unifr.ch/course/view.php?id=1224847

Join the *Discord* server: https://discord.gg/E668g7vjRG

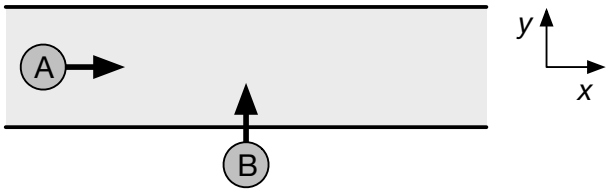
Exercise 1

A distributed system must check if a given integer *N* is a prime number. The system has a fixed number of processes. Initially only a specific process, known as the initiator, knows *N*. The final answer must be available to the initiator.

Imagine a distributed algorithm that could solve this problem *in an "efficient" manner*. Describe what each process will do and what interprocess messages will be exchanged. Assume that each process is able to check whether a number is divisible by another number (i.e., you don't need to describe that part of the algorithm).

Exercise 2

Two autonomous robots, *A* and *B*, must cross on a road. Robot *A* is moving horizontally from left to right on the road, while robot *B* crosses the road vertically from bottom to top as shown below.



Assuming that each robot can determine the (*x*, *y*) position of both robots, outline the program for each robot, so that they do not collide. Robots can move one *x* or *y* step at a time and they act synchronously (in discrete steps).

Exercise 3

How might the clocks in two computers that are linked by a local network be synchronized without reference to an external time source? What factors limit the accuracy of the procedure you have described?

How could the clocks in a large number of computers connected by the Internet be synchronized? Discuss the accuracy of that procedure.

Exercise 4

Consider the example presented in the course that converts a non-FIFO channel to a FIFO-channel. This example uses a buffer (queue) of infinite size. Describe the changes that must

be made so that it works with a buffer of size *w*. The size *w* is known from both the sender and the receiver process. There is no upper bound on the propagation delay of messages, so this delay can be arbitrarily large.

Exercise 5

install *Docker* on your computer. To do so, you should follow the steps below:

1. Read the documentation:
    a. https://en.wikipedia.org/wiki/Docker_(software)
    b. https://www.docker.com/resources/what-container
    c. Many online tutorials and videos on sur YouTube (explore!)
2. Install *Docker Desktop*: https://www.docker.com/get-started
3. Execute the **`docker101tutorial`** tutorial that starts automatically after installing *Docker Desktop*.
4. Get familiar with the terminal by running some commands, for instance:
    ```
    echo "Hello, world!"
    ls
    ```
5. You can even install a complete *Ubuntu* image in a *Docker* (requires a good Internet connection!):
    a. Open a terminal on your computer and run:
        ```
        docker pull ubuntu
        ```
    b. …then:
        ```
        docker run -it ubuntu
        ```
    c. Once in the virtual machine, you can install the Linux OS (warning: this requires more than 1 GB of disk space!)
        ```
        apt-get update && apt-get install -y ubuntu-desktop
        ```
    After answering a few questions, you will have a complete installation of *Ubuntu*. You can also optionally install the documentation locally:
        ```
        unminimize
        ```
    Now it is time to experiment!
6. Try to connect to a web site from the terminal, e.g., using the following command that downloads and prints the home page of the **`example.com`** site:
    ```
    wget -O - example.com
    ```