Gebze Technical University
Department Of Computer Engineering

CSE 312 /CSE 504 Spring 2024

Operating Systems
Homework #01
Part A (50pts)

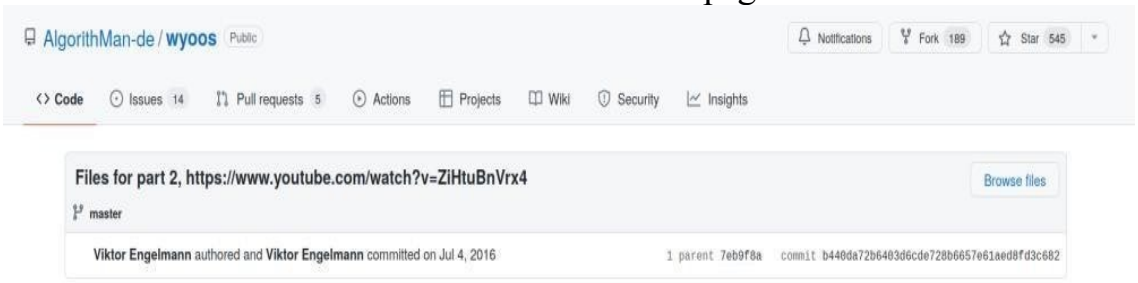
Due Date: 13.05.2024

1. **Before you start the homework**

Throughout the semester, we will try to write our operating system that runs on the web site. This operating system is created by Viktor Engelmann. He explains how to write his own operating system step by step in the video series. Before you start HW#1, we strongly suggest you apply following steps:

- Firstly, watch and implement the first three videos in the playlist. The first video and the second video explain the basic idea and design of this project, so it helps you to understand his approach.
- The third video tells you how to install this operating system in a virtual box. To apply what he did so far in this video, you need to consider his source code of this video for your virtual machine. If you clone the source code on the GitHub page, you will clone the latest version which includes everything about the operating system. To download the source code, which is related to the video you consider, you need to do the following steps:
    - In case of the third video, go to the source page.
    - Select "Running the OS in a virtual machine" code.

- Click "Browse Files" button on the page shown below.



  - In the next page, under the "Code" button, there will be "Download ZIP" option. When you select this option, you can reach the source code which is related to the video that you consider.
- If you apply everything in the third video with the source code which is explained in the previous step, and you obtain the same result as in the video, then you can start to do this homework. If you get some errors at the end of the video, you are responsible for fixing them.
- Before you start the homework, you should watch all the videos.

2. **Your task for the homework**
   What we expect from your new OS is
   - Implementing these POSIX system calls: fork, waitpid, execve, any other POSIX call that you need.
   - **You must create all your processes by using fork system call.**
   - Loading multiple programs into memory: Kernel will be able to load multiple programs into memory.
   - Handling multi-programming: you need to develop a Process Table that will hold the necessary information about the processes in the memory. You should study what Process Tables holds. You can read carefully throughout chapter 2 of the course book or any other online resource).
   - Handling Interrupts: Our given source code can handle interrupts, and your kernel will handle and respond between multiple processes.

Perform Round Robin scheduling: Every time a timer interrupt occurs, there is a chance to make a process switch. Whenever a context scheduling occurs, you will print all the information about the processes in the process table including but not limited to the entries in the list below. You can modify anything that you want if you comment on the report.

Lifecycle

This Strategy is loading each program 3 times, starting them and will enter an infinite loop until all the processes terminate.

Programs that you will test are

- Collatz

  You are going to find collatz sequence for each number less than 100. You can either take input from the user or pass the number as a parameter.

  You can find information about (Collatz conjecture on internet). For each number you will show the number being interested in, and its collatz sequence and go to the next number.

  - Example for input 7
  - Output 7: 22, 11, 34, 17, 52, 26, 13, 40, 20, 10, 5, 16, 8, 4, 2, 1
- def long_running_program(n):
  result = 0
  for i in range(n):
  for j in range(n):
  result += i * j
  return result
  # Example usage
  # Use this without user input. There is no interaction with user for this.
  result = long_running_program(1000)

3. **General rules for homework**
   a. Submit all your source files!!!
   b. Submit ReadMe.txt as execution instructions.
   c. Submissions without Makefile, Report, and ReadMe.txt will not be evaluated!
   d. Start early!
   e. It is not a group project. Do not share your answers with anyone in any circumstance. Any cheating means **NA** from the course directly.
   f. Your homework report is very important, it should include your design decisions, your structures, your comments, codes, and results for each strategy with screen shots.
   g. For grading, syscall implementation and strategies implementation is very important.

h. Write comments on the lines of your code where any critical actions happen.
i. All the things that you have developed should be reported by using screen shots and comment on them!
    a. After the deadline, you are responsible for explaining your project to the course assistant in a demonstration.
    b. Each demo will be done in 10 minutes.
    c. Many appointments will be open so you can select the most available time slot for yourself.
    d. To answer all possible questions, you need to comment on your code. The solution is to write and to do everything on your own. Your homework grade will be evaluated by your answer

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Operating Systems
Homework #01
Part B (25pts)

Due Date: 13.05.2024

1. **Your task for this part of homework**
   What we expect from your new OS is
   - **You must create all your processes by using fork syscall.**
   - Loading multiple programs into memory: Kernel will be able to load multiple programs into memory.
   - Handling multi-programming: you use the Process Table that will hold the necessary information about the processes in the memory.
   - Handling Interrupts: Our given source code can handle interrupts, and your kernel will handle and respond between multiple processes.

   Perform Round Robin scheduling: Every time a timer interrupt occurs, there is a chance to make a process switch. Whenever a context scheduling occurs, you will print all the information about the processes in the process table including but not limited to the entries in the list below. You can modify anything that you want if you comment on the report.

   Perform Priority Based (Preemptive) Scheduling: In Preemptive Priority Scheduling, at the time of arrival of a process in the ready queue, its priority is compared with the priority of the other processes present in the ready queue as well as with the one which is being executed by the CPU at that point of time. The One with the highest priority among all the available processes will be given the CPU next. We must consider lowest number as highest priority.

Lifecycle

You will implement 4 different flavors of MicroKernel. Don't worry 90 percent of the code is same between the Micro Kernels. We further explain the details below. When your kernel is loaded your OS will start a process named init with process id 0. In different Micro Kernels Init processes will load programs into memory differently.

You should print all the tables, queues, all the information about the processes!

The first strategy is randomly choosing one of the programs and loading it into memory 10 times (Same program 10 different processes), start them and will enter an infinite loop until all the processes terminate.

Second Strategy is choosing 2 out 4 programs randomly and loading each program 3 times start them and will enter an infinite loop until all the processes terminate.

Third Strategy, init process will initialize Process Table and ready queue, let the Collatz program is in the ready queue with the lowest priority, and after the 5^{th} interrupt (we expect that the collatz lasts very longer than this of course), remaining programs will arrive as their priorities are the same.

Dynamic Priority Strategy: the init process initializes the Process Table and ready queue. The Collatz program is initially placed in the ready queue with a priority lower than the other programs. For every timer interrupt, the OS evaluates the execution status of the Collatz program. If the Collatz program is still executing after a certain number of interrupts (let's say after every 5th interrupt), the OS dynamically adjusts its priority to be higher than the other programs in the ready queue. The remaining programs maintain their initial priorities throughout execution. The OS continues to handle timer interrupts and adjust priorities dynamically based on the execution status of the Collatz program. Once the Collatz program completes its execution or is preempted by another process, the OS resumes executing the remaining programs in the ready queue based on their priorities. This strategy allows the OS to dynamically prioritize the Collatz program based on its execution progress, ensuring efficient resource allocation, and potentially speeding up the completion of the Collatz program without compromising the execution of other programs.

For every timer interrupt, OS should handle the interrupt and perform the strategies.

Programs that you will test are

- Collatz
  You are going to find collatz sequence for each number less than
  100. You can either take input from the user or pass the number as a parameter.
  You can find information about (Collatz conjecture on internet). For each number you will show the number being interested in, and its collatz sequence and go to the next number.
  - Example for input 7
  - Output 7: 22, 11, 34, 17, 52, 26, 13, 40, 20, 10, 5, 16, 8, 4, 2, 1

- BinarySearch
  - Ex; Input : {10, 20, 80, 30, 60, 50, 110, 100, 130, 170} x = 110;
    Output : 6
- LinearSearch
  - Input : {10, 20, 80, 30, 60, 50, 110, 100, 130, 170} x = 175;
    Output
    : -1

- def long_running_program(n):
  result = 0
  for i in range(n):
  for j in range(n):
  result += i * j
  return result
  # Example usage
  # Use this without user input. There is no interaction with user for this.
  result = long_running_program(1000)

2. Rules for the homework

a. Submit all your source files!!!

b. **Submit ReadMe.txt as execution instructions.**

c. **Submissions without Makefile, Report, and ReadMe.txt will not be evaluated!!!**

d. **Start early!!!**

e. It is not a group project. Do not share your answers to anyone in any circumstance. **Any cheating means NA from the course directly.**

f. **Your homework report is very important, it should include your design decisions, your structures, your comments, codes, and results for each strategy with screen shots.**

Gebze Technical University
Department Of Computer
Engineering CSE 312 /CSE 504
Spring 2024
Operating Systems
Homework #01
Part C (25pts)
Due Date: 13.05.2024

1. **Your task for this part of homework**
   What we expect from your new OS is
   - **You must create all your processes by using fork syscall.**
   - Loading multiple programs into memory: Kernel will be able to load multiple programs into memory.
   - Handling multi-programming: you use the Process Table that will hold the necessary information about the processes in the memory.
   - Handling Mouse and Keyboard Interrupts: Our given source code can handle these interrupts, and your kernel will handle and respond between multiple processes.

Random Process Spawning with Interactive Input Handling Strategy:

In this strategy, the operating system randomly chooses one of the programs and loads it into memory multiple times, each time creating a new process. These processes then enter an infinite loop, awaiting interactive input events such as mouse clicks or keyboard presses. Upon receiving an input event, the process reacts accordingly before returning to its idle state.

Interactive Input Priority Strategy:

In this strategy, processes are spawned with varying levels of priority based on the type of interactive input they handle. Processes handling high-priority input events,

such as keyboard interrupts for critical system commands, are given higher priority, while processes handling lower-priority input events, such as mouse clicks for non-critical actions, are given lower priority.

- Collatz

  You are going to find collatz sequence for each number less than
  100. You can either take input from the user or pass the number as a parameter.
  You can find information about (Collatz conjecture on internet). For each number you will show the number being interested in, and its collatz sequence and go to the next number.
  - Example for input 7
  - Output 7: 22, 11, 34, 17, 52, 26, 13, 40, 20, 10, 5, 16, 8, 4, 2, 1

- BinarySearch
  - Ex; Input : {10, 20, 80, 30, 60, 50, 110, 100, 130, 170} x = 110;
    Output : 6
- LinearSearch
  - Input : {10, 20, 80, 30, 60, 50, 110, 100, 130, 170} x = 175;
    Output
    : -1

- def long_running_program(n):
  result = 0
  for i in range(n):
  for j in range(n):
  result += i * j
  return result

  # Example usage
  # Use this without user input. There is no interaction with user for this.
  result = long_running_program(1000)

2. Rules for homework

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