

## Solution of Exercise Sheet 8

### Exercise 1 (Scheduling Strategies)

1. Why exists a system idle process in some operating systems?

*If no process is in the state **ready**, the system idle process gets the CPU assigned. The system idle process is always active and has the lowest priority. Due to the system idle process, the scheduler must never consider the case that no active process exists.*

2. Explain the difference between preemptive and non-preemptive scheduling.

*When using non-preemptive scheduling, a process, which gets the CPU assigned by the scheduler, remains control over the CPU until its execution is finished or it gives the control back on a voluntary basis.*

*When using preemptive scheduling, the CPU may be removed from a process before its execution is completed.*

3. Name one drawback of preemptive scheduling.

*A process may occupy the CPU for as long as it wants and other (maybe more important) processes need to wait.*

4. Name one drawback of non-preemptive scheduling.

*Higher overhead compared with non-preemptive scheduling because of the frequent process switches.*

5. How does multilevel feedback scheduling work?

*It works with multiple queues. Each queue has a different priority or time multiplex. Each new process is inserted in the top queue and this way it has the highest priority. For each queue, Round Robin is used. If a process resigns the CPU on voluntary basis, it is inserted in the same queue again. If a process utilized its complete time slice, it is inserted in the next lower queue, with has a lower priority.*

6. Which scheduling strategies are fair?

*A scheduling method is „fair“ when each process gets the CPU assigned at some point.*

- |   |   |
|---|---|
| <input type="checkbox"/> Priority-driven scheduling               | <input checked="" type="checkbox"/> Earliest Deadline First |
| <input checked="" type="checkbox"/> First Come First Served       | <input checked="" type="checkbox"/> Fair share              |
| <input checked="" type="checkbox"/> Round Robin with time quantum |   |

7. Which scheduling strategies operate preemptive?

- ☐ First Come First Served      ☒ Fair share  
☒ Round Robin with time quantum      ☒ Multilevel feedback scheduling

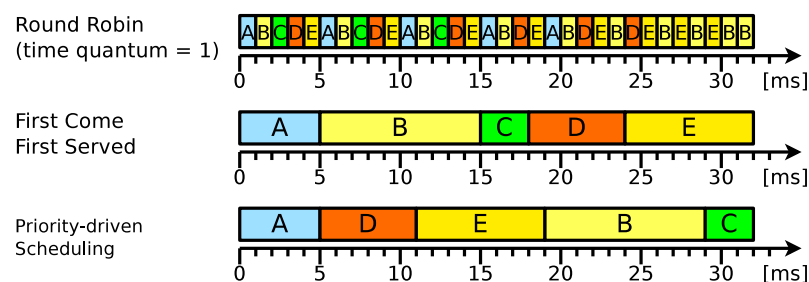
## Exercise 2 (Scheduling)

Process	CPU runtime [ms]	Creation time [ms]
A	5 ms	15
B	10 ms	5
C	3 ms	4
D	6 ms	12
E	8 ms	7

Five processes shall be processed on a single CPU system. All processes are at time point 0 in state **ready**. High priorities are characterized by high values.

Draw the execution order of the processes with a Gantt chart (timeline) for **Round Robin** (time quantum  $q = 1$  ms), **FCFS** and **priority-driven scheduling**.

Calculate the average runtimes and waiting times of the processes.



Runtime = Time between creation and termination.

Runtime	A	B	C	D	E
RR	20	32	13	25	30
FCFS	5	15	18	24	32
Priority-driven scheduling	5	29	32	11	19

$$\text{RR} \quad (20 + 32 + 13 + 25 + 30) / 5 = 24 \text{ ms}$$

$$\text{FCFS} \quad (5 + 15 + 18 + 24 + 32) / 5 = 18,8 \text{ ms}$$

$$\text{PS} \quad (5 + 29 + 32 + 11 + 19) / 5 = 19,2 \text{ ms}$$

Waiting time = time of a process being in state **ready**.

Waiting time = runtime - CPU runtime.

Waiting time	A	B	C	D	E
RR	15	22	10	19	22
FCFS	0	5	15	18	24
Priority-driven scheduling	0	19	29	5	11

$$\text{RR} \quad (15 + 22 + 10 + 19 + 22) / 5 = 17,6 \text{ ms}$$

$$\text{FCFS} \quad (0 + 5 + 15 + 18 + 24) / 5 = 12,4 \text{ ms}$$

$$\text{PS} \quad (0 + 19 + 29 + 5 + 11) / 5 = 12,8 \text{ ms}$$

## Exercise 3 (Shell Scripts)

1. Program a shell script, which requests the user to select one of the four basic arithmetic operations. After selecting a basic arithmetic operation, the user is requested to enter two operands. Both operands are combined with each other via the previously selected basic arithmetic operation and the result is printed out in the following form:

<Operand1> <Operator> <Operand2> = <Result>

```
1 #!/bin/bash
2 #
3 # Skript: operanden1.bat
4 #
5 echo "Bitte geben Sie den gewünschten Operator ein."
6 echo "Mögliche Eingaben sind: + - * /"
7 read OPERATOR
8 echo "Bitte geben Sie den ersten Operanden ein:"
9 read OPERAND1
10 echo "Bitte geben Sie den zweiten Operanden ein:"
11 read OPERAND2
12
13 # Eingabe verarbeiten
14 case $OPERATOR in
15   +) ERGEBNIS=`expr $OPERAND1 + $OPERAND2` ;;
16   -) ERGEBNIS=`expr $OPERAND1 - $OPERAND2` ;;
17   \*) ERGEBNIS=`expr $OPERAND1 \* $OPERAND2` ;;
18   /) ERGEBNIS=`expr $OPERAND1 / $OPERAND2` ;;
19   *) echo "Falsche Eingabe: $OPERATOR" >&2
20     exit 1
21     ;;
22 esac
23
24 # Ergebnis ausgeben
25 echo "$OPERAND1 $OPERATOR $OPERAND2 = $ERGEBNIS"
```

2. Modify the shell script from subtask 1 in a way that for each basic arithmetic operation a separate function exists. These functions should be relocated into an external function library and used for the calculations.

```
1 #!/bin/bash
2 #
3 # Skript: operanden2.bat
4 #
5 # Funktionsbibliothek einbinden
6 . funktionen.bib
7
8 echo "Bitte geben Sie den gewünschten Operator ein."
9 echo "Mögliche Eingaben sind: + - * /"
10 read OPERATOR
11 echo "Bitte geben Sie den ersten Operanden ein:"
12 read OPERAND1
13 echo "Bitte geben Sie den zweiten Operanden ein:"
14 read OPERAND2
15
16 # Eingabe verarbeiten
17 case $OPERATOR in
18   +) add $OPERAND1 $OPERAND2 ;;
19   -) sub $OPERAND1 $OPERAND2 ;;
20   \*) mul $OPERAND1 $OPERAND2 ;;
21   /) div $OPERAND1 $OPERAND2 ;;
22   *) echo "Falsche Eingabe: $OPERATOR" >&2
23       exit 1
24       ;;
25 esac
26
27 # Ergebnis ausgeben
28 echo "$OPERAND1 $OPERATOR $OPERAND2 = $ERGBNIS"
```

```
1 # Funktionsbibliothek funktionen.bib
2
3 add() {
4   ERGBNIS=`expr $OPERAND1 + $OPERAND2`
5 }
6
7 sub() {
8   ERGBNIS=`expr $OPERAND1 - $OPERAND2`
9 }
10
11 mul() {
12   ERGBNIS=`expr $OPERAND1 \* $OPERAND2`
13 }
14
15 div() {
16   ERGBNIS=`expr $OPERAND1 / $OPERAND2`
17 }
```

3. Program a shell script, which prints out a certain number of random numbers up to a certain maximum value. After starting the shell script, it should interactively query the values of these parameters:

- Maximum value, which must be in the number range from 10 to 32767.
- Desired number of random numbers.

```
1 #!/bin/bash
2 #
3 # Skript: random.bat
4 #
5 echo "Geben Sie den Maximalwert ein: "
6 read MAX
7 echo "Geben Sie an, wie viele Zufallszahlen Sie wünschen: "
8 read ANZAHL
9
10 for ((i=1; i<=${ANZAHL}; i+=1))
11 do
12     echo "Zufallszahl Nr. $i hat den Wert `expr $RANDOM % $MAX`"
13 done
```

4. Program a shell script, which creates the following empty files:

image0000.jpg, image0001.jpg, image0002.jpg, ..., image9999.jpg

```
1 #!/bin/bash
2 #
3 # Skript: dateien_anlegen.bat
4 #
5 for i in {0..9999}
6 do
7     filename="image"$(printf "%04u" $i)".jpg"
8     touch $filename
9 done
```

5. Program a shell script, which renames the files from subtask 4 according to this scheme:

BTS\_Exercise\_<YEAR>\_<MONTH>\_<DAY>\_0000.jpg  
BTS\_Exercise\_<YEAR>\_<MONTH>\_<DAY>\_0001.jpg  
BTS\_Exercise\_<YEAR>\_<MONTH>\_<DAY>\_0002.jpg  
...  
BTS\_Exercise\_<YEAR>\_<MONTH>\_<DAY>\_9999.jpg