Report 1 – Leonhardt Schwarz

- What are the necessary conditions for deadlocks (discussed in the lecture) [0.5 points]?
    - Mutual Exclusion – multiple threads may use the same resource concurrently
    - Hold and wait – threads request resources and wait until they get it
    - No preemption – an acquired resource can only be released voluntarily by the holder
    - Circular wait – threads T1 to Tn each hold a resource and wait to acquire the resource of their predecessor thread, except thread Tn who is waiting for the resource of T1.
- Why does the initial solution lead to a deadlock (by looking at the deadlock conditions) [0.5 points]?
    - It's a circular wait each philosopher is holding the left fork and is waiting to acquire the right fork which is held by the philosopher to his right in his left hand. This philosopher is in turn waiting for his right neighbour and so everyone is waiting to grab the right fork and nobody can start eating.

Prevent the deadlock by removing Circular Wait condition:

- Switch the order in which philosophers take the fork by using the following scheme: Odd philosophers start with the left fork, while even philosophers start with the right hand [6 points].
    - [Done]

- Does this strategy resolve the deadlock and why [1 point]?
    - Yes, it does. Now the circular wait deadlock condition cannot occur because not every philosopher is grabbing the left fork first.

- Measure the time spent in waiting for fork and compare it to the total runtime [3 points].
    - Eating and thinking time where each set to 10 ms.

    - 5 Philosophers
    - Total Runtime: 2985 ms
    - Average time each thread spent waiting: 1089 ms

    - 15 Philosophers
    - Total Runtime: 3799 ms
    - Average time each thread spent waiting: 995 ms

    - Eating time set to 5 ms and thinking time set to 100 ms

    - 5 Philosophers
    - Total Runtime: 3346 ms
    - Average time each thread spent waiting: 40 ms

    - 15 Philosophers

- Total Runtime: 4693 ms
- Average time each thread spent waiting: 44 ms

- Only the eating time affects the time spent waiting.
- The number of philosophers does not seem to affect the time spent waiting.

- Can you think of other techniques for deadlock prevention?
    - The philosophers could employ a waiter who is only handing out a plate of spaghetti when a philosopher has access to both forks. The philosopher must wait until the plate is put in front of him before he is grabbing the forks.

- Make sure to always shutdown the program cooperatively and to always clean up all allocated.
    - [Done]