

**Technion - Israel Institute of Technology**  
 Department of Electrical Engineering

**Homework Set 1**

Due: 28 May 2017, 16:30

**1. Placement and Indirection**

You are given a device with  $T = 7$  E\_units of physical storage, each comprising  $N_p = 2$  P\_units. The device stores  $U \cdot N_p = 10$  L\_units ( $U = 5$ ). The L\_unit size is equal to the P\_unit size.

- a) Find a write sequence that has *minimal* write amplification (WA) with the LRU garbage collection (GC). What is the resulting WA?
- b) Find a write sequence that has minimal WA with the greedy GC, but *strictly* higher WA with the LRU GC. What is the resulting WA?
- c) Find a write sequence that has *maximal* WA with the greedy GC. What is the resulting WA?
- d) Prove or disprove: for any write sequence, the LRU GC has greater or equal WA than the greedy GC.

**2. Balls and Bins**

You are given a device with  $T$  E\_units of physical storage, each comprising  $N_p$  P\_units.

Throughout the problem assume the uniform workload, and that the probability to write to an E\_units does not depend on the number of valid P\_units in it.

- a) After  $m$  writes, what is the expected number of E\_units that were not written to?
- b) Give a lower bound on the probability that all the E\_units were written to after  $m$  writes.
- c) Find the probability that E\_unit  $i$  was written to *exactly once* after  $m$  writes. In what conditions this probability is higher than the probability that E\_unit  $i$  received no writes?
- d) Give an upper bound on the probability that *only* E\_unit  $i$  received no writes after  $m$  writes.

**3. Research Question: SSD Parallelization**

Research and summarize all the forms of parallelization implemented in an SSD. Your summary should include:

- a) Names of and relationships between memory units (e.g., page, block, chip, plane, channel, etc.). A pictorial description is highly recommended.

- b) The ways by which the architecture in a above improves read/write performance.
- c) A suggestion to further improve a and b above.
- d) List of sources used to answer a-c above.