

# Mandatory Exercise: External memory

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**1 Databases** You are working as a consultant for the company "*Shoes, Shoes and Shoes*", that sells shoes. They want a database containing information about all their shoes. Each shoe has a unique id, a size, a type, a color, and a price. They want to be able to update the database with insertions and deletions of shoes. The database should—in addition to the updates—support the following queries efficiently:

- $\text{report-price-size}(p_1, p_2)$ : Return the size of all shoes with a price between  $p_1$  and  $p_2$ .
- $\text{report-size-price}(s_1, s_2)$ : Return the price of all shoes with a size between  $s_1$  and  $s_2$ .
- $\text{report-size-type}(s_1, s_2)$ : Return the type and id of all shoes with a size between  $s_1$  and  $s_2$ .

Give an I/O efficient data structure supporting the required updates and queries. Analyse the space and the I/O complexity of your data structure.