**COMP 5120/6120 Database Systems I**

**Homework #4**

1. Suppose that a page can contain at most four data values and that all data values are integers. Using only B+ trees of order 2, give examples of each of the following:
   1. A B+ tree whose height changes from 2 to 3 when the value 25 is inserted. Show your structure before and after the insertion.

[10, 20]

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[1, 2, 3, 4] [11, 12, 13, 14]

After: [10, 20]

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[1, 2, 3, 4] [11, 12, 13] [25, \_\_, \_\_, \_\_]

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[14, \_\_, \_\_, \_\_]

* 1. A B+ tree in which the deletion of the value 30 leads to a redistribution. Show your structure before and after the deletion.
  2. Before: [10, 20]

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[1, 2, 3, 4] [11, 12, 13, 30]

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[21, 22] [31, 32]

* 1. After: [10, 20]

/ | \

[1, 2, 3, 4] [11, 12, 13, 21]

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[22, \_\_] [31, 32]

* 1. A B+ tree in which the deletion of the value 35 causes a merging of two nodes but without altering the height of the tree.
  2. Before: [20, 40]

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[1, 2, 3, 4] [35, 36] [41, 42, 43, 44]

* 1. After: [20, 40]

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[1, 2, 3, 4, 36] [41, 42, 43, 44]

1. Answer the following questions about Linear Hashing:
   1. How does Linear Hashing provide an average-case search cost of only slightly more than one disk I/O, given that overflow buckets are part of its data structure?

Linear Hashing provides an average-case search cost of only slightly more than one disk I/O by dynamically splitting the hash table into more buckets as needed. When a bucket becomes too full due to overflow, it is split into two, and the records are redistributed between the old and new buckets. This process continues as needed, so that each bucket contains a manageable number of records.

* 1. Does Linear Hashing guarantee at most one disk access to retrieve a record with a given key value?

No, Linear Hashing does not guarantee at most one disk access to retrieve a record with a given key value. While it is true that the average-case search cost is only slightly more than one disk I/O, in worst-case scenarios, multiple disk accesses may be required to retrieve a record with a given key value.