1 True and False

(a) When querying for a 16 byte record, exactly 16 bytes of data are read from disk.

(b) In a heap file, all pages must be filled to capacity except the last page.

(c) Assuming integers take 4 bytes and pointers take 4 bytes, a slot directory that is 512 bytes can address 64 records in a page.

(d) In a page containing fixed-length records with no nullable fields, the size of the bitmap never changes.

2 Fragmentation And Record Formats

(a) Is fragmentation an issue with fixed length records on an unpacked page?

(b) Is fragmentation an issue with variable length records on an unpacked page?

3 Record Formats

Assume we have a table that looks like this:

```
CREATE TABLE Questions (
    qid integer PRIMARY KEY,
    answer integer NOT NULL,
    qtext text NOT NULL,
);
```

Recall that integers and pointers are 4 bytes long. Assume for this question that the record header stores pointers to all of the variable length fields (but that is all that is in the record header).

(a) How many bytes will the smallest possible record be?

(b) Assume we have a page that is 1 KiB in size. What is the maximum number of records that can fit on a page?

(c) Now assume the fields can be null so we add a bitmap to the beginning of our record header indicating whether or not each field is null. Assume this bitmap is padded so that it takes up a whole number of bytes (i.e. if the bitmap is 10 bits it will take up 2 full bytes). How big is the largest possible record assuming that the qtext is null?

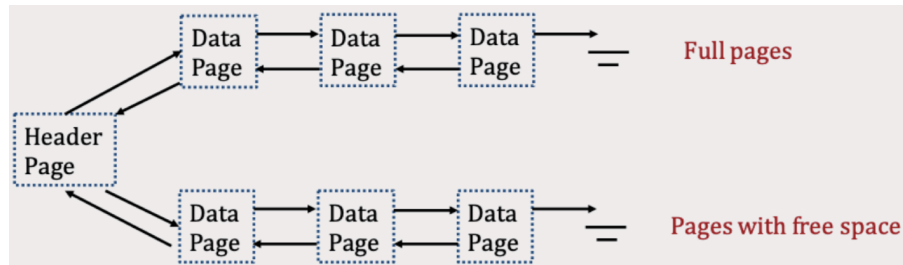# 4 Calculate the I/Os with Linked List Implementation

Figure 1: Linked List Implementation

Assume we have a heap file implemented with a linked list. The heap file contains 5 full pages and 2 pages with free space, at least one of which has enough space to fit the record we are trying to insert.

(a) In the worst case, how many I/Os are required to find a page with enough free space to insert a record?

(b) In the worst case, how many I/Os are required to insert a record into the 2nd page with free space? Consider what happens when after inserting the record, this page becomes full. Also, assume that we can modify the header page and insert to the beginning of the full pages linked list.

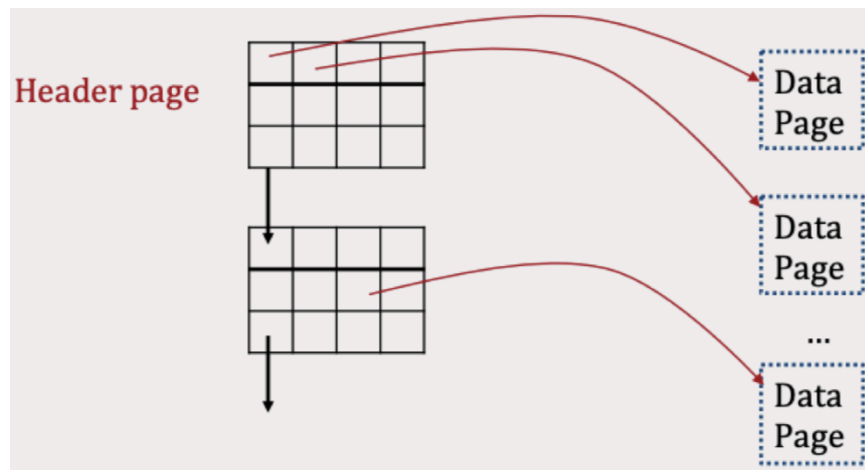# 5 Calculate the I/Os with Page Directory Implementation

Figure 2: Page Directory Implementation

We have a heap file implemented with a page directory containing 54 data pages. Each page in the directory can hold 16 page entries. Assume we have fixed length records.

(a) In the worst case, how many I/Os are required to find a page with free space?

(b) In the worst case, how many I/Os are required to insert a record into this file? Assume at least one data page has enough space to fit this record.