

A Bit More on Sorting

R & G Chapter 13



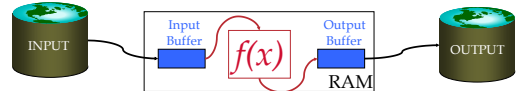
"There it was, hidden in alphabetical order."

Rita Holt



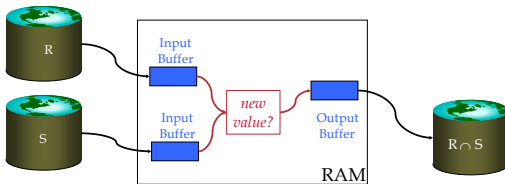
Streaming Data Through RAM

- An important method for sorting & other DB operations
- **Simple case:**
 - Compute $f(x)$ for each record, write out the result
 - Read a page from INPUT to Input Buffer
 - Write $f(x)$ for each item to Output Buffer
 - When Input Buffer is consumed, read another page
 - When Output Buffer fills, write it to OUTPUT
- **Reads and Writes are *not* coordinated**
 - E.g., if $f()$ is Compress(), you read many pages per write.
 - E.g., if $f()$ is DeCompress(), you write many pages per read.



Example: Merging Two Sorted Files

- A basic step in many operations
 - Intersect, Set Difference ("EXCEPT"), Merge Join



Internal Sort Algorithm

- Quicksort is a fast way to sort in memory.
- Alternative: "tournament sort" (a.k.a. "heapsort", "replacement selection")
- Keep two heaps in memory, **H1** and **H2**

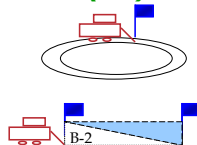
```

read B-2 pages of records, inserting into H1;
while (records left) {
    m = H1.removeMin(); put m in output buffer;
    if (H1 is empty)
        H1 = H2; H2.reset(); start new output run;
    else
        read in a new record r (use 1 buffer for input pages);
        if (r < m) H2.insert(r);
        else H1.insert(r);
}
H1.output(); start new run; H2.output();
                    
```



More on Heapsort

- **Fact: average length of a run is $2(B-2)$**
 - The "snowplow" analogy
- **Worst-Case:**
 - What is min length of a run?
 - How does this arise?
- **Best-Case:**
 - What is max length of a run?
 - How does this arise?
- **Quicksort is faster, but ... longer runs often means fewer passes!**



I/O for External Merge Sort

- Do I/O a page at a time
 - Not one I/O per record
- In fact, read a **block (chunk)** of pages sequentially!
- Suggests we should make each buffer (input/output) be a **block of pages**.
 - But this will reduce fan-in during merge passes!
 - In practice, most files still sorted in 2-3 passes.