Sorting Algorithms

- Number of Comparisons
- Number of Data Movements
- Additional Space Requirements

Sorting Algorithms

- Selection Sort
- Insertion Sort
- Bubble Sort
- Shaker Sort

- Merge Sort
- Heap Sort
- Quick Sort

- Bucket & Radix Sort
- Counting Sort

Animation Demos

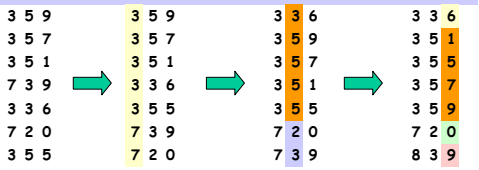
http://www-cse.uta.edu/~holder/courses/cse2320/lectures/applets/sort1/heapsort.html

http://cg.scs.carleton.ca/~morin/misc/sortalg/

Stable Sort

- A sort is stable if equal elements appear in the same order in both the input and the output.
- Which sorts are stable? Homework!

Radix Sort

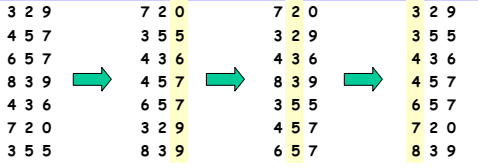


Algorithm
for i = 1 **to** d **do**
    sort array A on digit i using any sorting algorithm

Time Complexity: $O((N+m) + (N+m^2) + \ldots + (N+m^d))$

Space Complexity: $O(m^d)$

Radix Sort



Algorithm
for i = 1 **to** d **do**
    sort array A on digit i using a stable sort algorithm

Time Complexity: $O((n+m)d)$

Counting Sort

Initial Array

1	2	3	4	5	6	7	8
2	5	3	0	2	3	0	3

Counts

0	1	2	3	4	5
2	0	2	3	0	1

Cumulative Counts

0	1	2	3	4	5
2	2	4	7	7	8

External Sorting Methods

- Assumptions:
  - data is too large to be held in main memory;
  - data is read or written in blocks;
  - 1 or more external devices available for sorting
- Sorting in main memory is cheap or free
- Read/write costs are the dominant cost
- Wide variety of storage types and costs
- No single strategy works for all cases

External Merge Sort

- Initial distribution pass
- Several multi-way merging passes

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ASORTINGANDMERGINGEXAMPLEWITHFORTYFIVERECORDS.$
AOS.DMN.AEX.FHT.ERV.$
IRT.EGR.LMP.ORT.CEO.$
AGN.GIN.EIW.FIY.DRS.$
AAGINORST.FFHIORTTY.$
DEGGIMNNR.CDEEORRSV.$
AEEILMPWX.$
AAADEEEGGGIIILMMNNNOPRRSTWX.$
CDEEFFHIOORRRSTTVY.$
AAACDDEEEEEFFGGGHIIIILMMNNNOOOPRRRRRSSTTTWXY.$
```

With 2P external devices
Space for M records in main memory
Sorting N records needs
$1 + \log_P(N/M)$ passes

Order Statistics

- Maximum, Minimum n-1 comparisons

7	3	1	9	4	8	2	5	0	6

- MinMax
  - 2(n-1) comparisons
  - 3n/2 comparisons
- Max and 2ndMax
  - (n-1) + (n-2) comparisons
  - ???