Design and Analysis
of Algorithms I

QuickSort

Overview

QuickSort

- Definitely a “greatest hit” algorithm
- Prevalent in practice
- Beautiful analysis
- $O(n \log n)$ time “on average”, works in place
  - i.e., minimal extra memory needed
- See course site for optional lecture notes

The Sorting Problem

Input : array of n numbers, unsorted

3	8	2	5	1	4	7	6

Output : Same numbers, sorted in increasing order

1	2	3	4	5	6	7	8

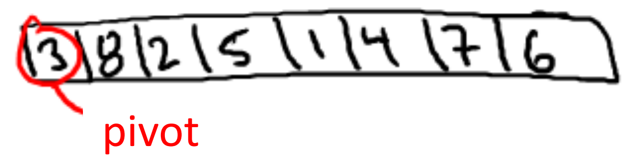
Assume : all array entries distinct.

Exercise : extend QuickSort to handle duplicate entries

Partitioning Around a Pivot

Key Idea : partition array around a pivot element.

-Pick element of array



-Rearrange array so that

  -Left of pivot => less than pivot

  -Right of pivot => greater than pivot

Note : puts pivot in its "rightful position".

Two Cool Facts About Partition

1. Linear $O(n)$ time, no extra memory
   [see next video]

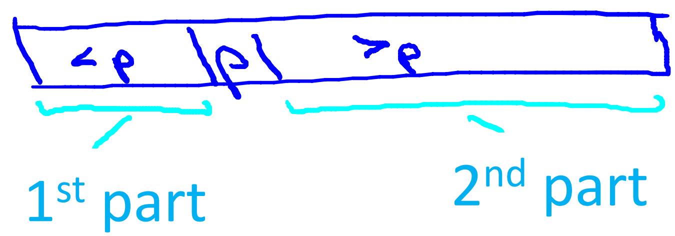
2. Reduces problem size

QuickSort: High-Level Description

[Hoare circa 1961]

QuickSort (array A, length n)
-If n=1   return
-p = ChoosePivot(A,n)
-Partition A around p
-Recursively sort 1^{st} part
-Recursively sort 2^{nd} part

[currently unimplemented]



Outline of QuickSort Videos

- The Partition subroutine
- Correctness proof [optional]
- Choosing a good pivot
- Randomized QuickSort
- Analysis
  - A Decomposition Principle
  - The Key Insight
  - Final Calculations