

# Data Structure and Algorithms

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## Agenda

- Searching and sorting
- Concept of internal and external sorting
- Sort stability
- Sorting methods: Bubble, insertion, Quick, Merge, shell and comparison of all sorting methods.
- Case Studies Set Operation, String Operation
- Fibonacci Series.

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## Sorting problem

Ex. Student records in a university.

	Chen	3	A	991-878-4944	308 Blair
	Rohde	2	A	232-343-5555	343 Forbes
	Gazsi	4	B	766-093-9873	101 Brown
item →	<b>Furla</b>	<b>1</b>	<b>A</b>	<b>766-093-9873</b>	<b>101 Brown</b>
	Kanaga	3	B	898-122-9643	22 Brown
	Andrews	3	A	664-480-0023	097 Little
key →	<b>Battle</b>	<b>4</b>	<b>C</b>	<b>874-088-1212</b>	<b>121 Whitman</b>

Sort. Rearrange array of  $N$  items into ascending order.

Andrews	3	A	664-480-0023	097 Little
Battle	4	C	874-088-1212	121 Whitman
Chen	3	A	991-878-4944	308 Blair
Furla	1	A	766-093-9873	101 Brown
Gazsi	4	B	766-093-9873	101 Brown
Kanaga	3	B	898-122-9643	22 Brown
Rohde	2	A	232-343-5555	343 Forbes

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## Sorting Algorithms

- Several algorithms are presented, including *Bubble Sort*, *Selection Sort*, *insertion sort*, *shell sort*, *Merge Sort*, and *quicksort*.
- Sorting by insertion is the simplest method, and doesn't require any additional storage.
- Shell sort is a simple modification that improves performance significantly. Probably the
- most efficient and popular method is quicksort, and is the method of choice for large arrays.

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## Sorting Algorithms

- Sorting
  - A process that organizes a collection of data into either ascending or descending order
- Categories of sorting algorithms
  - An internal sort
    - Requires that the collection of data fit entirely in the computer's main memory
  - An external sort
    - The collection of data will not fit in the computer's main memory all at once but must reside in secondary storage

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## Sorting Algorithms and Their Efficiency

- Data items to be sorted can be
  - Integers
  - Character strings
  - Objects
- Sort key
  - The part of a record that determines the sorted order of the entire record within a collection of records

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## Sort Stability- Stable Sort

- A sorting algorithm is stable if any equal items remain in the same relative order before and after the sort
- Why do we care?
  - “data exploration” Client code will want to sort by multiple features and “break ties” with secondary features

`[(8, "fox"), (9, "dog"), (4, "wolf"), (8, "cow")]`

`[(4, "wolf"), (8, "fox"), (8, "cow"), (9, "dog")]`

Stable

`[(4, "wolf"), (8, "cow"), (8, "fox"), (9, "dog")]`

Unstable

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## Stable Sort Example

sorted by time	sorted by location (not stable)	sorted by location (stable)
Chicago 09:00:00	Chicago 09:25:52	Chicago 09:00:00
Phoenix 09:00:03	Chicago 09:03:13	Chicago 09:00:59
Houston 09:00:13	Chicago 09:21:05	Chicago 09:03:13
Chicago 09:00:59	Chicago 09:19:46	Chicago 09:19:32
Houston 09:01:10	Chicago 09:19:32	Chicago 09:19:46
Chicago 09:03:13	Chicago 09:00:00	Chicago 09:21:05
Seattle 09:10:11	Chicago 09:35:21	Chicago 09:25:52
Seattle 09:10:25	Chicago 09:00:59	Chicago 09:35:21
Phoenix 09:14:25	Houston 09:01:10	Houston 09:00:13
Chicago 09:19:32	Houston 09:00:13	Houston 09:01:10
Chicago 09:19:46	Phoenix 09:37:44	Phoenix 09:00:03
Chicago 09:21:05	Phoenix 09:00:03	Phoenix 09:14:25
Seattle 09:22:43	Phoenix 09:14:25	Phoenix 09:37:44
Seattle 09:22:54	Seattle 09:10:25	Seattle 09:10:11
Chicago 09:25:52	Seattle 09:36:14	Seattle 09:10:25
Chicago 09:35:21	Seattle 09:22:43	Seattle 09:22:43
Seattle 09:36:14	Seattle 09:10:11	Seattle 09:22:54
Phoenix 09:37:44	Seattle 09:22:54	Seattle 09:36:14

no  
longer  
sorted  
by time

still  
sorted  
by time

Algorithms by ROBERT SEDGEWICK | KEVIN WAYNE

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## Sorting Algorithms

- Elementary Techniques
  - Bubble Sort
  - Insertion Sort
  - Shell Sort
- Two classic Algorithms- Divide and Conquer
  - Quick Sort
  - Merge Sort

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## References

- Books
  - D. E. Knuth, *The Art of Computer Programming: Vol. 3: Sorting and Searching*, 2d ed., Addison- Wesley, Reading, Mass., 1998.
  - SORTING AND SEARCHING ALGORITHMS: A COOKBOOK BY THOMAS NIEMANN
  - Robert Sedgewick, Kevin Wayne, "Algorithms", 4<sup>th</sup> edition, Addison-Wesley Professional
  - Samanta Debasis, "CLASSIC DATA STRUCTURES", PHI, 2nd ed.
  - Ellis Horowitz and Sartaj Sahni , "Fundamentals of Data Structures", Computer Science Press, 1983
  - R. Gilberg, B. Forouzan, "Data Structures: A pseudo Code Approach with C++", Cengage Learning, ISBN 9788131503140.
  - E. Horowitz, S. Sahni, D. Mehta, "Fundamentals of Data Structures in C++", Galgotia Book Source, New Delhi, 1995, ISBN 16782928
  - Dinesh P. Shah, Sartaj Sahani , "Handbook of DATA STRUCTURES and APPLICATIONS", CHAPMAN & HALL/CRC
  - Bayer B. et al. (2015) Electro-Mechanical Brake Systems. In: Winner H., Hakuli S., Lotz F., Singer C. (eds) Handbook of Driver Assistance Systems. Springer, Cham
  - Web
    - <http://statmath.wu.ac.at/courses/data-analysis/itdtHTML/node55.html>
    - <http://www.geogebra.org/m/4d1tD>
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