Data Structures and Algorithms
(Summer 2008)
Contents

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The course consists of a total of 43 units.

Introduction and Basic Techniques (6 units)

machine model and pseudocode, basic analysis techniques, Master Theorem,
Running Example: Integer (or maybe polynomial) multiplication including
(randomized) result checking
References: [MS08, Chapter 1,2], [CLR90, Chapters 2 to 6], [T.L], [AB98]

Sorting and Selection (4 units)

quicksort and selection, randomized quicksort, sorting in the word model,
lower bounds
References: [OW96, Chapter 2], [CLR90, Chapters 7 – 10], [MS08, Chapter
5], [Hag98]

Intro to Amortized Analysis and Priority Queues (3 units)

Fibonacci Heaps, Integer Queues,
References: [OW96, Chapter 6], [CLR90, Chapters 18, 20, and 21], [MS08,
Chapter 3,6].

Searching Extensions (4 units)

(a,b)-trees, randomized search trees, splay trees;
Bloom filters, cuckoo-hashing

References: [SA96], [CLR90, Chapters 13 – 15, 19], [OW96, Chapter 5], [MS08, Chapter 7].
We need references for Bloom filters, and cuckoo hashing

Graph Representations and Graph Algorithms (9 units)

depth-first search, breadth-first search, shortest path, spanning trees, union-find, maximum flow, matching (unweighted, weighted, bipartite, general)
References: [AMO93, Chapters 5 – 7], [OW96, Chapter 8], [CLR90, Chapters 22 – 27], [MS08, Chapters 8 – 12], [MN99, Chapter 7], [KT05, Chapter 7]

The midterm happens here.

There are 17 units available after the midterm. The contents will be selected from among the following topics. The instructors have not made up their mind yet.

Online Algorithms and Approximation Algorithms (6 units)

ski rental, paging, set cover, primal-dual algorithms

Computational Geometry (4 units)

convex hulls, Delaunay triangulations and Voronoi diagrams, plane sweep, line segment intersection, (smallest enclosing disk/ball)
References: ,[dBKOS97, Chapters 1, 2, 6, 8, 9], [Kle97, Chapters 2, 5, 7]
[OW96, Chapter 7], [CLR90, Chapter 35], [MN99, Chapters 9 and 10]

Polynomial Arithmetic, FFT and Applications
 (4 units)
FFT and applications, Polynomial division, GCD
References: [CLR90, Section 32], [AHU83, Section 8]

String Algorithms (3 units)

string matching, string matching with errors (FFT application), longest common subsequence
References: [OW96, Section 9.1], [CLR90, Chapter 34] missing reference for FFT based matching

Generic Approaches to Optimization, in particular Approximation (12 units)

linear programming, greedy method, dynamic programming, systematic search, local search, evolutionary algorithms, approximation algorithms, randomized algorithms,
References: [CLR90, Chapters 16 and 17], [KT05, Chapters 4 – 6, 11, 12, 13][MS08, Chapter 12], [JM08, Chapters? 10–12],[Vaz0X]

Contingency (3 units)

References

[AB98]   Mohamad Akra and Louay Bazzi. On the solution of linear recurrence equations. *Computational Optimization and Applications*, 10(2):195–210, 1998.

[AHU83]   A. V. Aho, J. E. Hopcroft, and J. D. Ullman. *Data Structures and Algorithms*. Addison-Wesley, 1983.

[AMO93]   R.K. Ahuja, T.L. Magnanti, and J.B. Orlin. *Network Flows*. Prentice Hall, 1993.

[CLR90]   T.H. Cormen, C.E. Leiserson, and R.L. Rivest. *Introduction to Algorithms*. MIT Press/McGraw-Hill Book Company, 1990.

[dBKOS97] M. de Berg, M. van Kreveld, M. Overmars, and O. Schwarzkopf. *Computational Geometry: Algorithms and Applications*. Springer, 1997.

[Hag98]   Torben Hagerup. Sorting and searching on the word ram. In *STACS*, volume 1373 of *LNCS*, pages 366–398, 1998.

[JM08]   K. Jansen and M. Margraf. *Approximative Algorithmen und Nichtapproximierbarkeit*. de Gruyter, 2008.

[Kle97]   R. Klein. *Algorithmische Geometrie*. Addison-Wesley, 1997.

[KT05]   J. Kleinberg and E. Tardos. *Algorithm Design*. Addison Wesley, 2005.

[MN99]   K. Mehlhorn and S. Näher. *The LEDA Platform for Combinatorial and Geometric Computing.* Cambridge University Press, 1999.

[MS08]   K. Mehlhorn and P. Sanders. *Algorithms and Data Structures: The Basic Toolbox.* Springer Verlag, 2008.

[OW96]   T. Ottmann and P. Widmayer. *Algorithmen und Datenstrukturen.* Spektrum Akademischer Verlag, 1996.

[SA96]   R. Seidel and C. R. Aragon. Randomized search trees. *Algorithmica*, 16(4/5):464–497, October/November 1996.

[T.L]   T.Leighton. Notes on better master theorems for divide and conquer recurrences. `http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.39.1636`.

[Vaz0X]   V. Vazirani. *Approximation Algorithms.* Springer, 200X.