Elective Courses Presentation

"the pizza meeting"

Kim Skak Larsen

May 26, 2014

DM2xx – Advanced Data Structures

Considerations

You know that red-black trees have worst-case $O(\log n)$ operations. However,

- $O(\log n)$ comes from searching – what about just rebalancing?
- how many of the rebalancing operations change pointers?
- are any changes possible to obtain $O(1)$ rebalancing?
- its precise height guarantee is $2 \log n$ – can any BST do better?

You know searching in a hash table is expected $O(1)$ using a table of size $O(n)$. However,

- "expected" is in relation to a uniform input distribution – can we make it independent of that?
- how difficult is it to make it worst-case $O(1)$ for static data?

Course Contents

- priority queues
- height and weight balanced trees
- multi-way trees
- randomized search structures
- disjoint sets with variations
- hashing methods
- techniques such as
  - global rebuilding
  - persistency
  - dynamization
  - expected quality vs. expected complexity
  - word RAM manipulations

More Concretely

- leftists heaps and skew heaps
- skip lists
- scapegoat trees
- universal and perfect hashing
- analysis of disjoint sets
- disjoint sets with backtracking
- making data structures partially persistent
- van Emde Boas trees
- splay trees
- AVL trees
- treaps
- (a, b)-trees
- ...
- ...

Example Applications

Data structures are important parts of:

- Efficient algorithms for fundamental problems in CS
- Database Systems
- Geographic Information Systems (GIS)
- Compilers/interpreters for various programming languages
- Robot Motion Planning
- Computer Aided Design
- ...
- ...

Prerequisites

DM508 - Algorithms and Complexity
(and the prerequisites implied by DM508, e.g., topics from DM507)

Specific Data Structures

- Search Trees (red-black trees)
- Priority Queues (binary heap)
- Disjoint Sets (Galler-Fischer representation)

General Techniques

- Asymptotic Notation
- Time and Space Analysis
- Amortized Analysis

Formal Details

- 10 ECTS
- semester course
- 2 hours of lectures and 2 hours of exercises per week
- articles and excerpts from textbooks
- obligatory project throughout (implementation, possibly optionally theory)
- oral exam with preparation (7 point scale)

Disclaimer

- There *will* be theorems and proofs in every lecture...
- —in particular, careful analysis of running time
- We will not look much at applications
- Chalk & blackboard lectures...
- Course language is English, if necessary...

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