# Algorithms & Data Structures

## Text Mining Tries, KD-Trees & Workshop Week 1

Jacob Trier Frederiksen & Anders Kalhauge


Spring 2019

# Program, Week 18

1. Test Exam & solution suggestion; hand-back
2. Overview: the last weeks of the course
3. Final Exam: information and clearing occasional questions
4. Project 5:
    1. overview
    2. choosing project
    3. hand-out
5. Two last theortical bits:
    1. Text Mining, 'Tries' (Ch. 5.2)
    2. kD-Trees, (*con amore* -- but part of one project 5 choice)

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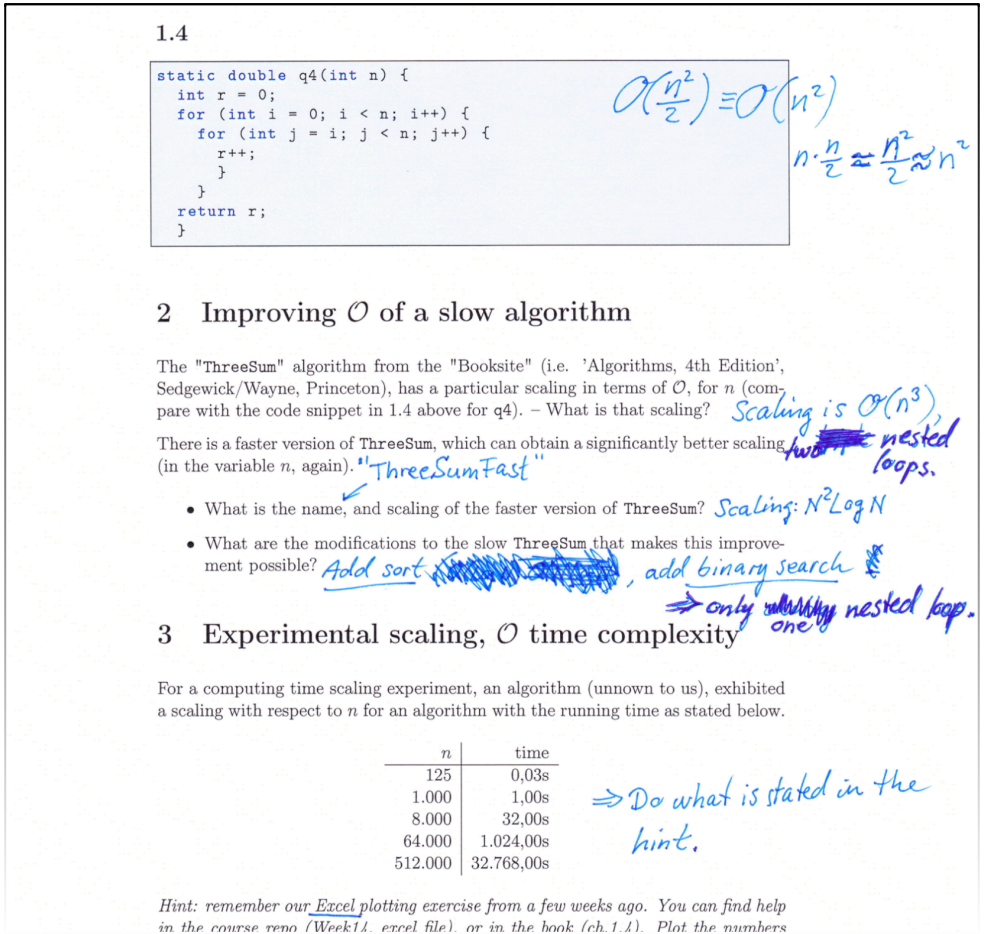
# Test Exam & solution suggestion; hand-back

- NB: This was an exercise, which we decided to do
- **NB: It is not graded**
- NB: Meant only as an *indicator* of your standing on knowledge
- **NB: There is still time before the finals**



1.4

```
static double q4(int n) {
  int r = 0;
  for (int i = 0; i < n; i++) {
    for (int j = i; j < n; j++) {
      r++;
      }
    }
  return r;
  }
```

$O(\frac{n^2}{2}) = O(n^2)$

$n \cdot \frac{n}{2} \approx \frac{n^2}{2} \approx n^2$

## 2 Improving $\mathcal{O}$ of a slow algorithm

The "ThreeSum" algorithm from the "Booksite" (i.e. 'Algorithms, 4th Edition', Sedgewick/Wayne, Princeton), has a particular scaling in terms of $\mathcal{O}$, for $n$ (compare with the code snippet in 1.4 above for q4). – What is that scaling?

Scaling is $O(n^3)$, two nested loops.

There is a faster version of ThreeSum, which can obtain a significantly better scaling (in the variable $n$, again). "ThreeSumFast"

- What is the name, and scaling of the faster version of ThreeSum? Scaling: $N^2 Log\, N$
- What are the modifications to the slow ThreeSum that makes this improvement possible? Add sort, add binary search

⇒ only one nested loop.

## 3 Experimental scaling, $\mathcal{O}$ time complexity

For a computing time scaling experiment, an algorithm (unnown to us), exhibited a scaling with respect to $n$ for an algorithm with the running time as stated below.

| $n$ | time |
|---|---|
| 125 | 0,03s |
| 1.000 | 1,00s |
| 8.000 | 32,00s |
| 64.000 | 1.024,00s |
| 512.000 | 32.768,00s |

⇒ Do what is stated in the hint.

*Hint: remember our Excel plotting exercise from a few weeks ago. You can find help in the course repo (Week14, excel file), or in the book (ch.1.4). Plot the numbers*

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# Overview: the last weeks of the course

*– 'Looking for the summer...' [Chris Rea]*

| Date | Week | Teacher | Study Points | Reading, NB: due date! | Main subject | Subject and Goal |
|---|---|---|---|---|---|---|
| 16-4-2019 | 16 | - | - | - | - | EASTER HOLIDAY |
| 23-4-2019 | 17 | JTF | - | - | Mid term. + Exam. | Midterm: Course Evaluation and Examination. |
| 30-4-2019 | 18 | AKA/JTF | 20 | 5.2 | Con Amore | Tries / KD-Trees, Project 5 selection and definition. |
| 7-5-2019 | 19 | JTF/AKA | | 5.5 | Con Amore | Work on Project 5, and student selected topics / or we choose. |
| 14-5-2019 | 20 | JTF (AKA) | | | Con Amore, written exam. | Work on Project 5, and student selected topics / or we choose. |
| 21-5-2019 | 21 | JTF | 10 | | Group presentations on a given topic. | Topic within entire syllabus, training presentation skills |
| | | | | | | |
| **03/06/2019** | | **Final exam** | | | | |

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# Final Exam: information

Information from the Course Catalogue

cphbusiness

| **Algorithms and Data Structures (elective course)** |
|---|
| **Timing:** Spring - 1st/2nd semester |
| **Scope:** 10 ECTS |
| **Contents:** The purpose of the module is to make the students able to explain and implement simple and complex data structures and to use algorithms to manipulate these. Further, equip students for designing their own algorithms to solve a given problem. Use of time and memory and scalability will be analysed. |
| **Learning Objectives:**<br>*Knowledge*<br>The graduate will possess knowledge of:<br>• basic data structures such as stacks, queues, heaps<br>• binary trees, balanced trees, and hash tables<br>• basic sorting and searching algorithms<br>• basic graph theory<br><br>*Skills*<br>The graduate will be able to:<br>• select and use a suitable data structure for a given task<br>• select and use suitable sorting, searching, and hashing routines<br>• select and use algorithms for graphs<br>• analyze algorithms for consumption of time, memory and scalability<br><br>*Competencies*<br>The graduate will be able to:<br>• select, scale test, and use appropriate algorithms for practical problems<br>• devise, develop, scale test, and use algorithms for practical problems |
| **Examination form:** Written test (pass/fail), and oral exam based on the student presentation and the syllabus.<br>**Assessment:** One single grade is given according to the 7-point grading scale.<br>**Admission criteria:** Min. 80% study points obtained. 80% of all mandatory assignments handed in. The written test passed.<br>**Examination basis:** all contents of the course syllabus, and mandatory hand-ins.<br>**Consequences of not passing exam:** Re-exam (limited number of attempts). |

# Final Exam: clearing occasional questions

## Exam details

cphbusiness

| Algorithms and Data Structures (elective course) | 10 ECTS | Internal |
|---|---|---|
| **Timing:** *ultimo* Spring semester 2019 | | |
| **Examination form:** The exam is oral but with part of the exam as a written (pass/fail) test in the end of the course. For the oral part, the student will prepare a presentation (max. 5 mins) of the solution of one of the major hand-in assignments. Further examination/discussion (max. 15 minutes) will be based on the presentation, but can include all aspects of the curriculum. | | |
| **Assessment:** One single grade is given according to the danish 7-point grading scale. | | |
| **Admission criteria:** Min. 80% study points obtained. 80% of all mandatory assignments handed in. Written test passed. | | |
| **Consequences of not passing the exam:** Re-exam (limited of number of attempts). | | |

## Study Points

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**Algorithms and data structures**
Dates for exam attempt and OLA:
1st attempt: xx. 2019 9.00 AM
2nd attempt: yy. 2019 9.00 AM
3rd attempt: zz. 2019 9.00 AM

| Mandatory learning activity | Description | Study Points |
|---|---|---|
| Hand-in assignments | Of which >= 80% must be completed | Total of 100 (equally weighted) |
| Written test | Pass/fail test; must pass for oral exam eligibility | - |
| Give a lesson | On a given topic in small groups | 10 |

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# Project 5 – reaching a level of independence...

## You get to choose your topic (from a list of four):

1. **Out-of-core Sorting** of 'Big Data'
2. **Text Mining**, using Tries for sorting 'Big Data'
3. **Error detection/correction** in sorting of 'Big Data'
4. **kD-Tree acceleration**, searching kD spaces w/applications

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# Text Mining

- ‘Tries’ by Anders Kalhauge
  - Relevant in particular for project 5 on text mining
  - Relevant generally for exam and in real ”IT Life” ☺

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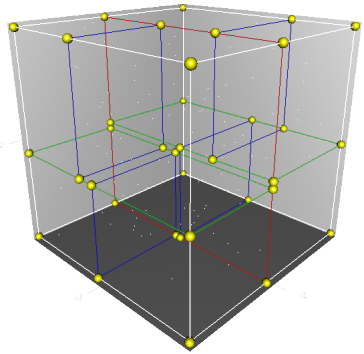
# kD-Trees (here just 2D but more general)

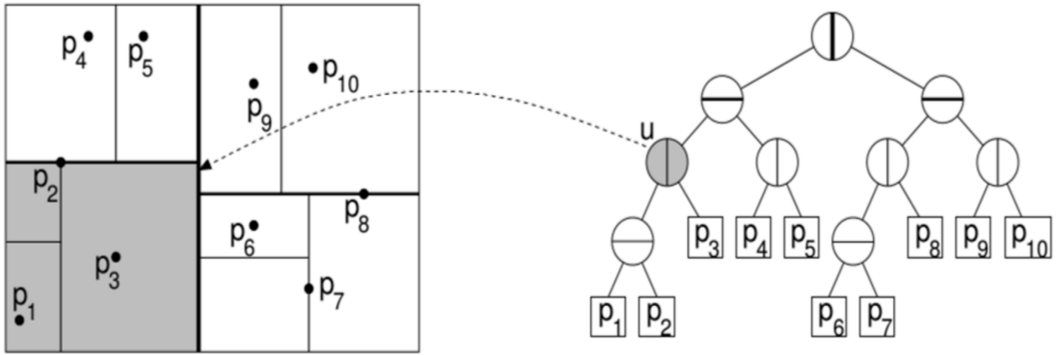
(*con amore,* but part of project 5 option)

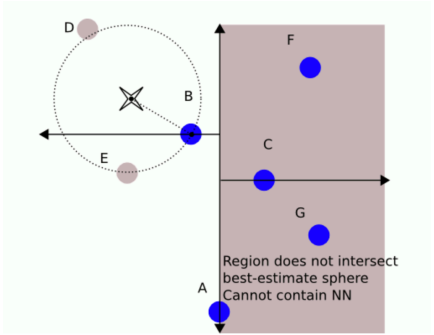
- This is the first of two formal slides on kD-Trees, today.
- The rest will be free wheeling, or ”*winging it*”, with some interesting applications in sight.



Oct-tree (for 3D, e.g.)

## Quad-tree (2D, e.g.)



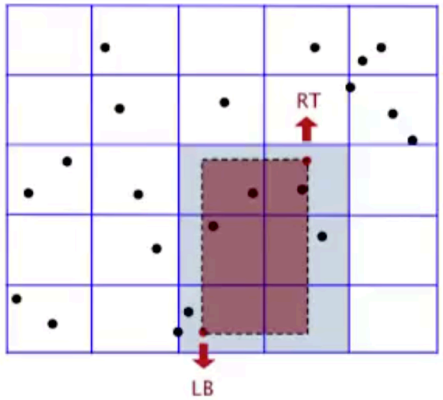




Nearest neighbor search

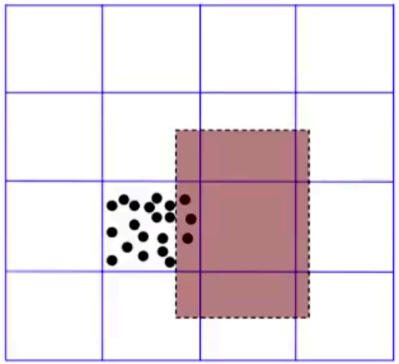
# Naiive Particle Model

- Space: $O(M^2 + N)$
- Time: $O(1 + N/M^2)$

The idea

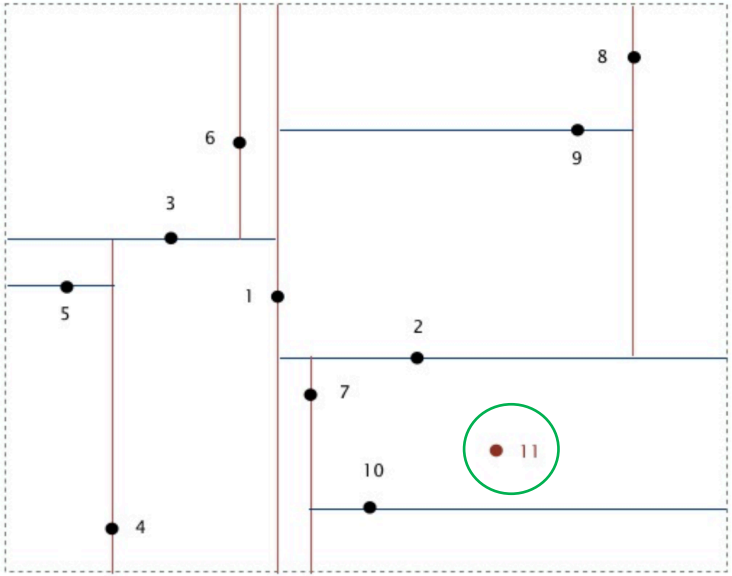


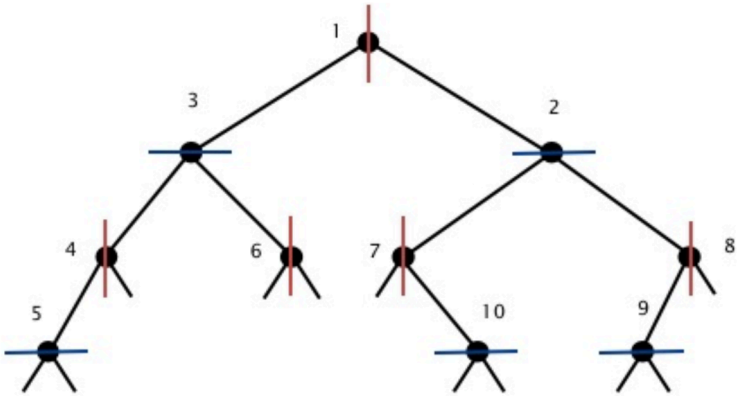

The problem



# Pop!

- Where should we put ‘11’ in the quad-tree?



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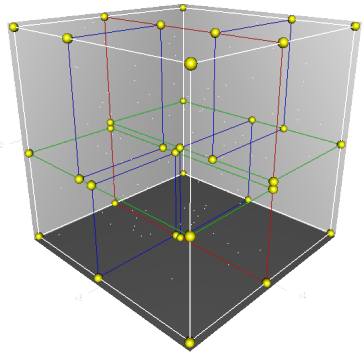

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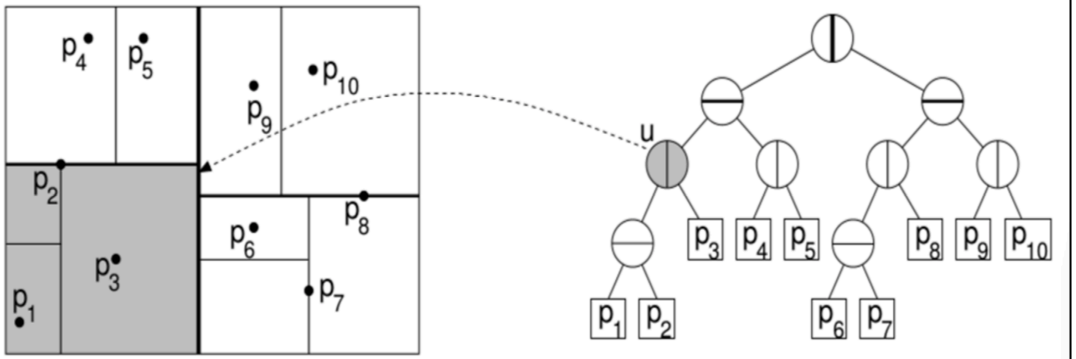


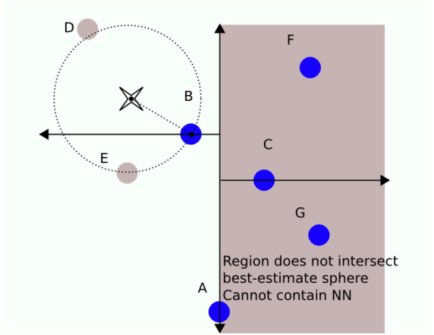


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