

# Database Tuning, ITU, Spring 2009

Rasmus Pagh

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## Project – 5th part and full report

**Deadline: May 20, 15.00 Danish time. Hand in at the exam office in *three* copies.**

**Office hours:** Rasmus Pagh is available in room 3C17 on Monday May 11, 10-11 AM, and Monday May 18 11-12 AM. In addition, Mai Sun will answer questions by e-mail (expect some delay in answers).

## Purpose

The purpose of the final part of the project is to allow students to pursue their own interests, within the scope of the project. While the “core” project is supposed to be done by all group members together, extensions may be pursued by any subset of the group (e.g., by single group members), based on differences in interests or ambition. Note that you should prioritize the “core” part of the project over extensions — it is possible to pass the course without doing any extensions.

The full report documents each group’s work on the project, and the ability to communicate clearly on complicated technical matters. It also documents the ability to independently formulate a small research project (a possible thesis project) within the subject area. In addition, it forms the basis for the examination and grade.

## Suggested topics

Below you can find some inspiration for topics to address in the last part of the project. Feel free to modify or extend the suggestions, or come up with your own.

**Sampling.** In the course you have seen several uses of sampling: Query result size estimation, “on-line aggregation”, and producing early join results. Use the **SAMPLE** operator of Oracle to experiment with sampling. Can sampling be used to improve, in some sense, any of the queries studied in the project? How do sampling-based estimates of query result sizes compare with the estimates made by the Oracle query optimizer, and with the actual sizes? Is it efficient to maintain a materialized view that is a sample of a relation?

**OLAP and bitmap indexing.** Come up with some OLAP-like queries in the context of the project, and try to implement them such that response time is small. You may use materialized views, bitmap (join) indexes, and “on-line aggregation”.

**Partitioning.** Suppose that, for performance reasons, it has been decided to put the VXL system on a larger machine having 4 disks. Describe how you would partition the data (considering both vertical and horizontal partitioning, range and hash partitioning). Give arguments why this would enhance the performance of the system. Also try to estimate the downtime needed to do the repartitioning. You may take into account the contents of the guest lecture by Kaare Kristoffersen.

**Solid state devices.** Suppose that it is considered to move the VXL database to a flash-based drive that has seek time 100 times smaller than a normal hard drive, and is able to read and write a disk block 10 times faster than a normal hard drive. Make a rough assessment of how much this would improve the speed of the VXL database. To do this you need to investigate how many physical I/Os are performed, and how many of these are sequential. You may take into account the contents of the guest lectures by Mogens Nørgaard and Philippe Bonnet.

**R-trees vs space-filling curves vs grid files.** You have seen at least three techniques that may be used for the “nearest point” query on the geographical data in the VXL database. Using the R-trees built into Oracle is one such option. Two other indexing techniques can be tried, by reduction to a one-dimensional query: Space-filling curves (Z-ordering is the easiest) and grid files. Let’s call a grid file *uniform* if all the grid rectangles are squares of the same size. Consider a uniform grid file, based on the GPS coordinates, for road segment endpoints. Implement this such that each square has at most 1000 points in it, and such that the total number of squares is (close to) minimal. Use a clustered B-tree index to make sure that points in the same square are stored physically together. How does this compare to the performance of R-trees? To space-filling curves?

**Temporal databases and OLAP.** Do a literature study on subjects in the intersection of temporal databases and OLAP, e.g., read (part of) the papers [1, 2]. You should focus on writing a short overview of selected aspects, aiming at a reader who is familiar with OLAP and temporal databases, but not familiar with ways of combining them. In particular, you should make the relationship to the contents of DBT clear.

**Index design.** There is a rich literature giving practical advice on database performance tuning. Tapio Lahdenmäki ([www.tapio1.com](http://www.tapio1.com)) has received attention in recent years for his method for choosing indexes. Describe the main aspects of Lahdenmäki’s method (described in the book *Relational Database Index Design and the Optimizers*), and evaluate it based on the knowledge and experience you have from the course. What are the strengths and weaknesses of the method?

## The full report

The report should be written as if the reader is a student who has followed the lectures of DBT, but not worked on the project. If it seems most natural to you, the report may summarize parts of the material covered by the DBT lectures, but it is the *application* of this knowledge, with accompanying analysis and arguments, that is the main focus.

The full report should contain:

- An introductory section describing the relevant prerequisites (courses and projects) of each group member. Also, you must clearly describe how each group member contributed to the project and report, to enable individual grading.
- The same information as in answers to the four deliverables. You may, and probably should, revise this material according to the feedback received.
- You are encouraged to extend your discussion to aspects that seem relevant for the VXL case, but not touched upon by the deliverables. For example, if there are cases where acceptable performance could not be achieved, you may discuss what could be done to alleviate this, including restrictions on what (or when) queries are performed, hardware enhancements, etc. If you need more specific knowledge than what is available, make reasonable assumptions.
- A brief experience report: What aspects of the work were harder (or easier) than expected? Was this because of special restrictions (or features) of the DBMS software, hardware limitations, or other constraints? Was there any information that you would have liked to have at the beginning of the project? Etc.

- Documentation of the programming performed: Printouts of Java programs, DDL statements, and other relevant files. These should be easily understandable in the context of the report (e.g., through a combination of in-code comments and overview sections in the report).
- A proposal for at least one thesis project related to performance of databases. You are supposed to independently formulate a small “research problem” that would be interesting to pursue, based on the knowledge you have obtained in DBT. Also, you should outline a possible methodology using which the problem could be addressed. You are *not* expected to investigate the literature on the subject to find out if the problem has been addressed before.
- A CD or DVD containing the source files needed to test your database on `kursusdb.itu.dk`. For completeness, the report should also briefly state how this should be run.

### Uploading the database

Before the project deadline you must make the final snapshot of your database available on `kursusdb.itu.dk`. Note that this database is only accessible from within the ITU campus. Please do not make changes to the database after the deadline for handing in. Though it is not formally part of your report, we want to be able to use it before (and possibly during) the exam, so the snapshot should reflect what is described in the report.

### Credit

If some section of the report (and the programming work behind it) was done by a proper subset of the group members, this should be indicated below the section heading. At the exam, you will be expected to be able to discuss any section on the “core” part of the project, whereas a section on an extension will not be discussed with students who did not contribute to it.

Of course, if you have used (even for inspiration only) any papers or books when doing the report, these should be appropriately cited.

## References

- [1] Michael H. Böhlen, Johann Gamper, and Christian S. Jensen. Multi-dimensional aggregation for temporal data. In Yannis E. Ioannidis, Marc H. Scholl, Joachim W. Schmidt, Florian Matthes, Michael Hatzopoulos, Klemens Böhm, Alfons Kemper, Torsten Grust, and Christian Böhm, editors, *EDBT*, volume 3896 of *Lecture Notes in Computer Science*, pages 257–275. Springer, 2006.
- [2] Jun Yang and Jennifer Widom. Incremental computation and maintenance of temporal aggregates. *VLDB J*, 12(3):262–283, 2003.