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Datasheet for the decision
of 24 March 2017

Case Number: T 1965/11 - 3.5.07

Application Number: 01123065.3

Publication Number: 1193618

IPC: G06F17/30

Language of the proceedings: EN

Title of invention:
Cost-based materialised view selection for query optimisation

Applicant:
Microsoft Technology Licensing, LLC

Headword:
Cost-based materialised view selection/MICROSOFT TECHNOLOGY
LICENSING

Relevant legal provisions:
EPC Art. 56, 123(2)

Keyword:
Added subject-matter - (no)
Inventive step - (yes)

Decisions cited:
G 0003/08, T 1569/05, T 1003/09

Catchword:

Case Number: **T 1965/11 - 3.5.07**

D E C I S I O N
of Technical Board of Appeal 3.5.07
of 24 March 2017

Appellant: (Applicant)	Microsoft Technology Licensing, LLC One Microsoft Way Redmond, WA 98052 (US)
Representative:	Grünecker Patent- und Rechtsanwälte PartG mbB Leopoldstraße 4 80802 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 20 April 2011 refusing European patent application No. 01123065.3 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	R. Moufang
Members:	M. Jaedicke
	P. San-Bento Furtado

Summary of Facts and Submissions

I.   The applicant (appellant), which at the time was
        Microsoft Corporation, appealed against the decision of
        the Examining Division refusing European patent
        application No. 01123065.3.

II.   In the course of the appeal proceedings, the
        application was transferred to Microsoft Technology
        Licensing, LLC, which thereby obtained the status of
        appellant.

III.   The Examining Division decided that the subject-matter
        of claims 1 and 9 of the main request contained added
        subject-matter. Moreover, it refused to admit the first
        and second auxiliary requests using its discretion
        under Rule 137(3) EPC, stating that the first and
        second auxiliary requests appeared to comprise the same
        violations of Article 123(2) EPC as the main request.

IV.   In the written proceedings the Examining Division cited
        the following prior-art documents:

        D1: WO-A-99/50762, published on 7 October 1999;

        D2: US-A-6,026,390, published on 15 February 2000;

        D3: US-A-5,897,632, published on 27 April 1999;

        D4: Gupta, Ashish et al.: "Aggregate-Query Processing
             in Data Warehousing Environments", Proceedings of
             21st International Conference on Very Large Data
             Bases, 11 to 15 September 1995, Zurich,
             Switzerland, Morgan Kaufmann, ISBN 1-55860-379-4,
             pages 358 to 369;

D5:   WO-A-99/50732, published on 7 October 1999;

D6:   Chang, Jae-young et al.: "An Extended Query
       Reformulation Technique Using Materialized
       Views", Proceedings of Ninth International
       Workshop on Database and Expert Systems
       Applications, 1998, Vienna, Austria, 26 to
       28 August 1998, pages 931 to 936;

D7:   Zhang, Chuan et al.: "Evolving Materialized Views
       in Data Warehouse", Proceedings of IEEE Congress
       on Evolutionary Computation, Washington D.C.,
       USA, vol. 2, 6 July 1999, pages 823 to 829.

V.   In the statement of grounds of appeal, the appellant
       requested that the decision be set aside. It also asked
       the Board to decide that the claims of one of the main
       and the two auxiliary requests, considered in the
       contested decision and resubmitted with the grounds of
       appeal, were allowable.

VI.   In a communication under Article 15(1) RPBA
       accompanying a summons to oral proceedings, the Board
       expressed its provisional opinion that the reasons for
       the refusal were not convincing. However, the Board
       raised several objections under Articles 123(2) and 84
       EPC.

       The Board also drew the appellant's attention to the
       following document:

D8:   Chaudhuri, S.: "An Overview of Query Optimization
       in Relational Systems", Proceedings of the
       seventeenth ACM SIGACT-SIGMOD-SIGART Symposium on
       Principles of Database Systems, pages 34 to 43,

Seattle, Washington State, USA, 1 to 4 June 1998.

VII.   With its reply to the Board's communication, the appellant submitted third and fourth auxiliary requests and new description pages 3, 3a, and 3b to replace description page 3 as on file.

VIII.   In the course of the oral proceedings the appellant replaced its previous requests with a sole request corresponding to the fourth auxiliary request. At the end of the oral proceedings, the chairman pronounced the Board's decision.

IX.   The appellant's final request is that the decision under appeal be set aside and that a patent be granted on the basis of the following application documents:
- description pages 1, 2, and 4 to 13 as originally filed, and pages 3, 3a and 3b as filed with the letter dated 24 February 2017;
- drawings of Figures 1 to 8 as originally filed;
- claims 1 to 3 of the sole request maintained at the oral proceedings before the Board, corresponding to the fourth auxiliary request filed with letter dated 24 February 2017.

X.   Claim 1 of the sole request reads as follows:

"A method for a computer-implemented query optimizer for selecting an execution plan for use in execution of a relational database query, the method comprising:
   generating, by a cost-based query optimizer, a table (300) of alternatives, the table (300) of alternatives comprising several groups, one group having a root entry representing the database query and additional entries representing alternative possibilities for executing the database query and the other groups

having root entries representing sub-expressions of the
database query and additional entries representing
alternative possibilities for executing the respective
sub-expression of the database query;
   selecting candidate views for the query from a
number of materialized views by using information about
what database tables are referenced in the query and
whether or not the query contains aggregations;
   for each root entry,
      extracting an operator tree for the root entry,
      collapsing binary joins contained in the
   operator tree to obtain a query graph for the root
   entry, the query graph listing all underlying
   tables along with predicates that are applied on
   them,
      matching the query graph for the root entry and
   the candidate views, and
      if a match is found, extending the table (300)
   of alternatives with the corresponding candidate
   view by extending the group of the root entry with
   the corresponding candidate view; and
   using the cost based query optimizer to select an
execution plan based on the extended table (300) of
alternatives."

Claim 2 reads as follows:

"A computer readable medium having instructions for
causing a computer to perform a method according to
claim 1."

Claim 3 reads as follows:

"A computer-implemented query optimizer configured to
perform a method according to claim 1."

XI.   The appellant's arguments relevant to the decision are
         discussed in detail below.

Reasons for the Decision

1.   The appeal complies with the provisions referred to in
         Rule 101 EPC and is therefore admissible.

The invention

2.   The application relates to the optimisation of
         relational database queries in the presence of
         materialised views. According to page 1, last
         paragraph, of the description, the basic idea of
         materialised views is to store the result of a query
         and to use this stored result to answer similar later
         queries. The invention addresses the known view
         utilisation problem: given a user query written over
         base tables, as well as a collection of materialised
         views, which materialised views can be used to answer
         the query (description, page 2, first paragraph)?

         According to the technical background section on page 2
         of the application, prior attempts to determine which
         views should be used treated the problem in isolation,
         handled limited scenarios, and often assumed a "global"
         structure that covered the whole query. There was a
         need to deal with arbitrary queries, and to integrate
         view utilisation within the actual architecture of
         query optimisers. There was a further need to decide
         whether a view that could be used to answer the query,
         should actually be used to execute that query.
         Constructing a "global" structure for the user query,
         for the purpose of view matching, was incompatible with
         common optimiser architecture and was sometimes

infeasible.

According to page 7, lines 14 to 16, query optimisers
are normally structured such that there is an initial
simplification stage, followed by exploration of
alternatives and cost-based selection of an execution
plan as illustrated in Figure 2 of the application.
Considering materialised views during query
simplification is inadequate, because only a single
solution can be generated, and there is no detailed
cost information (page 7, lines 31 to 33). Hence, the
invention proposes to extend the table of alternatives,
which is generated by the query optimiser at the
exploration stage and which compactly encodes for each
sub-expression of a query the various possibilities for
its execution (page 3, lines 9 to 13, and page 10,
lines 1 to 21). In other words, materialised views are
detected and substituted during exploration of the
various query execution possibilities and added to the
table of alternatives.

Admission of request

3.   Since the current request was a legitimate response to
        the preliminary opinion of the Board, does not
        introduce additional complexity into the proceedings
        and could be dealt with without adjournment of the oral
        proceedings, the Board admitted it into the appeal
        proceedings.

Clarity and added subject-matter

4.   The appealed decision found that the following features
        of the method of claim 1 of the then pending main
        request infringed the requirements of Article 123(2)

EPC:

(a) "selecting candidate views for the query from a
    number of materialized views";

(b) "extracting, for each candidate view, an operator
    tree from a view definition of the candidate view".

4.1   The appellant argued that present claim 1 was based on
       claims 1 to 3, 8 and 17 as originally filed and page 1,
       lines 3 to 5 and 18 to 26, page 3, lines 9 to 14 and 21
       to 24, page 4, line 32, to page 5, line 1, page 8,
       lines 12 to 19 and 21 to 31, page 9, lines 8 to 16,
       page 10, lines 14 to 19, and page 11, lines 2 and 3, of
       the original description and original Figures 3 and 5.

4.2   The method of present claim 1 no longer contains
       feature (b). Feature (a) is still present, but the
       method of present claim 1 adds at the end of that
       feature the text "by using information about what
       database tables are referenced in the query and whether
       or not the query contains aggregations".

4.3   The appellant argued in the statement of grounds of
       appeal that feature (a) was supported by page 9,
       lines 8 to 14. In particular, page 9, lines 8 to 10,
       stated that for a particular query there was in general
       a number of "candidate views", as not all of the
       materialised views stored in conjunction with previous
       database queries were relevant to a particular query
       submitted to the database.

4.4   The Board agrees with the appellant that a database
       usually has a limited set of materialised views (for
       example due to the high costs associated with
       maintaining views). A particular database query will

normally refer only to a subset of all base tables and hence some materialised views will not be relevant for this query. Other views might not be relevant due to the use of aggregation. The appellant points correctly to page 9, lines 10 to 13, in support.

Hence, the Board does not share the view of the Examining Division that the cited passage on page 9 merely describes "the process of narrowing down a set of already present candidate views" and that the "origin of this initial set of candidate views ... remains undefined". The appellant suggested that the Examining Division had misinterpreted the following sentence (page 9, lines 13 to 14): "This provides the ability to narrow down the set of candidate views." The Board does not share the alleged interpretation by the Examining Division, namely that the first word ("this") of the cited sentence referred to the process of identifying views as not relevant for a particular query. The sentence simply means that the initial set of (all) materialised views is reduced to a subset of the candidate views by eliminating irrelevant views as described on page 9, lines 11 to 13.

4.5   Hence, the Board accepts the basis for the amendments to claim 1. Present claims 2 and 3 are directed to a computer-readable medium and to a computer-implemented query optimiser, both defined by reference to the method of claim 1.

4.6   Moreover, the amendments to the claims overcome the Board's objections under Article 84 EPC as detailed in its communication to the appellant.

4.7   Hence, the Board is satisfied that the claims comply
        with the requirements of Articles 84 and 123(2) EPC.

Novelty and inventive step

5.   Inventive step was not examined in detail during the
        proceedings before the first instance. Nevertheless, in
        view of the age of the application, the Board considers
        it appropriate to deal with this issue itself under
        Article 111(1) EPC.

5.1   According to decision T 1569/05 of 26 June 2008,
        reasons 3.6, retrieving data in a computer database is
        normally considered to have technical character. While
        the method of claim 1 does not include the actual data
        retrieval, the Board considers that the cost-based
        optimisation of a query in a relational database system
        has normally technical character (see T 1003/09 of
        29 April 2015, reasons 13.3 and 13.5). Such cost-based
        query optimisation searches for low-cost query
        execution plans using a cost estimate for the computer
        resources (such as CPU, main memory or hard disk)
        needed to execute a query plan (see D8, section 2, for
        technical background). Hence, this cost-based approach
        involves further technical considerations (see opinion
        G 3/08, "Programs for computers", OJ EPO 2011, 10,
        reasons 13.5) relating to the internal functioning of
        the computer system.

5.2   The Board summarises below the relevance of the prior
        art on file. Seven documents, D1 to D7, were cited in
        the European search report.

        Document D1 describes that a query rewriter intercepts
        and attempts to rewrite user database queries using
        aggregate tables (materialised aggregate views; see for

example page 12, line 18 to page 13, line 5; page 15,
line 18 to page 16, line 12) in order to improve query
performance. The query rewriter uses a cost-based
algorithm to choose among potential rewrites and is
detailed only in document D5 (D1 refers on page 24,
lines 9 to 12, to U.S. Application Serial
No. 09/049,784, the priority document of D5).

Document D5 explains the query rewriting approach in
Figures 6 to 9 and page 19, line 23 to page 25,
line 14. A query is submitted to the rewrite system
(Figure 6, reference sign 700), where it is initially
screened to determine whether it should be rewritten
(Figure 7). If so, then a block-wise rewrite process is
performed, where a block represents part of an SQL
query (Figure 8). Figure 9 describes that for each
block, views from a list of precomputed (materialised)
views (PCV_List) are processed. For each view, it is
checked whether a rewrite of the current block using
this view would lower the costs for the current block
compared to the estimated cost for the best available
rewrite found so far. Hence, alternatives are generated
for single blocks and the cost-based selection is
limited to alternative views for a single block.

Document D2 concerns the incremental maintenance of a
first materialised view of data in a database, by means
of an additional materialised view, if this reduces the
maintenance costs.

Document D3 discloses a method of evaluating a query
using materialised views, which starts by semantically
analysing a first materialised view to determine
whether it is usable in evaluating the query. If the
view is usable, then the method rewrites the query into
an equivalent query using the materialised view.

Subsequently the process is iterated for the other available materialised views. Rewriting of the query is not integrated into the plan exploration phase and is not cost-based.

Document D4 concerns methods for rewriting queries to consider materialised views. Rewriting is usually applied before the plan exploration phase.

Document D6 (see abstract and sections 1 and 3) concerns query reformulations to use materialised views, and in particular proposes rules to identify potentially useful views, but does not address the problem of generating alternative plans during the exploration phase of a query optimiser.

Document D7 addresses the following problem: based on multiple queries, select a set of views to be materialised in order that the total query and maintenance cost is minimised.

Document D8, introduced into the proceedings by the Board, provides an overview of known query optimisation techniques in relational database systems. Section 7.3 describes the optimisation problem for materialised views. It explains that the steps of enumerating and generating equivalent expressions in the presence of materialised views may overlap, but does not explain in detail how the exploration phase or the table of alternatives is implemented.

5.3   None of these prior-art documents addresses the problem of extending a table of alternatives generated by the query optimiser by adding further alternatives using materialised views. The invention makes it possible to find low-cost query execution plans that make use of

the available materialised views in order to improve
query performance (see page 2, third paragraph).
Moreover, in order to explore the search space for such
low-cost query execution plans, it proposes integrating
the materialised views into the table of alternatives
during the plan exploration stage. For this
integration, it is necessary to match query plans with
materialised views in order to identify useful plan
alternatives for such views. The invention teaches
using query graphs for the matching in order to
substantially reduce the complexity of extracting
operator trees which encode a specific join order. In
the technical context of query optimisation in
relational database systems, this teaching is based on
further technical considerations and solves the problem
of providing a technically feasible implementation, in
particular one that achieves an acceptable time
complexity for query optimisation in relational
database systems. In the oral proceedings the appellant
argued along these lines in favour of inventive step,
and the Board agrees.

5.4   The Board therefore concludes that the subject-matter
        of independent claims 1 to 3 involves an inventive step
        (Articles 52(1) and 56 EPC) over the available prior
        art.

Conclusion

6.   Since the appellant's request complies with the
        provisions of the EPC, the appeal is to be allowed.

Order

For these reasons it is decided that:

1.   The decision under appeal is set aside.

2.   The case is remitted to the department of first
        instance with the order to grant a patent on the basis
        of the following application documents:
          - description pages 1, 2, and 4 to 13 as originally
            filed, and pages 3, 3a and 3b as filed with the
            letter dated 24 February 2017;
          - drawings of Figures 1 to 8 as originally filed;
          - claims 1 to 3 of the sole request maintained at
            the oral proceedings before the Board,
            corresponding to the fourth auxiliary request
            filed with the letter dated 24 February 2017.

The Registrar: The Chairman:

I. Aperribay   R. Moufang

Decision electronically authenticated