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# Experiences Building the Open OODB Query Optimizer By Jose A. Blakeley, Texas Instruments

Presented By **Pradeep Jagannath**March 4, 2002

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# Roadmap

- 1. Introduction
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- 4. The Open OODB Query Optimization Framework
- 5. Reexamination on using Volcano Optimizer Generator
- 6. Open Issues
- 7. Summary



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## **Early efforts in Query Optimization**

- Object Algebra
- Query Rewriting Techniques
- Indexing Techniques
- New Execution algorithms
  - Efficient traversal of Complex Object Structures
  - Complex Object Assembly

However, little has been reported on the development of complete working object query optimizers!

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## **Major Goals in Designing Open OODB**

- Extensibility
  - 1. new algebraic operators
  - 2. new algebraic transformation rules
  - 3. new execution algorithms
  - 4. improved statistics and cost models
  - 5. physical formats and structures
  - 6. enforcer algorithms for physical properties(e.g. sort order)
  - 7. new state space search stratergies, and
  - 8. improved quality of plans(e.g. thoroughness of search)
- Cost-effective rapid development
- Performance
  - Moderately complex queries should be optimized in less than 1 sec.
- Effectiveness

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## **Contributions of this Paper**

- Design and development of a complete OODB optimization framework
- Reexamining the algenra for specifying queries on whhich the optimizers work
- Suggesting a new operator materialize for bring objects connected through path-expressions in to scope
- Revisioning the importance of physical properties in the search process
- Suggesting a new physical property presence in memory
- Experimental evidence to show that techniques designed in the relational context are applicable in context of OODB also
- Validation of the volcano optimizer generator for the generation of an object query optimizer

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## **Previous works**

- Mitchell et al and Sciore and Sieg

  Optimizer design consists of a collection of optimization regions, each of which can transform queries according to a particular control startegy, a set of algebraic transformations and a cost model. A global optimizer control coordinates the movement of query among these regions
- Orenstein et al
   Dynamic plan selection capability
   However, this was not yet validated in an implementation!
   Drawbacks:
  - Uses only index based scans
  - It is not cost based
  - Optimizer was based on query algebra





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## **Previous works (Contd.)**

## • Cluet and Delobel

- Use type information to decompose initial complex arguments into a set of simpler operators.
- Prune the search space based on physical information(clustering, indexing).
- Common subexpressions factorization is an important issue in OODB
- Straube and Ozsu

A query processing methodology that includes a formal oject calculus and algebra.



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## **Open OODB: User Query Language**

- designed to be well-integrated with C++
- uses the C++ object data model

## Example:

Set ¡Newobject¿ \*result;

Date lr(01,01,2002); result = SELECT Newobject(e.name(), d.name())

FROM Employee e IN Employees, Department d IN Departments

WHERE d.floor==3 and e.age() $\xi$ =32 and e.department()==d;



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## **Open OODB: Logical Algebra**

## Basic operations:

- Operators borrowed from relational domain select, project, join, intersection and union
- *unnest* used to manipulate set–valued components
- materialize or mat used to indicate the use of inter-object references explicitly

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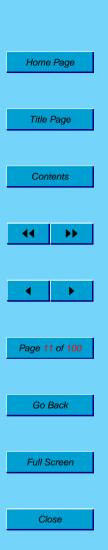
# **Query Simplification**

This is used to transform ZOL[C++] parse trees into an equivalent algebraic operator graph

Example:

Project e.name(), d.name()

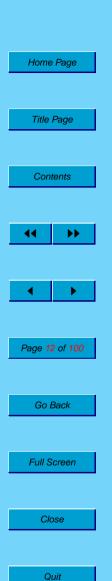
SELECT d.floor==3 and e.age();=32 and e.department()==d Get Employees e — Get Departments d



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# **Execution Algorithm**

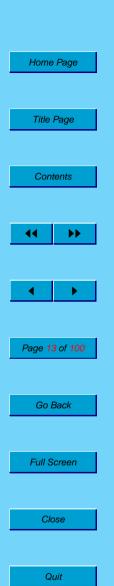
- Set processing algorithms file and index-scan
- Value based matching intersection, union and join
- Assembly generation



# **Properties and Property Enforcement**

- logical properties
- physical properties E.g.: *presence in memory*

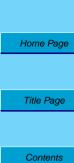
The execution algorithms implement a logical operator 'enforce' which forces a certain physical property on the operators



## **Cost model**

Currently only CPU and I/O costs are considered

- sequential I/O is charged less when compared to random I/O
- assembly performance costs are expected to be studied on operational systems















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## **Transformation and Implementation Rules**

## **Transformation Rules**

- Since the logical algebra is based on relational constructs the transformation rules remain the same as in relational case.
- Materialize operator introduces new operations

## **Implementation Rules**

This establishes a correspondence between logical algebraic expressions and execution algorithms. The rules are based on the algorithms ability to deliver the logical expression with the desired physical properties and cost estimations

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