OPTIMIZATION AND EXPRESSIBILITY OF RELATIONAL QUERIES

By

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fulfilment of the requirements
for the degree of

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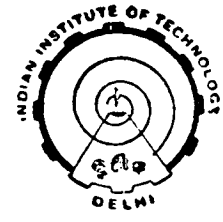

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CERTIFICATE

This is to certify that the thesis entitled "OPTIMIZATION AND EXPRESSIBILITY OF RELATIONAL QUERIES" being submitted by Mr. Pratul Dublish to the Department of Computer Science & Engineering, Indian Institute of Technology, Delhi for the award of the degree of Doctor of Philosophy is a record of the bona fide research work carried out by him. Mr. Pratul Dublish worked under my guidance for the submission of this thesis which to my knowledge has reached the requisite standard.

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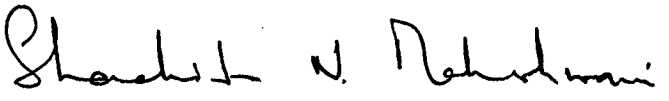

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ABSTRACT

This thesis deals with the optimization and expressibility of relational queries. In query optimization, we have primarily focussed our attention on designing efficient optimization and equivalence algorithms for fan-out free queries, a reasonably expressive subclass of conjunctive queries. We give $O(n^2)$ optimization and equivalence algorithms for fan-out free queries. The computational complexity of conjunctive query optimization is investigated and this problem is shown to be D^p-complete. The optimization problem for 1-restricted fan-out-2 queries, an immediate extension of fan-out free queries, is shown to be NP-hard. We also show that no polynomial-time ϵ-approximation algorithms can exist for 1-restricted fan-out-2 query optimization.

The second part deals with the expressibility of query languages based on the extension of first-order logic (FO) by the fixed-point operators : least fixed-point (LFP), inductive fixed-point (IFP) and generalized fixed-point (GFP). We study the bounded arity hierarchies $FO+LFP^k$, $FO+IFP^k$ and $FO+GFP^k$ formed by restricting the arity of the iteratively defined predicate to some constant k. For each of these hierarchies we show that there exist k-ary predicates which are not expressible in the k^{th} level of the hierarchy but are expressible in the $k+1^{th}$ level. We also show that $FO+IFP^k$ is more expressive than $FO+LFP^k$ and $FO+GFP^k$ is more expressive than $FO+IFP^k$. The problem of identifying structures (or databases) for which the query languages FO+LFP

and FO+LFP+CQ, obtained by augmenting FO+LFP with counting quantifiers, express all queries computable in polynomial time (in the size of the structure) is also investigated. We show that FO+LFP+CQ expresses all Boolean queries, computable in polynomial time, for structures which are rooted trees. We refine this result to show that FO+LFP+I, a weaker version of FO+LFP+CQ, suffices to express all such queries for rooted k-valent trees. Finally, we attempt to identify those structures for which a total ordering on the domain is expressible in FO+LFP since for such structures FO+LFP expresses all queries computable in polynomial time. We show that any total ordering on the domain is not expressible in FO+LFP for non-identity structures. We conjecture that a total ordering on the domain is expressible in FO+LFP for identity structures and show that this conjecture is valid for rooted identity trees.

C O N T E N T S