

Contents

1	Introduction	1
1.1	Data Warehousing and Materialized Views	2
1.1.1	Multidimensional data model	3
1.1.2	Aggregations of data as data warehouse views	5
1.1.3	Materialized views for efficient computation of data cubes .	7
1.1.4	Materializing views in RDBMS technology	7
1.1.5	Common SQL sub-expressions of SQL queries as materialized views	8
1.1.6	Materializing results of common sub-expressions in Big data framework	11
1.2	Multi-Objective Optimization to Select Views for Materializing . .	12
1.2.1	The view selection problem for materializing	12
1.2.2	The costs to be minimized and trade-offs	13
1.2.3	Multi-Objective Optimization (MOO)	13
1.2.4	Selecting views by multi-objective optimization technique .	14
1.3	Motivation of this Research	15
1.4	Research Objectives	15
1.5	Contributions	17
1.6	Organization of the Thesis	17
2	Materialized View Selection in Data Warehouses: Approaches, Issues and Challenges	19

Contents

2.1	Introduction	19
2.2	Representations of views in Data Warehouses	20
2.2.1	Multidimensional lattice representation of views	20
2.2.2	AND-OR view graph representation of queries and views .	22
2.2.3	Optimal multiple query execution plan based graphical representation	24
2.2.4	Query - Attribute matrix representation	26
2.2.5	Associated issues in different representations	26
2.3	Existing View Selection Techniques	28
2.3.1	Greedy algorithmic approaches	28
2.3.2	Stochastic algorithmic approaches	33
2.3.3	Data mining based approaches	39
2.4	A Brief Discussion on Existing Approaches	42
2.4.1	Issues and challenges	44
2.5	Discussion	45
3	Multi-Objective Differential Evolution Algorithm for Selecting Views to Materialize	47
3.1	Introduction	47
3.1.1	Motivation	47
3.1.2	Contribution	48
3.2	The View Selection for Materializing as a Multi-objective Optimization Problem	49
3.2.1	DAG representation of multiple query processing plan	50
3.2.2	The cost model	51
3.2.3	Multi-objective optimization	53
3.2.4	The view selection problem as multi-objective optimization problem representation	54
3.2.5	Solution representation	55

Contents

3.3	Multi-objective Differential Evolution Algorithm for Selecting Views to Materialize in Data Warehouse	56
3.3.1	The Differential Evolution (DE) algorithm	56
3.3.2	Differential Evolution algorithm adapted with binary encoded data	57
3.3.3	Multi-objective DE	60
3.3.4	Multi-objective DE with binary encoded data for view selection : MODE-BE	62
3.3.5	Complexity analysis	64
3.3.6	Convergence	64
3.4	Experimentation and Observations	67
3.4.1	The test-bed used	67
3.4.2	Control parameters	67
3.4.3	Observations	68
3.5	Discussion	70
4	Materialized View Selection by Evolutionary Algorithm for Big Data Query Processing	75
4.1	Introduction	75
4.1.1	Materialized views and materialized queries in Big data . . .	76
4.1.2	View selection for materializing in Big data	77
4.1.3	Contribution	77
4.2	The Problem of Selecting Views for Materializing in Big data Framework	78
4.2.1	The cost model and problem definition	78
4.3	View Selection in Big data Systems as Multi-Objective Optimization Problem	81
4.3.1	Simple problem representation	81
4.3.2	Scalability	82
4.3.3	Well defined objectives	82

Contents

4.4	Multi-Objective Evolutionary Algorithm for View Selection to Materialize in Big data	83
4.4.1	Multi-objective DE with binary encoded solutions for Big data view selection	83
4.4.2	Implementing NSGA-II for view selection	87
4.5	Experimentation and Observations	88
4.5.1	Experimental setup	89
4.5.2	Parameters used	92
4.5.3	Results and observations	98
4.6	Discussion	99
5	Multi-Objective Simulated Annealing Algorithm in Big data View Selection for Materializing	101
5.1	Introduction	101
5.1.1	Motivation	101
5.1.2	SA for multi-objective optimization	102
5.1.3	Contribution	103
5.2	Dominance based Energy Functions in Multi-Objective Simulated Annealing Algorithm	103
5.2.1	Energy function in terms of number of dominating solutions	104
5.2.2	Energy function in terms of amount of domination	106
5.3	Representation of the View Selection Problem for Applying AMOSA	110
5.3.1	Representing view selection problem for Big data	110
5.3.2	Solution representation	111
5.4	AMOSA for Materialized View Selection	112
5.4.1	Initializing the archive of solutions	112
5.4.2	Enforcing diversity in solution space for restricting the archive size	112
5.4.3	The main process of AMOSA-MVS	114

Contents

5.4.4	Parameter selection	116
5.4.5	Complexity analysis	119
5.4.6	Convergence	121
5.5	Experimental Results and Performance Analysis	122
5.5.1	Experimental setup and test data sets	122
5.5.2	Experimentation and results	125
5.5.3	Comparison measures	126
5.5.4	Comparative analysis	132
5.6	Discussion	134
6	Conclusion and Future Direction	141
6.1	Conclusions	141
6.2	Future Directions	143
Bibliography		145
Publications based on the Thesis Works		153