

Contents

1	Introduction	1
2	Object Shareability	6
2.1	Overview	6
2.2	Shareability relation	7
2.2.1	Definition	7
2.2.2	Properties	8
2.3	Redundant objects and groups	9
2.4	Shareability Oracle	10
3	Object Equivalence	11
3.1	Intuition	11
3.2	Object Equivalence	12
3.3	Equivalence example	14
3.4	Properties	15
3.5	Equivalent object group	15
4	Experiment design	16
4.1	Pharo object model	16
4.2	Object characterization	16
4.3	System specific objects	17
4.4	Experiment	18
4.5	Metrics	19
4.6	Benchmarks	20
4.7	Summary	21
5	Results	22
5.1	Metrics analysis	22
5.2	Avoiding equivalent object creation	24
5.3	Summary	27
6	Solving object redundancy	29
6.1	Tool report and use strategy	29
6.1.1	Large equivalent object groups	30
6.1.2	Shareable object groups with shared allocation context	30
6.2	Classification of optimizations	31
6.2.1	Single object cache (5 implementations)	31

6.2.2	Map of objects cache (2 implementations)	33
6.2.3	Weak map of objects cache (5 implementations)	35
6.2.4	Others (2 implementations)	36
6.3	Optimizations performed	38
7	Feedback from developers	40
7.1	Roassal Case	40
7.2	NeoJSON and NeoCSV Case	42
7.3	Summary	44
8	Implementation	45
8.1	Profiling Technique	45
8.1.1	Events and strategies for data collection	46
8.1.2	Architecture of the profiler	47
8.1.3	Unique id specification	47
8.2	Object graph replication	49
8.3	Graph analysis and object equivalence evaluation	49
8.4	Implementation difficulties	51
9	Discussion	53
9.1	Memory impact on the system	53
9.2	Partial replication of Marinov <i>et al.</i> experiment	54
9.2.1	Similarities	54
9.2.2	Differences	54
9.2.3	Results and Conclusions comparison	55
9.2.4	Summary	57
9.3	Threat to validity	57
9.4	Limitations of our approach	58
9.4.1	Limitations of Object Equivalence definition	58
9.4.2	Limitations of System specific objects	58
9.4.3	Tool design	59
9.5	Extensibility to other languages	59
10	Related work	61
11	Conclusion	63
	Bibliography	65
A	Specification of profiler events	67

List of Tables

4.1	Metric definitions	20
4.2	Applications metrics	20
5.1	Results in number of objects	22
5.2	Number of equivalent objects	23
5.3	Results in memory usage (KB)	23
5.4	Reduction of memory footprint due to our optimizations	24
6.1	Classification of implemented optimizations for the applications in benchmark suite.	39
6.2	Time spent for producing optimizations for the applications in benchmark suite.	39
9.1	OEP Marinov's mergeability results	56

List of Figures

2.1	Object Shareability Relation	8
3.1	Object graph of example which shows that $a1 \approx a2$, $b1 \approx b2$, and $c1 \approx c2$	14
5.1	Distribution of objects and equivalent objects in benchmarks.	24
5.2	Comparison of initial memory consumption, optimal consumption and after optimizations consumption.	25
5.3	Comparison between initial number of domain objects, optimal number of domain objects and after optimizations number of domain objects.	26
5.4	Comparison between initial number of system specific objects, optimal number of system specific objects and after optimization number of system specific objects.	26
5.5	Comparison between initial number of external objects and after optimizations number of external objects.	27
8.1	Illustration for simplified Subgraph isomorphism problem for Object Equivalence.	50
A.1	SOEvent hierarchy class diagram.	72