Ask and You Shall Receive: Empirically Evaluating Declarative Approaches to Finding Data in Unstructured Heaps

William F. Jones and **Gregory M. Kapfhammer**

Allegheny College
http://www.cs.allegheny.edu/~gkapfham/

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Overview of the Presentation

Finding
Data in
Unstructured
Heaps

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Finding Data in Unstructured Heaps

Challenges

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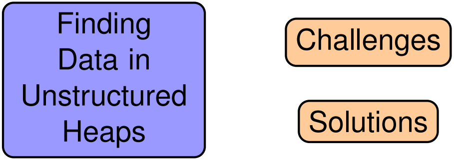

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Benchmarking Framework

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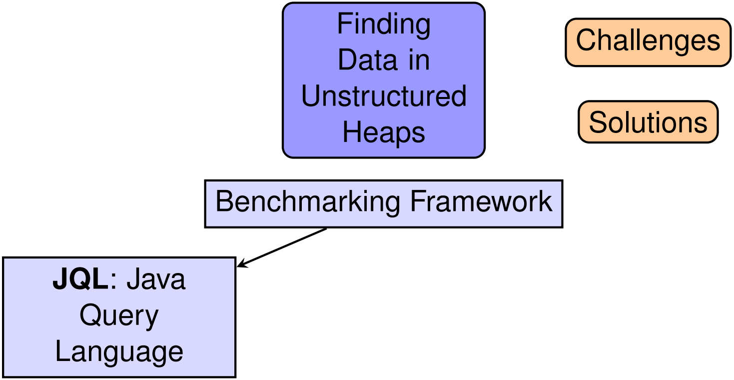

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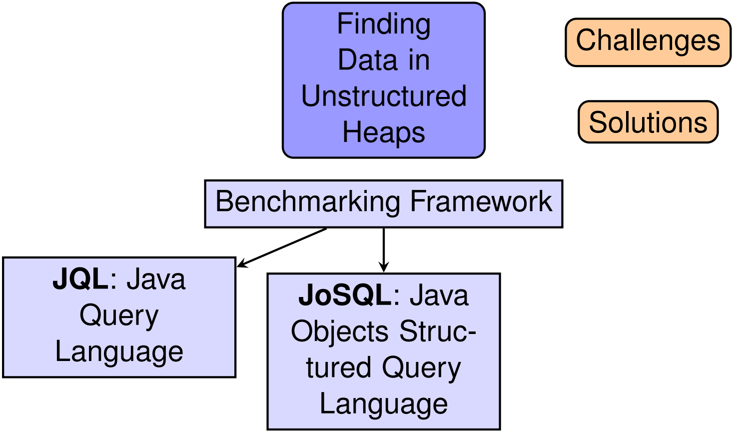

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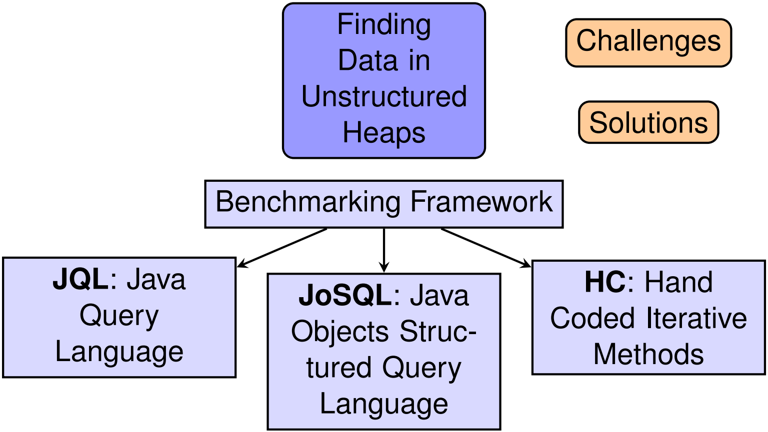

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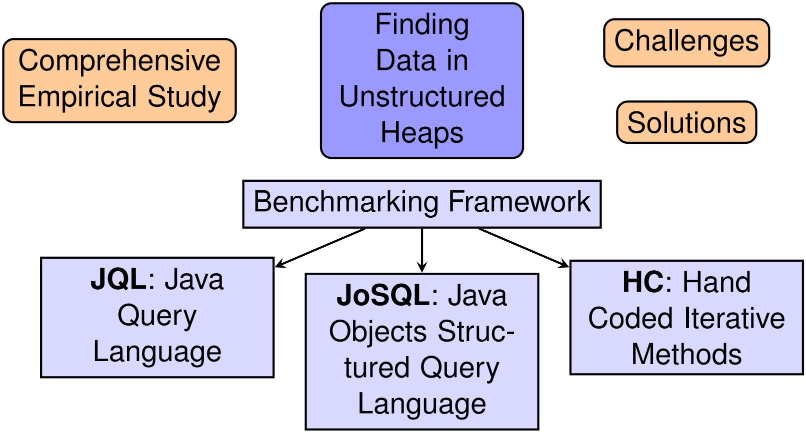

Overview of the Presentation

Experiments Reveal Trade-offs in Performance and Overall Viability

Comprehensive Empirical Study

Finding Data in Unstructured Heaps

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Benchmarking Framework

- **JQL**: Java Query Language
- **JoSQL**: Java Objects Structured Query Language
- **HC**: Hand Coded Iterative Methods

Correctly and Efficiently Finding Objects in the Heap

The unstructured heap in a Java virtual machine stores objects that are connected in complex and unpredictable ways (Xu and Rountev, ICSE 2008)

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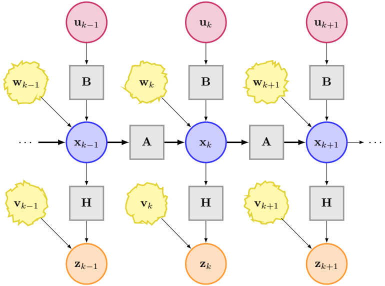
Let's Allocate Some Objects to the Heap!

Correctly and Efficiently Finding Objects in the Heap



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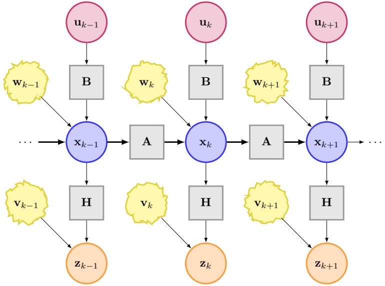

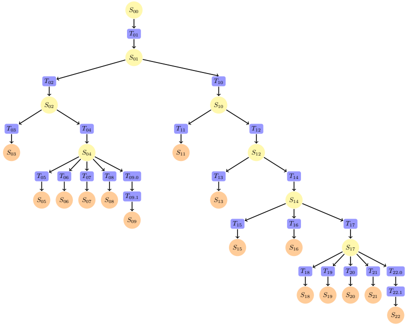

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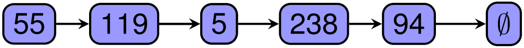

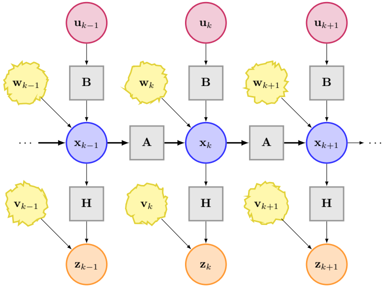

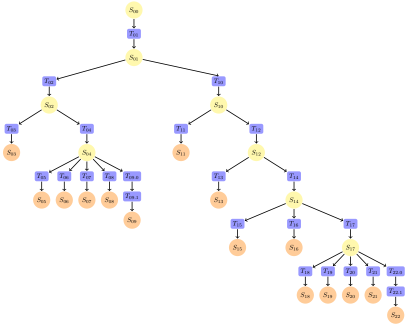

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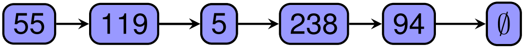

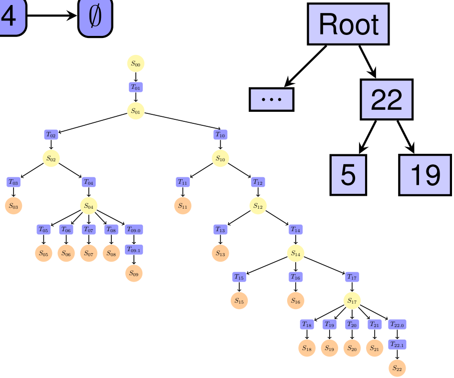

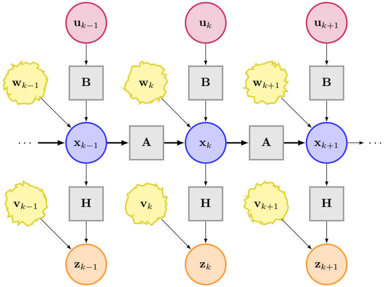

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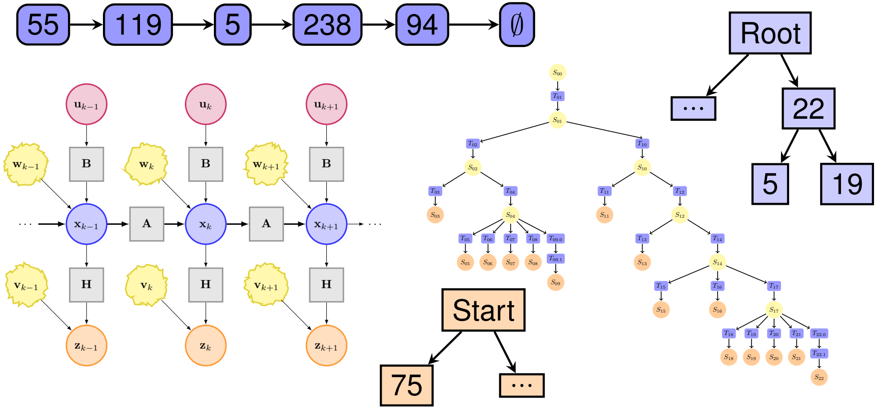

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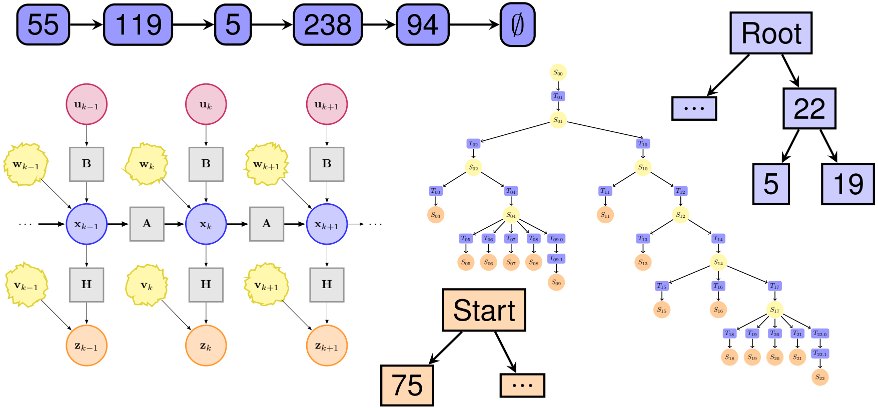

`LinkedList` Node(s) with Values Greater Than Those in the Trees

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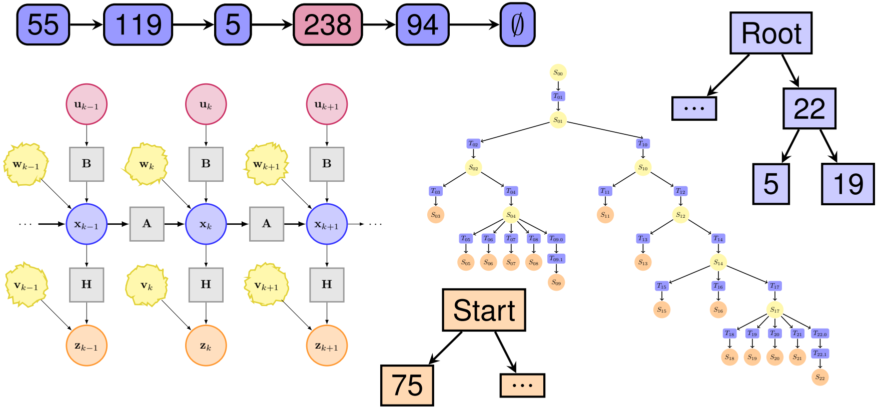

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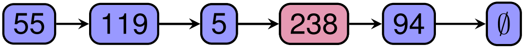
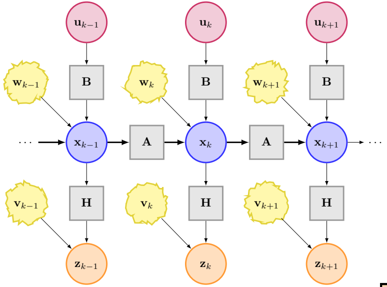
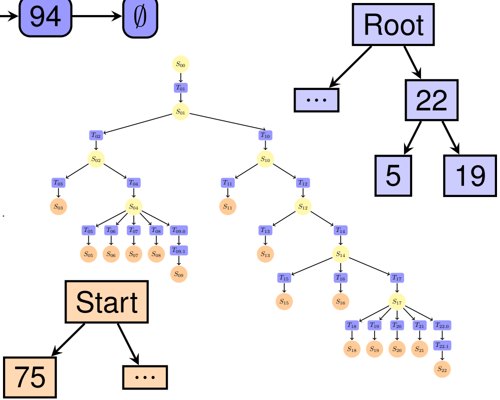
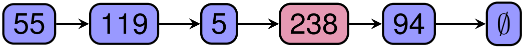


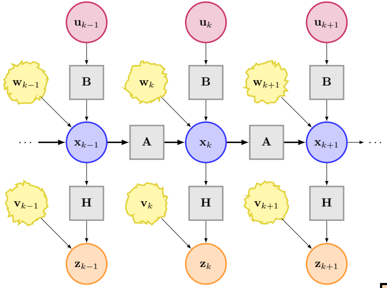


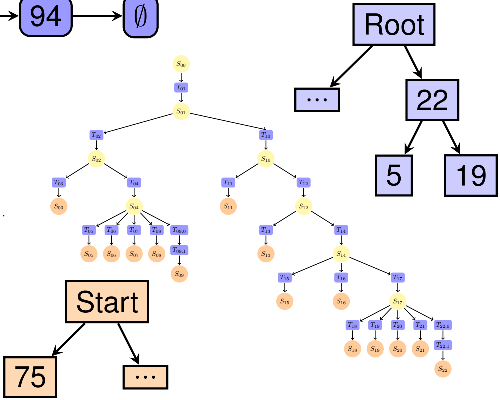


How Do We Find These Nodes?

Correctly and Efficiently Finding Objects in the Heap



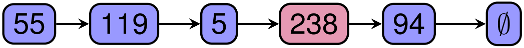


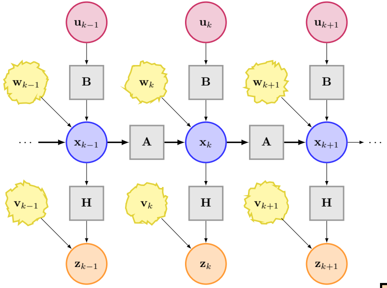


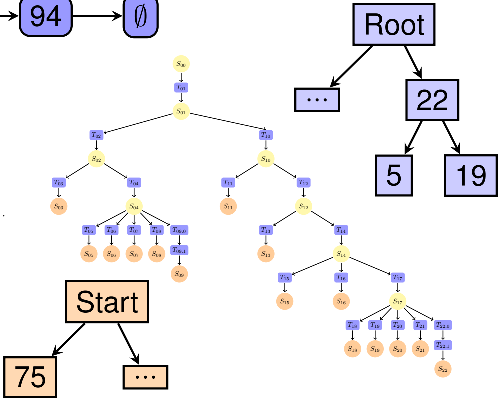
How Do We Find These Nodes?

Imperative - Give the Procedure

Correctly and Efficiently Finding Objects in the Heap



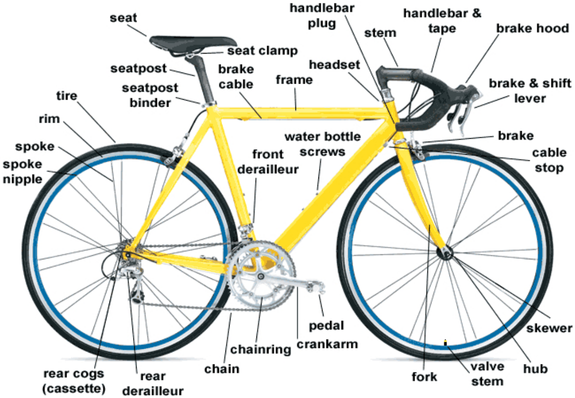




How Do We Find These Nodes?

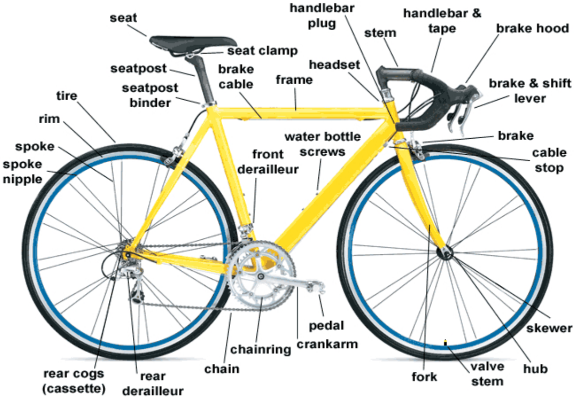
Declarative - Give the Specification

Object Query Languages and Bicycles



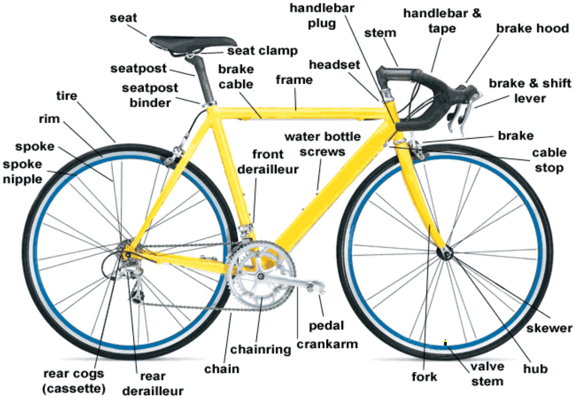
Efficiency - Bicycle: Low wind resistance and time to destination

Object Query Languages and Bicycles



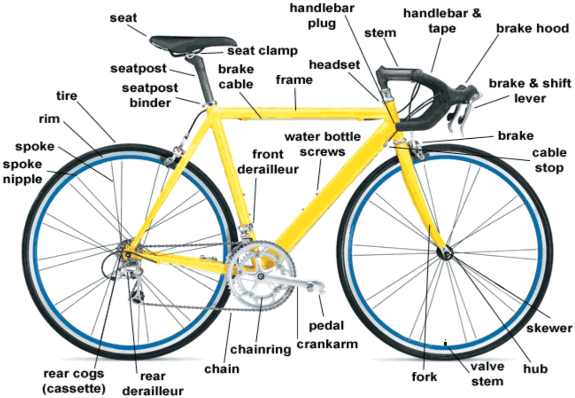
Efficiency - Query: Minimal space overhead and a low response time

Object Query Languages and Bicycles



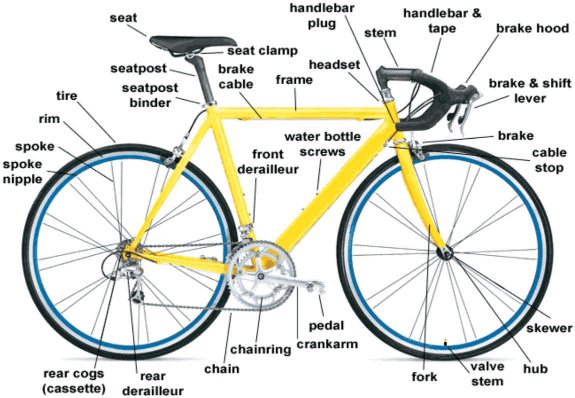
Effectiveness - Bicycle: Transports all item(s) with no break downs

Object Query Languages and Bicycles



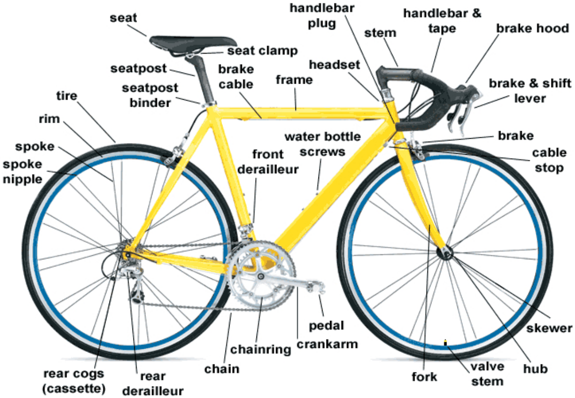
Effectiveness - Query: Always returns the correct result(s) to a query

Object Query Languages and Bicycles



Cost - Bicycle: Frame material(s) and components cause price to vary

Object Query Languages and Bicycles

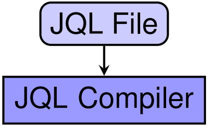


Cost - Query: Must consider installation and development challenges

JQL: Java Query Language

JQL Compiler

JQL: Java Query Language



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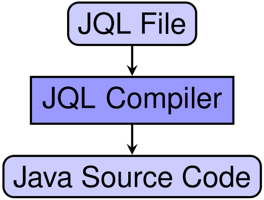

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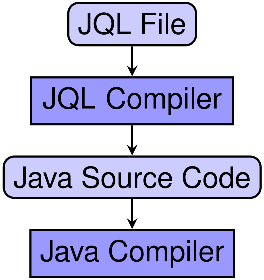

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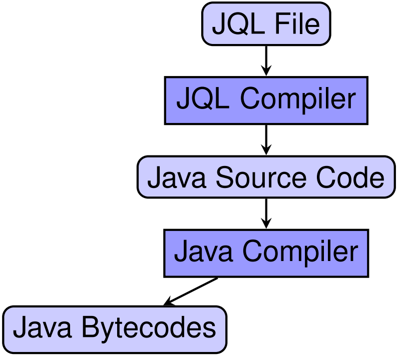

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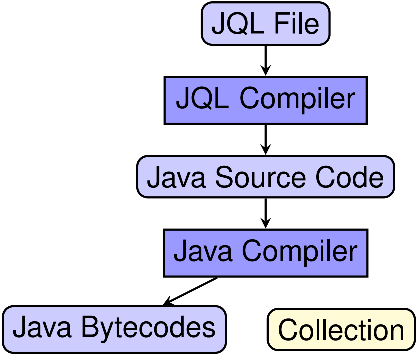

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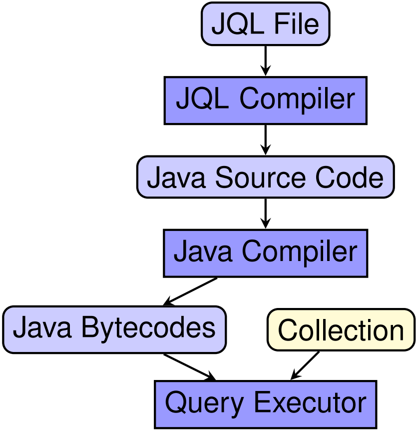

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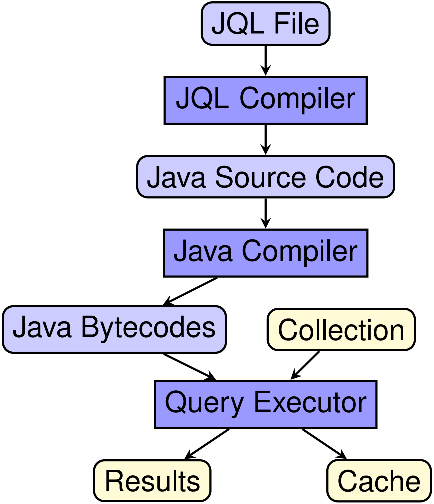
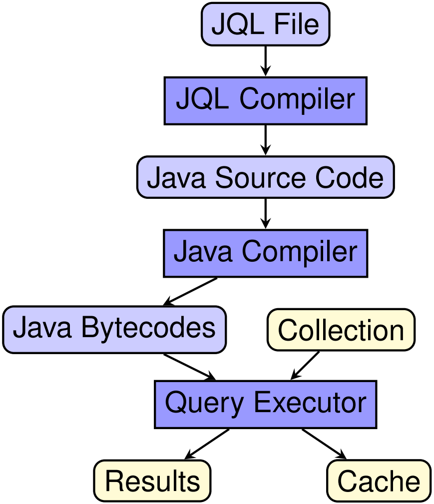


JQL: Java Query Language

Features

- Pre-compilation
- AOP with AspectJ
- Method Queries
- Caching
- Optimizations



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References

- (Willis et al. ECOOP 2006)
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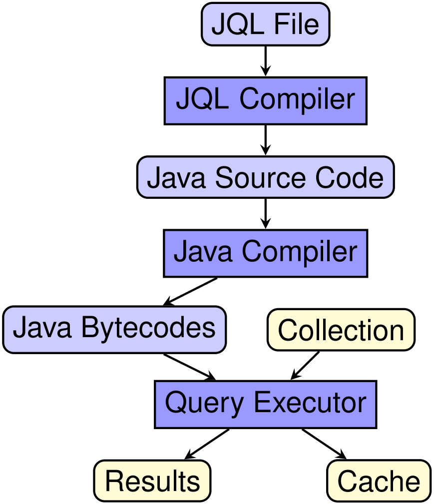

JoSQL: Java Objects Structured Query Language

Parse SQL

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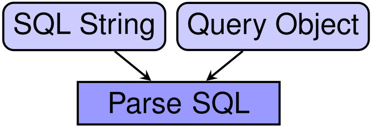

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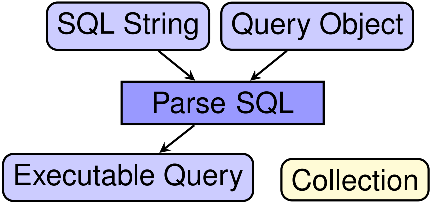

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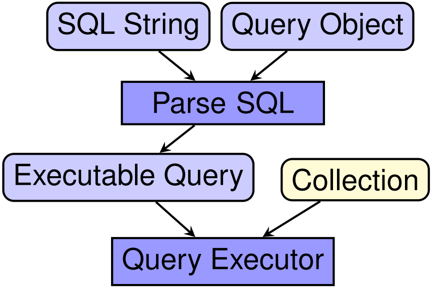

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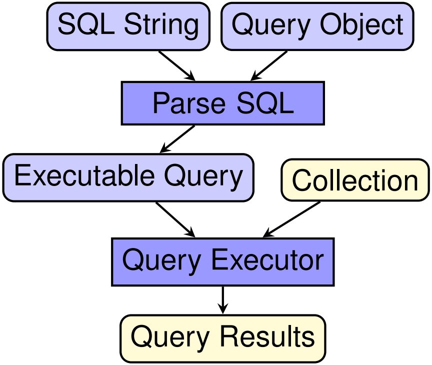

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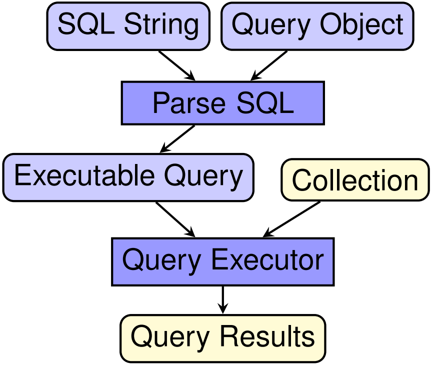
- String Parsing
- Java Reflection
- Query Facilities



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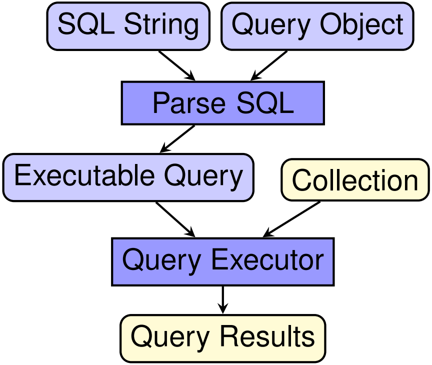
- http://josql.sf.net



Comparison of Data Finding Methods

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Performance Trade-Offs?

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JQL: Compile-Time

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Performance Trade-Offs?

Effectiveness Concerns?

Comparison of Data Finding Methods

Benchmarking Framework Helps to Answer These Questions

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Benchmarking Framework to Evaluate Query Methods

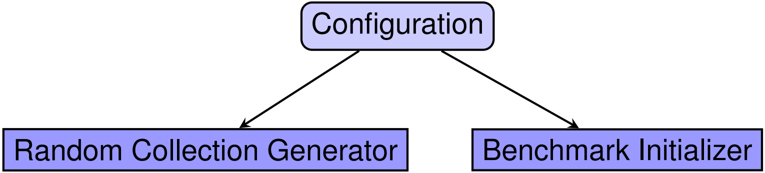
Random Collection Generator

Benchmarking Framework to Evaluate Query Methods

Random Collection Generator

Benchmark Initializer

Benchmarking Framework to Evaluate Query Methods



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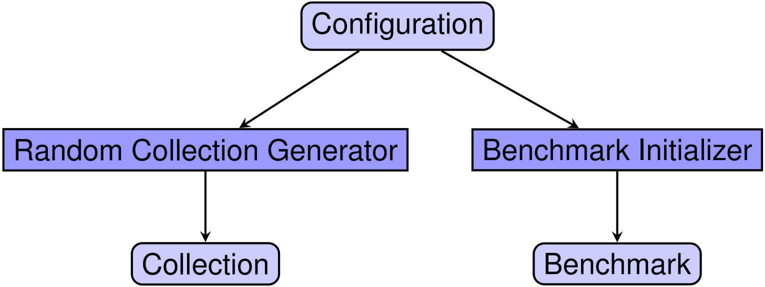

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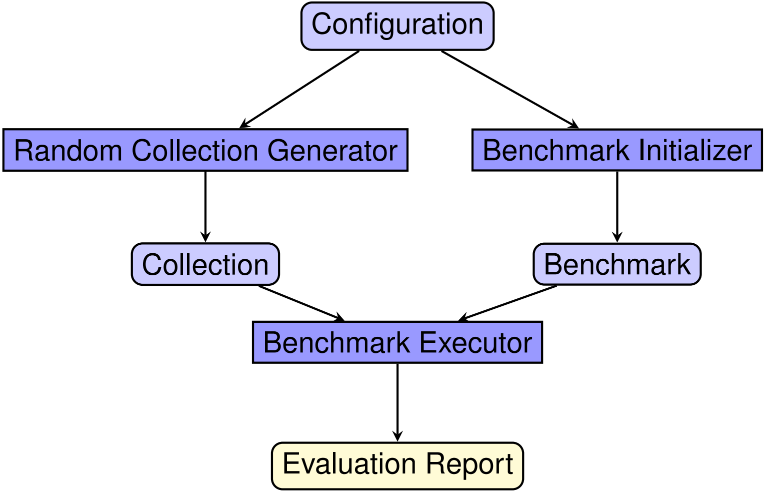

Configuration of the Benchmarking Framework

Possible Configurations

Operations

Objects

Sizes

Methods

Explored a **wide variety** of benchmark **configurations**

Configuration of the Benchmarking Framework

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What **operations** do we run to **evaluate** the query methods?

Configuration of the Benchmarking Framework

Possible Configurations

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Parameter Values

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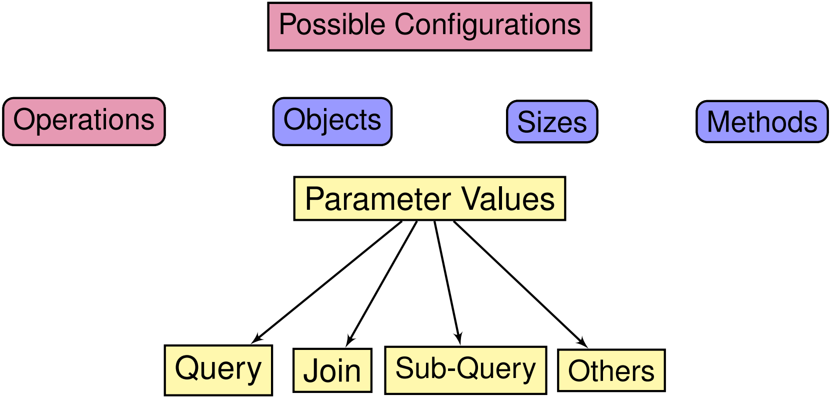

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Operations | Objects | Sizes | Methods

What **objects** will we **allocate** to the JVM's **heap**?

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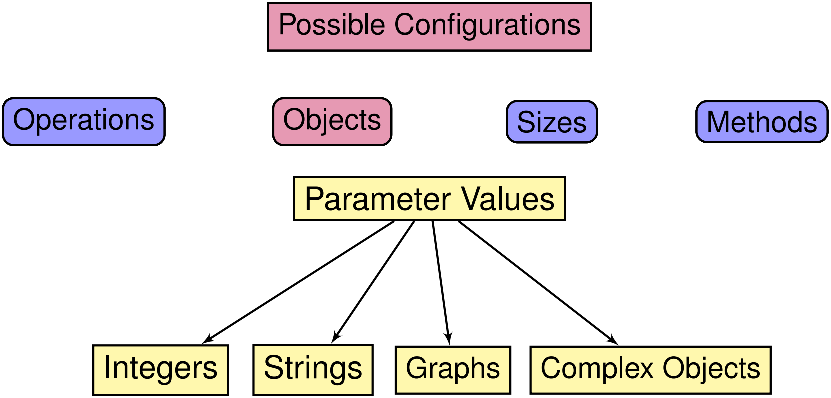

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How **big** should we make the **objects** and the **collections**?

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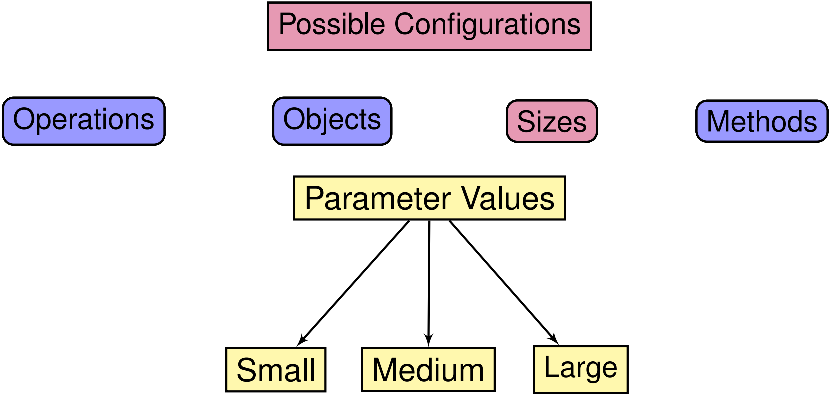

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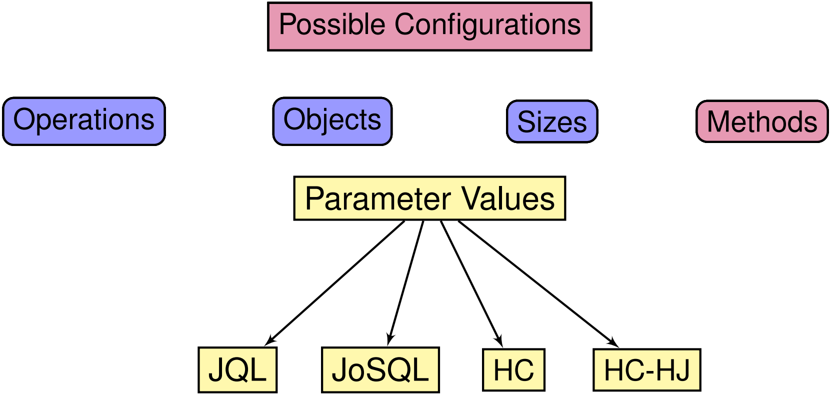

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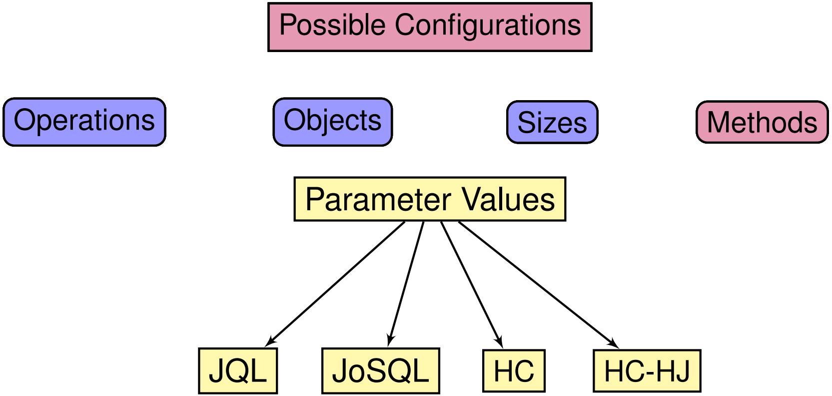


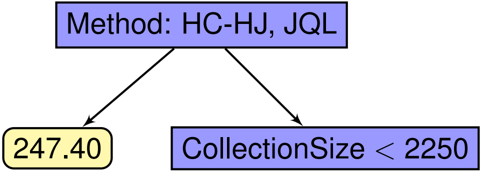
See the **paper** for further **operator** and **configuration** details

Analysis Techniques: Regression Tree Models

Method: HC-HJ, JQL

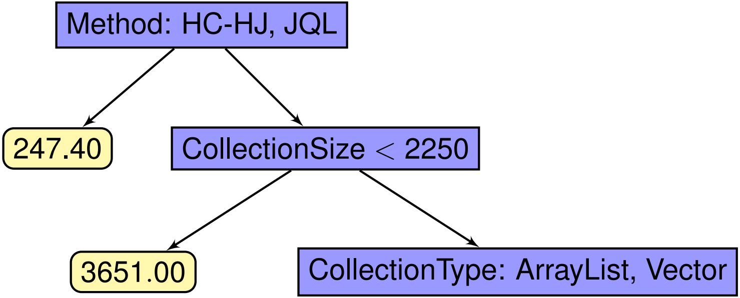
Tree Models: Recursive partitioning creates hierarchical view of data

Analysis Techniques: Regression Tree Models



Tree Models: Recursive partitioning creates hierarchical view of data

Analysis Techniques: Regression Tree Models



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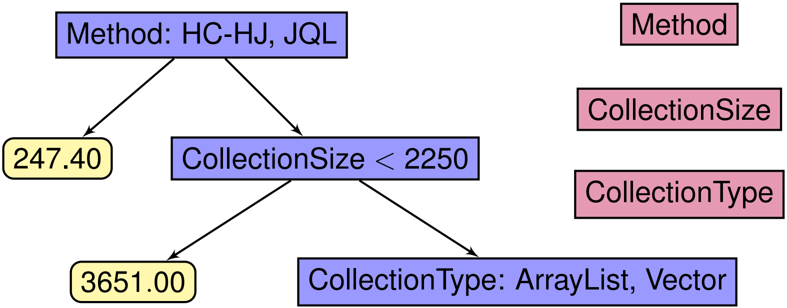
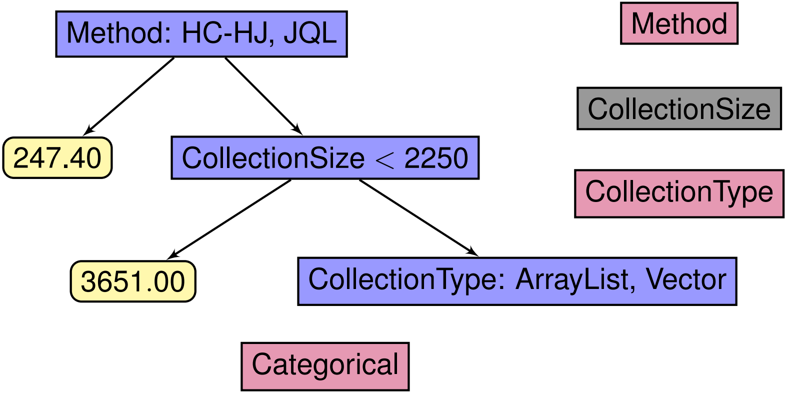


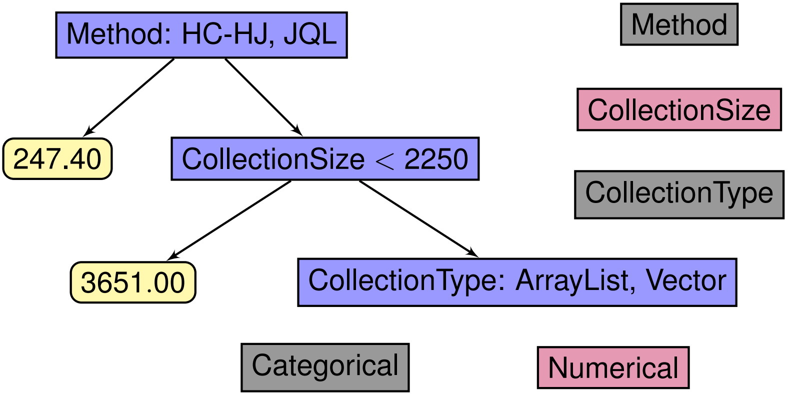
Explanatory Variable: Configuration of the benchmarking framework

Analysis Techniques: Regression Tree Models



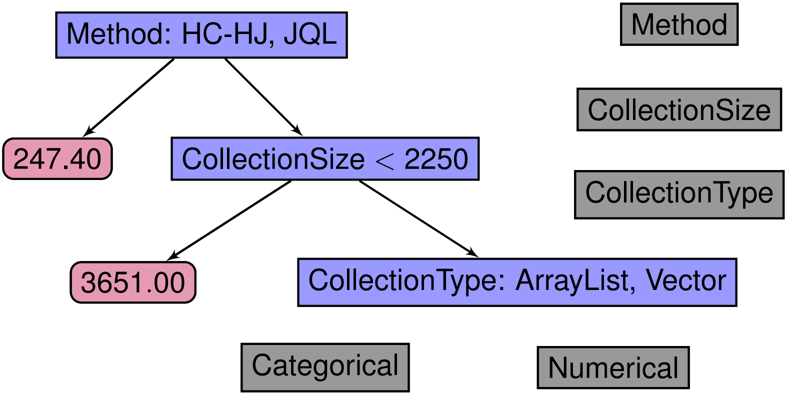
Non-parametric techniques that handles **different** variable types

Analysis Techniques: Regression Tree Models



Non-parametric techniques that handles **different** variable types

Analysis Techniques: Regression Tree Models

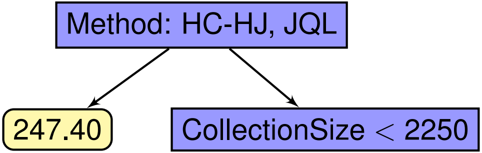


Response Variable: Response time of the benchmark

Join Benchmark with Integers and Strings

Method: HC-HJ, JQL

Join Benchmark with Integers and Strings



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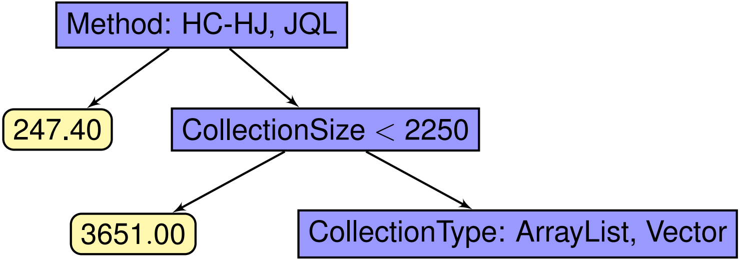

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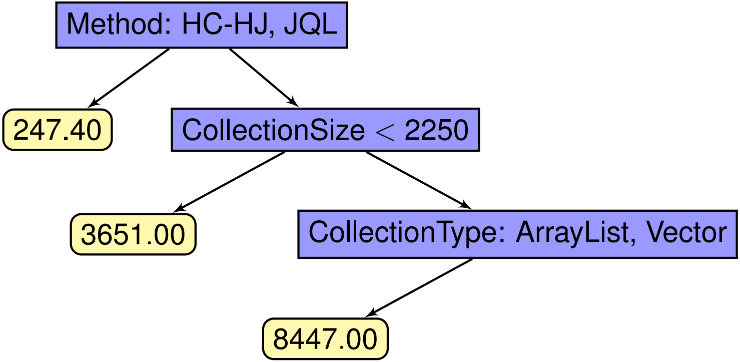

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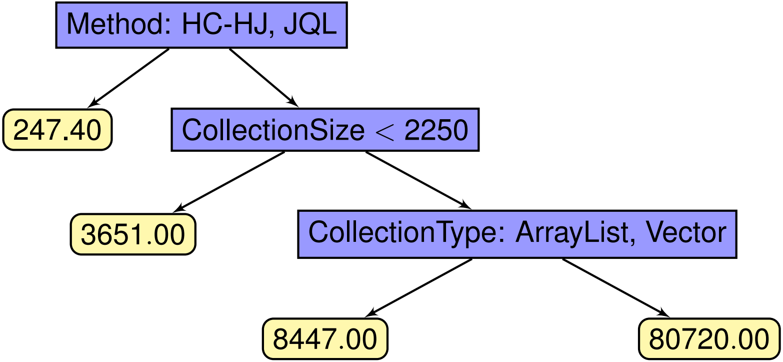

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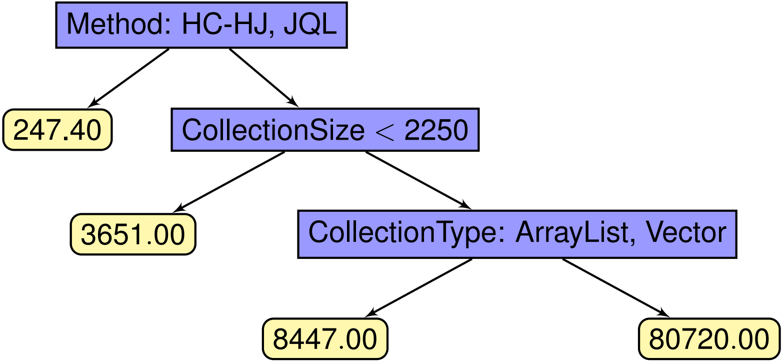
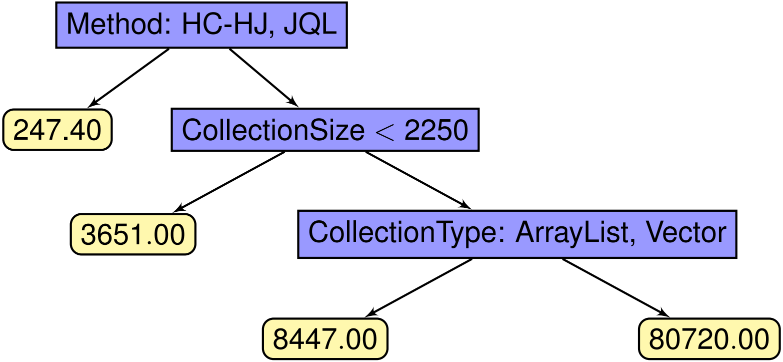


Reflection's Impact: HC-HJ and JQL exhibit lower values than JoSQL

Join Benchmark with Integers and Strings



Reflection's Impact: LinkedList further degrades JoSQL's performance

Impact of Object Size on Joining

Small Objects

	Collection Size		
Method	**Small**	**Medium**	**Large**
JQL	57.2	390.2	981.8
HC-HJ	69.3	378.1	923.5
JoSQL	997.3	3620.2	8823.1

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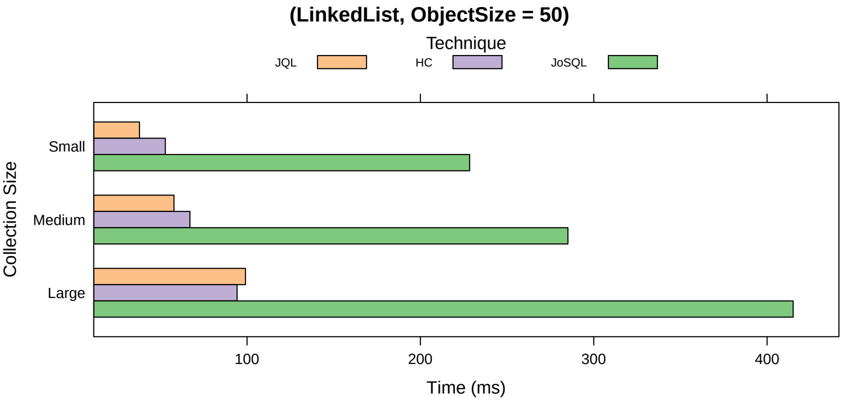
SubQuery Benchmark with Graphs Containing Strings



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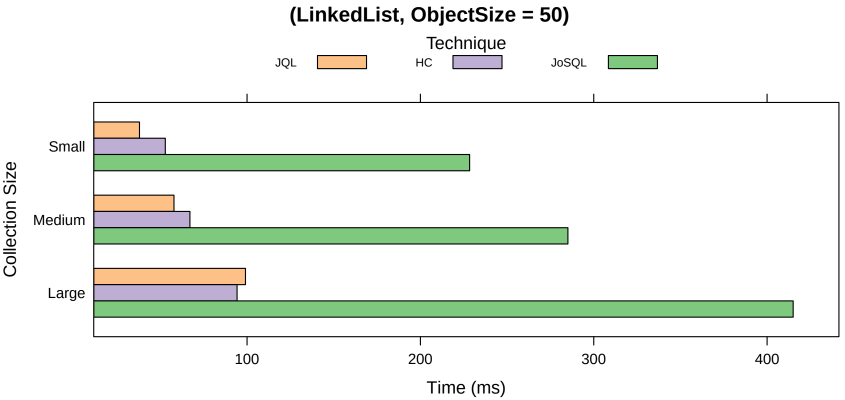

JQL is Faster Than HC When the Collection Size is Small and Medium

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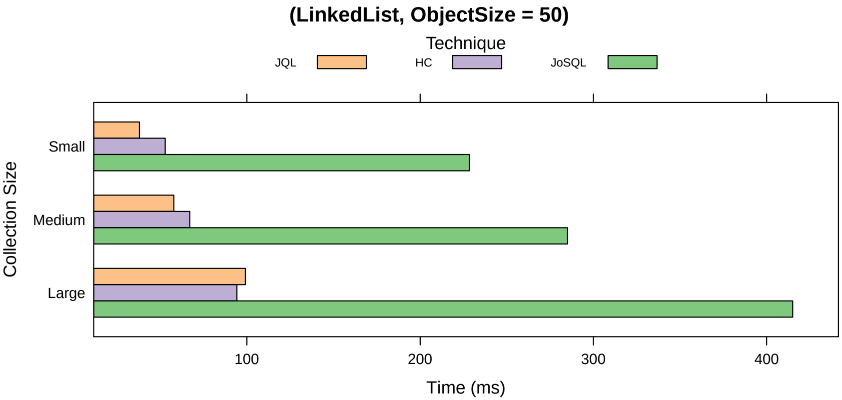
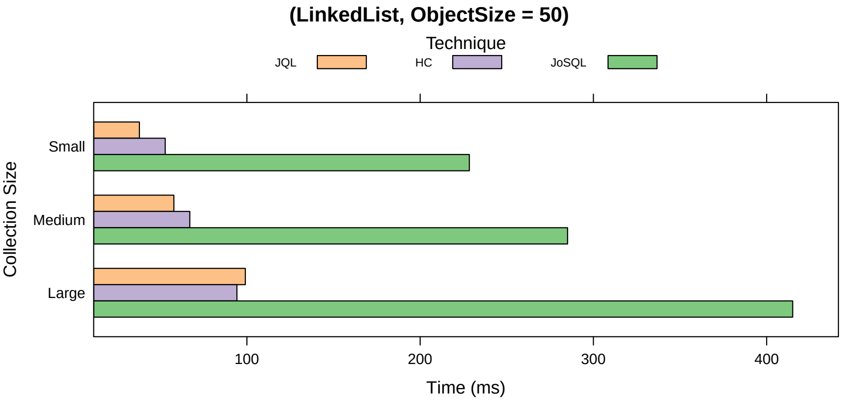


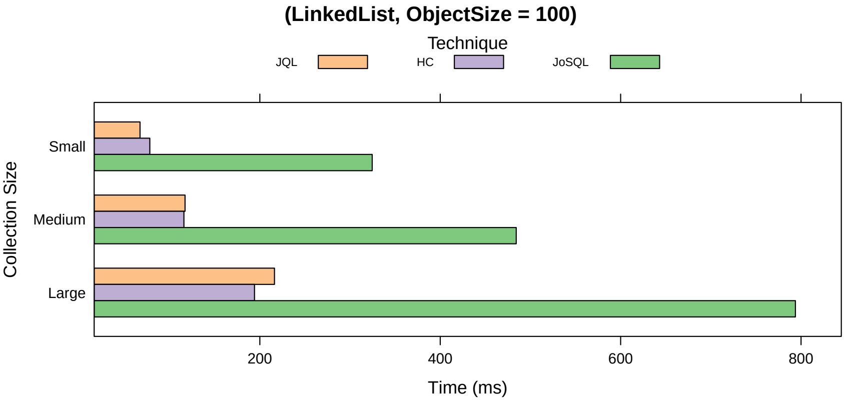
HC is Faster Than JQL When the Collection Size is Large

SubQuery Benchmark with Graphs Containing Strings



Why? JQL Must Track All of the Objects in the Heap

SubQuery Benchmark with Graphs Containing Strings



Trend is Even More Pronounced as the Object Size Increases

Conclusions and Future Work

Concluding Remarks

- Comprehensive empirical study of query methods
- Interesting trends concerning JQL, JoSQL, HC, and HC-HJ
- Refer to the paper for many more insights

Future Work

- Integrate new benchmarks and object types
- Consider different sizes of objects and collections
- Incorporate different data finding methods
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Ask and You Shall Receive: Empirically Evaluating Declarative Approaches to Finding Data in Unstructured Heaps

Thank you for your attention!
Questions?

"Ask, and you will receive. Search, and you will find. Knock, and the door will be opened for you."
Matthew 7:7 (GWT) http://bible.cc/matthew/7-7.htm