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Modern Stored Procedures Using GraalVM

Oracle Labs

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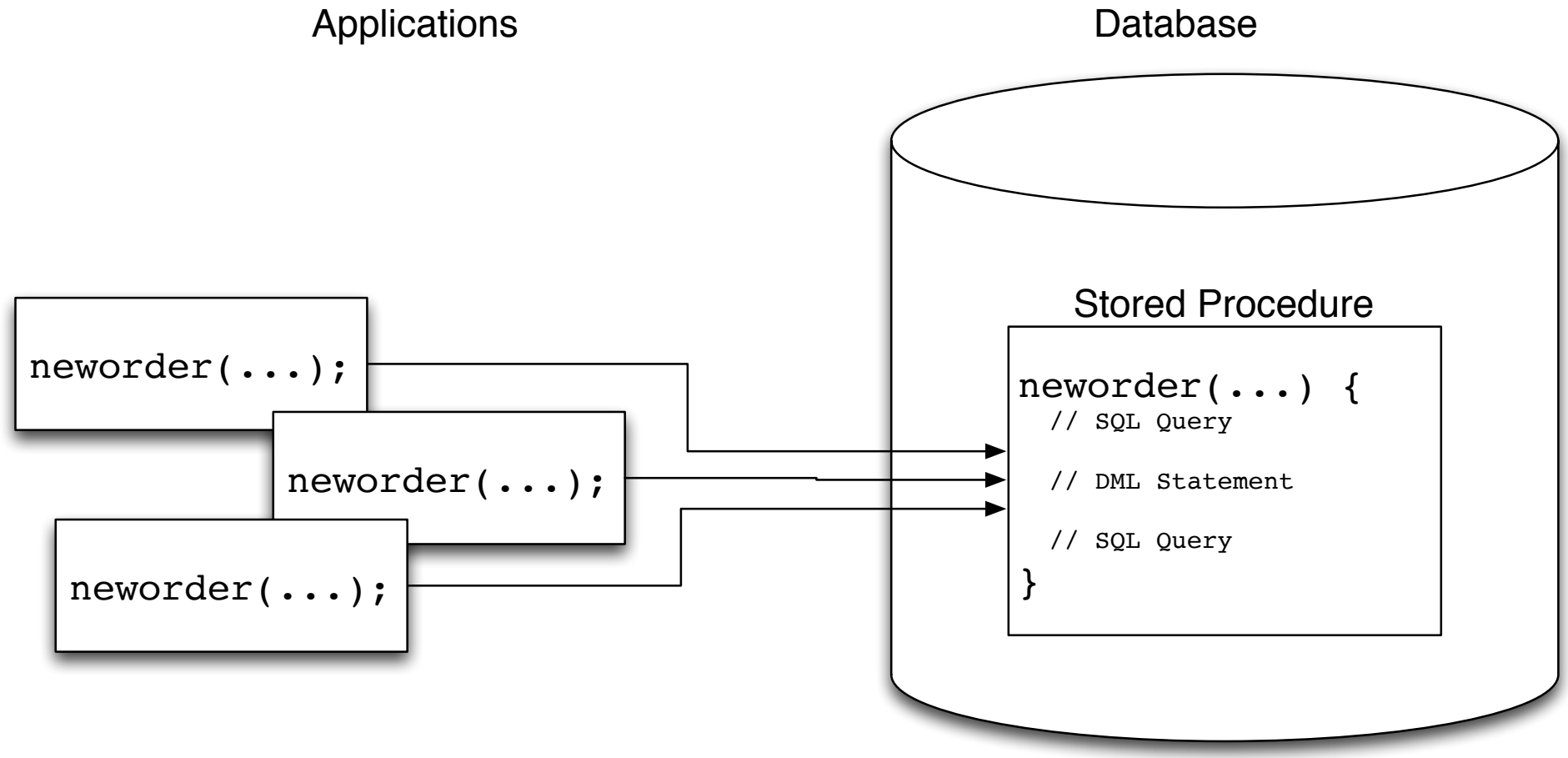
Stored Procedures & UDFs



Problems

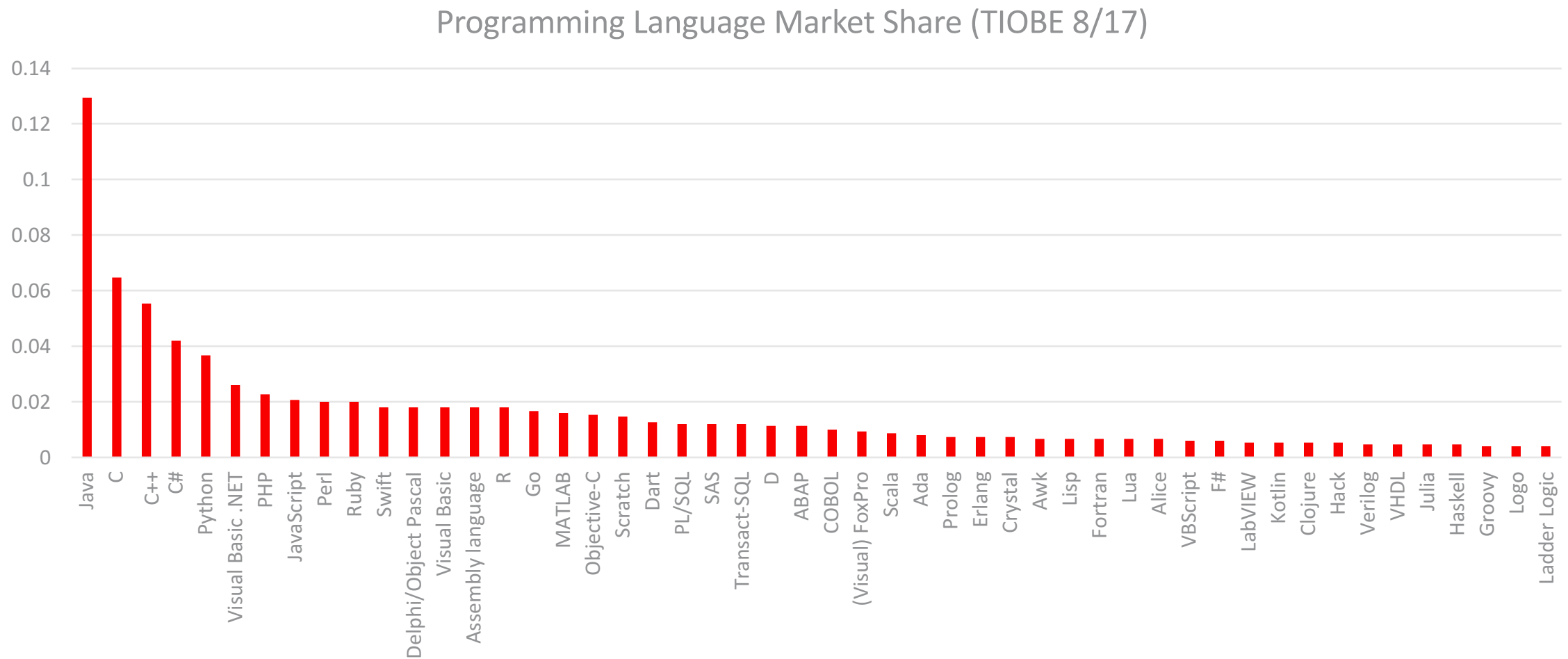
- Often vendor specific languages (e.g., PL/SQL, Transact-SQL)
- Hard to find developers ($$$)
- Relatively small ecosystems & marketplaces
- Lacking behind with tool support
- Hard to manage within VCSs


JavaScript UDF Demo

Features

- High-performance JavaScript / TypeScript
- MySQL and Oracle Database
- Driver for executing SQL (also ORM support)
- Support for querying JSON tables
- User-defined JavaScript functions
  - Scalar UDFs
  - Aggregation
  - Table functions
- Deployment tool (allows for integration with JS CIs)

Proliferation of Languages

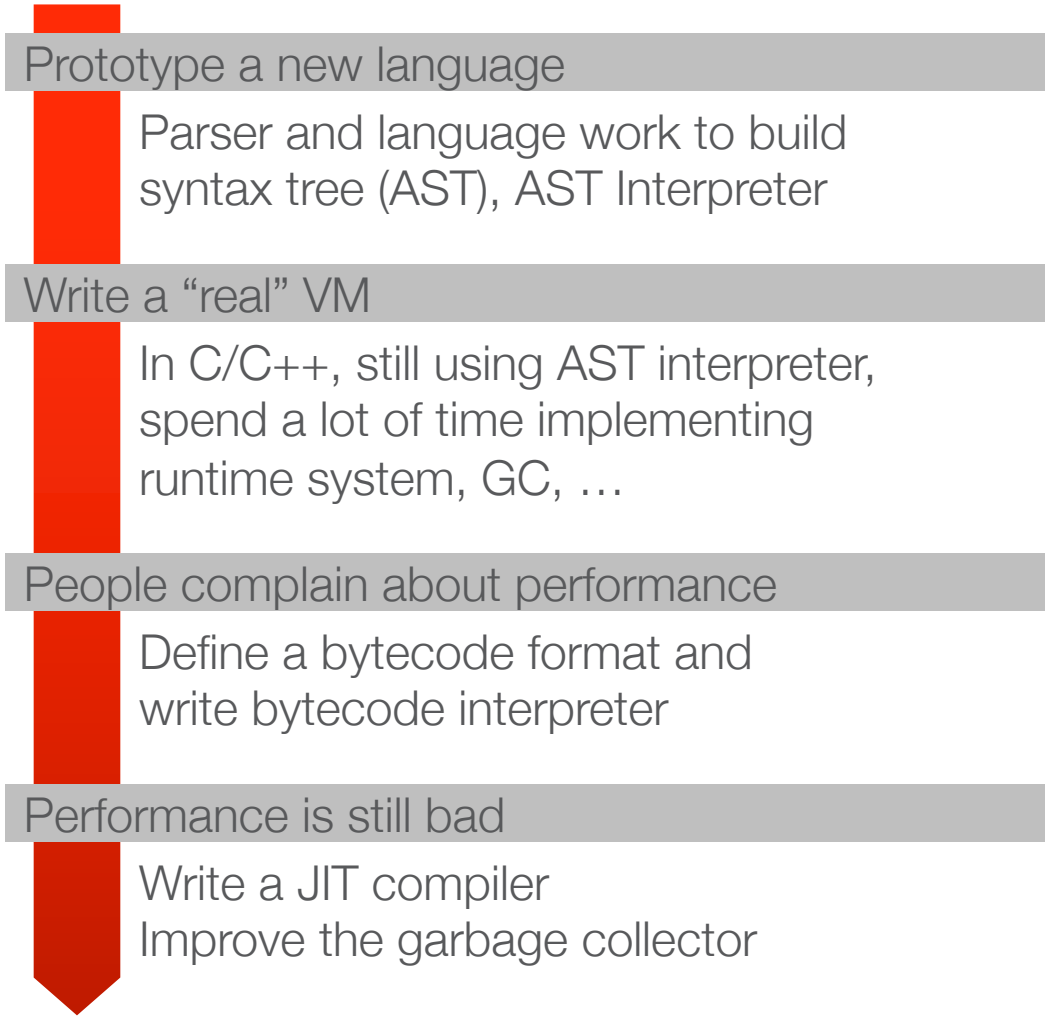


Embedding New Stored Procedure Languages is Hard

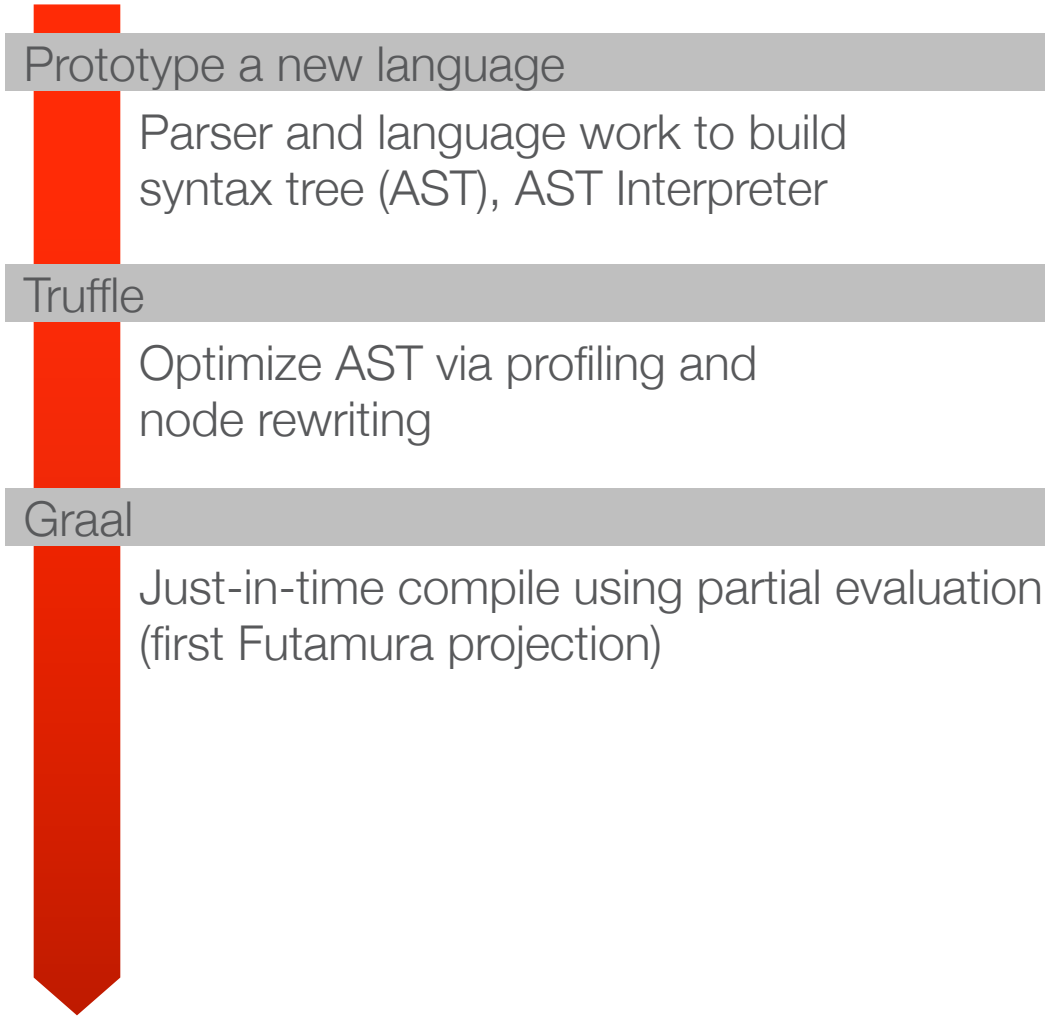
- Choose or implement
- Integrate
  - Integrate with query runtime for UDFs
  - Access to data (no copy, data conversion)
  - Manage & secure system resources
  - Provide driver for executing SQL
  - Provide tooling
- Maintain

Repeat for each new language

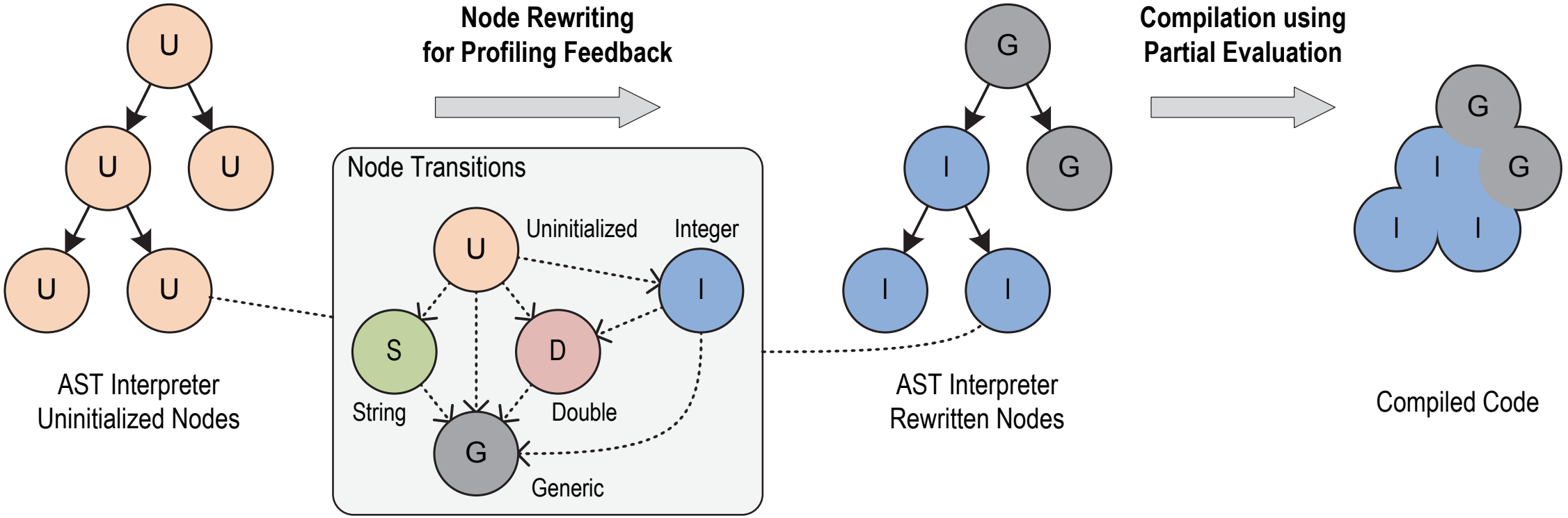
State-of-the-Art Language Implementation



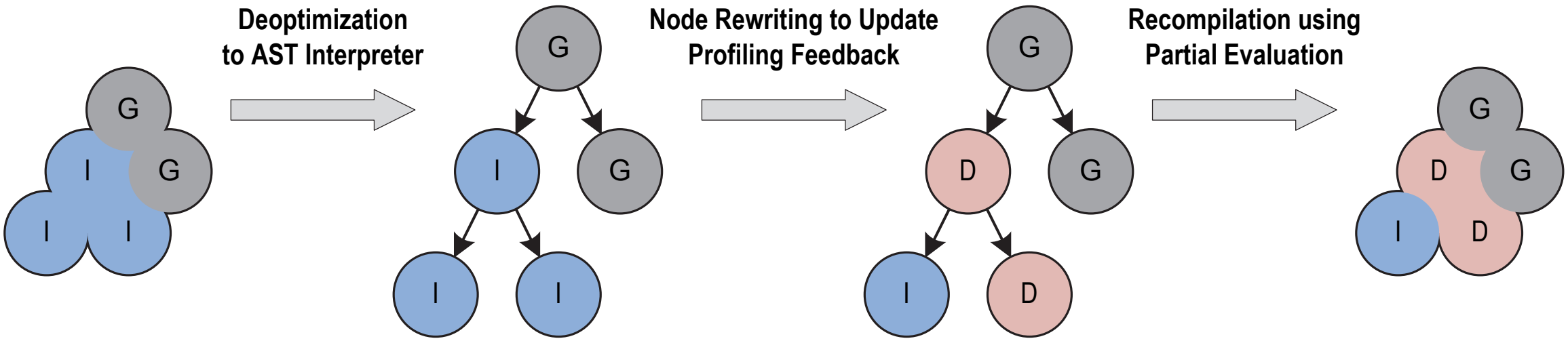
Truffle & Graal



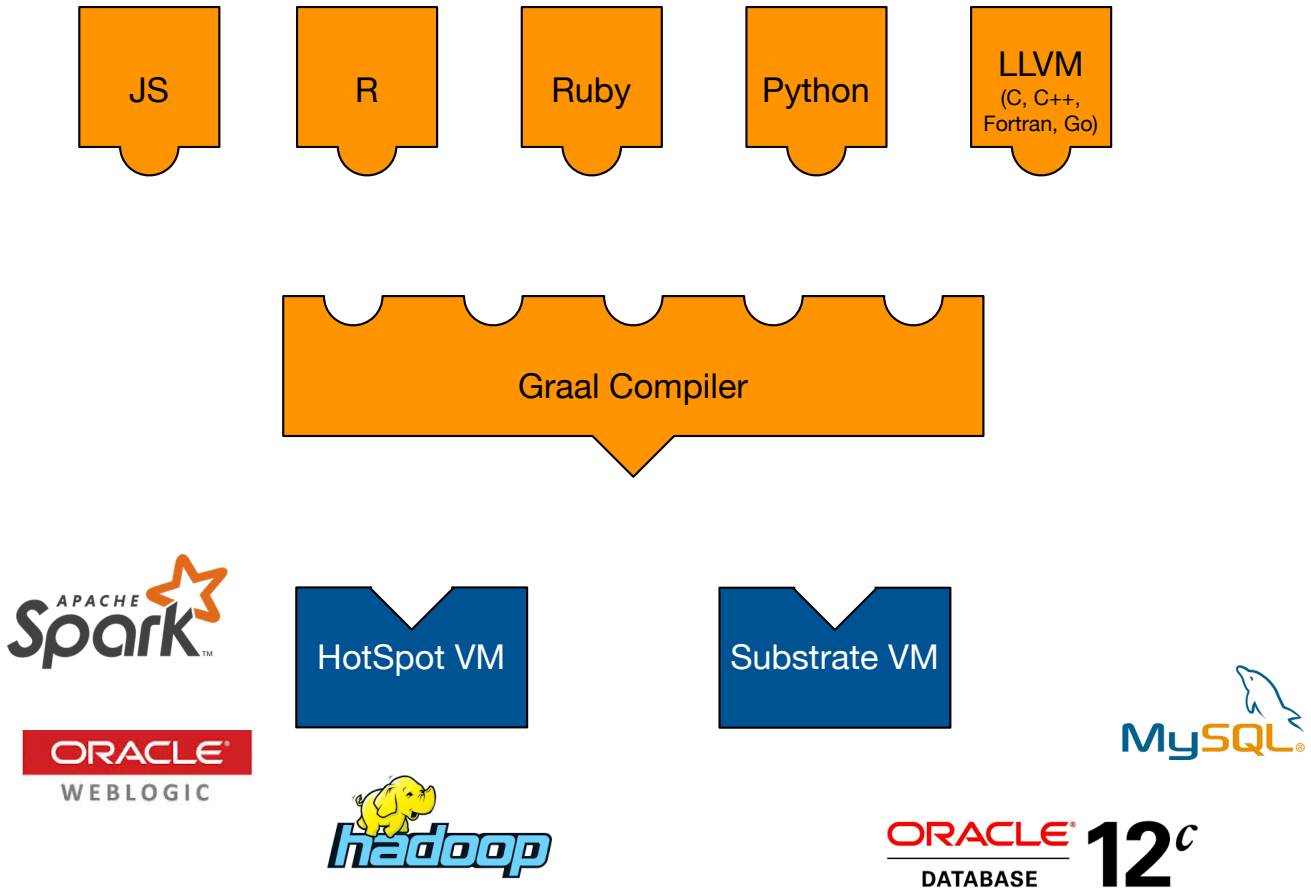
Profiling, Node Rewriting and Compilation



Deoptimization, Node Rewriting and Recompilation

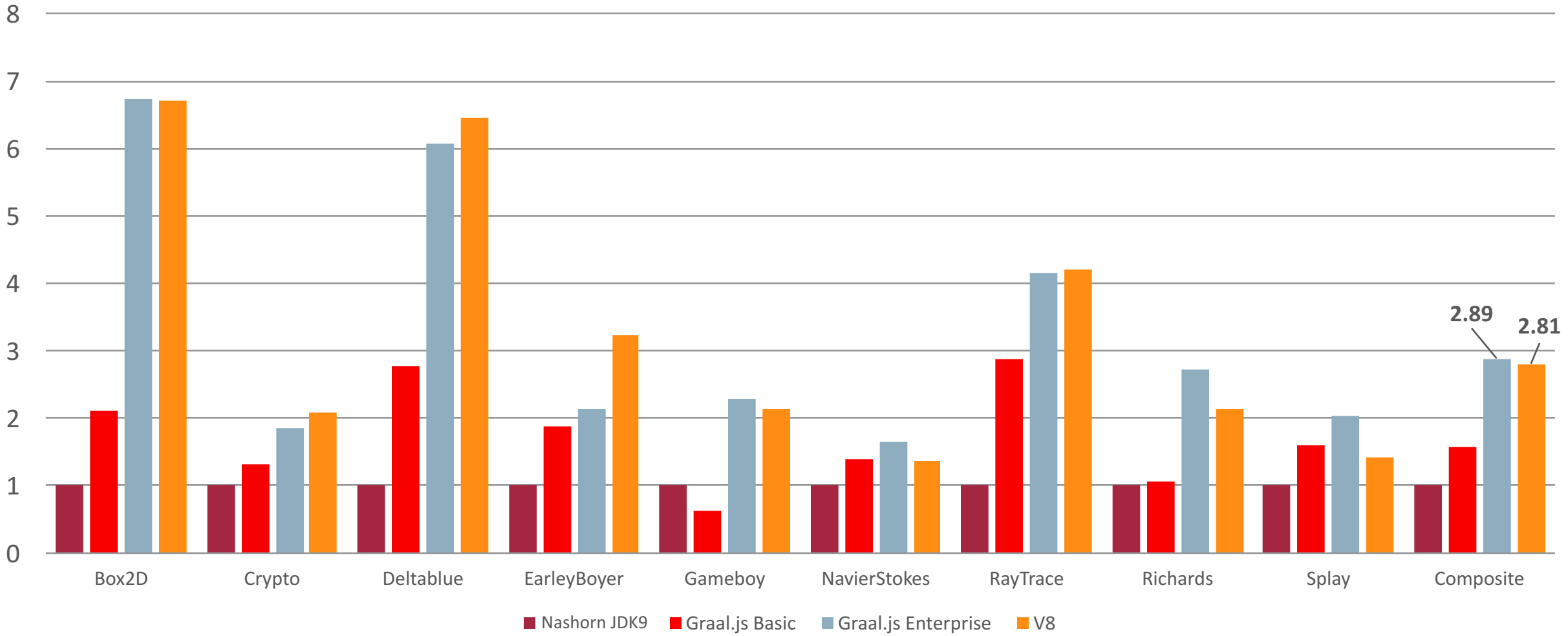


Embedding GraalVM



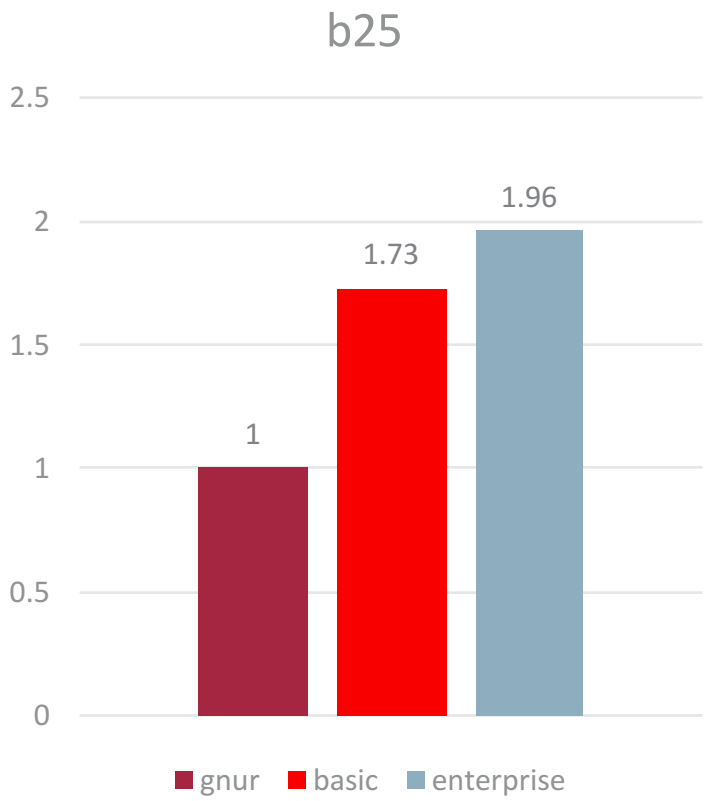
JavaScript Performance (Octane 1.0 benchmark suite)

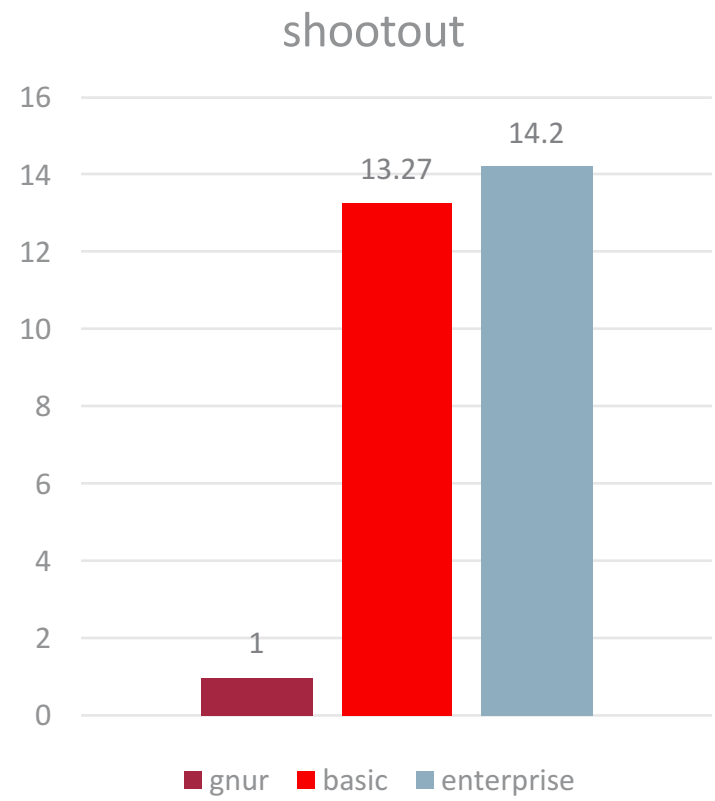
Speed-up normalized vs Nashorn JDK9, higher is better



R Performance

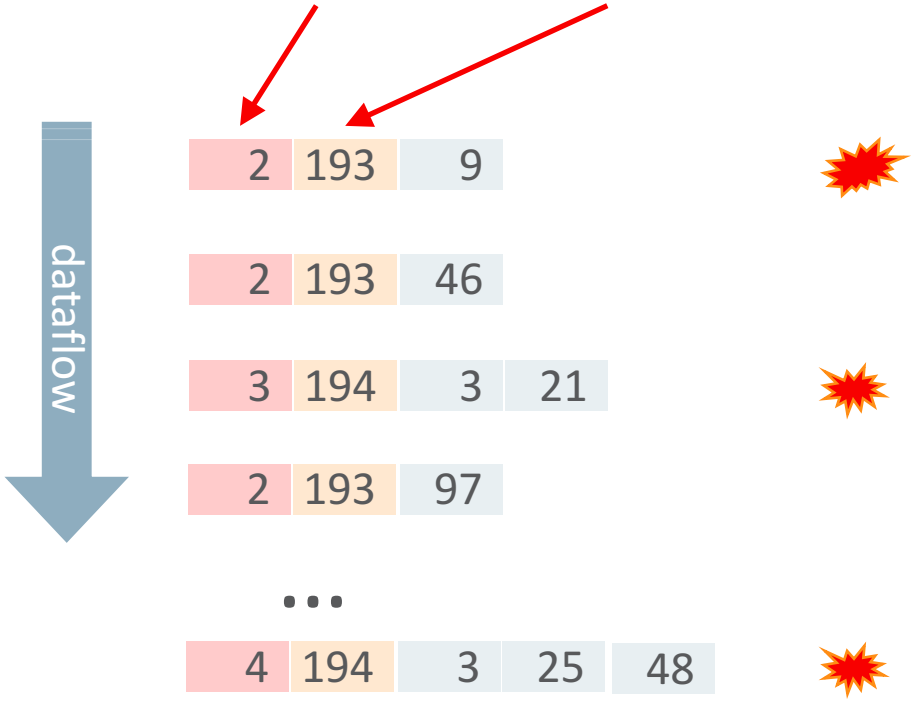
Speedup over latest GNU R version on simple benchmarks





Specialization of Data Conversion (Oracle Number => IEEE 754 double)

Profile length and exponent



Self-rewriting conversion code

```
specialize(length, exp, mantissaBytes);
```

```
if (length == 2 && exp == 0xc1) { result = mantissaBytes[0] – 1;}
else specialize(length, exp, mantissaBytes);
```

```
if (length == 2 && exp == 0xc1) { result = mantissaBytes[0] – 1;}
else if (length == 3 && exp == 0xc2) {
   result = (mantissaBytes[0] – 1) * 100 + (mantissaBytes[1] – 1;});}
else specialize(length, exp, mantissaBytes);
        ...
if (length == 2 && exp == 0xc1) { result = mantissaBytes[0] – 1;}
else if (length == 3 && exp == 0xc2) {
   result = (mantissaBytes[0] – 1) * 100 + (mantissaBytes[1] – 1;});}
else genericConversion(length, exp, mantissaBytes);
```

Conclusion

- Stored procedures and their challenges
- Demo of JavaScript UDF development and deployment
- Proliferation of languages
- GraalVM to simplify implementation of languages
- GraalVM embedded in various data processing platforms
- Speculative optimization for data conversion

Thank You!
Questions?

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