Oracle Multilingual Engine (MLE)

Java, JavaScript, Python or PL/SQL in the Database

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Philipp

- Database centric development
- Model Driven Software Development
- Author of free SQL Developer Extensions PL/SQL Unwrapper, PL/SQL Cop, utPLSQL, plscope-utils, oddgen and Bitemp Remodeler

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Agenda

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1. Code in the Database
2. GraalVM
3. Version 12c – Beta (Experimental)
4. Version 21c – Production (Sensible Guess)
5. Version 30c – Production (Highly Speculative)
6. Core Messages

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Code in the Database

Processing Data

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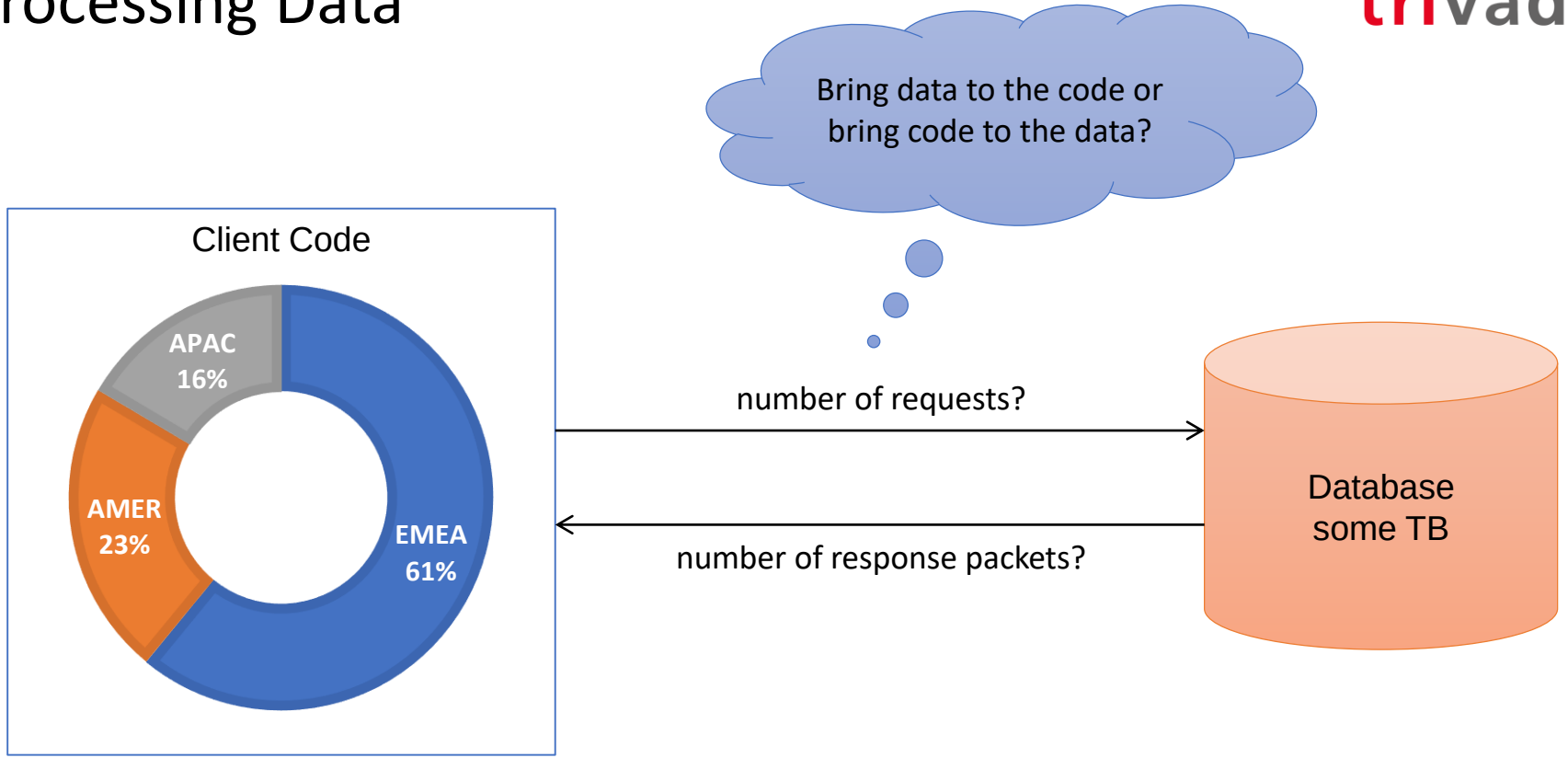

Bring Code to the Data

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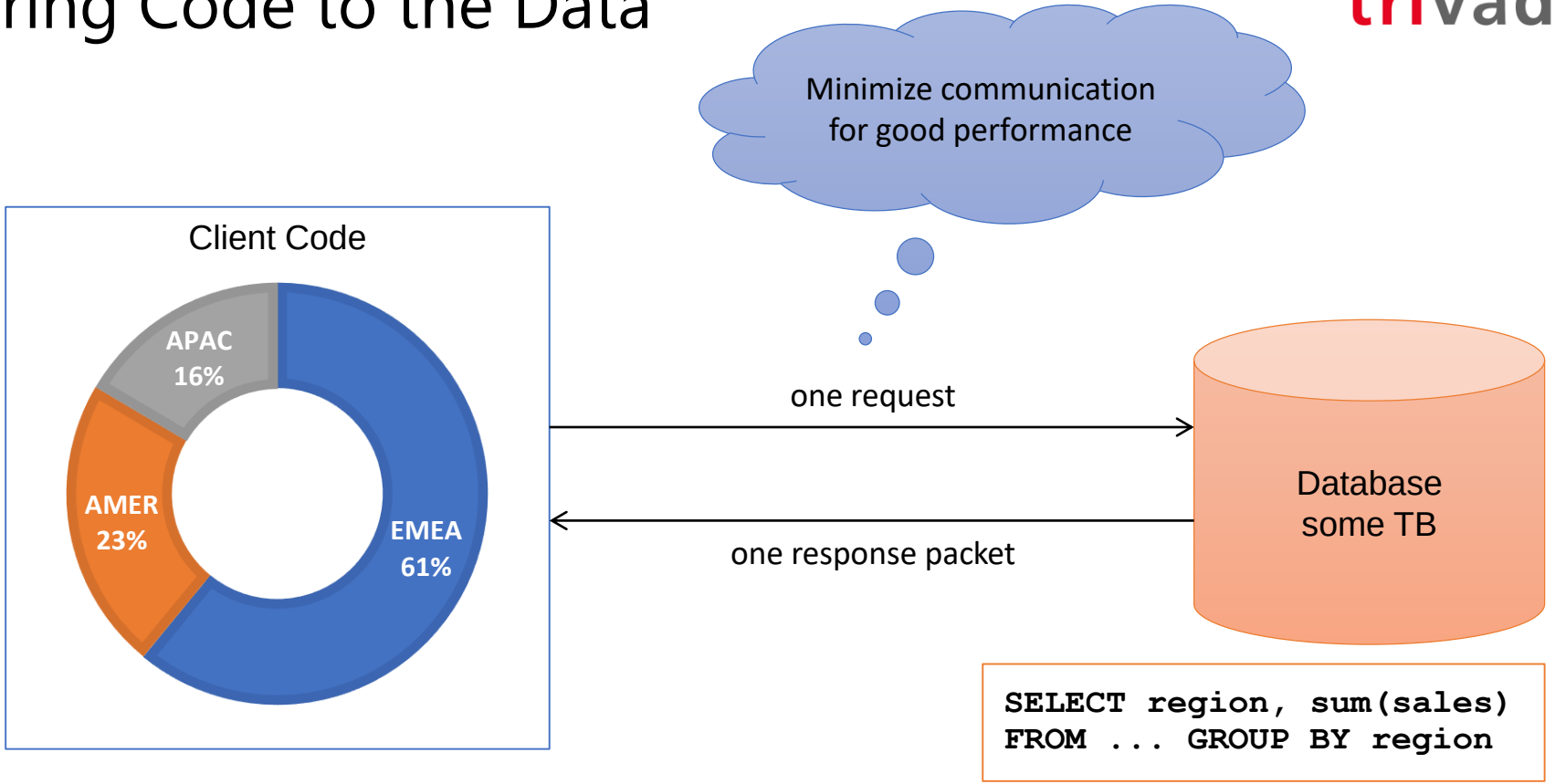

Languages in Oracle Database 19c

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Connection is enough

- SQL
- PL/SQL
- XSLT
- XQuery

Needs a PL/SQL wrapper

- C
  - Requires command line access on the DB server
- Java
  - Requires access to loadjava
  - Simple Java sources without additional dependencies can be installed with SQL

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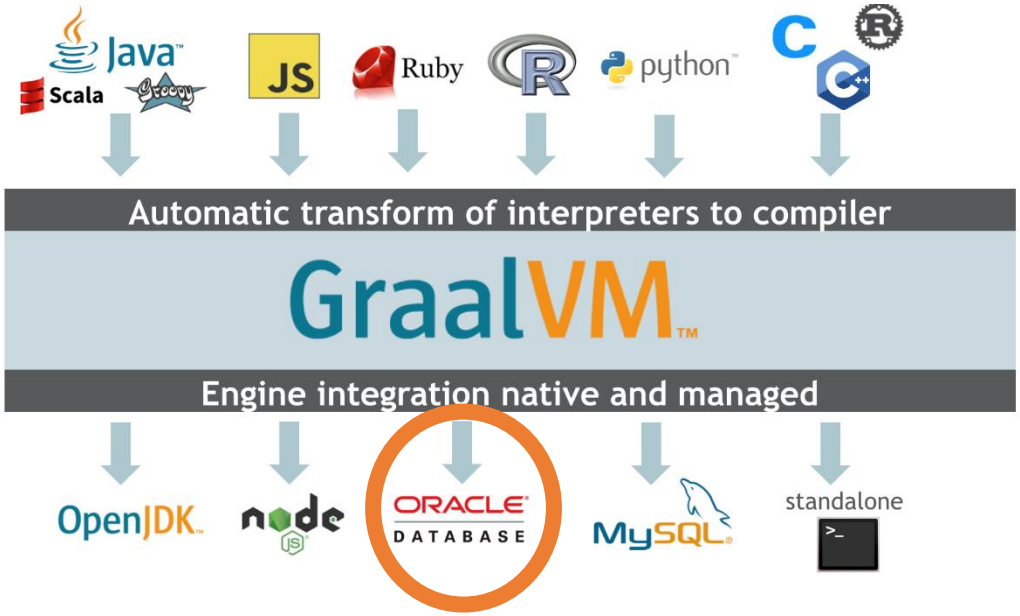
GraalVM

Properties

- **Polyglot**
  - Languages
- **Embeddable**
  - Databases
  - HTTP-Server
- **Efficient**
  - Standalone
  - Interoperability (shared memory)



Source: https://www.graalvm.org/docs/

Architecture Today

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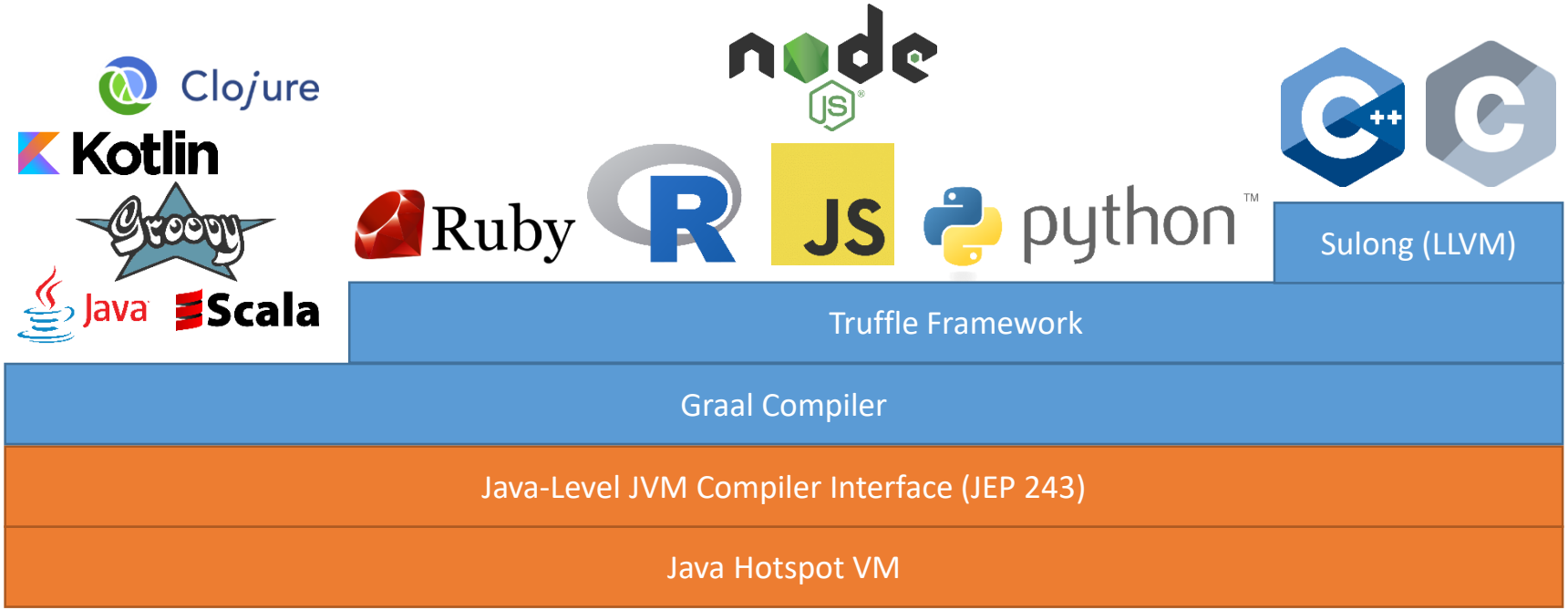

Architecture Tomorrow

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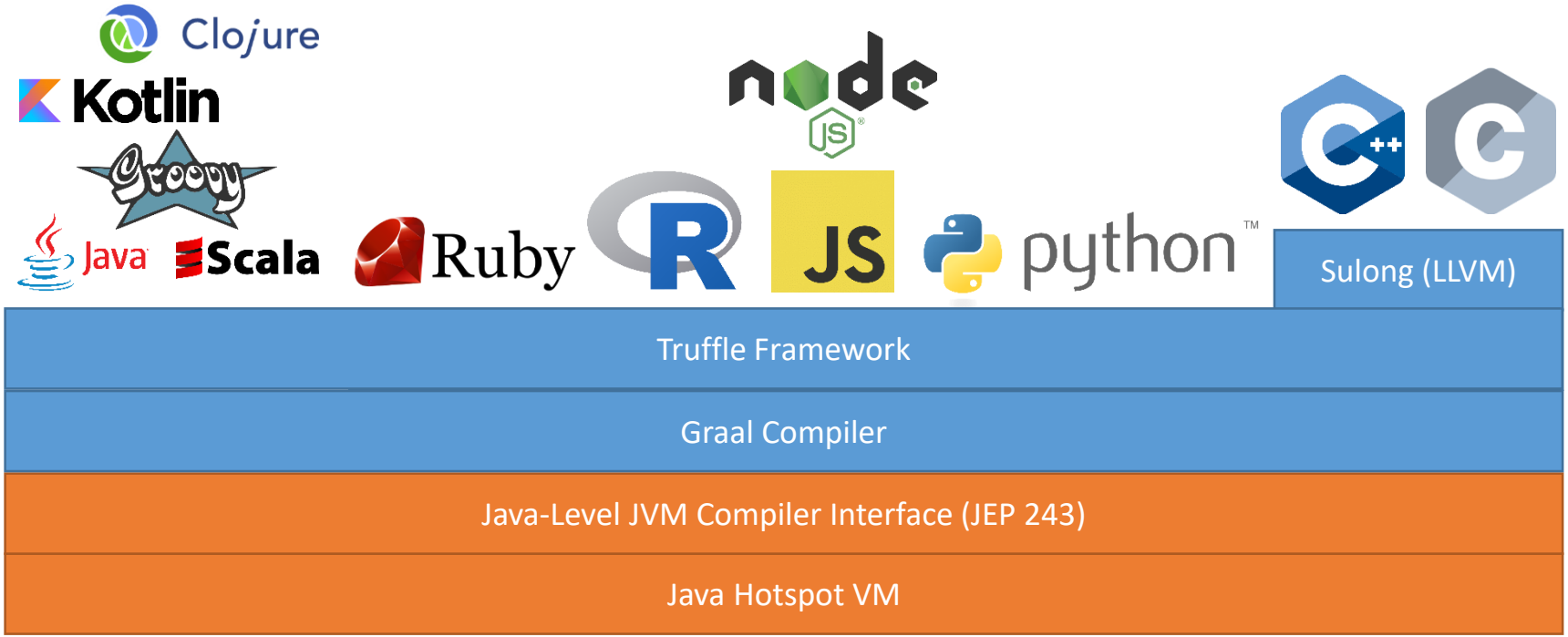

Performance

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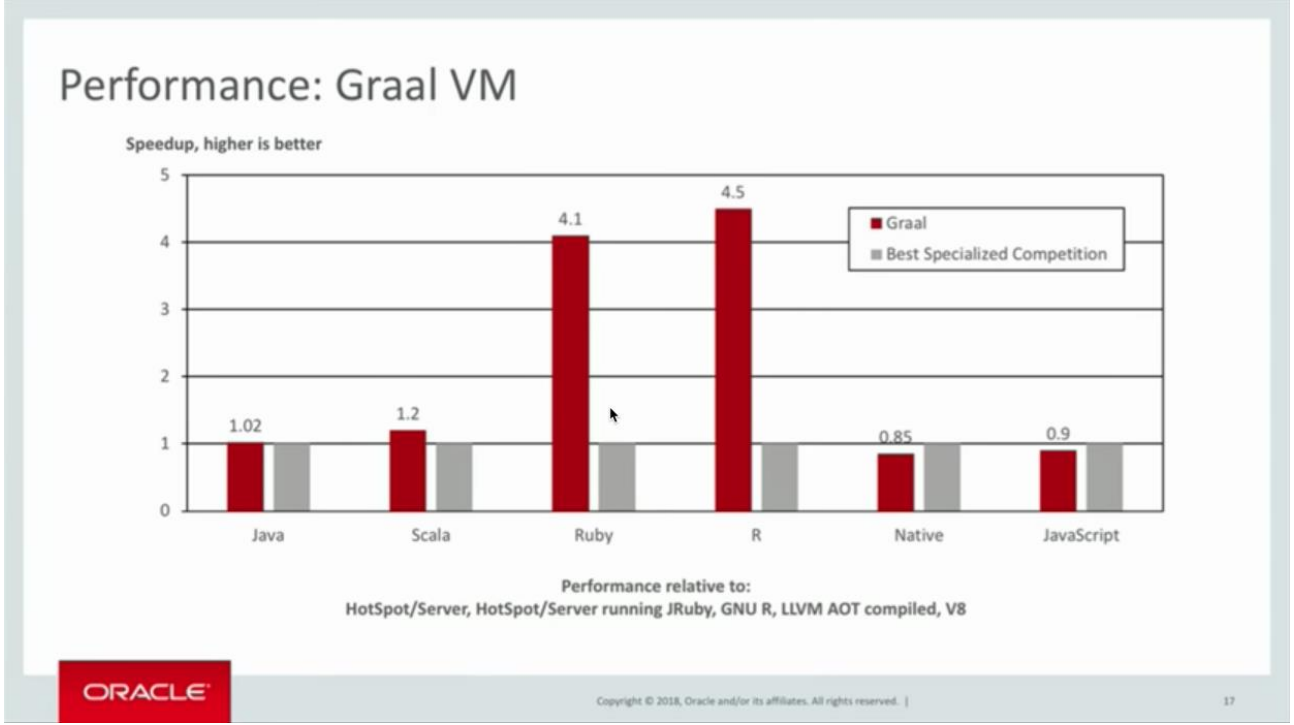

Source: https://youtu.be/8AYESZIaacg?t=1002

Graal: High-Performance Polyglot Runtime by Thomas Wuerthinger and Aleksandar Prokopec, Voxxed Days, Zürich, March 2018

Open Source

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Community Edition (CE)

GraalVM CE is available for free for development and production use. It is built from the GraalVM sources available on GitHub. We provide pre-built binaries for GraalVM CE for Linux and Mac OS X on x86 64-bit systems.

DOWNLOAD FROM GITHUB

Enterprise Edition (EE)

GraalVM EE provides additional performance, security, and scalability relevant for running critical applications in production. It is free for evaluation uses and available for download from the Oracle Technology Network. We provide binaries for GraalVM EE for Linux or Mac OS X on x86 64-bit systems.

DOWNLOAD FROM OTN

Source: https://www.graalvm.org/downloads/

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Version 12c – Beta (Experimental)

MLE Beta History

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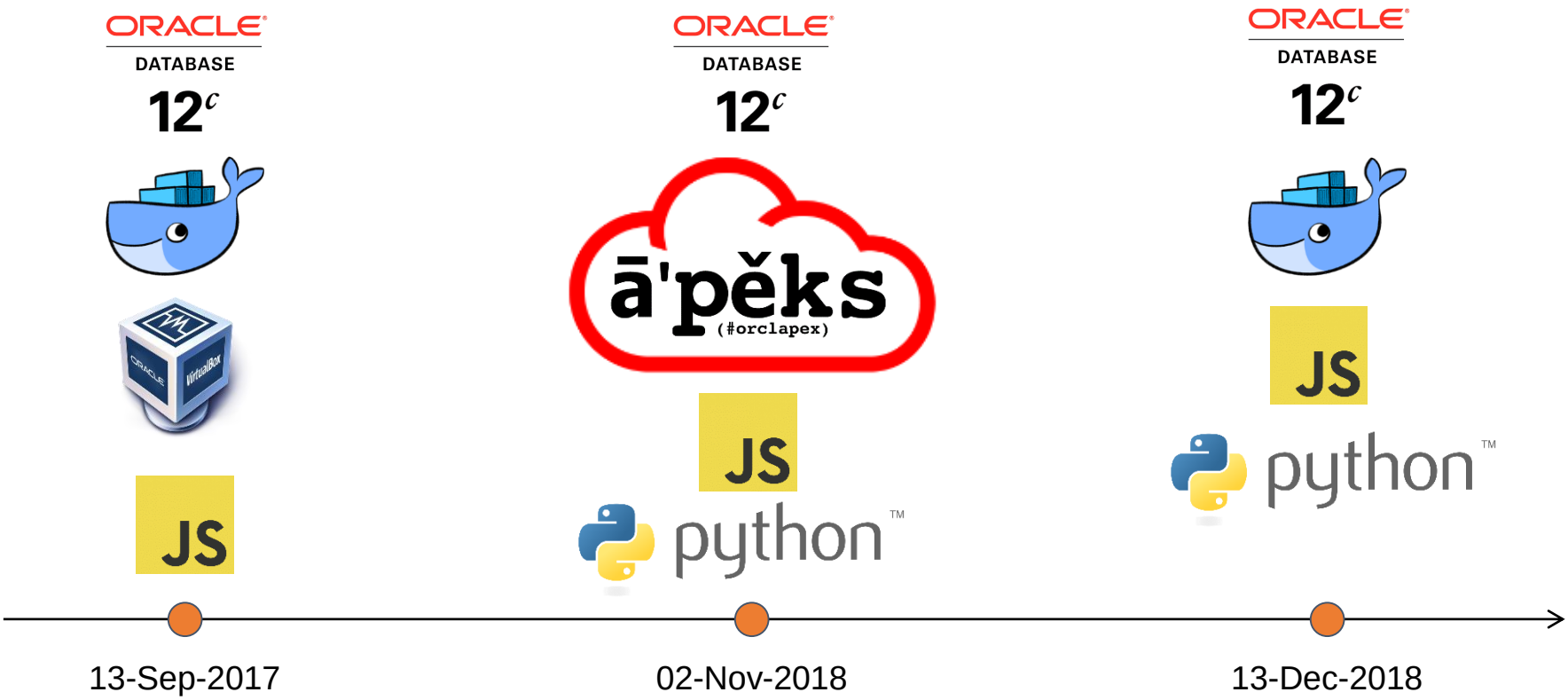

Documentation

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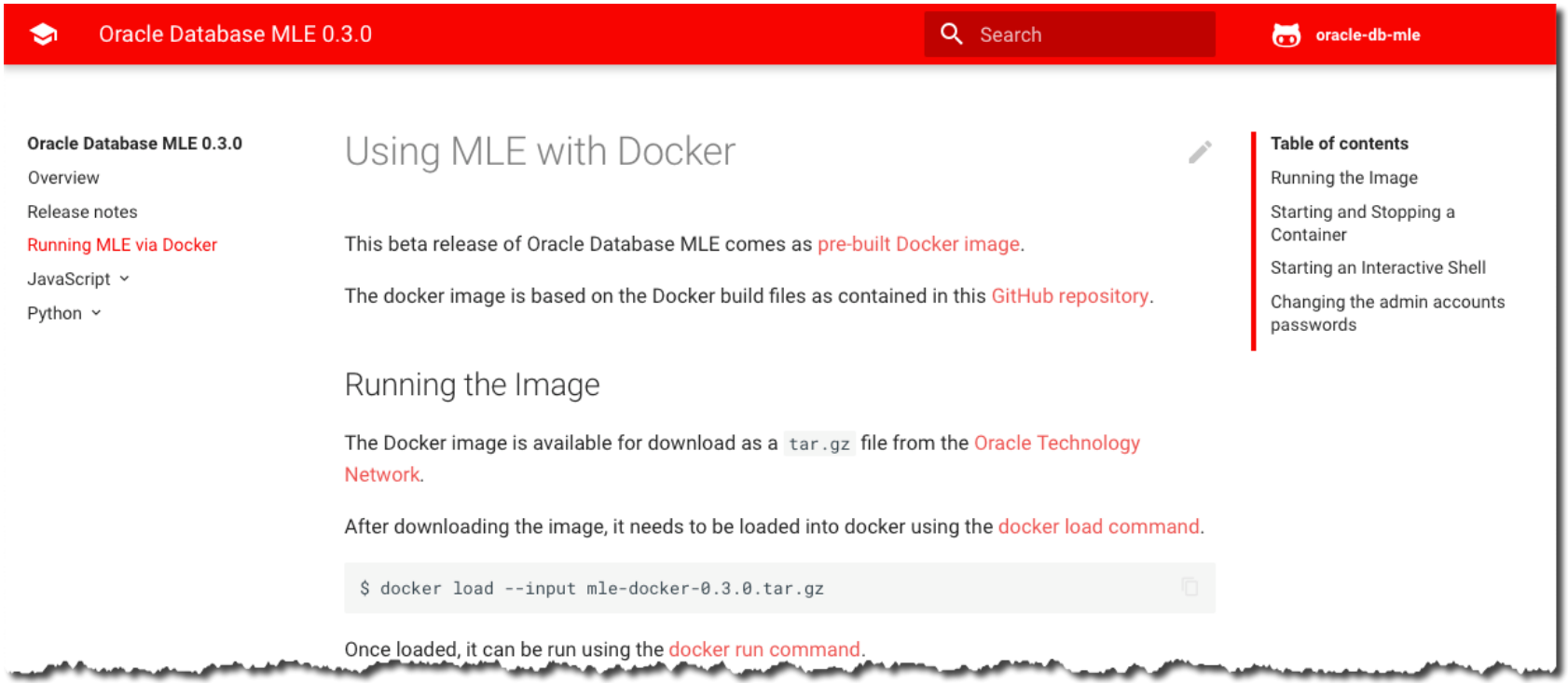

Source: https://oracle.github.io/oracle-db-mle/docker/

Create Docker Container

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1. Load image from downloaded archive file

```
docker import mle-docker-0.3.0.tar.gz
```

2. Create container

```
docker run --privileged --name mle2 \
  -p 1581:1521 -p 5081:5500 \
  -e ORACLE_SID=mlecdb \
  -e ORACLE_PDB=mlepdb1 \
  -e ORACLE_PWD=oracle \
  -v /Users/phs/docker/mle2/oradata:/opt/oracle/oradata \
  -v /Users/phs/docker/mle2/myproject:/home/oracle/myproject \
  mle-docker:0.3.0
```

Install Node.js

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1. Open a shell in within the MLE docker container as ”root”

```
docker exec -u root --privileged -it mle2 bash
```

2. Install nodejs and dependencies-bundler browserify within the mle2 container

```
yum install -y gcc-c++ make
curl -sL https://rpm.nodesource.com/setup_6.x | bash -
yum install -y nodejs
npm install -g browserify
```

Install SQLcl

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1. Copy downloaded and extracted SQLcl folder into the mle2 container

```
docker cp sqlcl mle2:/opt/oracle/product/12.2.0.1/dbhome_1/sqlcl/
```

2. Open a shell in within the MLE docker container as "root"

```
docker exec -u root --privileged -it mle2 bash
```

3. Fix privileges and set environment within the mle2 container

```
chown -R oracle:oinstall /opt/oracle/product/12.2.0.1/dbhome_1/sqlcl/
echo "export PATH=\$ORACLE_HOME/sqlcl/bin:\$PATH" >> /home/oracle/.bashrc
echo "export LC_ALL=en_US.UTF-8" >> /home/oracle/.bashrc
```

Use Case – Sentiment Analysis

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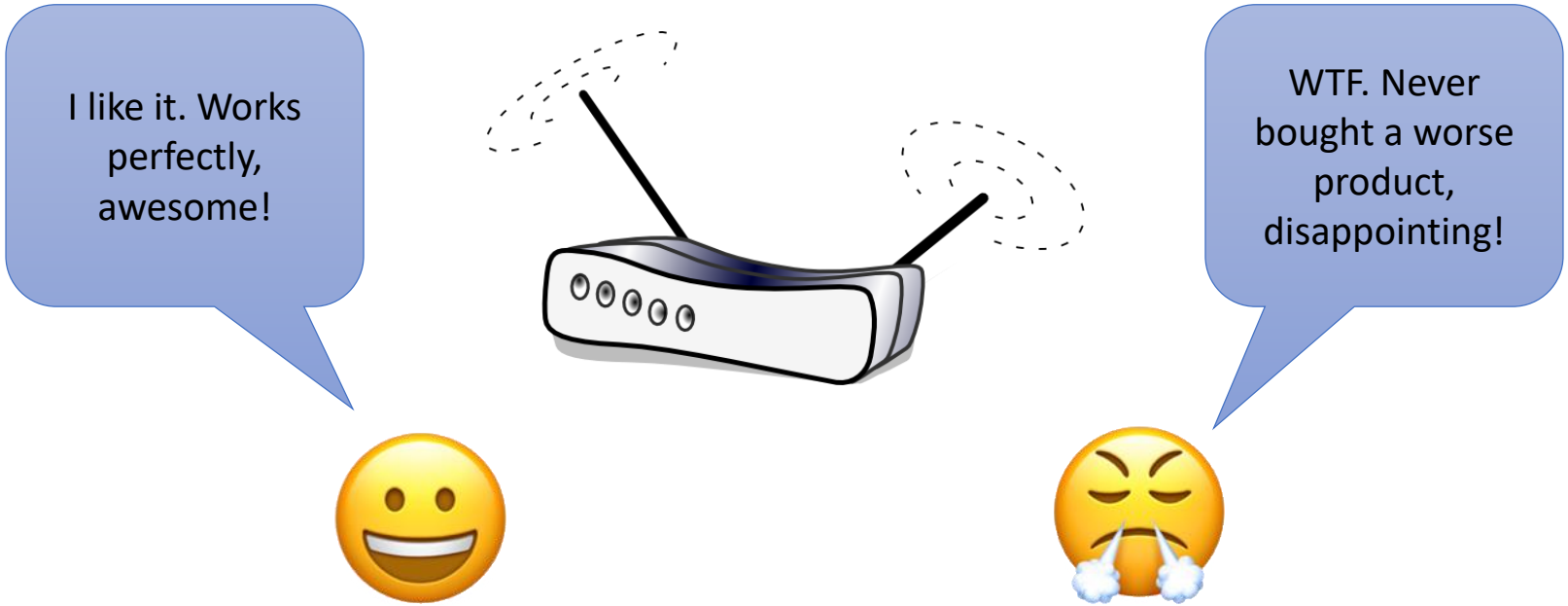

Open Data: https://www.cs.uic.edu/~liub/FBS/sentiment-analysis.html#datasets

npm – Package Manager for JavaScript

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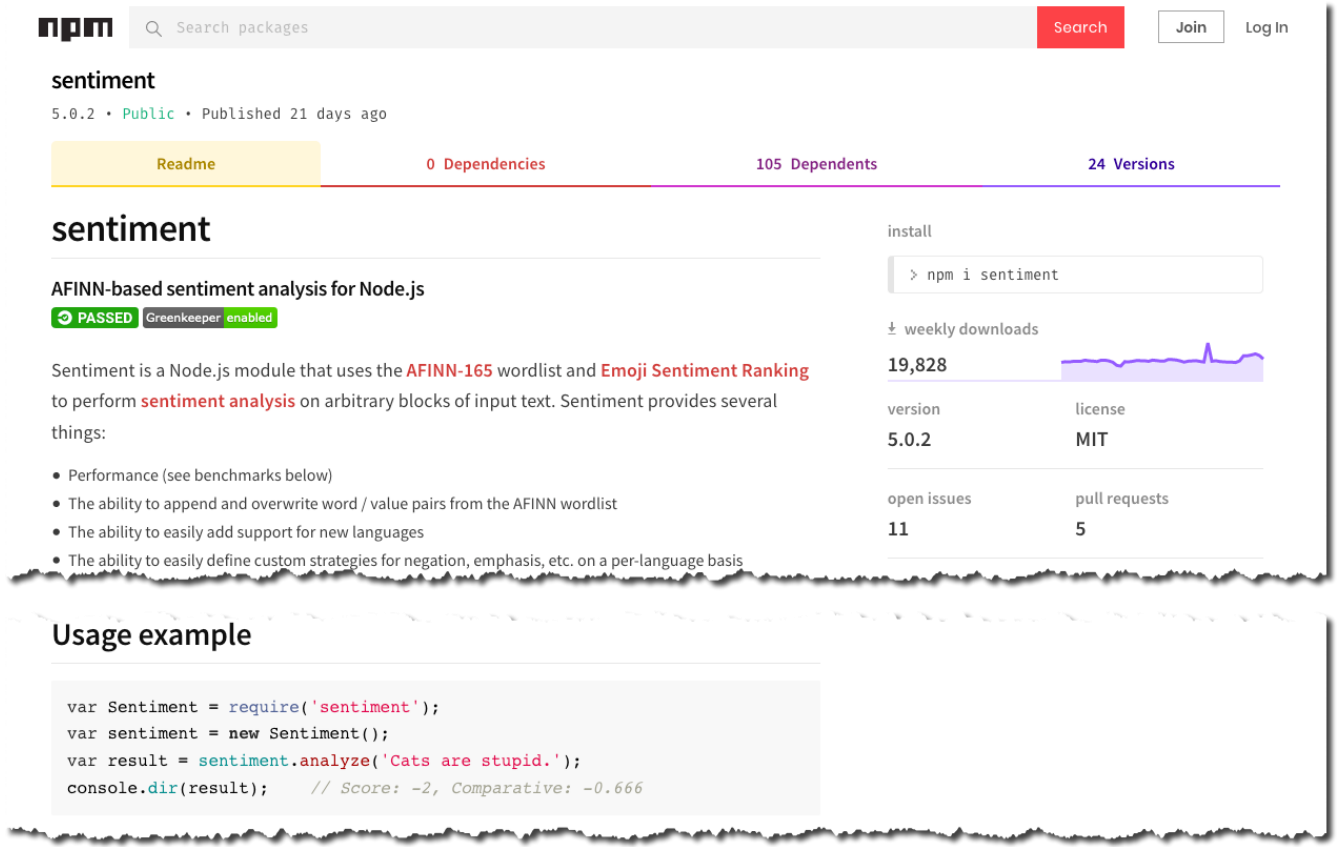

Source: https://www.npmjs.com/package/sentiment

Install "sentiment" Package

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1. Open a shell in within the MLE docker container

```
docker exec -it mle2 bash
```

2. Install package in your project directory

```
cd myproject; mkdir -p demo; cd demo
npm install sentiment
```

JavaScript Wrapper

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analyze.js

```
function analyze(phrase) {
    var Sentiment = require('sentiment');
    var sentiment = new Sentiment();
    var result = sentiment.analyze(phrase);
    return JSON.stringify(result, null, 3);
}

module.exports.analyze = analyze;
```

Positive Sentiment – Test via Node.js

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```
node -p 'require("./analyze.js")
    .analyze("I like it. Works perfectly, awesome!")'
```

```
{
    "score": 9,
    "comparative": 1.5, …
    "tokens": [
        "i",
        "like",
        "it",
        "works",
        "perfectly",
        "awesome"
    ],
…
```

```
  "words": [
        "awesome",
        "perfectly",
        "like"
    ],
    "positive": [
        "awesome",
        "perfectly",
        "like"
    ],
    "negative": []
}
```

Deploy Into Database – without dbjs (1)

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1. Create single JavaScript bundle file including all dependencies

```
browserify analyze.js -s analyze -o analyzeBundle.js
```

2. Create and JavaScript DDL and install it with SQLcl

```
SET SCAN OFF
CREATE OR REPLACE JAVASCRIPT SOURCE NAMED "analyzeBundle.js" AS
{content of analyze-bundle.js}
/
```

Deploy Into Database – without dbjs (2)

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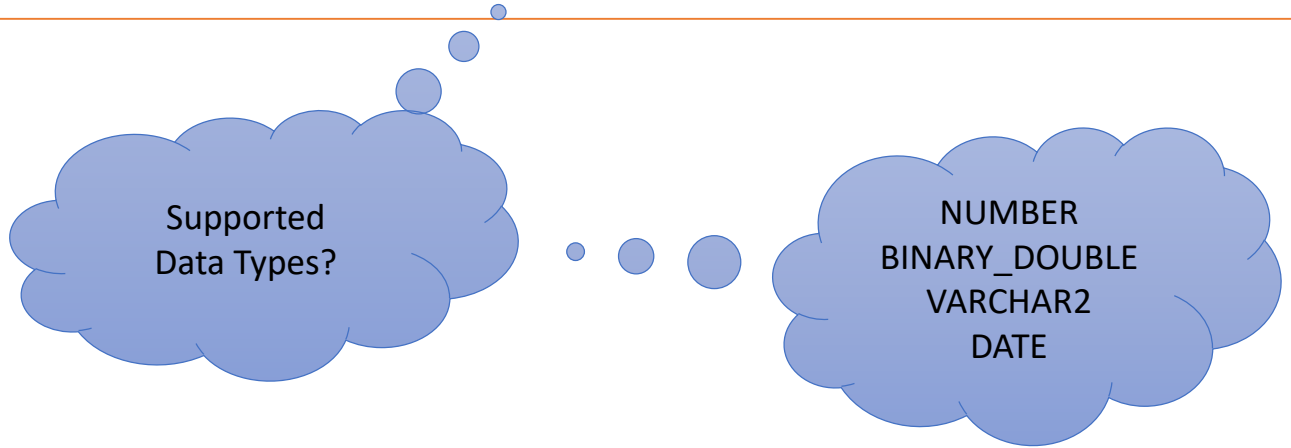
3. Create PL/SQL wrapper and install it

```
CREATE OR REPLACE FUNCTION analyze(
   in_phrase IN VARCHAR2
) RETURN VARCHAR2 AS
LANGUAGE JAVASCRIPT
NAME 'analyzeBundle.js.analyze(phrase string) return string';
```



Negative Sentiment – Test Query

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```
SELECT analyze('WTF. Never bought a worse product, disappointing!')
  FROM dual;
```

```
{
   "score": -9,
   "comparative": -1.2857142857142858, …
   "tokens": [
      "wtf",
      "never",
      "bought",
      "a",
      "worse",
      "product",
      "disappointing"
   ],
…
```

```
 "words": [
      "disappointing",
      "worse",
      "wtf"
   ],
   "positive": [],
   "negative": [
      "disappointing",
      "worse",
      "wtf"
   ]
}
```

Negative Sentiment – Test Query

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```
WITH
   base AS (
      SELECT analyze(text) AS jdoc, text
        FROM router),
   scored AS (
      SELECT to_number(json_value(jdoc, '$.score')) AS score,
             round(to_number(
                json_value(jdoc, '$.comparative')), 2) AS comparative,
             text
        FROM base)
SELECT score, comparative, text
  FROM scored
 ORDER BY score, comparative
 FETCH FIRST 10 ROWS ONLY;
```

Top 10 Negative Sentiments – Result

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```
SCORE COMPARATIVE TEXT
----- ----------- ----------------------------------------
   -8       -0.57 All in all , bad device , bad customer
                  service ... run like hell from this product
   -8       -0.47 Exasperated at 3 AM , I called it quits and
                  will be sending this awful , deceptive
                  product back
…
   -5       -0.15 I suspect Netgear takes defective returns ,
                  wraps them in new plastic , and labels them
                  " Refurb , " and hopes they work or that
                  whatever defect they had would not be noticed
                  by the new buyer

10 rows selected.
```

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Version 21c – Production (Sensible Guess)

MLE in Oracle Database 21c

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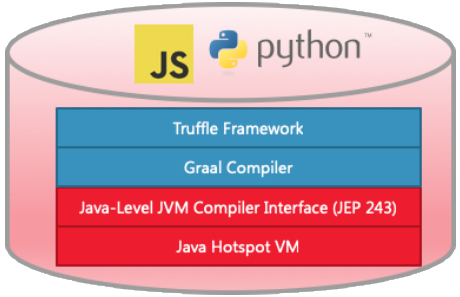
- Stored Objects based on GraalVM for JavaScript and Python
- Dynamic execution of GraalVM languages for JavaScript and Python
- Interoperability between all languages via SQL and PL/SQL for a subset of data types
- Run dynamic SQL from JavaScript and Python via default connection



- No dbjs and dbpy as part of the Oracle Database
- No access to network nor file system via JavaScript and Python
- No references to other MLE modules
- Deliberately undocumented features, e.g. to implement aggregate or table functions in JavaScript
- Java based on OJVM without dependencies between OJVM and GraalVM

Some Open Questions

How to Deal with the Growing Language Base?

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- Dedicated tool chain for each language (like "dbjs" and "dbpy")?
- Generic tool chain, configurable for each language?
- Include less common languages that are part of the GraalVM distribution?
- Include custom languages?
- Update, upgrade embedded GraalVM?

How to Integrate Package Managers/Repositories?

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- Examples
  - Maven Central for Java (incl. other public and private repositories)
  - npm for JavaScript
  - PyPi for Python
  - RubyGems for Ruby
  - NuGet for .NET
- Dealing with references to foreign packages during deployments?
  - Security vs. usability
- Solution for languages without package managers/repositories?

How to Deal with "non-browserify-able" Languages?

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- browserify and webpack
  - produce a single source incl. dependencies for JavaScript
  - make deployments simpler and faster
- Some languages like Java are “non-browserify-able”
- What are the concepts to store ”non-browserify-able” language files for GraalVM?
- Is it really necessary to store every file in a JAR file as a separate database object?

What Happens to the Existing Languages in the Database?

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- Namely
  - SQL
  - PL/SQL
  - XSLT
  - XQuery
  - Java
  - C

- Technically they could all run on GraalVM, right?
- Static SQL and PL/SQL are special though, as the compiler needs a connection

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Version 30c – Production (Highly Speculative)

MLE in Oracle Database 30c (1)

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- All code in the Oracle Database is running on GraalVM
  - C (kernel, custom libraries), C++
  - Java, Scala, Kotlin, Groovy, Clojure, …
  - SQL (many dialects), PL/SQL, T-SQL, …
  - XSLT, XQuery, …
  - JavaScript, Phyton, R, Ruby, …
  - C#, Visual Basic .NET, …
- Enable/disable optional and custom languages
- Efficient interoperability between all languages supporting all data types
- Run static and dynamic SQL from all languages via default connection

MLE in Oracle Database 30c (2)

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- Controlled access to network and file system for all languages
- Integration with “Oracle Universal Package Manager”
  - Free cloud service for public packages, supporting all languages
  - Cost option for private packages
  - Integration with other package managers/repositories such as npm, Maven Central
  - Manages local copies, security aspects, and more …
- Ad-hoc use of all languages in SQL
  - E.g. in the with_clause of a select statement
  - Including references to other packages known by the Universal Package Manager
- OJVM is not available anymore

MLE in Oracle Database 30c (3)

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- Moving code at runtime between Java Virtual Machines
  - Based on statistics
  - To reduce network roundtrips
  - To improve overall runtime performance

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Core Messages

The Future Is Bright

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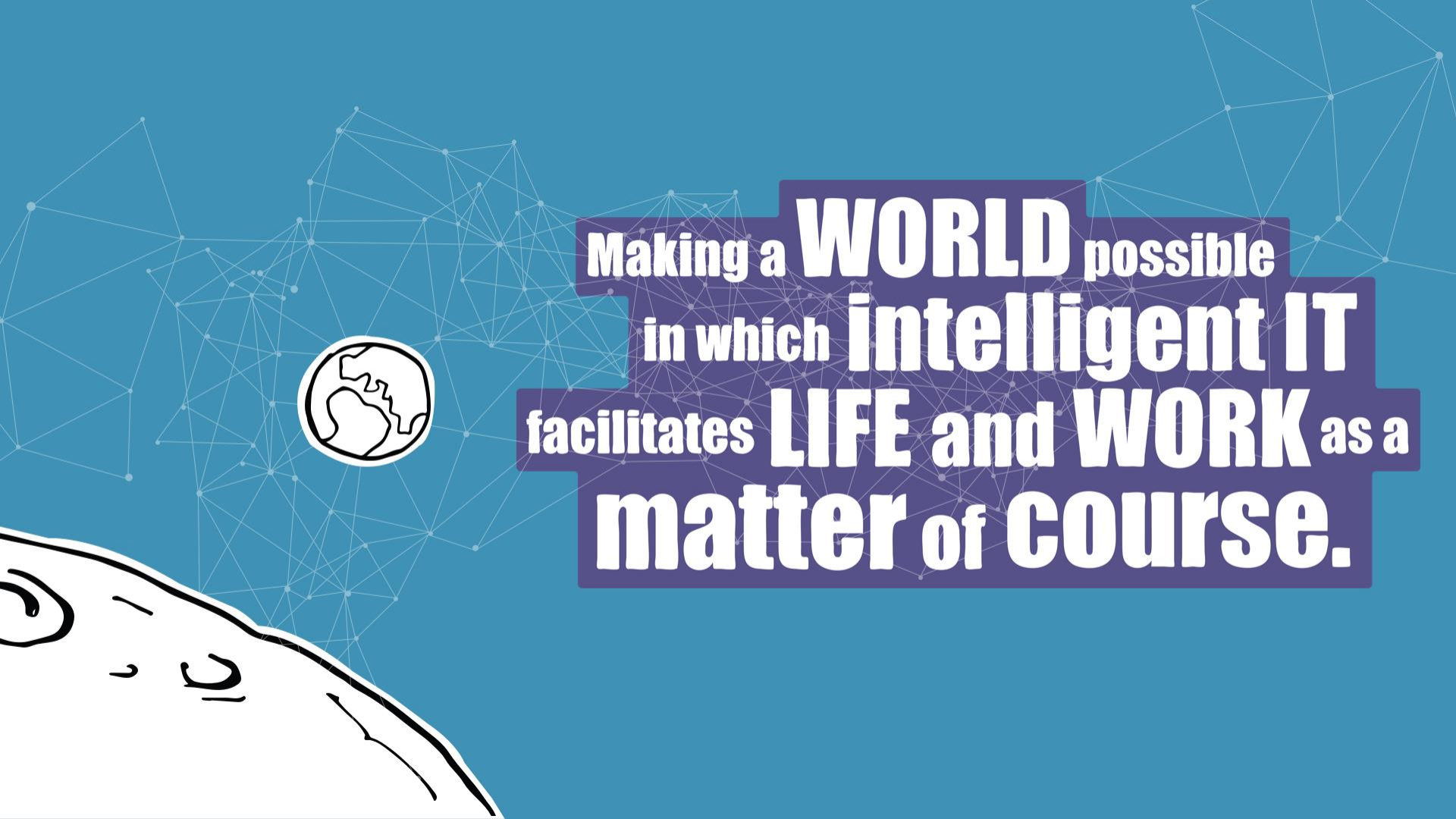
- GraalVM is polyglot, embedded, efficient, open-sourced.
- Code in the client or database server?
  - Option to choose
  - Easier to move
- Database centric development becomes easier when additional languages (besides PL/SQL) are treated as first-class citizens.


Making a WORLD possible
in which intelligent IT
facilitates LIFE and WORK as a
matter of course.