

PL/SQL vs. JavaScript in the Oracle Database 23c

*“a journey from innocence to experience”
-- Don Henley, about “Hotel California”*

Philipp Salvisberg
18th November 2023

Philipp Salvisberg

Data Engineering Principal

- Database Centric Development
- Model Driven Software Development
- Open-Source Development

philipp.salvisberg@accenture.com

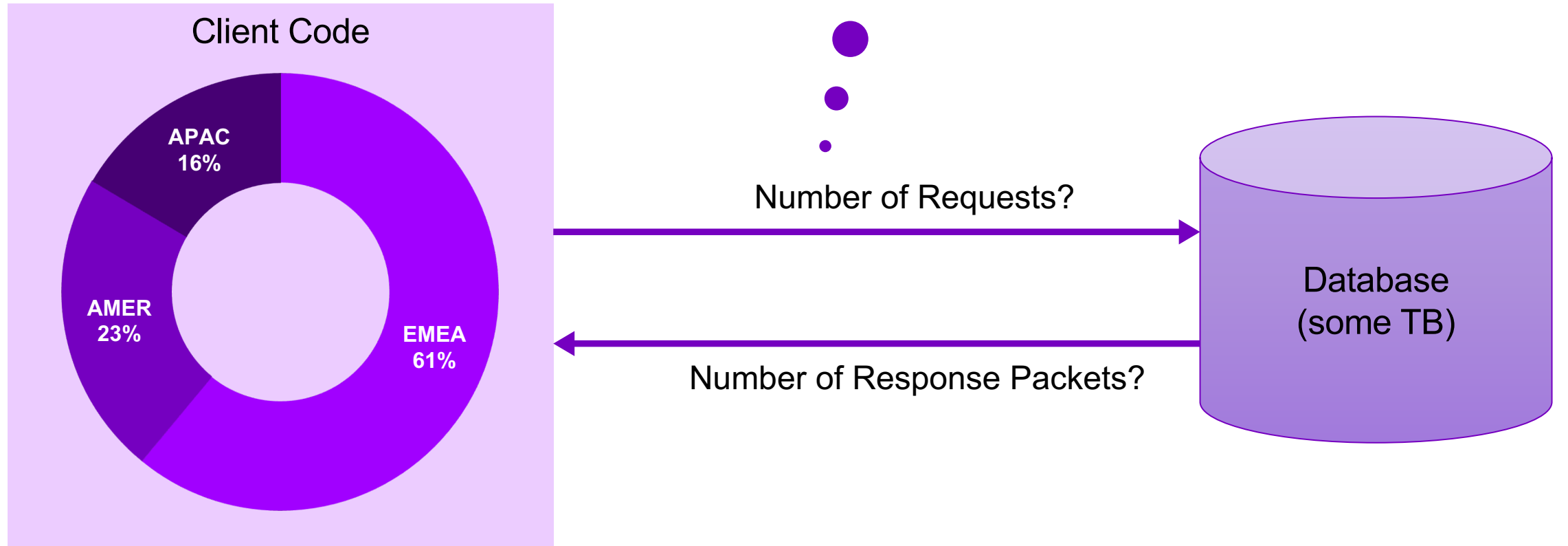
<https://www.salvis.com/blog>

<https://github.com/PhilippSalvisberg/js23c/tree/main>

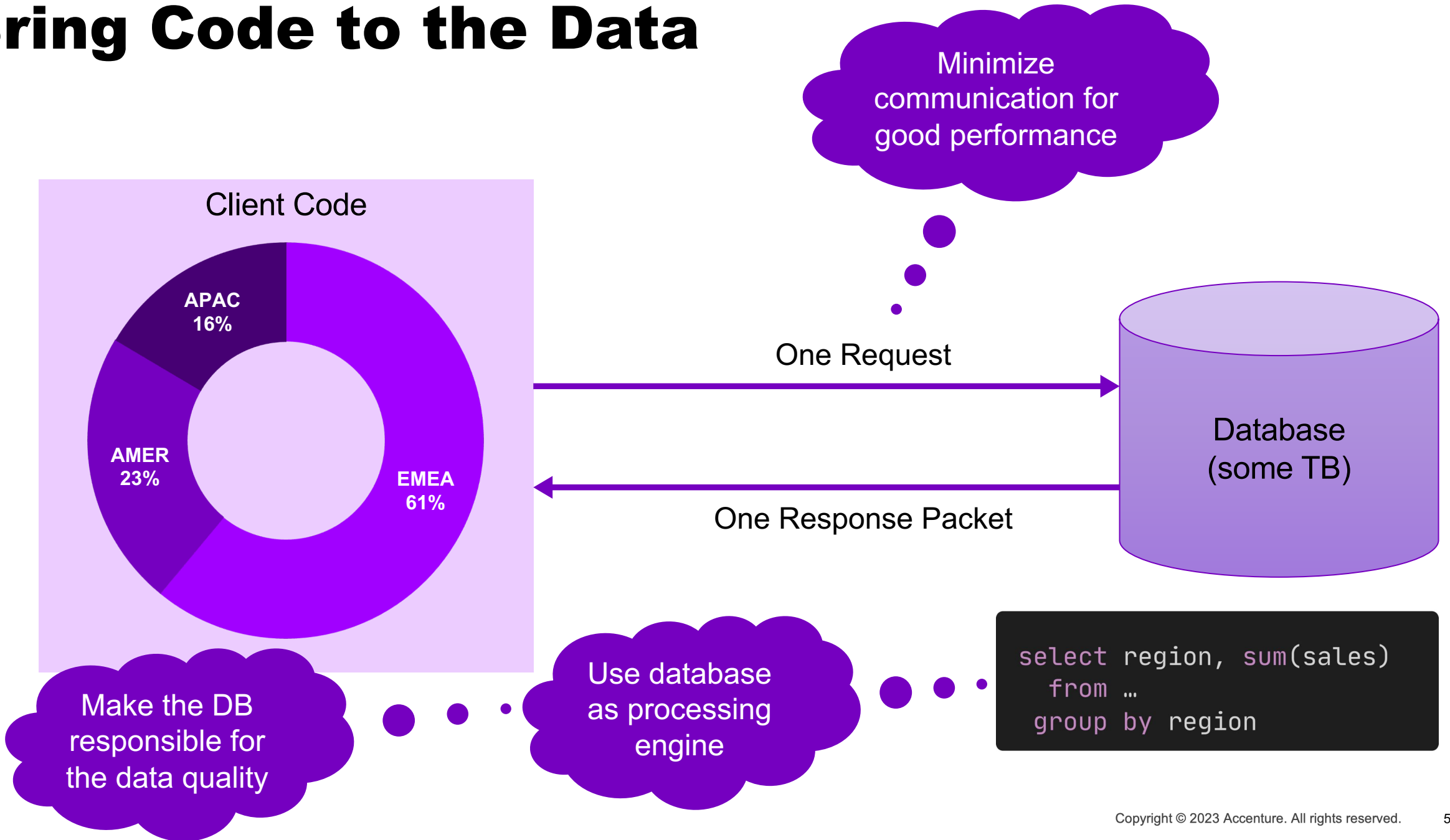


Why Do We Need Code in the Database?

Processing Data



Bring Code to the Data



Programming Languages in the Oracle Database

C (Version 8.0)

Shared library must be installed on the database server's file system

```
1 create or replace procedure utl_xml_parse_query(  
2   in_current_userid in          number,  
3   in_schema_name   in          varchar2,  
4   in_query         in          clob,  
5   io_result        in out nocopy clob  
6 ) is  
7   language c  
8   library sys.utl_xml_lib          -- static lib, part of the oracle binary  
9   name "kuxParseQuery"            -- name of the C function in the lib  
10  with context parameters (  
11    context,                        -- connection context, allows callbacks  
12    in_current_userid ocinumber,    -- content  
13    in_current_userid indicator,    -- null indicator  
14    in_schema_name   ocistring,     -- content  
15    in_schema_name   indicator,     -- null indicator  
16    in_query         ociloblocator, -- content  
17    in_query         indicator,     -- null indicator  
18    io_result        ociloblocator, -- content  
19    io_result        indicator      -- null indicator  
20 );  
21 /
```

PL/SQL (Version 7.0)

```
1 create or replace procedure increase_salary_plsql(  
2   in_deptno      in number,  
3   in_by_percent  in number  
4 ) is  
5 begin  
6   update emp  
7     set sal = sal + sal * in_by_percent / 100  
8     where deptno = in_deptno;  
9 end increase_salary_plsql;  
10 /
```

Usages in the
data dictionary

Compile errors
& no SQLi

Static
SQL

PL/SQL – Without Data Processing (DML)?

```
1 create or replace function to_epoch_plsql(in_ts in timestamp) return number is
2   co_epoch_date constant timestamp with time zone := timestamp '1970-01-01 00:00:00 UTC';
3   l_interval      interval day(9) to second (3);
4 begin
5   l_interval := in_ts - co_epoch_date;
6   return 1000 * (extract(second from l_interval)
7     + extract(minute from l_interval) * 60
8     + extract(hour from l_interval) * 60 * 60
9     + extract(day from l_interval) * 60 * 60 * 24);
10 end;
11 /
```

Is it necessary
that we implement
that ourselves?

Java (Version 8.1)



```
1 create or replace and compile java source named "Util" as
2 public class Util {
3     public static long toEpoch(java.sql.Timestamp ts) {
4         return ts.getTime();
5     }
6 }
7 /
```

PL/SQL wrapper for
accessibility and
data type conversions



```
1 create or replace function to_epoch_java(in_ts in timestamp)
2     return number is language java name
3     'Util.toEpoch(java.sql.Timestamp) return java.lang.long';
4 /
```

Java – Using 3rd Party Libraries

```
1 loadjava -thin \  
2   -user myuser/mypassword@localhost:1521:orcl \  
3   -genmissing \  
4   -resolve \  
5   -resolver "((* MYUSER) (* PUBLIC) (* -))" \  
6   -verbose \  
7   -stdout \  
8   mysql-connector-java-5.0.8-bin.jar
```

Must be compatible with
the OJVM in the database

1.8.0_371 in 19.19
11.0.20 in 23.3

Every class/resource
becomes an object in the
Oracle data dictionary

Java – Permissions (Network, Filesystem, ...)

```
1 declare
2   co_user constant all_users.username%type := 'DEMO';
3 begin
4   dbms_java.grant_permission(co_user,
5     'SYS:java.net.SocketPermission', '*:1024-65535', 'connect, resolve');
6   dbms_java.grant_permission(co_user,
7     'SYS:java.io.FilePermission', '/tmp', 'read, write');
8   dbms_java.grant_permission(co_user,
9     'SYS:java.lang.RuntimePermission', 'getClassLoader', '');
10  dbms_java.grant_permission(co_user,
11    'SYS:java.lang.RuntimePermission', 'setContextClassLoader', '');
12 end;
13 /
```

Dynamic JavaScript (Version 21)

```
1 create or replace function to_epoch_djs(in_ts in timestamp) return number is
2   co_js      constant clob := q'~
3     const bindings = require("mle-js-bindings");
4     const ts = bindings.importValue("ts");
5     bindings.exportValue("millis", ts.valueOf());
6   ~';
7   l_ctx      dbms_mle.context_handle_t;
8   l_millis number;
9 begin
10  l_ctx := dbms_mle.create_context();
11  dbms_mle.export_to_mle(l_ctx, 'ts', in_ts);
12  dbms_mle.eval(l_ctx, 'JAVASCRIPT', co_js);
13  dbms_mle.import_from_mle(l_ctx, 'millis', l_millis);
14  dbms_mle.drop_context(l_ctx);
15  return l_millis;
16 end to_epoch_djs;
17 /
```

mle-js-oracle-db,
mle-js-plsqltypes,
mle-js-fetch (23c),
mle-encode-base64 (23c)

Map input and output
types dynamically

Static JavaScript (Version 23)



```
1 create or replace mle module util_mod language javascript as
2 export function toEpoch(ts) {
3     return ts.valueOf();
4 }
5 /
```

PL/SQL wrapper for
accessibility and
optional data type conversions



```
1 create or replace function to_epoch_js(in_ts in timestamp)
2     return number is
3     mle module util_mod
4     signature 'toEpoch(Date)'; -- conversion to OracleTimestamp is also possible
5 /
```

SQL in JavaScript

```
1 create or replace mle module increase_salary_mod language javascript as
2 export function increase_salary(deptno, by_percent) {
3   session.execute(`
4     update emp
5       set sal = sal + sal * :by_percent / 100
6       where deptno = :deptno`, [by_percent, deptno]);
7 }
8 /
```

No need to import
mle-js-oracledb

Dynamic SQL
using ES6
template literals

Runtime errors
& SQLi risk

No usages in the
data dictionary

JavaScript – 3rd Party Libraries

Requires SQLcl
or SQL Developer

```
1 set define off
2 script
3 var url = new java.net.URL("https://esm.run/validator@13.11.0");
4 var content = new java.lang.String(url.openStream().readAllBytes(),
5     java.nio.charset.StandardCharsets.UTF_8);
6 var script = 'create or replace mle module validator_mod '
7     + 'language javascript as ' + '\n'
8     + content + "\n"
9     + '/' + "\n";
10 sqlcl.setStmt(script);
11 sqlcl.run();
12 /
```

Disconnected
from npm

ES 5.1 (JDK 11)
No Template Literals

Single object in the
Oracle data dictionary

JavaScript – MLE Module Wrapper

```
1 create or replace package validator_api is
2   function is_email(
3     in_email in varchar2
4   ) return boolean as mle module validator_mod signature 'default.isEmail(string)';
5
6   function is_email(
7     in_email in varchar2,
8     in_options in json
9   ) return boolean as mle module validator_mod signature 'default.isEmail(string, any)';
10
11  function is_email_djs(
12    in_email in varchar2,
13    in_options in json default null
14  ) return boolean;
15 end validator_api;
16 /
```

Does it make sense to expose in_options?

Default values for parameters are not supported

JavaScript wrapper in package body

Validator Documentation for isEmail “options”

Default options:

```
{
  allow_display_name: false,
  allow_underscores: false,
  require_display_name: false,
  allow_utf8_local_part: true,
  require_tld: true,
  allow_ip_domain: false,
  domain_specific_validation: false,
  blacklisted_chars: '',
  ignore_max_length: false,
  host_blacklist: [],
  host_whitelist: []
}
```

If **allow_display_name** is set to true, the validator will also match Display Name <email-address>.

If **require_display_name** is set to true, the validator will reject strings without the format Display Name <email-address>.

If **allow_utf8_local_part** is set to false, the validator will not allow any non-English UTF8 character in email address' local part.

If **require_tld** is set to false, email addresses without a TLD in their domain will also be matched.

If **allow_ip_domain** is set to true, the validator will allow IP addresses in the host part.

If **domain_specific_validation** is true, some additional validation will be enabled, e.g. disallowing certain syntactically valid email addresses that are rejected by Gmail.

If **blacklisted_chars** receives a string, then the validator will reject emails that include any of the characters in the string, in the name part.

If **ignore_max_length** is set to true, the validator will not check for the standard max length of an email (254).

If **host_blacklist** is set to an array of strings and the part of the email after the @ symbol matches one of the strings defined in it, the validation fails.

If **host_whitelist** is set to an array of strings and the part of the email after the @ symbol matches none of the strings defined in it, the validation fails

JavaScript – Importing MLE Modules

```
1 create or replace package body validator_api is
2   function is_email_djs(
3     in_email   in varchar2,
4     in_options in json default null
5   ) return boolean is
6     co_js      constant clob := q'~
7       (async () => {
8         const bindings = await import("mle-js-bindings");
9         const email = bindings.importValue("email");
10        const options = bindings.importValue("options");
11        const validator = await import("validator");
12        const result = validator.default.isEmail(email, options);
13        bindings.exportValue("result", result);
14      })();
15    ~';
16    l_ctx      dbms_mle.context_handle_t;
17    l_options  json;
18    l_result   boolean;
19  begin
20    l_options := coalesce(in_options, JSON('{}'));
21    l_ctx := dbms_mle.create_context(environment => 'DEMO_ENV');
22    dbms_mle.export_to_mle(l_ctx, 'email', in_email);
23    dbms_mle.export_to_mle(l_ctx, 'options', l_options);
24    dbms_mle.eval(l_ctx, 'JAVASCRIPT', co_js);
25    dbms_mle.import_from_mle(l_ctx, 'result', l_result);
26    dbms_mle.drop_context(l_ctx);
27    return l_result;
28  end is_email_djs;
29 end validator_api;
30 /
```

Import requires
async/await interface
in dynamically executed
JavaScript

Available imports
& compile options

JavaScript – MLE Environments

```
1 create or replace mle env demo_env
2   imports(
3     'create_temp_table' module create_temp_table_mod,
4     'increase_salary'   module increase_salary_mod,
5     'sql-assert'        module sql_assert_mod,
6     'validator'         module validator_mod,
7     'util'              module util_mod
8   )
9   language options 'js.strict=true, js.console=false, js.polyglot-builtin=true';
```

Modules that
can be imported
from JavaScript

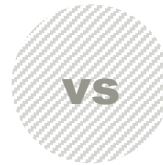
Can handle
different module
versions

Compile options

Languages in the Oracle Database 23c

Connection is Enough

- Primarily
 - SQL
 - PL/SQL (anonymous blocks, with_clause)
 - JavaScript (DBMS_MLE)
- Secondly
 - SQL/PGQ
 - SQL/JSON
 - SQL/XML
 - XPath
 - XSLT
 - XQuery



Code in the DB is Required

- C
 - Requires access to the DB server to install shared libraries
- PL/SQL
 - Procedures, Functions, Packages, Types, Triggers, Views
 - Static SQL, compile-time dependencies
- Java
 - Requires loadjava to install JARs
 - Simple Java source via SQL
- JavaScript
 - Requires scripting to install libraries
 - Simple JavaScript source via SQL

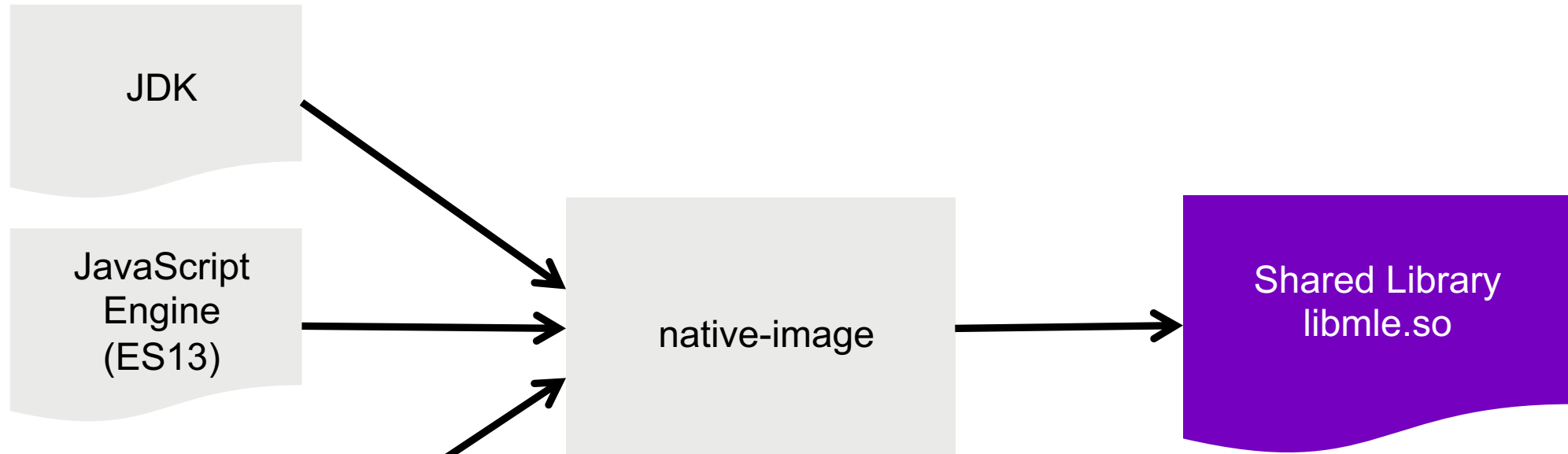
How Many JVMs are in the Oracle Database?

Java – Full JVM as Part of the DB (Option)

```
$ pwd
/u01/app/oracle/product/19.0.0/dbhome/javavm
$ du -h | sort -k2
437M      .
12K       ./admin
56K       ./doc
612K      ./install
32K       ./install/sbs
430M      ./jdk
430M      ./jdk/jdk8
397M      ./jdk/jdk8/admin
34M       ./jdk/jdk8/lib
168K      ./jdk/jdk8/lib/security
4.0M      ./lib
340K      ./lib/cmm
2.0M      ./lib/fonts
8.0K      ./lib/security
2.6M      ./ojvmwcu
8.0K      ./ojvmwcu/bin
36K       ./ojvmwcu/install
2.5M      ./ojvmwcu/lib
```

```
$ pwd
/opt/oracle/product/23c/dbhomeFree/javavm
$ du -h | sort -k2
229M      .
20K       ./admin
108K      ./conf
24K       ./conf/management
84K       ./conf/security
44K       ./doc
700K      ./install
28K       ./install/sbs
220M      ./jdk
220M      ./jdk/jdk11
185M      ./jdk/jdk11/admin
36M       ./jdk/jdk11/lib
120K      ./jdk/jdk11/lib/security
4.0M      ./lib
336K      ./lib/cmm
2.0M      ./lib/fonts
16K       ./lib/security
3.5M      ./ojvmwcu
4.0K      ./ojvmwcu/bin
40K       ./ojvmwcu/install
3.5M      ./ojvmwcu/lib
```

MLE/JS – Native Image as Part of the DB



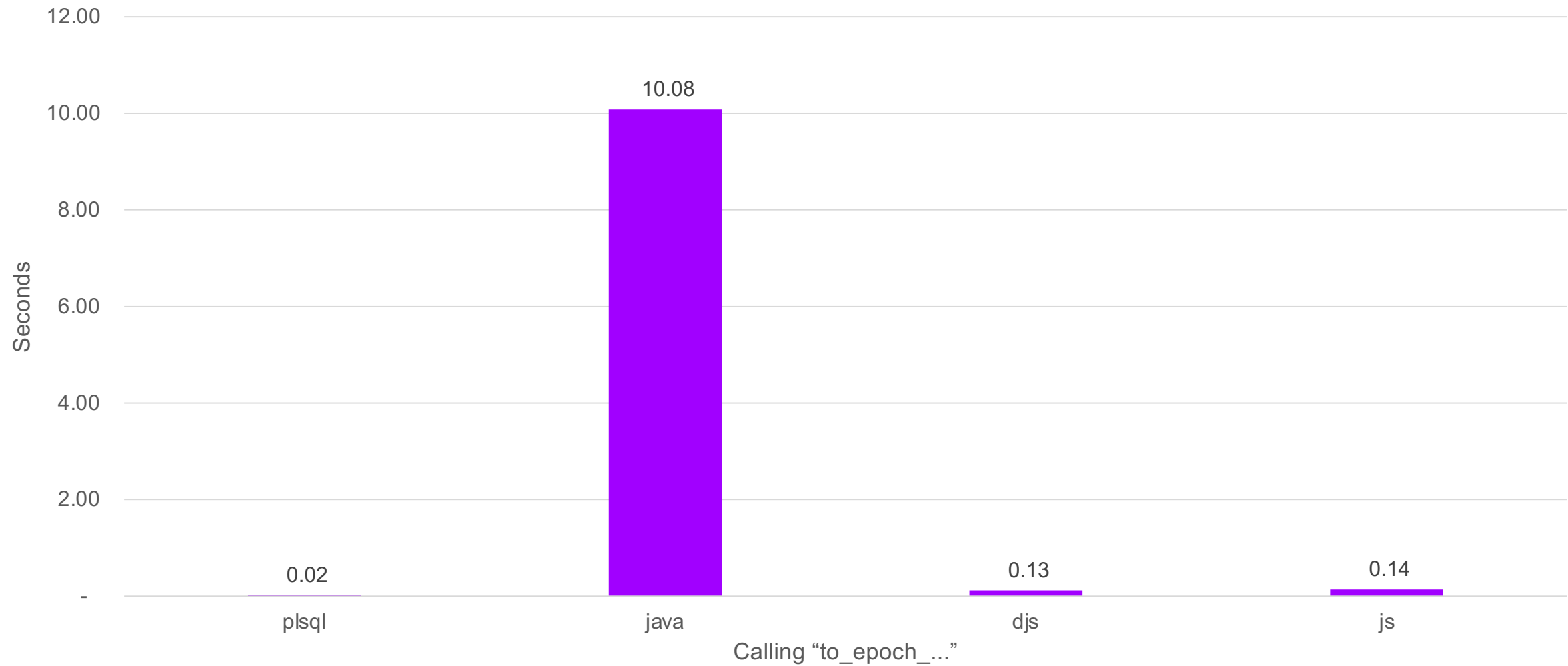
```
1 $ pwd
2 /opt/oracle/product/23c/dbhomeFree/lib
3 $ ls -lh libmle.so
4 -rw-r----- 1 oracle oinstall 195M Sep  1 19:00 libmle.so
```


Comparing Performance & Resource Usage

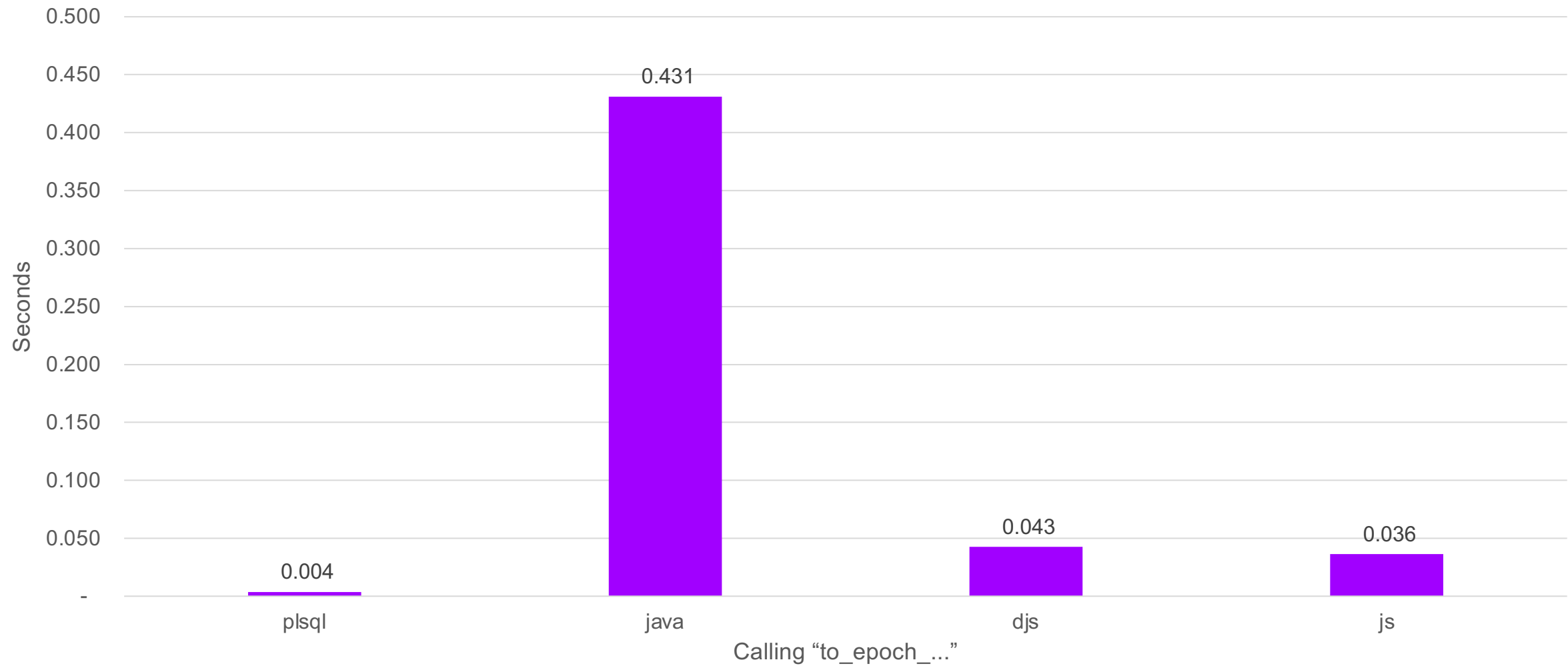
**Best of 3
Attempts**



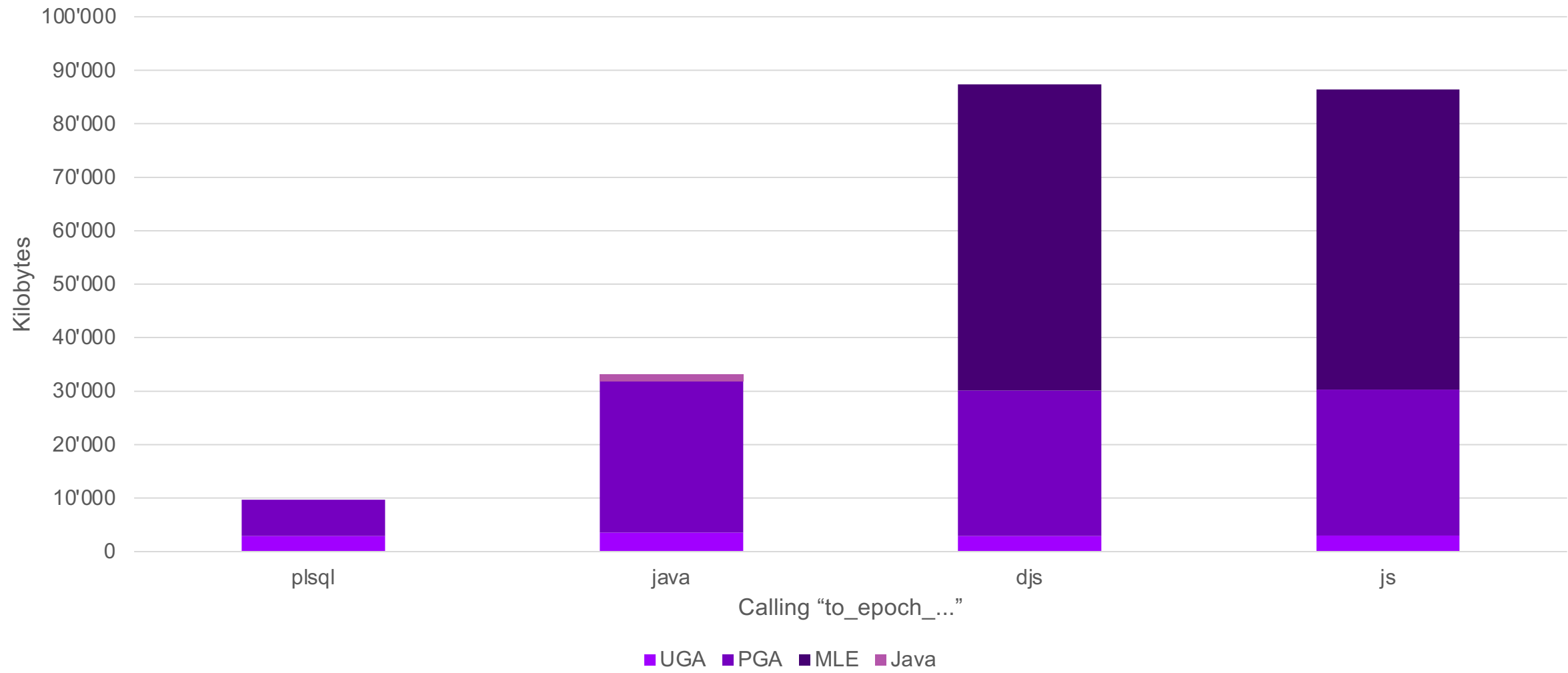
Runtime of First Call after DB Restart



Runtime of First Call in New DB Session



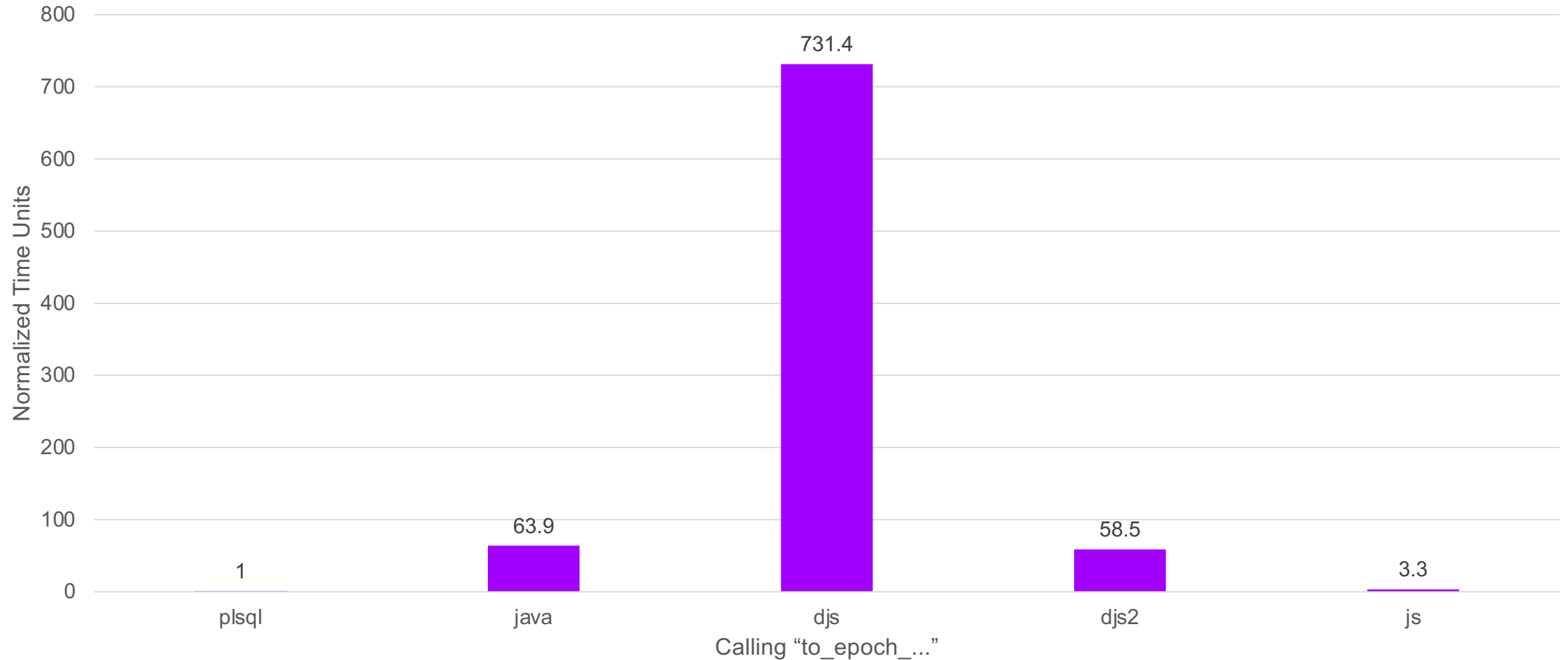
Max. Memory Usage After Single Call



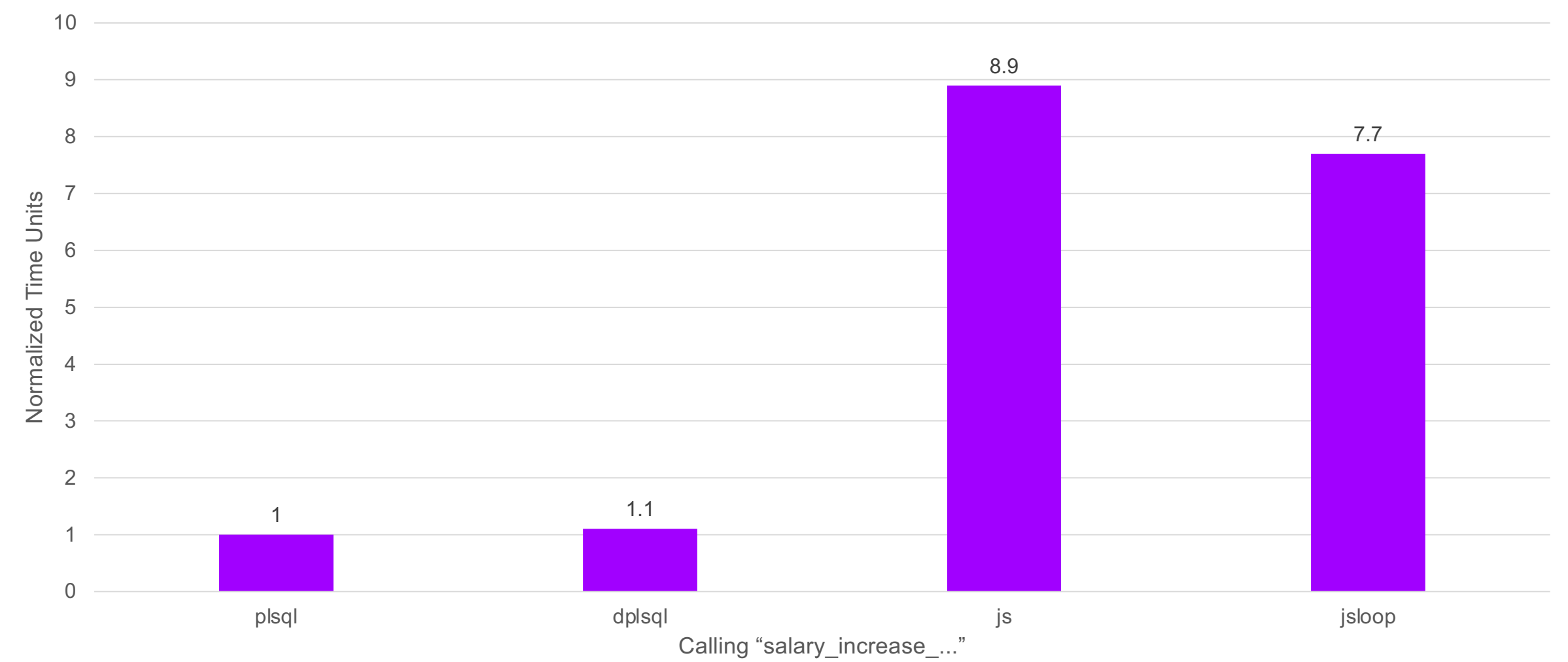
Comparing Apples with Pears?



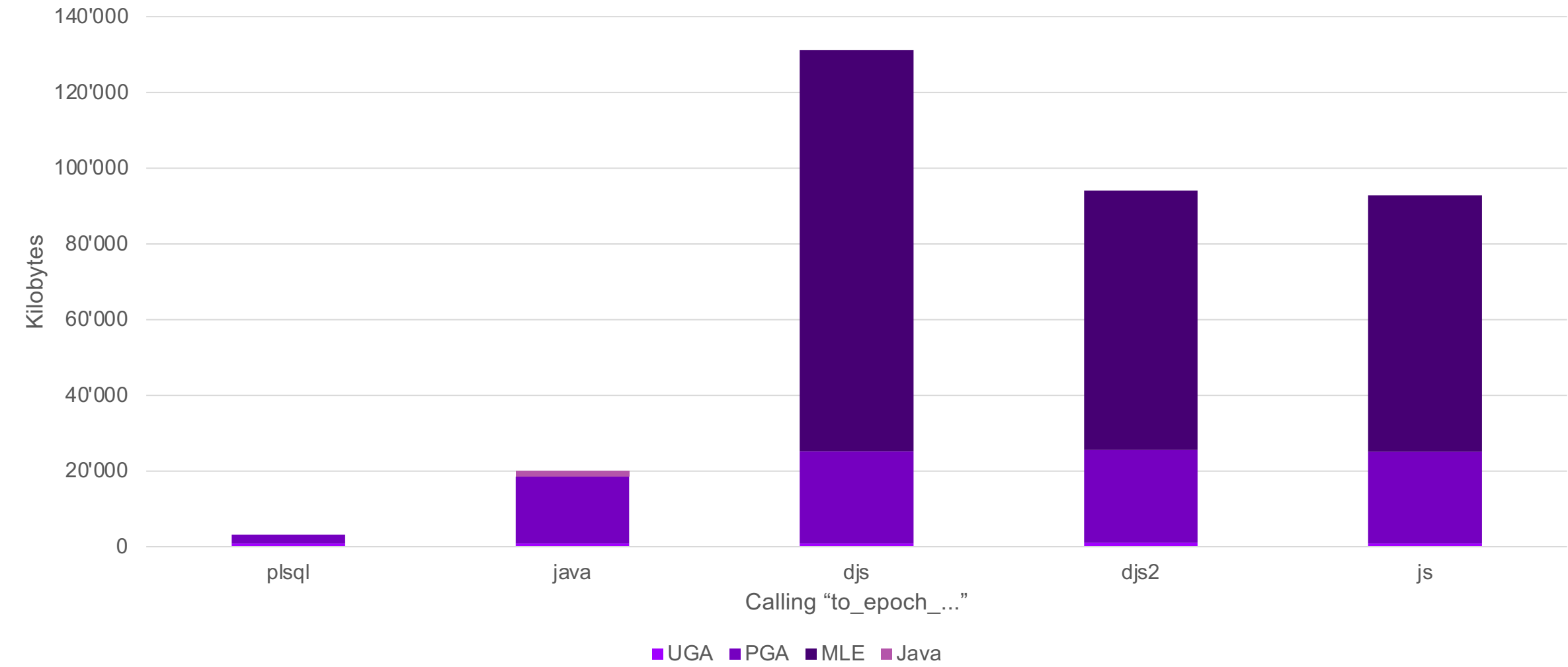
Runtime of 100'000 Calls of to_epoch



Runtime of 100'000 Calls of salary_increase



Max. Memory Usage After 100'000 Calls



Good Security Practices & Default Exceptions

Binds and Assertions

```
1 create or replace mle module
2   create_temp_table_mod language javascript as
3
4 export function createTempTable(tableName) {
5   const result = session.execute(
6     `select dbms_assert.simple_sql_name(
7       :tableName
8     ) as tab`,
9     [tableName]
10  );
11
12  session.execute(
13    `create private temporary table
14      ora\${ptt_${result.rows[0].TAB}} (id number)`
15  );
16 }
17 /
```

```
1 create or replace procedure create_temp_table_plsql(
2   in_table_name in varchar2
3 ) is
4   co_template constant varchar2(1000 char) :=
5     'create private temporary table
6       ora$ptt_#valid_table_name# (id number)';
7 begin
8   execute immediate replace(co_template,
9     '#valid_table_name#',
10    dbms_assert.simple_sql_name(in_table_name));
11 end;
12 /
```

Template literals and
JSON integration are great

Error Stack

No JavaScript
reference (name, line)
for ORA-04161

```
1 SQL> exec create_temp_table_js('my-table');
2
3 Error starting at line : 1 in command -
4 BEGIN create_temp_table_js('my-table'); END;
5 Error report -
6 ORA-04161: Database Error
7 ORA-44003: invalid SQL name
8 ORA-06512: at "SYS.DBMS_ASSERT", line 192
9 ORA-06512: at "DEMO.CREATE_TEMP_TABLE_JS", line 1
10 ORA-06512: at line 1
11 04161. 00000 - "%s"
12 *Cause:      A runtime error occurred while evaluating a Multilingual Engine
13              (MLE) code snippet or call specification.
14 *Action:     Fix the MLE language code that causes the runtime error. Use the
15              source location reported in the error message to identify the code
16              that needs to be fixed. Use the DBMS_MLE.get_error_stack or
17              DBMS_MLE.get_ctx_error_stack functions to retrieve the MLE language
18              stack trace for the error.
19
20 More Details :
21 https://docs.oracle.com/error-help/db/ora-04161/
22 https://docs.oracle.com/error-help/db/ora-44003/
23 https://docs.oracle.com/error-help/db/ora-06512/
```

```
1 SQL> exec create_temp_table_plsql('my-table');
2
3 Error starting at line : 1 in command -
4 BEGIN create_temp_table_plsql('my-table'); END;
5 Error report -
6 ORA-44003: invalid SQL name
7 ORA-06512: at "SYS.DBMS_ASSERT", line 192
8 ORA-06512: at "DEMO.CREATE_TEMP_TABLE_PLSQL", line 8
9 ORA-06512: at line 1
10 44003. 0000 - "invalid SQL name"
11 *Document: Yes
12 *Cause:      The input parameter string was not a valid SQL name.
13 *Action:     Check the DBMS_ASSERT specification to verify that the parameter
14              string is a valid SQL name.
15
16 More Details :
17 https://docs.oracle.com/error-help/db/ora-44003/
18 https://docs.oracle.com/error-help/db/ora-06512/
```

Value of ORA-04161?

PL/SQL from JavaScript as Workaround

```
1 create or replace mle module
2   create_temp_table_mod language javascript as
3
4 export function createTempTable(tableName) {
5   const result = session.execute(
6     `begin
7       :tab :=
8         dbms_assert.simple_sql_name(:tableName);
9     end;`,
10    {tab: {dir: oracledb.BIND_OUT}, tableName}
11  );
12
13  session.execute(
14    `create private temporary table
15      ora\${ptt_${result.outBinds.tab}} (id number)`
16  );
17 }
18 /
```

```
1 SQL> exec create_temp_table_js('my-table');
2
3 Error starting at line : 1 in command -
4 BEGIN create_temp_table_js('my-table'); END;
5 Error report -
6 ORA-44003: invalid SQL name
7 ORA-06512: at "SYS.DBMS_ASSERT", line 192
8 ORA-06512: at line 2
9 ORA-04171: at createTempTable (DEMO.CREATE_TEMP_TABLE_MOD:2:18)
10 ORA-06512: at "DEMO.CREATE_TEMP_TABLE_JS", line 1
11 ORA-06512: at line 1
12 44003. 0000 - "invalid SQL name"
13 *Document: Yes
14 *Cause:      The input parameter string was not a valid SQL name.
15 *Action:     Check the DBMS_ASSERT specification to verify that the parameter
16               string is a valid SQL name.
17
18 More Details :
19 https://docs.oracle.com/error-help/db/ora-44003/
20 https://docs.oracle.com/error-help/db/ora-06512/
21 https://docs.oracle.com/error-help/db/ora-04171/
```

ORA-04161 is gone,
JavaScript module in
the error stack

Assert in JavaScript

```
1 create or replace mle module
2   create_temp_table_mod language javascript as
3
4 import { simpleSqlName } from "sql-assert";
5
6 export function createTempTable(tableName) {
7   session.execute(
8     `create private temporary table
9       ora\${ptt_}${simpleSqlName(tableName)} (id number)`
10  );
11 }
12 /
```

```
1 SQL> exec create_temp_table_js('my-table');
2
3 Error starting at line : 1 in command -
4 BEGIN create_temp_table_js('my-table'); END;
5 Error report -
6 ORA-04161: Error: Invalid SQL name.
7 ORA-04171: at e (DEMO.SQL_ASSERT_MOD:7:463)
8 ORA-06512: at "DEMO.CREATE_TEMP_TABLE_JS", line 1
9 ORA-06512: at line 1
10 04161. 00000 - "%s"
11 *Cause:      A runtime error occurred while evaluating a Multilingual Engine
12              (MLE) code snippet or call specification.
13 *Action:     Fix the MLE language code that causes the runtime error. Use the
14              source location reported in the error message to identify the code
15              that needs to be fixed. Use the DBMS_MLE.get_error_stack or
16              DBMS_MLE.get_ctx_error_stack functions to retrieve the MLE language
17              stack trace for the error.
18
19 More Details :
20 https://docs.oracle.com/error-help/db/ora-04161/
21 https://docs.oracle.com/error-help/db/ora-04171/
```

Good ORA-04161 message,
get missing references via
dbms_mle.get_error_stack...

Get Missing Error Stack

```
1 SQL> exec create_temp_table_js('my-table');
2
3 Error starting at line : 1 in command -
4 BEGIN create_temp_table_js('my-table'); END;
5 Error report -
6 ORA-04161: Error: Invalid SQL name.
7 ORA-04171: at e (DEMO.SQL_ASSERT_MOD:7:463)
8 ORA-06512: at "DEMO.CREATE_TEMP_TABLE_JS", line 1
9 ORA-06512: at line 1
10 04161. 00000 - "%s"
11 *Cause:      A runtime error occurred while evaluating a Multilingual Engine
12              (MLE) code snippet or call specification.
13 *Action:     Fix the MLE language code that causes the runtime error. Use the
14              source location reported in the error message to identify the code
15              that needs to be fixed. Use the DBMS_MLE.get_error_stack or
16              DBMS_MLE.get_ctx_error_stack functions to retrieve the MLE language
17              stack trace for the error.
18
19 More Details :
20 https://docs.oracle.com/error-help/db/ora-04161/
21 https://docs.oracle.com/error-help/db/ora-04171/
```



John McEnroe, June 22, 1981

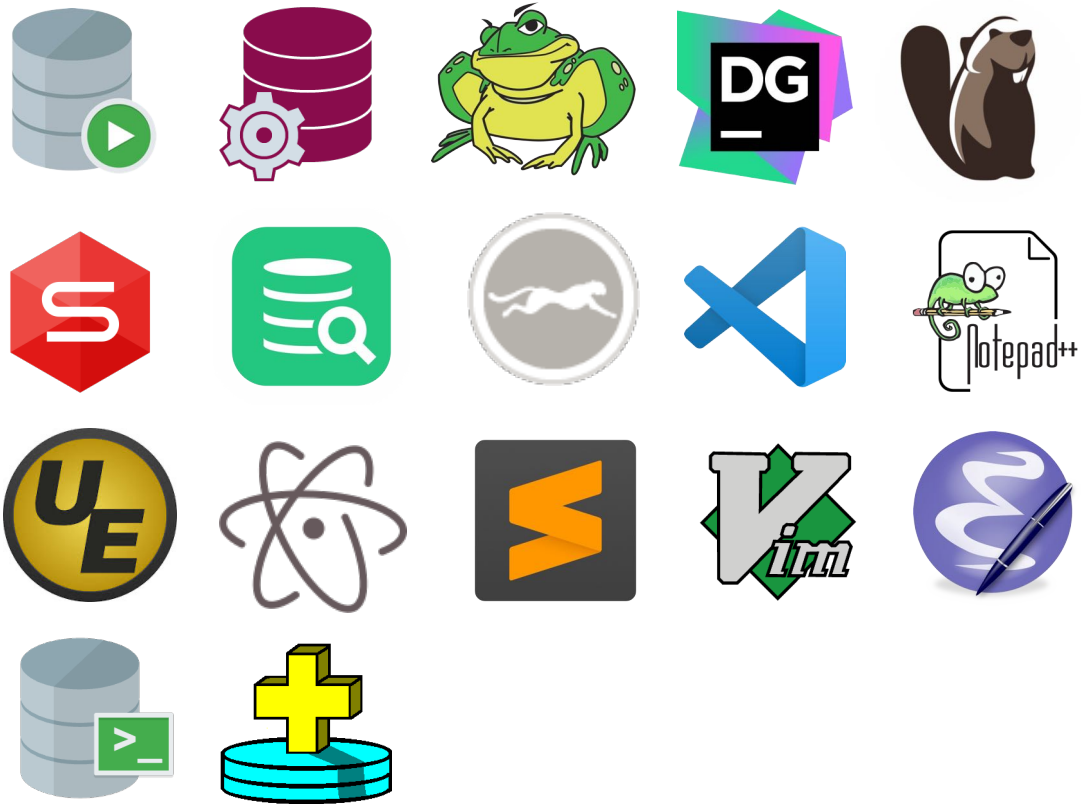
"You cannot
be serious!"

```
1 set serveroutput on size unlimited
2 declare
3     t_frames dbms_mle.error_frames_t;
4 begin
5     t_frames := dbms_mle.get_error_stack(
6         module_name => 'CREATE_TEMP_TABLE_MOD',
7         env_name     => 'DEMO_ENV'
8     );
9     for i in t_frames.count
10     loop
11         dbms_output.put_line(
12             'ORA-04171: at '
13             || t_frames(i).func
14             || ' ('
15             || t_frames(i).source
16             || ':'
17             || t_frames(i).line
18             || ':'
19             || t_frames(i).col
20             || ')'
21         );
22     end loop;
23 end;
24 /
25
26 ORA-04171: at createTempTable (DEMO.CREATE_TEMP_TABLE_MOD:6:20)
27
28
29 PL/SQL procedure successfully completed.
```

Development & Tooling

Development Tools

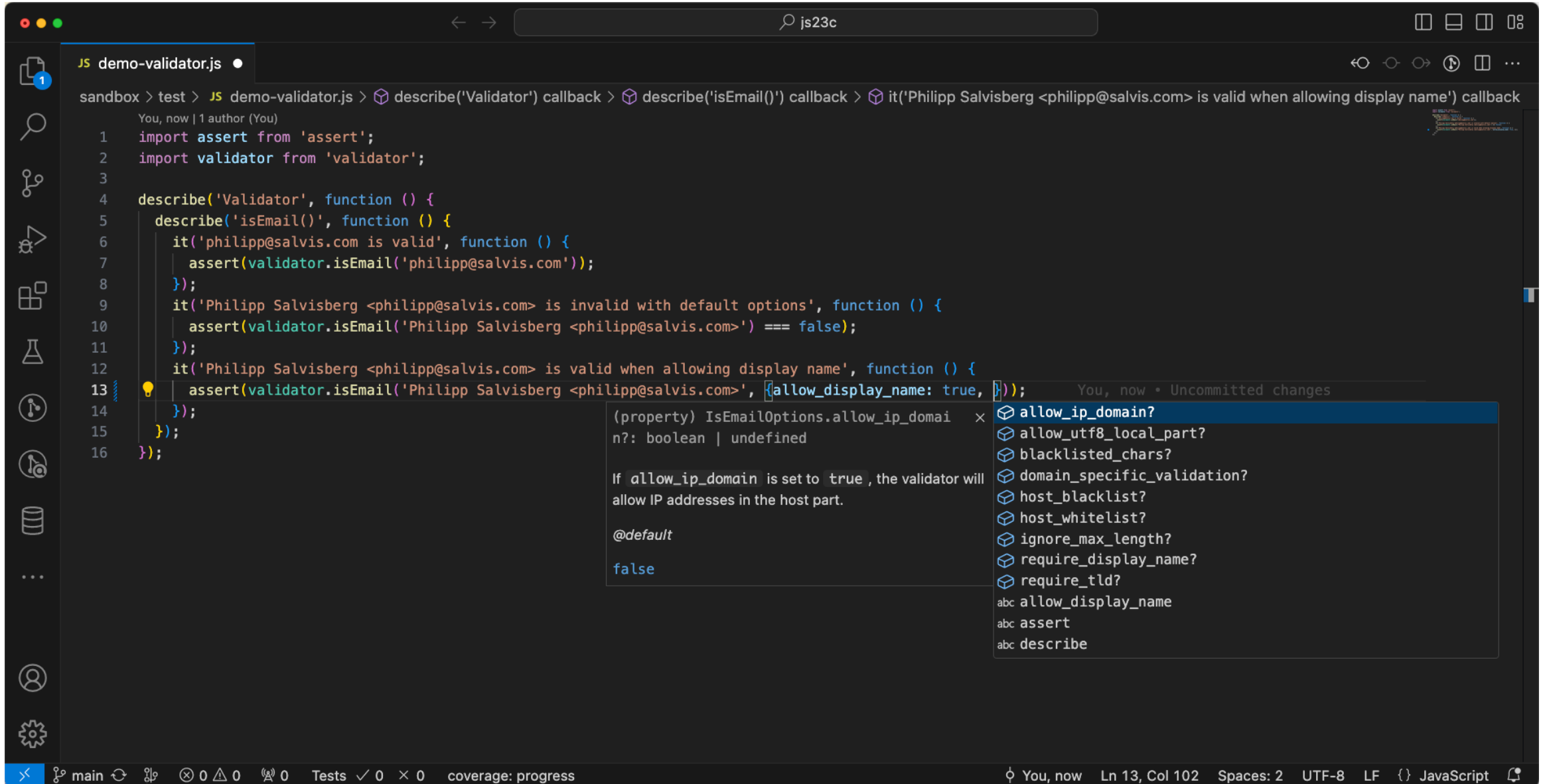
SQL & PL/SQL



JavaScript



IntelliSense in VS Code



Debugging in VS Code

The screenshot displays the VS Code interface during a debugging session. The sidebar on the left contains several panels:

- VARIABLES:** Shows the current state of variables. `options` is expanded, showing properties like `allow_display_name: true`, `allow_underscores: false`, `allow_utf8_local_part: true`, `blacklisted_chars: ''`, `host_blacklist: (0)`, `host_whitelist: (0)`, `ignore_max_length: false`, `require_display_name: false`, `require_tld: true`, `[[Prototype]]: Object`, `parts: undefined`, and `pattern: undefined`.
- WATCH:** Empty panel.
- CALL STACK:** Shows the call stack with `Node.js Process: npm [59456]` (RUNNING) and `mocha [59500]` (PAUSED ON BREAKPOINT). The current frame is `Object.isEmail sandbox/node_modules/valid...`.
- LOADED SCRIPTS:** Shows the loaded scripts, including `sandbox/test/demo-validator.js`.
- BREAKPOINTS:** Shows the breakpoints, including `demo-validator.js` at line 13.

The main editor displays the `isEmail.js` file. The code is as follows:

```
79 function isEmail(str, options) {
80   (0, _assertString.default)(str);
81   options = (0, _merge.default)(options, default_email_options);
82
83   if (options.require_display_name || options.allow_display_name) {
84     var display_email = str.match(splitNameAddress);
85
86     if (display_email) {
87       var display_name = display_email[1]; // Remove display name and angle brackets to get email address
88       // Can be done in the regex but will introduce a ReDOS (See #1597 for more info)
89
90       str = str.replace(display_name, '').replace(/(<|>)/g, ''); // sometimes need to trim the last space to get the display name
91       // because there may be a space between display name and email address
92       // eg. myname <address@gmail.com>
93       // the display name is `myname` instead of `myname `, so need to trim the last space
94
95       if (display_name.endsWith(' ')) {
96         display_name = display_name.slice(0, -1);
97       }
98       str = str.replace(display_name, 'Philipp Salvisberg');
99       if (!validateDisplayName(display_name)) {
100         return false;
101       }
102     }
103     if (options.require_display_name) {
```

The breakpoint is set at line 99. The terminal output shows the following messages:

```
Debugger attached.

increase_salary
  ✓ By 0 percent for dept 10 (400ms)

util
  toEpoch()
    ✓ Convert today to Unix Time

Validator
  isEmail()
    ✓ philipp@salvis.com is valid
    ✓ Philipp Salvisberg <philipp@salvis.com> is invalid with default options
```

MLE Post-Execution Debugging

```
1 set serveroutput on size unlimited
2 declare
3   co_breakpoints constant json := json(q'~
4 {
5   "version": "1.0",
6   "debugpoints": [
7     {
8       "at": {"name": "CREATE_TEMP_TABLE_MOD", "line": 4},
9       "actions": [{"type": "watch", "id": "tableName"}],
10      "condition": "tableName.includes('-')"
11    },
12    {
13      "at": {"name": "CREATE_TEMP_TABLE_MOD", "line": 12},
14      "actions": [{"type": "snapshot"}]
15    }
16  ]
17 }
18 ~');
19   l_sink          blob;
20   l_output         json;
21 begin
22   dbms_lob.createtemporary(l_sink, false, dbms_lob.call);
23   dbms_mle.enable_debugging(co_breakpoints, l_sink);
24   ut.run('test_create_temp_table.create_invalid_temp_table_js');
25   l_output := dbms_mle.parse_debug_output(l_sink);
26   dbms_output.put_line('MLE debug output: '
27     || chr(10)
28     || json_serialize(l_output returning clob pretty));
29   dbms_mle.disable_debugging();
30 end;
31 /
```

```
1 all
2   test_create_temp_table
3   js
4     create_invalid_temp_table_js [.039 sec]
5
6 Finished in .043893 seconds
7 1 tests, 0 failed, 0 errored, 0 disabled, 0 warning(s)
8
9 MLE debug output:
10 [
11   [
12     {
13       "at" :
14       {
15         "name" : "DEMO.CREATE_TEMP_TABLE_MOD",
16         "line" : 4
17       },
18       "values" :
19       {
20         "tableName" : "TEST-JS"
21       }
22     }
23   ]
24 ]
25
26
27 PL/SQL procedure successfully completed.
```

Debugging in Database Actions

ORACLE Database Actions | MLE JS

Search

?

DEMO

Navigator

Snippets

DEMO

Modules

Search...

CREATE_TEMP_TABLE_MOD

Environments

DEMO_ENV

Call Specifications

CREATE_TEMP_TABLE_JS

INCREASE_SALARY_LOOP_MOD

INCREASE_SALARY_MOD

JIMP_MOD

SENTIMENT_MOD

SQL_TEMPLATE_TAG_MOD

UTIL_MOD

VALIDATOR_MOD

Environments

DEMO_ENV

Call Specifications

VALIDATOR_API

IS_EMAIL

IS_EMAIL

Editor

Snippet

snippet_debug_create_temp_table*

Environment

DEMO_ENV

Debug Specification

create_temp_table_mod_debug

1 {
2 async() => {
3 const ctt = await import('create_temp_table');
4 ctt.createTempTable('ok');
5 }
6 }();

Output

Debug Console

"create_temp_table" - line 12

result: {"metaData":{"name":"TAB"},"rows":{"TAB":"ok"}}
conn: {"_parameters":{"_extendedMetaData":false,"_fetchArraySize":10,"_fetchAsPsqlWrapper":[],"_fetch/this: {}
tableName: ok

1 import oracledb from "mle-js-oracledb";
2
3 export function createTempTable(tableName) {
4 const conn = oracledb.defaultConnection();
5
6 // may throw a "ORA-04161: Database Error" without reference to this module (bad)
7 const result = conn.execute(
8 `select dbms_assert.simple_sql_name(:tableName) as tab`,
9 [tableName]
10);
11
12 conn.execute(
13 `create private temporary table ora\${ptt}\${result.rows[0].TAB} (id number)`
14);
15 }
16
17 export function createTempTable2(tableName) {
18 const conn = oracledb.defaultConnection();
19
20 // may throw a "ORA-44003: invalid SQL name" with reference to this module (good)
21 const result = conn.execute(
22 `begin
23 :tab := dbms_assert.simple_sql_name(:tableName);
24 end;`,
25 {tab: {dir: oracledb.BIND_OUT}, tableName}
26);

2 0 1:37:09 PM - REST call resolved successfully.

Powered by ORDS

Key Messages

Pros & Cons

PL/SQL



Pros

- Faster runtime
- Lower SQL injection risk
- Lower memory consumption
- All data types are supported
- Fastest startup times



Open

- Compile-time dependencies (static SQL)



Cons

- Less ready-to-use 3rd party libs
- Rudimentary ecosystem
- Less popular, more difficult to find devs
- Slower evolution – feels old

vs

JavaScript



Pros

- More ready-to-use 3rd party libs [npm](#)
- Excellent ecosystem
- More popular, easier to find devs
- Faster evolution – feels modern
- Fast startup times



Open

- Runtime dependencies (dynamic SQL)



Cons

- Slower runtime (gap is disappointing)
- Higher SQL injection risk
- Higher memory consumption
- No support for long, long raw, xmltype, object types, bfile, ref cursor

Is Tom Kyte's Mantra Still Valid?

"I have a pretty simple mantra when it comes to developing database software, one that has been consistent for many years:

- You should do it in a single **SQL** statement if at all possible. And believe it or not, it is almost always possible. This statement is even truer as time goes on. SQL is an extremely powerful language.
- If you can't do it in a single SQL Statement, do it in **PL/SQL**—as little PL/SQL as possible! Follow the saying that goes "more code = more bugs, less code = less bugs."
- If you can't do it in PL/SQL, try a **Java** stored procedure. The times this is necessary are extremely rare nowadays with Oracle9i and above. PL/SQL is an extremely competent, fully featured 3GL.
- If you can't do it in Java, do it in a **C** external procedure. This is most frequently the approach when raw speed or using a third-party API written in C is needed.
- If you can't do it in a C external routine, you might want to seriously think about why it is you need to do it. "

-- Tom Kyte, *Expert Oracle Database Architecture, Third Edition, 2014, page 13*

1 Consider the [technical dept.](#)

2 If you can't do it in a single SQL Statement, do it in PL/SQL or JavaScript...



Welcome JavaScript in the Oracle Database

- **Excellent for ...**

- Reusing existing algorithms to process data
- Example npm modules:
 - [validator](#) (isMail, isEAN, isIBAN, isCreditCard, isHash, ...)
 - [sentiment](#) (sentiment analysis of arbitrary text)
 - [jimp](#) (image processing as replacement for Oracle Multimedia)
 - [sql-assert](#) (alternative for dbms_assert to avoid SQL injection)

- **However, ...**

- Develop and test MLE modules outside of the DB
- Avoid the use of DBMS_MLE whenever possible
- Use connection pools and monitor resource usage
- JavaScript is not for everything ...
 - ... consider using DB features before reinventing things



Source: https://en.wikipedia.org/wiki/Hotel_California

"a journey
from innocence
to experience"

-- Don Henley



Thank You