WELCOME

Modern PL/SQL Code Checking and Dependency Analysis

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BASEL BERN LAUSANNE ZÜRICH DÜSSELDORF FRANKFURT A.M. FREIBURG I.BR. HAMBURG MÜNCHEN STUTTGART WIEN

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About Me

- With Trivadis since April 2000
  - Senior Principal Consultant
  - Partner
  - Member of the Board of Directors
  - philipp.salvisberg@trivadis.com
  - www.trivadis.com
- Member of the trivadis performanceteam

- Main focus on database centric development with Oracle DB
  - Application Performance Management
  - Application Development
  - Business Intelligence
- Over 20 years experience in using Oracle products

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AGENDA

1. Introduction
2. Xtext Live – Parsing & Validating
3. Finalizing Grammar, Checks and Tooling
4. Dependency Analysis
5. Challenges
6. Conclusion

PL/SQL & SQL Coding Guidelines

Coding Guidelines are a crucial part of software development. It is a matter of fact, that code is more often read than written – therefore we should take efforts to ease the work of the reader, which is not necessarily the author.
I am convinced that this standard may be a good starting point for your own guidelines.

Roger Troller
Senior Consultant Trivadis

"Roger and his team have done an excellent job of providing a comprehensive set of clear standards that will undoubtedly improve the quality of your code. If you do not yet have standards in place, you should give strong consideration to using these as a starting point."

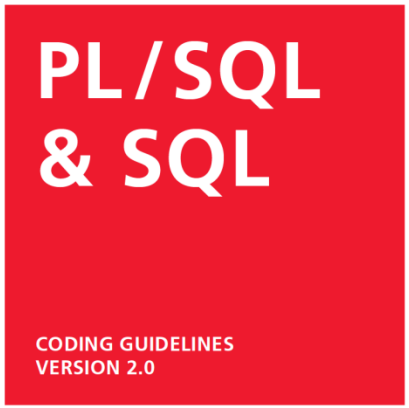
Steven Feuerstein

Steven Feuerstein
PL/SQL Evangelist

- Openly available since August 2009
- Download for free from www.trivadis.com

See http://www.trivadis.com/technologie/oracle/oracle-application-development/oracle-sql-und-plsql.html

Trivadis PL/SQL & SQL Guideline #26



26. Always specify the target columns when executing an insert command.

Reason: Data structures often change. Having the target columns in your insert statements will lead to change-resistant code.

Example:

```
-- Bad
INSERT INTO messages
    VALUES (l_mess_no
           ,l_mess_typ
           ,l_mess_text );
```

```
-- Good
INSERT INTO messages (mess_no
                     ,mess_typ
                     ,mess_text )
  VALUES (l_mess_no
         ,l_mess_typ
         ,l_mess_text );
```

PL/SQL Assessment

- Code Analysis based on Trivadis SQL & PL/SQL Guidelines
- Cookbook using e.g.
  - Quest CodeXpert
  - SQL Scripts using PL/Scope
  - SQL Scripts
  - Manual checks
  - Interviews
- Final Report
  - Results
  - Recommendations
- Fixed Price Offering

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Shortcoming of PL/SQL Assessment

- Some guidelines check scripts need manual post-processing
- Some guidelines checks are not automated at all
- One snapshot – Assessment of a defined release
- Repetitive execution is time-consuming, expensive, not feasible
- Not part of an automated, continuous integration strategy

Goal

- Fully automated code checking
- Considering the Trivadis PL/SQL & SQL Guidelines
- Extendable and adaptable to suit customer needs
- Part of an automated build process

Approach & Considerations

- Requirements
  - Parser to process SQL*Plus files
  - Code checking framework
- Options
  - SQL & PL/SQL grammar as part of Oracle JDeveloper Extensions
    - http://www.oracle.com/technetwork/developer-tools/jdev/index-099997.html, see class oracle.javatools.parser.plsql.PlsqlParser
    - Required libraries (javatools-nodeps.jar) are part of SQL Developer
  - ANTLR
    - Several SQL & PL/SQL grammars on http://www.antlr.org/grammar/list
  - Eclipse Xtext
    - Framework for development of textual domain specific languages (DSL)
    - Used successfully to generate database access layer for bitemporal tables
    - Uses ANTLR behind the scenes

Xtext Features

- Eclipse-based Editors
  - Validation and Quick Fixes
  - Syntax Coloring
  - Code Completion
  - Outline View
  - Code Formatting
  - Bracket Matching
- Integration
  - Eclipse Modeling Framework (e.g. for graphical editors)
  - Eclipse Workbench (e.g. for list of problems/warnings)
  - Export into self-executing JAR (e.g. to build a command-line utility)

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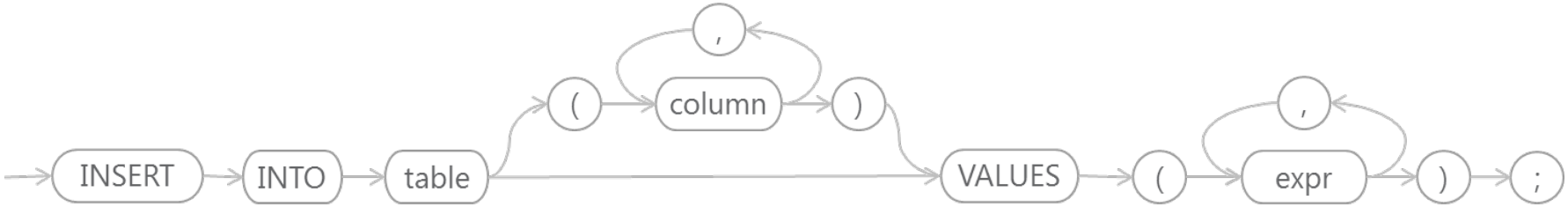
Demo Grammar (BNF)

insert_statement::=



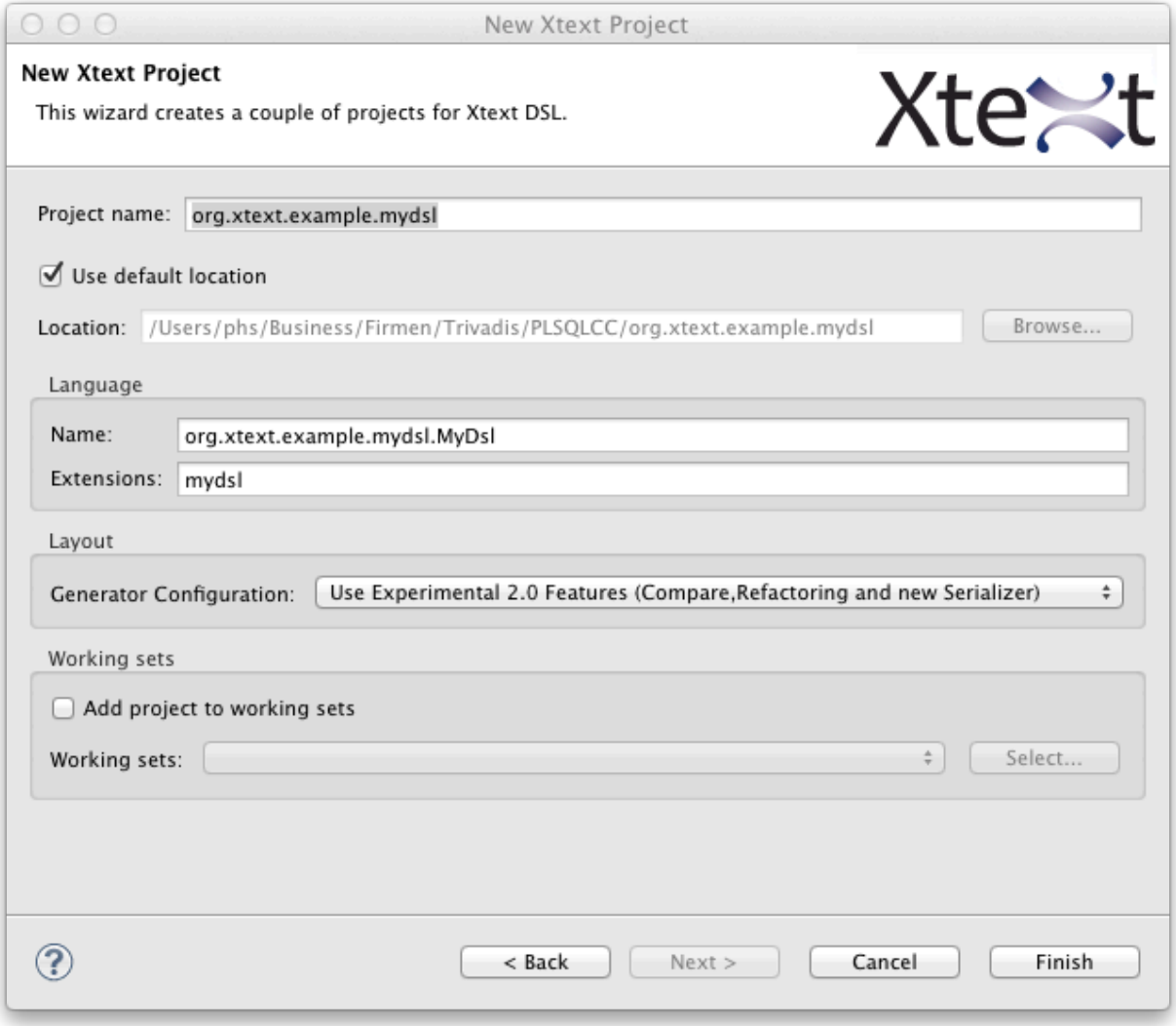

```
INSERT INTO table [( column [, column ]... )]
VALUES ( expr [, expr ]... ) ;
```

plsql_unit::=


```
BEGIN insert_statement END ;
```

Default Xtext Project

DEMO



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Demo Grammar (Xtext)

DEMO

Java – org.xtext.example.mydsl/src/org/xtext/example/mydsl/MyDsl.xtext – Eclipse SDK...

MyDsl.xtext

```
grammar org.xtext.example.mydsl.MyDsl with org.eclipse.xtext.common.Terminals

generate myDsl "http://www.xtext.org/example/mydsl/MyDsl"

sqlFile:
     command+=Command*
;

Command:
      InsertStatement
    | PlsqlUnit
;


InsertStatement:
    'insert' 'into' tableName=ID ('(' columns+=ID (',' columns+=ID)* ')')?
    'values' '(' expr+= Expression (',' expr+=Expression)* ')' ';'
;

PlsqlUnit:
    'begin' insertStmt=InsertStatement 'end' ';'
;

Expression:
    ID | INT | STRING
;
```

Writable | Insert

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Eclipse Editors

DEMO

Java – test/src/test.mydsl – Eclipse SDK

test.mydsl

platform:/resource/test/src/test.mydsl
- Sql File
  - Insert Statement t1
  - Plsql Unit
    - Insert Statement t2
  - Insert Statement t3

```
insert into t1 (a,b,c) values (1,2,3);

begin
   insert into t2 values (1,2,3);
end;

insert into t3 values (1,2,'3');
```

Outline

- <unnamed>
  - t1
- <unnamed>
  - t2
  - t3

Problems | Javadoc | Declaration | Properties

Property	Value

Writable | Insert | 4 : 6

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Validator for Guideline #26

DEMO

Java – org.xtext.example.mydsl/src/org/xtext/example/mydsl/validation/MyDslJavaValidator.java – Eclipse SDK – /Users/phs...

MyDsl.xtext | MyDslJavaValidator.java

```java
package org.xtext.example.mydsl.validation;

import org.eclipse.xtext.validation.Check;
import org.xtext.example.mydsl.myDsl.InsertStatement;
import org.xtext.example.mydsl.myDsl.MyDslPackage;


public class MyDslJavaValidator extends AbstractMyDslJavaValidator {

    @Check
    public void checkGuideline26(InsertStatement insertStatement) {
        if (insertStatement.getColumns().isEmpty()) {
            warning("Guideline 26 violated: Always specify the target columns when executing an insert command.",
                    MyDslPackage.Literals.INSERT_STATEMENT__TABLE_NAME);
        }
    }

}
```

Writable | Smart Insert | 10 : 1

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Validator in Action

DEMO

Java – demo/src/demo.mydsl – Eclipse SDK

demo.mydsl

platform:/resource/demo/src/demo.mydsl
- Sql File
  - Insert Statement t1
  - Plsql Unit
    - Insert Statement t2
  - Insert Statement t3

```
insert into t1 (a, b, c) values (1, 2, 3);

begin
   insert into t2 values (1, 2, 3);
end;

insert into t3 values (1, 2, '3');
```

Guideline 26 violated: Always specify the target columns when executing an insert command.

Outline

An outline is not available.

Problems | Javadoc | Declaration

0 errors, 2 warnings, 0 others

Description	Resource	Path	Location	Type
Warnings (2 items)				
Guideline 26 violated: Always specify the target columns when executing an insert command.	demo...	/demo/src	line: 4 /demo/src/demo.mydsl	Xtext Check
Guideline 26 violated: Always specify the target columns when executing an insert command.	demo...	/demo/src	line: 7 /demo/src/demo.mydsl	Xtext Check

Selected Object: Insert Statement t3

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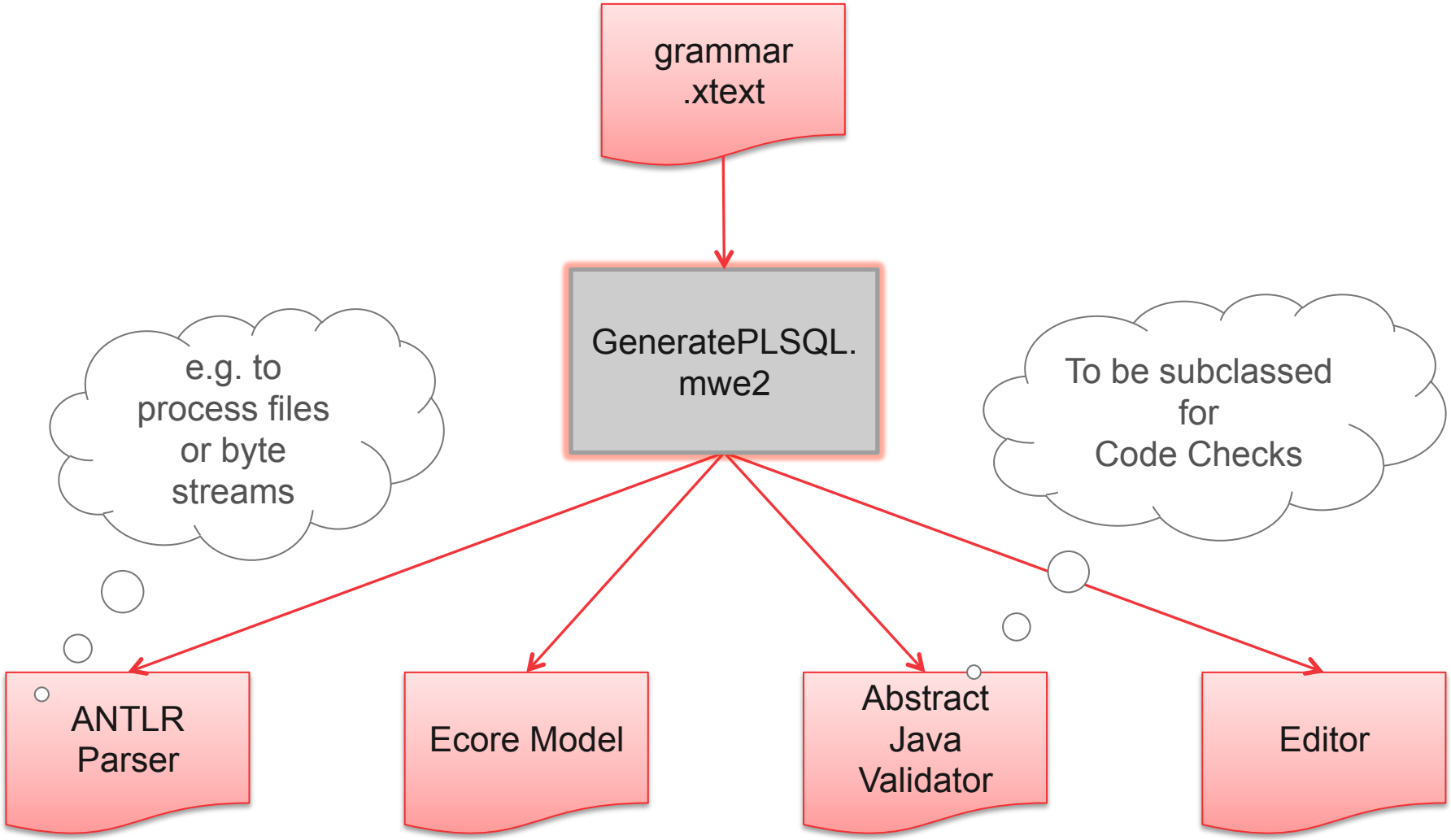
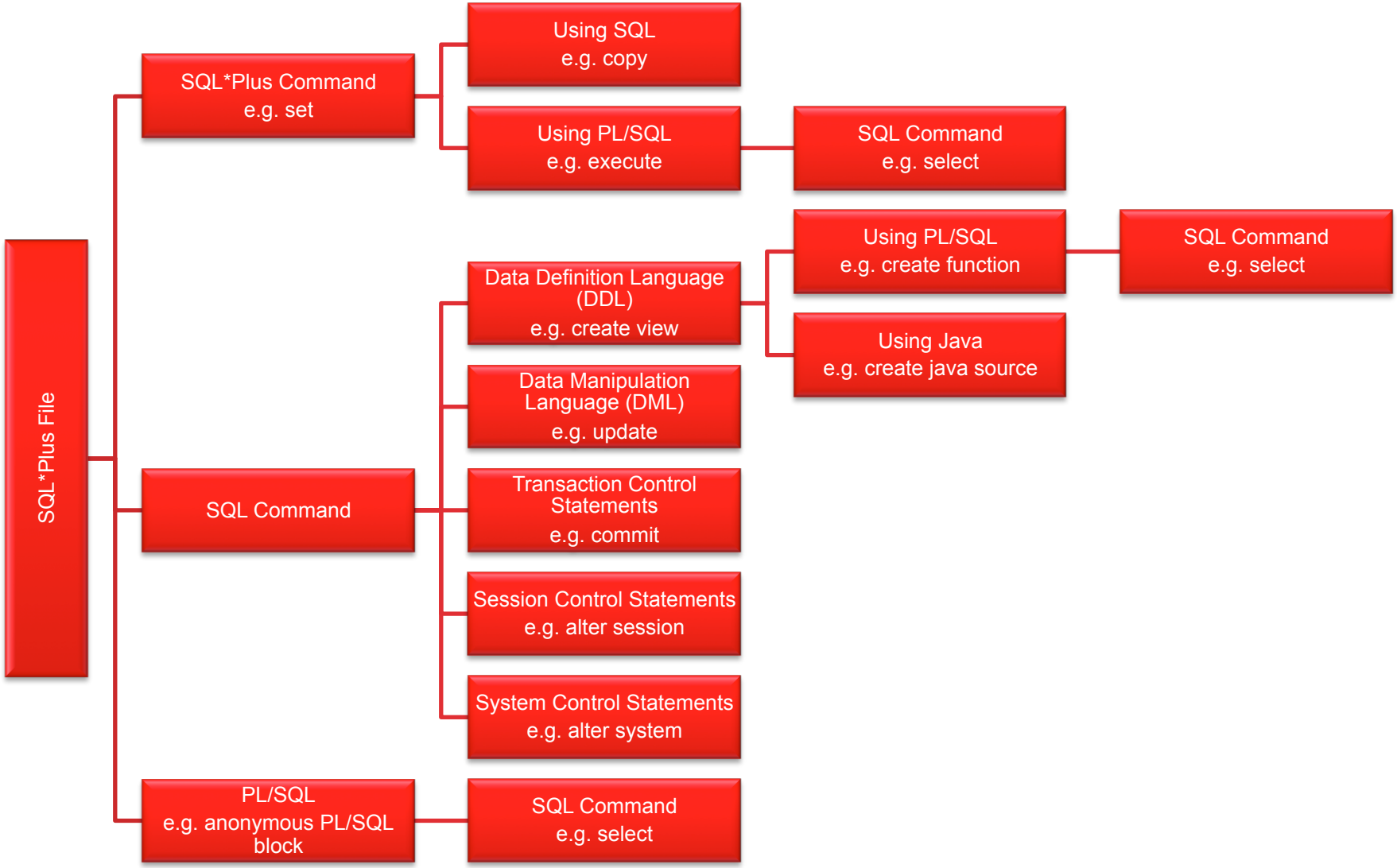
Generate Grammar via Xtext



Content of a SQL*Plus File



Complete Single Grammar Approach

- One, huge grammar (SQL*Plus, PL/SQL, SQL, Java)
- Conflicting keywords between SQL*PLUS and SQL, PL/SQL
  - "describe" is a SQL*Plus keyword, but not a reserved word in SQL (valid for table etc.)
  - Abbreviatory notation of SQL*Plus, e.g.
    - run command (r | ru | run)
    - accept command (a | ac | acc | acce | accep | accept)
- Grammar for a lot of complex commands which are not in focus for any analysis (e.g. CREATE DATABASE)
- Xtext and ANTLR cannot handle such a huge grammar
  - Maximum size of 64 KB for Java classes and methods
  - Maximum number of 65535 fields for Java classes

Reduced Single Grammar Approach

- One grammar, still huge
- Skeleton definition for less interesting commands
  - Swallow everything between start and end keywords

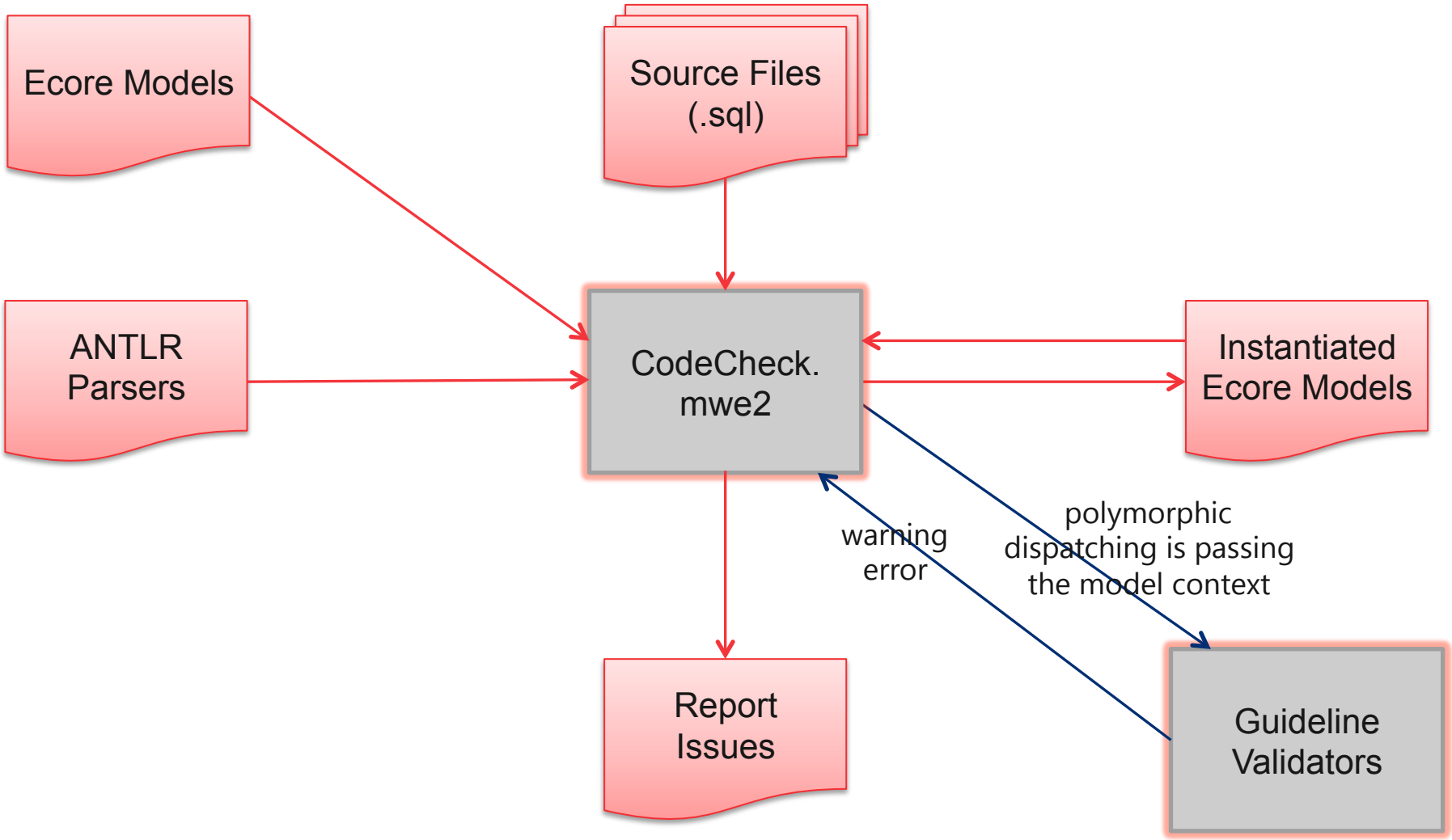
```
TtitleCommand: {TtitleCommand}
K_TTITLE3 text=GenericText? =>SqlPlusCmdEnd;
```

  - Necessary to avoid parse errors which would lead to incomplete analysis
- Complete definition of more interesting commands (e.g. SELECT)
- Not feasible before Xtext 2.0.1 because of generator limitations
- Still conflicting keywords between SQL*PLUS and SQL, PL/SQL

Multiple Grammar Approach

- Skeleton grammar for SQL*Plus files (SQL*Plus, SQL, PL/SQL, Java)
- Complete grammar for PL/SQL and more interesting SQL commands (e.g. CREATE VIEW)
- Chaining grammars
  - Parse SQL*Plus files using SQL*Plus parser
  - Parse PL/SQL and chosen SQL commands in SQL*Plus validator
  - Apply guidelines checks in PL/SQL validator
- No conflicting keywords between SQL*PLUS and SQL, PL/SQL

Apply Code Checks (via Command Line)



Source, Model & Warning for Guideline #26

```
BEGIN
   INSERT INTO app_messages
   VALUES
      (mesg_seq.nextval,
       p_mesg_type,
       p_mesg_name,
       p_mesg_text);
END;
/
```

line 2 - Guideline 26 violated: Always specify the target columns when executing an insert command.

Generic Editor – guideline_26.plsql

Model

- platform:/resource/test/guideline_26.plsql
  - PLSQL File
    - Insert
      - Insert Statement
        - Single Table Insert
          - Insert Into Clause
            - Dml Table Expression Clause
          - Values Clause
            - Parenthesis Expression false
              - Function Or Parenthesis Parameter List Expression
                - Function Or Parenthesis Parameter
                - Binary Compound Expression Level6 .
                - Simple Expression Name Value mesg_seq
                - Simple Expression Name Value nextval
                - Function Or Parenthesis Parameter
                - Simple Expression Name Value l_mesg_type
                - Function Or Parenthesis Parameter
                - Simple Expression Name Value l_mesg_name
                - Function Or Parenthesis Parameter
                - Simple Expression Name Value l_mesg_text
                - Function Parameter List Suffix

Excerpt of Grammar for Insert Statement

```
InsertStatement:
    InsertPlusHintsAndComments
        (
              singleTableInsert=SingleTableInsert
            | multiTableInsert=MultiTableInsert
        )
;

InsertPlusHintsAndComments returns InsertStatement hidden(WS/*, SL_COMMENT, ML_COMMENT*/):
    {InsertStatement}
    'insert' (hints+=HintOrComment)*
;

SingleTableInsert:
    intoClause=InsertIntoClause
        (
              (valuesClause=ValuesClause returningClause=ReturningClause?)
            | (subquery=SelectStatement)
        ) errorLoggingClause=ErrorLoggingClause?
;

InsertIntoClause:
    'into' dmlExpressionClause=DmlTableExpressionClause alias=SqlName?
        ('(' columns+=QualifiedColumnAlias (',' columns+=QualifiedColumnAlias)* ')')?
;

// simplified to support forall values clause
ValuesClause:
    'values' expression=Expression
;
```

Validator for Guideline #26

```java
@Check
public void checkGuideline26(InsertIntoClause intoClause) {
    // column list empty?
    if (intoClause.getColumns().isEmpty()) {
        InsertStatement insert = EcoreUtil2.getContainerOfType(intoClause,
                InsertStatement.class);
        // model must be wrong if no insert is found
        if (insert != null) {
            Boolean ignore = false;
            SingleTableInsert singleTableInsert = insert
                    .getSingleTableInsert();
            // check for record variable in single table inserts
            if (singleTableInsert != null) {
                ValuesClause valuesClause = singleTableInsert
                        .getValuesClause();
                // ensure it's a values clause
                if (valuesClause != null) {
                    Expression expr = valuesClause.getExpression();
                    // not a column list in parenthesis?
                    if (!(expr instanceof ParenthesisExpression)) {
                        // must be a record variable
                        ignore = true;
                    }
                }
            }
            if (!ignore) {
                warning("Guideline 26 violated: Always specify the target columns when executing an insert command.",
                        intoClause.getDmlExpressionClause(), null,
                        GUIDELINE_26,
                        serialize(NodeModelUtils.getNode(insert)
                                .getParent()));
            }
        }
    }
}
```

```oracle
CREATE OR REPLACE PROCEDURE p_test(i_deptno NUMBER,
                                   i_dname  VARCHAR2,
                                   i_loc    VARCHAR2) IS
   l_record dept%ROWTYPE;
BEGIN
   l_record.deptno := i_deptno;
   l_record.dname  := i_dname;
   l_record.loc    := i_loc;
   INSERT INTO dept VALUES l_record;
END;
/
```

Build Runnable JAR

Runnable JAR File Export

Runnable JAR File Specification

Program arguments will not be part of the runnable JAR. Arguments can be passed on the command line when launching the JAR

Launch configuration:

CodeCheckAsJava - com.trivadis.codecheck

Export destination:

/usr/local/bin/tvdcc/codecheck.jar

Browse...

Library handling:

- Extract required libraries into generated JAR
- Package required libraries into generated JAR
- Copy required libraries into a sub-folder next to the generated JAR

Save as ANT script

ANT script location:

Browse...

< Back | Next > | Cancel | Finish

Command Line Interface

DEMO

```
processing file 'guideline_63.sql'... 1 issue found.
processing file 'guideline_64.sql'... 1 issue found.
processing file 'oracle_sql_plus_reference_examples.sql'... no issues found.
processing file 'oracle_sql_reference_examples.sql'... 39 issues found.
processing file 'px_granuale_from_clause.sql'... no issues found.
processing file 'test_declaresection.sql'... no issues found.
processing file 'test_refcursorreturntypes.sql'... no issues found.
processing file 'test_referencetypes.sql'... no issues found.

Summary:
- Total files: 29
- Total bytes: 302038
- Total lines: 9524
- Total commands: 1020
- Total issues: 153
- Total warnings: 153
- Total errors: 0
- Total processing time in seconds: 13.267

transforming tvdcc_report.xml into tvdcc_report.html... done.
transforming tvdcc_report.xml into tvdcc_report.xlsx... done.
cleanup completed.
```

XML, HTML, Excel Strategies

Console Strategy

File overview

File name	# warnings	# errors	# bytes	# lines	# cmds	Elapsed seconds
sample/f2qapenv.sql	66	0	159,623	4,307	4	8.322
sample/oracle_sql_reference_examples.sql	39	0	104,634	3,559	624	2.292
sample/guideline_03.sql	9	0	820	35	2	0.052
sample/guideline_01.sql	7	0	1,073	70	2	0.216
sample/guideline_02.sql	7	0	1,179	75	2	0.039
sample/guideline_04.sql	5	0	1,391	62	2	0.049
sample/guideline_06.sql	3	0	543	32	3	0.042
sample/guideline_15.sql	3	0	469	27	2	0.065
sample/guideline_16.sql	3	0	447	27	2	0.026
sample/guideline_09.sql	1	0	554	24	3	0.033
sample/guideline_11.sql	1	0	239	17	2	0.025
sample/guideline_12.sql	1	0	287	21	2	0.036
sample/guideline_13.sql	1	0	699	27	2	0.042
sample/guideline_14.sql	1	0	1,105	39	2	0.039
sample/guideline_17.sql	1	0	289	21	2	0.024
sample/guideline_26.sql	1	0	325	9	2	0.027
sample/guideline_51.sql	1	0	433	23	2	0.017
sample/guideline_58.sql	1	0	521	23	2	0.035
sample/guideline_63.sql	1	0	570	25	2	0.033
sample/guideline_64.sql	1	0	435	16	2	0.020
sample/guideline_05.sql	0	0	651	38	3	0.038
sample/guideline_07.sql	0	0	289	19	2	0.013
sample/guideline_08.sql	0	0	478	25	2	0.027
sample/guideline_10.sql	0	0	425	22	3	0.128
sample/oracle_sql_plus_reference_examples.sql	0	0	19,697	843	340	0.157
sample/px_granuale_from_clause.sql	0	0	4,110	111	1	0.051
sample/test_declaresection.sql	0	0	35	5	1	0.010
sample/test_refcursorreturntypes.sql	0	0	416	16	1	0.028
sample/test_referencetypes.sql	0	0	301	6	1	0.009
Total	153	0	302,038	9,524	1,020	11.895

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Customer Use Case

- Starting Position
  - Database centric application environment
    (business logic within the database)
  - Views are granted to roles and additionally protected by FGAC policies
  - Views are accessible via GUI and 3rd party products
  - Some columns contain sensitive data
    (e.g. turnover, margins, costs per order/customer)
- Questions to be answered
  - Which views present sensitive data as columns?
  - Who may access these data?

Sample – View SH.PROFITS (existing)

Which view columns use COSTS.UNIT_COST?

```
CREATE OR REPLACE VIEW PROFITS AS
SELECT s.channel_id,
       s.cust_id,
       s.prod_id,
       s.promo_id,
       s.time_id,
       c.unit_cost,
       c.unit_price,
       s.amount_sold,
       s.quantity_sold,
       c.unit_cost * s.quantity_sold TOTAL_COST
 FROM  costs c, sales s
 WHERE c.prod_id = s.prod_id
   AND c.time_id = s.time_id
   AND c.channel_id = s.channel_id
   AND c.promo_id = s.promo_id;
```

Sample – View SH.GROSS_MARGINS (new)

Which view columns use PROFITS.UNIT_COST, PROFITS.TOTAL_COST?

```
CREATE OR REPLACE VIEW GROSS_MARGINS AS
WITH gm AS
 (SELECT time_id, revenue, revenue - cost AS gross_margin
    FROM (SELECT time_id,
                 unit_price * quantity_sold AS revenue,
                 total_cost AS cost
            FROM profits))
SELECT t.fiscal_year,
       SUM(revenue) AS revenue,
       SUM(gross_margin) AS gross_margin,
       round(100 * SUM(gross_margin) / SUM(revenue), 2)
            AS gross_margin_percent
  FROM gm
 INNER JOIN times t ON t.time_id = gm.time_id
 GROUP BY t.fiscal_year
 ORDER BY t.fiscal_year;
```

Sample – View SH.REVENUES (new)

Which view columns use GROSS_MARGINS.GROSS_MARGIN, GROSS_MARGINS.GROSS_MARGIN_PERCENT?

```
CREATE OR REPLACE VIEW REVENUES AS
SELECT fiscal_year, revenue
  FROM gross_margins;
```

Sample – View SH.SALES_ORDERED_BY_GM (new)

Which view columns use PROFITS.UNIT_COST, PROFITS.TOTAL_COST?

```
CREATE OR REPLACE VIEW SALES_ORDERED_BY_GM AS
SELECT channel_id,
       cust_id,
       prod_id,
       promo_id,
       time_id,
       amount_sold,
       quantity_sold
  FROM profits
 ORDER BY (unit_price - unit_cost) DESC;
```

unit_cost is not part of a column expression

Approach

- Use PL/Scope (DBA_IDENTIFIERS)
  - Not applicable, PL/Scope collects data for PL/SQL source data only
- Query the Oracle data dictionary (DBA_DEPENDENCIES)
  - No column dependencies
- Create own Oracle data dictionary view with column dependencies (which are internally available since 11gR1)
  - See Rob van Wijk's post about DBA_DEPENDENCY_COLUMNS
  - No usage context
    (part of column expression, part of where clause, part of order by clause?)
  - No relation to affected view columns
- Use a PL/SQL parser in conjunction with data dictionary queries
  - Query Oracle dictionary to get dependent views and DDLs
  - Parse DDLs to get affected view columns

Which Parser? How to Use?

- Oracle Parser if applicable
  - E.g. UTL_XML.PARSEQUERY, see http://www.salvis.com/blog/?p=117
- Use 3rd party in other cases
  - Get parse tree as XML
  - Wrapped to be used within the database to allow analyis in conjunction with Oracle data dictionary

```
SQL> SELECT *
  2  FROM TABLE(coldep_pkg.get_dep('sh', 'costs', 'unit_cost'));

SCHEMA_NAME VIEW_NAME     COLUMN_NAME
----------- ------------- --------------------
SH          PROFITS       UNIT_COST
SH          PROFITS       TOTAL_COST
SH          GROSS_MARGINS GROSS_MARGIN
SH          GROSS_MARGINS GROSS_MARGIN_PERCENT
```

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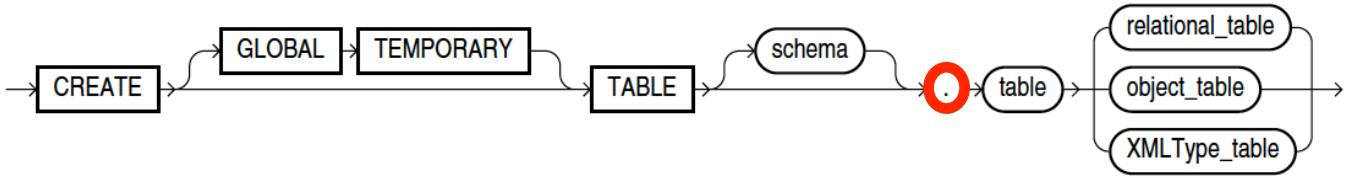
Xtext

- One grammar, one Parser
  - The workflow GeneratePLSQL.mwe2 needs 4 minutes to complete
  - Bug 256403 - Multiple Grammar Mixin / Grammars as Library
- Maximum size of 64 KB for Java classes and methods
  - Use Xtext 2.0.1 and later to address "... is exceeding 65535 bytes ..." errors
- Output of underlying parser generator is passed 1:1 to the user
  - Fundamental knowledge of ANTLR is mandatory
  - Ability to distinguish between ANTLR and Xtext artifacts is necessary
- Convention over configuration
  - The first DSL incl. editors are created very fast using Xtext
  - Typically it's working but you easily do not know why and how
  - Usually things may be amended very elegantly and with just a few lines of code (e.g. outline, validators, formatter)
  - However, to find out what to do could take a serious time for an inexperienced fellow

Grammar

- Undocumented, old or incorrect grammar may break the parser
  - "timestamp" clause for packages, procedures and functions
  - Use of "id" or "oid" instead of "identifier" for object views
- Documentation bugs may lead to wrong grammar



- User defined operators lead to ambiguous grammar
  - Probably solvable by refactoring the Expression and Condition parser rules
  - The workaround is, to simply add the customer's operators when needed

SQL*Plus – CodeChecker Limitations

- The block terminator character '.' is not supported (nor configurable)
- The command separator character ';' is not supported (nor configurable)
- The SQLTerminator is not configurable, the default ';' is supported
- The line continuation character '-' does not support tailing whitespaces
- REMARK and PROMPT must not contain unterminated single/double quotes, single line or multi line comments (these commands cannot be defined as terminals because of conflicts with other parser rules – mainly identifiers)

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Conclusion

PL/SQL & SQL

Tooling

- The grammar to parse SQL*Plus files is huge
  - Chaining multiple parsers is the way to go
- Xtext is a complete DSL framework
  - More than just a parser generator
  - Separation of parser and validators
  - Promising for further applications like code fixing, presenting graphical models, calculating complexity, etc.
- Even if a significant subset of the SQL*Plus, SQL, PL/SQL grammar needs to be maintained continuously, Xtext is a good choice to implement the future PL/SQL CodeChecker and Dependency Analysis requirements

THANK YOU.

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