Better PL/SQL

Philipp Salvisberg
Senior Principal Consultant

Philipp Salvisberg

- Trivadian since April 2000
  - Senior Principal Consultant, Partner
  - Member of the Board of Directors
  - philipp.salvisberg@trivadis.com
  - www.salvis.com/blog
  - @phsalvisberg
- Database centric development with Oracle database
- Over 20 years experience in using Oracle products
- Author of SQL Developer Extensions PL/SQL Cop und PL/SQL Unwrapper

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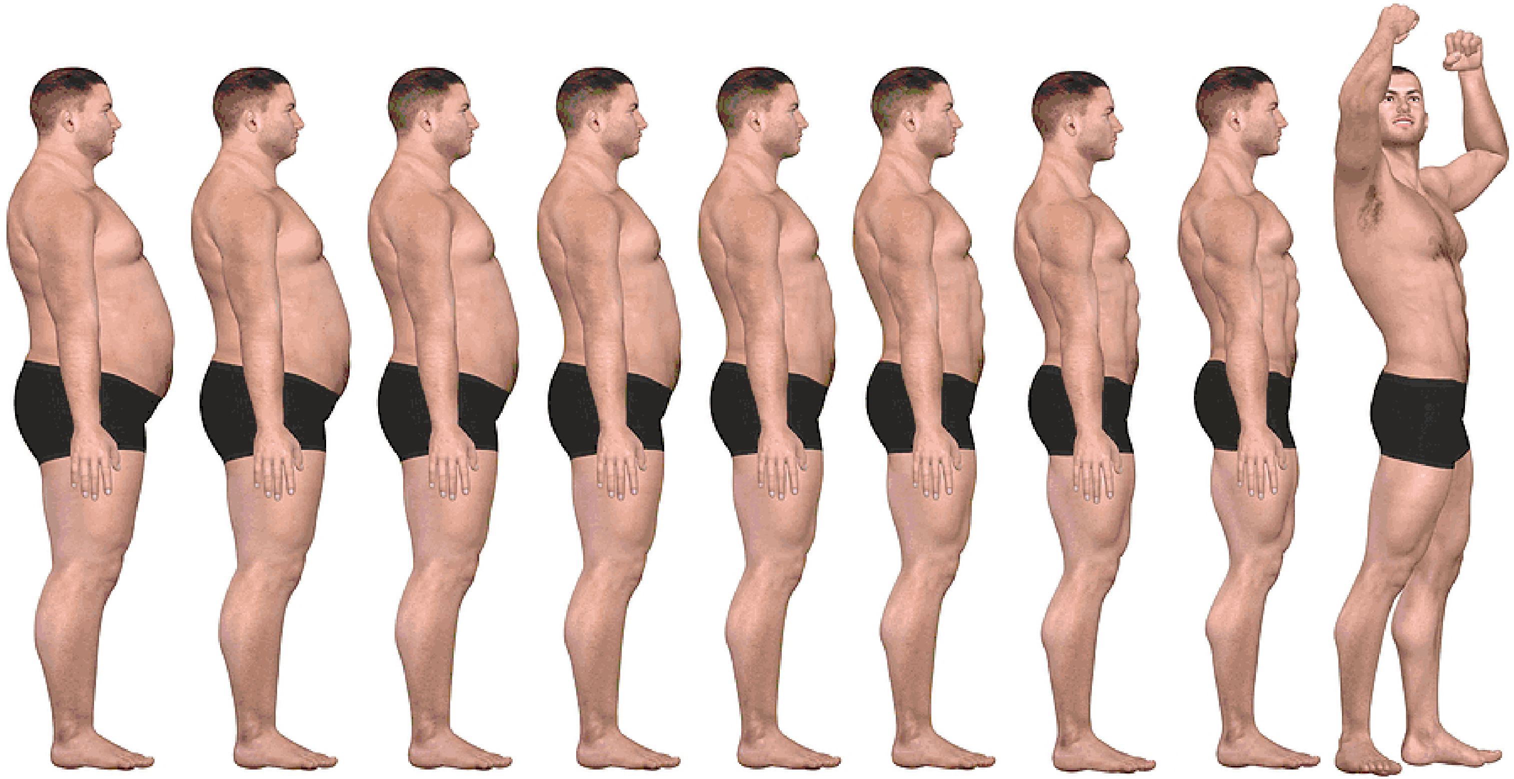
Agenda

Introduction

Loosing Weight



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Set Targets – Measure Actuals

- Weight in Kilogram
- Body Fat Percentage
- Skeletal Muscles in Kilogram
- Height in Centimeter
- Abdominal girth in Centimeter
- Girth of … in Centimeter
- Body-Mass-Index ($bmi = \frac{weightInKg}{heightInMeter^2}$)

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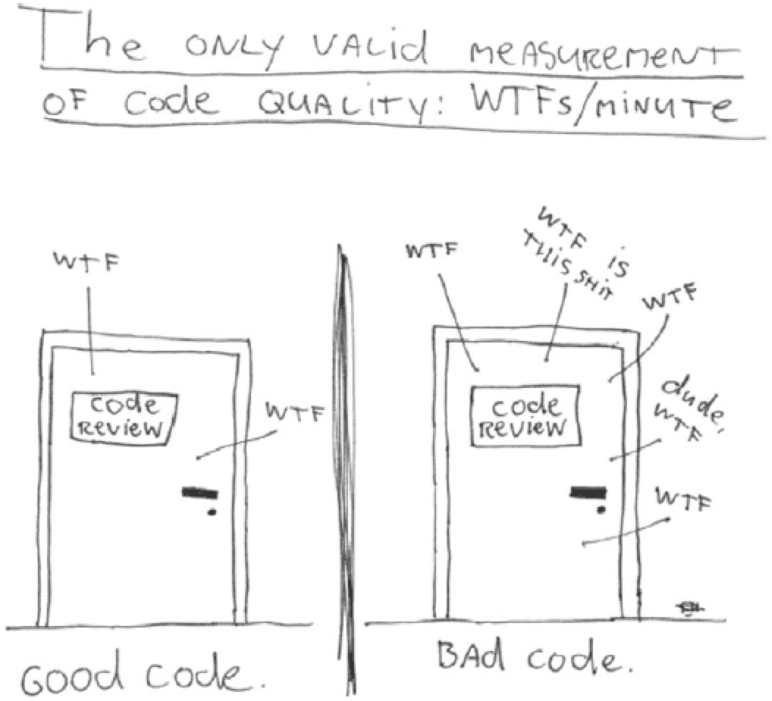
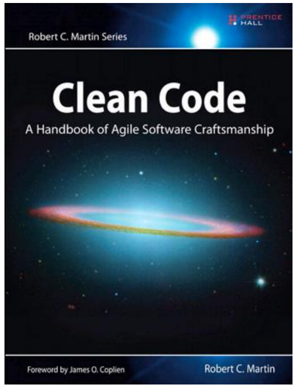
Measuring Code Quality



- "How can we make sure we wind up behind the right door when the going gets tough?"
- "The answer is: *craftsmanship*."



Robert C. Martin Series
PRENTICE HALL
Clean Code
A Handbook of Agile Software Craftsmanship
Foreword by James O. Coplien
Robert C. Martin

Source: http://www.osnews.com/story/19266/WTFs_m; Clean Code, Robert C. Martin, 2009

Trivadis 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 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."

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

Metrics

PL/SQL Cop

Checks code against Trivadis PL/SQL & SQL Guidelines. Calculates various metrics.

Command-Line	SonarQube	SQL Developer
▪ Code folder	▪ Code folder	▪ Editor content
▪ Snapshot reports	▪ Snapshot reports	▪ Snapshot reports
▪ Since 2013	▪ Metrics repository	▪ Since 2014 (Free)
	▪ Metrics evolvement	
	▪ Continuous Integration	
	▪ Expected in Q4 2015	

Download from: https://www.salvis.com/blog/download/

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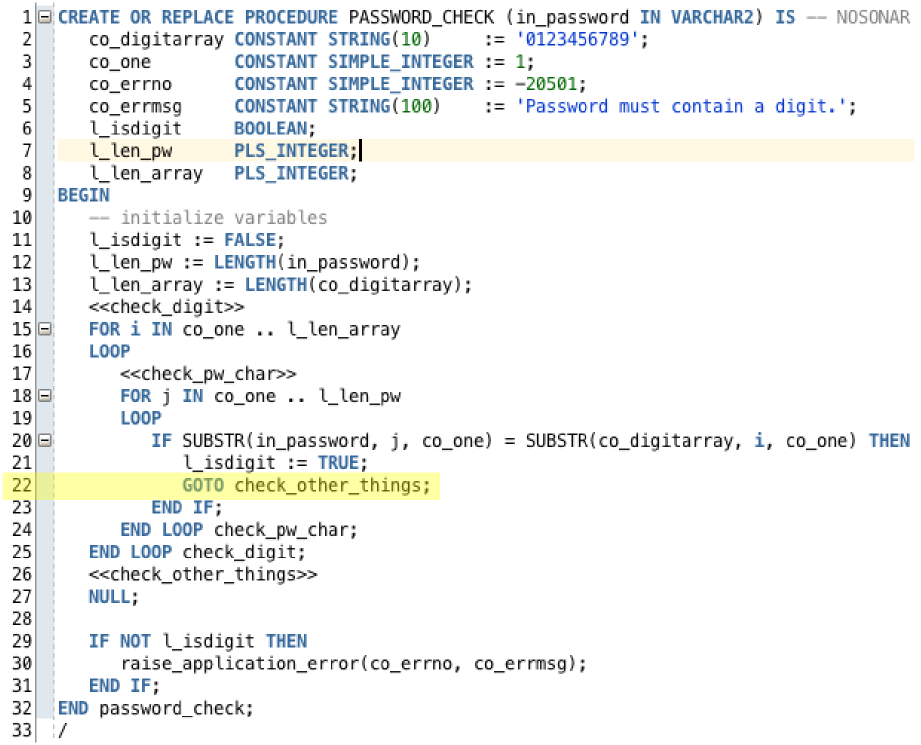
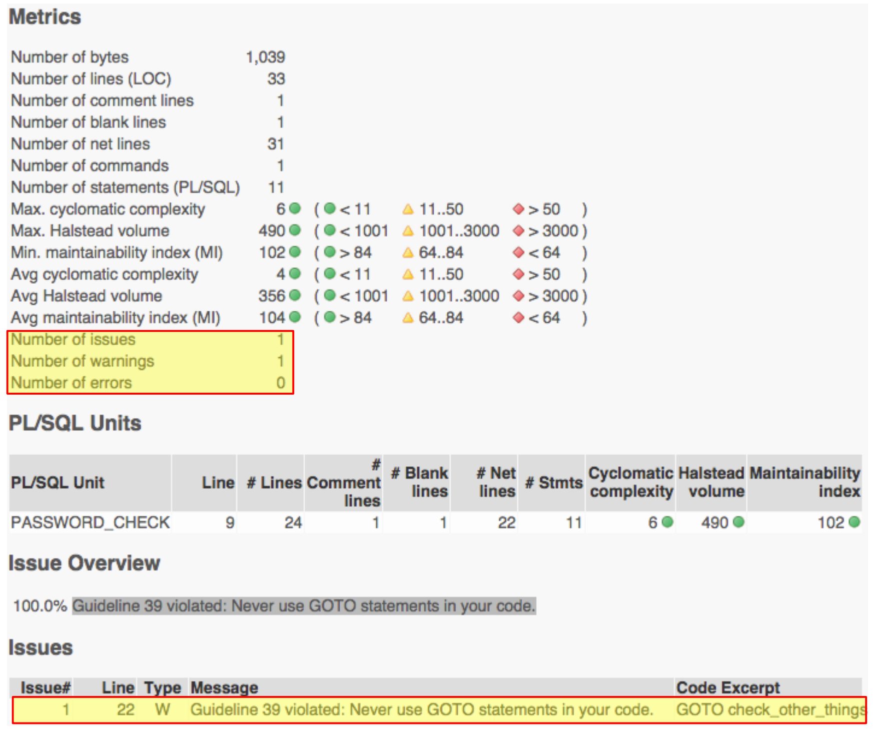
Simple Metrics (Number of …)



```
 1  CREATE OR REPLACE PROCEDURE PASSWORD_CHECK (in_password IN VARCHAR2) IS -- NOSONAR
 2     co_digitarray CONSTANT STRING(10)      := '0123456789';
 3     co_one        CONSTANT SIMPLE_INTEGER := 1;
 4     co_errno      CONSTANT SIMPLE_INTEGER := -20501;
 5     co_errmsg     CONSTANT STRING(100)     := 'Password must contain a digit.';
 6     l_isdigit     BOOLEAN;
 7     l_len_pw      PLS_INTEGER;
 8     l_len_array   PLS_INTEGER;
 9  BEGIN
10     -- initialize variables
11     l_isdigit := FALSE;
12     l_len_pw := LENGTH(in_password);
13     l_len_array := LENGTH(co_digitarray);
14     <<check_digit>>
15     FOR i IN co_one .. l_len_array
16     LOOP
17        <<check_pw_char>>
18        FOR j IN co_one .. l_len_pw
19        LOOP
20           IF SUBSTR(in_password, j, co_one) = SUBSTR(co_digitarray, i, co_one) THEN
21              l_isdigit := TRUE;
22              GOTO check_other_things;
23           END IF;
24        END LOOP check_pw_char;
25     END LOOP check_digit;
26     <<check_other_things>>
27     NULL;
28
29     IF NOT l_isdigit THEN
30        raise_application_error(co_errno, co_errmsg);
31     END IF;
32  END password_check;
33  /
```



Metrics

Number of bytes	1,039				
Number of lines (LOC)	33				
Number of comment lines	1				
Number of blank lines	1				
Number of net lines	31				
Number of commands	1				
Number of statements (PL/SQL)	11				
Max. cyclomatic complexity	6 ●	(● < 11	▲ 11..50	◆ > 50	)
Max. Halstead volume	490 ●	(● < 1001	▲ 1001..3000	◆ > 3000	)
Min. maintainability index (MI)	102 ●	(● > 84	▲ 64..84	◆ < 64	)
Avg cyclomatic complexity	4 ●	(● < 11	▲ 11..50	◆ > 50	)
Avg Halstead volume	356 ●	(● < 1001	▲ 1001..3000	◆ > 3000	)
Avg maintainability index (MI)	104 ●	(● > 84	▲ 64..84	◆ < 64	)
Number of issues	1				
Number of warnings	1				
Number of errors	0				

PL/SQL Units

PL/SQL Unit	Line	# Lines	# Comment lines	# Blank lines	# Net lines	# Stmts	Cyclomatic complexity	Halstead volume	Maintainability index
PASSWORD_CHECK	9	24	1	1	22	11	6 ●	490 ●	102 ●

Issue Overview

100.0% Guideline 39 violated: Never use GOTO statements in your code.

Issues

Issue#	Line	Type	Message	Code Excerpt
1	22	W	Guideline 39 violated: Never use GOTO statements in your code.	GOTO check_other_things

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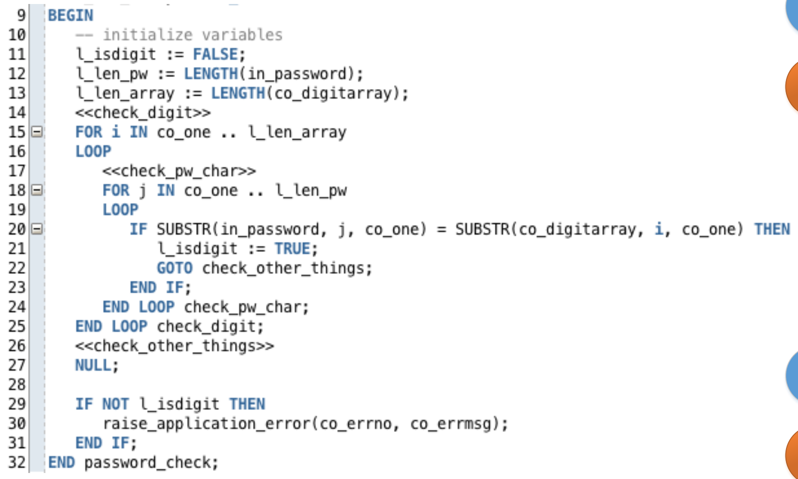
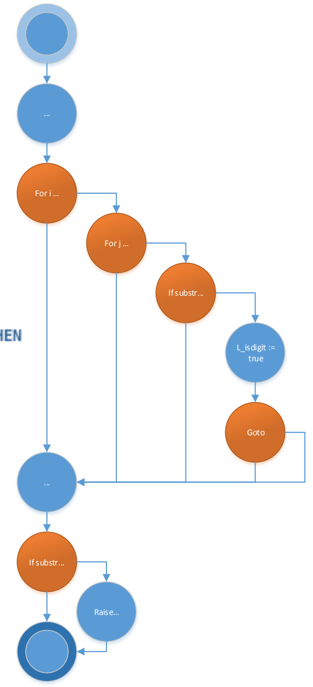
McCabe's Cyclomatic Complexity



```
BEGIN
   -- initialize variables
   l_isdigit := FALSE;
   l_len_pw := LENGTH(in_password);
   l_len_array := LENGTH(co_digitarray);
   <<check_digit>>
   FOR i IN co_one .. l_len_array
   LOOP
      <<check_pw_char>>
      FOR j IN co_one .. l_len_pw
      LOOP
         IF SUBSTR(in_password, j, co_one) = SUBSTR(co_digitarray, i, co_one) THEN
            l_isdigit := TRUE;
            GOTO check_other_things;
         END IF;
      END LOOP check_pw_char;
   END LOOP check_digit;
   <<check_other_things>>
   NULL;

   IF NOT l_isdigit THEN
      raise_application_error(co_errno, co_errmsg);
   END IF;
END password_check;
```



- Number of paths in code
- $M = E - N + 2P$
  - M = Cyclomatic Complexity
  - E = Number of edges
  - N = Number of nodes
  - P = Connected components (number of programs)
- Additional Path for Goto?
  - 15 – 11 + 2*1 = 6 (Toad Xpert)
  - 14 – 11 + 2*1 = 5 (correct here)

Definition see: http://www.mccabe.com/pdf/mccabe-nist235r.pdf (1976-1996)

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Cyclomatic Complexity – Drivers & Assessment

- Basic Loops
- Cursor For Loops
- While Loops
- If branches (if, elsif)
- Case branches (when)
- Exception handlers (when)
- Just for Toad Xpert compatibility
  - Else in if/case branches
  - PL/SQL blocks
  - Gotos

Cyclomatic Complexity	Complexity evaluation
<11	Reasonable: An average programmer should be able to comprehend and maintain this code.
11..50	Challenging: More senior skills most likely required to comprehend and maintain this code.
>50	Too complex: Candidate for re-design or re-factoring to improve readability and maintainability.

Halstead Volume

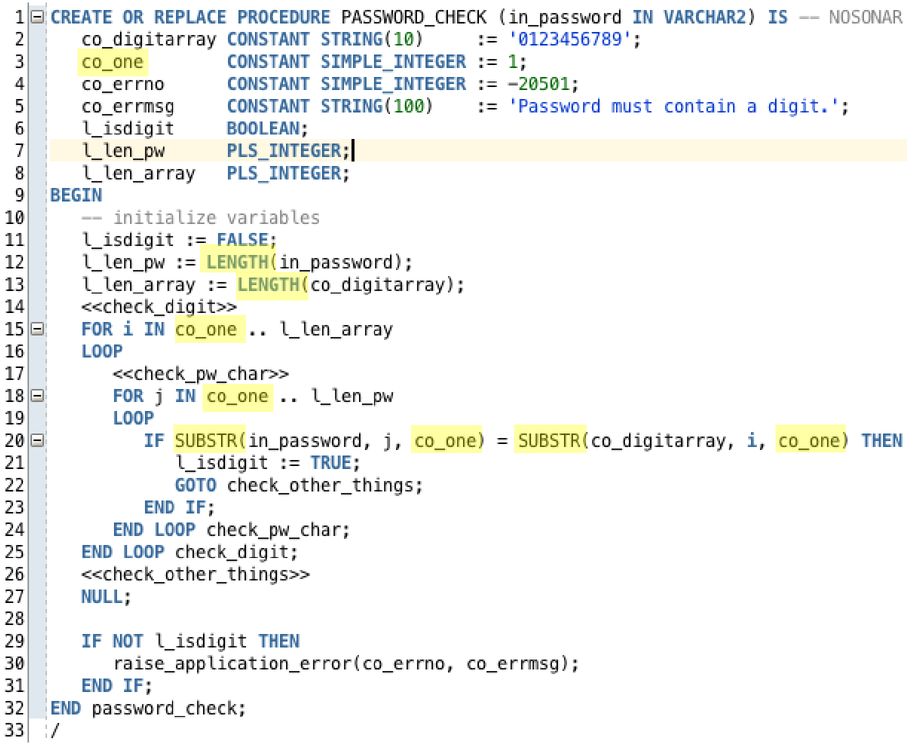
- n1 = number of distinct operators
- n2 = number of distinct operands
- N1 = total number of operators
- N2 = total number of operands
- Program length $N = N1 + N2$
- Program vocabulary $n = n1 + n2$
- Volume $V = N \times \log_2 n$

Applicable within SQL statements, but no SQL operators!

- Operators (based on Toad Xpert):
  - if, then, elsif, case, when, else, loop, for-loop, forall-loop, while-loop, exit, exit-when, goto, return, close, fetch, open, open-for, open-for-using, pragma, exception, procedure-call, assignment, function-call, sub-block, parenthesis, and, or, not, eq, ne, gt, lt, ge, le, semicolon, comma, colon, dot, like, between, minus, plus, star, slash, percent
- Operands (based on Toad Xpert):
  - identifier, string, number

Definition see: Elements of Software Science (1977)

Halstead Volume – Example



```
CREATE OR REPLACE PROCEDURE PASSWORD_CHECK (in_password IN VARCHAR2) IS -- NOSONAR
   co_digitarray CONSTANT STRING(10)     := '0123456789';
   co_one        CONSTANT SIMPLE_INTEGER := 1;
   co_errno      CONSTANT SIMPLE_INTEGER := -20501;
   co_errmsg     CONSTANT STRING(100)    := 'Password must contain a digit.';
   l_isdigit     BOOLEAN;
   l_len_pw      PLS_INTEGER;
   l_len_array   PLS_INTEGER;
BEGIN
   -- initialize variables
   l_isdigit := FALSE;
   l_len_pw := LENGTH(in_password);
   l_len_array := LENGTH(co_digitarray);
   <<check_digit>>
   FOR i IN co_one .. l_len_array
   LOOP
      <<check_pw_char>>
      FOR j IN co_one .. l_len_pw
      LOOP
         IF SUBSTR(in_password, j, co_one) = SUBSTR(co_digitarray, i, co_one) THEN
            l_isdigit := TRUE;
            GOTO check_other_things;
         END IF;
      END LOOP check_pw_char;
   END LOOP check_digit;
   <<check_other_things>>
   NULL;

   IF NOT l_isdigit THEN
      raise_application_error(co_errno, co_errmsg);
   END IF;
END password_check;
/
```

- Operators
  - goto: 1, function-call: 4, if: 2, for-loop: 2, comma: 5, not: 1, assignment: 4, semicolon: 19, then: 2, procedure-call: 1, eq: 1
- Operands
  - 'Password must contain a digit.': 1, co_digitarray: 3, check_pw_char: 2, simple_integer: 2, co_errno: 2, raise_application_error: 1, length: 2, false: 1, boolean: 1, check_other_things: 2, substr: 2, 20501: 1, l_len_pw: 3, co_one: 5, l_isdigit: 4, in_password: 2, check_digit: 2, true: 1, j: 2, '0123456789': 1, i: 2, 1: 1, string: 2, pls_integer: 2, co_errmsg: 2, l_len_array: 3

Halstead Volume – Assessment

- $n1$ = number of distinct operators (11)
- $n2$ = number of distinct operands (26)
- $N1$ = total number of operators (42)
- $N2$ = total number of operands (52)
- Program length $N = N1 + N2$ (94)
- Program vocabulary $n = n1 + n2$ (37)
- Volume $V = N \times \log_2 n$ (490)

Halstead Volume	Complexity evaluation
<1001	Reasonable: An average programmer should be able to comprehend and maintain this code.
1001..3000	Challenging: More senior skills most likely required to comprehend and maintain this code.
>3000	Too complex: Candidate for re-design or re-factoring to improve readability and maintainability.

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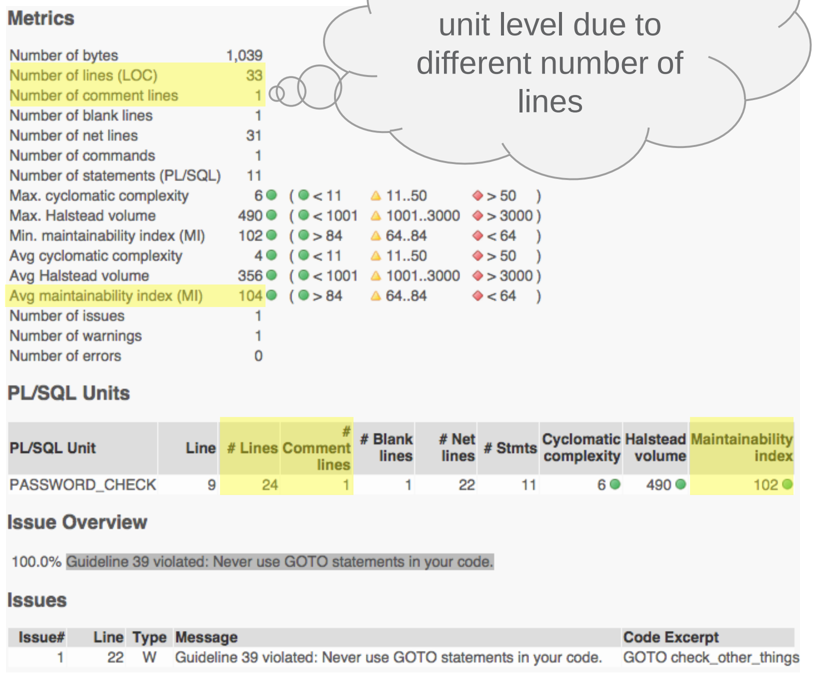
Maintainability Index (MI)

Weighs comments and combines it with Halstead Volume and Cyclomatic Complexity

- $aveV = average\ Halstad\ Volume = \frac{\sum LOCunit \times V}{LOCfile}$
- $aveM = average\ Cyclomatic\ Complexity = \frac{\sum LOCunit \times M}{LOCfile}$
- $aveLOC = average\ lines\ of\ code = \frac{\sum LOCunit}{numberOfUnits}$
- $aveComments = average\ lines\ of\ comment = \frac{\sum linesOfCommentInUnit}{numberOfUnits}$
- $MIwoc = MI\ without\ comments = 171 - 5.2 \times \log_e aveV - 0.23 \times aveM - 16.2 \times \log_e aveLOC$
- $MIcw = MI\ comment\ weight = 50 \times \sin\sqrt{2.4 \times \frac{aveComments}{aveLOC}}$
- $MI = MIwoc + MIcw$

Definition see: The Software Maintainability Index Revisited (1991-2001)

Maintainability Index (MI) – Assessment



Metrics

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Max. Halstead volume	490 ●	(● < 1001	△ 1001..3000	◆ > 3000	)
Min. maintainability index (MI)	102 ●	(● > 84	△ 64..84	◆ < 64	)
Avg cyclomatic complexity	4 ●	(● < 11	△ 11..50	◆ > 50	)
Avg Halstead volume	356 ●	(● < 1001	△ 1001..3000	◆ > 3000	)
Avg maintainability index (MI)	104 ●	(● > 84	△ 64..84	◆ < 64	)
Number of issues	1				
Number of warnings	1				
Number of errors	0				

PL/SQL Units

PL/SQL Unit	Line	# Lines	# Comment lines	# Blank lines	# Net lines	# Stmts	Cyclomatic complexity	Halstead volume	Maintainability index
PASSWORD_CHECK	9	24	1	1	22	11	6 ●	490 ●	102 ●

Issue Overview

100.0% Guideline 39 violated: Never use GOTO statements in your code.

Issues

Issue#	Line	Type	Message	Code Excerpt
1	22	W	Guideline 39 violated: Never use GOTO statements in your code.	GOTO check_other_things

Differences on file and unit level due to different number of lines

MI	Complexity evaluation
>84	Reasonable: An average programmer should be able to comprehend and maintain this code.
64..84	Challenging: More senior skills most likely required to comprehend and maintain this code.
<64	Too complex: Candidate for re-design or re-factoring to improve readability and maintainability.

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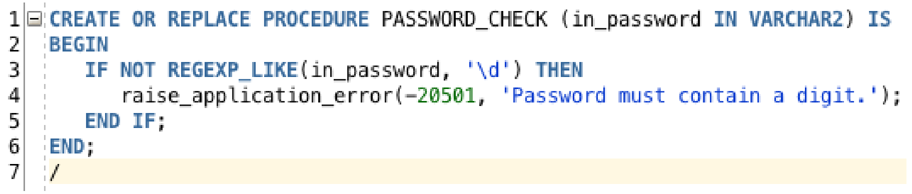
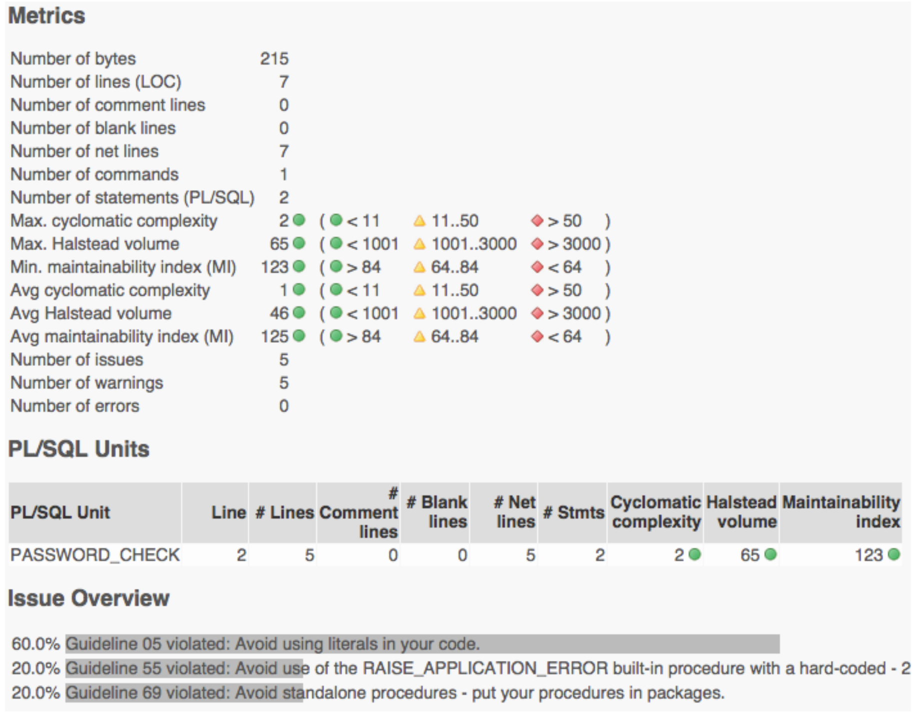
Better Code



```
CREATE OR REPLACE PROCEDURE PASSWORD_CHECK (in_password IN VARCHAR2) IS
BEGIN
   IF NOT REGEXP_LIKE(in_password, '\d') THEN
      raise_application_error(-20501, 'Password must contain a digit.');
   END IF;
END;
/
```



Metrics

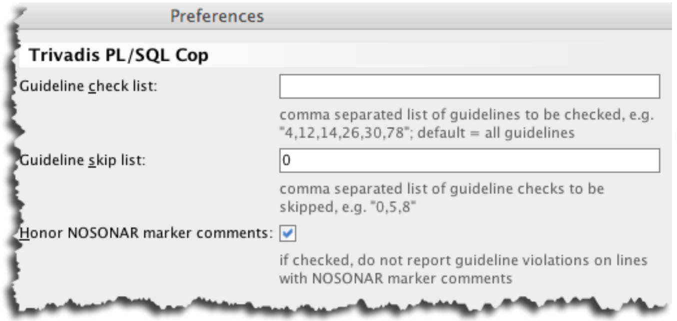
Number of bytes	215				
Number of lines (LOC)	7				
Number of comment lines	0				
Number of blank lines	0				
Number of net lines	7				
Number of commands	1				
Number of statements (PL/SQL)	2				
Max. cyclomatic complexity	2 ●	(● < 11	△ 11..50	◆ > 50	)
Max. Halstead volume	65 ●	(● < 1001	△ 1001..3000	◆ > 3000	)
Min. maintainability index (MI)	123 ●	(● > 84	△ 64..84	◆ < 64	)
Avg cyclomatic complexity	1 ●	(● < 11	△ 11..50	◆ > 50	)
Avg Halstead volume	46 ●	(● < 1001	△ 1001..3000	◆ > 3000	)
Avg maintainability index (MI)	125 ●	(● > 84	△ 64..84	◆ < 64	)
Number of issues	5				
Number of warnings	5				
Number of errors	0				

PL/SQL Units

PL/SQL Unit	Line	# Lines	# Comment lines	# Blank lines	# Net lines	# Stmts	Cyclomatic complexity	Halstead volume	Maintainability index
PASSWORD_CHECK	2	5	0	0	5	2	2 ●	65 ●	123 ●

Issue Overview

60.0% Guideline 05 violated: Avoid using literals in your code.
20.0% Guideline 55 violated: Avoid use of the RAISE_APPLICATION_ERROR built-in procedure with a hard-coded - 2
20.0% Guideline 69 violated: Avoid standalone procedures - put your procedures in packages.



Preferences

Trivadis PL/SQL Cop

Guideline check list:

comma separated list of guidelines to be checked, e.g. "4,12,14,26,30,78"; default = all guidelines

Guideline skip list: 0

comma separated list of guideline checks to be skipped, e.g. "0,5,8"

Honor NOSONAR marker comments: ✓

if checked, do not report guideline violations on lines with NOSONAR marker comments

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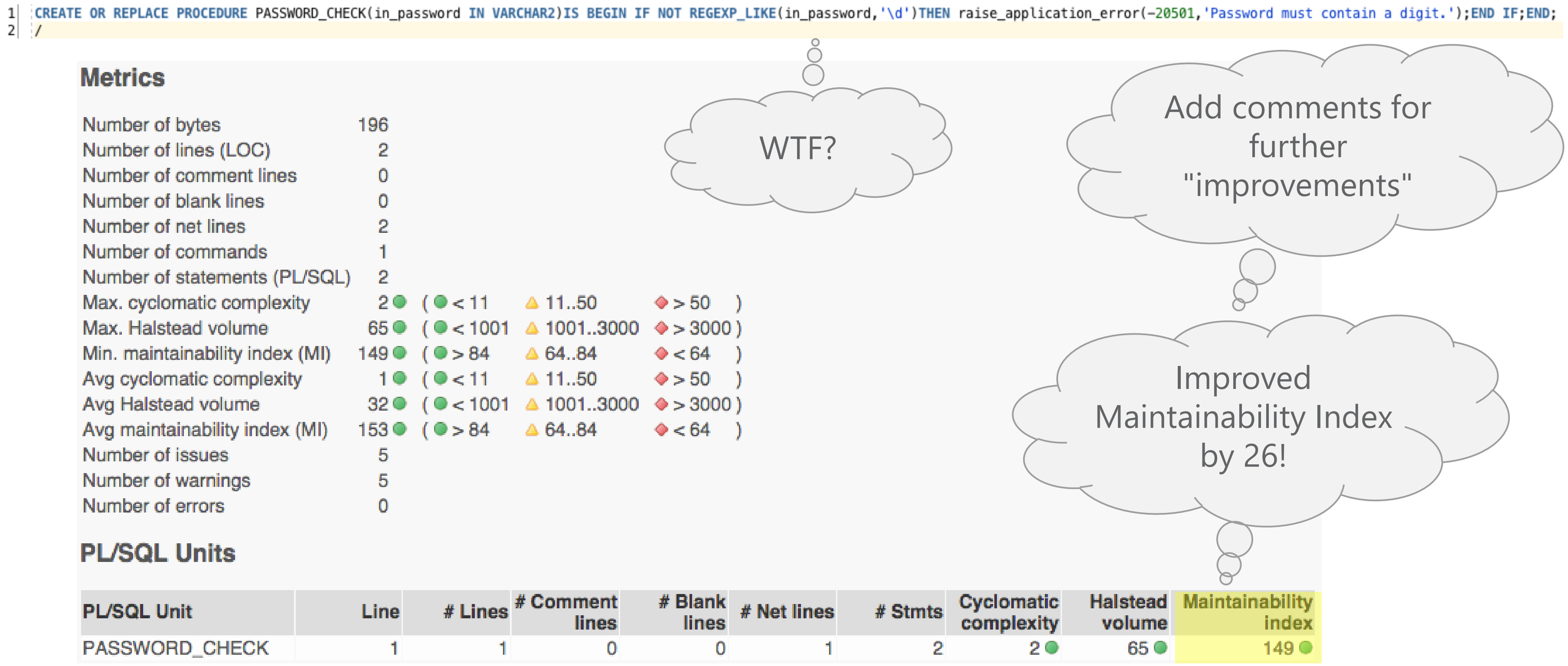
Even Better Code?



```
CREATE OR REPLACE PROCEDURE PASSWORD_CHECK(in_password IN VARCHAR2)IS BEGIN IF NOT REGEXP_LIKE(in_password,'\d')THEN raise_application_error(-20501,'Password must contain a digit.');END IF;END;
/
```

Metrics

Number of bytes	196				
Number of lines (LOC)	2				
Number of comment lines	0				
Number of blank lines	0				
Number of net lines	2				
Number of commands	1				
Number of statements (PL/SQL)	2				
Max. cyclomatic complexity	2 ●	(● < 11	⚠ 11..50	◆ > 50	)
Max. Halstead volume	65 ●	(● < 1001	⚠ 1001..3000	◆ > 3000	)
Min. maintainability index (MI)	149 ●	(● > 84	⚠ 64..84	◆ < 64	)
Avg cyclomatic complexity	1 ●	(● < 11	⚠ 11..50	◆ > 50	)
Avg Halstead volume	32 ●	(● < 1001	⚠ 1001..3000	◆ > 3000	)
Avg maintainability index (MI)	153 ●	(● > 84	⚠ 64..84	◆ < 64	)
Number of issues	5				
Number of warnings	5				
Number of errors	0				

PL/SQL Units

PL/SQL Unit	Line	# Lines	# Comment lines	# Blank lines	# Net lines	# Stmts	Cyclomatic complexity	Halstead volume	Maintainability index
PASSWORD_CHECK	1	1	0	0	1	2	2 ●	65 ●	149 ●

WTF?

Add comments for further "improvements"

Improved Maintainability Index by 26!

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Core Messages

Every Metric Has Its Flaws…

- For example
  - *Lines of code* does not account for the code complexity
  - *Cyclomatic Complexity* does not account for the length of a program and the complexity of a statement
  - *Halstead Volume* does not account for the number of paths in the program
  - *Maintainability index* cannot distinguish between useful and useless comments and does not account for code formatting

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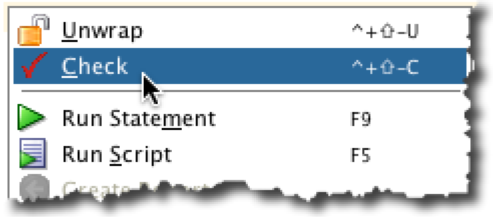
… But They Are Still Useful

- To Identify complex programs
- To measure code improvements and code degradations
- To help you writing better PL/SQL, if you do not trust in metrics blindly

Get PL/SQL Cop – Now!

- The PL/SQL Developer extension is free and has not size limitations
- Drop me an e-mail if you need an unlimited license key for the command line utility



Download from: https://www.salvis.com/blog/download/

Questions and answers…

Philipp Salvisberg
Senior Principal Consultant

Tel. +41 58 459 52 31
philipp.salvisberg@trivadis.com

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