Testwell CMT++

Complexity Measurement Tool for C/C++/C#

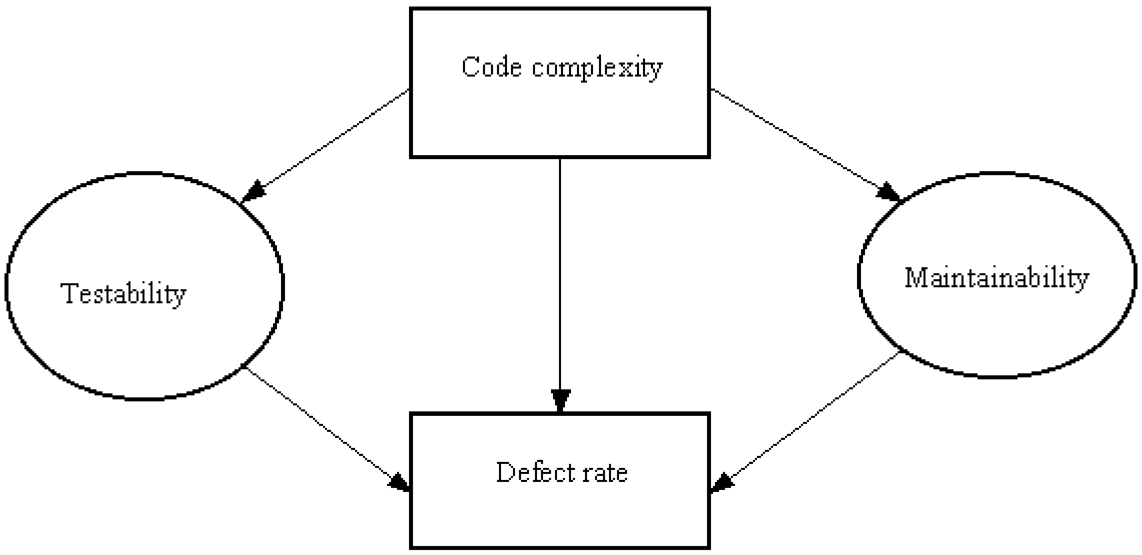
Information in this document corresponds to the CMT++ version 6.0.1.

1. INTRODUCTION

Testwell CMT++, Complexity Measurement Tool for C/C++/C#, is an easy-to-use code metrics tool for C, C++ and C# languages. Also assembly code, either inlined in a C/C++ source file or separate assembly file, can be measured.

CMT++ is intended for mature software development organizations striving for productive development process resulting in low error rate and good maintainability in the code.

Code complexity has effect on how difficult it is to test and maintain the program.



CMT++ helps you to estimate the overall maintainability of your code base and easily locate the complex parts of it. You then can assess them separately: put special testing focus on them or perhaps redesign them. You can use CMT++ also for just measuring how much code you have: physical lines, comment lines, program lines, statements. Measuring the whole project code base is no problem to CMT++.

Here are some quick links to CMT++ capabilities:

- Command line mode use
- GUI mode use (Windows)
- Source files of which these cmt reports are worked of
- Default textual report and same report with file level summary only

- HTML report (textual report converted to HTML and assigned to source files, started in new window)
- Long XML report and same report with operand/operator frequencies and of file summary level only
- Excel report and same report with file level summary only

CMT++ facilitates:

- Calculating the basic code complexity metrics
  - McCabe's cyclomatic number (can be calculated in 4 "flavors": basic, extended (=default), basic_modified, extended_modified)
  - Halstead's software science metrics
  - Lines of code metrics
  - Some other metrics like: number of semicolons, number of function parameter, depth of control structure nesting
- Calculating Maintainability Index (MI).
  - MI is a single number value (or index), which expresses the relative maintainability of the code
  - MI is derived with an arithmetic formulae from the code's McCabe, Halstead and lines of code measures.
  - The used formulae is widely accepted at the industry and is defined at various places in the web.
- Extremely fast processing
  - CMT++ can measure many thousand source lines in a second
- Configurable alarm limits
  - If the calculated measure is outside of the given alarm limits, the measure is flagged in the report
- Usage in the large
  - In one CMT++ session you can analyze a single file, a couple of files, or your whole code base. Over 1 million lines of code is no problem to the tool
- Measuring of "unrealted" code files
  - Each file is measured independently of other files. The input files need not make up a complete compilable project. For example C/C++ code files can be measured without the header files.
- Measuring non-preprocessed code
  - By default CMT++ measures non-preprocessed C/C++ code, i.e. exactly the one that is seen, edited, tested, and that needs to be maintained
- Independent of the used C/C++/C# compiler
  - CMT++ does not use, not even assume the presence, of a C/C++/C# compiler
- The language recognized
  - ANSI C, but the legacy K&R 1 level functions are not recognized
  - ANSI C++, including C++11 standard level language constructs
  - Practically also any other C/C++ dialect can be parsed thanks to CMT++'s novel technique for handling unknown keywords
  - C#
- Assembly code can be measured
  - Lines of code and Halstead measures
  - Assembly code input can be embedded in a C/C++ input file or is a separate assembly file
  - The assembly code specialties (source file extensions, comment character, identifier syntax, etc.) can be parameterized to the tool for their correct parsing

- Reporting in textual form, in HTML form, in XML form and in Excel form
    - The default textual report is usable for viewing the measures on the screen and for printing on paper
    - The HTML form is a reformatted representation of the default textual report with summary/detailed levels, highlighting the alarmed items in red color, and providing links (if possible to construct) all the way to the actual C/C++/C# source files.
    - The XML report contains all the measures, summary level information and alarms information in XML format. With your own xml-utility you can select the interesting information and process it onwards.
    - The Excel report contains the measures in the format, which can be directly inputted to Excel
- Ease of use
    - CMT++ is outmost simple to use already from the command line
    - On Windows platform there is a GUI layer for using the tool, see more of CMT++ Graphical User Interface.
    - Includes thorough on-line helps, User's Guide as .pdf, man pages in Unix
- Available on many platforms
    - These include Windows and many Unix environments (see CMT++ availability)

CMT++ intended use is:

- Use as a testing tool
    - Identifies code sections which are suspiciously complex and thus more error prone, and which should be tested more thoroughly. The limited and expensive human testing resources can be utilized more optimally
    - McCabe's cyclomatic number v(G) gives an estimate for how many test cases at least are needed to test all paths of a function.
    - Halstead's estimated number of bugs B gives a goal on how many bugs at least the testers should try to find from a source file.
- Use as a quality assurance tool
    - CMT++ Complexity Measures Report as supplementary material in code reviews
    - Maintainability Index (MI) gives a simple to understand estimate of the relative maintainability of the code (calculated at function, file and whole code base levels)
    - With consistent use of CMT++, and when the alarms are assessed and appropriate actions taken, there are far better changes to come out with more maintainable software
- Enforcing company standards with regard to accepted code complexity
    - Configurable alarm limits
    - Measures outside the limits are highlighted in the report
- Assessing foreign code
    - CMT++ gives you a good overall view of the coding style and maintainability expectations of a set of C/C++/C# files that you are supposed to take over or your subcontractor is delivering to you.
- Use as a measuring tool
    - Simply measure how much code there is (code/comment/blank lines, semicolons, also assembly code can be measured)

    - Integrate CMT++ use to automated program builds and collect measures of interest to your own repository and follow how your overall system complexity and size has changed over time
- CMT++'s output can be easily processed further by Excel or by your own XML-based add-on utilities
    - Graphical presentations
    - More thorough statistical analysis of the measurements

2. USE OF CMT++

2.1. Command line mode

The "core component" of CMT++ is *cmt*. Its on-line help for command-line options is:

```
Usage:
    cmt [-h] [-H] [-c cnffiles] [-C cnfparam=value]... [-v] [-l[f]]
        [-s] [-w] [-x] [-nxh] [-f filenames] [-o outfile] [srcfiles...]
```

And it can be used for example as follows:

```
cmt -o report.txt ..\srcs\*.cpp      (measure these files)
notepad report.txt                   (view the report)
dir /b /s ..\srcs\*.cpp > fnames.lst (names of .cpp files)
dir /b /s ..\srcs\*.h >> fnames.lst  (add names of .h files)
cmt -o report.txt -f fnames.lst      (measure these files)
cmt -l -o report.xml - fnames.lst    (take "long" report, in XML)
myxmlutility -i report.xml           (process onwards...)
cmt -x -o xreport.txt -f fnames.lst  (take Excel form report)
start excel xreport.txt              (start Excel on it)
```

The default form textual report can be converted to HTML form with the *cmt2html* tool. Its on-line help for command line options is:

```
Usage:
    cmt2html   [-i   inputfile]   [-o   outputdir]   [-s   sourcedir]...
             [-l    splitsize]    [-no-html-sources]    [-no-javascript]
                         [-nsb]                [-p                prefix]
                                cmt2html                                -h

Command-line                                                      options:
  -i inputfile     Input Complexity Measures Report file. Default 'stdin'.
    -o   outputdir      Output   HTML   directory.   Default   'CMTHTML'.
  -s  sourcedir     Source  files  are  searched  also  from  this  directory.
  -l splitsize     Specify number of lines reported per page. Default 1000.
     -no-html-sources     Do     not     convert     sources     to     HTML.
   -no-javascript     Do    not    generate    javascript    on    HTML    pages.
  -p prefix       File name prefix in generated HTML files. Default 'index'.
  -nsb            Do not start HTML browser automatically (only Windows).
        -h                      Display       command       line       help.
Start browsing from <outputdir>/<prefix>.html (default CMTHTML/index.html)
```

And it can be used for example as follows:

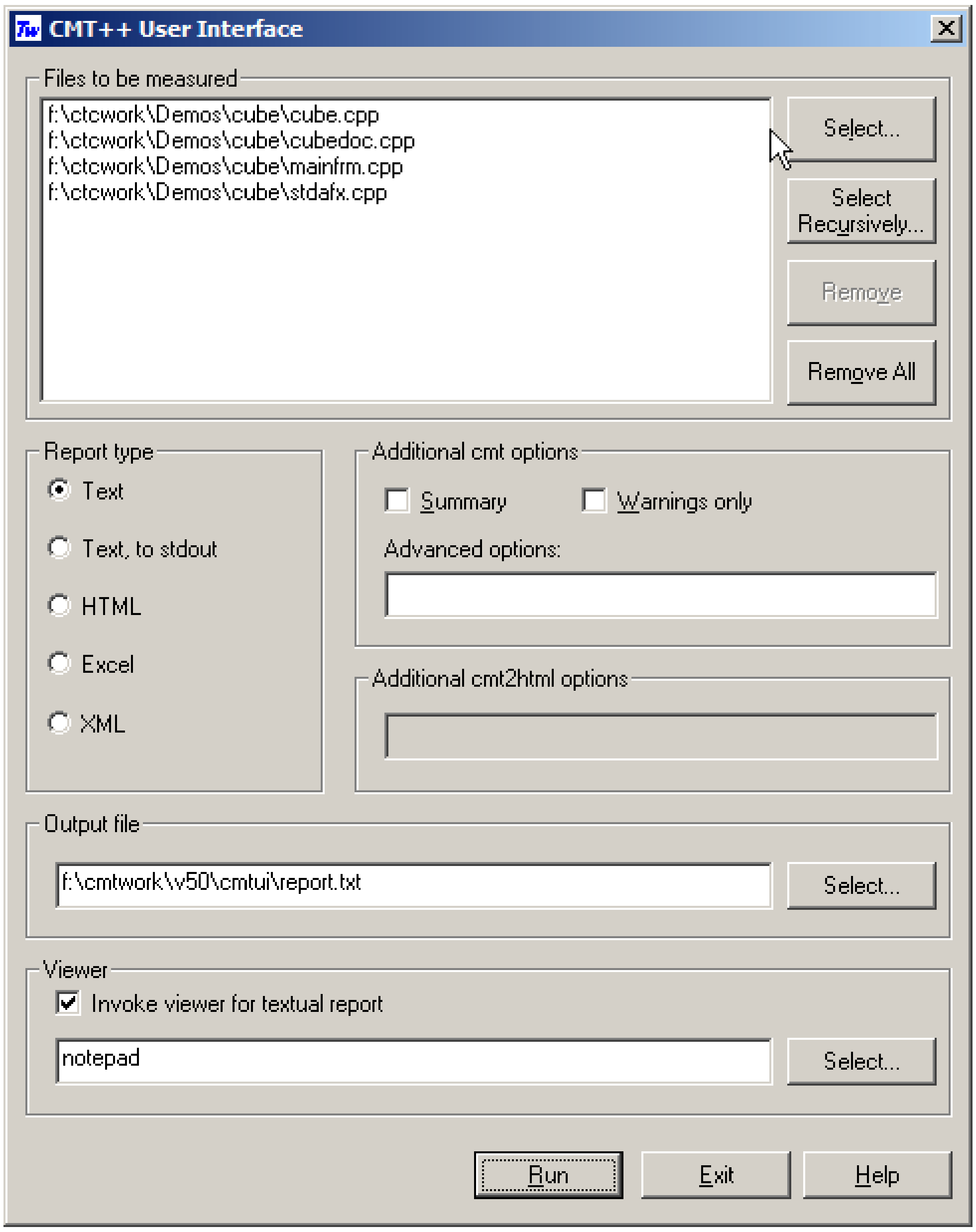
```
cmt  -o  report.txt  -f  fnames.lst           (first  normal  textual  report)
cmt2html -i report.txt -nsb          (convert to HTML and link to the source
files)
start CMTHTML\index.html             (start the machine's default browser on
the HTML)
```

2.2. CMT++ GUI

The CMT++ Graphical User Interface (CMT++ GUI) is supported on Windows. The CMT++ GUI is primarily a graphical wrapper program for using the core cmt command line tool and the add-on tools cmt2html and cmt2xml, and for starting the viewer program on the CMT++ output file.

CMT++ GUI can be started in many ways. For example, starting the program cmtui.exe directly from command window, or starting it via Start > Programs > Testwell CMT++, or the following program icon may have been copied on the desktop, and clicking on it.

It starts the following program dialog box:



CMT++ User Interface

Files to be measured

```
f:\ctcwork\Demos\cube\cube.cpp
f:\ctcwork\Demos\cube\cubedoc.cpp
f:\ctcwork\Demos\cube\mainfrm.cpp
f:\ctcwork\Demos\cube\stdafx.cpp
```

Report type: [✓ Text] / Text, to stdout / HTML / Excel / XML

Additional cmt options: ☐ Summary ☐ Warnings only

Advanced options:

Additional cmt2html options

Output file: f:\cmtwork\v50\cmtui\report.txt

Viewer: ☑ Invoke viewer for textual report

notepad

In this dialog box you can select the files to be measured and fully control how the basic cmt run is done. You can specify a viewer (eg. notepad or Excel), which will be started on the generated report. You can also ask that the CMT++ report is further processed with cmt2html utility and your default browser can be started on the HTML form report.

3. CMT++ REPORTS

3.1. Short report

CMT++ calculates many different measures of the source files. The measures shown in the short report are perhaps the ones that you'll find most useful. This report captures in a compact and easy-to-read format the key complexity measures. The report is convenient to view on the screen with normal text editors and it suits well to printing on paper.

Short report contains the following measures:

- v(G), McCabe cyclomatic number: control flow complexity.
- LOCphy: how many physical lines the measured entity has
- LOCpro: how many program lines the measured entity has
- c%: alarm mark '-' if the commenting percentage (100 * LOCcom / LOCphy) is outside of the recommended configuration limits.
- V, Halstead's 'volume': information content of the entity.
- B, Halstead's 'estimated number of bugs': how many errors there likely is based on the calculated complexity.
- MI, Maintainability Index: relative maintainability rating of the measured entity.
- Summary counts of LOCphy, LOCbl, LOCpro, LOCcom, number of semicolons, McCabe's v(G) and Maintainability Index over all measured files.

Example of short report (default form). Example of same report, of file level summary.

This report type can be further converted to HTML form with cmt2html tool.

3.2. HTML report

HTML report is worked up from the short report with cmt2html tool. Technically the HTML report is some number of generated .html files, which are written to the specified output directory. The HTML report is a hierarchical (file summary level, detailed function level) and color-coded (red color is used to indicate warned items) representation of the CMT++ report. The resultant HTML representation can be viewed with normal HTML browsers.

If at the cmt2html time the actual source files were accessible, html'ized copies of the sources are created to the output directory. With ctc2html option is is possible to deny the creation of the html'ized copy of the sources. In such case the source files and their individual functions are read for display from their original locations. With some browsers this may not work either because Javascipts are not allowed or because of some issues how file extensions are associated to different tools.

The HTML report is an easy to use way to study the complexity of a large software--at system level, at singe file level, at single function level, and having the possibility to see the actual source code, too.

See example of a HTML report (started in new window).

3.3. Long report (in XML)

The long report is obtained with cmt option -f (or -lf). It contains all the measures that CMT++ calculates. The report form is XML. This report form is meant to be used in CMT++ integrations to tool chains. The report can be taken with operand and operator frequencies (option -lf) or without them (option -l only). The report can be taken containing function information and file summary information (no -s option) or to contain only file summary information (-s option).

Example of long report (default form). Example of same report, of file level summary and operand/operator frequencies.

3.4. Excel report

The Excel report is obtained with cmt option -x. It contains the same measures than in short default form report, either the detailed function level measures only (no -s option) or the file level summary measures only (-s option). This report can be inputted to Excel.

Examples of excel report (default form). Example of same report, of file level summary.

4. OPERATING ENVIRONMENTS

See CMT++ availability for the detailed list of machine / operating system environments where CMT++ is currently available.

The resource requirements of your normal C or C++ development environment are sufficient for using the CMT++. A C or C++ compiler is not necessarily needed with CMT++ although CMT++ assumes that the source code it analyzes is correct C or C++.

CMT++ (Complexity Measures Tool for C/C++) complements the other Testwell testing tools for C and C++, CTA++ (C++ Test Aider) and CTC++ (Test Coverage Analyzer for C/C++) to a powerful testing toolpack.

Testwell has a similar tool, called CMTJava (Complexity Measures Tool for Java), for measuring Java code.