

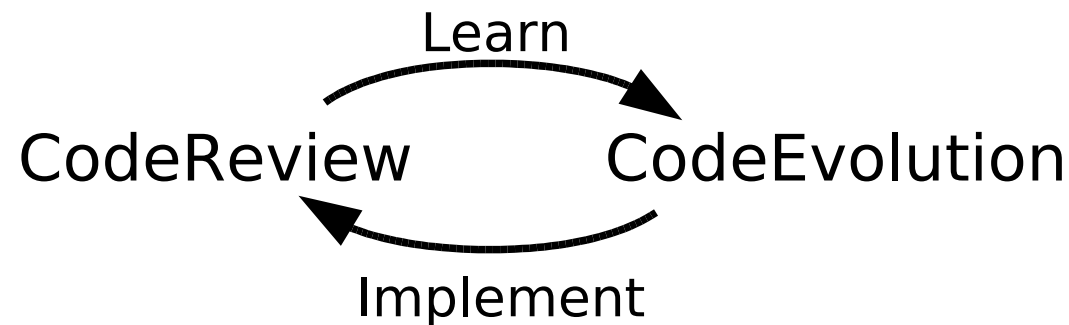
Code Reviews - Best Practices

Gerhard Brandt
(University of Heidelberg)



Contents

- Code Review in a Top-Down Approach
- Documentation from Code
- Code Evolution: Best Practices



Not Contents of this lecture:

- Brilliant theories – just many small tips
- Professional engineering – just practical experience in poorly equipped HEP environments
- Dilbert Cartoons

Why Code Reviewing ?

- Other people have engineered code for you
 - Maintenance
 - It's your honour to adjust this code where it shows suboptimal behaviour (= fix bugs)
 - Evolution
 - You need to add a feature. But where and how?
 - Learning
 - They were not completely stupid: You can learn from their ingenuity

Approaching an unknown body of code

- “Eagle method”: Stay on top - dive in only as required!
 - Don't try to read 100k lines of code from the beginning to the end
- Read in increasing level of detail
 - 1) Directory Level
 - 2) Structure Level
 - 3) Codeline level

Approaching an unknown body of code: Tools and Example

- Tools used in this lecture:
 - Free and Simple
 - Easily available (come with Linux'es / Downloadable)
 - No IDEs (not available everywhere)
 - Mostly Cmdline and WWW based
- Example used: The ROOT Source Code
 - Used by many HEP physicists in practice
 - Never hurts to know something about it
 - (More suggestions for practice:
Geant4, Mozilla, Linux Kernel, offline sw of your experiment, ...)
- Starting point:

```
root_v4.00.08.source.tar.gz
```

Reading Code: Things to notice at Directory Level

- The Shell: First tool, even before the editor
- Size & Complexity ?
 - No. of Packages, Files, Classes, Lines of Code
- Documentation ?
 - Standard Set of README Files?
- Build Process ?
 - Configuration? Compilation? Linkage?
- Unit Tests ?
 - What is code, what are tests?

At Directory Level: **Project Organization**

Reading Code: Size and Complexity with *ls* and *wc*

- Most powerful tool: *ls*
 - Show organization
 - See filename conventions

Example

```
/root/html/Module.mk  
/root/html/inc/THtml.h  
/root/html/src/THtml.cxx
```

- Pipe output into *wc* for size estimates
- Example: Size of ROOT:
 - `ls | wc` ~ 90 top level directories (Packages)
 - `ls -R1 * | wc` ~ 6285 files
 - ~ 772 *.cxx files (Classes)
 - `cat */src/*.cxx | wc` ~ 660k lines of code: a lot if read sequentially ...

Reading Code

Know your Editor

- We now start up or favorite editor
 - Lucky people have IDEs
 - The others have at least vi, Emacs, nedit, kate, ...
- Learn to profit from their features. They know:
 - Searching / Regular Expressions
 - Syntax Highlighting
 - ctags / idutils Index files
 - Block (un)indentation
 - Column selection
 - Block collapsing
 - File Browser / Tabbed Windows
 - ...

Reading Code: Things to at structural level

- What **Design Patterns** are used? How do they look like?
- What **Data Structures** are used? What is their interface?
- What are the **Framework Facilites** ?
 - Error Handling / Logging / Steering / Cmdline Parsing
 - Maths
 - GUI / Graphics
 - I/O
 - Wrappers / Interfaces to legacy code (FORTRAN)
- If you happen upon these during browsing: Remember them !
 - Either ... you must use them anyway
 - ... if not, you avoid reinventing the wheel



Reading Code: Things to notice at Line Level

- Coding Conventions used
 - Naming Conventions
 - Formatting Rules: Layout, Indentation ?
 - Commenting Rules / Comment Enrichment
 - Control Structures
- What Subset of C++ is used/allowed? STL? Templates?
- C++ Coding Standards in HEP are quite similar to each other
 - Taligent based: ROOT, ATLAS, ...
- Remember:
 - Advantage of Coding Standards comes mostly from **Consistent Use**
 - Even if they are suboptimal/outdated, continuing them makes sense within the same project

Reading Code: Things to skip at line level

- For quick reading, it's crucial to bypass skin and bones and get to the meat right away.
- Skip
 - Preprocessor Statements
 - Initialization
- Instead: Look for
 - Text (like window titles) or print-out you have seen
 - Comments marking important sections, like `//FIXME`
 - Tutorial Markers
 - Inner Loops

Layout and Indentation

- Scientific Studies exist on what is best (*see Refs*)
 - But most important is to be consistent
 - Advantages only gained when being consequent
- Also it is known what is not
 - Spaghetti Code
 - Inverse Polish Christmas Tree Notation (Align operators in center)
 - Dangling else
- Code beautifiers exist: indent (C/C++), Jalopy (Java)
- But Caveat:
 - Colleagues could get lost if you reformat their code
 - Time “lost” formatting code properly is regained only on second iteration (reviewing)

Reading Code

Searching and RegExps

- Most powerfull tool: *grep*
- Searching covers code and comments
- Stay general - Use word stem
- Chain *grep* to narrow your search

Documentation from Code

Introduction

- Tools exist to convert code into readable, navigable formats (HTML, LaTeX, PDF ...)
- Source: Code itself + enriched comments
- Progenitor: javadoc (by Sun for Java)
- Many different tools exist
 - ~40 listed on Doxygen page
 - <http://www.stack.nl/~dimitri/doxygen/>
- Mostly incompatible formats - chose wisely **before** coding
- Examples:

Javadoc, Doxygen, Thhtml, LXR, custom

Documentation from Code

Javadoc

- Example: Convert java code to HTML

```
/**
 * Get a dummy object
 * @param name An unused string
 * @return      Nothing (Null)
 * @see         Dummy
 */
public Dummy getDummy(
    String name) {
    return null;
}
```

javadoc



getDummy

```
public Dummy getDummy(String name)
```

Get a dummy object

Parameters:

name - An unused string

Returns:

Nothing (Null)

See also:

Dummy

Documentation from Code

Doxygen

- “King” of doc tools (popular)
- Output to LaTeX, RTF, PS, PDF, HTML, man
- Good results for any (unenriched) source
- Create indices, graphs, diagrams ...
- Too many bells & whistles?
 - Some people prefer less features

Example
 Mozilla Code Documentation

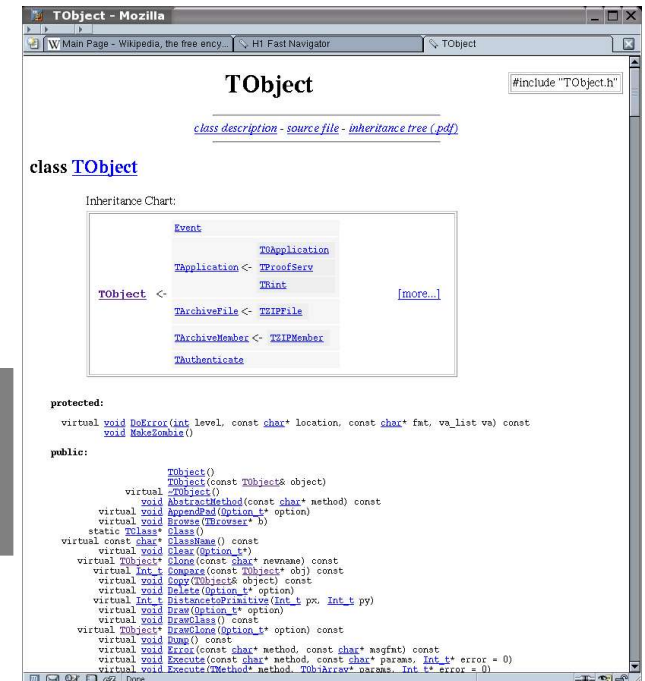


The screenshot shows a web browser window displaying the Mozilla Code Documentation for the CMozillaBrowser class. The page title is "CMozillaBrowser Class Reference". It includes an inheritance diagram showing CMozillaBrowser as the base class, with WebBrowserImp, CCommandTargetImp, and CWebBrowserContainer as subclasses. A collaboration diagram shows the relationships between CMozillaBrowser, CWebBrowserContainer, and CCommandTargetImp. Below the diagrams is a list of public methods for the CMozillaBrowser class, including virtual methods like OnCreate, OnDestroy, OnSize, OnSetFocus, OnKillFocus, OnGetDlgCode, OnMouseActivate, OnPrint, and OnPageSetup.

Documentation from Code THtml

- Doctool for the ROOT world
- Classes must be linked to ROOT executable
 - ClassImp, ClassDef Macros required
 - Non-C++-Files not documented

Example
Class TObject in
HTML Format



```

class TObject

class TObject

Inheritance Chart:
  TEvent
  TApplication <- TProofServer
  TPrint
  TObject <- TArchiveFile
  TArchiveMember <- TArchiveMember
  TAuthenticate

protected:
virtual void DoError(int level, const char* location, const char* fmt, va_list va) const
void MakeTombia()

public:
  TObject()
  TObject(const TObject& object)
  virtual ~TObject()
  void AbortMethod(const char* method) const
  virtual void AppendRad(Option_t* option)
  virtual void Close(Browser* b)
  static TObjas* class()
  virtual const char* ClassName() const
  virtual void Clear(Option_t*)
  virtual TObjas* Clone(const char* newname) const
  virtual int_t Compare(const TObject* obj) const
  virtual void Copy(TObjas* object) const
  virtual void Delete(Option_t* option)
  virtual int_t DistancePrimitive(int_t px, int_t py)
  virtual void Draw(Option_t* option)
  virtual void DrawClass() const
  virtual TObjas* DrawClass(Option_t* option) const
  virtual void Dump() const
  virtual void Error(const char* method, const char* msgfmt) const
  virtual void Execute(const char* method, const char* params, int_t* error = 0)
  virtual void Execute(Method* method, TObjas* params, int_t* error = 0)

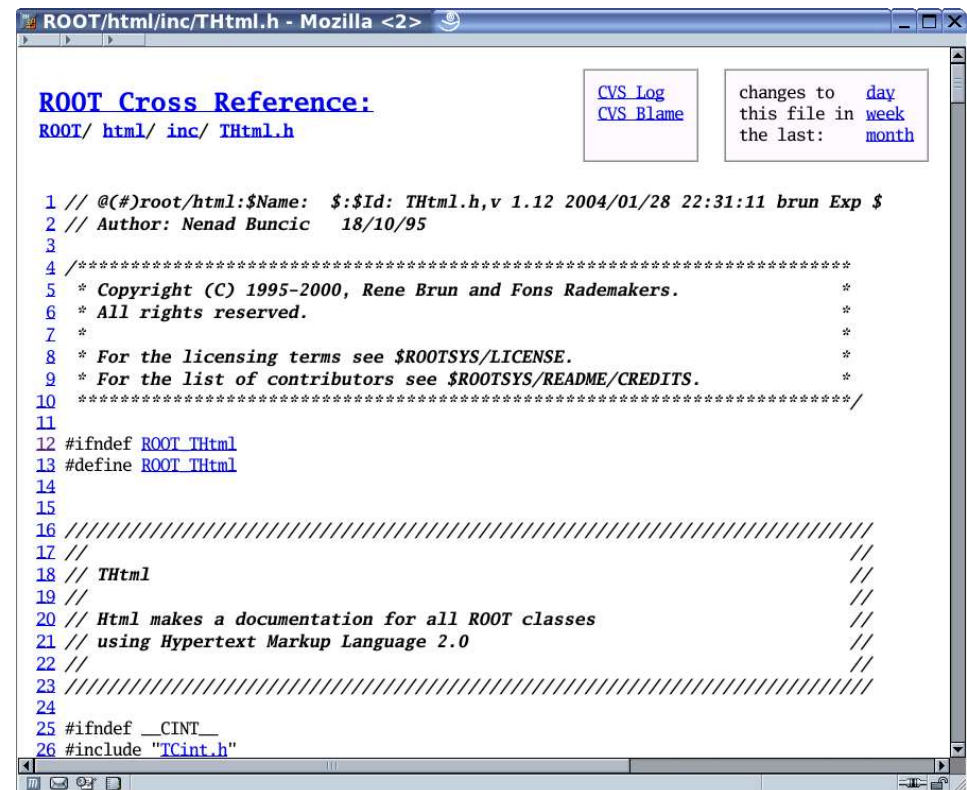
```

- Inofficial outlook: THtml2
 - ROOT team choice: rewrite doc tool from scratch, incl. C++ parser etc.
 - more output formats, code browsing, ...

Documentation from Code LXR

- Perl to HTML – Source Code Cross Referencing Script
- Serves pages through webserver
- Used by Mozilla, FreeBSD, ROOT, ...
- Freetext search possible
- Updates several times a day
but: not current state
of repository!

Example
Class THtml in LXR

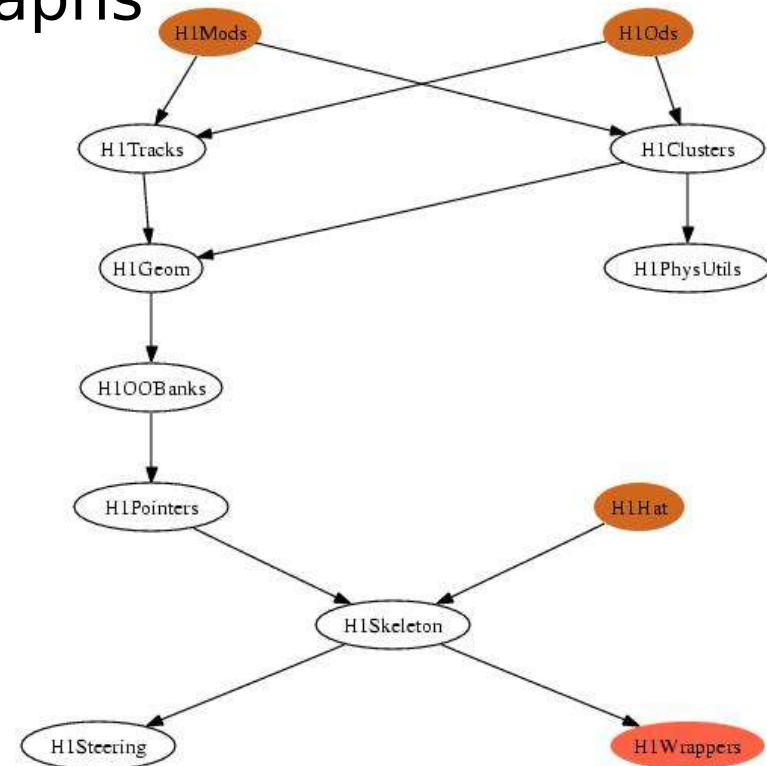
A screenshot of a web browser window displaying the LXR page for the file ROOT/html/inc/THtml.h. The browser title is 'ROOT/html/inc/THtml.h - Mozilla <2>'. The page content includes a 'ROOT Cross Reference:' section with a link to 'ROOT/ html/ inc/ THtml.h'. There are two boxes: one with links for 'CVS Log' and 'CVS Blame', and another with a table showing 'changes to this file in the last:' with options for 'day', 'week', and 'month'. The main content is a code snippet from the file, showing copyright information and preprocessor directives.

```
1 // @(#)root/html:$Name:  $:$Id: THtml.h,v 1.12 2004/01/28 22:31:11 brun Exp $
2 // Author: Nenad Buncic  18/10/95
3
4 /*****
5  * Copyright (C) 1995-2000, Rene Brun and Fons Rademakers.
6  * All rights reserved.
7  *
8  * For the licensing terms see $ROOTSYS/LICENSE.
9  * For the list of contributors see $ROOTSYS/README/CREDITS.
10 *****/
11
12 #ifndef ROOT_THtml
13 #define ROOT_THtml
14
15
16 //////////////////////////////////////
17 //
18 // THtml
19 //
20 // Html makes a documentation for all ROOT classes
21 // using Hypertext Markup Language 2.0
22 //
23 //////////////////////////////////////
24
25 #ifndef __CINT__
26 #include "TCint.h"
```

Documentation from Code

GraphViz

- Free Graph generation package from BellLabs
- Simple Syntax - can be generated automatically
- Graphical representation of code structure
- Used by Doxygen for its graphs



Example

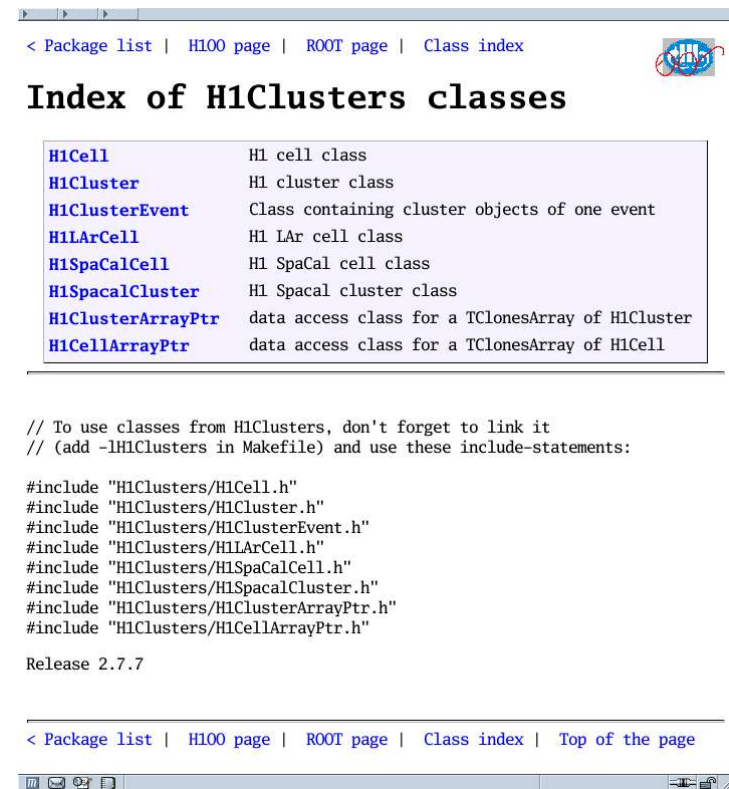
H1 Analysis Software
Package Dependencies Graph
(Perl to GraphViz Script)

Docu from Code: Do it yourself !

- Your doctool is missing a feature? Write your own tool!
- Code is written to be parsed – do so
- Possible in *ix world since 30 years
 - Classic tools: grep, sed, ...
- And of course there are Perl, Python, Ruby ...

Example

Package Index HTML page:
Hyperized Directory Listing
(Perl Script)



< Package list | H100 page | ROOT page | Class index

Index of H1Clusters classes

H1Cell	H1 cell class
H1Cluster	H1 cluster class
H1ClusterEvent	Class containing cluster objects of one event
H1LArCell	H1 LAr cell class
H1SpaCalCell	H1 SpaCal cell class
H1SpaCalCluster	H1 Spacal cluster class
H1ClusterArrayPtr	data access class for a TClonesArray of H1Cluster
H1CellArrayPtr	data access class for a TClonesArray of H1Cell

```
// To use classes from H1Clusters, don't forget to link it
// (add -lh1clusters in Makefile) and use these include-statements:

#include "H1Clusters/H1Cell.h"
#include "H1Clusters/H1Cluster.h"
#include "H1Clusters/H1ClusterEvent.h"
#include "H1Clusters/H1LArCell.h"
#include "H1Clusters/H1SpaCalCell.h"
#include "H1Clusters/H1SpaCalCluster.h"
#include "H1Clusters/H1ClusterArrayPtr.h"
#include "H1Clusters/H1CellArrayPtr.h"

Release 2.7.7
```

< Package list | H100 page | ROOT page | Class index | Top of the page

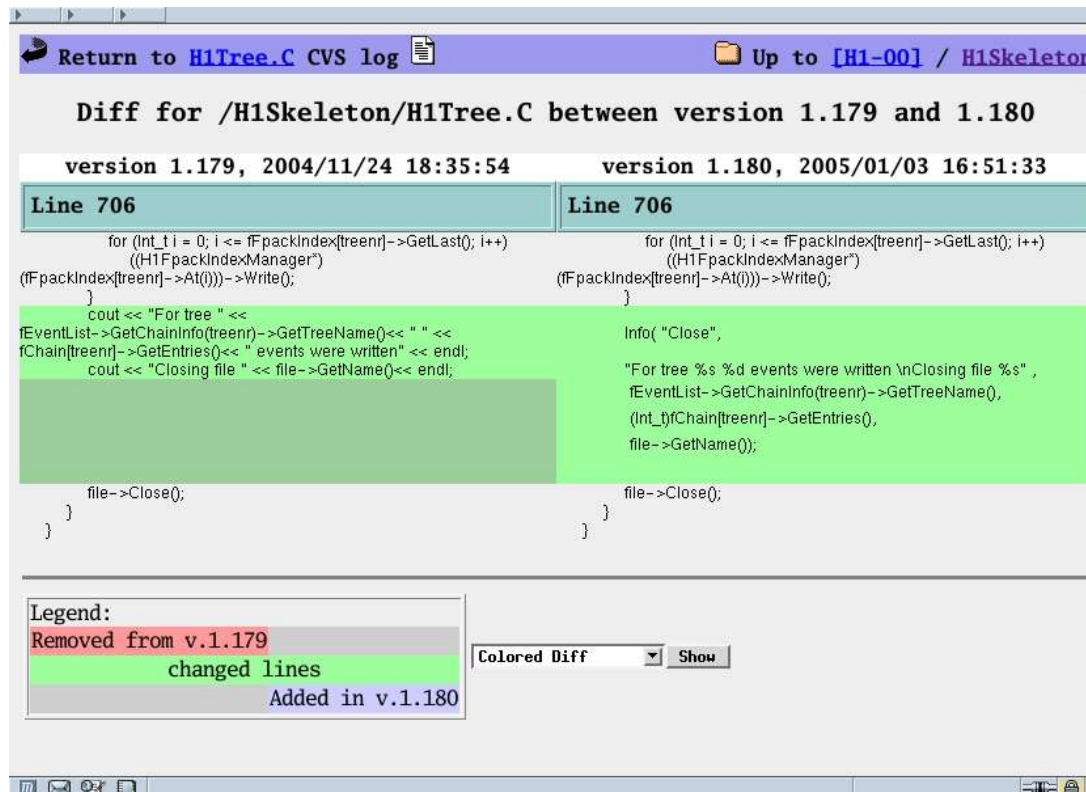
Code Evolution

- When adding new code it is time to apply the best practices learned in code reading
- If possible use tools to check contributions
- Compiler
 - Is a professional code reader
 - Tell him to be verbose, eg. on gcc use `-Wall`
- Regression Testing
 - Remember `junit`, `cppunit`
 - Often simpler testing possible
 - For HEP software exploit that the output must make sense in terms of physics
- `cv`s diff

Evolution of Code

CVS Browsers

- Most useful tools for manual checks of changes to code
- View the CVS Repository in the web browser
- Popular: CVSweb, ViewCVS



Return to [H1Tree.C CVS log](#) Up to [\[H1-00\] / H1Skeleton](#)

Diff for /H1Skeleton/H1Tree.C between version 1.179 and 1.180

version 1.179, 2004/11/24 18:35:54	version 1.180, 2005/01/03 16:51:33
Line 706	Line 706
<pre>for (Int_t i = 0; i <= fFpackIndex[treerf]->GetLast(); i++) ((H1FpackIndexManager*) (fFpackIndex[treerf]->At(i)))->Write(); } cout << "For tree " << fEventList->GetChainInfo(treerf)->GetTreeName() << " " << fChain[treerf]->GetEntries() << " events were written " << endl; cout << "Closing file " << file->GetName() << endl; file->Close(); } }</pre>	<pre>for (Int_t i = 0; i <= fFpackIndex[treerf]->GetLast(); i++) ((H1FpackIndexManager*) (fFpackIndex[treerf]->At(i)))->Write(); } Info("Close", "For tree %s %d events were written \nClosing file %s" , fEventList->GetChainInfo(treerf)->GetTreeName(), (Int_t)fChain[treerf]->GetEntries(), file->GetName()); file->Close(); } }</pre>

Legend:
Removed from v.1.179
changed lines
Added in v.1.180

Colored Diff Show

Summary

- Reading Code
 - Is a "soft skill" to be learned by experience
 - Can be automatized using tools: General ones (ls, wc), Dedicated ones (doctools) and your own
 - Goes hand in hand with writing new code
- Documentation from Code
 - Is easy to extract using doctools
- Evolution of Code
 - Can be monitored by tools

Bibliography

- Spinellis D., *Code Reading*, Addison Wesley 2003
- McConnell S., *Code Complete*, Microsoft Press, 2nd ed. 2004
- Coplien J., *Advanced C++: Programming Styles and Idioms*, Addison Wesley, 1992
- Peter Thömmes, *Notizen zu C++*, Springer 2003
- Gamma, E. et al., *Design Patterns, Elements of Reusable Software*, Addison Wesley 1995
- ...