

CubeGUI 4.6 | Plugin Developer Guide

How to develop a Cube GUI Plugin, road map
and examples

April 2021
The Scalasca Development Team
scalasca@fz-juelich.de

Attention

The Cube GUI User Guide is currently being rewritten and still incomplete. However, it should already contain enough information to get you started and avoid the most common pitfalls.

Contents

1 Copyright	1
2 Abstract	3
3 Cube Plugin Types	5
3.1 Context sensitive Cube Plugins	5
3.2 Context Free Plugins	5
4 Step by step example for CubePlugin	7
4.1 Qt project file	7
4.2 SimpleExample.h	7
4.3 SimpleExample.cpp	8
5 Step by step example for ContextFreePlugin	11
5.1 Qt project file	11
5.2 ContextFreePluginExample.h	11
5.3 ContextFreeExample.cpp	12
6 Developing plugins	15
6.1 Further examples	15
6.1.1 Extensive example	15
6.1.2 ValueView example	15
6.2 Problems loading plugins	15
7 Usage of the Cube Plugin API	17
7.1 Functions to show information provided by the plugin	17
7.1.1 Add a new Tab next to the System tree	17
7.1.2 Add a context menu to a tree view	17
7.1.3 Create a toolbar	17
7.1.4 Define a shortcut	17
7.1.5 Create an additional colormap	17
7.1.6 Create an alternative value view	18
7.1.7 Add a metric to the metric tree	18
7.1.8 Add a marker to a tree	18
7.1.9 Add a status message	18
7.2 Parallel execution of compute-intensive tasks	19
Bibliography	21

1 Copyright

Copyright © 1998–2020 Forschungszentrum Jülich GmbH, Germany

Copyright © 2009–2015 German Research School for Simulation Sciences GmbH, Jülich/Aachen, Germany

All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

- Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
- Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
- Neither the names of Forschungszentrum Jülich GmbH or German Research School for Simulation Sciences GmbH, Jülich/Aachen, nor the names of their contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT OWNER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

2 Abstract

The version 4 of CUBE implementation provides support of varios types of Plugins.

This Guide helps an user to develop an additional standalone plugin which can be used within CUBE.

3 Cube Plugin Types

CUBE supports two types of plugins

- Context sensitive general Plugin
- Context free plugin

3.1 Context sensitive Cube Plugins

Plugins that derive from CubePlugin depend on a loaded cube file. They can react on user actions, e.g. tree item selection, and may insert a context menu or add a new tab next to the tree views. Examples for this type of plugins are the System Topology Plugin or the Statistics Plugin which are part of the Cube installation.

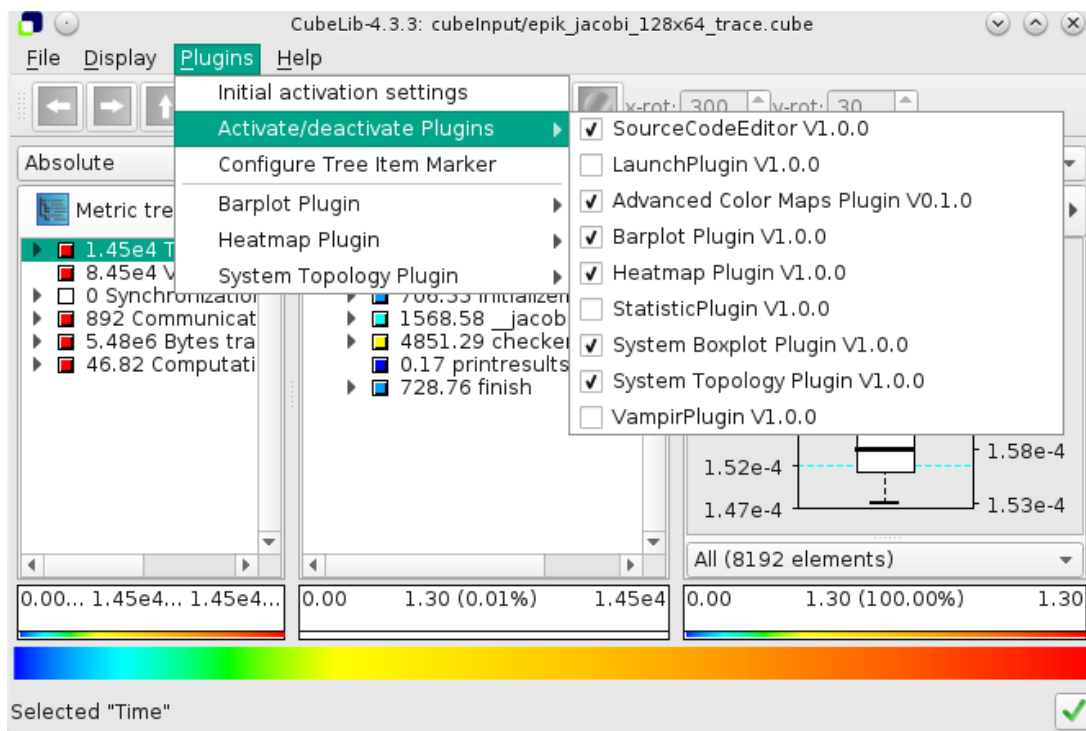


Figure 3.1: plugin menu

3.2 Context Free Plugins

Plugins that derive from ContextFreePlugin are only active if no cube file is loaded. These plugins create or modify Cube objects, which can be loaded and displayed.

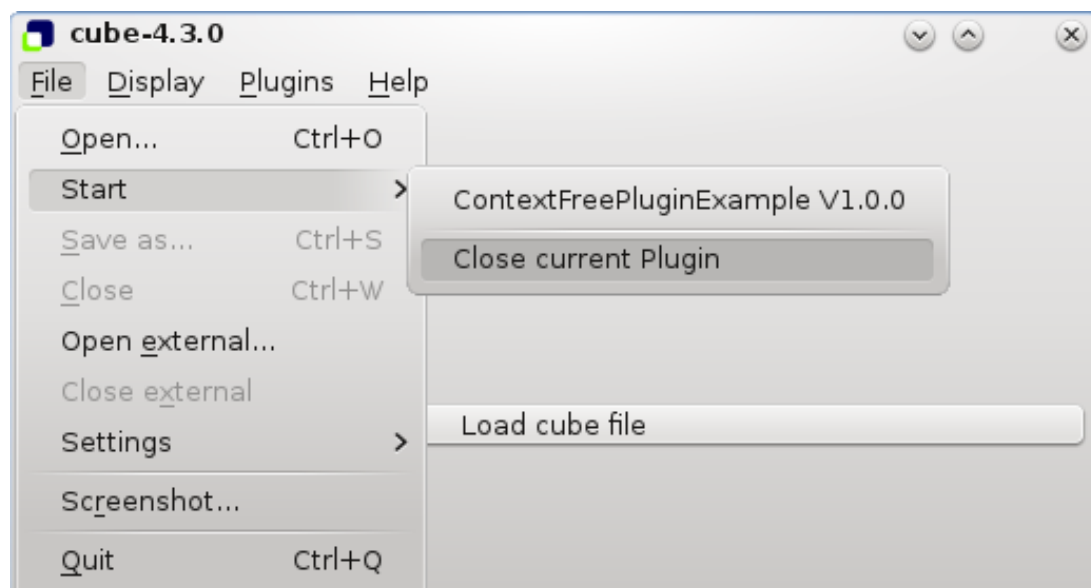


Figure 3.2: context free plugin menu

4 Step by step example for CubePlugin

The following sections describe the steps that are required to create a plugin. For simplicity, a separate project is created and the generated binary will to be copied to the plugin directory of the given cube installation.

Files of the simple cube plugin project:

- example-simple.pro.in
- SimpleExample.h
- SimpleExample.cpp

4.1 Qt project file

To create a cube plugin, a makefile and source files have to be generated. The makefile can be generated automatically from a Qt project file

First we specify the path to the "cube-config" script of the cube installation. This script delivers correct flags for compiling and linking.

```
CUBELIB_CONFIG = @CUBE_CUBELIB@

INCLUDEPATH += $$system($$CUBEGUI_CONFIG --include) $$system($$CUBELIB_CONFIG --include)
LIBS += $$system($$CUBEGUI_CONFIG --ldflags) $$system($$CUBEGUI_CONFIG --libs)

TEMPLATE = lib
CONFIG += plugin
greaterThan(QT_MAJOR_VERSION, 4): QT += widgets

HEADERS = SimpleExample.h
SOURCES = SimpleExample.cpp
TARGET = $$qtLibraryTarget(SimpleExamplePlugin)
```

qmake && make will build the first plugin example libExamplePluginSimple.so. The plugin will be copied to the plugin directory, e.g. /opt/cube/lib64/plugins.

4.2 SimpleExample.h

The example describes a minimal cube plugin, which is inserted as an additional tab next to the SystemTree. It shows the text of the recently selected tree item. The complete source of the example can be found in \$CUBE_INSTALL_PREFIX/share/doc/cube/example/gui/plugin-example.

Every cube plugin has to derive from `cubepluginapi::CubePlugin`. To use Qt's signal and slot mechanism it also has to derive from `QObject`. If the plugin should be added as a tab next to a tree widget, it has to derive from `cubegui::TabInterface`.

```
class SimpleExample : public QObject, public cubepluginapi::CubePlugin, cubepluginapi::TabInterface
```

The class header is followed by the following macro definitions:

- `Q_OBJECT` is required to handle signals and slots.
- `Q_INTERFACES(cubepluginapi::CubePlugin)` tells Qt that the class implements the `CubePlugin` interface and generates the method `qt_metacast(char*)` to cast the plugin object to `CubePlugin` using the class name given as a character array.
- For Qt versions ≥ 5.0 the plugin has to be exported using the `Q_PLUGIN_METADATA()` macro. The unique plugin name "SimpleExamplePlugin" is assigned. For Qt versions < 5.0 , `Q_EXPORT_PLUGIN2` has to be used (see Section 4.3).

```
class SimpleExample : public QObject, public cubepluginapi::CubePlugin, cubepluginapi::TabInterface
{
    Q_OBJECT
    Q_INTERFACES( cubepluginapi::CubePlugin )

#ifdef QT_VERSION >= 0x050000
    Q_PLUGIN_METADATA( IID "SimpleExamplePlugin" ) // unique plugin name
#endif
}
```

The class `SimpleExample` has to implement the pure virtual methods from `cubepluginapi::CubePlugin` and `cubegui::TabInterface`.

```
public:
    SimpleExample();

    // CubePlugin implementation
    virtual bool
    cubeOpened( cubepluginapi::PluginServices* service );
    virtual void
    cubeClosed();
    virtual QString
    name() const;
    virtual void
    version( int& major,
            int& minor,
            int& bugfix ) const;
    virtual QString
    getHelpText() const;

    // TabInterface implementation
    virtual QString
    label() const;
    virtual QWidget*
    widget();
```

4.3 SimpleExample.cpp

`SimpleExample.cpp`

For Qt versions < 5.0 , `Q_EXPORT_PLUGIN2` is used to export the plugin. The first argument is a unique name for the plugin, the second the name of the class.

```
using namespace cubepluginapi;
using namespace simpleexampleplugin;

#if QT_VERSION < 0x050000
Q_EXPORT_PLUGIN2( SimpleExamplePlugin, SimpleExample ); // ( PluginName, ClassName )
#endif
```

The function `cubeOpened(PluginServices* service)` is the starting point of our plugin. Allocation of data and GUI objects should be done here, not in the constructor. This allows to free the resources, if the plugin is deactivated.

Here we create the main widget, which should be added as a system tab. Our plugin derives from `TabInterface`, so `service->addTab(SYSTEMTAB, this)` can be called.

If the user selects a tree item, service will emit a corresponding signal. To react on this event, the signal has to be connected to the slot `treeItemIsSelected()` of our plugin class.

The function returns true, if the plugin should be started. If it returns false, the plugin is closed and deleted.

The function `cubeClosed()` is called if the cube file is closed or if the plugin is unloaded by the user. All resources which have been allocated in `cubeOpened` have to be deleted here.

```
bool
SimpleExample::cubeOpened( PluginServices* service )
{
    this->service = service;

    widget_ = new QWidget();
    QLabel_ = new QLabel( "example string" );
    QVBoxLayout* layout = new QVBoxLayout();
    widget_->setLayout( layout );
    layout->addWidget( QLabel_ );

    service->addTab( SYSTEM, this );

    connect( service, SIGNAL( treeItemIsSelected( cubepluginapi::TreeItem* ) ),
            this, SLOT( treeItemIsSelected( cubepluginapi::TreeItem* ) ) );
    return true; // initialisation is ok => plugin should be shown
}

void
SimpleExample::cubeClosed()
{
    delete widget_;
}
```

Each plugin has to set a version number. If several plugins with the same identifier (see function `name()`) exist, the one with the highest version number will be loaded.

```
void
SimpleExample::version( int& major, int& minor, int& bugfix ) const
{
    major = 1;
    minor = 0;
    bugfix = 0;
}
```

This function returns the unique plugin name. Only one plugin with this name will be loaded.

```
QString
SimpleExample::name() const
{
    return "Simple Example";
}
```

The following function returns a text to describe the plugin. It will be used by help menu of the cube GUI.

```
QString
SimpleExample::getHelpText() const
{
    return "Just a simple example.";
}
```

The following two functions contain the implementation of TabInterface.

The function `widget()` returns the `QWidget` that will be placed into the tab, which has been created with `service->addTab` in `initialize()`.

```
QWidget*
SimpleExample::widget()
{
    return widget_;
}
```

The function `label()` returns the label of the new tab.

```
QString
SimpleExample::label() const
{
    return "Example Plugin Label";
}
```

This method is a slot, which is called if a tree item is selected. The argument provides information about the selected item. With `item->getDisplayType()`, the location (METRIC, CALL, SYSTEM) can be identified.

```
void
SimpleExample::treeItemIsSelected( TreeItem* item )
{
    QString txt = item->getName() + " " + QString::number( item->getValue() );
    qlabel_>setText( txt );
}
```

5 Step by step example for ContextFreePlugin

The following sections describe the steps that are required to create a plugin which derives from ContextFreePlugin. For simplicity, a separate project is created and the generated binary will to be copied to the plugin directory of the given cube installation.

5.1 Qt project file

To create a cube plugins, a makefile and source files have to be generated. The makefile can be generated automatically from a Qt project file

First we specify the path to the "cube-config" script of the cube installation. This script delivers correct flags for compiling and linking.

```
CUBEGUI_CONFIG = @prefix@/bin/cubegui-config
CUBELIB_CONFIG = @CUBE_CUBELIB@

INCLUDEPATH += $$system($$CUBEGUI_CONFIG --include) $$system($$CUBELIB_CONFIG --include)
LIBS += $$system($$CUBEGUI_CONFIG --ldflags) $$system($$CUBEGUI_CONFIG --libs)

TEMPLATE = lib
CONFIG += plugin
greaterThan(QT_MAJOR_VERSION, 4): QT += widgets

HEADERS = ContextFreePluginExample.h
SOURCES = ContextFreePluginExample.cpp
TARGET = $${qtLibraryTarget(ContextFreeExamplePlugin)}
```

qmake && make will build the first plugin example libContextFreeExamplePlugin.so. The plugin will be copied to the plugin directory, e.g. /opt/cube/lib64/plugins.

5.2 ContextFreePluginExample.h

The example ContextFreePluginExample.h describes a minimal context free plugin. The plugin becomes active, if Cube is started without an input file, or if the cube file is closed.

The complete source of the example can be found in \$CUBE_INSTALL_PREFIX/share/doc/cube/example/gui/contextFreePluginExample.h

A context free plugin has to derive from ContextFreePlugin. To use Qt's signal and slot mechanism it also has to derive from QObject.

```
class ContextFreePluginExample : public QObject, public cubepluginapi::ContextFreePlugin
```

The class header is followed by the following macro definitions:

- `Q_OBJECT` is required to handle signals and slots.
- `Q_INTERFACES(ContextFreePlugin)` tells Qt that the class implements the `ContextFreePlugin` interface and generates the method `qt_metacast(char*)` to cast the plugin object to `ContextFreePlugin` using the class name given as a character array.
- For Qt versions ≥ 5.0 the plugin has to be exported using the `Q_PLUGIN_METADATA()` macro. The unique plugin name "ContextFreePlugin" is assigned. For Qt versions < 5.0 , `Q_EXPORT_PLUGIN2` has to be used (see Section 5.3).

```
class ContextFreePluginExample : public QObject, public cubepuginapi::ContextFreePlugin
{
    Q_OBJECT
    Q_INTERFACES( cubepuginapi::ContextFreePlugin )
    #if QT_VERSION >= 0x050000
        Q_PLUGIN_METADATA( IID "ContextFreePluginExample" )
    #endif
}
```

The class `ContextFreePluginExample` has to implement all pure virtual methods from `ContextFreePlugin`.

```
public:
    // ContextFreePlugin interface
    virtual QString
    name() const;

    virtual void
    opened( cubepuginapi::ContextFreeServices* service );

    virtual void
    closed();

    virtual void
    version( int& major,
            int& minor,
            int& bugfix ) const;

    virtual QString
    getHelpText() const;

private slots:
```

5.3 ContextFreeExample.cpp

`ContextFreePluginExample.cpp`

For Qt versions < 5.0 , `Q_EXPORT_PLUGIN2` is used to export the plugin. The first argument is a unique name for the plugin, the second the name of the plugin class.

```
using namespace contextfreepluginexample;
using namespace cubepuginapi;

#if QT_VERSION < 0x050000
Q_EXPORT_PLUGIN2( ContextFreePluginExample, ContextFreePluginExample ) // ( PluginName, ClassName )
#else

```

The function `opened(ContextFreeServices* service)` is the starting point of our plugin. With `service->getWidget()` we get a widget on Cube's main screen, in which we can

place the GUI elements of our plugin. In this example, only one button will be placed on the main screen. Activation of this button will call the slot function `startAction()`.

```
void
ContextFreePluginExample::opened( ContextFreeServices* service )
{
    this->service = service;
    qDebug() << "context free plugin opened";

    QWidget* widget = service->getWidget();
    QVBoxLayout* layout = new QVBoxLayout();
    widget->setLayout( layout );

    QPushButton* but = new QPushButton( "Load cube file" );
    layout->addWidget( but );

    connect( but, SIGNAL( clicked() ), this, SLOT( startAction() ) );
}
```

The function `closed()` is called if the plugin gets inactive because a cube file is loaded or the Cube GUI is closed. All resources which have been allocated in `opened()` have to be deleted here.

```
void
ContextFreePluginExample::closed()
{
    qDebug() << "context free plugin closed";
    // free all resources allocated in ContextFreePluginExample::opened()
    // children of service->getWidget() will be deleted automatically
}
```

This function is called, if the user clicks on the Button "Load cube file". Usually, a context free plugin will create cube data. In this small example, it simply loads the cube file which is chosen from a file dialog.

```
void
ContextFreePluginExample::startAction()
{
    QString openFileName = QFileDialog::getOpenFileName( service->getWidget(),
                                                         tr( "Choose a file to open" ),
                                                         "",
                                                         tr( "Cube3/4 files (*.cube *.cube.gz *.cubex);;Cube4
                                                         files (*.cubex);;Cube3 files (*.cube.gz *.cube);;All files (*.*);;All files (*)" ) );
    std::vector<std::string> fileNames;
    fileNames.push_back( openFileName.toStdString() );
    cube::CubeProxy* cube = cube::CubeProxy::create( cube::ALGORITHM_EMPTY, fileNames );
    service->openCube( cube ); // will be deleted automatically, if user closes cube
}
```

Each plugin has to set a version number. If several plugins with the same identifier (see function `name()`) exist, the one with the highest version number will be loaded.

```
void
ContextFreePluginExample::version( int& major, int& minor, int& bugfix ) const
{
    major = 1;
    minor = 0;
    bugfix = 0;
}
```

This function returns the unique plugin name. Only one plugin with this name will be loaded.

```
QString
ContextFreePluginExample::name() const
{
    return "Context Free Demo";
}
```

The following function returns a text to describe the plugin. It will be used by help menu of the cube GUI.

```
QString
ContextFreePluginExample::getHelpText() const
{
    return "context free plugin help text";
}
```

6 Developing plugins

6.1 Further examples

6.1.1 Extensive example

The example in `$CUBE_INSTALL_PREFIX/share/doc/cube/example/gui/plugin` uses all major functions of `PluginServices`. It contains functions to handle

- settings, global preferences e.g. number formats
- further tab functions
- selections
- menus, context menus and toolbars
- global values to communicate with other plugins

See also

```
cubepuginapi::PluginServices
DemoPlugin.h
DemoPlugin.cpp
demo-plugin.pro.in
```

6.1.2 ValueView example

`$CUBE_INSTALL_PREFIX/share/doc/cube/example/gui/value-view` is an example of a plugin that offers an additional value view. It adds a boxplot view for tau metrics. The example

- implements `cubepuginapi::ValueView` and replaces the colored box with a boxplot
- adds a user dialog which allows the user to change the icon size
- implements `cubepuginapi::SettingsHandler` to save the icon size settings

See also

```
cubepuginapi::PluginServices
TauValueView.h
TauValueView.cpp
tau-value.pro.in
```

6.2 Problems loading plugins

If the plugin doesn't load, start cube with `-verbose` to get further information. The most likely reason is an undefined reference:

```
plugin /opt/cube/lib64/cube-plugins/libSimpleExamplePlugin.so is not a valid
CubePlugin version cubeplugin/1.1
Cannot load library /opt/cube/lib64/cube-plugins/libSimpleExamplePlugin.so:
(undefined symbol: _ZN13SimpleExample10cubeClosedEv)
```

If we remove the definition of the method `cubeClosed()` in `SimpleExample.cpp`, the plugin is created without errors, but it cannot be loaded. `cube -verbose` shows the error message above.

When building plugins, it is important to ensure that the plugin is configured in the same way as `cube`. A plugin build with incompatible options shows the following error:

```
Plugin verification data mismatch in '/opt/cube/lib64/cube-plugins/libSimpleExamplePlugin.so'
```

The same compiler, the same Qt library and the same configuration options have to be used. Only plugins which are created using a Qt library with a lower minor version can also be loaded.

7 Usage of the Cube Plugin API

The class `cubepuginapi::PluginServices` is used by the plugins to interact with the cube GUI. This Chapter will provide an overview about the most important functions.

7.1 Functions to show information provided by the plugin

7.1.1 Add a new Tab next to the System tree

To add one or more tabs next to the system tree, the plugin has to call `cubepuginapi::PluginServices::addTab`. This function requires a `cubegui::TabInterface` as parameter. The tab has to define a label and a widget. See [4](#) for a simple demo.

7.1.2 Add a context menu to a tree view

A context menu is shown, if the user clicks with the right mouse button on a tree. With `cubepuginapi::PluginServices::addContextMenu`, the plugin can add a menu item to the context menu.

7.1.3 Create a toolbar

Cube provides toolbars, if they are enabled (e.g. Preferences, Synchronisation). A plugin may create additional toolbars with `cubepuginapi::PluginServices::addToolBar`. A toolbar may be assigned to a tab. In this case, the toolbar is only visible, if the tab is also visible. If the tab gets detached, the toolbar will be moved to the new window.

7.1.4 Define a shortcut

Shortcuts can be defined with `QAction::setShortcut`. To ensure that the plugin shortcuts don't interfere with the default shortcuts, the context should be set using `QAction::setShortcutContext(Qt::WidgetWithChildrenShortcut)`.

7.1.5 Create an additional colormap

The colormap plugin example (`ColorMapPlugin.h`, `ColorMapPlugin.cpp`) demonstrates how to use `cubepuginapi::PluginServices::addColorMap`

7.1.6 Create an alternative value view

The default value view shows a colored square next to the numerical value. The function `cubepuginapi::PluginServices::addValueView` adds the given value view to the list of available views from which the user can choose the active one. See [6.1.2](#) for an example implementation.

7.1.7 Add a metric to the metric tree

To add a new metric to the metric tree, call `cubepuginapi::PluginServices::addMetric`.

7.1.8 Add a marker to a tree

A plugin may define one or more tree item marker to tag items of interest.

Tree items are marked in different ways:

- Items with a colored background show that a plugin has set a marker
- Items with a colored frame indicate that a collapsed child has been marked.
- Items with a black frame indicate that there are several collapsed children with different marker.
- Items with a dotted frame show a dependency. A marked item of the right neighbor tree depends on
- Items can be grayed out. These items are either marked as unimportant by a plugin, or the user has chosen to gray out all items, for which no marker is set. this item. The dependent item is only marked, if the dotted item is selected.

To create a new marker, `cubepuginapi::PluginServices::getTreeItemMarker` has to be called. Then, the marker can be added in two different ways:

- for one `TreeItem`
`cubepuginapi::PluginServices::addMarker(TreeItem *item, const TreeItemMarker *marker, bool isDependency)`
- for a set of dependent items
`cubepuginapi::PluginServices::addMarker(const TreeItemMarker *marker, TreeItem *metric, TreeItem *call, TreeItem *system)`

See [6.1.1](#) for an example implementation.

7.1.9 Add a status message

To write a message to the status line at the bottom of the cube window, call `cubepuginapi::PluginServices::setMessage`.

7.2 Parallel execution of compute-intensive tasks

The API function `cubepuginapi::PluginServices::createFuture(TabInterface* tab = 0)` creates a `Future` object to execute a task in parallel. The `Future` object is deleted after the plugin has been closed. If a `TabInterface` is given, a progress bar will be displayed in the given tab while the tasks are running.

The parallel plugin example (`ParallelPlugin.h`, `ParallelPlugin.cpp`) demonstrates how to use `cubepuginapi::Future`

