Forum Nokia

Qt Data

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Contents

- Properties
- Data Types
- Settings
- Resource Files

Properties

Property System

- **Add data to meta-object of class instances**
  - **Behaves like class property member**
  - Define in class **header file**
  - Or add **dynamically at runtime**
    (any property to any class)
  - Used by **Qt Designer** for widget setup

Query Properties

- **Example: default properties of QPushButton instance**
  - Default: 71 properties defined


```
// Get meta object of target object
const QMetaObject *metaobject = but->metaObject();
// Number of properties
int count = metaobject->propertyCount();
for (int i=0; i<count; ++i) {
    // Retrieve current property
    QMetaProperty metaproperty = metaobject-
>property(i);
    // Print name and value to debug out
    const char *name = metaproperty.name();
    QVariant value = but->property(name);
    qDebug() << "Name:" << name << ", value:" << value;
}
```

```
Name: objectName , value: QVariant(QString, "")
Name: enabled , value: QVariant(bool, true)
Name: pos , value: QVariant(QPoint, QPoint(0,0) )
Name: size , value: QVariant(QSize, QSize(200, 100) )
Name: width , value: QVariant(int, 200)
Name: height , value: QVariant(int, 100)
Name: rect , value: QVariant(QRect, QRect(0,0 200x100) )
Name: isActiveWindow , value: QVariant(bool, true)
Name: focus , value: QVariant(bool, true)
Name: visible , value: QVariant(bool, true)
Name: minimized , value: QVariant(bool, false)
Name: maximized , value: QVariant(bool, false)
Name: fullScreen , value: QVariant(bool, false)
Name: sizeHint , value: QVariant(QSize, QSize(76, 23) )
Name: toolTip , value: QVariant(QString, "")
Name: statusTip , value: QVariant(QString, "")
Name: whatsThis , value: QVariant(QString, "")
Name: locale , value: QVariant(QLocale, )
Name: text , value: QVariant(QString, "Hello Property")
Name: down , value: QVariant(bool, false)
...
```

Adding Own Properties

- **Define with Q_PROPERTY() macro (inherited from QObject)**
  - In **private section** of class
  - **READ** function: creator(). Must be const. (required)
  - **WRITE** function: setCreator(). Must return void, exactly one argument with type of property or pointer/reference to that type (optional)

mybutton.h

```
class MyButton : public QPushButton
{
    Q_OBJECT
    Q_PROPERTY(QString creator READ creator WRITE setCreator)

public:
    MyButton(const QString& text, QWidget* parent = NULL);

    void setCreator(QString aCreator);
    QString creator() const { return iCreator; }

private:
    QString iCreator;
};
```

mainwindow.cpp

```
but->setCreator(tr("Mopius"));
```

```
...
Name: creator , value: QVariant(QString, "Mopius")
```

mybutton.cpp

```
void MyButton::setCreator(QString aCreator)
{
    iCreator = aCreator;
}
```

Dynamic Properties

- **Add new properties to an instance at runtime**
- **setProperty() behaviour:**
  - **Name equals existing property & type is compatible:** updates property
  - **Non-compatible type compatible:** no update
  - **Name does not exist** (not declared with Q_PROPERTY()): new property is added

mainwindow.cpp

```
but->setProperty("Owner", tr("Andreas Jakl"));

QList<QByteArray> dynProperties = but->dynamicPropertyNames();
foreach (QByteArray curProperty, dynProperties)
{
    QVariant value = but->property(curProperty);
    qDebug() << "Dyn-Name:" << curProperty << ", value:" << value;
}
```

```
Dyn-Name: "Owner" , value: QVariant(QString, "Andreas Jakl")
```

Data Types

Fundamental Data Types

- Can be important for cross platform development
- Datatypes defined via typedef

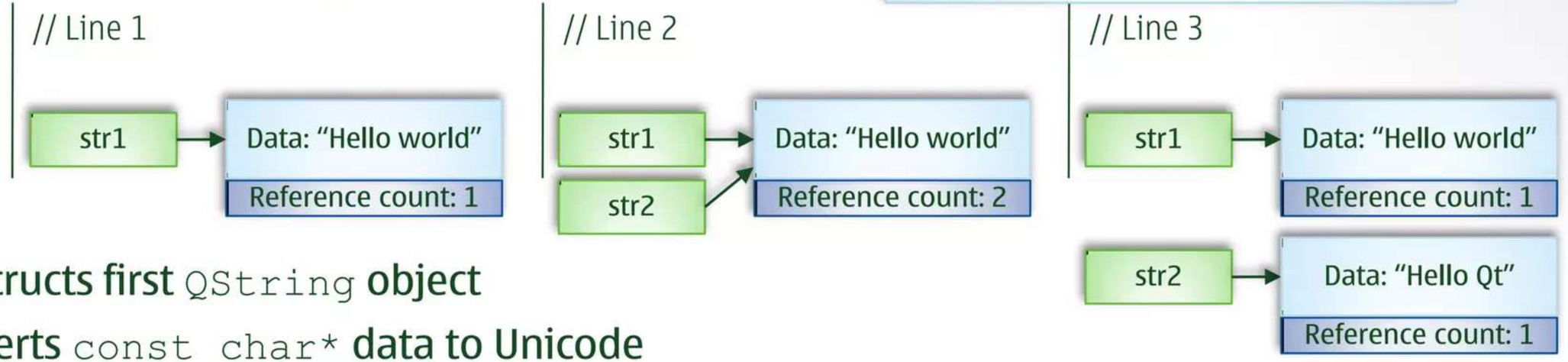
Qt type	typedef from	Value range
qint8	signed char	-128 to +127
qint16	signed short	-32768 to +32767
qint32	signed int	-2147483648 to +2147483647
qint64	long long int	signed 64 bit
qreal	double / float (ARM)	
uchar / quint8	unsigned char	0 to 255
ushort / quint16	unsigned short	0 to 65535
uint / quint32	unsigned int	0 to 4294967296
ulong	unsigned long	0 to 4294967296
qulonglong / quint64	unsigned long long int	unsigned 64 bit values

QString

- **Main facts**
  - Similar to standard **C++ String**
  - Qt always uses **Unicode** (16 bit QChar)
  - Uses **implicit sharing** to increase efficiency and reduce memory overhead
  - Use a **QByteArray** to store raw bytes and 8-bit '\0'-terminated strings

Implicit Sharing – Example

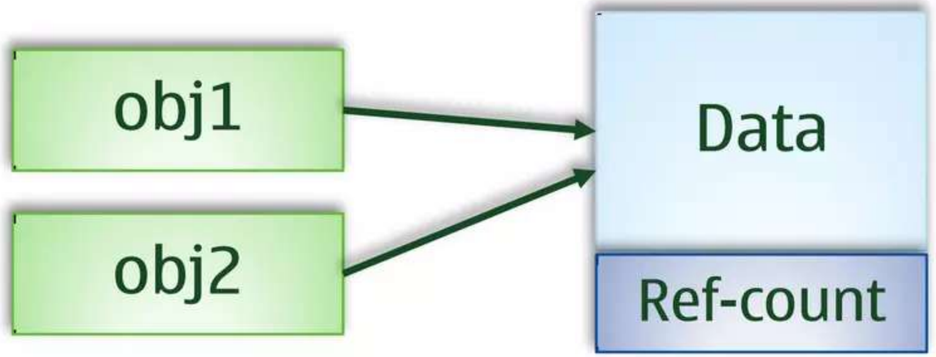
```
QString str1 = "Hello world";
QString str2 = str1;
str2.replace("world", "Qt");
```



- **Line 1**
  - Constructs first `QString` object
  - Converts `const char*` data to Unicode
- **Line 2**
  - Assigns value of `str1` to `str2`, but Qt doesn‘t copy it right away
  - **Instead:** only pointer is passed (“shallow copy”)
- **Line 3**
  - Modifies `str2`: Qt separates both strings in memory (“deep copy”)
  - Happens behind the scenes

Implicit Sharing

- **Works automatically behind the scenes**
  - Only **pointer to data is passed**
  - **Data only copied** if a function **writes** on it (copy-on-write)
- **Pointer to shared data block, which contains reference count and data**
  - Reference counting implemented as atomic operation (thread-safe)
- **Copies**
  - **Shallow copy:** reference copy
  - **Deep copy:** duplicates object
  - Object assignment (`operator=()`) uses shallow copies
  - Modifying methods perform deep copy if needed
- **Usage in Qt**
  - `QString`, `QImage`, etc.
  - Using for own classes: `QSharedDataPointer`



Returning QString Objects

- **You can treat QStrings like basic C++ types:**
  - `result` is allocated on the stack
  - Return by value
  - Calls copy constructor
  - No actual copying takes place (implicit sharing)

→ **works perfectly fine**

```
QString Widget::boolToString(bool b) {
    QString result;
    if (b)
        result = "True";
    else
        result = "False";
    return result;
}
```

QVariant

- Acts like a union for most common Qt data types
- Stores one type of data
- Converts between different types

```
QDataStream out(...);
QVariant v(123);                    // The variant now contains an int
int x = v.toInt();                  // x = 123
out << v;                           // Writes a type tag and an int to out
v = QVariant("hello");              // The variant now contains a QByteArray
v = QVariant(tr("hello"));          // The variant now contains a QString
int y = v.toInt();                  // y = 0 since v cannot be converted to an int
QString s = v.toString();           // s = tr("hello")  (see QObject::tr())
out << v;                           // Writes a type tag and a QString to out
[...]
QDataStream in(...);                // (opening the previously written stream)
in >> v;                            // Reads an Int variant
int z = v.toInt();                  // z = 123
qDebug("Type is %s",                // prints "Type is int"
v.typeName());
v = v.toInt() + 100;                // The variant now hold the value 223
v = QVariant(QStringList());
```

Lists, etc.

- **"Tulip" Container classes similar to STL**
  - Less error-prone syntax than STL
  - Using STL is possible, but might not be fully implemented by all compilers

Sequential containers	Associative containers
QList (QStringList)	QMap
QLinkedList	QMultiMap
QVector	QHash
QStack	QMultiHash
QQueue	QSet

Iterating over QStringList

```
// Define and populate a string list
// (like QList<QString> with some enhancements)
QStringList sList;
sList << "apple" << "pear" << "orange";

1 // foreach is a Qt specific addition to C++, implemented via the preprocessor
foreach(QString str, sList)
    std::cout << str.toAscii().constData() << std::endl;

2 // Iterate over list using indexing
for (int i = 0; i < sList.size(); i++)
    std::cout << sList.at(i).toAscii().constData() << std::endl;

3 // Use an STL-style iterator
QStringList::const_iterator constIt;
for (constIt = sList.constBegin(); constIt != sList.constEnd(); ++constIt)
    std::cout << (*constIt).toAscii().constData() << std::endl;

4 // Java-style iterator
QStringListIterator javaStyleIterator(sList);
while (javaStyleIterator.hasNext())
    std::cout << javaStyleIterator.next().toAscii().constData() << std::endl;
```

QDebug

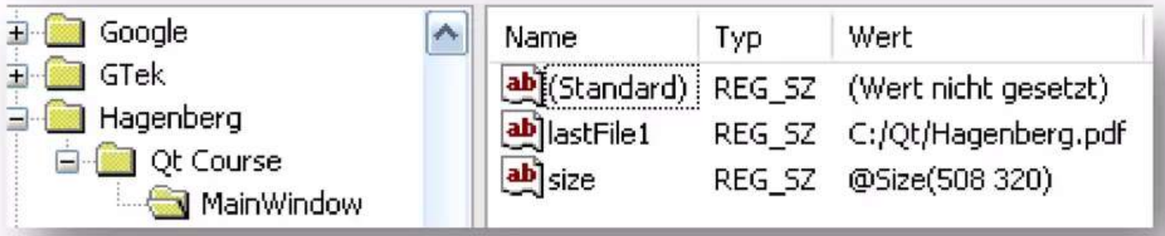
```
// The global functions are available anywhere.
qDebug("Processing Fruits...");

// Using the << operator requires including <QDebug>
qDebug() << "Fruit: " << sList.at(1);
```

- **Four global functions available:**
  - **qDebug():** writing custom debug output.
  - **qWarning():** report warnings and recoverable errors in your application.
  - **qCritical():** writing critical error messages and reporting system errors.
  - **qFatal():** writing fatal error messages shortly before exiting.
- **Outputs to:**
  - **Mac OS X and Unix:** stderr
  - **Windows:** Console application → console. GUI application → debugger.

Settings

QSettings

- **Persistent platform-independent application settings**
  - **Windows:** registry
  - **Mac OS X:** XML files (.plist)
  - **Linux/Unix:** no standard, often .ini
- **Can be set to use .ini-file on all platforms**



Application Properties

- **Define properties in main():**

```
QCoreApplication::setOrganizationName("Hagenberg");
QCoreApplication::setApplicationName("Qt Course");
```

  - **Alternative:** specify each time when creating a `QSettings` object
- **Corresponds to:**
  - Windows (user context):
    HKEY_CURRENT_USER\Software\Hagenberg\Qt Course\
  - Unix: file ~/.config/Hagenberg/Qt Course.conf
- **API based on QVariant → easy to store values**

Saving Settings

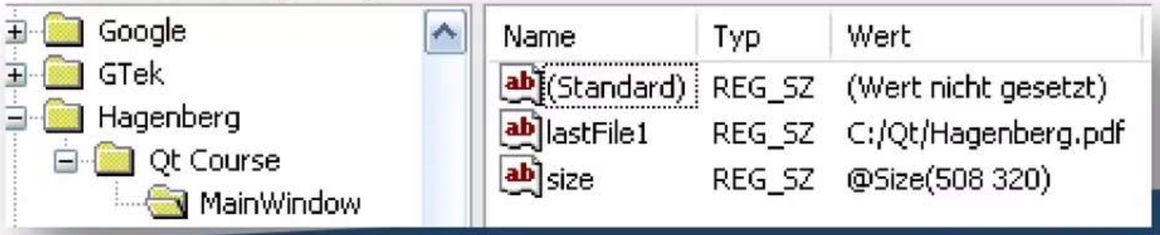
- Keys should be kept case-sensitive and not contain slashes ('/' and '\')

```
void MainWindow::closeEvent(QCloseEvent *event) {
    QSettings settings;
    // Store the current size to the settings
    settings.beginGroup("MainWindow");
    settings.setValue("size", size());
    settings.setValue("lastFile1", "C:/Qt/Hagenberg.pdf");
    settings.endGroup();
    // Instead, we could also write: settings.setValue("MainWindow/size", size());

    // Accept the close event so that the window is shut down
    event->accept();
}
```

.ini-file

```
[MainWindow]
lastFile1=/home/qtexample/main.cpp
size=@Size(508 320)
```

Windows Registry



Loading Settings

- Read settings through key
- Convert resulting QVariant to real type (e.g., QSize, QString, ...)
- Second parameter = Default value

```
QSettings settings;
// The next statements all refer to the group "MainWindow"
settings.beginGroup("MainWindow");
// Convert the QVariant from key "lastFile1" to a QString
QString lastFile1 = settings.value("lastFile1").toString();
// Convert key "size" to a QSize object and use 480x320 as default
// size if it's not defined (yet).
QSize size = settings.value("size", QSize(480, 320)).toSize();
// Close the group again
settings.endGroup();

if (!lastFile1.isEmpty()) {
    // Last file is defined - try to load the file...
}

// Set window size to previous size
resize(size);
```

Resource Files

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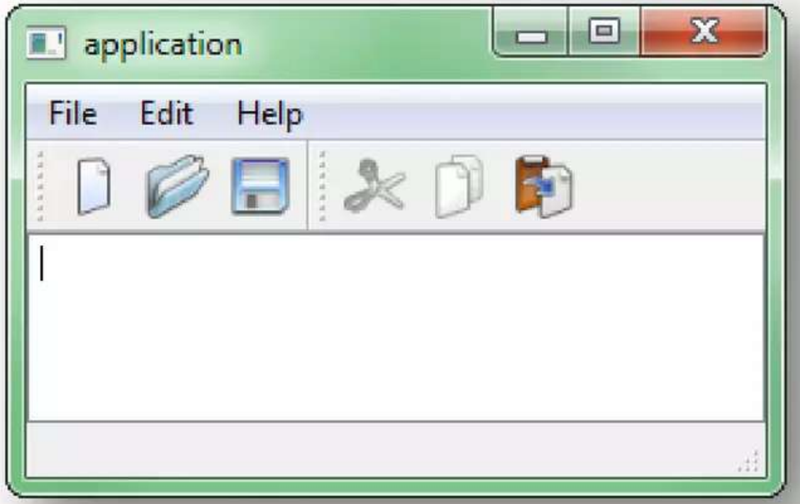
External Application Data

- **Common extra files**
  - Images, icons
  - Translation files
  - Generic data files
- **Distributing extra files with application**
  - Risk of losing files
  - Easier for user to mess with data

⇨ **Embed files into executable**



Resource Collection Files

- **Define resources in xml-file (.qrc)**
  - Specify directories relative to .qrc location

application.qrc

```
<!DOCTYPE RCC><RCC version="1.0">
<qresource>
    <file>images/copy.png</file>
    <file>images/cut.png</file>
    <file>images/new.png</file>
    <file>images/open.png</file>
    <file>images/paste.png</file>
    <file>images/save.png</file>
    <file alias="bg.jpg">images/mountain.jpg</file>
</qresource>
</RCC>
```

- **File alias**
  - Allows using different files for platforms / languages, but referring to one filename from source code

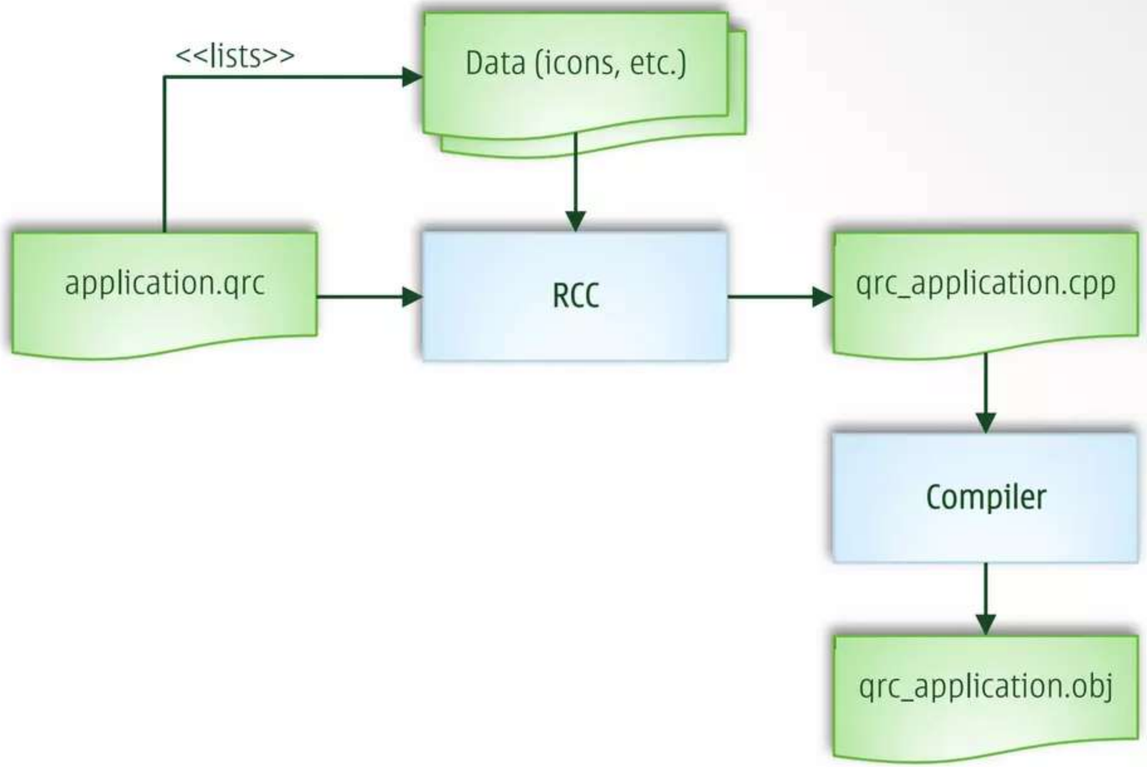
Compiled-In Resources

- **Add to project file (.pro)**

application.pro

```
RESOURCES         = icons.qrc
```

- **Invokes resource compiler (RCC)**
  - **Generates C++** source files
  - Data specified as static C++ arrays



qrc_application.cpp

```
#include <QtCore/qglobal.h>

static const unsigned char qt_resource_data[] = {
  // C:/Qt/2009.05/qt/examples/mainwindows/application/images/new.png
  0x0,0x0,0x3,0x54,0x89,
  […]
```

Accessing Resources

- Qt uses virtual file tree for compiled-in resources
- Used when file name starts with " :"

```
newAct = new QAction(QIcon(":/images/new.png"), tr("&New"), this);
```

Resource Paths and Localization

- **Change path prefix for group of items**

```
<qresource prefix="/myresources">
    <file alias="cut-img.png">images/cut.png</file>
</qresource>
```

  - **Access file through:**

    `:/myresources/cut-img.png`

- **Different files by user's locale**
  - `lang`-attribute to `qresource` tag
  - Specify suitable locale string

```
<qresource>
    <file>cut.jpg</file>
</qresource>
<qresource lang="fr">
    <file alias="cut.jpg">cut_fr.jpg</file>
</qresource>
```

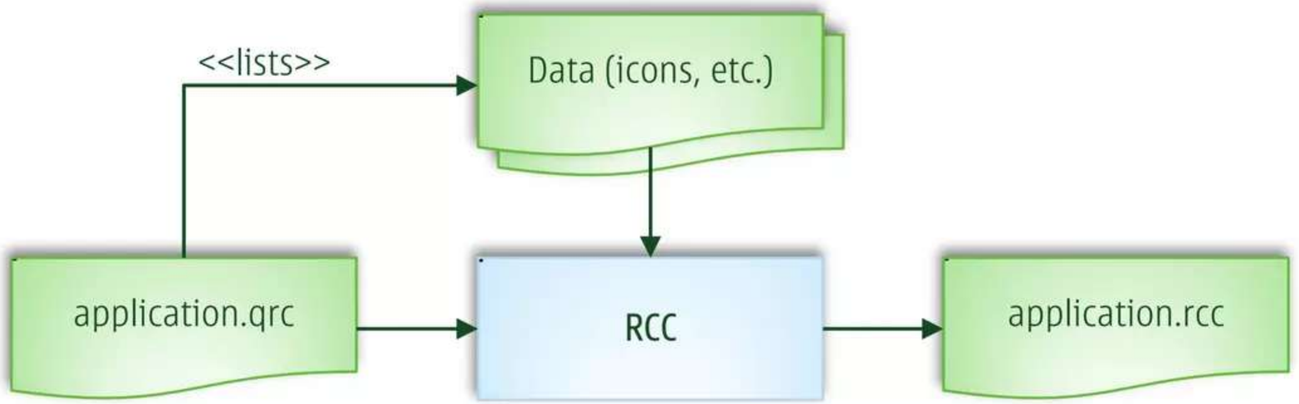
External Resources

- **Manually compile resource files (.rcc)**

```
rcc -binary application.qrc -o application.rcc
```

- **Register resource with code**

```
QResource::registerResource("/path/to/application.rcc");
```



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Thank You.