Qt Fundamentals: QtCore Module

Click to add text

Managing text using QString

- Stores strings as Unicode characters
  - Can represent almost all writing systems in use today.
- Support conversions from one locale to another
- Provides convenient API for string inspection and modification:
  - replace, insert, compare, remove, etc.
- `QString` can be created in a number of ways:

constructors e.g.:
```
QString hello("hello you");
```

operator+() e.g.:
```
QString helloworld = "hello " + world;
```

string builder e.g.:
```
QString answer = "hello" % world;
```

QStringBuilder

- Using the operator+ to join strings results in numerous memeory allocations and checks for string length
- A better way to do it is to include `QStringBuilder` and use the % operator.

Good:
```
QString answer = "hello" % world % anotherString % andAnother;
```

Bad:
```
QString answer = "hello";
answer = answer % world;
answer = answer % anotherString;
answer = answer % andAnother;
```

Can be a little tricky to use, one of the strings must be a QString

QString::arg

- The arg method replaces %1-99 with values

```
QString answer = QString("%1 plus %2 equal %3).arg(4).arg(2).arg(6);
```

- Can handle strings, chars, integers and floats
- Can convert between number bases

```
...).arg(value, width, base, fillchar);
...).arg(42, 3, 16, QChar('0')); // Results in 02a
```

```
...).arg(qulonglong a)        ...).arg(QString, ... QString)
...).arg(short a)             ...).arg(int a)
...).arg(ushort a)            ...).arg(uint a)
...).arg(QChar a)             ...).arg(long a)
...).arg(char a)              ...).arg(ulong a)
...).arg(double a)            ...).arg(qlonglong a)
```

Substrings

- Access substrings using **left**, **right** and **mid**

```
QString s = "Hello world";
r = s.left(5); // "Hello"
r = s.right(5); // "world"
r = s.mid(6,5); // world
```

- By not specifying a length to **mid**, the rest of the string is returned:

```
r = s.mid(6); // world
```

- Use replace to search and replace in strings:

```
r = s.replace("world", "universe"); // Hello universe
```

Empty and null strings

- A string can be null, i.e. contain nothing

```
QString s();
s.isNull(); // true
s.isEmpty(); // true
```

- It can also be empty i.e. contain an empty string

```
QString s("");
s.isNull(); // false
s.isEmpty(); // true
```

Handling Binary Data

`QByteArray` provides a container for binary data

Advantages over using a raw `char *`:
1. You do not have to handle memory allocation/deallocation
– Rich API for manipulation
– Tight integration with other Qt APIs

API very similar to QString, but instead of 16-bit (unicode) data the QByteArray stores 8-bit (ascii or raw bytes).

Qt Collection Classes

- QList is one of many of Qt's container template classes
- QLinkedList – quick insert in the middle, access through iterators
- QVector – uses continous memory, slow inserts
- QStack – LIFO, last in – first out
- QQueue – FIFO, first in – first out
- QSet – unique values
- QMap – associative array
- QHash – associative array, faster than QMap, but requires hash
- QMultiMap – associative array with multiple values per key
- QMultiHash – associative array with multiple values per key

Specialization for popular combinations of value and containers exist e.g.: QStringList is derived from QList<QString>

QList

The QList class is a template class that provides lists.
- Use the stream operator to populate the list

```
QList<QString> list;
list << "one" << "two" << "three";
// list: ["one", "two", "three"]
```

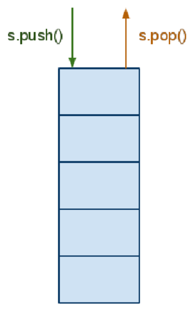
- Or use the QStringList which inherits QList<QString>

QVector

- Similar functionality to QList

Which to use? Depends on the type of items stored. In general QList is recommended for most use cases.

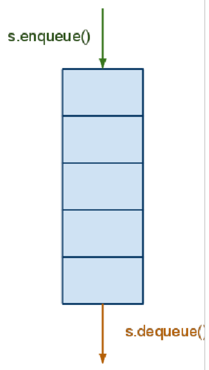
QStack



- A stack if a LIFO container
  last in, first out
- Items are pushed onto the stack
- Items are popped off the stack
- The top item can be seen using top()

```
QStack<int> stack;
stack.push(1);
stack.push(2);
stack.push(3);
qDebug("Top: %d", stack.top()); // 3
qDebug("Pop: %d", stack.pop()); // 3
qDebug("Pop: %d", stack.pop()); // 2
qDebug("Pop: %d", stack.pop()); // 1
qDebug("isEmpty? %s", stack.isEmpty()?"yes":"no");
```

QQueue



- A queue is a FIFO container
  first in, first out
- Items are enqueued into the queue
- Items are dequeued from the queue
- The first item can be seen using head()

```
QQueue<int> queue;
queue.enqueue(1);
queue.enqueue(2);
queue.enqueue(3);
qDebug("Head: %d", queue.head());   // 1
qDebug("Pop: %d", queue.dequeue()); // 1
qDebug("Pop: %d", queue.dequeue()); // 2
qDebug("Pop: %d", queue.dequeue()); // 3
qDebug("isEmpty? %s", queue.isEmpty()?"yes":"no");
```

QSet

- A set contains values, but only one instance of each value.
- It is possible to determine if a value is a part of the set or not

```
QSet<int> primes;
primes << 2 << 3 << 5 << 7 << 11 << 13;
for(int i=1; i<=10; ++i)
   qDebug("%d is %sprime", i, primes.contains(i)?"":"not ");
```

- You can also iterate over a set, to see all values

```
foreach(int prime, primes)
   qDebug("Prime: %d", prime);
```

- It is possible to convert a QList to a QSet

```
QList<int> list;
list << 1 << 1 << 2 << 2 << 2 << 3 << 3 << 5;
QSet<int> set = list.toSet();
qDebug() << list; // (1, 1, 2, 2, 2, 3, 3, 5)
qDebug() << set;  // (1, 2, 3, 5)
```

Key/value collections aka. QMap & QHash

- The QMap and QHash classes let you create associative arrays

```
QMap<QString, int> map;

map["Helsinki"] = 1310755;
map["Oslo"] = 1403268;
map["Copenhagen"] = 1892233;
map["Stockholm"] = 2011047;

foreach(const QString &key, map.keys())
   qDebug("%s", qPrintable(key));

if(map.contains("Oslo"))
{
   qDebug("Oslo: %d",
              map.value("Oslo"));
}
```

```
QHash<QString, int> hash;

hash["Helsinki"] = 1310755;
hash["Oslo"] = 1403268;
hash["Copenhagen"] = 1892233;
hash["Stockholm"] = 2011047;

foreach(const QString &key, hash.keys())
   qDebug("%s", qPrintable(key));
```

- QHash faster lookup
- QHash requires specification of hash function for user-defined types

QVariant

- QVariant is an implementation of *a Single Value, Multiple Types* class.
- What does this mean?
  - A QVariant allows us to store and retrieve a number of different arguments in a generic value.
- Maybe we need an example:
- You will encounter it in an increasing number of places in the Qt APIs

```
QList<QVariant> m_list;

m_list << QVariant(QString("hello world"));
m_list << QVariant(5);

if(m_list[0].type() == QVariant::String)
   {
      qDebug() << "I'm a string: " << m_list[0].toString();
   }

if(m_list[1].type() == QVariant::Int)
   {
      qDebug() << "I'm a int " << m_list[1].value<int>();
   }
```

Files and file systems

- Referring to files and directories in a cross platform manner poses a number of problems
  - Does the system have drives, or just a root?
  - Are paths separated by “/” or “\”?
  - Where does the system store temporary files?
  - Where does the user store documents?
  - Where is the application stored?

Paths

- Use the `QDir` class to handle paths

```
QDir d = QDir("C:\\");
```

- Use the static methods to initialize

```
QDir d = QDir::root(); // "C:\" on windows and "/" on Linux


QDir::current() // Current directory
QDir::home()    // Home directory
QDir::temp()    // Temporary directory

// Executable directory path
QDir(QApplication::applicationDirPath())
```

Finding directory contents

- The `entryInfoList` returns a list of information for the directory contents

```
QDir d = QDir(QApplication::applicationDirPath());

QFileInfoList infos = d.entryInfoList();

foreach(const QFileInfo &info, infos)
   qDebug() << info.fileName();
```

this function supports filters

- You can add filters to skip files or directories

QDir::Dirs
QDir::Files
QDir::NoSymLinks
Dirs, files or symbolic links?

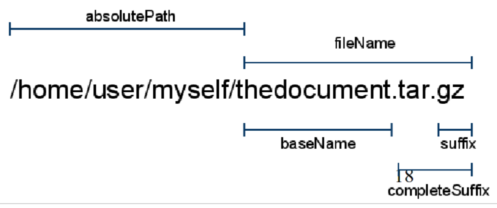
QDir::Readable
QDir::Writable
QDir::Executable
Which files?

QDir::Hidden
QDir::System
Hidden files?
System files?

QFileInfo

Each `QFileInfo` object has a number of methods

- `absoluteFilePath` – full path to item
- `isDir` / `isFile` – type of item
- `isWriteable` / `isReadable` / `isExecutable` – **permission for file**



Opening and reading files

- The `QFile` is used to access files

```
QFile f("/home/john/input.txt");

if (!f.open(QIODevice::ReadOnly))
   qFatal("Could not open file");
```

```
QByteArray data = f.readAll();
processData(data);
```

```
while(!f.atEnd())
{
   QByteArray data = f.read(160);
   processData(data);
}
```

```
f.close();
```

Read chunks or read everything

Writing to files

- When writing files, open it in WriteOnly mode and use the write method to add data to the file

```
QFile f("/home/john/input.txt");

if (!f.open(QIODevice::WriteOnly))
   qFatal("Could not open file");

QByteArray data = createData();
f.write(data);

f.close();
```

- Files can also be opened in ReadWrite mode
- The flags Append or Truncate can be used in combination with write-enabled modes to either append data to the file or to truncate it (i.e. clear the file from its previous contents)

```
if (!f.open(QIODevice::WriteOnly|QIODevice::Append))
```

The QIODevice

- `QFile` is derived from `QIODevice`
- The constructors `QTextStream` and `QDataStream` take a `QIODevice` pointer as an argument, not a `QFile` pointer
- There are `QIODevice` implementations
  - `QBuffer` – for reading and writing to memory buffers
  - `QextSerialPort` – for serial (RS232) communication (3rd party)
  - `QAbstractSocket` – the base of TCP, SSL and UDP socket classes
  - `QProcess` – for reading and writing to processes' standard input and output

Timer Events

`int QObject::startTimer(int interval)`

- Starts the timer, which will continuously send timer events at specified intervals (ms)
- Returns the timer id
- Stops when `QObject::killTimer(id)` is called

```
class MyObject : public QObject
{
Q_OBJECT

public:
MyObject(QObject *parent = 0);

protected:
void timerEvent(QTimerEvent *event);
};

MyObject::MyObject(QObject *parent)
: QObject(parent)
{
startTimer(50); // 50-millisecond timer
startTimer(1000); // 1-second timer
startTimer(60000); // 1-minute timer
}

void MyObject::timerEvent(QTimerEvent *event)
{
qDebug() << "Timer ID:" << event->timerId();
}
```

Timer Events

Using `QTimer` we can have repetitive and/or single-shot timers.

- Emits the `timeout()` signal when the timer expires

```
QTimer *timer = new QTimer(this);
connect(timer, SIGNAL(timeout()), this, SLOT(update()));
timer->start(1000);
```