Lecture Qt009
Events

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Outline

- Event Loop
- Handling Events
- Event Handling Options
- Hands-On Example: Stopwatch
- Timers
- Event Filters
- Key Points

Event Loop

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- Performs two tasks
  - Manages window events
  - Generates its own events
    - Derived from QEvent (base class of all events)
    - Each event has a type
    - Events processed by event loop

Event Loop

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- Events passed to objects that inherit from **QObject**
- The **event()** method of target object processes or ignores the event
- Events may be queued for later delivery
- If processing of queued events is delayed, application may appear to have crashed

Event Handling Options

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1. Reimplement specific event handler
2. Reimplement generic event handler
   QObject::event()
3. Use event filters on **QObject**
4. Use event filter on **QApplication** object
5. Subclass **QApplication** and reimplement **notify()**

C++ GUI Programming with Qt 4, 2nd Ed. by Jasmin Blanchette and Mark Summerfield

Example: Stop Watch

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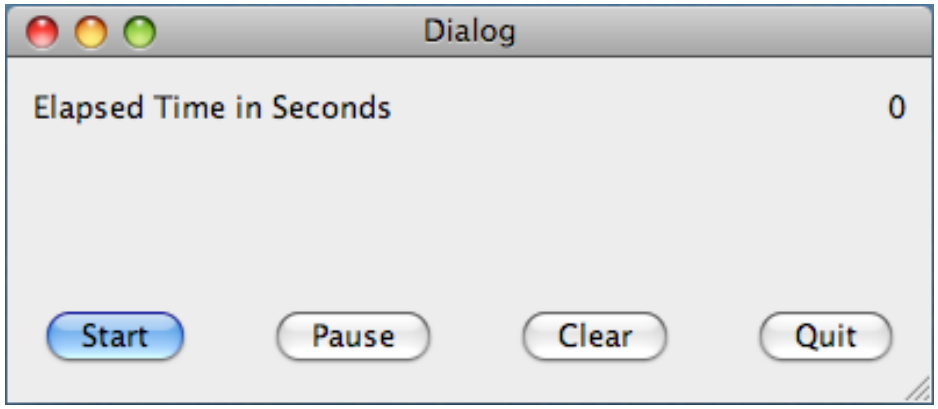
- Create a Stopwatch dialog with four controls
  - Start
  - Pause
  - Clear
  - Quit



- Display updates every second when not paused or cleared

Example: Method #1
Reimplement Specific Event Handler

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```
// Customized main.cpp
#include <QApplication>
#include "dialog.h"

int main(int argc, char *argv[])      // Standard main function
{
    QApplication a(argc, argv);
    Dialog w;
    w.show();
    return a.exec();
}
```

Example: Method #1
Reimplement Specific Event Handler

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```
// Customized dialog.h
#ifndef DIALOG_H
#define DIALOG_H
#include <QDialog>

namespace Ui
{
  class Dialog;
}
```

```
class Dialog : public QDialog
{
  Q_OBJECT

public:
  Dialog(QWidget *parent = 0);
  ~Dialog();

protected:
  void timerEvent(QTimerEvent* someEvent);

private:
  Ui::Dialog *ui;
  int updateTimer;
  bool paused;

private slots:
  void initiateTimer();
  void pauseTimer();
  void clearTimer();
};

#endif // DIALOG_H
```

Timer-Specifc Event Handler

Example: Method #1
Reimplement Specific Event Handler

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```
// Customized dialog.cpp
#include "dialog.h"
#include "ui_dialog.h"
#include <QTimer>
#include <QtDebug>

Dialog::Dialog(QWidget *parent) : QDialog(parent), ui(new Ui::Dialog)
{
    ui->setupUi(this);

    ui->timeLabel->setText("0");
    updateTimer = QObject::startTimer(1000); // Timer event every 1000msec
    paused = true;

    connect(ui->startButton, SIGNAL(clicked()), this, SLOT(initiateTimer()));
    connect(ui->pauseButton, SIGNAL(clicked()), this, SLOT(pauseTimer()));
    connect(ui->clearButton, SIGNAL(clicked()), this, SLOT(clearTimer()));

    QTimerEvent* event = new QTimerEvent(updateTimer);

    QCoreApplication::postEvent(this, event);  // Manually add to event queue
} // End Dialog::timerEvent()
```

Example: Method #1
Reimplement Specific Event Handler

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```
// Customized dialog.cpp – continued
void Dialog::timerEvent(QTimerEvent* someTimerEvent)
{
    if (!someTimerEvent)   return;
    if (someTimerEvent->timerId() == updateTimer) // updateTimer event?
    {
        if (!paused)
        {
            bool ok;
            int n = ui->timeLabel->text().toInt(&ok) + 1;
            if (ok)
            {
                ui->timeLabel->setText(QString::number(n));
                qDebug() << "Updating display";
            }
            else
            {
                ui->timeLabel->setText("");
                qDebug() << "Dialog::eventTimer(): Unknown error";
            }
        }
        else
            qDebug() << "Timer paused";
    }
    else
        QObject::timerEvent(someTimerEvent);
} // End Dialog::timerEvent()
```

Example: Method #1
Reimplement Specific Event Handler

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```
// Customized dialog.cpp – continued

void Dialog::initiateTimer()
{
    qDebug() << "Initiating Timer”;
    paused = false;
} // End Dialog::initiateTimer()

void Dialog::pauseTimer()
{
    qDebug() << "Pausing Timer";
    paused = true;
} // End Dialog::pauseTimer()

void Dialog::clearTimer()
{
    qDebug() << "Clearing Timer";
    ui->timeLabel->setText("0");
    paused = true;
} // End Dialog::clearTimer()

Dialog::~Dialog()
{
    delete ui;
}
```

Event Handlers: Guidelines

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- If a specialized event handler already exists, override it instead of the general event handler
- Input parameter will already be of the correct data type
- No need to forward unhandled events

Timers

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- In most cases, the signal-slot mechanism is the simplest and most direct way to make use of **QTimers**
- At the end of each time interval, a **timeout()** event is emitted
- This event can be used to trigger an appropriate slot function

Hands-On Example: Timers

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```
// Customized dialog.h
#ifndef DIALOG_H
#define DIALOG_H
#include <QDialog>
#include <QTimer>

namespace Ui
{
  class Dialog;
}

class Dialog : public QDialog
{
  Q_OBJECT

public:
  Dialog(QWidget *parent = 0);
  ~Dialog();

private:
  Ui::Dialog *ui;
  int updateTimer;
  bool paused;
  QTimer* timer;

private slots:
  void initiateTimer();
  void pauseTimer();
  void clearTimer();
  void updateDisplay();
};

#endif // DIALOG_H
```

Hands-On Example: Timers

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```
// Customized dialog.cpp
#include "dialog.h"
#include "ui_dialog.h"
#include <QTimer>
#include <QtDebug>

Dialog::Dialog(QWidget *parent) : QDialog(parent), ui(new Ui::Dialog)
{
    ui->setupUi(this);
    ui->timeLabel->setText("0");
    timer = new QTimer(this);
       // Allocate timer and set interval but don't start timer

    timer->setInterval(1000);
    paused = true;
    connect(ui->startButton, SIGNAL(clicked()), this, SLOT(initiateTimer()));
    connect(ui->pauseButton, SIGNAL(clicked()), this, SLOT(pauseTimer()));
    connect(ui->clearButton, SIGNAL(clicked()), this, SLOT(clearTimer()));

    connect(timer, SIGNAL(timeout()), this, SLOT(updateDisplay()));

} // End Dialog::timerEvent()
```

Hands-On Example: Timers

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```
// Customized dialog.cpp -- continued

void Dialog::updateDisplay()
{
    if (!paused)
    {
        bool ok;
        int n = ui->timeLabel->text().toInt(&ok) + 1;
        if (ok)
        {
            ui->timeLabel->setText(QString::number(n));
            qDebug() << "Updating display";
        }
        else
        {
            ui->timeLabel->setText("");
            qDebug() << "Dialog::eventTimer(): Unknown error";
        }
    }
    else
    {
        qDebug() << "Timer paused";
    }
} // End Dialog::updateDisplay()
```

Hands-On Example: Timers

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```
// Customized dialog.cpp -- continued

void Dialog::initiateTimer()
{
    qDebug() << "Initiating Timer";
    paused = false;
    timer->start();
} // End Dialog::initiateTimer()

void Dialog::pauseTimer()
{
    qDebug() << "Pausing Timer";
    paused = true;
    timer->stop();
} // End Dialog::pauseTimer()

void Dialog::clearTimer()
{
    qDebug() << "Clearing Timer";
    ui->timeLabel->setText("0");
    paused = true;
    timer->stop();
} // End Dialog::clearTimer()

Dialog::~Dialog()
{
    delete ui;
}
```

Example: Method #2
Reimplement Generic Event Handler

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```
// Customized dialog.h
#ifndef DIALOG_H
#define DIALOG_H
#include <QDialog>

namespace Ui
{
  class Dialog;
}
```

```
class Dialog : public QDialog
{
  Q_OBJECT

public:
  Dialog(QWidget *parent = 0);
  ~Dialog();

protected:
  bool event(QEvent* someEvent);

private:
  Ui::Dialog *ui;
  int updateTimer;
  bool paused;

private slots:
  void initiateTimer();
  void pauseTimer();
  void clearTimer();
};

#endif // DIALOG_H
```

Example: Method #2
Reimplement Generic Event Handler

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```
bool Dialog::event(QEvent* someEvent)
{
    if (!someEvent)  return QObject::event(someEvent);
    if (someEvent->type() == QEvent::Timer)
    {
        QTimerEvent* timerEvent = static_cast<QTimerEvent*>(someEvent);
        if (timerEvent->timerId() == updateTimer)   // updateTimer event?
        {
            if (!paused)
            {
                bool ok;
                int n = ui->timeLabel->text().toInt(&ok) + 1;
                if (ok) {
                    ui->timeLabel->setText(QString::number(n));
                    qDebug() << "Updating display";
                }
                else  {
                    ui->timeLabel->setText("");
                    qDebug() << "Dialog::eventTimer(): Unknown error";
                }
            }
            else
                qDebug() << "Timer paused”;
        }
    }
    return QObject::event(someEvent);
} // End Dialog::timerEvent()
```

Event Filters

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- QObject-derived classes have both event handlers and event filters
- Object A can receive Object B events
- Each B event received by A may be
  - Forwarded on to B
  - Removed from B's event stream

Event Filters

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- Event filters must be installed
  - Within A's constructor, call installEventFilter() to monitor B events

    b->installEventFilter(this);

    where b is a pointer to B
  - B events now pass to A first where A has the option of filtering them

Event Filters

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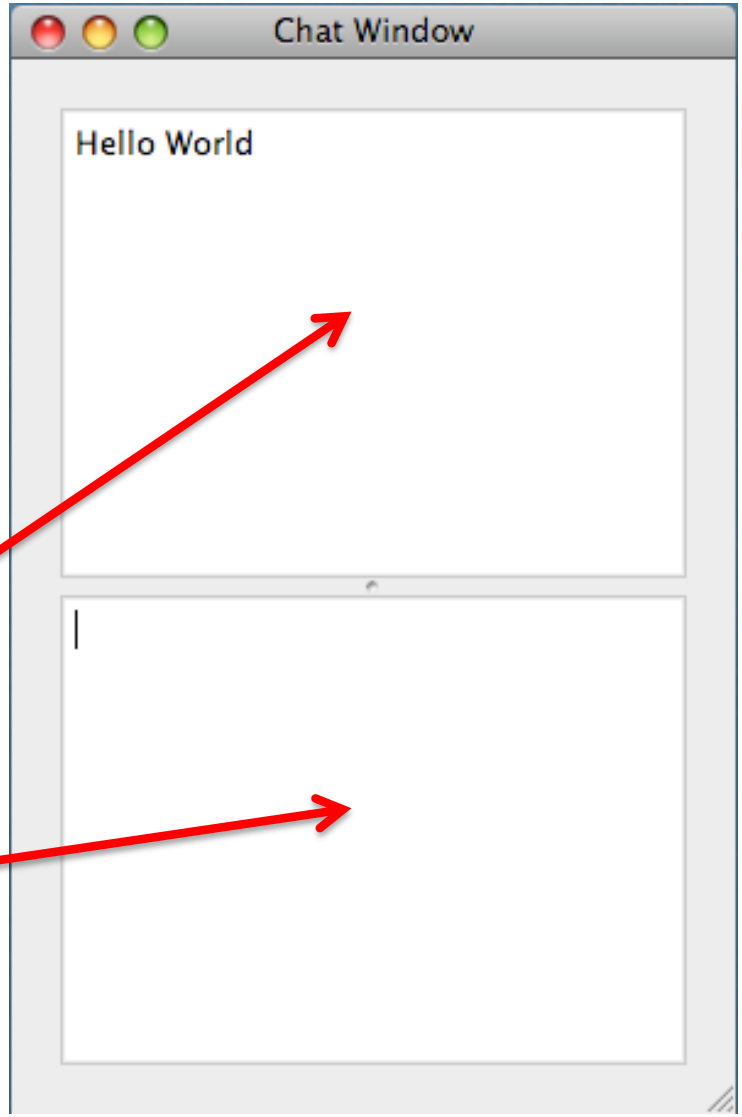
- Event filters must be installed (continued)
  - An **eventFilter()** must then be reimplemented in A (virtual method of QObject)

```
bool QObject::eventFilter(QObject *watched, QEvent *e);
```

  - A **false** return value causes Qt to forward event to B
  - A **true** return value results in the event does not get forwarded to B

Example: Chat Window

- Classic event filter example
  - Enter/Return key press forwards typed text rather than starts new lines of text



Example: Chat Window

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```
// chatwindow/chatwindow.h
// Molkentin, Book of Qt4

#ifndef CHATWINDOW_H
#define CHATWINDOW_H

#include <QWidget>
#include <QTextBrowser>
#include <QTextEdit>

class QTextBrowser;
class QTextEdit;
class QEvent;

class ChatWindow : public QWidget
{
  Q_OBJECT

  public:
    ChatWindow(QWidget *parent = 0);
    void submitChatText();
    bool eventFilter(QObject *watched, QEvent *e);

  private:
    QTextBrowser *conversationView;
    QTextEdit *chatEdit;
};
#endif // CHATWINDOW_H
```

Example: Chat Window

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```
// chatwindow/chatwindow.cpp
// Molkentin, Book of Qt4

#include <QVBoxLayout>
#include <QSplitter>
#include "chatwindow.h"

ChatWindow::ChatWindow(QWidget *parent) : QWidget(parent)
{
  QVBoxLayout *lay = new QVBoxLayout(this);
  QSplitter *splitter = new QSplitter(Qt::Vertical, this);
  lay->addWidget(splitter);

  conversationView = new QTextBrowser;
  chatEdit = new QTextEdit;

  splitter->addWidget(conversationView);
  splitter->addWidget(chatEdit);

  ChatWindow->chatEdit->installEventFilter(this);

  setWindowTitle("Chat Window");
  setTabOrder(chatEdit, conversationView);
}
```

Example: Chat Window

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```
// chatwindow/chatwindow.cpp
// Molkentin, Book of Qt4

bool ChatWindow::eventFilter(QObject *watched, QEvent* e)
{
  if (watched == chatEdit && e->type() == QEvent::KeyPress)
  {
    QKeyEvent *ke = static_cast<QKeyEvent*>(e);

    if (ke->key() == Qt::Key_Enter || ke->key() == Qt::Key_Return)
    {
      submitChatText();
      return true;
    }
  }

  return QWidget::eventFilter(watched, e);
}
```

Example: Chat Window

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```
// chatwindow/chatwindow.cpp
// Molkentin, Book of Qt4

void ChatWindow::submitChatText()
{
   // append text as new paragraph
   conversationView->append(chatEdit->toPlainText());

   // clear chat window
   chatEdit->setPlainText("");
}
```

Key Points

- Event handling may be fine-tuned by
  - Modifying an event-specific handler
  - Modifying the generic event hander
- Approach
  - Inherit from the appropriate base class
  - Modify the event-specific handler or generic event handler as needed
  - In some cases after executing the custom code within the modified event handler, you may still want to call the unmodified event handler code from within your modified event handler