The Binding of Objects in orx/Scroll

I keep a github repository for the code in this tutorial at https://github.com/fmahnke/OrxScroll-ObjectBinding. I like to keep the coding social, so please feel free to fork off my repo and create your own interesting projects!

What is "Object Binding"?

When we refer to “Object Binding” in this sense, we're describing “hooking up” a game object to a C++ class defining behaviors of the object.

This means when an Orx/Scroll Object is created, it can automatically be set to use a C++ class of choice for its implementation. This makes it easy to implement behavior that is specific to certain object types.

For instance, you want game objects to do certain things every frame. You want enemies to move on a path, or possibly attack. You want the player's character to be moved based on user input.

Additionally, binding objects to classes makes it easy to handle Orx events on an object-specific basis. For example, each type of object can have its own OnCreate function which is called whenever an object of that type is created. OnDelete is called when the object is deleted, etc.



In this tutorial, we're going to create a small game with two specific examples of object binding. We'll create an Enemy Bug object and a Hero object and bind them to classes. Our enemy bugs will move semi-randomly across the screen. Our Hero will be controlled by the player. He'll flash red if he collides with an enemy bug, showing that he's hurt.

First, some preparation…

Trouble?

If you have trouble following this tutorial, please let us know in the “Help Request” section of the Orx forums. The community is very helpful.

If your problems are related to physics (collision detection), it can be very useful to turn on physics debugging. This is done in .ini config. Just see the comments in the provided config.

Create a new Scroll Project

Before you begin this tutorial, you need a basic Orx/Scroll project ready. For details on doing this, see the previous tutorial, An Introduction to Scroll.

This tutorial assumes you've made a new Orx/Scroll project by following the instructions in the previously tutorial exactly!

Get the Config Ready

You'll need to download these textures [1] for use in your config:

Then, you'll need to prepare this config in your main Orx .ini file for use with this tutorial:

```
; OrxScroll - config file
; Should be used with orx v.1.3+

[Render]
ShowProfiler  = false

[Display]
ScreenWidth   = 1024
ScreenHeight  = 768
Title         = The Binding of Objects
VSync         = true
Smoothing     = true
FullScreen    = false

[Physics]
; Uncomment to show object bounding boxes
; ShowDebug = true

[Input]
SetList = Input

[Input]
KEY_LEFT  = MoveLeft
KEY_RIGHT = MoveRight
KEY_UP    = MoveUp
KEY_DOWN  = MoveDown

[MainViewport]
Camera          = MainCamera
BackgroundColor = (50, 50, 50)
```

```
[MainCamera]
FrustumWidth  = @Display.ScreenWidth
FrustumHeight = @Display.ScreenHeight
FrustumFar    = 10
Position      = (512, 384, -2)

[O-Hero]
Graphic  = G-Hero
Position = (512, 384, 0)
Body     = B-Hero

; Hero Class Data
MovementSpeed = 100.0

[G-Hero]
Texture = ../data/Character_Boy.png

[B-Hero]
PartList = BP-Hero
Dynamic  = true

[BP-Hero]
Type      = box
SelfFlags = 0x0001
CheckMask = 0xFFFF

[O-EnemyBug]
Position = (0, 200, 0) ~ (1000, 200, 0)
Graphic  = G-EnemyBug
Body     = B-EnemyBug

; EnemyBug Class Data
MovementSpeed           = 25.0
DirectionChangeInterval = 0.5 ~ 2.5

[G-EnemyBug]
Texture = ../data/Enemy_Bug.png
Pivot   = center

[B-EnemyBug]
PartList = BP-Hero

[BP-EnemyBug]
Type      = box
SelfFlags = 0x0002
CheckMask = 0xFFFF

[FX-Flash]
SlotList = FXS-FlashRed # FXS-Unflash

[FXS-FlashRed]
```

```
Type       = color
Curve      = smoother
StartTime  = 0
EndTime    = 0.1
Absolute   = true
StartValue = (255, 255, 255)
Period     = 0.5
EndValue   = (255, 0, 0)

[FXS-Unflash]
Type       = color
Curve      = smoother
StartTime  = @FXS-FlashRed.EndTime
EndTime    = 0.2
Absolute   = true
StartValue = @FXS-FlashRed.EndValue
EndValue   = (255, 255, 255)
```

It's all the typical object, graphic, physics stuff you've seen in previous Orx tutorials. Notice, however, we've added some extra properties to our EnemyBug and Hero objects. The Orx engine doesn't use these, but we'll use them later in this tutorial.

Creating Game Objects in Scroll

In Orx, you define objects in config files and create them at runtime using orxObject_CreateFromConfig. With Scroll, object creation is just as easy. In your class deriving from Scroll, modify your OrxScroll::Init function as follows:

```
orxSTATUS OrxScroll::Init ()
{
    orxSTATUS result = orxSTATUS_SUCCESS;

    for (orxU32 i = 0; i < 5; i++)
    {
    CreateObject ("O-EnemyBug");
    }
    return result;
}
```

Run your project. As you might expect, you'll see a few randomly placed enemy bugs in a gray expanse. Nothing happens since we've defined no behavior to control them.

Stop and think for a moment about how you might add behavior to the objects in Orx.

Giving the Bugs a Brain (Deriving the ScrollObject Class)

The first step to object binding is to create a binding class. To do that, we derive from the ScrollObject base class.

First, let's create the interface for our derived class. Create a file called EnemyBug.h and add it to your project. Add the following code to EnemyBug.h:

```
#include "OrxScroll.h"

enum Direction { NORTH, SOUTH, EAST, WEST };

class EnemyBug : public ScrollObject
{
private:
    //! Called on object creation.
    virtual void OnCreate ();
    //! Called on object deletion
    virtual void OnDelete ();
    //! Called on clock update
    virtual void Update (const orxCLOCK_INFO &_rstInfo);

    //! Direction of movement
    Direction   m_direction;
    //! Speed of movement
    float       m_movementSpeed;
    //! Time since change of direction
    float       m_timeSinceDirectionChange;
    //! Time interval between direction changes
    float       m_directionChangeInterval;
};
```

This class represents a single enemy bug. In our derived class, we override ScrollObject's OnCreate, OnDelete, and Update functions [2)].

Let's create the class implementation. Add a file called EnemyBug.cpp to your project and add the following code to it:

```
#include "EnemyBug.h"

void EnemyBug::OnCreate ()
{
    // Set initial movement direction
    m_direction = SOUTH;
    // Get movement speed from config value
    m_movementSpeed = orxConfig_GetFloat ("MovementSpeed");
    // Get direction change interval from config value
    m_directionChangeInterval = orxConfig_GetFloat
("DirectionChangeInterval");
}
```

```
void EnemyBug::OnDelete ()
{
    // Do nothing when deleted
}

void EnemyBug::Update(const orxCLOCK_INFO &_rstInfo)
{
    // Always initialize thy variables
    orxVECTOR speed = orxVECTOR_0;

    // Set rotation, flip, and speed based on the object's
    // current direction of movement.
    switch (m_direction)
    {
    orxBOOL flipX, flipY;
    case NORTH:
    speed.fY = -m_movementSpeed;
    SetRotation (270 * orxMATH_KF_DEG_TO_RAD);
    SetFlip (false, false);
    break;
    case SOUTH:
    speed.fY = m_movementSpeed;
    SetRotation (90 * orxMATH_KF_DEG_TO_RAD);
    SetFlip (false, false);
    break;
    case WEST:
    speed.fX = -m_movementSpeed;
    SetRotation (0 * orxMATH_KF_DEG_TO_RAD);
    SetFlip (true, false);
    GetFlip (flipX, flipY);
    break;
    case EAST:
    speed.fX = m_movementSpeed;
    SetRotation (0);
    SetFlip (false, false);
    GetFlip (flipX, flipY);
    break;
    default:
    orxASSERT (false);
    }

    // Update object's speed of movement
    SetSpeed (speed);

    // Time since direction change exceeds interval of direction change?
    if ((m_timeSinceDirectionChange += _rstInfo.fDT) >=
m_directionChangeInterval)
    {
```

```
    // Reset time
    m_timeSinceDirectionChange = 0;
    // Pick random number between bounds of Direction enum
    orxU32 randomNum = orxMath_GetRandomU32 (0, highDirection);
    // Update object's direction of movement
    m_direction = static_cast<Direction> (randomNum);
    }
}
```

This is all the code we need to bring our enemy bug to life. The code comments should explain what is happening, but note the following:

- An instance of the EnemyBug class is created for every enemy bug ScrollObject created. Recall in our OrxScroll::Init function we create 5 enemy bug objects. Therefore, 5 instances of EnemyBug are created. Each enemy bug shown on the screen has a class instance defining its behavior.
- This class makes use of the SetRotation, SetFlip, and SetSpeed functions defined in the ScrollObject base class.
- OnCreate is called when the object is first created. We didn't define a constructor, so data members must be initialized here.
- In OnCreate, we query values in config without pushing the object's section first. That's okay, because Scroll pushes the binding Orx object's config section as a convenience before calling OnCreate.
- We initialize our class members using the “custom” values we defined in config. While not strictly necessary, this is good data-driven design. It means we can adjust these variables and run again without recompiling.
- OnDelete is called when the object is deleted. We must provide a body for the function, but it does nothing in our case.
- Update is called on every frame. This is the interesting part of EnemyBug. In our case, we update its rotation and speed based on its currently direction of travel. [3)]

ScrollObject Callbacks and Accessors

- OnCreate, OnDelete, and Update are private callbacks from the ScrollObject class. That means these functions are called by Orx when these events occur on the object, allowing you to easily override their behavior. You should never call these functions directly.
- SetRotation, SetFlip, and SetSpeed are public accessors from the ScrollObject class. You call them directly from other object class functions (and any other class can call them if it has a pointer to the class instance). The accessors correspond to the similar orxObject_ functions (e.g. SetPosition == orxObject_SetPosition).

If you want to see all the accessors and callbacks available for overriding, see the ScrollObject class interface in the ScrollObject.h file.

We've now programmed a much more interesting bug. If you run the game, however, you'll still see nothing but still objects. That's because we haven't yet told Scroll that we want our enemy bug objects to take on the behavior in our EnemyBug class. One step remains.

Telling Scroll about the Enemy Bug Class (Overriding BindObjects)

The ScrollBindObject function accepts as a template parameter a class deriving from ScrollObject. It accepts as a regular parameter an Orx config section name. Then it binds any instance of the Orx object to the class.

Add the following private function declaration to your OrxScroll class in OrxScroll.h:

```
virtual void BindObjects ();
```

Now add the function's definition in OrxScroll.cpp:

```
void OrxScroll::BindObjects ()
{
    ScrollBindObject<EnemyBug> ("O-EnemyBug");
}
```

The BindObjects function is called when the game starts. It basically says, “Whenever we create an object of O-EnemyBug as defined in Orx config, make it take on all the behavior defined in the EnemyBug class.”

Of course, the EnemyBug class must exist for this to work, which is why we made it first.

Run the game and you should see all your enemy bugs come to life.

Our Unfortunate Hero (Another Derived ScrollObject)

The bugs in our game must be very hungry! Let's add another bound object. First, add Hero.h to your project and write its interface.

```
#include "OrxScroll.h"

class Hero : public ScrollObject
{
private:
    virtual void    OnCreate ();
    virtual void    OnDelete ();
    virtual orxBOOL OnCollide (ScrollObject *_poCollider,
                  const orxSTRING _zPartName,
                  const orxSTRING _zColliderPartName,
                  const orxVECTOR &_rvPosition,
                  const orxVECTOR &_rvNormal);
    virtual void    Update (const orxCLOCK_INFO &_rstInfo);

    orxFLOAT        m_movementSpeed;
```

```
};
```

Hero has a similar interface, but notice we've added an override for OnCollide. This function will be called whenever Orx detects a physics collision between this object and another.

And add this code:

```
#include "Hero.h"

void Hero::OnCreate ()
{
    // Get movement speed from config value
    m_movementSpeed = orxConfig_GetFloat ("MovementSpeed");
}

void Hero::OnDelete ()
{
    // Do nothing when deleted
}

void Hero::Update(const orxCLOCK_INFO &_rstInfo)
{
    // Always initialize thy variables
    orxVECTOR speed = orxVECTOR_0;

    if (orxInput_IsActive ("MoveLeft"))
    {
    speed.fX = -m_movementSpeed;
    }
    else if (orxInput_IsActive ("MoveUp"))
    {
    speed.fY = -m_movementSpeed;
    }
    else if (orxInput_IsActive ("MoveRight"))
    {
    speed.fX = m_movementSpeed;
    }
    else if (orxInput_IsActive ("MoveDown"))
    {
    speed.fY = m_movementSpeed;
    }
    SetSpeed (speed, false);
}

orxBOOL Hero::OnCollide(ScrollObject *_poCollider,
          const orxSTRING _zPartName,
          const orxSTRING _zColliderPartName,
          const orxVECTOR &_rvPosition,
          const orxVECTOR &_rvNormal)
{
    // Add flash effect
```

```
    AddFX ("FX-Flash");

    return true;
}
```

The code should be almost self-explanatory. The hero's movement speed will be pulled from its config value. The update function (called every frame) sets the speed of the character based on what keyboard arrow is pressed. The OnCollide function adds a “flash” effect to the character.

Remember you need to modify the OrxScroll::Init function so it creates your O-Hero config object. Otherwise the Hero will not appear on the screen.

You also have to modify the OrxScroll::BindObjects function to make it bind the new Hero class to the O-Hero object. Otherwise, the Hero will not be bound to its class and will just stand still in the middle of the screen!

Try to do those things yourself. If you need help, though, here are the modified functions:

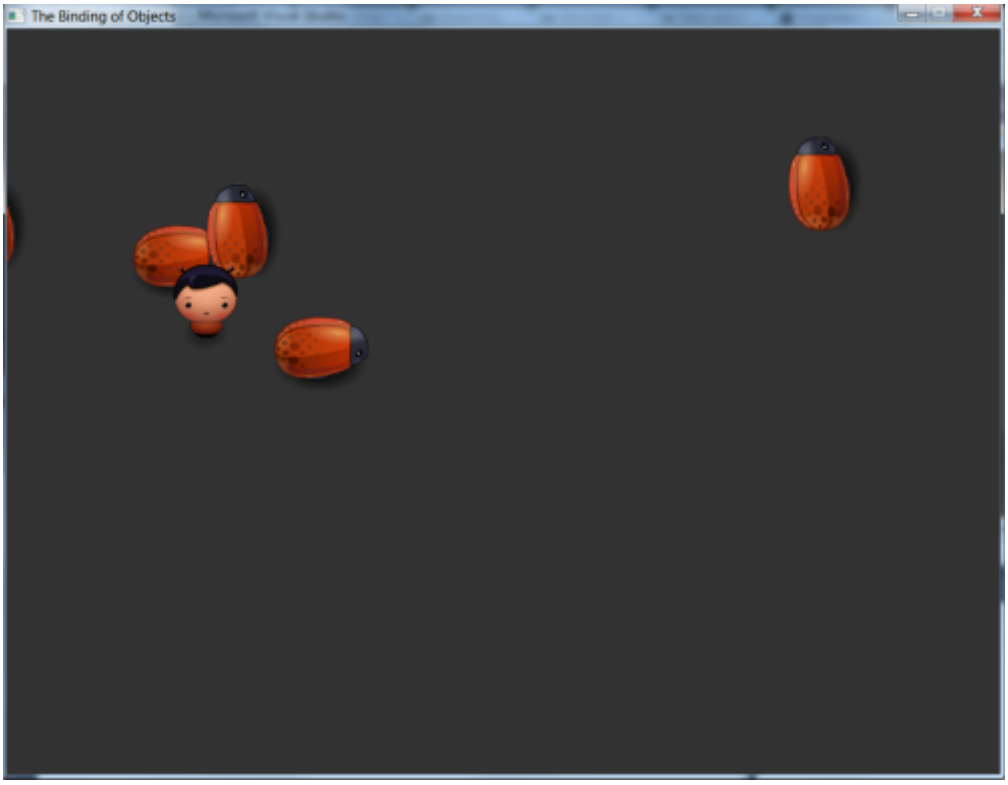
```
orxSTATUS OrxScroll::Init ()
{
    orxSTATUS result = orxSTATUS_SUCCESS;

    CreateObject ("O-Hero");

    for (orxU32 i = 0; i < 5; i++)
    {
    CreateObject ("O-EnemyBug");
    }
    return result;
}

void OrxScroll::BindObjects ()
{
    ScrollBindObject<EnemyBug> ("O-EnemyBug");
    ScrollBindObject<Hero>     ("O-Hero");
}
```

When you run the game, you'll be able to control the hero with the arrow keys. Be careful, the bugs will bite him if he gets too close and the OnCollision callback will make him “flash” red.



What Now?

Well, you just finished making what could loosely be considered a game! Here are some additions you could make.

- Add a “Life” property to the Hero. Modify OnCollision so the Hero loses life each time he's hit. Give him an untimely death when life reaches 0.
- Give the Hero a weapon he can fire at the bugs. The OnCollision callback for the enemy bugs can be used to make them take damage from the weapon.
- Be sure to add interesting death animations in the OnDelete callback.
- Add a more interesting background, of course.

1)

Thanks to Daniel Cook of www.lostgarden.com for the great prototyping graphics

2)

Overriding OnCreate and OnDelete is required for any class deriving from ScrollObject

3)

Why use SetSpeed and not SetPosition? Because the objects in this tutorial have physics bodies. Calling SetPosition on objects with physics bodies messes up the physics simulation. If you want to watch that happen, change SetSpeed to SetPosition and turn on physics debugging as described in the config.

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