1 Example Technology: Macromedia Flash & ActionScript

1.1 Multimedia authoring tools - Example Macromedia Flash

1.2 Elementary concepts of ActionScript

Scripting in General + „History“ of ActionScript

Objects and Types in ActionScript

Animation with ActionScript

1.3 Interaction in ActionScript

1.4 Media classes in ActionScript

File Types in Flash Development

- Flash Project (.flp)
  - Bundles the information required for a specific development project
  - Easily readable XML file
  - Mainly: Links to involved files
- Flash Movie (.fla)
  - Contains the main animation (timelines and symbols)
  - Binary file, difficult to understand
  - Edited with the Flash authoring environment
- ActionScript (.as)
  - Contains an ActionScript class
  - Readable ActionScript ASCII file
  - Editable with any editor or with the built-in ActionScript editor of the Flash authoring environment
- Shockwave Flash (.swf)
  - Output format for Flash Player

Objects in Flash

- Everything is an object.
- *Visual objects:* Can be created and manipulated in the graphical authoring environment (but also in other ways):
  - Objects of classes MovieClip, Button, TextField, Component, ...
  - Example: MovieClip object
    - » Has a TimeLine object where the class TimeLine defines methods like: **`play(), stop(), gotoFrame()`**
  - Dynamic creation of visual objects via method call
    - » Using specific methods like **`createEmptyMovieClip, duplicateMovieClip, attachMovie, ...`**
- *Non-visual objects:*
  - In particular objects of most developer-defined classes ("custom classes")
  - Explicit instantiation
    - » Script contains new-statement like in Java
  - Example: "Account" objects

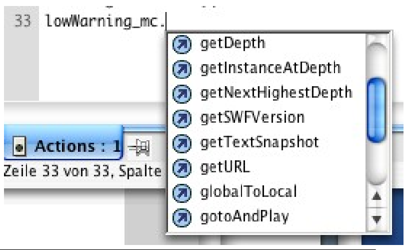
Strong vs. Weak Typing

- Weak Typing:
  - Variables and properties can be assigned different types of data at different times
  - Variables are declared without explicit type information
  - Example programming languages: BASIC, ActionScript 1.0
- Strong Typing:
  - Type information part of the variable declaration
  - All assigned values have to conform to the declared type at all time
  - Example programming languages: PASCAL, Java, ActionScript 2.0 (partially)
- Suffixing:
  - Only way in AS1 to get "code hinting"
  - See next slide

Type Hinting

- Naming convention for variables according to type of contained value
  - "Hungarian notation" also used in C/C++, e.g. Microsoft standard
- Specific prefix or suffix of variable name indicates type
  - E.g. "variable names starting with 'p' indicate pointer values."
  - E.g. "variable names ending with '_mc' indicate MovieClip values"
- Particularly helpful for weakly typed languages

- Type information in programming environment
  - "Hinting" = interactive offer of adequate additions to currently edited programming text
  - For a variable named **`xy_mc`**, the special methods available for **`MovieClip`** objects are offered for selection


```
lowWarning_mc.
```

Types in ActionScript 2.0

- Types (= classes) for non-visual objects:
  - Array
  - Boolean
  - Number
  - Object
  - String
  - ...

  + custom classes defined by the developer using **`class { … }`**
- Types (= classes) for visual objects:
  - MovieClip
  - Button
  - TextField
  - Component

  For visual objects, type information by suffixing is recommended !

A Full List of ActionScript 2.0 Data Types

- Accordion*
- Alert*
- Array
- Binding*
- Boolean
- Button**
- Camera**
- CheckBox*
- Color
- ComboBox*
- ComponentMixing*
- CustomActions*
- DataField*
- DataGrid*
- DataHolder*
- DataSet*
- DataType*
- Date
- DateChooser*
- Delta*
- DeltaItem*
- DeltaPacket*
- Endpoint*
- Error*
- Function**
- Label*
- LoadVars**
- LocalConnection**
- Log*
- MediaController*
- MediaDisplay*
- MediaPlayback*
- Menu*
- MenuBar*
- Microphone**
- MovieClip
- MovieClipLoader*
- NetConnection**
- NetStream**
- Number
- Object
- PendingCall*
- PopUpManager*
- PrintJob*
- ProgressBar*
- RadioButton*
- RadioButtonGroup*
- RDBMSResolver*
- ScrollPane*
- SharedObject**
- Slide*
- SOAPCall*
- Sound
- String
- TextArea*
- TextField**
- TextFormat**
- TextInput*
- TextSnapshot*
- Tree*
- TypedValue*
- Video**
- Void*
- WebService Connector*
- Window*
- XML
- XMLConnector*
- XMLNode
- XMLSocket
- XUpdateReceiver*

no sign = already contained in Flash 5   * = added in Flash MX   ** = added in Flash MX 2004

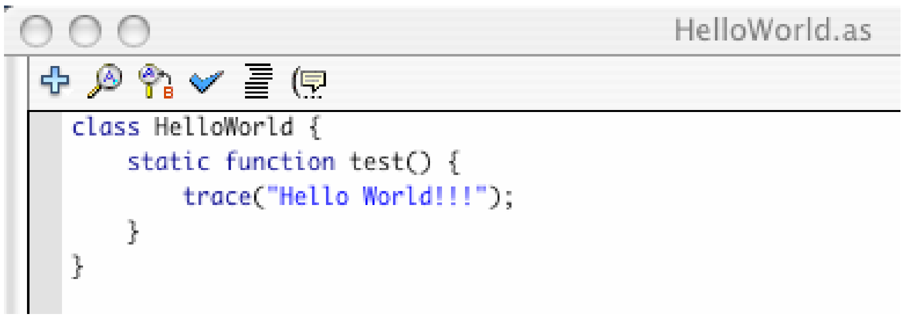
Type-hinting suffixes in ActionScript 2.0

Array:	_array
Button:	_btn
Camera:	_cam
Color:	_color
Date:	_date
Error:	_err
LoadVars:	_lv
LocalConnection:	_lc
Microphone:	_mic
MovieClip:	_mc
NetConnection:	_nc
Sound:	_sound
String:	_str
TextField:	_txt
Video:	_video
XML:	_xml
XMLNode:	_xmlnode

Partial list !

A HelloWorld Program in ActionScript

- ActionScript class in file “HelloWorld.as”

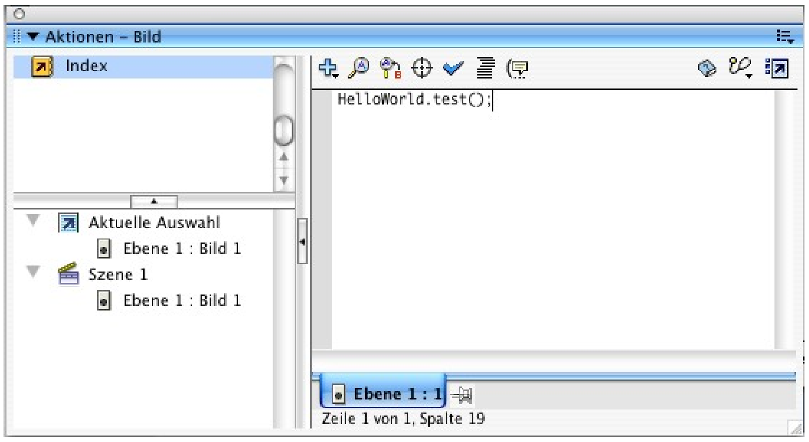


```
class HelloWorld {
     static function test() {
          trace("Hello World!!!");
     }
}
```

- **`trace()`**
  - – Built-in function
  - – Reports a message during runtime on the output console
  - – Works only if debugger is present

A Flash Movie Invoking the Hello World Program

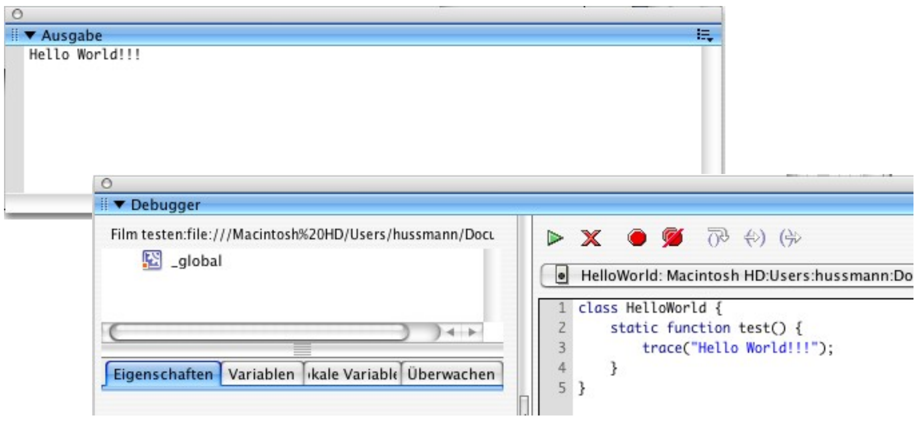
- Flash movie “HelloWorld.fla”
  - – Without any visible objects
  - – ActionScript attached to Frame 1 of Scene 1



```
HelloWorld.test();
```

Running the Flash Hello World Movie

- Export as SWF file and start player
- Optional interactive debugger



Ausgabe
Debugger
Film testen:file:///Macintosh%20HD/Users/hussmann/Docu
_global
Eigenschaften
Variablen
ıkale Variabl
Überwachen
HelloWorld: Macintosh HD:Users:hussmann:Do

```
Hello World!!!
```

```
class HelloWorld {
    static function test() {
        trace("Hello World!!!");
    }
}
```

Design Patterns

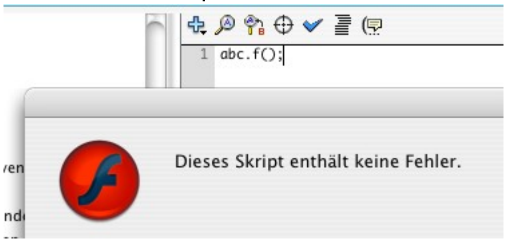
- A *design pattern* is a generic solution for a class of recurring programming problems
  – Helpful idea for programming
  – No need to adopt literally when applied
- Origin:
  – Famous book by Gamma/Helm/Johnson/Vlissides
    » List of standard design patterns for object-oriented programming
    » Mainly oriented towards graphical user interface frameworks
    » Examples: Observer, Composite, Abstract Factory
- Frequently used in all areas of software design
- Basic guidelines:
  – Patterns are not invented but recovered from existing code
  – Pattern description follows standard outline
    » E.g.: Name, problem, solution, examples

Flash Pattern: Start Frame Code

- **Problem**: A Flash movie needs to carry out some ActionScript code which cannot be easily defined in a local, object-oriented style
  - Creation of objects on an application-global scale
  - Invocation of methods defined in external ".as" files
  - Assignment of methods to visible objects instantiated from the standard library (e.g. TextField)
- **Solution:**
  - Keep the "global code" in the main timeline (_root).
  - Add a separate layer (e.g. "code" or "actions") to the main timeline.
  - Add all "global" code to frame 1 of the newly created layer of the main timeline.
  - Advantage: There is just one place where all global code can be found.
- **Examples**:
  - Plenty found in literature

Undefined Variables & Methods in ActionScript

- Situations *not* recognized as errors in ActionScript:
  - Referencing an undefined variable
  - Calling a method not defined in the class/type of a variable



```
abc.f();
```

Dieses Skript enthält keine Fehler.

- Do "sloppy" definition/typing rules in scripting languages make sense?
  - Advantage: Product can be tested and presented even in incomplete state
  - Danger: Static error detection methods (e.g. type check) loose power to detect problems

Modifying Attributes in ActionScript

- All visible objects come with a predefined (more or less large) set of attributes
  - Example: “_x” and “_y” for screen position
- ActionScript code can e.g. move visible objects around the screen by modifying these attributes
- Example:
  - Modifying an object (with an independent timeline)
  - In Frame 1 (key frame) : **`inst_mc._x = 10; inst_mc._y = 10;`**
  - In Frame 6 (key frame): **`inst_mc._x = 20; inst_mc._y = 20;`**
  - In Frame 11 (key frame): **`inst_mc._x = 40; inst_mc._y = 40;`**

Example RVML: Nested Timelines, ActionScript

```
...
<Definitions>
  <MorphShape id='inst_mc.MorphShape_1'> ...
  </MorphShape>
  <MovieClip id='inst_mc'>
    <Timeline frameCount='5'>
      <Frame frameNo='1'>
        <Place name='inst_mc.MorphShape_1' depth='1' />
       </Frame>
    ...</Timeline>
  </MovieClip>
</Definitions>
<Timeline frameCount='11'>
  <Frame frameNo='1'>
    <Place name='inst_mc' depth='1' instanceName='inst_mc'>
      <Transform translateX='199.0' translateY='98.0' />
    </Place>
    <FrameActions><![CDATA[
inst_mc._x = 10;
inst_mc._y = 10;
]]></FrameActions>
  </Frame>
...
```

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Animation as Attribute Modification

- Animation:
  - Modification of object attributes dependent on time / current frame
- Questions:
  - (1) How to flexibly react on progress of time?
  - (2) How to program time-dependent code?
    - » Absolute computation of attributes (e.g. position)
    - » Relative computation of attributes (e.g. position)
- Regarding question (1):
  - Most multimedia runtime systems have a notion of an event marking progress of time
    - » Timer objects
    - » Global clock
  - ActionScript:
    - » Special clip event **`EnterFrame`** is fired regularly at specified frame rate of the movie

Events in ActionScript

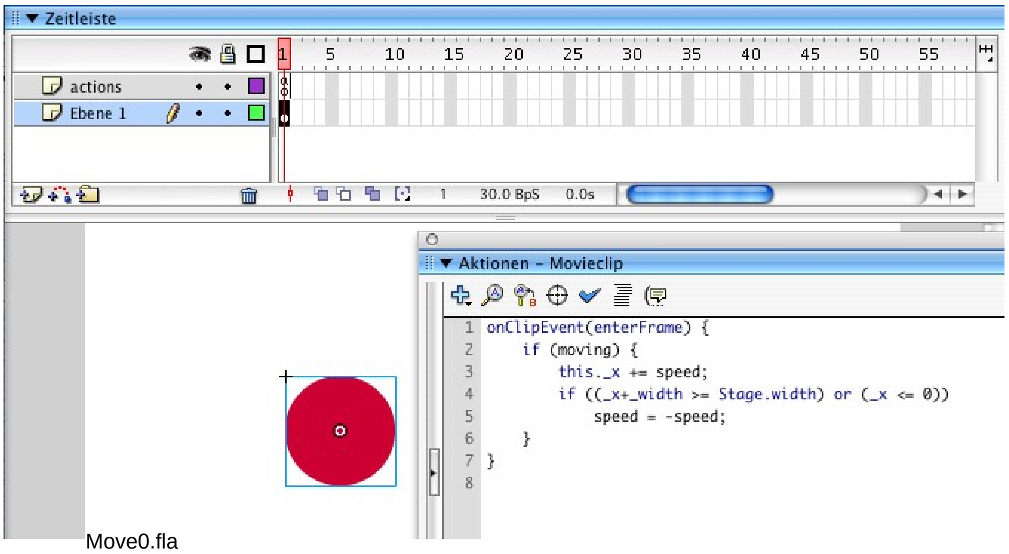
- Clip events (affecting a whole movie clip):
  – Load
  – Unload
  – EnterFrame
  – Mouse...
  – Key..
  – Data

`onClipEvent(...)`

- Interaction events (caused by specific interaction objects, e.g. buttons):
  – Press
  – Release
  – ReleaseOutside
  – RollOut, RollOver
  – DragOut, DragOver
  – KeyPress

`on(...)`

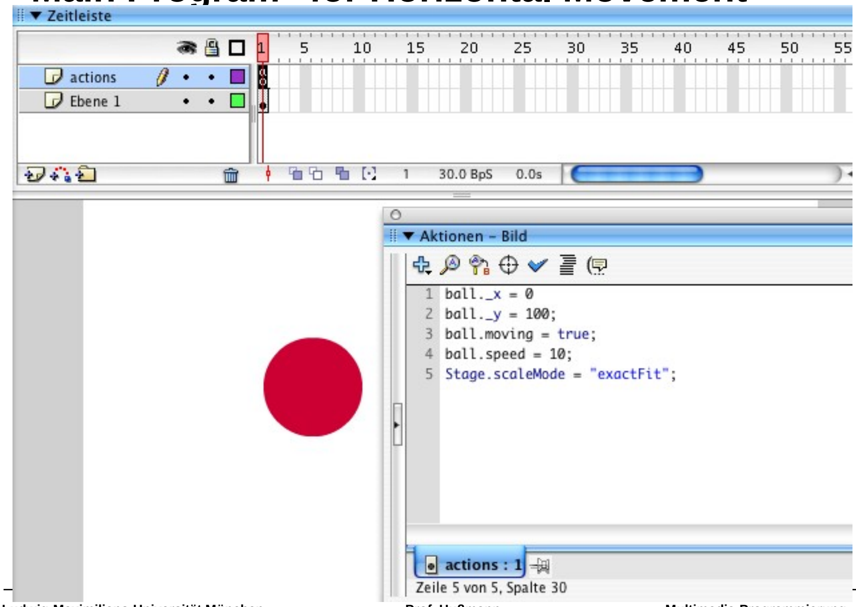
Horizontal Movement with EnterFrame-Events



```
onClipEvent(enterFrame) {
    if (moving) {
        this._x += speed;
        if ((_x+_width >= Stage.width) or (_x <= 0))
            speed = -speed;
    }
}
```

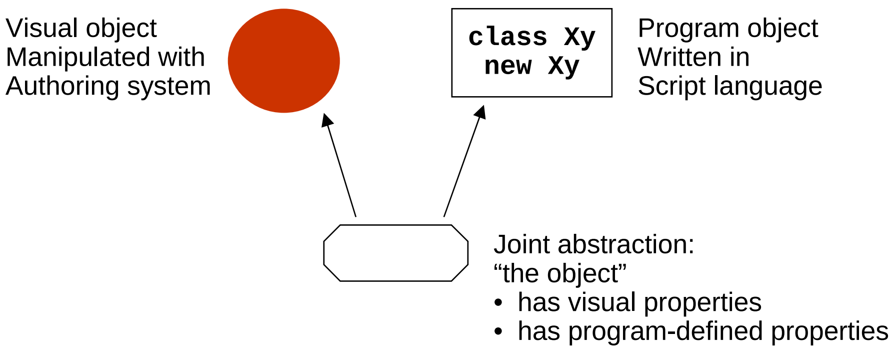
Move0.fla

“Main Program” for Horizontal Movement



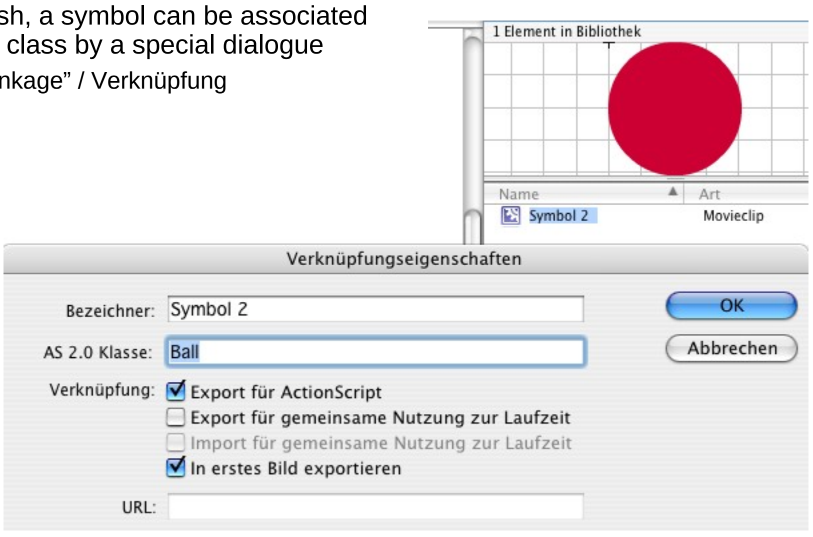
```
ball._x = 0
ball._y = 100;
ball.moving = true;
ball.speed = 10;
Stage.scaleMode = "exactFit";
```

Visual Objects and Program Objects



Flash: Linking AS2 Classes to Symbols

- In Flash, a symbol can be associated with a class by a special dialogue
  - "Linkage" / Verknüpfung


1 Element in Bibliothek

Name	Art
Symbol 2	Movieclip

Verknüpfungseigenschaften

Bezeichner: Symbol 2
AS 2.0 Klasse: Ball
Verknüpfung: ☑ Export für ActionScript
☐ Export für gemeinsame Nutzung zur Laufzeit
☐ Import für gemeinsame Nutzung zur Laufzeit
☑ In erstes Bild exportieren
URL:

Move.fla

ActionScript 2 Class for Movement Example

```
class Ball extends MovieClip {
  public var speed:Number = 0;
  public var moving:Boolean = false;

  public function onEnterFrame() {
     if (moving) {
          this._x += speed;
          if ((_x+_width >= Stage.width) or (_x <= 0))
               speed = -speed;
     }
  }
}
```

Equivalent event handler declarations:
- attached to the object with generic keywords **`on`** and **`onClipEvent`**
- separate *callback* method (naming convention)

More powerful:
- listeners (see below)

Adding Vertical Movement

```
class Ball1 extends MovieClip {

  public var speed:Number = 0;
  public var jump:Number = 0;
  public var moving:Boolean = false;
  public var toRight = true;
  public var inLeftHalf:Boolean;

  public function onEnterFrame() {
      if (moving) {
           this._x += speed;
           if ((_x+_width >= Stage.width) or (_x <= 0)) {
                speed = -speed;
                toRight = !toRight;
           };
           inLeftHalf = (_x+_width)*2 <= Stage.width;
           if ((inLeftHalf && toRight) ||
           (!inLeftHalf && !toRight))
                _y -= jump;
           else
                _y += jump;
      }
  }
}
```

Move1.fla

Absolute vs. Relative Movement Calculation

- Absolute calculation
  - Based on some base index
    - » Frame count, time, relative position on stage, ...
  - Base index to be provided by the programmer
    - » _currentframe, _totalframe etc. provide statically defined information
  - “Save” in terms of predictibility of the effect
- Relative calculation
  - Based on most recent frame (“differential programming”)
  - Often easier (see example)
  - More flexible for changing situations
  - Problem: Rounding errors and other algorithmic problems may lead to unexpected effects (see example)

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Handling of Mouse Events

Classical Model-View-Controller Programming

1.4 Media classes in ActionScript

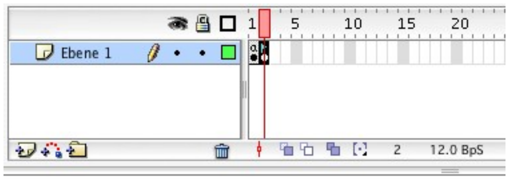
What’s Specific for an Animated (Flash) Interface?

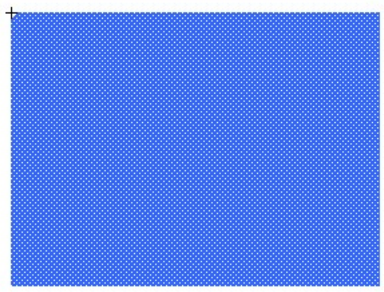
- Traditional user interface elements:
  - Buttons, Text Fields, Menus, ...
  - All available also in Flash and other modern multimedia interface tools
- Animation in user interfaces:
  - Graphical feedback illustrating program actions
    - » E.g. animation clips to visualize internal activity
  - Direct feedback “on touching”
    - » E.g. change of graphical representation on “mouse over”
- Direct interaction:
  - Drag and drop
  - Drawing-like actions

- Everything (in principle) realisable also by “normal” programming languages! (But often much more complex.)

Example: Highlighting a Region on "RollOver"

- Graphical element with AS event handler for "RollOver" event
  - E.g. changing the colour of a box
- "Traditional" solution with the Flash authoring tool:
  - Create a symbol with different key frames
  - Create an instance with an event handler switching between key frames





MouseColors.fla

Event Handler for Frame Switching

```
on(rollOver) {
  gotoAndStop("on");
}
on(rollOut) {
  gotoAndStop("off");
}
```

"on" and **"off"** are labels for the key frames of the symbol.

Not to be forgotten: **`stop()`** in first frame.

Flash Pattern: Graphical Response

- **Problem**: Dependent on some application-internal condition, we would like to show the user what the current status is, by selection among different graphical representations.
- **Solution:**
  - Create a MovieClip object and create different key frames showing the different graphical representations of status information. If the information is not to be shown sometimes, one key frame may remain empty.
  - Add a **`stop();`** action to the first key frame.
  - Optionally, assign labels to the key frames.
  - Place the MovieClip object on the stage
  - Show various status information by "gotoAndStop()" to the MovieClip object.
- **Examples**:
  - Realisation of the generic pre-defined Button class
  - Quiz example from ActionScript 2.0 Dictionary, pp. 8 ff.

A More Object-Oriented Solution

- Problems with the "traditional" solution:
  - Four different regions (with different highlighting colours) require four symbols
  - Event handling code has to be attached to *instance* of MovieClip symbol
  - Event handling code is duplicated
    - » See e.g. the "movie explorer" view!
- A Programmer's solution (next few slides):
  - Create a reusable class for a highlightable region
  - Make the color into a parameter settable from outside

Symbols and Instances

- Symbols
  - Reusable entities
  - May be of the types: graphics, button, movie clip
  - Symbols resides in library
  - Symbol is created either by "Insert -> New symbol" or by conversion
  - Symbol has its own timeline
- Instance
  - Individual object on the stage
  - Representing an instance of a symbol
  - Inherits behaviour of the symbol (timeline etc)
  - May have individual behaviour (ActionScript code)

Reusable Highlighting Color Block

```
class ColorBlock extends MovieClip {

  private var myColor:Color;
  public var myOnRgb:Number;

  public function onLoad() {
     myColor = new Color(this);
  }

  public function onRollOver() {

     myColor.setRGB(myOnRgb);
  }

  public function onRollOut() {

     myColor.setRGB(0xffffff);
  }
}
```

Used built-in technology:

`Color` object controls the color of the movie clip.

Constructor assigns a new color object to the movie clip.

`setRGB` function actually changes the color.

Creating Instances of the Reusable Symbol

- There is *one* symbol with several instances
  (example: lo_mc, ro_mc, lu_mc, ru_mc)
- The symbol defines the graphical shape with irrelevant color.

- Initialisation code:

```
lo_mc.myOnRgb = 0xff0000; //red
ro_mc.myOnRgb = 0x0000ff; //blue
lu_mc.myOnRgb = 0x00ff00; //green
ru_mc.myOnRgb = 0xffff00; //yellow
```