CSc 165
Computer Game Architecture

7 - Scripting

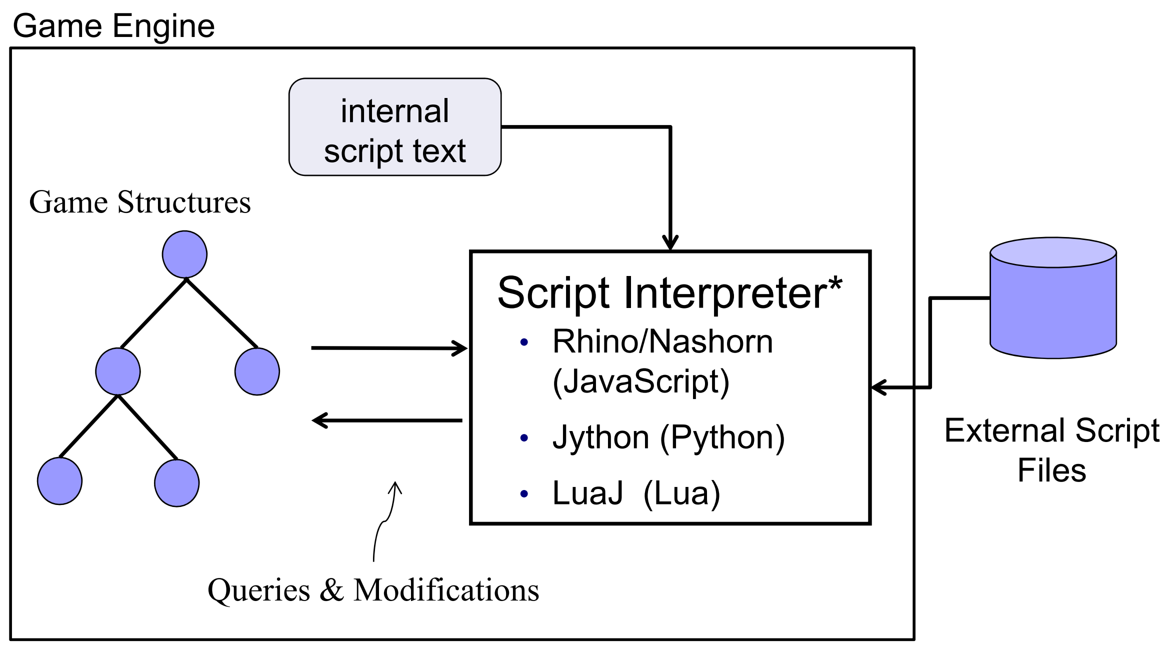
Overview

- Scripting Concepts
- Script Interpreters ("Engines")
- Scripting Languages
  - JavaScript Basics
- Communicating with Scripts
- Using Scripts in Games
- Additional Scripting Engines

Scripting

- Using external code to alter game world structure or game play
- Common "scripting languages":
  - JavaScript, Python, Lua
  - Others (Tcl, Scheme, Ruby, Smalltalk, VB…)
- Scripts often need access to game objects
  - Or at least, to a API
- Requires embedding an *interpreter* in game/game engine

Script Interpreters



*Also known as a Script *Engine*

Using a script engine in Java

- Get the Java script engine manager
- Use it to get the desired script engine*
- Use `eval(…)` to run the script interpreter
  - `eval(`*String*`)`, or
  - `eval(`*FileReader*`)`
- Scripts can also be compiled

(*) *be careful not to confuse the script engine with the game engine!*

JavaScript Basics

Comments

- Same as Java: // or /*… */ (no JavaDoc /** … */ form)

Variables

- Declared with ‘var’ (optional)
- Either *global* or *local* (inside a function) – no “class scope”
- Syntax: same as Java (e.g. start with letter or “_”)
  - Cannot use reserved words (most Java reserved words, plus others)
- “weakly typed” – type determined by assigned value

```
var i = 8;                          // i is an int
var pi = 3.14159;                   // pi is a real
var j = “Hello”;                    // j is a string
var k = 42 + “ is the answer”;      // k is also a string
var m = i < 10;                     // m is a Boolean = true
```

JavaScript Basics (cont.)

Operators

same as Java (+, -, *, /, %, ==, !=, <, >, <=, >=, &&, ||, !, =)

Control statements

```
if (cond) {...} else {...}         // same as Java
for (var i=0; i<3; i++) {...}      // almost Java
while (cond) {...}                 // same as Java
try {...} catch(e){...}            // same as Java
```

Functions

- Global scope by default
- Defined with keyword: **`function`**

Communicating with Scripts

The Java Scripting API: **`javax.script.*`**

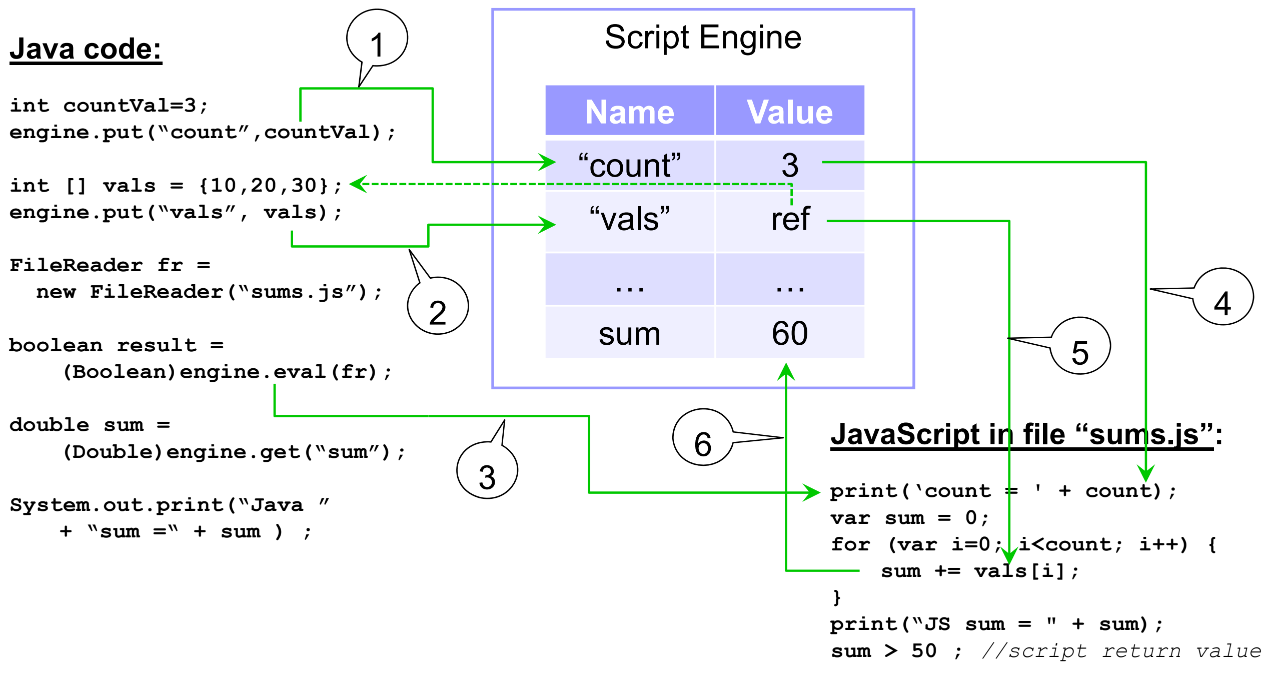
Allows Java to:

- Pass data into a script: **`engine.put()`**
- Get data back from a script: **`engine.get()`**
  - Scripts can assign values to vars accessible by Java
  - Scripts also have a “return value”

Allows scripts to:

- Get data from Java
- Pass data to Java
- Invoke methods in Java objects

Java/Script Communication



Java code:

```
int countVal=3;
engine.put("count",countVal);

int [] vals = {10,20,30};
engine.put("vals", vals);

FileReader fr =
  new FileReader("sums.js");

boolean result =
    (Boolean)engine.eval(fr);

double sum =
    (Double)engine.get("sum");

System.out.print("Java "
   + "sum =" + sum ) ;
```

Script Engine

Name	Value
"count"	3
"vals"	ref
…	…
sum	60

JavaScript in file "sums.js":

```
print('count = ' + count);
var sum = 0;
for (var i=0; i<count; i++) {
    sum += vals[i];
}
print("JS sum = " + sum);
sum > 50 ; //script return value
```

Invoking Script Functions

- Define script function
- Load function into engine (using `eval()`)
- Cast engine as an "Invocable" object
- Use `invokeFunction()` to call function

Java code:

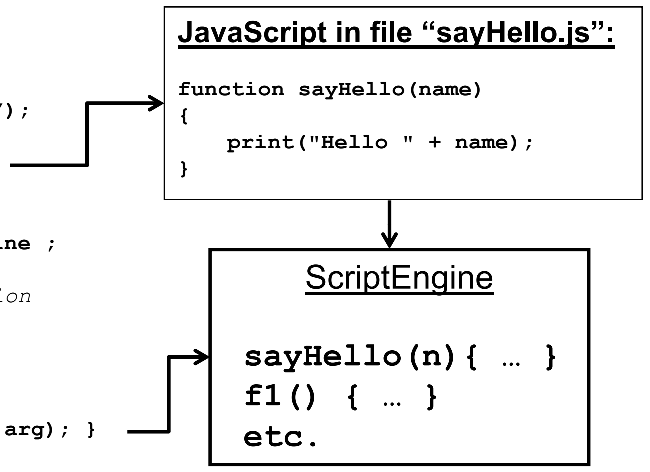
```
FileReader fr = new FileReader("sayHello.js");

engine.eval(fr);   //load script function

//make the engine invocable
Invocable invocableEngine = (Invocable) engine ;

//define argument to be passed to the function
Object [] arg = {"Rufus"};

//invoke the function in the engine
try {
{ invocableEngine.invokeFunction("sayHello",arg); }
catch (NoSuchMethodException e1) {...}
catch (ScriptException e2) {...}
```



JavaScript in file "sayHello.js":

```
function sayHello(name)
{
    print("Hello " + name);
}
```

ScriptEngine

```
sayHello(n){ … }
f1() { … }
etc.
```

Uses for scripting

- Gameworld creation and initialization
- Dynamically modifying game details
- Providing user-defined functions that can be called from a Java application
- Modifying player and non-player characters
- Modifying game features
- Testing

Using Other Script Engines

```
//get the Lua engine
ScriptEngine luaEngine = factory.getEngineByExtension(".lua");
//insert variable "x" with value 25
luaEngine.put("x", 25);
//run a Lua script to compute a function of x
try
{   luaEngine.eval("y = math.sqrt(x)"); }
catch (ScriptException e)
{   System.out.println(e); }
System.out.println("Hello Lua: " + "y=" + luaEngine.get("y"));
```

Lua

```
// construct a Python script
String lsep = System.getProperty("line.separator");
String a = "import sys" + lsep;
        a += "import java.io as javaio" + lsep;
        a += "currentdir = javaio.File (\".\")" + lsep;
        a += "print \"Hello Python: Current directory : \" +
                        currentdir.getCanonicalPath()" + lsep;
//get the Python engine (Jython)
ScriptEngine pythonEngine = factory.getEngineByExtension("py");
//run the Python script
try
{   pythonEngine.eval(a); }
catch (ScriptException e)
{   System.out.println(e); }
```

Python

Additional JavaScript Features

Arrays

- Size defined by *parentheses* at declaration

```
var foo = new Array(10);
var bar = new Array(5);
```

- Indexing from zero and using brackets (like Java)

```
foo[0] = 42;   bar[4] = 99.9;
```

- Mixed element types allowed

```
var stuff = new Array ("a string", 12, 98.6, true);
```

- Dynamically resizeable

```
var colors = new Array();     //colors has no elements
colors[2] = "red" ;           //colors now has 3 elements
                              //  ( [0] and [1] == null )
```

- Properties and methods

```
length,  indexOf(),  concat(), toString(), ...
```

Additional JavaScript Features (cont.)

Built-in Objects :

```
var currentTime = new Date();
var month = currentTime.getMonth() + 1;
var day = currentTime.getDate();
var year = currentTime.getFullYear();
```

User-created Objects :

```
var personObj=new Object();
personObj.firstname="John";       //properties ("fields") are
personObj.lastname="Doe";         //  created when defined
personObj.age=50;
personObj.eyecolor="blue";
```

Additional JavaScript Features (cont.)

User-defined Object Constructors:

```
function person(firstname,lastname,age,eyecolor)
{  this.firstname = firstname;
   this.lastname = lastname;
   this.age = age;
   this.eyecolor = eyecolor;
   this.newLastName = newLastName;        //method invocation
}
function newLastName(new_lastname)
{  this.lastname = new_lastname;
}
var myFather = new person("John","Doe",50,"blue");
var myMother = new person("Sally","Rally",48,"green");
myMother.newLastName(“Doe”);
```

Additional JavaScript Features (cont.)

User-defined Object Constructors (another example):

```
//object creation function
function circle(r)
{  this.radius = r;                  //radius property
   this.area = getArea;              //function invocation
   this.diameter = getDiameter;      //function invocation
}
function getArea()                   //function definition
{  var area = this.radius*this.radius*3.14;
   return area;
}
function getDiameter()               //function definition
{  var d = this.radius*2;
   return d;
}

var myCircle = new circle(20);
print("area = " + myCircle.area());    //print is a Nashorn method
print("diameter = " + myCircle.diameter());
```