Java™

Square Pegs, Round Holes

or: How To Fit a Language On the JVM (Without a Hammer.)

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  Principal Member of Technical Staff

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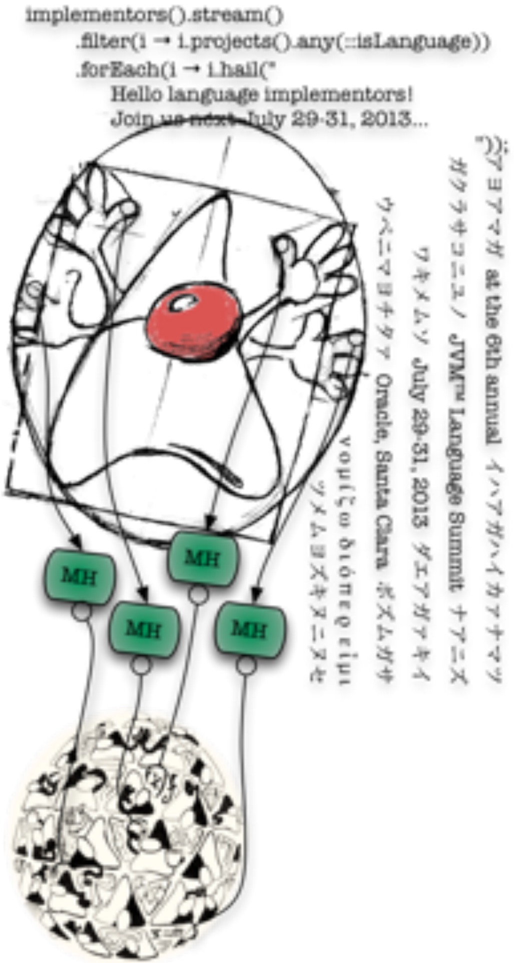
Program Agenda

- Extending Java Classes
- Type Conversion Fun
- Arrays
- The Incredible Package Illusion
- Linking
- Security

So, You Want To Write a Language on JVM

- You likely want to have your language somehow interface with the underlying platform: VM, libraries, etc.
- There are some typical things that you need to solve for a rich interop story.
  - Extending JVM classes and implementing interfaces in your language
  - Type conversions
  - Handling arrays (yes, it can be quite a special case)
  - Invocation of Java methods

Extending Java Classes



```
implementors().stream()
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Extend/Implement a JVM Class/Interface

- Typical Nashorn code:

```
var r = new java.lang.Runnable() {
   run: function() {
      print(“Hello!”)
   }
}
```

Extend/Implement a JVM Class/Interface

- Simpler Nashorn code:

```
var r = new java.lang.Runnable(function() {
    print(“Hello!”)
})
```

Adapter Classes

- Obviously, when you write code like this, we instantiate an adapter class.
- Question is: how is it supposed to look like when implemented around invokedynamic?

Anatomy of an Adapter

```
package jdk.nashorn.javaadapters.java.lang;

public final class Runnable implements java.lang.Runnable {

  private final ScriptObject global;

  private final MethodHandle run;
  private final MethodHandle toString;
  private final MethodHandle hashCode;
  private final MethodHandle equals;

  ...
}
```

Anatomy of an Adapter - Fields

Can’t define classes in java.* package

```
package jdk.nashorn.javaadapters.java.lang;

public final class Runnable implements java.lang.Runnable {

  private final ScriptObject global;

  private final MethodHandle run;
  private final MethodHandle toString;
  private final MethodHandle hashCode;
  private final MethodHandle equals;

  ...
}
```

Need defining context

Overridable toString, hashCode, equals

Anatomy of an Adapter - Constructors

```
public <init>(Ljava/lang/Object;)V
    ALOAD 0
    INVOKESPECIAL java/lang/Object.<init> ()V

    ALOAD 0
    ALOAD 1
    LDC "run"
    LDC ()V.class
    INVOKESTATIC JavaAdapterServices.getHandle();
    PUTFIELD run;
```

Repeated for every MethodHandle field

Anatomy of an Adapter - Constructor in Java

```
public Runnable(Object o) {
    super();
    this.run = JavaAdapterServices.getHandle(o, “run”,
        MethodType.methodType(void.class));
    this.equals = JavaAdapterServices.getHandle(o, “equals”,
        MethodType.methodType(boolean.class, Object.class));
    this.hashCode = JavaAdapterServices.getHandle(o, “hashCode”,
        MethodType.methodType(int.class));
    this.toString = JavaAdapterServices.getHandle(o, “toString”,
        MethodType.methodType(String.class));

    this.global = Context.getGlobal();
    this.global.getClass();
}
```

Anatomy of an Adapter

```
public static MethodHandle getHandle(Object obj, String name, MethodType type) {
    final ScriptObject sobj = (ScriptObject)obj;

    // Since every JS Object has a toString, we only override
    // "String toString()" it if it's explicitly specified
    if ("toString".equals(name) && !sobj.hasOwnProperty("toString")) {
        return null;
    }

    final Object fnObj = sobj.get(name);
    if (fnObj instanceof ScriptFunction) {
        return adaptHandle(
            ((ScriptFunction)fnObj).getBoundInvokeHandle(sobj), type);
    } else if(fnObj == null || fnObj instanceof Undefined) {
        return null;
    } else {
        throw typeError("not.a.function", name);
    }
}
```

Anatomy of an Adapter - Constructors

```
public <init>(ScriptFunction)V
   ALOAD 0
   INVOKESPECIAL java/lang/Object.<init> ()V

   ALOAD 0
   ALOAD 1
   LDC ()V.class
   INVOKESTATIC JavaAdapterServices.getHandle();
   PUTFIELD run

   ALOAD 0
   ACONST_NULL
   PUTFIELD toString
```

Single method handle for the function.

null for all other overrides

Anatomy of an Adapter - Constructor in Java

```
@Override
public Runnable(ScriptFunction f) {
    super();
    this.run = JavaAdapterServices.getHandle(f,
        MethodType.methodType(void.class));

    this.equals = null;
    this.hashCode = null;
    this.toString = null;

    this.global = Context.getGlobal();
    this.global.getClass();
}
```

Anatomy of an Adapter - Constructors

- A public constructor is emitted for every superclass public or protected constructor.
- We add Object at the end of superclass constructor signature.
  - Yes, we convert variable arity constructors into fixed arity.
  - Allows us to use the `new T(x, y) { ... }` syntax extension.
- If we're implementing a SAM, another constructor with ScriptFunction as its final argument is emitted too.
- Dynalink overloaded method resolution ensures the right constructor is picked up at run time.

Anatomy of an Adapter - Methods

- For an abstract method:

```
  public run()V
    ALOAD 0
    GETFIELD run;
    DUP
    IFNONNULL L4
    POP
    NEW java/lang/UnsupportedOperationException
    DUP
    INVOKESPECIAL UnsupportedOperationException.<init> ()V
    ATHROW
L4  INVOKEVIRTUAL java/lang/invoke/MethodHandle.invokeExact
    RETURN
```

Anatomy of an Adapter - Methods

- For a non-abstract method:

```
  public toString()Ljava/lang/String;
    ALOAD 0
    GETFIELD toString
    DUP
    IFNONNULL L4
    POP
    ALOAD 0
    INVOKESPECIAL java/lang/Object.toString;
    ARETURN
L4  INVOKEVIRTUAL java/lang/invoke/MethodHandle.invokeExact
    ARETURN
```

Anatomy of an Adapter - Methods

- Exception handling

```
public toString()Ljava/lang/String;
  TRYCATCHBLOCK L0 L1 L3 java/lang/RuntimeException
  TRYCATCHBLOCK L0 L1 L3 java/lang/Error
  TRYCATCHBLOCK L0 L1 L2 java/lang/Throwable
  ...
 L2
  NEW java/lang/RuntimeException
  DUP_X1
  SWAP
  INVOKESPECIAL RuntimeException.<init>(Throwable)V
 L3
  ATHROW
```

How often do you get to use this opcode?

Anatomy of an Adapter - Method in Java

```
@Override
public boolean equals(Object o) {
    if(equals == null) {
        return super.equals(o);
    }
    try {
        return equals.invokeExact(this, o);
    } catch(RuntimeException|Error) {
        throw e;
    } catch(Throwable t) {
        throw new RuntimeException(t);
    }
}
```

Anatomy of an Adapter - Method in Java, real

```
@Override
public boolean equals(Object o) {
    if(equals == null) {
        return super.equals(o);
    }
    final Global currentGlobal = Context.getGlobal();
    final boolean differentGlobal = currentGlobal != global;
    if(differentGlobal) {
        Context.setGlobal(global);
    }
    try {
        return equals.invokeExact(this, o);
    } catch(RuntimeException|Error) {
        throw e;
    } catch(Throwable t) {
        throw new RuntimeException(t);
    } finally {
        if(differentGlobal) {
            Context.setGlobal(currentGlobal);
        }
    }
}
```

Anatomy of an Adapter

- MethodHandle objects - the behavior - is instance bound.
- What if you want class bound?

```
var Hello = Java.extend(java.lang.Runnable, {
   run: function() {
      print(“Hello!”)
   }
})

var h1 = new Hello()
var h2 = new Hello()
```

Anatomy of an Adapter - Class Behavior

```
package jdk.nashorn.javaadapters.java.lang;

public final class Runnable implements java.lang.Runnable {

  private final ScriptObject global;
  private static final ScriptObject staticGlobal;

  private final MethodHandle run;
  private final MethodHandle toString;
  private final MethodHandle hashCode;
  private final MethodHandle equals;

  private static final MethodHandle run_static;
  private static final MethodHandle toString_static;
  private static final MethodHandle hashCode_static;
  private static final MethodHandle equals_static;
  ...
```

Anatomy of an Adapter - Class Behavior

Pass parameter to static block in a thread local.

```
static {
    Object o = JavaAdapterServices.getClassOverrides();
    if(o instanceof ScriptFunction) {
        run_static = JavaAdapterServices.getHandle((ScriptFunction)o, …);
        hashCode_static = null;
        ...
    } else {
        run_static = JavaAdapterServices.getHandle(o, “run”, …);
        hashCode_static = JavaAdapterServices.getHandle(o, “hashCode”, …);
        ...
    }
}
```

Anatomy of an Adapter - Class Behavior

```
@Override
public boolean equals(Object o) {
    try {
        if(equals != null) {
            return equals.invokeExact(o);
        } else if(equals_static != null) {
            return equals_static.invokeExact(o);
        }
    } catch(RuntimeException|Error) {
        throw e;
    } catch(Throwable t) {
        throw new RuntimeException(t);
    }
    return super.equals(o);
}
```

Anatomy of an Adapter - Class Behavior

- Of course, actual code is more complex, as it needs to deal with management of appropriate global too.
- Up to three constructors emitted for every superclass constructor:
  - One with same arguments as superclass constructor
  - One with added Object argument for instance overrides
  - One with added ScriptFunction argument for SAM instance override.

Overrides and Overloads in Adapters

- JavaScript has no concept of overloaded methods.
- Our adopted policy is: a named function is used as the implementation of all non-final overloads with the same name.
- True for adapters written in JavaScript; if your language could distinguish between overloads, feel free to write a different adapter.

Adapters and Security

- Adapters can only extend/implement public classes/interfaces.
  - Classes/interfaces in restricted packages subject to access check.
- Can only override public and protected methods.
  - `@CallerSensitive` methods can't be overridden as it'd mess up the caller identification.

Adapters and Security

- Adapters are defined in a separate ProtectionDomain with AllPrivileges.
  - So as to not narrow the caller privileges.
  - They are just pass-through delegates, so no risk of privilege escalation.
  - They <u>don't</u> use doPrivileged blocks.
  - Effective permissions are the intersection of permissions of caller and delegate function.

Adapters and Security

```
private static final ProtectionDomain GENERATED_PROTECTION_DOMAIN =
    createGeneratedProtectionDomain();

private static ProtectionDomain createGeneratedProtectionDomain() {
    final Permissions permissions = new Permissions();
    permissions.add(new AllPermission());
    return new ProtectionDomain(
        new CodeSource(null, (CodeSigner[])null), permissions);
}

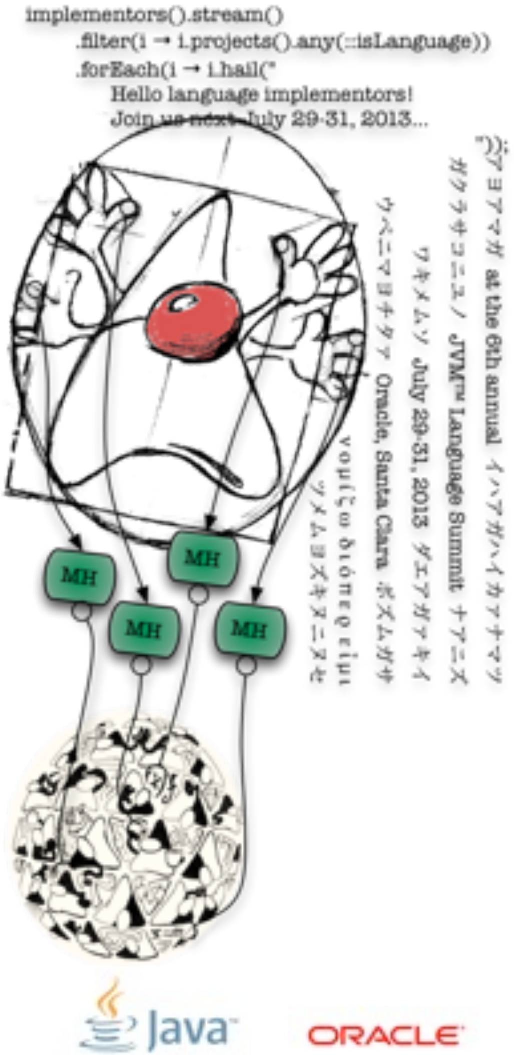
...
defineClass(name, classBytes, 0, classBytes.length,
    GENERATED_PROTECTION_DOMAIN);
```

- Obviously, our own code needs “createClassLoader” permission to create a class loader to invoke defineClass in.

Where Should I Define Thee?

- What’s the parent class loader for your adapter class?
- Take the set of class loaders for the extended class and all implemented interfaces…
- …as well as the class loader for your language runtime classes.
- Find the “Maximum Visibility Loader” - one that sees classes in all the other loaders.
- If there’s no such loader, can’t define the adapter!
- Can cause surprises in exotic situations.

Type Conversion Fun



Ain’t No Script Like JavaScript…

- … for ultimate type conversion fun.
- ‘cause `[+!+[]]+[+[]] == 10`, of course!
- Most type conversions are straightforward; some are more interesting.
- We mostly encounter type conversions to target Java types when invoking Java methods and have to match parameters to their signatures.

Stuff that's almost trivial

```
var x = new (Java.type("boolean[]"))(1)
test(0)
test(1)
test({})
test([])
test("")
test("false")
test(null)
test(undefined)

function test(v) {
   x[0] = v
   print(JSON.stringify(v) + " => " + x[0])
}
```

```
0 => false
1 => true
{} => true
[] => true
"" => false
"false" => true
null => false
undefined => false
```

Stuff that's almost trivial

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```

```
0 => false
1 => true
{} => true
[] => true
"" => false
"false" => true
null => null
undefined => null
```

- When converting to boxed type, we can preserve nulls.

Stuff that's nifty

- If the target is a SAM type, and you supply a ScriptFunction, we supply an on-the-fly allocated adapter.

```
Collections.sort(new function(x, y) { return y < x })
```

- All of this is handled with Dynalink linkers implementing the optional `GuardingTypeConverterFactory` interface's `GuardedInvocation getTypeConverter(Class from, Class to)` method.

Comparison prioritization

- Yet another Dynalink feature. To wit:

```
new Thread(new function() { print(“Hello!”) })
```

- Can apply both to `Thread(Runnable)` and sadly also to `Thread(String)` method, as JS has implicit object-to-string conversion.

Comparison prioritization

- By definition needed whenever your language allows more conversions than JLS does.
- ‘Cause you’ll end up widening the set of applicable overloaded methods at a call site.

```
public interface ConversionComparator {
    enum Comparison { TYPE1_BETTER, TYPE2_BETTER, INDETERMINATE }

    public Comparison compareConversion(Class sourceType,
        Class targetType1, Class targetType2);
}
```

Comparison prioritization

```
public class NashornLinker implements
    TypeBasedGuardingDynamicLinker,
    GuardingTypeConverterFactory,
    ConversionComparator {

    ...
    public Comparison compareConversion(Class sourceType,
        Class targetType1, Class targetType2) {
    if(ScriptObject.class.isAssignableFrom(sourceType)) {
        if(targetType1.isInterface()) {
            if(!targetType2.isInterface()) {
                return Comparison.TYPE_1_BETTER;
            }
        } else if(targetType2.isInterface()) {
            return Comparison.TYPE_2_BETTER;
        }
    }
    return Comparison.INDETERMINATE;
}
```

Handling Strings, Numbers, and Booleans

- JavaScript string, number, and boolean values are represented as Java String, Number, and Boolean objects. These are considered JS primitive types and handled as such.
- Still possible to invoke Beans methods on them, e.g. `“foo”.hashCode()`.

Primitives’ Conversion Prioritization

- Say you’re invoking bean.foo(“123”) and you have overloaded methods foo(int) and foo(Object).
- Three types in play: type of value “123” (String), and the types of formal parameters in the method.
- Which one do you choose?

Primitives' Conversion Prioritization

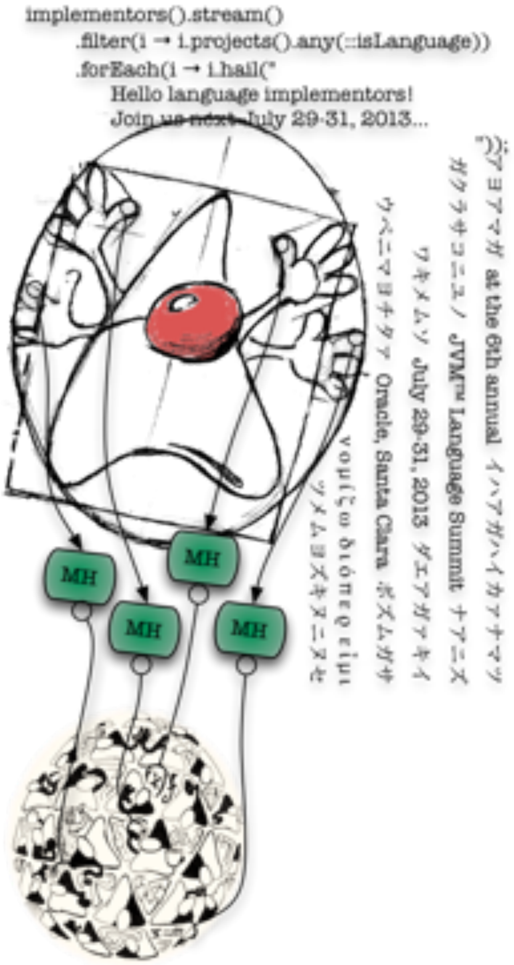
- Conversion prioritization turned out to be somewhat hairy:
  - If exactly one target type matches source type, pick it.
  - if exactly one target type is a number, pick it
  - if exactly one target type is char, pick it (number to UTF-16 conversion)
  - Between possible two number types, choose the wider one.
  - In all other cases, if one of the target types is string, choose it as strings can represent any value without precision loss.

SAM Type Conversion

- A.K.A. instant lambdas
- Pass a function in place of an argument expecting a SAM type…
- … it gets wrapped.

```
new Thread(function() { print(“Hello!”) }).start()
```

Arrays



```
implementors().stream()
        .filter(i → i.projects().any(::isLanguage))
        .forEach(i → i.hail("
            Hello language implementors!
            Join us next July 29-31, 2013...
"));
```

Java Array vs. Your Language’s Arrays

- JavaScript arrays are particularly nasty:
  - They can grow and shrink.
  - They can be sparse.
- If we provided an automatic conversion from JavaScript array to Java array, what would the semantics be?
  - Decision: we don’t provide automatic conversion!

Java Array vs. Your Language’s Arrays

- This won’t work:

```
java.lang.Array.toString([1, 2, 3])
```

- This will:

```
java.lang.Array.toString(Java.to([1, 2, 3]))
```

- Rare case of mandating explicit conversion.

Java Array vs. Your Language's Arrays

- API design is a tradeoff.
- No way we are making a copying operation with linear time and unbounded memory needs implicit.
- The programmer is also expected to understand there are no two-way updates between Java and JavaScript arrays.

Java Array vs. Your Language's Arrays

- `Java.to(jsObj[, clazz])` converts a JavaScript `Array` to a Java array, a `List`, or a `Deque`.
  - Default value for `clazz` is `Object[]`.
- `Java.from(javaObj)` converts a Java array or `List` to a JavaScript `Array`.
- Finally, it is perfectly possible to use Java arrays and lists in JS; `for..in` and `[]` syntax work on them.
- Only if you need functionality from the JS prototype (e.g. map, reduce, etc.) is when you need to explicitly use `Java.from` to get an actual JS `Array`.

Component Type Conversion

- `Java.to([12, false, “55”], int.class])` will use language conversion logic to int elementwise.

Component Type Conversion

```
public Object asArrayOfType(final Class<?> componentType) {
    final Object[] src = asObjectArray();
    final int l = src.length;
    final Object dst = Array.newInstance(componentType, l);
    final MethodHandle converter =
        linkerServices.getTypeConverter(Object.class, componentType);
    for (int i = 0; i < src.length; i++) {
        Array.set(dst, i, converter.invokeExact(converter, src[i]));
    }
    return dst;
}
```

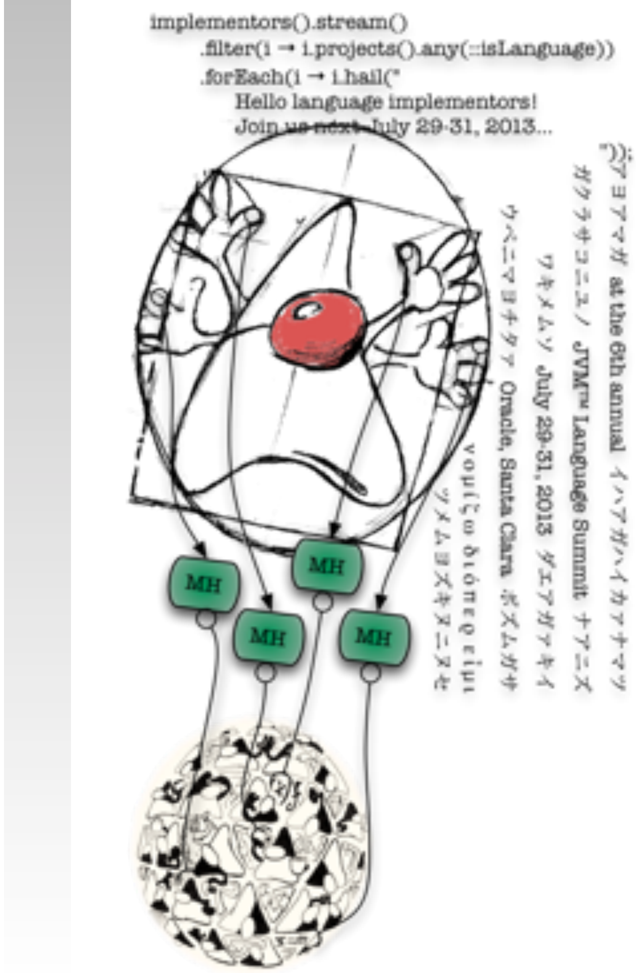
Java Objects are Maps, So Why Aren’t…

- Fun fact: `ScriptObject` implements `java.util.Map`.
- So, why doesn’t our `NativeArray` implement `java.util.List`?

Java Objects are Maps, So Why Aren’t…

- `NativeArray` extends `ScriptObject`, implicitly implements `Map`.
- Turns out no class can implement both `List` and `Map`:
  - `boolean List.remove(Object)`
  - `Object    Map.remove(Object)`
- Some battles you can’t win.

Statics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Class vs. Statics

- As a Java programmer, you understand the difference between `java.io.File` and `java.io.File.class`.
- One is a compile-time identifier providing access to constructors and static members. It is not reified at run-time.
- Other is a reified run-time representation of an object’s class.
- They are separate concepts.
- Probably shouldn’t mix them up in other languages either.

StaticClass

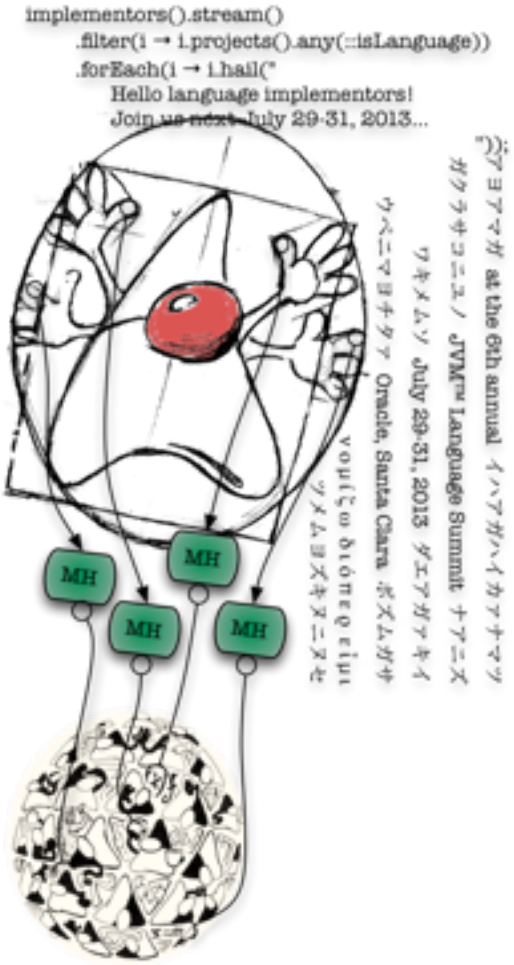
- Dynalink has a `StaticClass` class that is a reification of Java’s compile-time class identifier.
- It’s just a boring little wrapper around a `Class` object.
- However, the linker will correctly link to static members of the represented class when faced with such object.
- It will also link to constructors when linking `dyn:new` operation.

StaticClass

- `dyn:getProp:class` is also linked to retrieve the runtime `Class`.

-
  ```
  var fileClazz = Java.type(“java.io.File”).class // or
  var fileClazz = java.io.File.class // familiar, right?
  ```
- On the other hand, `dyn:getProp:static` is linked to static class from a `Class` object - a capability you don’t have in the Java language.
  ```
  var file = ... // somehow get a java.io.File
  file.class === java.io.File.class // like in Java
  file.class !== java.io.File // wouldn’t compile in Java!
  file.class.static === java.io.File // neither would this!
  file instanceof java.io.File // true: special handling
  ```

The Incredible Package Illusion



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Packages Aren’t Reified

- There’s no object in JVM that represents a package, e.g. `java.util`.
- `java.lang.Package` doesn’t count.
- Can’t verify existence of a package.
- Yet dynamic languages often want to give users stuff like:
  `var list = new java.util.List().`

Stepping Stones

- Typical solution: “stepping stones” approach: provide a `java` object, that provides a `util` object, that provides a `List` object.
- Problem: must optimistically presume any identifier to be a package when a class of that name is not found

  ```
  var PirateList = java.util.ArrrayList
  var list = new PirateList()
  ```

- Typos can end up being detected late; effort must be taken to report the right error.

Stepping Stones

```
@Override
protected GuardedInvocation findCallMethod(CallSiteDescriptor desc) {
    final MethodType type = desc.getMethodType();
    return new GuardedInvocation(MH.dropArguments(CLASS_NOT_FOUND, 1,
        type.parameterList().subList(1, type.parameterCount())),
        TYPE_GUARD);
}

@SuppressWarnings("unused")
private static void classNotFound(final NativeJavaPackage pkg) throws
ClassNotFoundException {
    throw new ClassNotFoundException(pkg.name);
}
```

Linking a Thrower vs. Throwing an Exception

- In previous example, we linked an exception throwing method handle.
- We could’ve also thrown the exception from linking code too.
- Design choice:
  - Linking an exception thrower eliminates linker plumbing frames from the call stack.
  - Throwing in-situ can help debugging the runtime because it does not eliminate those same stack frames.
    - Possible compromise: `Throwable.addSuppressed()`

Nashorn solution

- We support stepping stones, but try to steer users towards avoiding them.
- Preferred idiom is `Java.type()`.

  ```
  var List = Java.type(“java.util.ArrayList”)
  var list = new List()
  ```

- Can invoke it directly too, but a bit awkward because of call operator precedence:

  ```
  var list = new (Java.type(“java.util.ArrayList”))
  ```

Also supports arrays

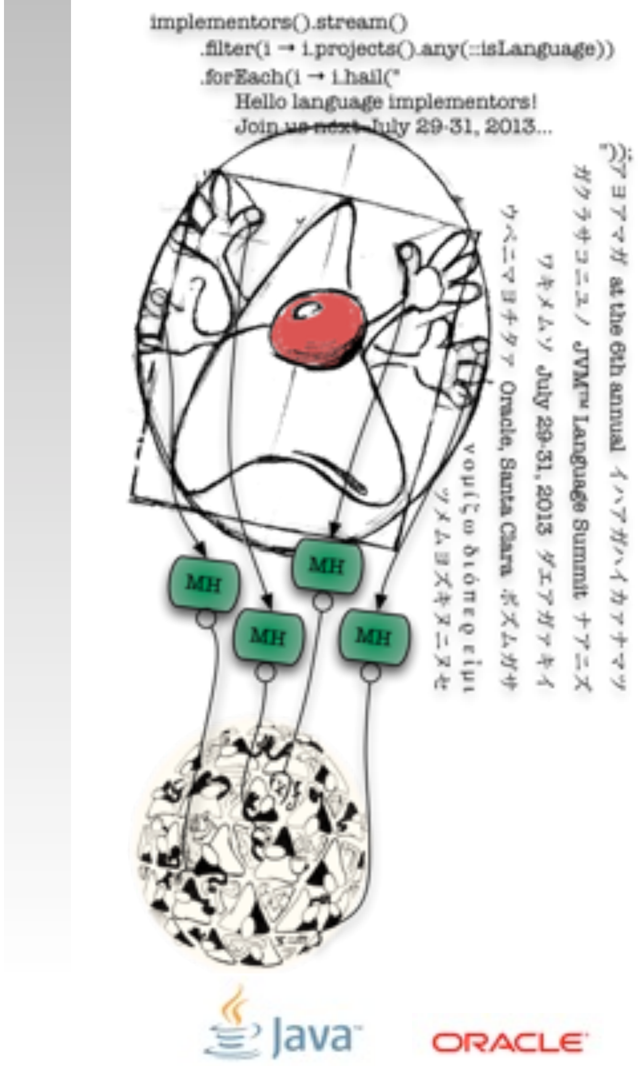
-
  ```
  var intArr5 = new (Java.type(“int[]”))(5)
  ```

-
  ```
  var IntArray = Java.type(“int[]”)
  var intArr5 = new IntArray(5)
  ```

Educate the Users

- In general, we try to actively educate users to use `Java.type()` and if we can help it don’t even mention stepping stones.
- It’s your choice how much of JVM do you want to expose or hide.
- Hey Dorothy, You’re not in Java anymore.

Linking



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Dynalink Evolved

- Nashorn embeds Dynalink.
- Dynalink underwent lots of improvements as a result of having an actual client runtime.
- Still available as external standalone project.

Composite Operations

- JavaScript doesn’t have separate namespaces for methods, properties, and collection elements.
- Which one of `dyn:getProp`, `dyn:getElem`, or `dyn:getMethod` do you emit for `obj.foo`?
- Correct answer: all of them!

Composite operations

source operation	operation name
`obj.foo`	`dyn:getProp|getElem|getMethod:foo`
`obj.foo()`	`dyn:getMethod|getProp|getElem:foo`
`obj[x]`	`dyn:getElem|getProp|getMethod`
`obj[x]()`	`dyn:getMethod|getElem|getProp`

Composite Operations

- BeansLinker correctly supports them.
- In most cases, can evaluate the effective operation at link time.
- Except `getElem` on a map followed by `getProp` and/or `getMethod`.

Linking Security

- Dynalink BeansLinker uses publicLookup for cacheable method handles (most of them).
- Completely prevents access to restricted packages (in presence of a security manager!)
- Correctly handles methods marked as `@CallerSensitive`.
  - Method handles are never cached, but unreflected on every link request, with caller's Lookup.

Miscellaneous Dynalink Improvements

- Inner classes are properties of StaticClass
- Detection of frequently relinked call sites; `LinkRequest.isCallSiteUnstable()`.
- `dyn:callMethod` was split into `dyn:getMethod` and `dyn:call`.
  - ‘cause you don’t always call a named function on an object.
- `dyn:new` for invoking constructors.
- Manual overload resolution: `dyn:getMethod:println(char)`.
  - Never really needed; usable by programmer as a performance enhancement. Really introduced for compatibility with Rhino.

Leveraging It From Java

```
private static final MethodHandle REDUCE_CALLBACK_INVOKER =
    Bootstrap.createDynamicInvoker("dyn:call", Object.class,
        Object.class, Undefined.class, Object.class, Object.class,
        long.class, Object.class);

...
private static Object reduceInner(...) {
    ...
    return new IteratorAction<Object>(...) {
        protected boolean forEach(...) {
            result = REDUCE_CALLBACK_INVOKER.invokeExact(
                callbackfn, ScriptRuntime.UNDEFINED, result, val, i,
                    self);
            return true;
        }
    }.apply();
```

Leveraging It From Java

- `createDynamicInvoker` is simply a dynamic invoker on a Nashorn-linked call site.
- `dyn:call` will be able to invoke anything that Nashorn can invoke.

```
public static MethodHandle createDynamicInvoker(
    final String opDesc, final MethodType type) {
        return bootstrap(MethodHandles.publicLookup(), opDesc, type,
            0).dynamicInvoker();
}
```

“InvokeByName” pattern

- Java code needs to invoke a function on a JavaScript object.
- e.g. `Array.toString` invokes `this.join()`.

```
class NativeArray {
    ...
    private static final InvokeByName JOIN = new InvokeByName("join",
        ScriptObject.class);
    ...
    public static Object toString(final Object obj) {
        ...
        final ScriptObject sobj = (ScriptObject)obj;
        final Object joinFn = JOIN.getGetter().invokeExact(sobj);
        if (Bootstrap.isCallable(joinFn)) {
            return JOIN.getInvoker().invokeExact(joinFn, sobj);
        }
```

InvokeByName

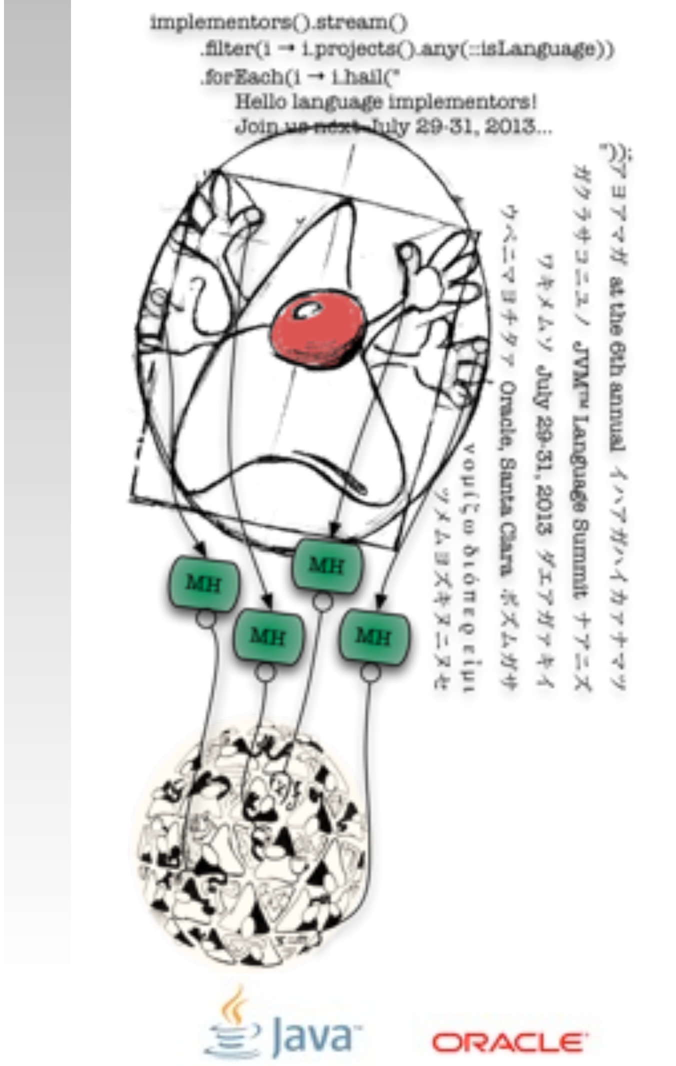
```
public class InvokeByName {
    private final MethodHandle getter;
    private final MethodHandle invoker;

    public InvokeByName(String name, Class targetClass, Class rtype,
        Class... ptypes) {

        getter  = Bootstrap.createDynamicInvoker(
            "dyn:getMethod|getProp|getElem:" + name, Object.class,
                targetClass);

        final Class[] finalPtypes = ...; // omitted type massaging
        invoker = Bootstrap.createDynamicInvoker("dyn:call", rtype,
            finalPtypes);
    }
```

Security



```
implementors().stream()
        .filter(i → i.projects().any(::isLanguage))
        .forEach(i → i.hail("
            Hello language implementors!
            Join us next July 29-31, 2013...
"));
```

アヨアマガ at the 6th annual イハアガハイカアナマツ
ガクラキヨニユノ JVM™ Language Summit ナアニズ
ワキメムソ July 29-31, 2013 ダエアガアキイ
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Security So Far

- Dynalink prevents access to non-public members
- Also to classes in restricted packages.
  - That’s stricter than Java, but a conscious decision.
  - Package restrictions are only in place with SecurityManager.
- Dynalink correctly handles `@CallerSensitive` methods.

Nashorn Additional Security Features

- Nashorn prevents `Java.type()` access to classes in restricted packages.
- Nashorn ties access to reflective classes to a a new `"Nashorn.JavaReflect"` runtime permission.
  - `Class`, `ClassLoader`, everything in `java.lang.reflect` and `java.lang.invoke` packages.

Rationale

- None of the restrictions are in place when there is no security manager.
- Most uses are unaffected even under a security manager.
- You can do less things from JavaScript than from Java
  - Namely, manipulate stuff in restricted packages.
  - Actually, you can: through reflection; if you have the permission.
  - Even then, it won't be pleasant.
- Nashorn runs with `AllPermission` since it lives in `jre/lib/ext`.

Program Agenda

- Extending Java Classes
- Type Conversion Fun
- Arrays
- The Incredible Package Illusion
- Linking
- Security

Java™