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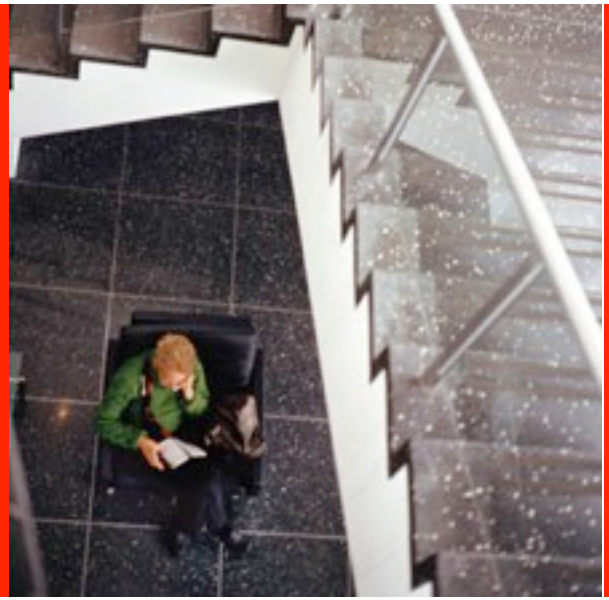

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Gathering the threads

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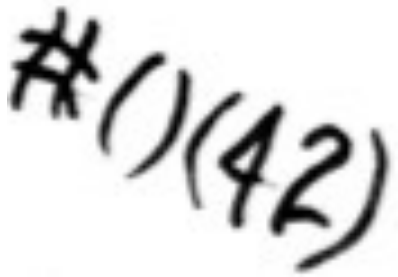
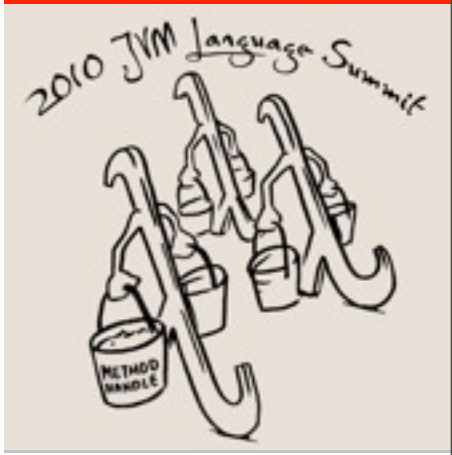
Outline



- What's new with invokedynamic
- Why languages are important
  - (and threads are bad)
- JVM features to investigate

What's new with invokedynamic



JSR 292 News

(in the constant pool)

- New pool types for use with `ldc`
  - lazy symbol linkage, like `ldc` of CONSTANT_Class
- CONSTANT_MethodType (u2 Utf8_signature_ref)
- CONSTANT_MethodHandle (u1 kind, u2 ref)
  - kind is one of getField, putStatic, invokeVirtual, etc.
  - ref is a Fieldref, Methodref, or InterfaceMethodref
- No notational support (maybe Project Lambda?)
- Informally, we can write "`String#length()`"

JSR 292 News

(bootstrap methods in more places)

- New pool type for use with `invokedynamic`
  - scope + (name + type signature), like CONSTANT_Methodref
- Bootstrap method reference takes place of class.
  - BSM ref + (name + type signature)
  - BSM ref is a CONSTANT_MethodHandle
- Bootstrap method is a statically defined property
- Can be different for each `invokedynamic` instr.

Java Notation

(polymorphic signatures for MH & indy)

- Existing notation (since 2/2009) looks like:

```
int x = mh.<int>invokeExact("foo", false);
```

- Simplified notation uses target typing:

```
int x = mh.invokeExact("foo", false);
```

- Parameter and return types are equally implicit.

- Advising with Project Coin and Project Lambda

Java Notation

(local bootstrap methods)

- Existing notation looks like:

```
static { registerBootstrapMethod("foo"); }
```

- Declarative notation (*draft*):

```
@@@BootstrapMethod(name="foo")
```

- Advising with Project Coin and Project Lambda

Invokedynamic and Lambda

(what depends on what?)

- JSR 292 does not and will not require closures
  - It is an “assembly kit” for multiple language features
  - Closures are merely a feature in a language...
- But, of course, we will interoperate and synergize
- The `MethodHandle` is a useful building block
  - Non-bound closures could be direct method handles.
  - Bound closures could be bound direct method handles.
  - SAM conversion is a natural method handle operation

Case study

(generic arithmetic)

- Scheme: (set! acc (+ acc 1))
- Compiled: AddOp.$PI(acc, Integer.valueOf(1))
- Modified: InvokeDynamic.#"kawa:+"(acc, (int)1)

- Result: ~10% slower if already optimized
- ~10% faster if type profile is polluted (~20% penalty)
- ~80% of cost is Integer.valueOf (need *fixnums*)

  - See: http://blogs.sun.com/jrose/entry/an_experiment_with_generic_arithmetic
  - Thalinger & Rose, PPPJ 2010

Case study

(JavaScript objects)

- Rhino retrofit
- Hidden classes
- Monomorphic inline caches (using invokedynamic)

- One benchmark! ~4x performance gain
- What's left?
  - better indy calls
  - better split classes (*species*)
  - etc.

- See: kenai.com/projects/davincimonkey

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Why languages are important

What's in a loop?

```
for (i = 0; i < a.length; i++)
  foo(a[i]);
```

- Essentially sequential
- Meaningless without side effects

What's in a loop?

```
100 let i = 0
110 goto 150
120 call foo(a[i])
130 let i = i+1
150 if i < a.length goto 120
```

fun with Lisp: a better “for”?

```
a.forEach(#foo);
```

- Still essentially sequential
- Still meaningless without side effects

Lisp with functions

```
a.mapReduce(...#foo...);
```

- Task decomposition unknown to caller
- Should be meaningless *with side effects*

“for, while, break, continue, if, else”

- Sequential control flow: Considered harmful
- Changing paradigms: Known to be painful

“Our language inhabits us”

- language channelizes our basic presumptions
- (about software and computers, at least)

Meanwhile, in the computer factory

- HW Designer: do you like my capability machine?
- SW Designer: ummm, you are on your own
- SW Designer: do you like my event processing paradigm?
- HW Designer: now you are on your own
- SW Designer: (I'll keep my exceptions to myself.)

Meanwhile, in the computer factory

- SW Designer: what I want is a new machine for my old software
- HW Designer: what I can make for you is an old machine, *tessellated*
- JVM Designer: Hi! What ‘cha talking about?

how the JVM is part of the problem

- fundamentally, the JVM is a graph-mutation machine
- the graphs are type-safe, GC-ed, class-rich, modular
- It is all based on side effects, hence sequential
- Threads help, but they also confuse us

why I hate threads

- they only help at grain size which is VERY LARGE
  - at most scales, the paradigms are still sequential
- a thread is a huge promise about many tasks
  - they will be run in sequence
  - at any given moment, there is a huge ugly backtrace
  - backed by a huge immobile stack
- a thread *claims* to represent a virtual processor
  - as processors get numerous, the claim gets thinner
  - even more, as processors get *cheaper*
- **thread : task :: memory page : typed object**

how the JVM can help

- the JVM is also an *excellent* function-calling machine
- now we are cross-breeding functions & object graphs

- let's push for light-weight events and tasks
- let's design APIs that can allow task decomposition

JVM features to investigate

Value versus Identity

- Every Java object has a identity:
  - operator==, System.identityHashCode, clone
  - serialization: sync/wait/notify
  - these are necessary to manage the burden of **mutable fields**
  - a sequential, continuous story
    - fields change but the object remains the same
  - “His right rear paw is in a cast, but he’s still good old Rex.”
- Pure values are frozen in timelessness, have no story
  - comparisons have only to do with the permanent value parts
  - values don’t change; values can help us produce new similar

Tail calls

- One task can delegate to another w/o stack overflow
- Open loops
  - flexible, dynamic task decomposition
  - delegating (“threaded”!) control flow
- Sample syntax (prototype only!)

```
public static int tailcaller(int x) {
  if (x==0) return x+1;
  return goto tailcaller(x-1);
}
```

  - See: http://blogs.sun.com/jrose/entry/tail_calls_in_the_vm
  - http://hg.openjdk.java.net/mlvm/mlvm/hotspot/file/tip/tailc.txt

Better data structures

- Mixed arrays: [length: 2]{String, int, String, int}
- Array headers: {Object,String}[length: 2]{...}

- Why better?
  - object graphs ≠ memory structs
  - indirections are difficult to collapse
  - move back toward explicit memory layout

- We care, today, because of cache effects

- Better, really?
  - Research problem: treat this all as a hidden optimization

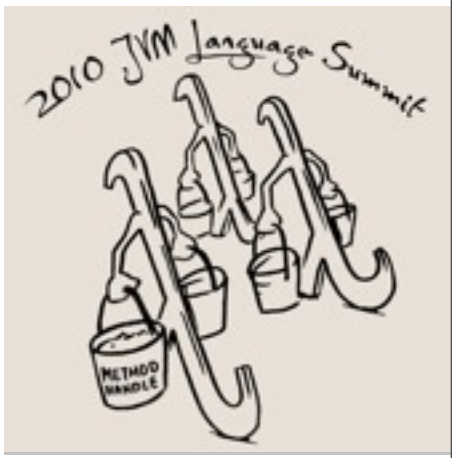
Origin of Species?

- List<String> strs = ...;
  List<Integer> ints = ...;
  String s = strs.get(0); int n = ints.get(0);
  assert strs.getClass() == ints.getClass();
- Species<List<String>> slspec = strs.getSpecies();
  Species<List<Integer>> ilspec = ints.getSpecies();
  assert slspec != ilspec;
- slspec.getString(); // List<String>
  slspec.getEnclosingClass() == List.class;
- GenericTypeSpecies g = (GenericTypeSpecies)slspec
  assert g.getTypeArg(0) == String.class;

Conclusion

- Paradigm shift hurts
- Getting left behind hurts even more
- Let's help our programmers adapt to tessellated HW

Q & A ... Workshop

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