

# Interoperability in Programming Languages

Todd Malone

Division of Science and Mathematics  
University of Minnesota, Morris  
Morris, Minnesota, USA

28 April 2014  
Senior Seminar

# What is Interop?

- Interoperability or Interop
- The ability for a system to use parts from another system
- In programming languages: The ability of a language to call on code from another language



Bluedrakon

<http://tr.im/pWUi>

# Why is Interop Important?

## Developer time and effort

- Existing and working code is easier to use as-is.
- Third-party systems: source code is unavailable
- Legacy systems: extensive or little-understood code base.

## Language Purpose:

- Low-level memory access (C)
- Parallel or distributed systems (Erlang, Clojure)
- Statistics (R)

# Outline

- 1 Tools used in achieving interoperability
- 2 What makes Interop difficult?

# Outline

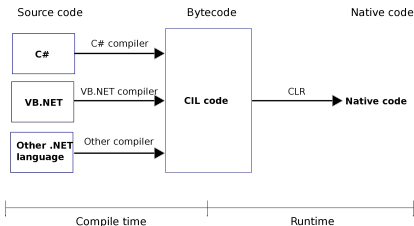
## 1 Tools used in achieving interoperability

- Virtual Machines
- Markup Languages

## 2 What makes Interop difficult?

# Virtual Machines

- Virtual Machines (VMs) are a runtime environment for a program
- High-level languages compile to an intermediate language
- Intermediate language: Java bytecode or Common Intermediate Language



Wikipedia

[https://en.wikipedia.org/wiki/Common\\_Language\\_Runtime](https://en.wikipedia.org/wiki/Common_Language_Runtime)

# High-level vs Bytecode

```
public class Fib{
    public int fibonacci(int n) {
        if(n == 0){
            return 0;
        }else if(n == 1){
            return 1;
        }else{
            return fibonacci(n - 1) + fibonacci(n - 2);
        }
    }
}

public class Fib {
    public Fib();
    Code:
        0: aload_0
        1: invokespecial #1          // Method java/lang/Object."<init>":()V
        4: return

    public int fibonacci(int);
    Code:
        0: iload_1
        1: ifne          6
        4: iconst_0
        5: ireturn
        6: iload_1
        7: iconst_1
        8: if_icmpne     13
        11: iconst_1
        12: ireturn
        13: aload_0
        14: iload_1
        15: iconst_1
        16: isub
        17: invokevirtual #2          // Method fibonacci:(I)I
        20: aload_0
        21: iload_1
        22: iadd
```

# Markup Languages

- Markup languages are a way of modeling data.
- XML and JSON can model data like objects.
- Markup languages are independent of programming languages.



# Outline

- 1 Tools used in achieving interoperability
- 2 What makes Interop difficult?**

# Some common difficulties in interop

- Languages represent data in different ways
- Languages act on data in different ways
- 
- 
-

# Outline

- 1 Tools used in achieving interoperability
- 2 What makes Interop difficult?

# Metadata and type conversion

## Metadata: Data about data

```
(def mylist [1, 2, 3, 4])  
(with-meta mylist {:length 4, :type Integer}))
```

## In Clojure:

- lists are untyped; can contain entries of different types.
- metadata, added as above, is all user-controlled.

# Why Metadata?

- Decontextualized data can carry context with it
- Data transfer between languages with different type strictness.

# The importance of Standards



# Outline

- 1 Tools used in achieving interoperability
- 2 What makes Interop difficult?

# Conclusions

- 
- 
- 
- 
-



# Thank you for listening!

**Contact:** `malone153@morris.umn.edu`

## Questions?

# References

See the GECCO '09 paper for additional references.