# Interoperability in Programming Languages

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# 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

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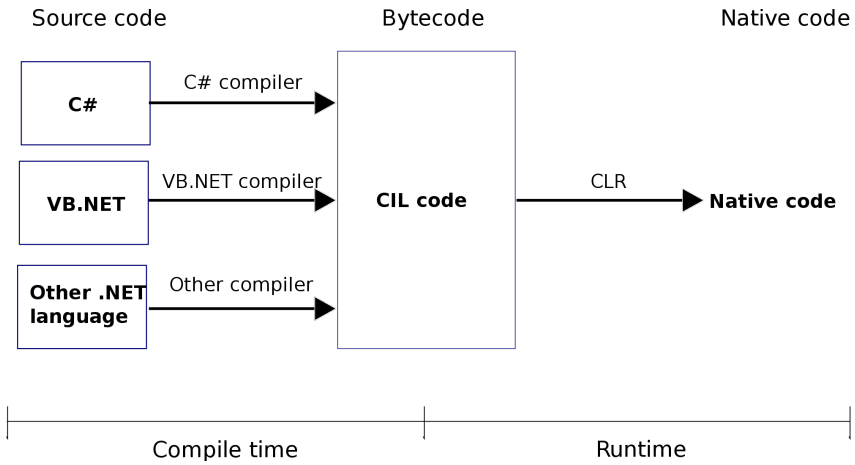
# Virtual Machines

- 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`

# 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
```

# 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

# Differences in type systems

- Languages represent data in different ways
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-
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# Mismatched structures

- Untyped lists can contain different types.
- Strongly typed lists can only contain the type given by the list.
- A language might not have an analogous structure
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# Handling data

- Languages act on data in different ways
-
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# Outline

# 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

# Conclusions

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# Thank you for listening!

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## Questions?

# References

See the GECCO ’09 paper for additional references.