Interoperability in Programming Languages

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What is Interop?

- Interoperability: The ability for a system to use parts from another system.
- Often shortened to interop.
- In programming languages: The ability of a language to call on code from another language.

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 Strength:

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

Outline

1. Tools used in achieving interoperability
2. Common difficulties in interop
3. Concepts in overcoming difficulties
4. Conclusions

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1. Tools used in achieving interoperability
   - Virtual Machines
   - Markup Languages
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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
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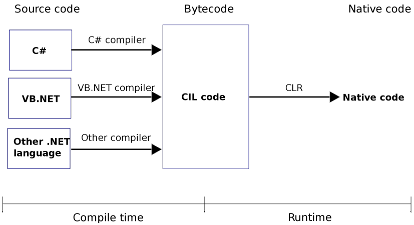
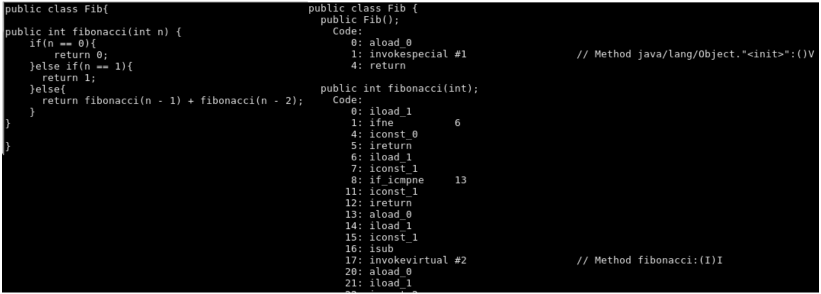


Wikipedia
`https://en.wikipedia.org/wiki/Common_Language_Runtime`

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.

```
<Person>
  <name> Cliff </name>
  <birthdate> 4/16/1978 </birthdate>
  <height> 74 </height>
  <weight> 212 </weight>
</Person>
```

```
{
 "name": "Cliff",
 "birthdate": "4/16/1978",
 "height": "74",
 "weight": "212";
}
```

Outline

1 Tools used in achieving interoperability

2 Common difficulties in interop
- Type systems
- Data structures
- Data processing

3 Concepts in overcoming difficulties

4 Conclusions

Differences in type systems

- Languages represent data in different ways
- Statically-typed languages assign types as soon as data is collected.
- Dynamically-typed languages only deal with types when evaluating data.
-

```
Class Person
  string name = "Cliff"
  date dateOfBirth = 4/16/1978
  int height = 74
  double weight = 212
end
```

```
Class Person
  var name = "Cliff"
  var dateOfBirth = 4/16/1978
  var height = 74
  var weight = 212
end
```

Mismatched structures

- Untyped lists can contain different types,
- Strongly typed lists can only contain the type given by the list.
- A data structure in one language may be absent in another
- Maps are common data structures, but absent in C.

```
[23, v, "hello", True]
```

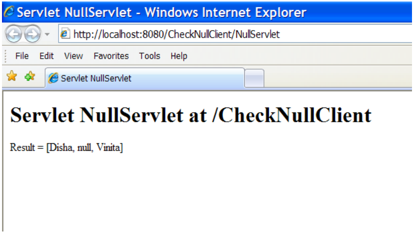
An untyped list

```
{:name "Cliff", :age 32}
```

A map

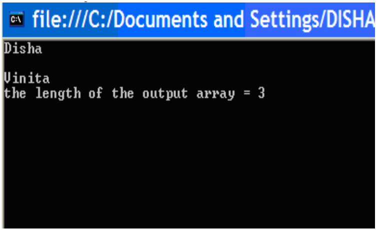
Handling data

- Languages act on data in different ways.
- Handling NULL or NIL objects.
- Decimal precision: Java returns 12.999999, .NET returns 13


Servlet NullServlet - Windows Internet Explorer
http://localhost:8080/CheckNullClient/NullServlet
File
Edit
View
Favorites
Tools
Help
Servlet NullServlet

Servlet NullServlet at /CheckNullClient

Result = [Disha, null, Vinita]



```
Disha

Vinita
the length of the output array = 3
```

[1]

Outline

1 Tools used in achieving interoperability

2 Common difficulties in interop

3 Concepts in overcoming difficulties
- Metadata
- Standards

4 Conclusions

Metadata and type conversion

Metadata: Data about data
or: Information beyond what the data itself can convey

```
(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

Standards are meant to ensure:

- Agreement on what metadata is being used, and how
- Unsurprising data processing
- Avoidance of data loss due to the above.
-
-

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Conclusions

Thank you for listening!

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Questions?

References

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