Agile Software Development

MSc in Computer Science

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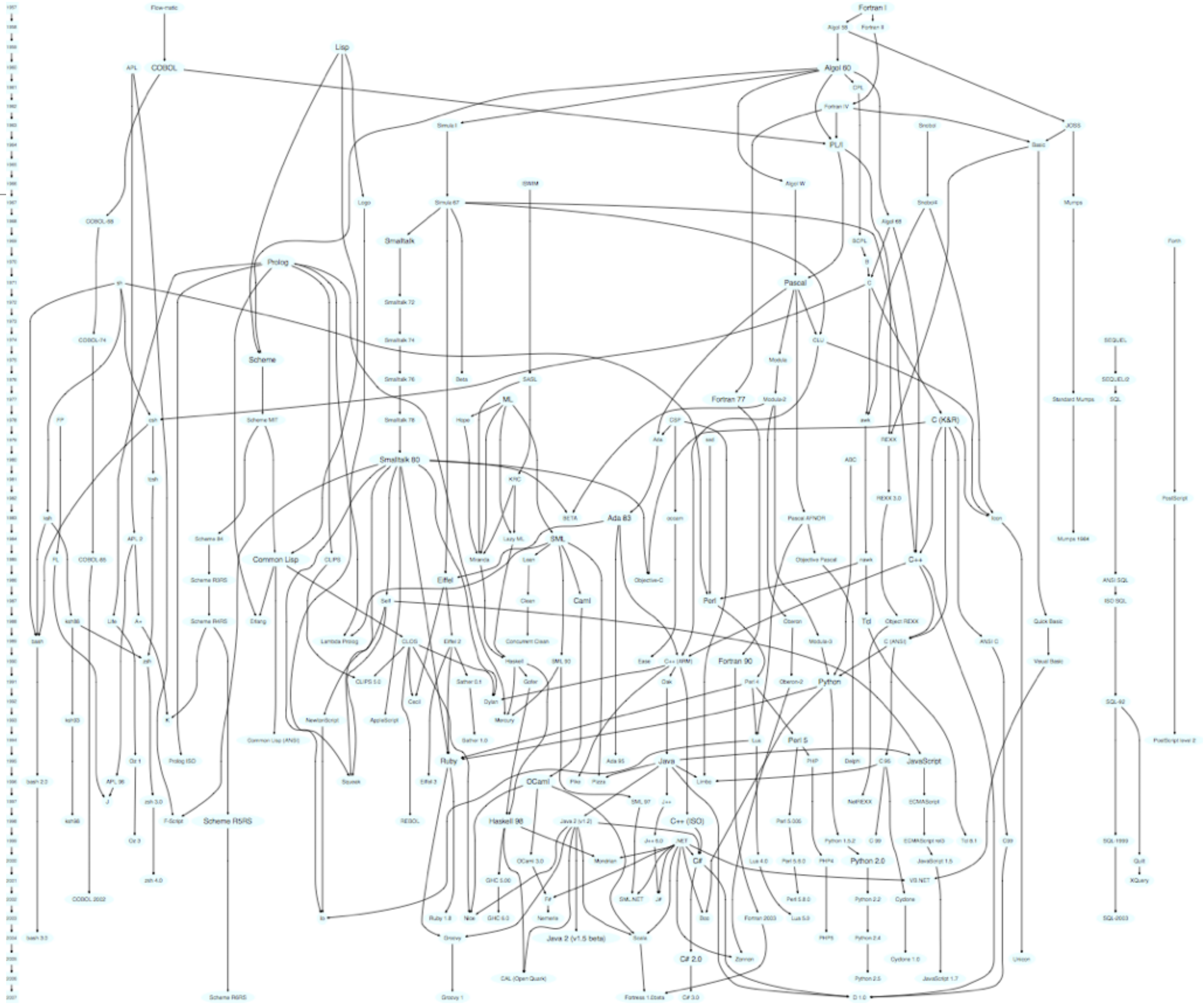
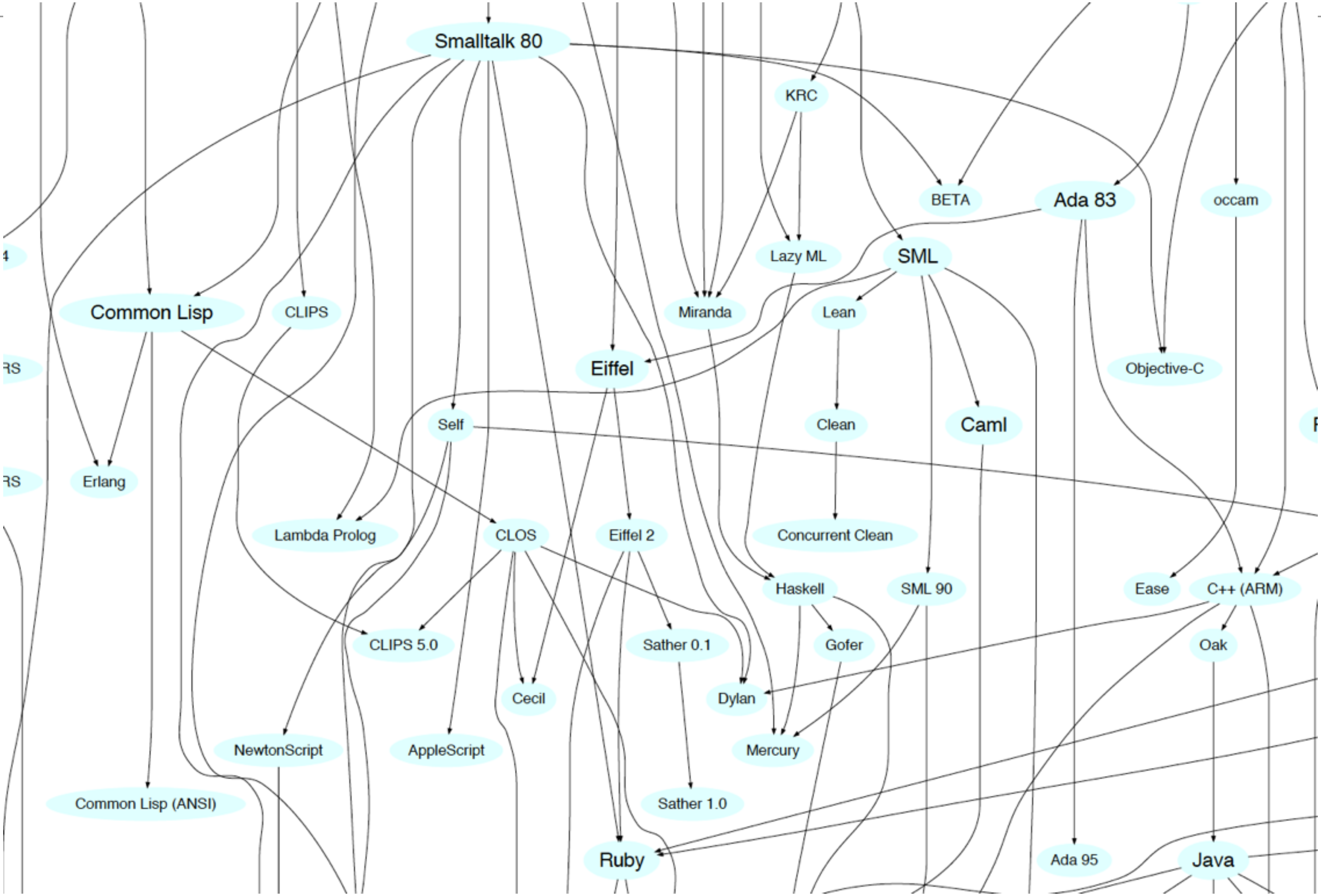
Programming Languages - Typing Wish Lists

Agile Software Development

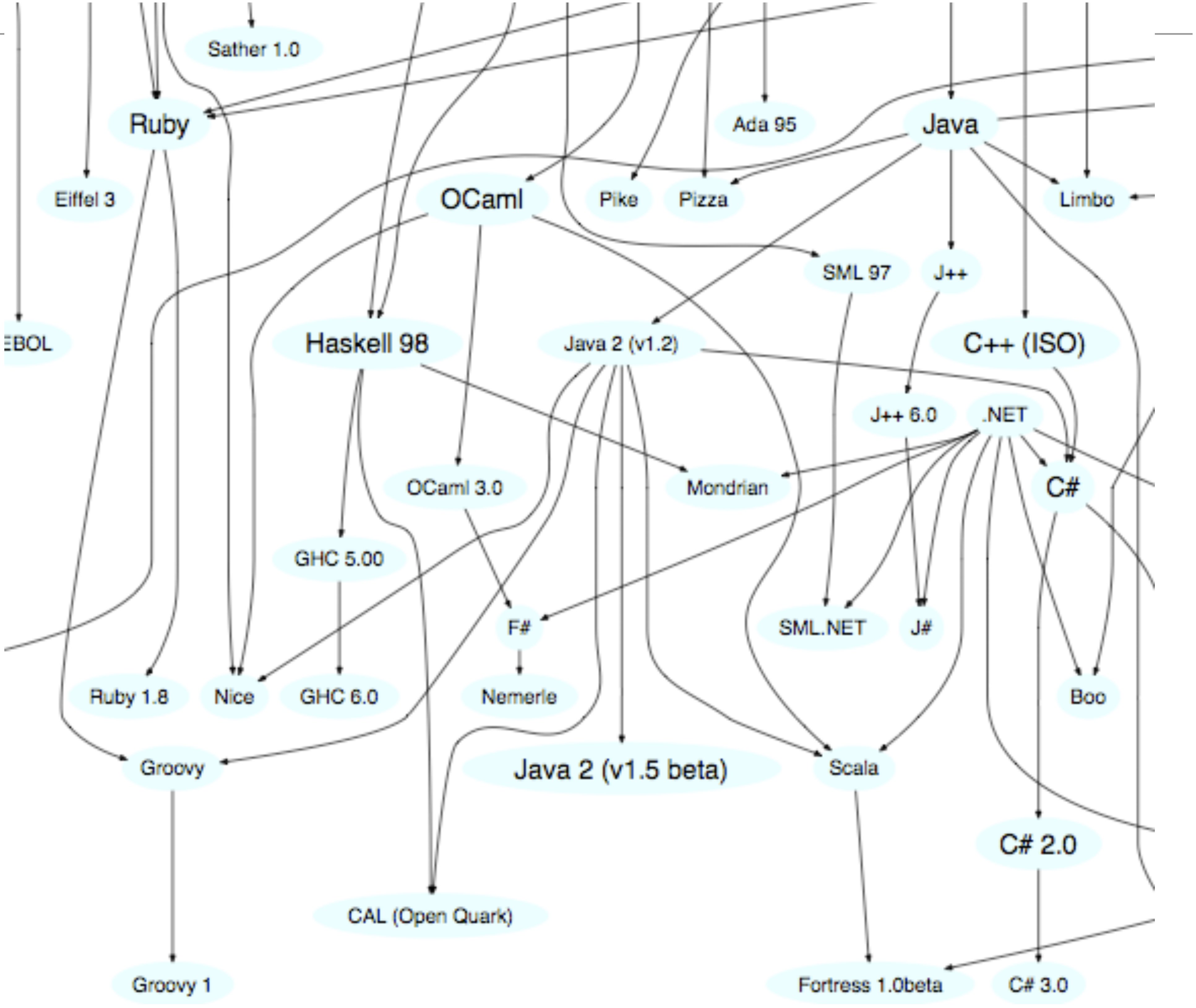
Family Tree (3)

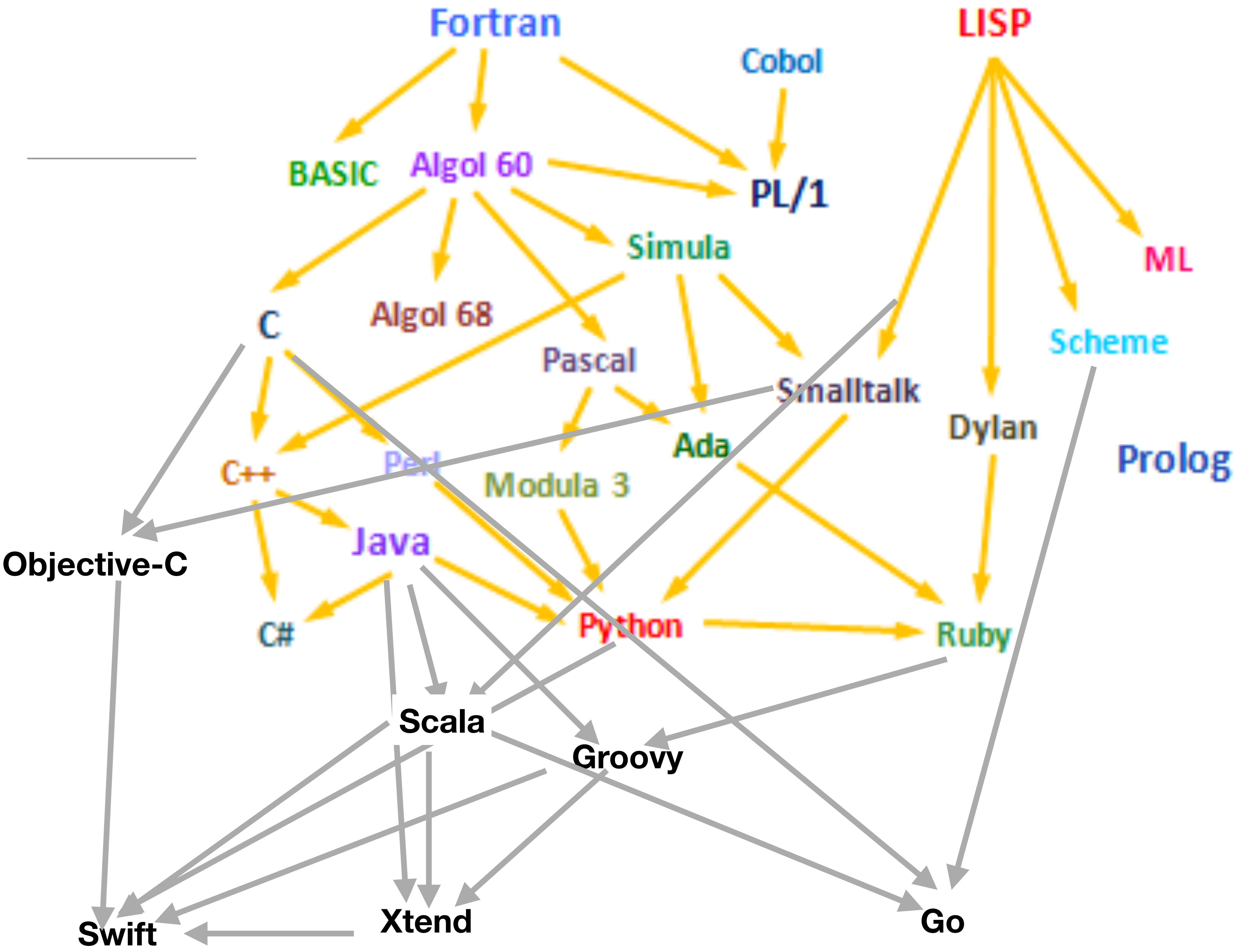


Smalltalk Cluster



Ruby, Groovy, Java, Scala Cluster




Fortran
LISP
Cobol
BASIC
Algol 60
PL/1
Simula
ML
C
Algol 68
Pascal
Smalltalk
Scheme
Dylan
Ada
Prolog
C++
Perl
Modula 3
Java
Objective-C
C#
Python
Ruby
Scala
Groovy
Swift
Xtend
Go

Paul Grahams Wish List for a Programming Language

http://www.paulgraham.com/diff.html

1. Conditionals
2. A function type
3. Recursion
4. Dynamic typing
5. Garbage collection
6. Programs composed of expressions
7. A symbol type
8. A notation for code using symbols and trees
9. The whole language there all the time

Lisp programming Language has all of these features (since mid 1960's)

Java?

1. Conditionals
2. A function type (Java 8 only)
3. Recursion
4. Dynamic typing
5. Garbage collection
6. Programs composed of expressions
7. A symbol type
8. A notation for code using symbols and trees
9. The whole language there all the time

Groovy/Ruby/Python/Scala/Xtend

(from Neal Ford)

1. Conditionals
2. A function type
3. Recursion
4. Dynamic typing (+ Type Inference)
5. Garbage collection
6. Programs composed of expressions
7. A symbol type
8. A notation for code using symbols and trees
9. The whole language there all the time

+ Metaprogramming

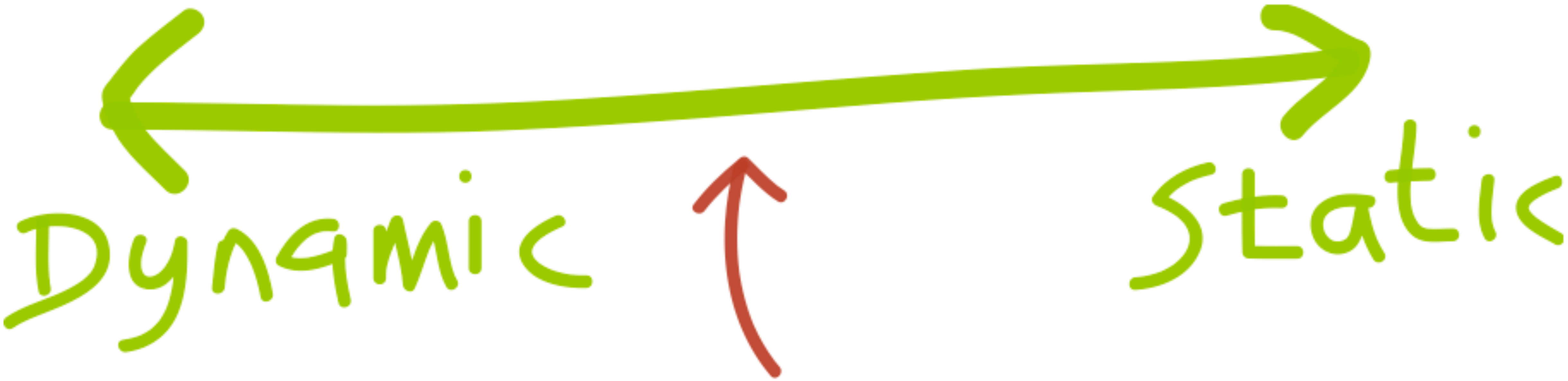
Groovy/Ruby/Python/Scala

(from Neal Ford)

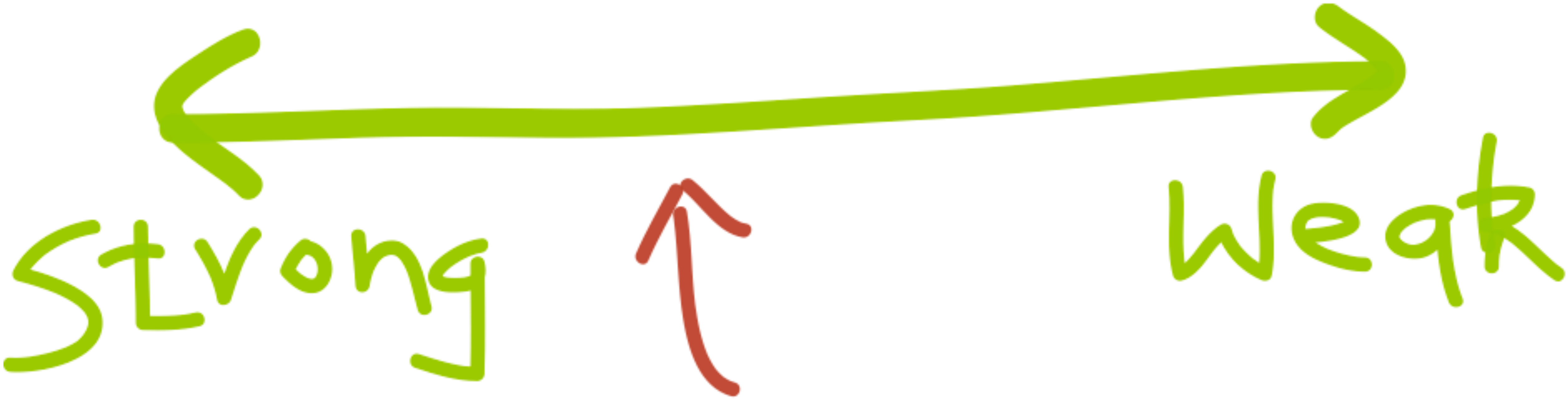
1. Conditionals
2. A function type
3. Recursion
4. Dynamic typing (+Type Inference)
5. Garbage collection
6. Programs composed of expressions
7. A symbol type
8. A notation for code using symbols and trees
9. The whole language there all the time

+ Metaprogramming

Typing



Amount of type checking enforced by the compiler vs. leaving it to the runtime



How the runtime constraints you from treating objects of different types (in other words treating memory as blobs or specific data types)

http://blogs.agilefaqs.com/2011/07/11/dynamic-typing-is-not-weak-typing/

Another Approach to Types?

- *Type Inference* : the compiler draws conclusions about the types of variables based on how programmers use those variables.

  - Yields programs that have some of the conciseness of Dynamically Typed Languages

  - But - decision made at *compile time*, not at *run time*

  - More information for static analysis - refactoring tools, complexity analysis. bug checking etc...

- Haskell, Scala, Swift, **Xtend**

```
object InferenceTest1 extends Application
{
  val x = 1 + 2 * 3         // the type of x is Int
  val y = x.toString()      // the type of y is String
  def succ(x: Int) = x + 1  // method succ returns Int va
}
```

‘Pragmatic’ Languages

- Python
- Smalltalk
- Ruby
- Groovy

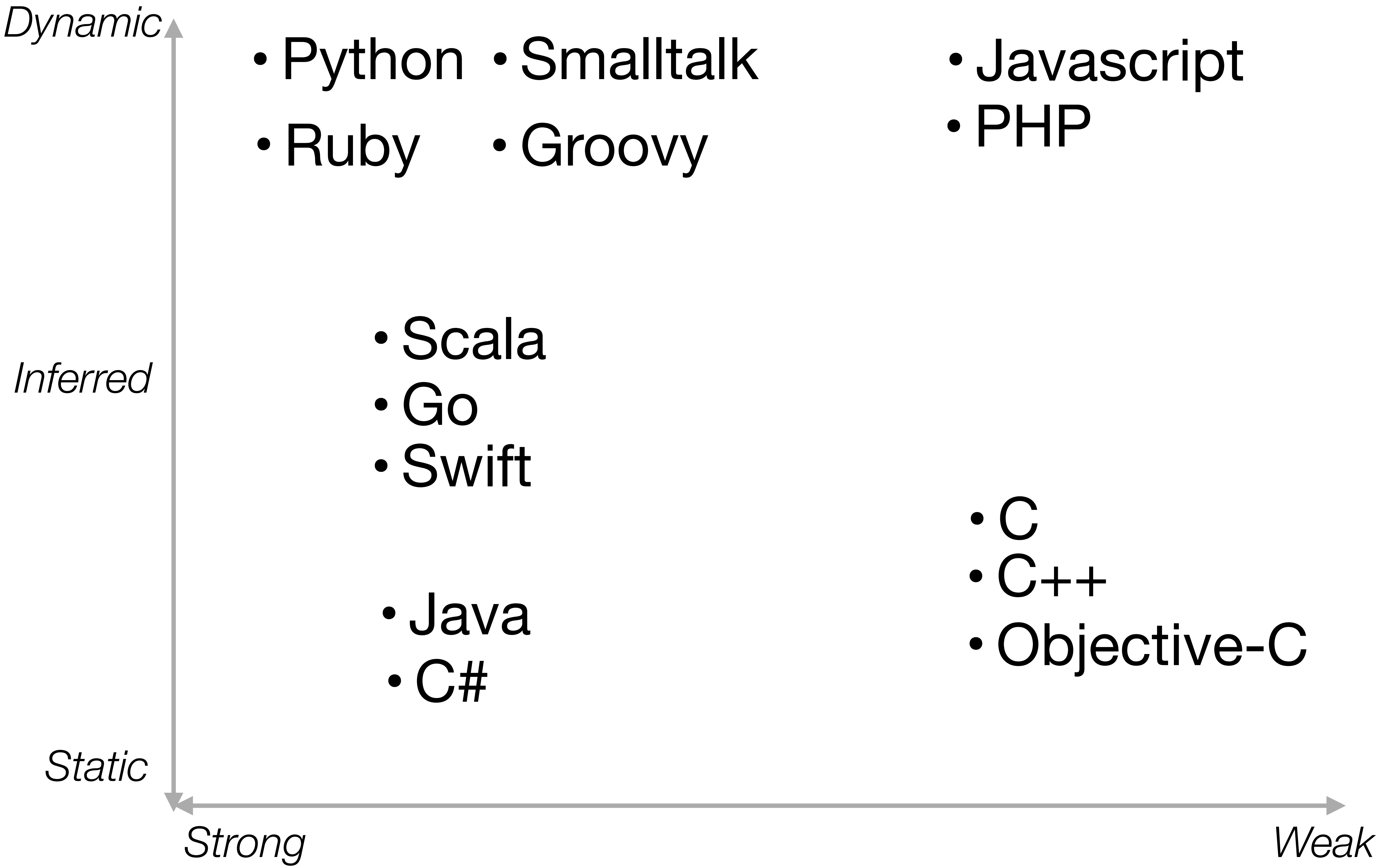
- Javascript
- PHP

- Scala
- Go
- Swift

- C
- C++
- Objective-C

- Java
- C#

Typing Spectrum



Dynamic

- Python
- Smalltalk
- Ruby
- Groovy

- Javascript
- PHP

Inferred

- Scala
- Go
- Swift

- C
- C++
- Objective-C

- Java
- C#

Static

Strong

Weak

Java Example

(from Jim Weirich)

- Java algorithm to filter a list of strings

- Only printing those shorter than 3 (in this test case).

```java
import java.util.ArrayList;
import java.util.List;

class Erase
{
  public static void main(String[] args)
  {
    List<String> names = new ArrayList<String>();
    names.add("Ted");
    names.add("Fred");
    names.add("Jed");
    names.add("Ned");
    System.out.println(names);
    Erase e = new Erase();
    List<String> short_names = e.filterLongerThan(names, 3);
    System.out.println(short_names.size());
    for (String s : short_names)
    {
      System.out.println(s);
    }
  }

  public List<String> filterLongerThan(List<String> strings, int length)
  {
    List<String> result = new ArrayList<String>();
    for (String s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s);
      }
    }
    return result;
  }
}
```

Groovy 1

- Also a valid Groovy program...

```
import java.util.ArrayList;
import java.util.List;

class Erase
{
  public static void main(String[] args)
  {
    List<String> names = new ArrayList<String>();
    names.add("Ted");
    names.add("Fred");
    names.add("Jed");
    names.add("Ned");
    System.out.println(names);
    Erase e = new Erase();
    List<String> short_names = e.filterLongerThan(names, 3);
    System.out.println(short_names.size());
    for (String s : short_names)
    {
      System.out.println(s);
    }
  }

  public List<String> filterLongerThan(List<String> strings, int length)
  {
    List<String> result = new ArrayList<String>();
    for (String s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s);
      }
    }
    return result;
  }
}
```

Groovy 1

- Do we need generics?
- What about semicolons...
- Should standard libraries be imported?

```java
import java.util.ArrayList;
import java.util.List;

class Erase
{
  public static void main(String[] args)
  {
    List<String> names = new ArrayList<String>();
    names.add("Ted");
    names.add("Fred");
    names.add("Jed");
    names.add("Ned");
    System.out.println(names);
    Erase e = new Erase();
    List<String> short_names = e.filterLongerThan(names, 3);
    System.out.println(short_names.size());
    for (String s : short_names)
    {
      System.out.println(s);
    }
  }

  public List<String> filterLongerThan(List<String> strings, int length)
  {
    List<String> result = new ArrayList<String>();
    for (String s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s);
      }
    }
    return result;
  }
}
```

Groovy 2

```
class Erase
{
  public static void main(String[] args)
  {
    List names = new ArrayList()
    names.add("Ted")
    names.add("Fred")
    names.add("Jed")
    names.add("Ned")
    System.out.println(names)
    Erase e = new Erase()
    List short_names = e.filterLongerThan(names, 3)
    System.out.println(short_names.size())
    for (String s : short_names)
    {
      System.out.println(s)
    }
  }

  public List filterLongerThan(Liststrings, length)
  {
    List result = new ArrayList();
    for (String s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s)
      }
    }
    return result
  }
}
```

Groovy 2

- Do we need the static types?

- Must we always have a main method and class definition?

- Consistency (size or length)?

```
class Erase
{
  public static void main(String[] args)
  {
    List names = new ArrayList()
    names.add("Ted")
    names.add("Fred")
    names.add("Jed")
    names.add("Ned")
    System.out.println(names)
    Erase e = new Erase()
    List short_names = e.filterLongerThan(names, 3)
    System.out.println(short_names.size())
    for (String s : short_names)
    {
      System.out.println(s)
    }
  }

  public List filterLongerThan(Liststrings, length)
  {
    List result = new ArrayList();
    for (String s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s)
      }
    }
    return result
  }
}
```

Groovy 3

```
def filterLongerThan(strings, length)
{
  List result = new ArrayList();
  for (String s : strings)
  {
    if (s.length() < length + 1)
    {
      result.add(s)
    }
  }
  return result
}

List names = new ArrayList()
names.add("Ted")
names.add("Fred")
names.add("Jed")
names.add("Ned")
System.out.println(names)
List short_names = filterLongerThan(names, 3)
System.out.println(short_names.size())
for (String s : short_names)
{
  System.out.println(s)
}
```

Groovy 3

- Should we have a special notation for lists?

- And special facilities for list processing?

```
def filterLongerThan(strings, length)
{
  List result = new ArrayList();
  for (String s : strings)
  {
    if (s.length() < length + 1)
    {
      result.add(s)
    }
  }
  return result
}

List names = new ArrayList()
names.add("Ted")
names.add("Fred")
names.add("Jed")
names.add("Ned")
System.out.println(names)
List short_names = filterLongerThan(names, 3)
System.out.println(short_names.size())
for (String s : short_names)
{
  System.out.println(s)
}
```

Groovy 4

```
def filterLongerThan(strings, length)
{
  return strings.findAll {it.size() <= length}
}

names = ["Ted", "Fred", "Jed", "Ned"]
System.out.println(names)
List short_names = filterLongerThan(names, 3)
System.out.println(short_names.size())
short_names.each {System.out.println(it)}
```

Groovy 4

- Method needed any longer?
- Is there an easier way to use common methods (e.g. println)?
- Are brackets always needed?

```
def filterLongerThan(strings, length)
{
  return strings.findAll {it.size() <= length}
}

names = ["Ted", "Fred", "Jed", "Ned"]
System.out.println(names)
List short_names = filterLongerThan(names, 3)
System.out.println(short_names.size())
short_names.each {System.out.println(it)}
```

Groovy 5

```
names = ["Ted", "Fred", "Jed", "Ned"]
println names
short_names = names.findAll{it.size() <= 3}
println short_names.size()
short_names.each {println it}
```

Java vs Groovy?

```java
import java.util.ArrayList;
import java.util.List;

class Erase
{
  public static void main(String[] args)
  {
    List<String> names = new ArrayList<String>();
    names.add("Ted");
    names.add("Fred");
    names.add("Jed");
    names.add("Ned");
    System.out.println(names);
    Erase e = new Erase();
    List<String> short_names = e.filterLongerThan(names, 3);
    System.out.println(short_names.size());
    for (String s : short_names)
    {
      System.out.println(s);
    }
  }

  public List<String> filterLongerThan(List<String> strings, int length)
  {
    List<String> result = new ArrayList<String>();
    for (String s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s);
      }
    }
    return result;
  }
}
```

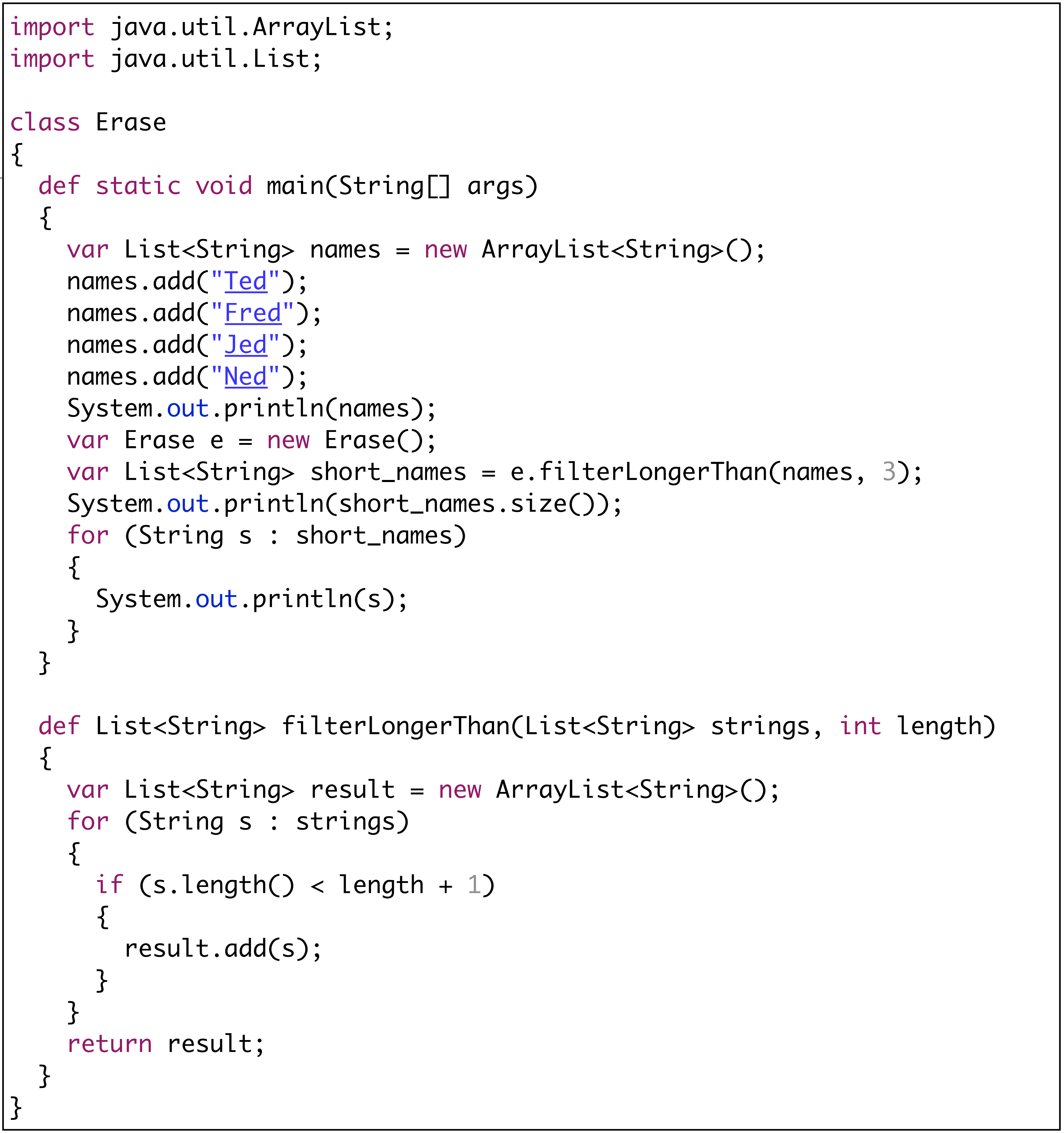
```groovy
names = ["Ted", "Fred", "Jed", "Ned"]
println names
short_names = names.findAll{it.size() <= 3}
println short_names.size()
short_names.each {println it}
```

Java Example -> **XTend**

- Unlike Groovy - this is NOT an XTend Program

```java
import java.util.ArrayList;
import java.util.List;

class Erase
{
  public static void main(String[] args)
  {
    List<String> names = new ArrayList<String>();
    names.add("Ted");
    names.add("Fred");
    names.add("Jed");
    names.add("Ned");
    System.out.println(names);
    Erase e = new Erase();
    List<String> short_names = e.filterLongerThan(names, 3);
    System.out.println(short_names.size());
    for (String s : short_names)
    {
      System.out.println(s);
    }
  }

  public List<String> filterLongerThan(List<String> strings, int length)
  {
    List<String> result = new ArrayList<String>();
    for (String s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s);
      }
    }
    return result;
  }
}
```

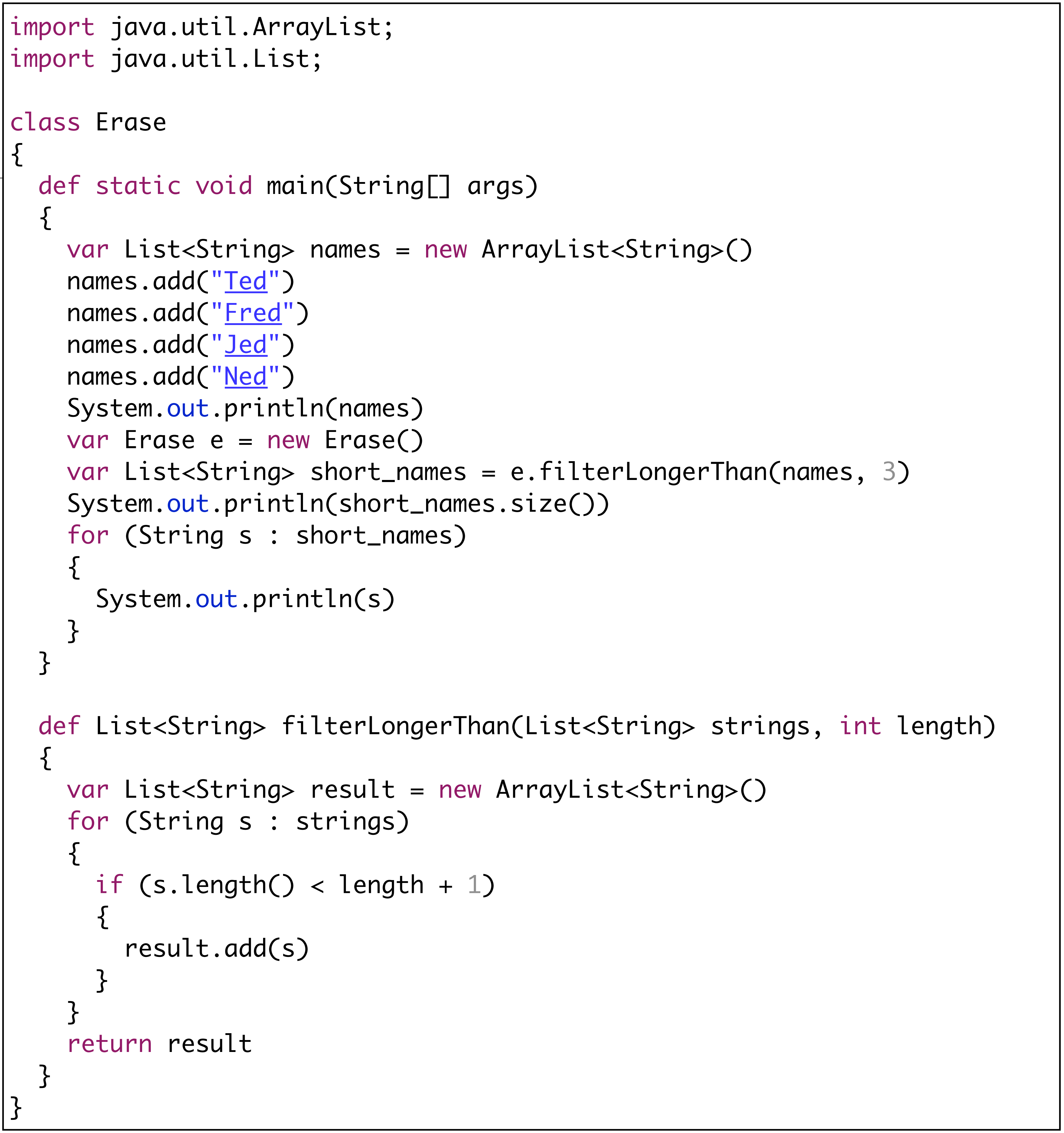
def & var



```
import java.util.ArrayList;
import java.util.List;

class Erase
{
  def static void main(String[] args)
  {
    var List<String> names = new ArrayList<String>();
    names.add("Ted");
    names.add("Fred");
    names.add("Jed");
    names.add("Ned");
    System.out.println(names);
    var Erase e = new Erase();
    var List<String> short_names = e.filterLongerThan(names, 3);
    System.out.println(short_names.size());
    for (String s : short_names)
    {
      System.out.println(s);
    }
  }

  def List<String> filterLongerThan(List<String> strings, int length)
  {
    var List<String> result = new ArrayList<String>();
    for (String s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s);
      }
    }
    return result;
  }
}
```

Are semicolons necessary?

No semicolons



```
import java.util.ArrayList;
import java.util.List;

class Erase
{
  def static void main(String[] args)
  {
    var List<String> names = new ArrayList<String>()
    names.add("Ted")
    names.add("Fred")
    names.add("Jed")
    names.add("Ned")
    System.out.println(names)
    var Erase e = new Erase()
    var List<String> short_names = e.filterLongerThan(names, 3)
    System.out.println(short_names.size())
    for (String s : short_names)
    {
      System.out.println(s)
    }
  }

  def List<String> filterLongerThan(List<String> strings, int length)
  {
    var List<String> result = new ArrayList<String>()
    for (String s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s)
      }
    }
    return result
  }
}
```

Can some types be inferred?

Type inference

```
import java.util.ArrayList;
import java.util.List;

class Erase
{
  def static void main(String[] args)
  {
    var names = new ArrayList<String>()
    names.add("Ted")
    names.add("Fred")
    names.add("Jed")
    names.add("Ned")
    System.out.println(names)
    var e = new Erase()
    var  short_names = e.filterLongerThan(names, 3)
    System.out.println(short_names.size())
    for (s : short_names)
    {
      System.out.println(s)
    }
  }

  def filterLongerThan(List<String> strings, int length)
  {
    var result = new ArrayList<String>()
    for (s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s)
      }
    }
    return result
  }
}
```

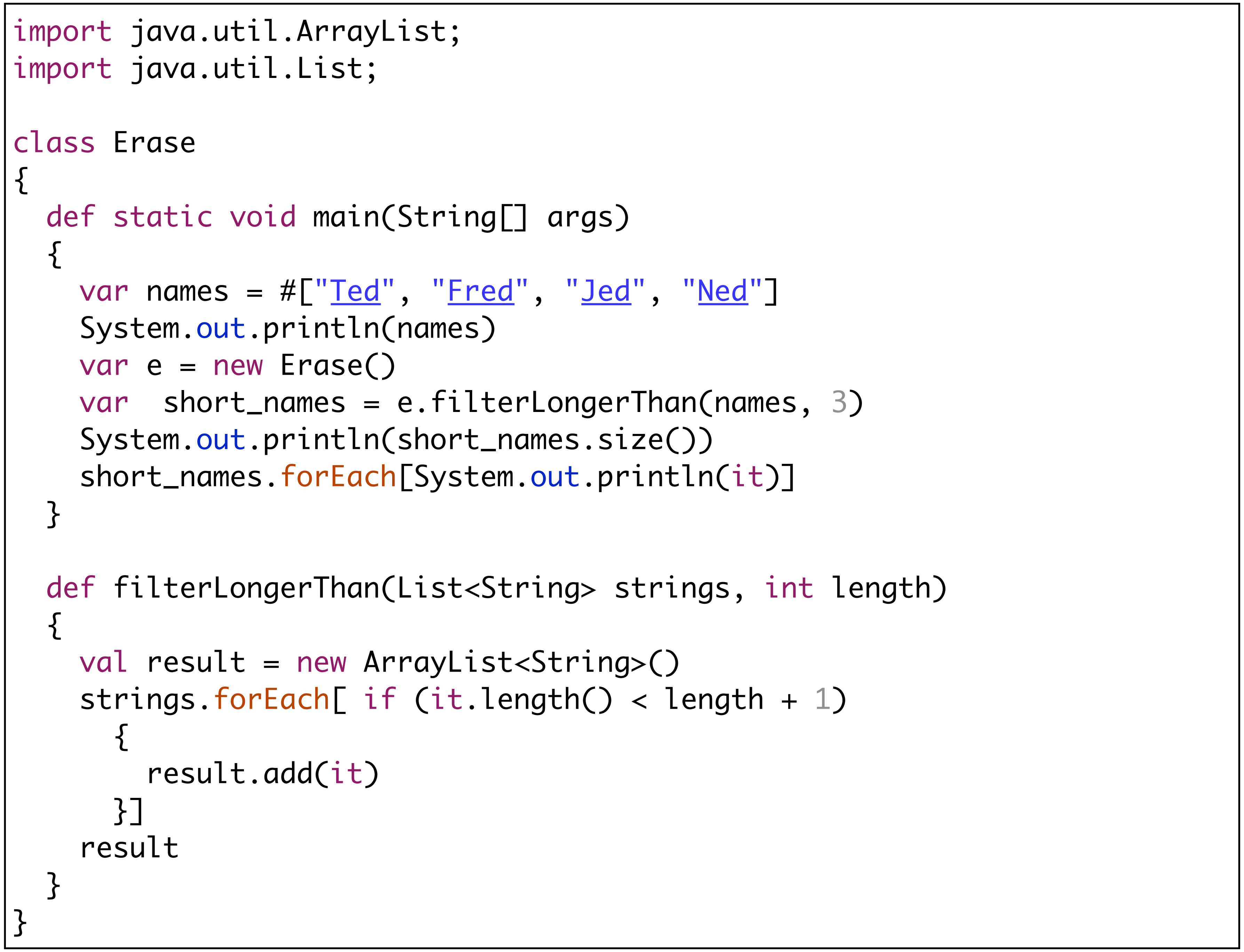
What about Collection Literals?

Collection Literals

```
import java.util.ArrayList;
import java.util.List;

class Erase
{
  def static void main(String[] args)
  {
    var names = #["Ted", "Fred", "Jed", "Ned"]
    System.out.println(names)
    var e = new Erase()
    var  short_names = e.filterLongerThan(names, 3)
    System.out.println(short_names.size())
    for (s : short_names)
    {
      System.out.println(s)
    }
  }

  def filterLongerThan(List<String> strings, int length)
  {
    var result = new ArrayList<String>()
    for (s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s)
      }
    }
    return result
  }
}
```

Can Lambas simplify code?

Lambdas



```
import java.util.ArrayList;
import java.util.List;

class Erase
{
  def static void main(String[] args)
  {
    var names = #["Ted", "Fred", "Jed", "Ned"]
    System.out.println(names)
    var e = new Erase()
    var  short_names = e.filterLongerThan(names, 3)
    System.out.println(short_names.size())
    short_names.forEach[System.out.println(it)]
  }

  def filterLongerThan(List<String> strings, int length)
  {
    val result = new ArrayList<String>()
    strings.forEach[ if (it.length() < length + 1)
      {
        result.add(it)
      }]
    result
  }
}
```

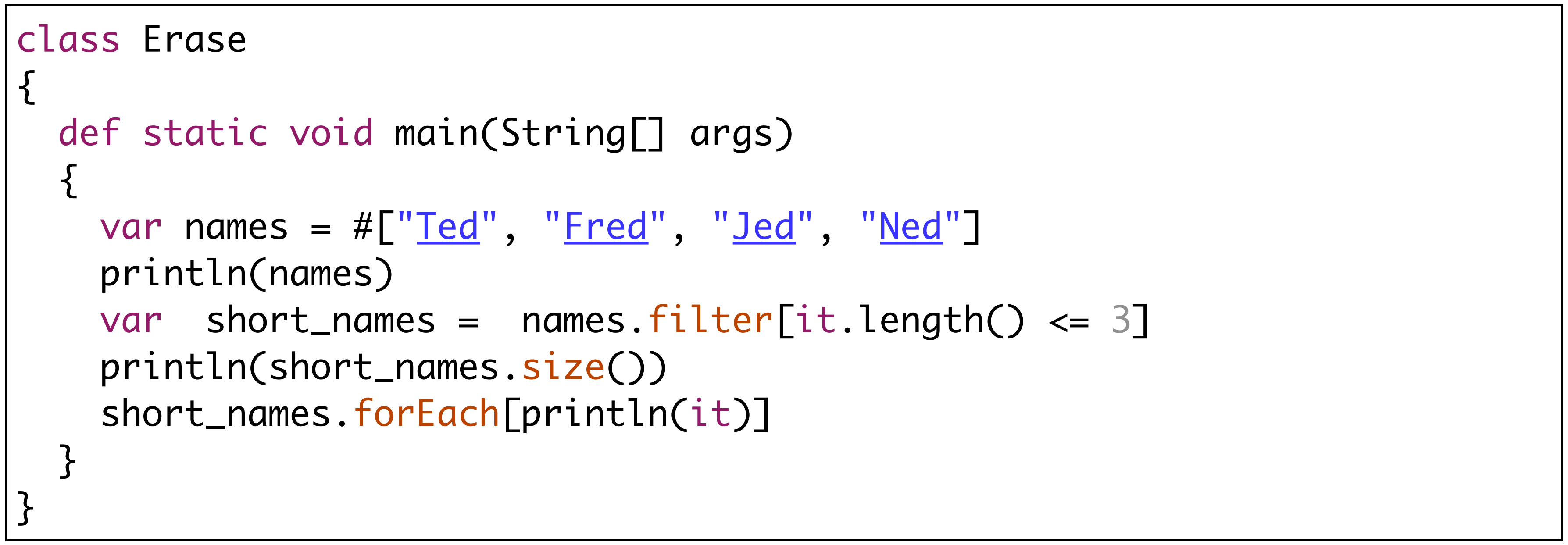
What are List Comprehensions?

Filters/List Comprehensions

```
import java.util.List;

class Erase
{
  def static void main(String[] args)
  {
    var names = #["Ted", "Fred", "Jed", "Ned"]
    System.out.println(names)
    var e = new Erase()
    var  short_names = e.filterLongerThan(names, 3)

    System.out.println(short_names.size())
    short_names.forEach[System.out.println(it)]
  }

  def filterLongerThan(List<String> strings, int length)
  {
    val list = strings.filter[it.length() <= 3]
    list
  }
}
```

Do we need the class Erase at all?

Final Version



```
class Erase
{
  def static void main(String[] args)
  {
    var names = #["Ted", "Fred", "Jed", "Ned"]
    println(names)
    var  short_names =  names.filter[it.length() <= 3]
    println(short_names.size())
    short_names.forEach[println(it)]
  }
}
```

```java
import java.util.ArrayList;
import java.util.List;

class Erase
{
  public static void main(String[] args)
  {
    List<String> names = new ArrayList<String>();
    names.add("Ted");
    names.add("Fred");
    names.add("Jed");
    names.add("Ned");
    System.out.println(names);
    Erase e = new Erase();
    List<String> short_names = e.filterLongerThan(names, 3);
    System.out.println(short_names.size());
    for (String s : short_names)
    {
      System.out.println(s);
    }
  }

  public List<String> filterLongerThan(List<String> strings, int length)
  {
    List<String> result = new ArrayList<String>();
    for (String s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s);
      }
    }
    return result;
  }
}
```

java

```
class Erase
{
  def static void main(String[] args)
  {
    var names = #["Ted", "Fred", "Jed", "Ned"]
    println(names)
    var  short_names =  names.filter[it.length() <= 3]
    println(short_names.size())
    short_names.forEach[println(it)]
  }
}
```

xtend

```groovy
names = ["Ted", "Fred", "Jed", "Ned"]
println names
short_names = names.findAll{it.size() <= 3}
println short_names.size()
short_names.each {println it}
```

groovy

Java Example (again)

```java
import java.util.ArrayList;
import java.util.List;

class Erase
{
  public static void main(String[] args)
  {
    List<String> names = new ArrayList<String>();
    names.add("Ted");
    names.add("Fred");
    names.add("Jed");
    names.add("Ned");
    System.out.println(names);
    Erase e = new Erase();
    List<String> short_names = e.filterLongerThan(names, 3);
    System.out.println(short_names.size());
    for (String s : short_names)
    {
      System.out.println(s);
    }
  }

  public List<String> filterLongerThan(List<String> strings, int length)
  {
    List<String> result = new ArrayList<String>();
    for (String s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s);
      }
    }
    return result;
  }
}
```

Swift

```
import Foundation

class Erase
{
  func main()
  {
    var names:String[] = String[]()
    names.append ("ted")
    names.append ("fred")
    names.append ("jed")
    names.append ("ned")
    println(names)
    var short_names:String[] = filterLongerThan(names, length:3)
    for name:String in short_names
    {
      println (name)
    }
  }

  func filterLongerThan (strings : String[], length : Int) -> String[]
  {
    var result:String[] = String[]()
    for s:String in strings
    {
      if countElements(s) < length + 1
      {
        result.append(s)
      }
    }
    return result
  }
}

var erase:Erase = Erase()
erase.main()
```

Swift

- Type Inference

```
import Foundation

class Erase
{
  func main()
  {
    var names = String[]()
    names.append ("ted")
    names.append ("fred")
    names.append ("jed")
    names.append ("ned")
    println(names)
    var short_names = filterLongerThan(names, length:3)
    for name in short_names
    {
      println (name)
    }
  }

  func filterLongerThan (strings : String[], length : Int) -> String[]
  {
    var result = String[]()
    for s in strings
    {
      if countElements(s) < length + 1
      {
        result.append(s)
      }
    }
    return result
  }
}

var erase = Erase()
erase.main()
```

Swift

- Literals

```
import Foundation

class Erase
{
  func main()
  {
    var names = ["ted", "fred", "jed", "ned"]
    var short_names = filterLongerThan(names, length:3)
    for name in short_names
    {
      println (name)
    }
  }

  func filterLongerThan (strings : String[], length : Int) -> String[]
  {
    var result = String[]()
    for s in strings
    {
      if countElements(s) < length + 1
      {
        result.append(s)
      }
    }
    return result
  }
}

var erase = Erase()
erase.main()
```

Swift

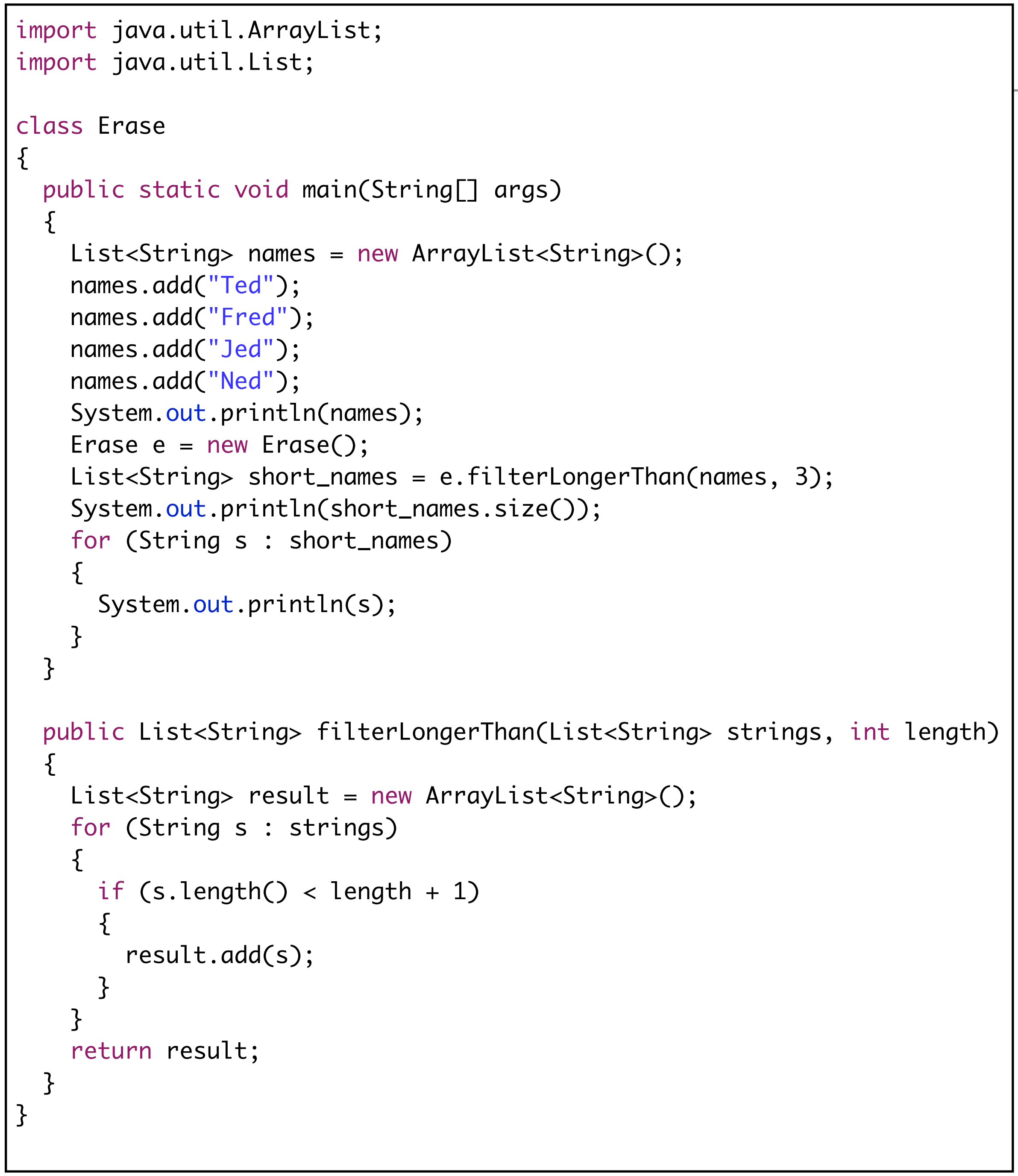
- Closures

```
import Foundation

class Erase
{
  func main()
  {
    var names = ["ted", "fred", "jed", "ned"]
    var short_names = names.filter { countElements($0) < 4 }
    for name in short_names
    {
      println (name)
    }
  }
}

var erase = Erase()
erase.main()
```

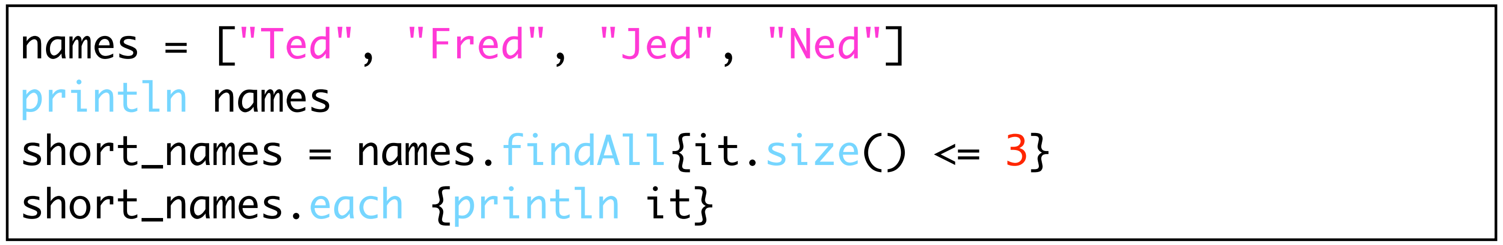
Swift

- Final version

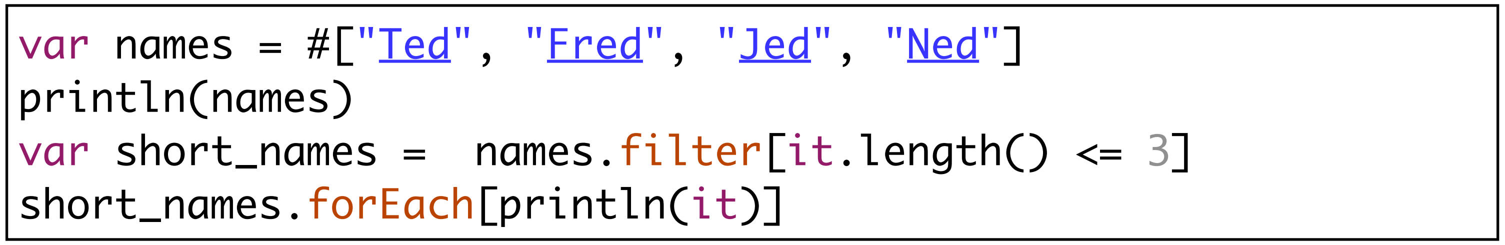
```
import Foundation

var names = ["ted", "fred", "jed", "ned"]
println(names)
var short_names = names.filter { countElements($0) < 4 }
println(short_names)
```



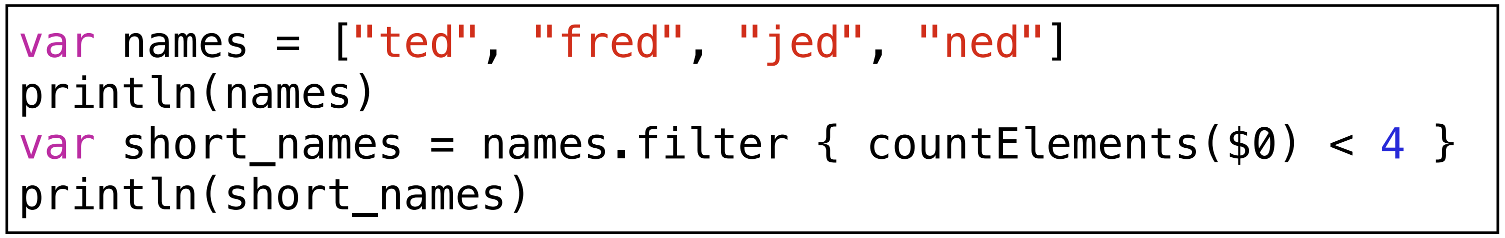
```java
import java.util.ArrayList;
import java.util.List;

class Erase
{
  public static void main(String[] args)
  {
    List<String> names = new ArrayList<String>();
    names.add("Ted");
    names.add("Fred");
    names.add("Jed");
    names.add("Ned");
    System.out.println(names);
    Erase e = new Erase();
    List<String> short_names = e.filterLongerThan(names, 3);
    System.out.println(short_names.size());
    for (String s : short_names)
    {
      System.out.println(s);
    }
  }

  public List<String> filterLongerThan(List<String> strings, int length)
  {
    List<String> result = new ArrayList<String>();
    for (String s : strings)
    {
      if (s.length() < length + 1)
      {
        result.add(s);
      }
    }
    return result;
  }
}
```



```groovy
names = ["Ted", "Fred", "Jed", "Ned"]
println names
short_names = names.findAll{it.size() <= 3}
short_names.each {println it}
```



```xtend
var names = #["Ted", "Fred", "Jed", "Ned"]
println(names)
var short_names =  names.filter[it.length() <= 3]
short_names.forEach[println(it)]
```



```swift
var names = ["ted", "fred", "jed", "ned"]
println(names)
var short_names = names.filter { countElements($0) < 4 }
println(short_names)
```

Another ‘Shopping List’

Object-literal syntax for arrays and hashes
Array slicing and other intelligent collection operators
Perl 5 compatible regular expression literals
Destructuring bind (e.g. x, y = returnTwoValues())
Function literals and first-class, non-broken closures
Standard OOP with classes, instances, interfaces, polymorphism, etc.
Visibility quantifiers (public/private/protected)
Iterators and generators
List comprehensions
Namespaces and packages
Cross-platform GUI
Operator overloading
Keyword and rest parameters
First-class parser and AST support
Type expressions and statically checkable semantics
Solid string and collection libraries
Strings and streams act like collections

http://steve-yegge.blogspot.com.au/2007/02/next-big-language.html

Java

Object-literal syntax for arrays and hashes	
Array slicing and other intelligent collection operators	
Perl 5 compatible regular expression literals	
Destructuring bind (e.g. x, y = returnTwoValues())	
Function literals and first-class, non-broken closures	
Standard OOP with classes, instances, interfaces, polymorphism,	y
Visibility quantifiers (public/private/protected)	y
Iterators and generators	y
List comprehensions	
Namespaces and packages	y
Cross-platform GUI	y
Operator overloading	
Keyword and rest parameters	
First-class parser and AST support	
Type expressions and statically checkable semantics	y
Solid string and collection libraries	y
Strings and streams act like collections	y

Google GO

Object-literal syntax for arrays and hashes	y
Array slicing and other intelligent collection operators	y
Perl 5 compatible regular expression literals	
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Function literals and first-class, non-broken closures	y
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Python

Object-literal syntax for arrays and hashes	y
Array slicing and other intelligent collection operators	y
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Xtend

Object-literal syntax for arrays and hashes	y
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List comprehensions	y
Namespaces and packages	y
Cross-platform GUI	y
Operator overloading	y
Keyword and rest parameters	Active Annotations ?
First-class parser and AST support	
Type expressions and statically checkable semantics	y
Solid string and collection libraries	y
Strings and streams act like collections	y

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