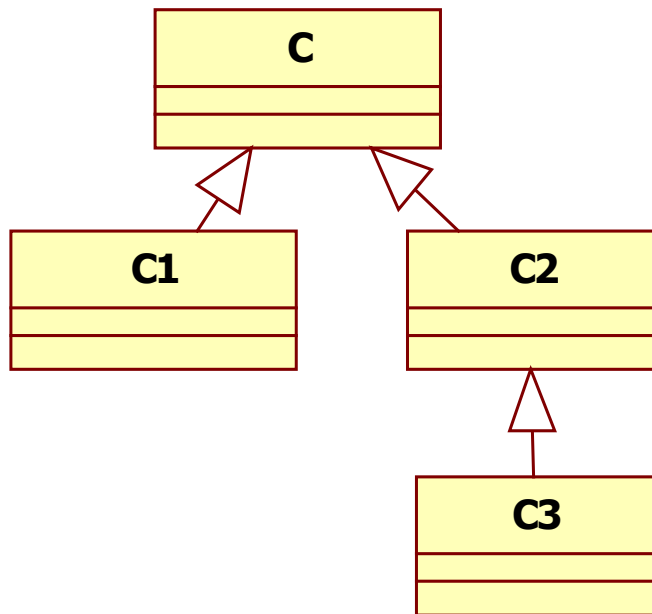


NFP121 an 7

cours n°7 --- Réflexivité

Avant compilation: des classes !



Des classes et des relations
entre classes sont définies
par édition de texte

Ce texte sera compilé

Après compilation: des objets !

v0 : C

Au 'runtime'

Il n'existe que des objets de ces classes

v : C1

C0 v0 = new C1();

C1 v;

Dont un objet spécifique pour chaque classe chargée !

v0 : C

C.class

v : C1

C1.class

C2.class

C3.class

Object.class

Parmi les objets figure un objet-Class
pour chaque classe chargée.

Cela vaut pour

String.class par exemple

ou

Object.class

Cet objet est de classe Class

| Class |
|---|
| <ul style="list-style-type: none">+toString(): String+forName(className: String): Class+newInstance(): Object+isInstance(obj: Object): boolean+isInterface(): boolean+isArray(): boolean+isPrimitive(): boolean+getName(): String+getClassLoader(): ClassLoader+getSuperclass(): Class+getPackage(): Package+getInterfaces(): Class+getComponentType(): Class+getModifiers(): int+getSigners(): Object+getDeclaringClass(): Class+getClasses(): Class+getFields(): Field+getMethods(): Method+getConstructors(): Constructor+getField(name: String): Field+getMethod(name: String, parameterTypes: Class): Method+getConstructor(parameterTypes: Class): Constructor+getDeclaredClasses(): Class+getDeclaredFields(): Field+getDeclaredMethods(): Method |

Il est construit
au chargement d'une classe
dans la JVM

Une méthode de classe pour charger de nouvelles classes

| Class |
|--|
| <pre>+toString(): String +forName(className: String): Class +newInstance(): Object +isInstance(obj: Object): boolean +isInterface(): boolean +isArray(): boolean +isPrimitive(): boolean +getName(): String +getClassLoader(): ClassLoader +getSuperclass(): Class +getPackage(): Package +getInterfaces(): Class +getComponentType(): Class +getModifiers(): int +getSigners(): Object +getDeclaringClass(): Class +getClasses(): Class +getFields(): Field +getMethods(): Method +getConstructors(): Constructor +getField(name: String): Field +getMethod(name: String, parameterTypes: Class): Method +getConstructor(parameterTypes: Class): Constructor +getDeclaredClasses(): Class +getDeclaredFields(): Field +getDeclaredMethods(): Method</pre> |

public static [Class](#)
forName([String](#) className)
throws [ClassNotFoundException](#)

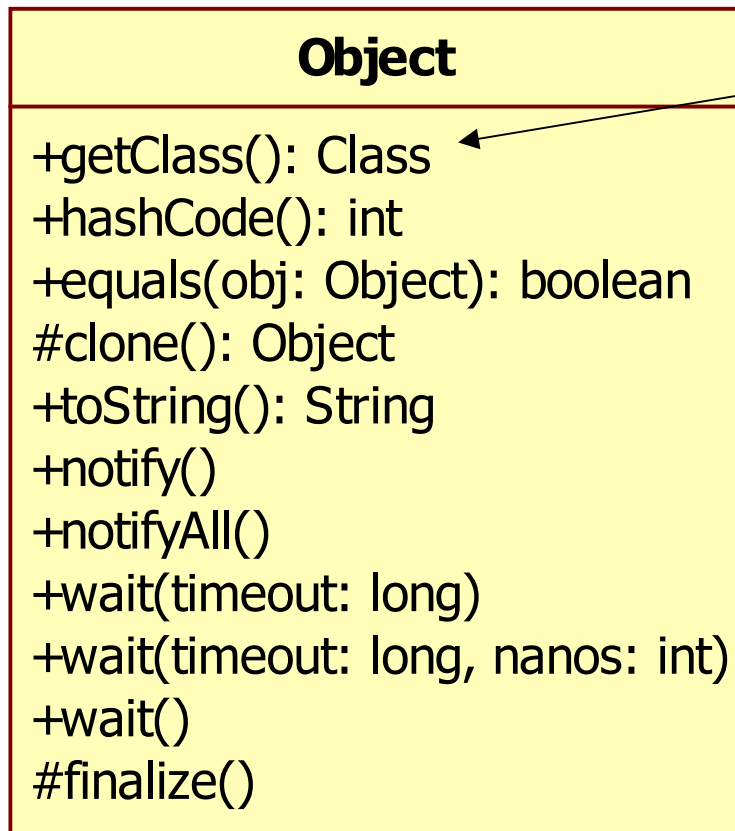
Retourne l'objet-Class associé au
type dont le nom est fourni.
(nom qualifié)

Exemple

Class t =

```
Class.forName("java.lang.Thread")
```

Tout objet peut être interrogé sur sa classe



A l'exécution il est possible de demander à tout objet quelle est sa classe

Exemple

```
v.getClass()==C1.class
```

```
String.class.getClass() == Class.class
```

Informations sur le type à l'exécution

- instanceof

```
if (g instanceof Graphics2D)
{
}
}
```

- instanceof

```
if ((Graphics2D.class).isInstance(instanceObject))
{
}
}
```

- getClass

```
if (g.getClass() == Graphics2D.class)
{
}
}
```


L'objet de classe Class lui-même peut-être interrogé

| Class |
|--|
| <pre>+toString(): String +forName(className: String): Class +newInstance(): Object +isInstance(obj: Object): boolean +isInterface(): boolean +isArray(): boolean +isPrimitive(): boolean +getName(): String +getClassLoader(): ClassLoader +getSuperclass(): Class +getPackage(): Package +getInterfaces(): Class +getComponentType(): Class +getModifiers(): int +getSigners(): Object +getDeclaringClass(): Class +getClasses(): Class +getFields(): Field +getMethods(): Method +getConstructors(): Constructor +getField(name: String): Field +getMethod(name: String, parameterTypes: Class): Method +getConstructor(parameterTypes: Class): Constructor +getDeclaredClasses(): Class +getDeclaredFields(): Field +getDeclaredMethods(): Method</pre> |

boolean isInstance(Object obj)

Cette méthode permet de savoir si obj est d'une sous-classe de la classe dont l'objet-Class est ici interrogé.

Exemple

```
v0.getClass().isInstance(v)
```

Il peut aussi servir à créer dynamiquement un nouvel objet

| Class |
|--|
| <pre>+toString(): String +forName(className: String): Class +newInstance(): Object +isInstance(obj: Object): boolean +isInterface(): boolean +isArray(): boolean +isPrimitive(): boolean +getName(): String +getClassLoader(): ClassLoader +getSuperclass(): Class +getPackage(): Package +getInterfaces(): Class +getComponentType(): Class +getModifiers(): int +getSigners(): Object +getDeclaringClass(): Class +getClasses(): Class +getFields(): Field +getMethods(): Method +getConstructors(): Constructor +getField(name: String): Field +getMethod(name: String, parameterTypes: Class): Method +getConstructor(parameterTypes: Class): Constructor +getDeclaredClasses(): Class +getDeclaredFields(): Field +getDeclaredMethods(): Method</pre> |

public [Object](#) newInstance()
throws [InstantiationException](#),
[IllegalAccessException](#)

Simuler l'opérateur instanceof

```
class A {}

public class instance1 {

    public static void main(String args[]) {
        try {
            Class cls = Class.forName("A");
            boolean b1 = cls.isInstance(new Integer(37));
            System.out.println(b1);
            boolean b2 = cls.isInstance(new A());
            System.out.println(b2);
        } catch (Throwable e) {
            System.err.println(e);
        }
    }
}
```

Récupérer les super classes

| Class |
|--|
| <pre>+toString(): String +forName(className: String): Class +newInstance(): Object +isInstance(obj: Object): boolean +isInterface(): boolean +isArray(): boolean +isPrimitive(): boolean +getName(): String +getClassLoader(): ClassLoader +getSuperclass(): Class +getPackage(): Package +getInterfaces(): Class +getComponentType(): Class +getModifiers(): int +getSigners(): Object +getDeclaringClass(): Class +getClasses(): Class +getFields(): Field +getMethods(): Method +getConstructors(): Constructor +getField(name: String): Field +getMethod(name: String, parameterTypes: Class): Method +getConstructor(parameterTypes: Class): Constructor +getDeclaredClasses(): Class +getDeclaredFields(): Field +getDeclaredMethods(): Method</pre> |

Class getSuperclass()

retourne l'objet class
représentant la super classe (class,
interface, primitive type or void)

```
TextField t = new TextField();
Class c = t.getClass(); // TextField
Class s = c.getSuperclass(); //TextComponent
```

Récupérer les interfaces implémentés

| Class |
|--|
| <pre>+toString(): String +forName(className: String): Class +newInstance(): Object +isInstance(obj: Object): boolean +isInterface(): boolean +isArray(): boolean +isPrimitive(): boolean +getName(): String +getClassLoader(): ClassLoader +getSuperclass(): Class +getPackage(): Package +getInterfaces(): Class +getComponentType(): Class +getModifiers(): int +getSigners(): Object +getDeclaringClass(): Class +getClasses(): Class +getFields(): Field +getMethods(): Method +getConstructors(): Constructor +getField(name: String): Field +getMethod(name: String, parameterTypes: Class): Method +getConstructor(parameterTypes: Class): Constructor +getDeclaredClasses(): Class +getDeclaredFields(): Field +getDeclaredMethods(): Method</pre> |

Class[] getInterfaces()

Determines the interfaces implemented by the class or interface represented by this object.

`s.getClass().getInterfaces()[0]`

Afficher les interfaces implémentées par un objet

```
static void printInterfaceNames(Object o) {  
    Class c = o.getClass();  
    Class[] theInterfaces = c.getInterfaces();  
    for (int i = 0; i < theInterfaces.length; i++) {  
        String interfaceName = theInterfaces[i].getName();  
        System.out.println(interfaceName);  
    }  
}
```

pourquoi introduire plus de capacités introspectives ?

- Une industrie du composant logiciel
- Des ateliers d'intégrations de composants
- Des outils de 'customisation' d'applications

Qu'est-ce que la réflexivité ?

C'est ce qui permet à un objet d'obtenir des informations sur sa propre structure et sur le traitement qu'il subit

Lorsqu'un langage supporte la réflexivité des méta données sont générées à la compilation et mises à jour à l'exécution.

C'est un outil puissant permettant d'assembler du code à l'exécution sans que soit nécessaire la disposition du code source.

java.lang.reflect.*

- java.lang: Class and Object
- java.lang.reflect: Constructor, Field, Method, Array
 - Constructeurs, Attributs, et Methodes
 - Array contient un ensemble de méthodes statiques pour la création

Les méthodes d'une classe

| Class |
|---|
| +toString(): String |
| +forName(className: String): Class |
| +newInstance(): Object |
| +isInstance(obj: Object): boolean |
| +isInterface(): boolean |
| +isArray(): boolean |
| +isPrimitive(): boolean |
| +getName(): String |
| +getClassLoader(): ClassLoader |
| +getSuperclass(): Class |
| +getPackage(): Package |
| +getInterfaces(): Class |
| +getComponentType(): Class |
| +getModifiers(): int |
| +getSigners(): Object |
| +getDeclaringClass(): Class |
| +getClasses(): Class |
| +getFields(): Field |
| +getMethods(): Method |
| +getConstructors(): Constructor |
| +getField(name: String): Field |
| +getMethod(name: String, parameterTypes: Class): Method |
| +getConstructor(parameterTypes: Class): Constructor |
| +getDeclaredClasses(): Class |
| +getDeclaredFields(): Field |
| +getDeclaredMethods(): Method |

Method[] [getMethods\(\)](#)

Returns an array containing Method objects reflecting all the public *member* methods of the class or interface represented by this Class object, including those declared by the class or interface and those inherited from superclasses and superinterfaces.

Method[] [getDeclaredMethods\(\)](#)

Returns an array of Method objects reflecting all the methods declared by the class or interface represented by this Class object.

java.lang.reflect.Method

Method

+getDeclaringClass(): Class
+getName(): String
+getModifiers(): int
+getReturnType(): Class
+getParameterTypes(): Class
+getExceptionTypes(): Class
+equals(obj: Object): boolean
+hashCode(): int
+toString(): String
+invoke(obj: Object, args: Object): Object

Appeler une méthode

| Method |
|--|
| +getDeclaringClass(): Class |
| +getName(): String |
| +getModifiers(): int |
| +getReturnType(): Class |
| +getParameterTypes(): Class |
| +getExceptionTypes(): Class |
| +equals(obj: Object): boolean |
| +hashCode(): int |
| +toString(): String |
| +invoke(obj: Object, args: Object): Object |

Object invoke(Object obj, Object[]) args)

appelle cette méthode sur obj avec les paramètres args

Récupérer les paramètres

| Method |
|--|
| +getDeclaringClass(): Class |
| +getName(): String |
| +getModifiers(): int |
| +getReturnType(): Class |
| +getParameterTypes(): Class |
| +getExceptionTypes(): Class |
| +equals(obj: Object): boolean |
| +hashCode(): int |
| +toString(): String |
| +invoke(obj: Object, args: Object): Object |

Class[] [getParameterTypes\(\)](#)

retourne un tableau
d'objets de classe Class
représentant le type des
paramètres formels de cette
méthode

Example

```
static void showMethods(Object o) {  
    Class c = o.getClass();  
    Method[] theMethods = c.getMethods();  
    for (int i = 0; i < theMethods.length; i++) {  
        String methodString = theMethods[i].getName();  
        System.out.println("Name: " + methodString);  
        String returnString = theMethods[i].getReturnType().getName();  
        System.out.println(" Return Type: " + returnString);  
        Class[] parameterTypes = theMethods[i].getParameterTypes();  
        System.out.print(" Parameter Types:");  
        for (int k = 0; k < parameterTypes.length; k++) {  
            String parameterString = parameterTypes[k].getName();  
            System.out.print(" " + parameterString);  
        } System.out.println(); }  
    }  
}
```

Incrementing a JavaBean property by reflection

```
public int incrementProperty(String name, Object obj) {  
    String prop = Character.toUpperCase(name.charAt(0)) + name.substring(1);  
    String mname = "get" + prop;  
    Class[] types = new Class[] {};  
    Method method = obj.getClass().getMethod(mname, types);  
    Object result = method.invoke(obj, new Object[0]);  
    int value = ((Integer)result).intValue() + 1;  
    mname = "set" + prop;  
    types = new Class[] { int.class };  
    method = obj.getClass().getMethod(mname, types);  
    method.invoke(obj, new Object[] { new Integer(value) });  
    return value;  
}
```

Obtenir les constructeurs

| Class |
|---|
| +toString(): String |
| +forName(className: String): Class |
| +newInstance(): Object |
| +isInstance(obj: Object): boolean |
| +isInterface(): boolean |
| +isArray(): boolean |
| +isPrimitive(): boolean |
| +getName(): String |
| +getClassLoader(): ClassLoader |
| +getSuperclass(): Class |
| +getPackage(): Package |
| +getInterfaces(): Class |
| +getComponentType(): Class |
| +getModifiers(): int |
| +getSigners(): Object |
| +getDeclaringClass(): Class |
| +getClasses(): Class |
| +getFields(): Field |
| +getMethods(): Method |
| +getConstructors(): Constructor |
| +getField(name: String): Field |
| +getMethod(name: String, parameterTypes: Class): Method |
| +getConstructor(parameterTypes: Class): Constructor |
| +getDeclaredClasses(): Class |
| +getDeclaredFields(): Field |
| +getDeclaredMethods(): Method |

Retourne le
ou les constructeurs l'objet .class
correspondant

Créer un nouvel objet

| Constructor |
|---|
| +getDeclaringClass(): Class +getName(): String +getModifiers(): int +getParameterTypes(): Class +getExceptionTypes(): Class +equals(obj: Object): boolean +hashCode(): int +toString(): String +newInstance(initargs: Object): Object |

Object [newInstance](#)([Object](#)[] initargs)
crée un objet et l'initialise avec les arguments

Listing 1.

```
public class TwoString {  
    private String m_s1, m_s2;  
    public TwoString(String s1, String s2) {  
        m_s1 = s1; m_s2 = s2;  
    }  
}
```

Le code du Listing 2 récupère le constructeur et l'utilise pour créer une instance de la classe TwoString utilisant les Strings "a" et "b":

Listing 2. Appel du constructeur par réflexion

```
Class[] types = new Class[] { String.class, String.class };  
Constructor cons = TwoString.class.getConstructor(types);  
Object[] args = new Object[] { "a", "b" };  
TwoString ts = cons.newInstance(args);
```

Exemple

```
/** * Affiche les paramètres des différents constructeurs publiques d'une classe */
static void showConstructors(Object o) {
    Class c = o.getClass();
    Constructor[] theConstructors = c.getConstructors();
    for (int i = 0; i < theConstructors.length; i++) {
        System.out.print("( ");
        Class[] parameterTypes = theConstructors[i].getParameterTypes();
        for (int k = 0; k < parameterTypes.length; k++) {
            String parameterString = parameterTypes[k].getName();
            System.out.print(parameterString + " ");
        } System.out.println(")");
    }
}
```

Obtenir les attributs d'une classe

| Class |
|--|
| <pre>+toString(): String +forName(className: String): Class +newInstance(): Object +isInstance(obj: Object): boolean +isInterface(): boolean +isArray(): boolean +isPrimitive(): boolean +getName(): String +getClassLoader(): ClassLoader +getSuperclass(): Class +getPackage(): Package +getInterfaces(): Class +getComponentType(): Class +getModifiers(): int +getSigners(): Object +getDeclaringClass(): Class +getClasses(): Class +getFields(): Field +getMethods(): Method +getConstructors(): Constructor +getField(name: String): Field +getMethod(name: String, parameterTypes: Class): Method +getConstructor(parameterTypes: Class): Constructor +getDeclaredClasses(): Class +getDeclaredFields(): Field +getDeclaredMethods(): Method</pre> |

Field[] getFields()

Returns an array containing Field objects reflecting all the accessible public fields of the class or interface represented by this Class object.

Field[] getDeclaredFields()

Returns an array of Field objects reflecting all the fields declared by the class or interface represented by this Class object.

| Field |
|--------------------------------------|
| +getDeclaringClass(): Class |
| +getName(): String |
| +getModifiers(): int |
| +getType(): Class |
| +equals(obj: Object): boolean |
| +hashCode(): int |
| +toString(): String |
| +get(obj: Object): Object |
| +getBoolean(obj: Object): boolean |
| +getByte(obj: Object): byte |
| +getChar(obj: Object): char |
| +getShort(obj: Object): short |
| +getInt(obj: Object): int |
| +getLong(obj: Object): long |
| +getFloat(obj: Object): float |
| +getDouble(obj: Object): double |
| +set(obj: Object, value: Object) |
| +setBoolean(obj: Object, z: boolean) |
| +setByte(obj: Object, b: byte) |
| +setChar(obj: Object, c: char) |
| +setShort(obj: Object, s: short) |
| +setInt(obj: Object, i: int) |
| +setLong(obj: Object, l: long) |
| +setFloat(obj: Object, f: float) |
| +setDouble(obj: Object, d: double) |

java.lang.reflect.Field

Récupérer la valeur d'un champ de obj

Affecter la valeur d'un champ de obj

Incrémenter un attribut

```
public int incrementField(String name, Object obj) throws... {  
    Field field = obj.getClass().getDeclaredField(name);  
    int value = field.getInt(obj) + 1;  
    field.setInt(obj, value);  
    return value;  
}
```

Les tableaux

| Class |
|---|
| +toString(): String |
| +forName(className: String): Class |
| +newInstance(): Object |
| +isInstance(obj: Object): boolean |
| +isInterface(): boolean |
| +isArray(): boolean |
| +isPrimitive(): boolean |
| +getName(): String |
| +getClassLoader(): ClassLoader |
| +getSuperclass(): Class |
| +getPackage(): Package |
| +getInterfaces(): Class |
| +getComponentType(): Class |
| +getModifiers(): int |
| +getSigners(): Object |
| +getDeclaringClass(): Class |
| +getClasses(): Class |
| +getFields(): Field |
| +getMethods(): Method |
| +getConstructors(): Constructor |
| +getField(name: String): Field |
| +getMethod(name: String, parameterTypes: Class): Method |
| +getConstructor(parameterTypes: Class): Constructor |
| +getDeclaredClasses(): Class |
| +getDeclaredFields(): Field |
| +getDeclaredMethods(): Method |

boolean isArray()

Determines if this Class object represents an array class.

Array

| Array |
|--|
| <u>+newInstance(componentType: Class, length: int): Object</u> |
| <u>+newInstance(componentType: Class, dimensions: int): Object</u> |
| <u>+getLength(array: Object): int</u> |
| <u>+get(array: Object, index: int): Object</u> ← |
| <u>+getBoolean(array: Object, index: int): boolean</u> |
| <u>+getBytes(array: Object, index: int): byte</u> |
| <u>+getChar(array: Object, index: int): char</u> |
| <u>+getShort(array: Object, index: int): short</u> |
| <u>+getInt(array: Object, index: int): int</u> |
| <u>+getLong(array: Object, index: int): long</u> |
| <u>+getFloat(array: Object, index: int): float</u> |
| <u>+getDouble(array: Object, index: int): double</u> |
| <u>+set(array: Object, index: int, value: Object)</u> |
| <u>+setBoolean(array: Object, index: int, z: boolean)</u> |
| <u>+setByte(array: Object, index: int, b: byte)</u> |
| <u>+setChar(array: Object, index: int, c: char)</u> |
| <u>+setShort(array: Object, index: int, s: short)</u> |
| <u>+setInt(array: Object, index: int, i: int)</u> |
| <u>+setLong(array: Object, index: int, l: long)</u> |
| <u>+setFloat(array: Object, index: int, f: float)</u> |
| <u>+setDouble(array: Object, index: int, d: double)</u> |

Object get(Object array, int index)

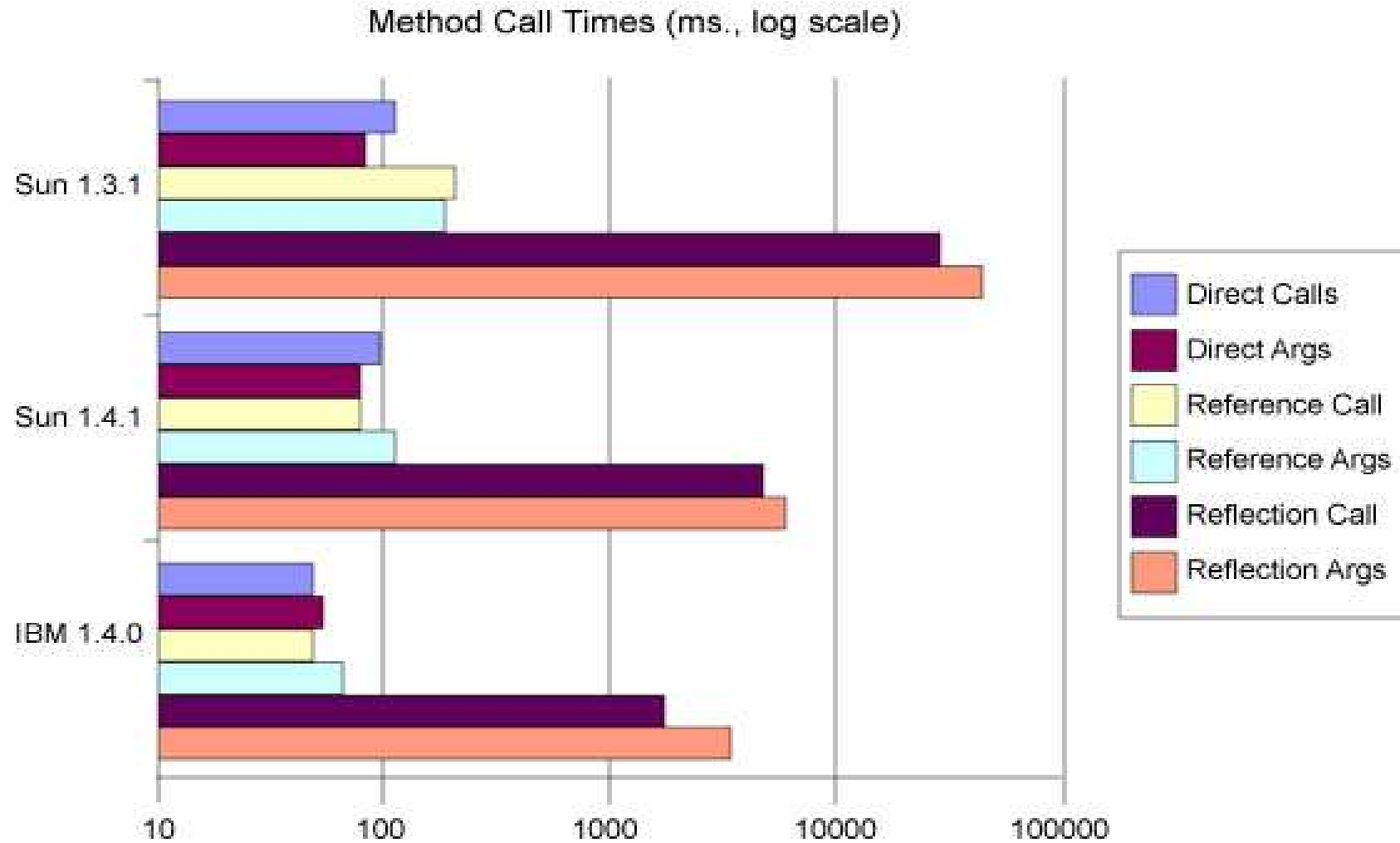
retourne la valeur située à
index dans array

Agrandir un tableau

```
public Object growArray(Object array, int size) {  
    Class type = array.getClass().getComponentType();  
    Object grown = Array.newInstance(type, size);  
    System.arraycopy(array, 0, grown, 0,  
                     Math.min(Array.getLength(array), size));  
    return grown;  
}
```

Performance

Beaucoup d'avantages mais pas efficace car interprété (au second niveau !)



Performance

