Introspection & Reflection

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Outline

Introspection

Ability to look inside the object

- class hierarchy
- fields/instance variables
- methods

Examples

- GLib 2.0 & GObject (`gobject.h`)

Outline

Read-only reflection

Introspection +

- read/write fields/instance variables
- invoke methods by name

Examples

- Java (`java.lang`, `java.lang.reflect`)

Case Study I – jUnit

```
1  /**
2  * Constructs a TestSuite from the given class.
3  * Adds all the methods starting with "test" as
4  * test cases to the suite.
5  * Parts of this method were written at 2337
6  * meters in the Hueffihuette, Kanton Uri
7  **/
8  public TestSuite(final Class<?  extends TestCase> theC
9    ...
10   Class<?> superClass = theClass;
11   List<String> names = new ArrayList<String>();
12   while (Test.class.isAssignableFrom(superClass)) {
13     for (Method each :
14       superClass.getDeclaredMethods())
15         addTestMethod(each, names, theClass);
16     superClass= superClass.getSuperclass();
17   }
18   ...
19 }
```

Case Study II – Hibernate

```
1  @Entity
2  @Table(name = "ACTOR")
3  public class Actor extends BaseEntity {
4     ...
5     @OneToOne(cascade = CascadeType.ALL)
6     @JoinColumn(name = EXTERN_USER_FK", unique = true)
7     @ForeignKey(name = "ACTOR_EXTERN_USER_FK")
8     private ExternUser externUser;
9     ...
10    @AccessType("property")
11    @Column(name = "LDAP_USER_PERSONAL_ID", unique = true
12    private String ldapUserPersonalId;
13    ...
14 }
```

Case Study III – OmniBrowser

```
1    commandSelectors
2      | all obsolete commands |
3      all←self class allSelectors.
4      obsolete←Set new.
5      all do:
6        [:ea |
7        (ea beginsWith: 'obsolete') ifTrue:
8          [obsolete add: (self perform: ea)]].
9      commands←all select:
10       [:ea | ea beginsWith: 'cmd'].
11     ↑commands reject:
12       [:ea | obsolete includes: ea]
```

Outline

Read-write Reflection

Read-only + ability to read and modify object's layout and behavior:

- add/remove fields/instance variables
- add/remove methods
- add/remove classes
- modify class hierarchy
- change object's class
- read/modify execution stack

Examples

- Smalltalk, SELF
- Python, ECMAScript, JavaScript
- CLOS

Case Study IV – Exception handling in Smalltalk

```
1  findNextHandlerContextStarting
2    "Return the next handler marked context,
3     returning nil if there is none.  Search
4     starts with self and proceeds up to nil."
5
6    | ctx |
7
8    ctx←self.
9    [
10     ctx isHandlerContext ifTrue:[↑ctx].
11     ctx←ctx sender) == nil
12   ] whileFalse.
13   ↑nil
```

Outline

CLOS & The Metaobject Protocol

In CLOS, you can redefine:

- class inheritance mechanism
- slot inheritance mechanism
- method lookup algorithm
- ...

Case Study V – Using LOOPS code inside CLOS

```
1 (defclass loops-class (standard-class) ())
2
3 (defmethod compute-class-precedence-list
4   ((class loops-class))
5     ...)
6 (defmethod compute-effective-slot-definition
7   ((class loops-class))
8     ...)
```

Sub-method Reflection

- Classical reflection ends at method level
- Sub-method reflection provides reflective API on statement level
- Changes to the AST results in changes to the behavior.
- PERSEPHONE framework for Squeak

Outline

Performance

- Reflective code is not necessarily slow
- Some implementations are slow

`#perform:` implementation in Smalltalk/X

Object perform:with:with:

Záložky Browse Hledat View Category Class Protocol Selector Code Debug Operations ?

Object

```
perform:aSelector with:arg1 with:arg2
    "send the two-arg-message aSelector to the receiver"

%{
    struct inlineCache *pIlc;

    if (InterruptPending == nil) {
        static struct inlineCache ilc_0 = __ILCPERF2(@line);
        static struct inlineCache ilc_1 = __ILCPERF2(@line);
        static OBJ last_0 = nil;
        static OBJ last_1 = nil;
        static flip = 0;

        if (aSelector == last_0) {
            pIlc = &ilc_0;
        } else if (aSelector == last_1) {
            pIlc = &ilc_1;
        } else {
            if (flip == 0) {
                pIlc = &ilc_0;
                flip = 1;
                last_0 = aSelector;
            } else {
                pIlc = &ilc_1;
                flip = 0;
                last_1 = aSelector;
            }
            pIlc->ilc_func = __SEND2ADDR__;
            if (pIlc->ilc_poly) {
                __flushPolyCache(pIlc->ilc_poly);
                pIlc->ilc_poly = 0;
            }
        }
        RETURN ( (*(pIlc->ilc_func))(self, aSelector, nil, pIlc, arg1, arg2) );
    } else {
        static struct inlineCache ilc2 = __DUMMYILCSELF2(@line+1);
        RETURN (_SEND2(self, aSelector, nil, &ilc2, arg1, arg2));
    }
%}.
    ^ self perform:aSelector withArguments:(Array with:arg1 with:arg2)
```

'aSelector' is a method argument. | **stx:libbasic** [1.611] | 1 | 9

Outline

Miracle

```
1  miracle
2
3     "
4       Miracle miracle
5     "
6
7     thisContext method at:39 put:  71.
8     false ifTrue:
9       [Transcript show:
10        'Hey guys, smalltalking is dynamic fun!']
```