Reflection: Introduction

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Just the basics

Definition: Two parter

- ***Reflection*** is the ability of a running program to:

  1. Examine itself and the run-time environment
     - Called introspection

  2. Change its behavior, structure, or data depending on what it finds

Introspection via?

- To do **introspection**, a program must have a **representation of itself** available at runtime
  - Called ***metadata***
  - In an OO language, metadata is organized using **metaobjects**
    - In Java, these are typically instances of classes like Class, Method, and Field

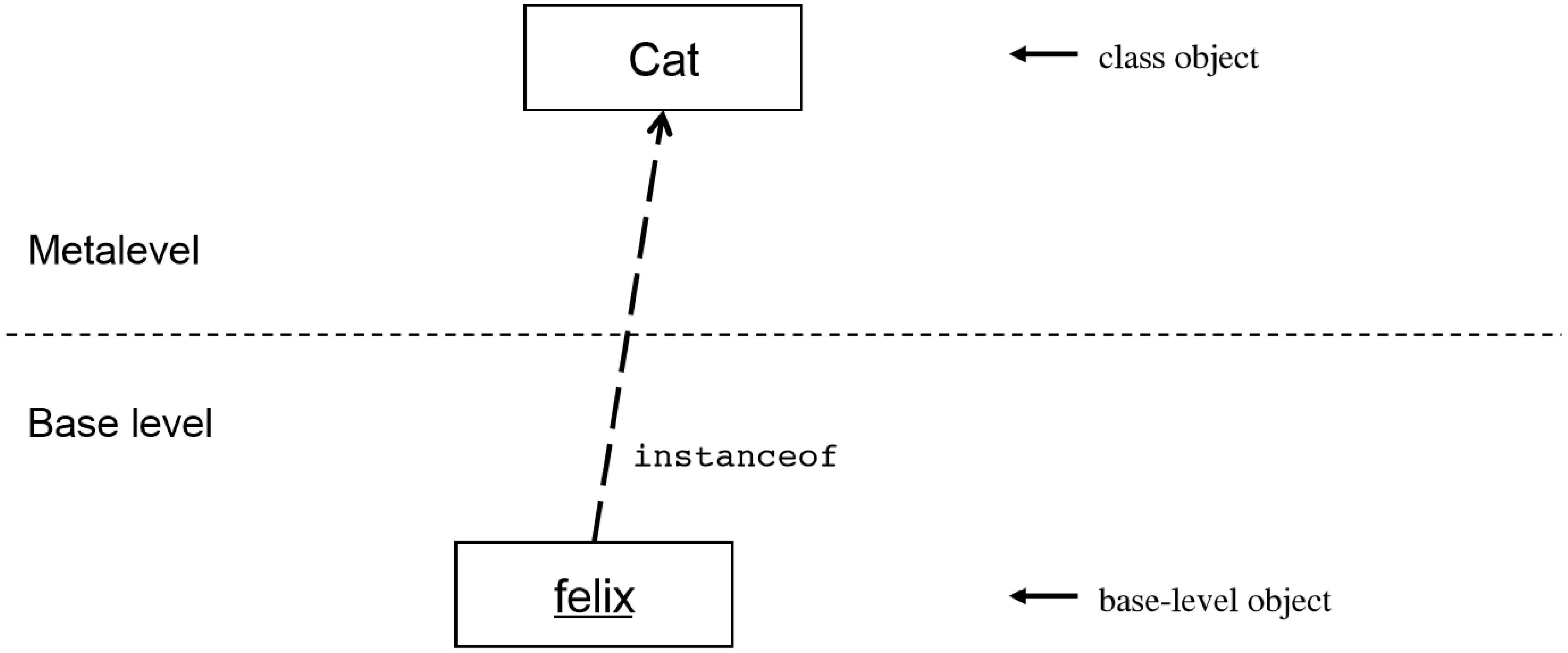
You basic, you meta

You basic, you meta

- The normal, non-reflective part of a program is called the base program
  - Consists of ***base-level objects***

- Each base-level object is an instance of some class
  - The class is represented at the **metalevel** as a **class object** (an example of a metaobject)

Basic Concepts



Basic Concepts

- The fields and methods for a class are represented with **Field** and **Method** metaobjects
    - Are contained within the class object

Flip it, and reverse it

Basic Concepts

- Once introspection is done, you can change a program's structure, data, or behavior
  - Three general techniques:
    1. Direct metaobject modification
       - E.g. Add methods or fields to an existing class
       - **Not possible in Java (avoids complications)**
    2. Operations using metadata
       - E.g. Dynamic method invocation, dynamic class loading, reflective construction
       - **Exists in Java**

Basic Concepts

3. Intercession
   - Where code intercedes modifies behavior as program runs
   - Typically involves intercepting method calls
   - **In Java, limited to dynamic proxies**

Work it

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Basic Concepts

- Growing number of languages support reflection
  - To some degree
  - This list is growing due to the power of it
  - Go, Java, Julia, Lisp, Logo, La, Mathematica, C#, Perl, PHP, Prolog, Python, R, Ruby, Scheme, Smalltalk, Wolfram language

Basic Concepts

- Issues with reflection:

  - Since behavior can be changed dynamically, security could be compromised
    - Not a problem with Java
      - Has a strong security model
      - Limited intercession

  - Reflective techniques are indirect, thus making code more complex
    - Use reflection only where it makes sense

Basic Concepts

- Reflective method calls are slower than normal calls
  - 20x improvement from Java 1.3 to 1.4

Do it already

A Simple Example

```java
import java.lang.reflect.Method;

public class MainReflect {
   public static void main(String[] args) {
      Object object = null;
      Class classObject = null;
      try {
         // Load the class dynamically
         //1st command line argument
         classObject = Class.forName(args[0]);
         object = classObject.newInstance();
         //Find method by name in
         //2nd command line argument
         Method m = classObject.getMethod(args[1], null);
         m.invoke(object, null);
      } catch (Exception e) {
         e.printStackTrace();
      }
   }
}
```

A Simple Example

- Can be used on any class
  - Example:

```
public class MyClass {
    public void print(){
        System.out.println("Hello, world!");
    }
    public void display(){
        System.out.println("Goodbye, cruel world!");
    }
}
```

A Simple Example

```
java Reflection.MainReflect Reflection.MyClass print
```

outputs:**Hello, world!**

```
java Reflection.MainReflect Reflection.MyClass display
```

outputs: **Goodbye, cruel world!**

Onward to …
Java reflection.

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