Predicate Dispatching: A Unified Theory of Dispatch

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Dispatching

Select one *case* from a *generic function*
- object-oriented dispatch, including multi-methods
- classifiers, predicate classes
- pattern matching

Case selection
- applicability
- overriding

Static checking
- completeness
- uniqueness

Goals

Unify and generalize dispatching mechanisms
Small, orthogonal basic model
Functions are extensible
Static checking

Solution: predicate dispatching

Outline

Predicate dispatching
Examples
Semantics

Applicability

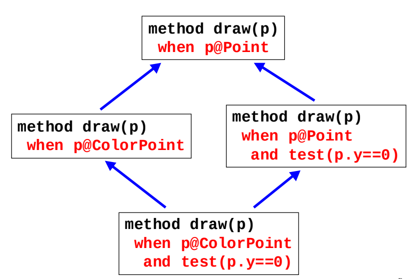
Predicates are boolean formulas over class tests and program expressions

pred ::= *expr* @ *class*
  | **test(***expr***)**
  | **let** *var* **:=** *expr*
  | **not** *pred*
  | *pred* **or** *pred*
  | *pred* **and** *pred*

```
method draw(p)
  when p@Point and test(p.y == 0)
  { draw point on x axis }
```


Overriding

Overriding is determined by logical implication



Object-oriented dispatch

(SmallTalk, C++, Java)

Applicability: run-time class is subclass of specializer

Overriding: subclassing (most specific specializer)

```
class Point;
method draw(p) when p@Point { … };

class ColorPoint extends Point;
method draw(p) when p@ColorPoint { … };
```

Equivalently:

```
method draw(p@Point) { … };
method draw(p@ColorPoint) { … };
```


Multi-method dispatch

(CLOS, Cecil, Dylan)

Applicability: run-time classes are subclasses of specializers

Overriding: subclassing over all specializers

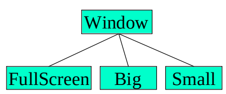
```
method equal(p1, p2)
  when p1@Point and p2@Point
  { return p1.x==p2.x and p1.y==p2.y; }

method equal(p1, p2)
  when p1@ColorPoint and p2@ColorPoint
  { return p1.x==p2.x and p1.y==p2.y
         and p1.color==p2.color; }
```


Classifiers

(Kea, Cecil)

Applicability: boolean conditions of runtime state

Overriding: lexical order




```
classify(w@Window)
  as FullScreen when test(w.area() == RootWindow.area())
  as Big when test(w.area() > RootWindow.area()/2)
  as Small otherwise;

method move(w) when w@FullScreen { do nothing }
method move(w) when w@Big { move wireframe outline }
method move(w) when w@Small { move opaque window }
```


Pattern matching

(ML, Haskell)

Applicability: structural equivalence

Overriding: lexical order

```
fun sumList (nil) = 0
  | sumList (h::t) = h + sumList(t);

method sumList(l) when l@Nil
  { return 0; }
method sumList(l)
  when l@Cons and let h:=l.head and let t:=l.tail
  { return h + sumList(t); }
```


New capability: disjunction

`zip`: given a pair of lists, return a list of pairs

```
method zip(l1, l2)
  when l1@Nil or l2@Nil
{ return Nil; }

method zip(l1, l2)
  when l1@Cons and l2@Cons
{ return Cons(Pair(l1.head, l2.head),
              zip(l1.tail, l2.tail)); }
```


Predicate abstractions

Capabilities of in-line predicates:

- return boolean value
- bind variables

```
predicate On_x_axis(p)
  when (p@CartesianPoint and test(p.y == 0))
    or (p@PolarPoint
        and (test(p.theta == 0) or test(p.theta == pi)))

method draw(p) when p@Point { … }
method draw(p) when On_x_axis(p) { … }
```

Run-time behavior

Applicability: evaluate predicates (at run time)

- Optimization: common subexpression elimination

Overriding: logical implication

- Computed at compile time, used at run time

Ernst, ECOOP '98, page 13

Typechecking

Completeness:

- *Informally,* disjunction of predicates = true

Uniqueness: for each pair of predicates,

- – disjoint,
- – one subsumes the other, or
- – their intersection is overridden

Ernst, ECOOP '98, page 14

Comparing predicates

Compile-time tautology tests

In general: undecidable

Black-box program expressions: NP-hard

Small predicate expressions: fast

Consistent classes: complete

Ernst, ECOOP '98, page 15

Future work

More efficient implementation strategies

Separate typechecking

Ernst, ECOOP '98, page 16

Contributions of predicate dispatching

Generalizes and subsumes previous techniques in a common framework

Enables new varieties of tests

Implementation:

- http://www.cs.washington.edu/research/projects/cecil/www/Gud

Ernst, ECOOP '98, page 17