Lab 1: CSG 711: Programming to Structure

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History

- Frege: Begriffsschrift 1879: “The meaning of a phrase is a function of the meanings of its immediate constituents.”
- Example:

```
AppleList : Mycons | Myempty.
Mycons = <first> Apple <rest> AppleList.
Apple = <weight>  int.
Myempty = .
```

Meaning of a list of apples?
Total weight

- (tWeight al)
  - [(Myempty? al) 0]
  - [(Mycons? al)

    (Apple-weight(Mycons-first al))

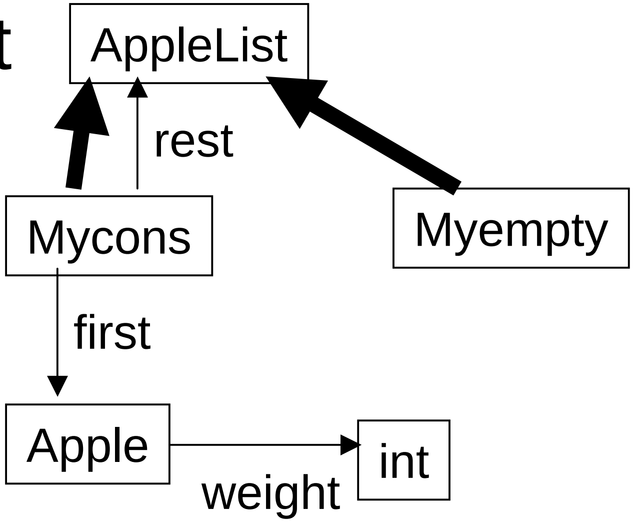
    // meaning of first constituent

    +

    (tWeight(Mycons-rest al))]

    // meaning of rest constituent

AppleList : Mycons | Myempty.
Mycons = <first> Apple <rest> AppleList.
Apple = <weight> int.
Myempty = .



PL independent

In Scheme: Structure

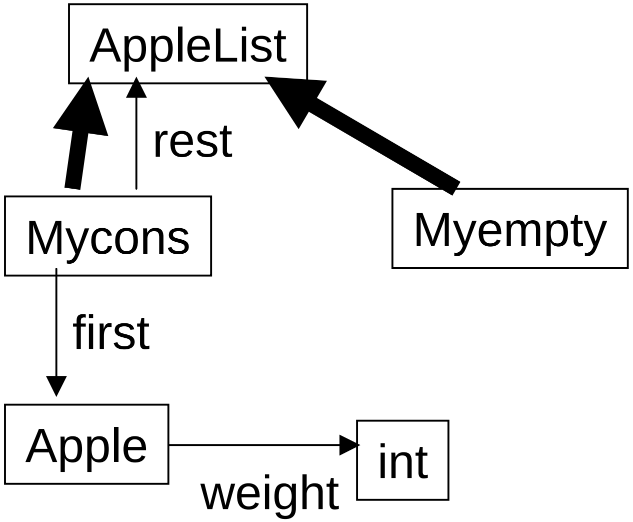
```
(define-struct Mycons (first rest))
(define-struct Apple (weight))
(define-struct Myempty ())
```

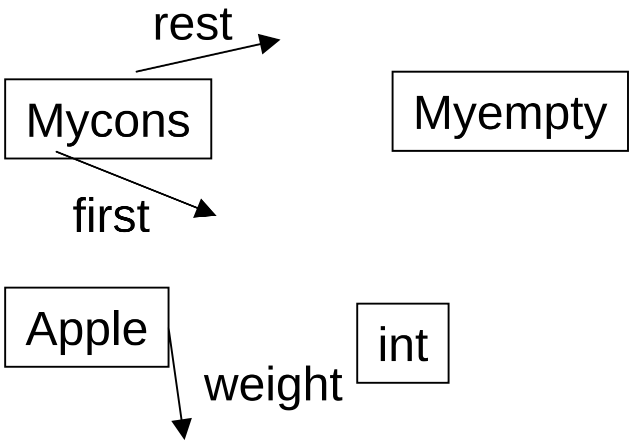
Design Information

AppleList : Mycons | Myempty.
Mycons = <first> Apple <rest> AppleList.
Apple = <weight> int.
Myempty = .

Scheme solution

```
(define-struct Mycons (first rest))
(define-struct Apple (weight))
(define-struct Myempty ())
```





In Scheme: Behavior

```
(define (tWeight al)
  (cond
    [(Myempty? al) 0]
    [(Mycons? al) (+
         (Apple-weight (Mycons-first al))
         (tWeight (Mycons-rest al)))]))
```

In Scheme: Testing

```
(define list1 (make-Mycons (make-Apple
   111) (make-Myempty)))
(tWeight list1)
111
(define list2 (make-Mycons (make-Apple 50)
   list1))
(tWeight list1)
161
```

Reflection on Scheme solution

- Program follows structure
- Design translated somewhat elegantly into program.
- Dynamic programming style.
- But the solution has problems!

Structure

- The Scheme program has lost information that was available at design time.
  - – The first line is missing.
  - – Scheme allows us to put anything into the fields.

```
AppleList : Mycons | Myempty.
Mycons = <first> Apple <rest> AppleList.
Apple = <weight>  int.
Myempty = .
```

Information can be expressed in Scheme

- Dynamic tests
- Using object system

Behavior

- While the purpose of this lab is programming to structure, the Scheme solution uses too much structure!

```
(define (tWeight al)
  (cond
    [(Myempty? al) 0]
    [(Mycons? al) (+
         (Apple-weight (Mycons-first al))
         (tWeight (Mycons-rest al)))]))
```

duplicates all of it!

How can we reduce the duplication of structure?

- First small step: Express all of structure in programming language once.
- Eliminate conditional!
- Implementation of tWeight() has a method for Mycons and Myempty.
- Extensible by addition not modification.
- Big win of OO.

Solution in Java

```
AppleList: abstract int tWeight();
Mycons: int tWeight() {
  return (first.tWeight() + rest.tWeight());
}
Myempty: int tWeight() {return 0;}
```

+

```
AppleList : Mycons | Myempty.
Mycons = <first> Apple <rest> AppleList.
Apple = <weight>  int.
Myempty = .
```

translated
to Java

What is better?

- structure-shyness has improved.
- No longer enumerate alternatives in functions.
- Better follow principle of single point of control (of structure).

Problem to think about (while you do hw 1)

- Consider the following two Shape definitions.
  - in the first, a combination consists of exactly two shapes.
  - in the other, a combination consists of zero or more shapes.
- Is it possible to write a program that works correctly for both shape definitions?

First Shape

Shape : Rectangle | Circle | Combination.

Rectangle = "rectangle" <x> int <y> int <width> int <height> int.

Circle = "circle" <x> int <y> int <radius> int.

Combination = "(" <top> Shape <bottom> Shape ")".

Second Shape

```
Shape : Rectangle | Circle | Combination.
Rectangle = "rectangle" <x> int <y> int
            <width> int <height> int.
Circle = "circle" <x> int <y> int
         <radius> int.
Combination = "(" List(Shape) ")".
List(S) ~ {S}.
```

Input (for both Shapes)

```
(
  rectangle 1 2 3 4
  (
    circle 3 2 1
    rectangle 4 3 2 1
  )
)
```

Abstractions

- abstraction through parameterization:
  - planned modification points
- aspect-oriented abstractions:
  - unplanned extension points