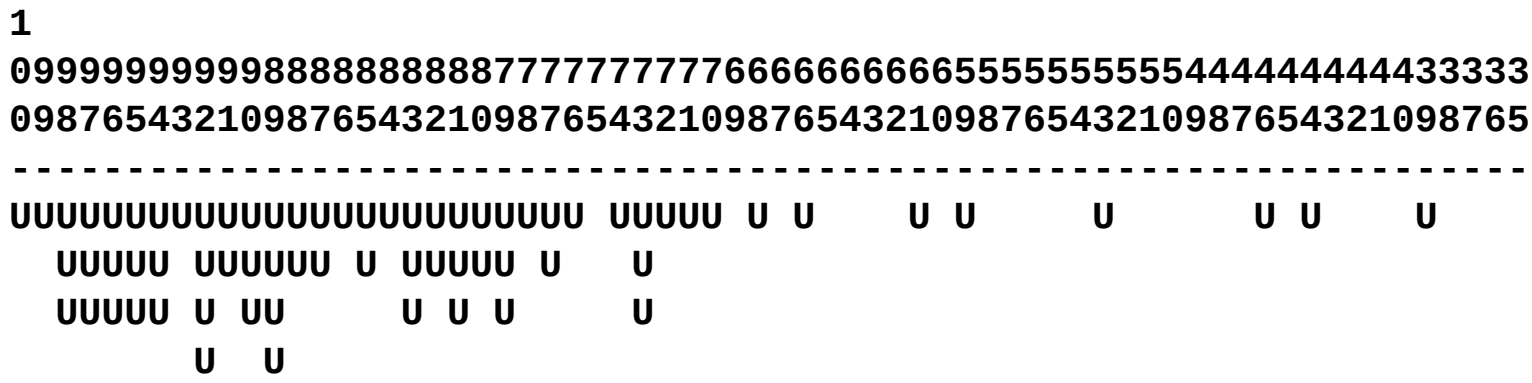
Mid-Term2 Results

Average: 83

Median: 87



From Functions to Objects

- Functional languages (Scheme, ML)
  - ADT is a type and a collection of functions

```
make-fish : num -> fish
grow-fish : fish num -> fish
fish-size : fish -> num
```

- Object-oriented languages (Java, C++, Smalltalk)
  - ADT is a class

```
fish class
  method initialize : num ->
  method grow : num ->
  method size : -> num
```

From Functions to Objects

- We can implement objects with functions

```
(define (mk-fish size)
  (letrec ([get-size (lambda () size)]
           [grow (lambda (s)
                   (set! size (+ s size)))]
           [eat (lambda (fish)
                  (grow ((fish 'get-size))))])
    (lambda (msg)
      (cond
       [(eq? msg 'get-size) get-size]
       [(eq? msg 'grow) grow]
       [(eq? msg 'eat) eat]))))
```

Elements of an OO Language

- (Expressed) values = objects
- Classes
  - superclass
  - fields
  - methods
- Expression forms
  - new
  - method call
  - super call
- Program = class declaration + expression

Syntax

```
<program>      := <class-decl>* <expr>

<class-decl>   := class <id> extends <id>
                    <field-decl>*
                    <method-decl>*
<field-decl>   := field <id>
<method-decl>  := method <id> (<id>*,) <expr>

<expr> := new <id> (<expr>*,)
<expr> := send <expr> <id> (<expr>*,)
<expr> := super <id> (<expr>*,)
```

Example

```
class fish extends object
  field size
  method initialize (s) set size = s
  method get_size() size
  method grow(food)
    set size = +(size, food)
  method eat(other_fish)
    let s = send other_fish get_size()
     in send self grow(s)

let f = new fish(10)
 in begin
     send f grow(2);
     send f get_size()
    end
```

Example

```
class fish extends object
  field size
  method initialize (s) set size = s
  method get_size() size
  method grow(food)
    set size = +(size, food)
  method eat(other_fish)
    let s = send other_fish get_size()
     in send self grow(s)
class colorfish extends fish
  field color
  method set_color(c) set color = c
  method get_color() color
...
```

Example

```
class fish extends object
  field size
  method initialize (s) set size = s
  method get_size() size
  method grow(food)
    set size = +(size, food)
  method eat(other_fish)
    let s = send other_fish get_size()
     in send self grow(s)
...
class pickyfish extends fish
  method grow(food)
   super grow(-(food, 1))
...
```

Class Tree

```
class fish ...

class colorfish
  extends fish
 ...

class pickyfish
  extends fish
 ...
```

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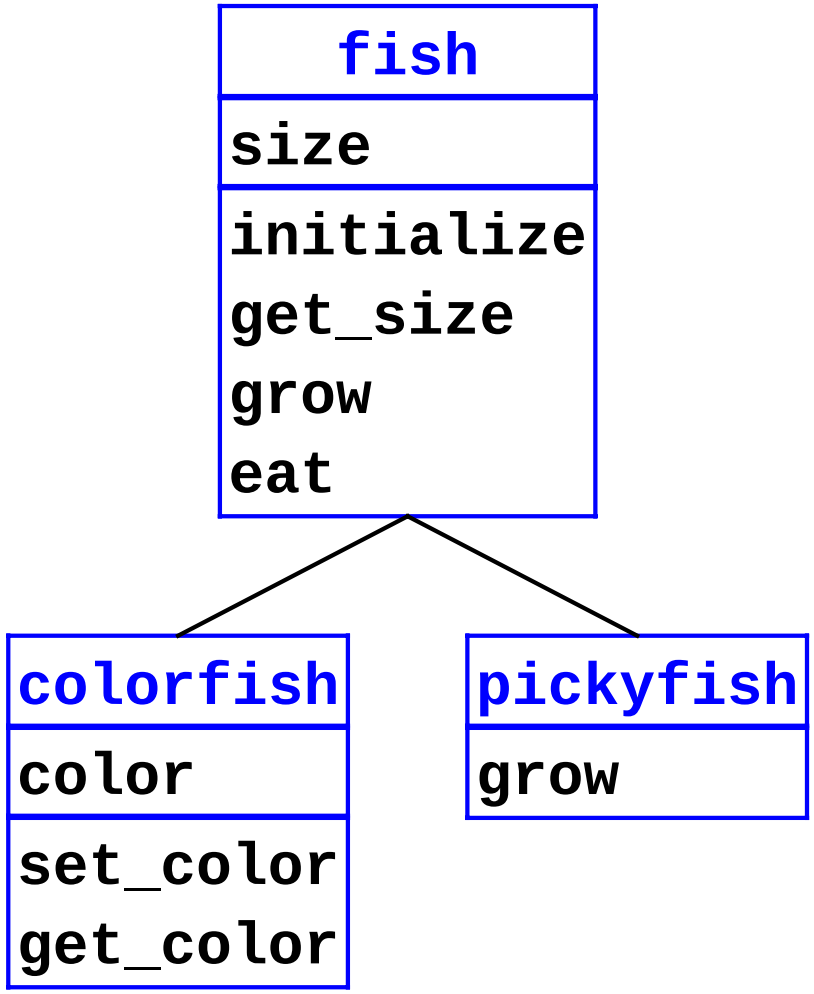
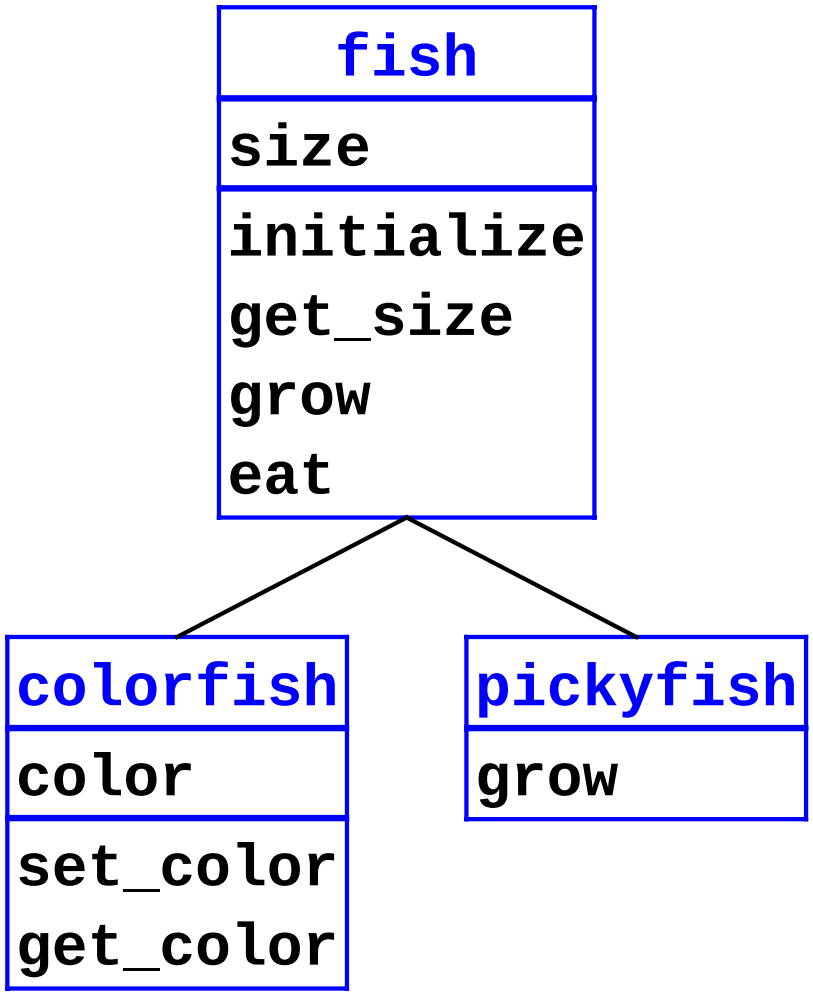
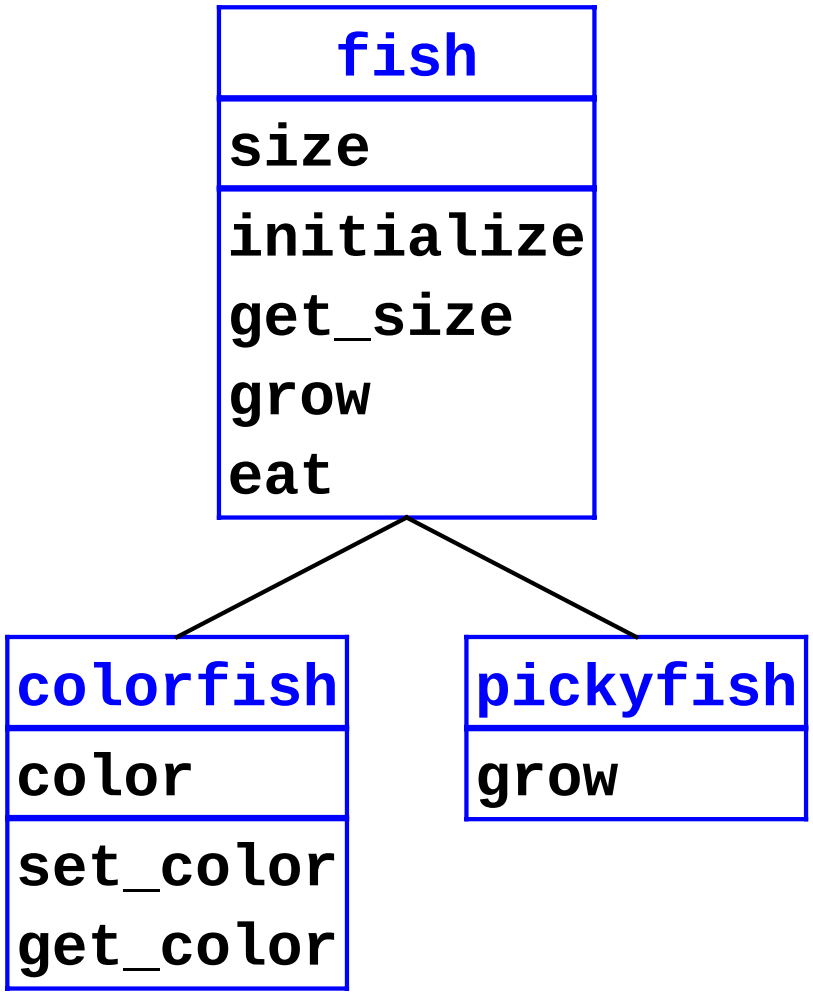


Evaluation




```
new colorfish(1)
```

Evaluation

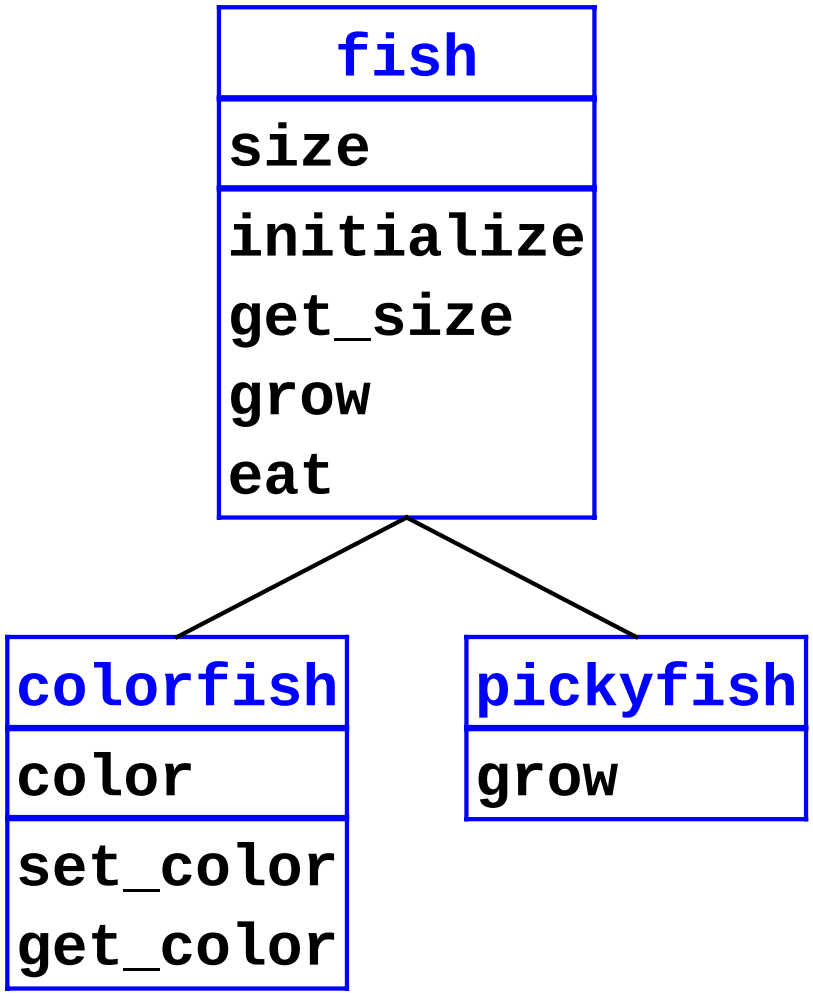



```
new colorfish(1)
```

obj =

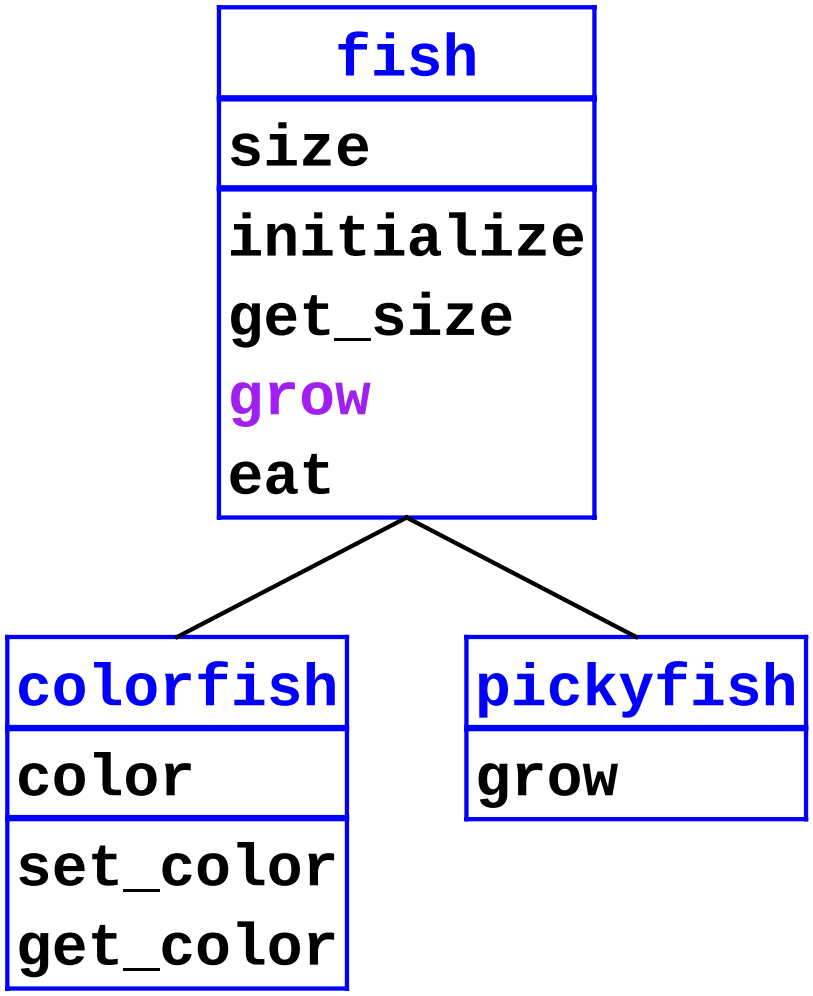
colorfish
size = 1
color = 0

Evaluation




```
let
o1 = new colorfish(3)
in begin
send o1 grow(4);
send o1 get_size()
end
```

Evaluation



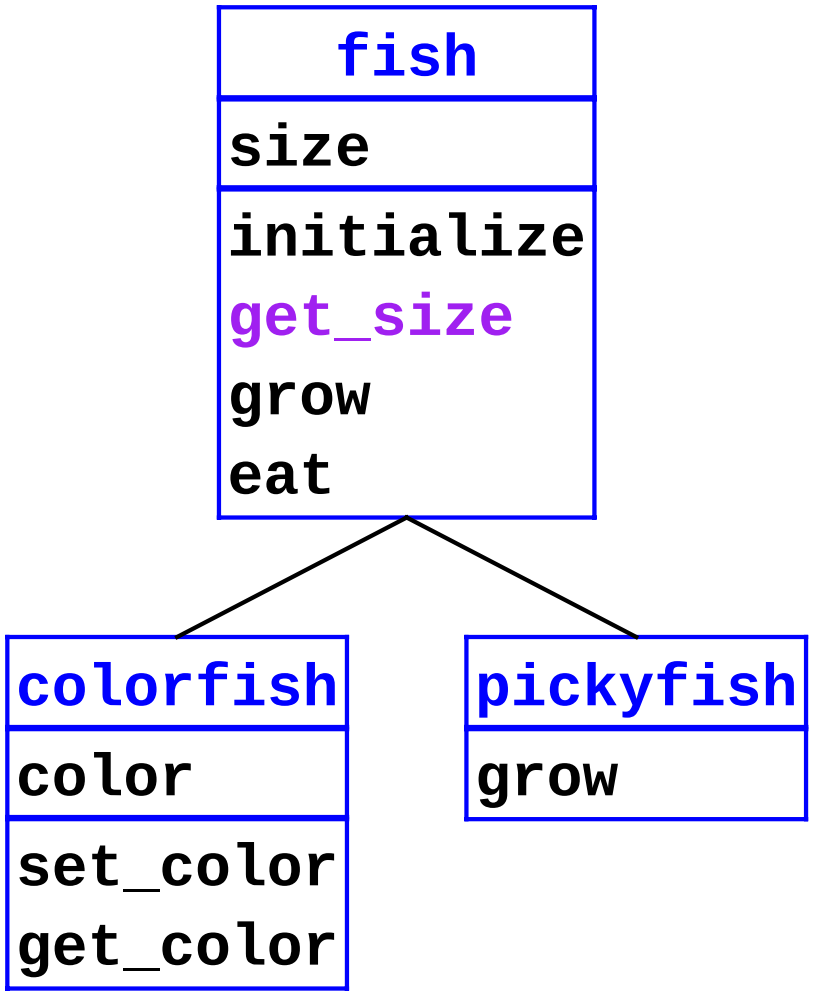

```
grow(f)
set size=+(size,f)
```

```
let
o1 = new colorfish(3)
in begin
send o1 grow(4);
send o1 get_size()
end
```

o1 =

colorfish
size = 3
color = 0

Evaluation



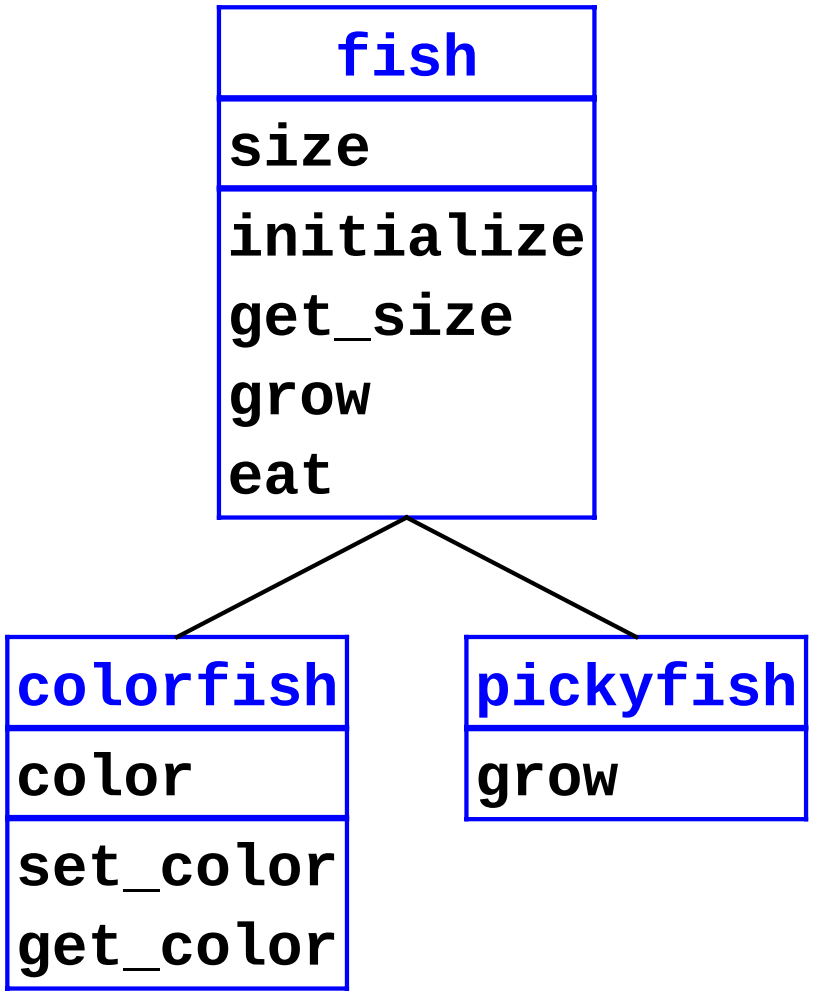
get_size() size

```
let
o1 = new colorfish(3)
in begin
send o1 grow(4);
send o1 get_size()
end
```

o1 =

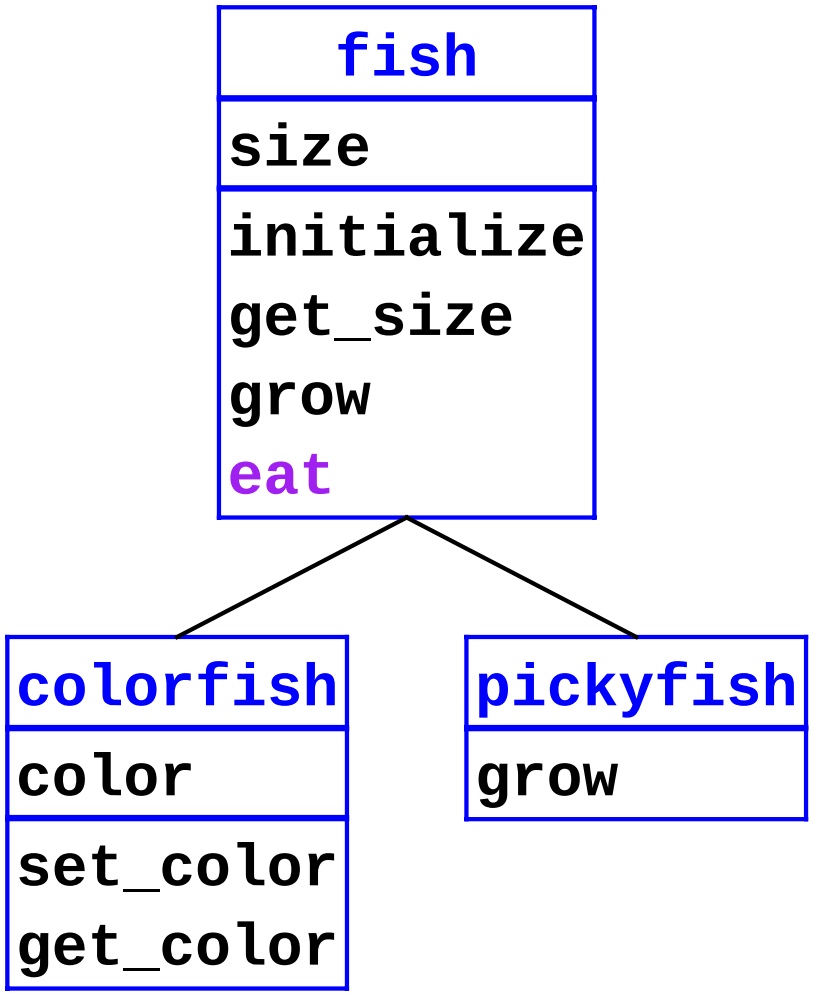
colorfish
size = 7
color = 0

Evaluation




```
let
o1 = new colorfish(3)
o2 = new pickyfish(6)
in begin
send o2 eat(o1);
send o2 get_size()
end
```

Evaluation




```
eat(o) let
s = send o get_size()
in send self grow(s)
```

```
let
o1 = new colorfish(3)
o2 = new pickyfish(6)
in begin
send o2 eat(o1);
send o2 get_size()
end
```

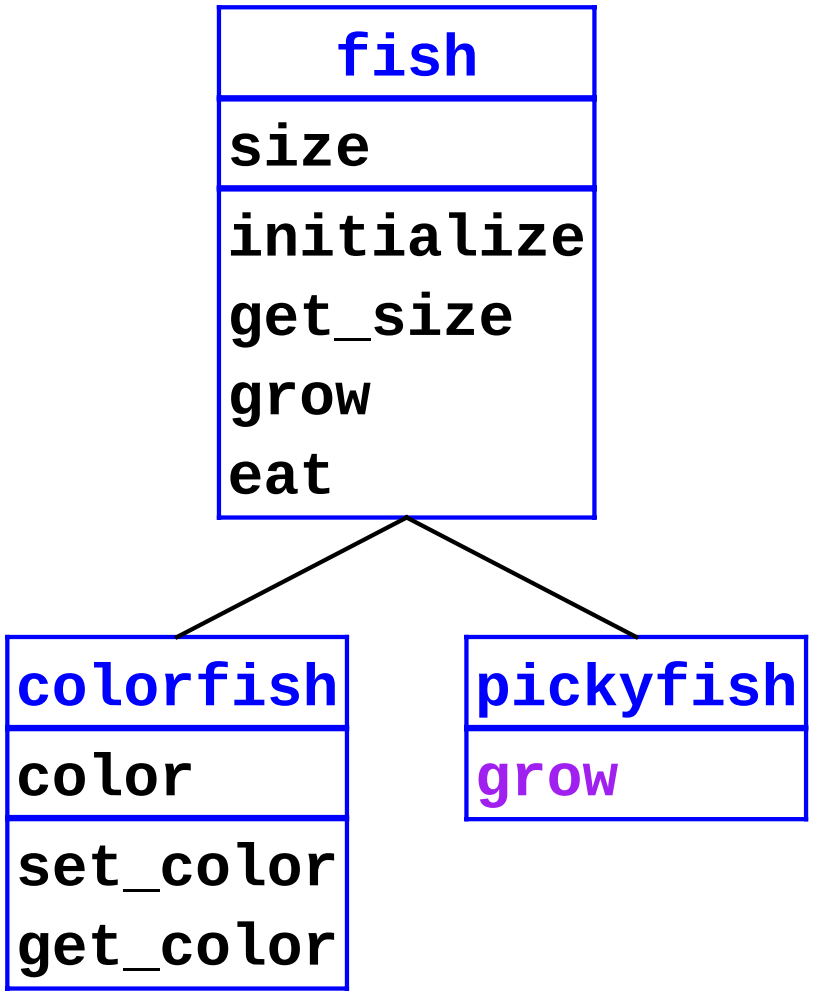
o1 =

colorfish
size = 3
color = 0

o2 =

pickyfish
size = 6

Evaluation




```
grow(f)
super grow(-(f, 1))
```

```
let
o1 = new colorfish(3)
o2 = new pickyfish(6)
in begin
send o2 eat(o1);
send o2 get_size()
end
```

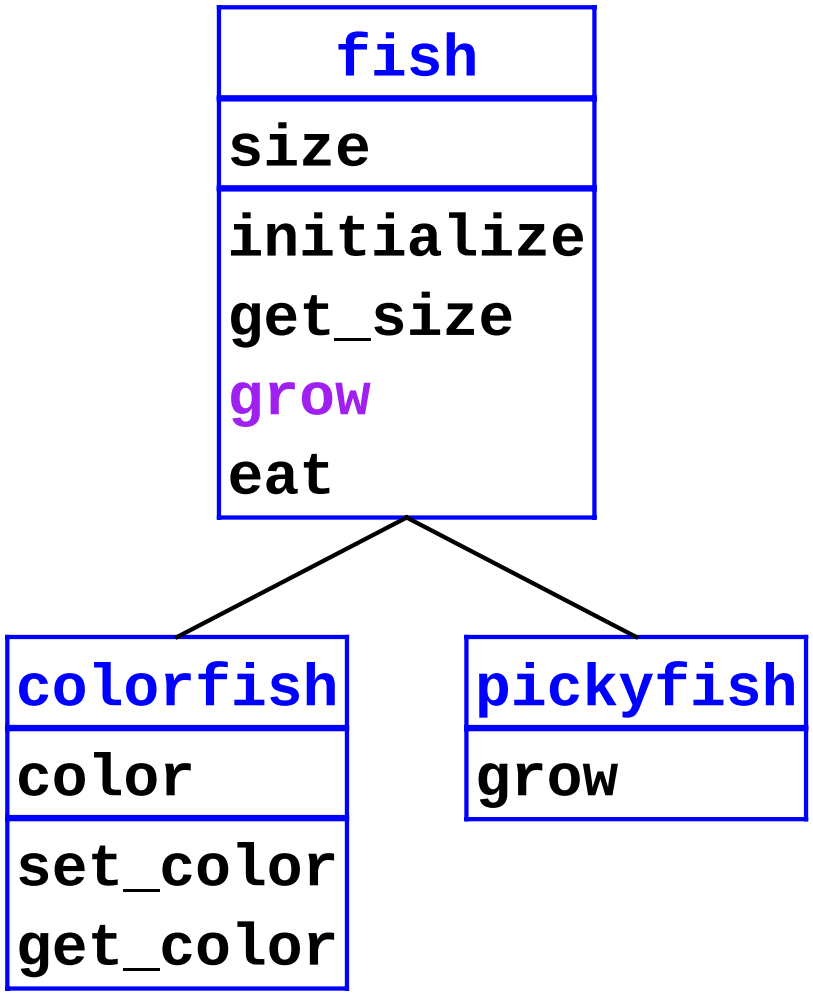
o1 =

colorfish
size = 3
color = 0

o2 =

pickyfish
size = 6

Evaluation




```
grow(f)
set size=+(size,f)
```

```
let
o1 = new colorfish(3)
o2 = new pickyfish(6)
in begin
send o2 eat(o1);
send o2 get_size()
end
```

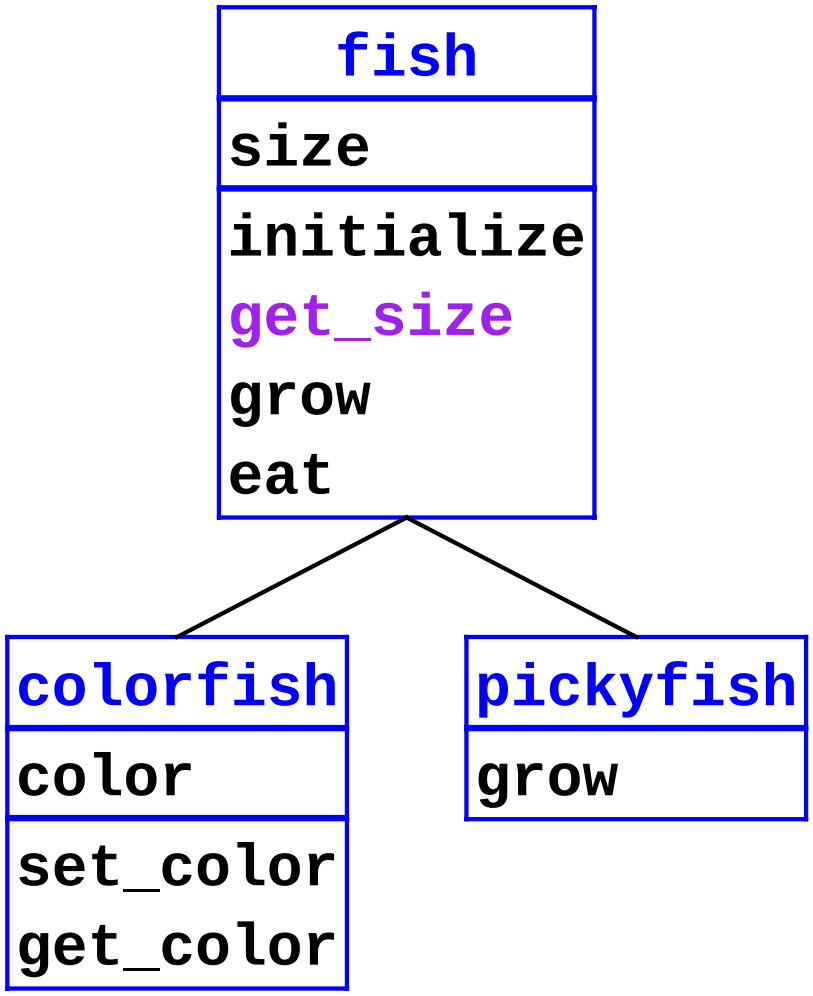
o1 =

colorfish
size = 3
color = 0

o2 =

pickyfish
size = 6

Evaluation



get_size() size

```
let
o1 = new colorfish(3)
o2 = new pickyfish(6)
in begin
send o2 eat(o1);
send o2 get_size()
end
```

o1 =

colorfish
size = 3
color = 0

o2 =

pickyfish
size = 8

Interpreter

- Build class tree

```
(define eval-program
  (lambda (pgm)
    (cases program pgm
      (a-program (c-decls exp)
        (elaborate-class-decls! c-decls)
        (eval-expression exp (init-env))))))
```

Interpreter

- Expression form: object creation

```
(new-object-exp (class-name rands)
  (let ((args (eval-rands rands env))
        (obj (new-object class-name)))
    (find-method-and-apply
      'initialize class-name obj args)
    obj))
```

Interpreter

- Expression form: method call

```
(method-app-exp (obj-exp method-name rands)
  (let ((args (eval-rands rands env))
        (obj (eval-expression obj-exp env)))
    (find-method-and-apply
      method-name (object->class-name obj)
      obj args)))
```

Interpreter

- Expression form: super call

```
(super-call-exp (method-name rands)
  (let ((args (eval-rands rands env))
        (obj (apply-env env 'self)))
    (find-method-and-apply
      method-name (apply-env env '%super)
      obj args)))
```

Interpreter: To Do

- Build tree given class declarations
- Implement object representation
- Implement method finding and invocation