### MASSACHVSETTS INSTITVTE OF TECHNOLOGY

Department of Electrical Engineering and Computer Science 6.001—Structure and Interpretation of Computer Programs Fall 2007

# Recitation 20 - 11/16/2007Amb Evaluator

#### AMB Eval

The AMB evaluator adds one new special form called amb which takes a set of possible values and returns one of them. For example,

```
(amb 1 2 3) could take on the value 1, 2, or 3.
```

amb called with no values represents a failure: there are no possible values, so the evaluator needs to backtrack and try another value.

In addition to the new special form, a new procedure named require is often useful:

```
(define (require p)
  (if (not p) (amb)))
```

One way to read that definition is to check the condition **p**, and if it is true, then proceed, otherwise backtrack to try some other set of values before proceeding.

Example:

```
(let ((a (amb 1 2 3 4)))
    (require (even? a))
    (require (> a 3))
    a)
```

How about this version?

```
(let ((a (an-element-of (list 1 2 3 4))))
    (require (even? a))
    (require (odd? a))
    a)
```

## Implementing AMB as an evaluator

In the normal version of the analyze evaluator, analyze takes in an expression, and returns a procedure that takes in an environment as argument and carries out that operation.

In amb-eval the procedures returned are different and all look like this:

```
(define (analyze-self-evaluating exp)
  (lambda (env succeed fail)
     (succeed exp fail)))
```

Rather than return a value, they all pass the value to success: nothing ever returns!

The difference is analyze-amb:

This one does call the failure continuation, to backtrack to the last branch point.

The rest of the amb definition are in SICP <sup>1</sup>

```
(define amb-fail '*)
(define initialize-amb-fail
  (lambda ()
    (set! amb-fail
      (lambda ()
        (error "amb tree exhausted")))))
(initialize-amb-fail)
(define-macro amb
  (lambda alts
    '(let ((+prev-amb-fail amb-fail))
       (call/cc
        (lambda (success)
          ,@(map (lambda (alt)
                    '(call/cc
                      (lambda (fail)
                        (set! amb-fail
                          (lambda ()
                            (set! amb-fail +prev-amb-fail)
                            (fail 'fail)))
                        (success ,alt))))
                 alts)
          (+prev-amb-fail))))))
```

<sup>&</sup>lt;sup>1</sup>If you want to try out amb in DrScheme, you can either run all the code for the amb evaluator (in SICP), or you can add the following definitions which will let you use amb in normal DrScheme. Don't ask me how this works (I didn't write it!), though if you look at it you'll see that it has success and failure continuations just like the amb-eval version. Note that there are two different quote characters here: normal quote (') and backquote (').

## 8 Queens

Suppose you have a  $n \times n$  chessboard. How can you place n queens on the board such that all the positions are safe (no other queen can capture one of the others in a single move).

For n=2, there are no solutions, though for n=8 there are several, one of which is:

*							
						*	
			*				
					*		
							*
							Α.
	*						Τ
	*	*		*			Τ

Write a procedure queens which uses amb to produce solutions to this puzzle.

To begin with, notice that any solution will have exactly one queen in each row and column of the solution. As such let's represent a solution as a list of n elements: each element represents the row that that column's queen is in. For example (queens 4)  $\implies$  (2 4 1 3) is one possible solution.

The following helper procedures may be useful: