Implementing Recursion via State

CS 350

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Recursion via State

Overview

- Goals

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  - To see how to implement an interpreter for a language with recursion

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  - To see how to implement an interpreter for a language with recursion
  - To see how recursion interacts with environments and stores
- Key Concepts
  - Landin's Knot

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    - Exactly like `letvar`, except **x is also in scope in e1**

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  - Should raise an error or loop forever
  - In a later lecture we'll see a way to give this semantics

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  - Definitions that refer to x but don't try to evaluate it
  - **Recursive occurrences of the variable must be in the body of a lambda**
    - Lambda bodies aren't evaluated until call time

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  - Then, interpret the body `e2` with this updated store

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```
(define (interp [env : Env]
                [e : Expr]
                [sto : Store]) : Result
  (type-case Expr e
   [(LetRec x xexpr body)
     (let* ([x-loc (new-loc sto)] ;; Location for x
            [dummy-sto ;; Put a dummy value at x's location
               (override-store (cell x-loc
                                     (Var 'recursionError)))])
       (with ([x-val x-sto]
               ;; Interpret xexpr in env with x's location
                 (interp (extendEnv (bind x x-loc) env)
                         xexpr
                         dummy-sto))
         ;; Interpret body in env with x's location
         ;; and store with x's newly computed value
         ;; plus any side-effects from xexpr
         (interp (extendEnv (bind x x-loc) env) body
                 (override-store (cell x-loc x-val) x-sto))))]
```

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               {if0 x
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                   {* x {fact {- x 1}}}}}}
      {fact 3}}
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- To evaluate `letrec` we:
  - Make a new location `0` for `fact`
  - Evaluate the value for `fact`
    - Env: `fact := 0`

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    - Make a new location `0` for `fact`
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        - Env: `fact := 0`
        - Store: `0 => (Var 'recursionError)` ~~

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(ClosureV
   (Fun 'x (Ifo (Var 'x)
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  - Interp of function doesn't interp body of function
- Closure captures environment with `fact := 0`
  - Only captures environment, **not store**

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  - Etc. until we reach 0 and don't have a recursive call

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  - Mutable references/variables
- Useful in typed languages that can't give the Y-combinator a type