

$\rho^b$  Closure  $\rightarrow$  Augmenting Semantics  $\rho \vdash e \Rightarrow v$

$\rightarrow$  Rewrite into F<sup>b</sup>SR

$\langle \lambda x.e, \rho \rangle$   $\rho \Rightarrow$  a mapping

$\downarrow$   
record

Add: Fun  $x \rightarrow$  Fun  $y \rightarrow x + y$

*Add 3* (with arrow pointing to  $x$ )

$\Downarrow$

Add': Fun  $x \rightarrow \{$   
  fu = Fun env  $\rightarrow$  Fun  $y \rightarrow$  env.x + y

*captured variable*  $\{$   
  env =  $\{$   
    *name*  $x = x$   $\rightarrow$  *evaluated to a value*

Rewrite A

Add' [3]  $\Rightarrow$   $\{$   
  fu = Fun env  $\rightarrow$  Fun  $y \rightarrow$  env.x + y  
  env =  $\{$   
    *struct*  $x = [3]$

Let  $\text{add3} = \text{Add}'\ 3$  In  
 $\boxed{\text{add3}\ 5}$   $\xrightarrow{\text{rewritten to}}$   $\text{add3.fn}\ \boxed{\text{add3.env}\ 5}$

## Encode Recursion

Rewrite B:

$\text{Add}'3 \Rightarrow ?$

Captured by Closure  $\left\{ \begin{array}{l} \text{fn} = \text{Fun this} \rightarrow \text{Fun } y \rightarrow \text{this.env.x} + y; \\ \text{env} = \{ x = 3 \}; \end{array} \right.$  Alternatively  $\text{this.fn arg}$

Call site  $\text{Add}'3\ 5$

$\Downarrow$  rewritten to

$\text{Add}'3.\text{fn}\ \boxed{\text{Add}'3}\ 5$

In a Closure, there are **Captured Variables**. CV

$\text{CV} \supset \text{FV}(\text{function body})$

$\Rightarrow$  function itself or all dependent functions