

Encoding

Use a language without a feature to exhibit behavior as if it has that feature

$$\begin{array}{l} \text{Fb} \xrightarrow{\text{(without Let)}} \text{Fbb} \\ \text{(with pairs)} \quad \text{FbP} \rightarrow \text{Fb} \\ \text{(with lists)} \quad \text{FbL} \rightarrow \text{FbP} \end{array}$$

Alternatively: define features directly.

Things Fb doesn't have it:

- Lists
- Imperative loops
- Variants
- Strings, floats, chars, other primitives
- Structs
- Mutable variables

FbR — record

$e \Rightarrow v$

$e ::= \dots \mid \{l=e; \dots l=e\} \mid e.l$

$v ::= \dots \mid \{l=v; \dots l=v\}$

$l ::= (\text{labels})$

$\forall i \in \{1..n\}. e_i \Rightarrow v_i$

$\{a=4; b=3\} \Rightarrow \{a=4; b=3\}$

$\{a=1+2; b=7\}.a \Rightarrow 3$

$\{a=\text{Function } z \rightarrow z+1; b=2\}.a \quad 4 \Rightarrow 5$

$\{a=\text{True}+1; b=6\}.b \not\Rightarrow$

Record

$$\frac{e_1 \Rightarrow v_1 \quad \dots \quad e_n \Rightarrow v_n}{\{l_1=e_1; \dots; l_n=e_n\} \Rightarrow \{l_1=v_1; \dots; l_n=v_n\}}$$

Projection

$$\frac{e \Rightarrow \{l_1=v_1; \dots; l_n=v_n\} \quad l=l_k \quad k \in \{1..n\}}{e.l \Rightarrow v_k}$$

FbV variants!

$e ::= \dots \mid 'l e \mid \text{Match } e \text{ With } 'l x \rightarrow e \mid 'l x \rightarrow e \mid \dots$

$v ::= \dots \mid 'l v$

'Int (5+1)

'Some True

'Shirt ('Green 0)

Variant

$$\frac{e \Rightarrow v}{'l e \Rightarrow 'l v}$$

Match

$$\frac{e_0 \Rightarrow 'l v_0 \quad l=l_k \quad k \in \{1..n\} \quad e_k[v_0/x_k] \Rightarrow v_k}{\text{Match } e_0 \text{ With } 'l_1 x_1 \rightarrow e_1 \mid \dots \mid 'l_n x_n \rightarrow e_n \Rightarrow v_k}$$

Match $'A5$ With
 $'l_1 \mid 'A q \rightarrow q$
 $\mid 'B r \rightarrow r+1$
 v_1

FbV $\rightarrow$ FbR

FbR $\rightarrow$ FbV

⁺
variants and records are duals
or
^{*}
and

FbR encoded in FbV

$\llbracket \{l_1 = e_1; \dots; l_n = e_n\} \rrbracket =$
 Let $x_1 = \llbracket e_1 \rrbracket$ In
 $\vdots$
 Let $x_n = \llbracket e_n \rrbracket$ In
 Function $|b| \rightarrow$
 Match $|b|$ With
 $|l_1 x_1 \rightarrow x_1$
 $| \dots$
 $|l_n x_n \rightarrow x_n$

$\llbracket e.l \rrbracket = \llbracket e \rrbracket (l 0)$

FbV encoded in FbR

$\llbracket l e \rrbracket =$ (exercise!)

$\llbracket \text{Match } e_0 \text{ With} \rrbracket$
 $|l_1 x_1 \rightarrow e_1$
 $\vdots$
 $|l_n x_n \rightarrow e_n \rrbracket =$
 $\{l_1 = \text{Function } x_1 \rightarrow \llbracket e_1 \rrbracket$
 $\vdots$
 $l_n = \text{Function } x_n \rightarrow \llbracket e_n \rrbracket\}$