

CS 421 HW4 Solution

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September 23, 2013

$$\begin{aligned} & [[\text{fn } f \Rightarrow \text{fn } x \Rightarrow \text{if } x > 0 \text{ then } f \ x \text{ else } f \ ((-1) * x)]]_{(\text{FUN } w \rightarrow \text{report } w)} \\ &= (\text{FUN } w \rightarrow \text{report } w)(\text{FN } f \ k1 \rightarrow [[\text{fn } x \Rightarrow \text{if } x > 0 \text{ then } f \ x \text{ else } f \ ((-1) * x)]]_{k1}) \\ &= (\text{FUN } w \rightarrow \text{report } w)(\text{FN } f \ k1 \rightarrow k1(\text{FN } x \ k2 \rightarrow [[\text{if } x > 0 \text{ then } f \ x \text{ else } f \ ((-1) * x)]]_{k2})) \\ &= (\text{FUN } w \rightarrow \text{report } w)(\text{FN } f \ k1 \rightarrow k1(\text{FN } x \ k2 \rightarrow [[x > 0]]_{(\text{FUN } y \rightarrow \text{IF } y \text{ THEN } [[f \ x]]_{k2} \text{ ELSE } [[f \ ((-1) * x)]]_{k2})})) \\ &= (\text{FUN } w \rightarrow \text{report } w)(\text{FN } f \ k1 \rightarrow k1(\text{FN } x \ k2 \rightarrow ((\text{FUN } y \rightarrow \text{IF } y \text{ THEN } [[f \ x]]_{k2} \text{ ELSE } [[f \ ((-1) * x)]]_{k2})(x > 0)))) \\ &= (\text{FUN } w \rightarrow \text{report } w)(\text{FN } f \ k1 \rightarrow k1(\text{FN } x \ k2 \rightarrow \\ & ((\text{FUN } y \rightarrow \text{IF } y \text{ THEN } [[f]]_{(\text{FUN } a \rightarrow [[x]]_{(\text{FUN } b \rightarrow a \ b \ k2)})} \text{ ELSE } [[f]]_{(\text{FUN } c \rightarrow [((-1) * x)]_{(\text{FUN } d \rightarrow c \ d \ k2)})})(x > 0)))) \\ &= (\text{FUN } w \rightarrow \text{report } w)(\text{FN } f \ k1 \rightarrow k1(\text{FN } x \ k2 \rightarrow ((\text{FUN } y \rightarrow \text{IF } y \text{ THEN } [[f]]_{(\text{FUN } a \rightarrow ((\text{FUN } b \rightarrow a \ b \ k2) \ x))} \\ & \text{ELSE } [[f]]_{(\text{FUN } c \rightarrow [((-1) * x)]_{(\text{FUN } m \rightarrow [[x]]_{(\text{FUN } n \rightarrow ((\text{FUN } d \rightarrow c \ d \ k2) (m * n))})))})(x > 0)))) \\ &= (\text{FUN } w \rightarrow \text{report } w)(\text{FN } f \ k1 \rightarrow k1(\text{FN } x \ k2 \rightarrow ((\text{FUN } y \rightarrow \text{IF } y \text{ THEN } ((\text{FUN } a \rightarrow \\ & ((\text{FUN } b \rightarrow a \ b \ k2) \ x)) \ f) \text{ ELSE } [[f]]_{(\text{FUN } c \rightarrow [((-1) * x)]_{(\text{FUN } m \rightarrow ((\text{FUN } n \rightarrow ((\text{FUN } d \rightarrow c \ d \ k2) (m * n)) \ x))})))})(x > 0)))) \\ &= (\text{FUN } w \rightarrow \text{report } w)(\text{FN } f \ k1 \rightarrow k1(\text{FN } x \ k2 \rightarrow ((\text{FUN } y \rightarrow \text{IF } y \text{ THEN } ((\text{FUN } a \rightarrow \\ & ((\text{FUN } b \rightarrow a \ b \ k2) \ x)) \ f) \text{ ELSE } ((\text{FUN } c \rightarrow ((\text{FUN } m \rightarrow ((\text{FUN } n \rightarrow ((\text{FUN } d \rightarrow c \ d \ k2) (m * n)) \ x))} \\ & \ (-1))) \ f)))(x > 0)))) \end{aligned}$$