

Week 5 - Midterm prep

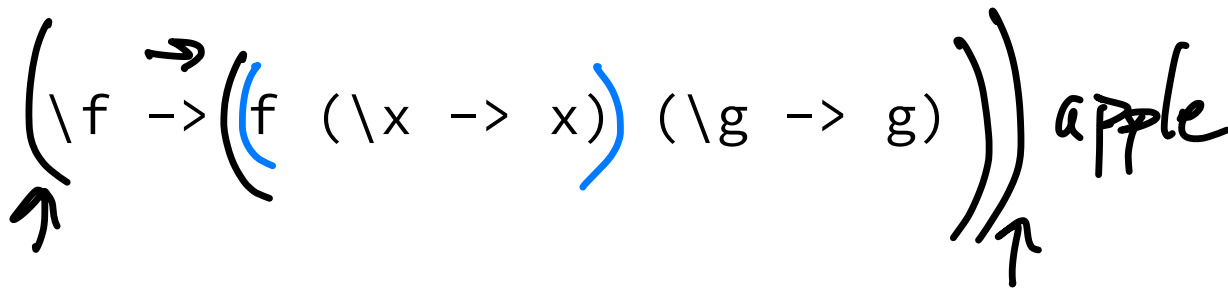
Agenda

- Lambda Calculus Reminder
- Haskell

Lambda Calculus

Tips:

1. Function application is LEFT associative!
2. Function abstraction is RIGHT associative!



The image shows a handwritten lambda calculus expression: $(\lambda f \rightarrow ((f (\lambda x \rightarrow x)) (\lambda g \rightarrow g))) \text{ apple}$. Annotations include a left-pointing arrow above the expression, a right-pointing arrow below it, an upward arrow under the first lambda symbol, a rightward arrow above the first lambda body, and a rightward arrow under the final closing parenthesis.

Lambda Calc

$$(\lambda x \rightarrow e_1) e_2$$

Check the box next to **each** term that contains **exactly one** redex (i.e. there is one and only one way to apply a beta step to this term).

(A) $(\lambda x \rightarrow x) (\lambda x \rightarrow x)$ $\rightarrow_b (\lambda x \rightarrow x)$ ☒

↓ (B) $\lambda x \rightarrow (x (\lambda x \rightarrow x))$ ☐

↗ (C) $(f (\lambda x \rightarrow x) (\lambda x \rightarrow x))$ ☐

↓ (D) $((\lambda x \rightarrow x) f) (\lambda x \rightarrow x)$ $\rightarrow_b f (\lambda x \rightarrow x)$ ☒

(E) $(\lambda f x \rightarrow f (f x)) y z$ $\rightarrow_b y(y z)$ ☒

Which are valid reductions?

$(X \Rightarrow X) (Y \Rightarrow \text{apple } Y) (Z \Rightarrow Z)$
 $\Rightarrow_b (Y \Rightarrow \text{apple } Y) (Z \Rightarrow Z)$
 $\Rightarrow_b \text{apple } (Z \Rightarrow Z)$

$((\backslash x \rightarrow x) (\backslash y \rightarrow \text{apple } y)) (\backslash z \rightarrow z)$

(A) $\Rightarrow_b (\backslash x \rightarrow x) (\text{apple } (\backslash z \rightarrow z))$

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$\uparrow\uparrow$ (B) $\Rightarrow_b (\backslash y \rightarrow \text{apple } y) (\backslash z \rightarrow z)$

☒

\uparrow (C) $\Rightarrow_a (\backslash z \rightarrow z) (\backslash y \rightarrow \text{apple } y) (\backslash z \rightarrow z)$
~~change $x \rightarrow z$~~

☒

$\uparrow\uparrow$ (D) $\Rightarrow_a (\backslash x \rightarrow x) (\backslash y \rightarrow \text{apple } y) (\backslash z \rightarrow z)$
~~THREE~~

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$\uparrow\uparrow$ (E) $\Rightarrow_{\sim} \text{apple } (\backslash z \rightarrow z)$

☒

Haskell

Go through an exam question live