CS421 HW04
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(Teamed with Yifang Zhang – zhang303 and Qian Sun - qiansun1)

Problem 1.

$[[\text{fn f => fn x => if x > 0 then f x else f ((-1) * x)}]]_{(\text{FUN w -> report w})}$

$= (\text{FUN w -> report w})\ (\text{FN f k0 -> } [[\text{fn x => if x > 0 then f x else f ((-1) * x)}]]_{k0})$

$= (\text{FUN w -> report w})\ (\text{FN f k0 -> k0 (FN x k1 -> } [[\text{if x > 0 then f x else f ((-1) * x)}]]_{k1}))$

$= (\text{FUN w -> report w})$
$(\text{FN f k0 -> k0 (FN x k1 -> } [[x > 0]]\ \text{FUN v -> IF v THEN } [[f\ x]]_{k1}\ \text{ELSE } [[f\ ((-1) * x)]]_{k1}))$

$= (\text{FUN w -> report w})$
$(\text{FN f k0 -> k0 (FN x k1 -> } [[x > 0]]\ \text{FUN v -> IF v THEN } [[f]]\ \text{FUN y -> } [[x]]\ \text{FUN z -> y z k1}\ \text{ELSE } [[f((-1)*x)]]k1))$

$= (\text{FUN w -> report w})$
$(\text{FN f k0 -> k0 (FN x k1 -> } [[x > 0]]\ \text{FUN v -> IF v THEN (FUN y -> (FUN z -> y z k1)x)f ELSE } [[f((-1)*x)]]_{k1}))$

$= (\text{FUN w -> report w})$
$(\text{FN f k0 -> k0 (FN x k1 -> } [[x > 0]]\ \text{FUN v -> IF v THEN (FUN y -> (FUN z -> y z k1)x)f ELSE } [[f]]\ \text{Fun y -> } [[((-1) * x)]]\ \text{FUN z -> y z k1}))$

$= (\text{FUN w -> report w})$
$(\text{FN f k0 -> k0 (FN x k1 -> } [[x > 0]]\ \text{FUN v -> IF v THEN (FUN y -> (FUN z -> y z k1)x)f ELSE } [[f]]\ \text{Fun y -> } [[-1]]\ \text{FUN g -> } [[x]]\text{FUN h -> (FUN z -> y z k1)(g*h)}))$

$= (\text{FUN w -> report w})$
$(\text{FN f k0 -> k0 (FN x k1 -> } [[x > 0]]\ \text{FUN v -> IF v THEN (FUN y -> (FUN z -> y z k1)x)f ELSE } [[f]]\ \text{Fun y -> } [[-1]]\ \text{FUN g -> } [[x]]\text{FUN h -> (FUN z -> y z k1)(g*h)}))$

$= (\text{FUN w -> report w})$
$(\text{FN f k0 -> k0 (FN x k1 -> } [[x]]\text{FUN a ->}[[0]]\text{FUN b -> (}\ \text{FUN v -> IF v THEN (FUN y -> (FUN z -> y z k1)x)f ELSE } [[f]]\ \text{Fun y -> } [[-1]]\ \text{FUN g -> } [[x]]\text{FUN h -> (FUN z -> y z k1)(g*h)})))$

```
= (FUN w -> report w)
      (FN f k0 -> k0
         (FN x k1 ->
            (FUN a ->
               (FUN b ->
                  (FUN v -> IF v THEN
                     (FUN y ->
                        (FUN z -> y z k1)
                     x)f
                     ELSE
                           (FUN y ->
                              (FUN g ->
                                 (FUN h->
                                    (FUN z -> y z k1)
                                       (g*h)
                                 )
                              x)
                           -1)
                  f)
               (a>b))
            0)
         x)
         )
```