Exercises
The Lambda Calculus

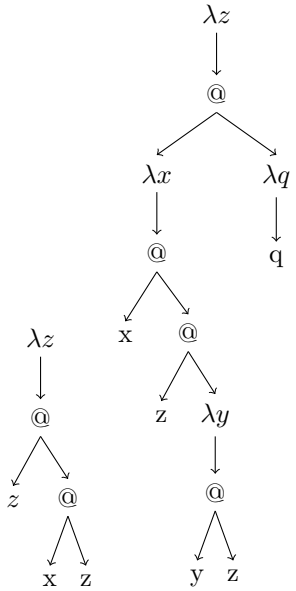
Exercise 1

Write out lambda calculus trees for the following expressions.

1. $\lambda x.\lambda y.xy$
2. $\lambda x..\lambda y.xy.\lambda z.yz$
3. $\lambda x.(.\lambda y.xy)(.\lambda z.yz)$

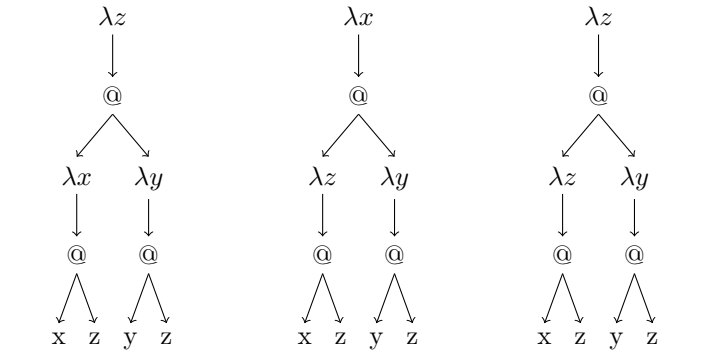
Exercise 2

Write out the equivalent lambda calculus expression for the following trees.



Exercise 3

Find the free variables What are the free variables? To which lambdas are bound variables bound?



Exercise 4

Using β reduction etc., rewrite these expressions in normal form.

1. $(\lambda x.x)y$
2. $(\lambda x.xz)(\lambda y.y)$
3. $(\lambda x.x(\lambda x.y))(\lambda z.z)$
4. $(\lambda x.(\lambda y.x))y(\lambda z.z))$
5. $(\lambda x.xx)(\lambda x.xx)$