

In this example, I always choose the *normal order* reduction. Normal order is always “outermost leftmost” in the AST. The **highlight** identifies the parts of the AST reduced in the next step.

expression	AST	derivation rule
$(\lambda f. \lambda x. f(fx))(\lambda z. (+xz))2$		given
$(\lambda f. \lambda a. f(fa))(\lambda z. (+xz))2$		α reduce a for x to avoid “capturing” the free x
$(\lambda a. (\lambda z. (+xz))((\lambda z. (+xz))a))2$		β reduce $(\lambda z. (+xz))$ for f

expression	AST	derivation rule
$((\lambda z.(+xz))((\lambda z.(+xz))2))$ $(\lambda z.(+xz))((\lambda z.(+xz))2)$		β reduce 2 for a eliminate parens
$((+x((\lambda z.(+xz))2)))$ $(+x((\lambda z.(+xz))2))$		β reduce $((\lambda z.(+xz))2)$ for z Eliminate parens.
$(+x(((+x2))))$ $(+x(+x2))$		β reduce 2 for z Eliminate parens. Done.