

# Lambda Calculus

## Abstract Syntax

$X = \{x, y, z, \dots\}$  — variables

$C = \{X, Y, Z, \dots\}$  — constructors

$\Lambda =$

$X$	— variable
$ $	$C$ — constructor
$ $	$\lambda X. \Lambda$ — abstraction
$ $	$\Lambda \Lambda$ — application

## Call by Name (Small-Step)

Substitution:

$$x[z \leftarrow B] = \begin{cases} B & , \quad z = x \\ x & , \quad z \neq x \end{cases}$$

$$X[x \leftarrow B] = X$$

$$(M N)[x \leftarrow A] = (M[x \leftarrow A])(N[x \leftarrow A])$$

$$(\lambda z. B)[x \leftarrow A] = \begin{cases} \lambda z. B & , \quad z = x \\ \lambda z. (B[x \leftarrow A]) & , \quad z \neq x \end{cases}$$

Reduction rules:

$$(\lambda x. A) B \rightarrow A[x \leftarrow B] \quad [\text{RED}]$$

$$\frac{M \rightarrow M'}{M N \rightarrow M' N}, \quad M \neq \lambda x. A \quad [\text{APP}]$$