

$$1. \quad I \quad [a \rightarrow b] \rightarrow a \Rightarrow [b]$$

$$f [] a = []$$

$$\cancel{f(h:t) a = (ha):(f t a)}$$

$$f(h:t) a = (h a):(f t a)$$

$$3. \quad I \quad Int$$

It is isomorphic to type of  
~~32~~ tuple of ~~32~~ <sup>64</sup> Booleans.

(Bool, Bool, ... Bool)  
<sup>64</sup> times.

from Int  $n = \cancel{n} \rightarrow (n \geq 0, n \text{ 'mod' } 2 == 1,$   
 $(n \text{ 'div' } 2) \text{ 'mod' } 2 == 1, \dots)$

3.  $I \quad Int$  is isomorphic to Data.Word  
 $to :: Int \rightarrow Word64$   
 $to \cancel{=} fromIntegral$

from :: Word64  $\Rightarrow$  Int  
from = fromIntegral.

in other words,  $y = (x + 2^{64}) \bmod 2^{64}$

for  $x :: \text{Int}$ ,  $y :: \text{from} \cdot \text{Word64}$ ,

$x = y - k \cdot 2^{64}$  where  $k$  is 1 if  $y \geq 2^{63}$   
and 0 otherwise,  $x :: \text{Int}$ ,  $y :: \text{Word64}$ .  
4.  $\lambda x f g. f (g x)$ , assuming that  $x :: t_2$ .

$g$  is applied to  $x$ , so  $g :: t_2 \Rightarrow t_1$ .

$f$  is applied to  $g(x)$ , so  
which is  $t_1$ ,

$f :: t_2 \rightarrow t_1 \Rightarrow t_3$ , and result is  $t_3$ .

So the whole term is

$t_2 \Rightarrow (t_1 \Rightarrow t_3) \Rightarrow (t_2 \Rightarrow t_1) \Rightarrow t_3$ .