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14.1

B(t) = true
B(f) = false

E = ...
if E M N

C = ...
if C C C

Bv: if M1 M2 M3
--> M1, in-hole E (if hole M2 M3)
b, (if hole M2 M3)
M2 if b == true
M3 if b == false

	$\frac{x:\text{num} \mid - \ x:\text{num}}{\text{-----}}$	$\frac{x:\text{num} \mid - \ x:\text{num}}{\text{-----}}$
$\frac{\theta : \text{num}}{\text{-----}}$	$\frac{x:\text{num} \mid - \ (\text{add1 } x) : \text{num}}{\text{-----}}$	$\frac{x:\text{num} \mid - \ (\text{sub1 } x) : \text{num}}{\text{-----}}$
$(\text{iszero } \theta) : \text{bool} \text{ and } (\lambda x:\text{num} (\text{add1 } x)) : (\text{num} \rightarrow \text{num}) \text{ and } (\lambda x:\text{num} (\text{sub1 } x)) : (\text{num} \rightarrow \text{num})$		

$\mid - \ (\text{if } (\text{iszero } \theta) (\lambda x:\text{num} (\text{add1 } x)) (\lambda x:\text{num} (\text{sub1 } x))) : (\text{num} \rightarrow \text{num})$		

$\rightarrow \rightarrow v (\lambda x:\text{num} (\text{add1 } x))$		

14.2

```

0:num
-----
(add1 0):num and t:bool
-----
<(add1 0), t> : (num * bool)
-----
(fst <(add1 0), t>) : num

(fst <(add1 0), t>)
->v
(fst <1, t>)
->v
1

```

14.3

(isnull (list1 13))

```

                x:bool |- t:bool                x:num |- f:bool
                -----                -----
l:bool+num |- l:(bool+num) and (λx:bool t):(bool->bool) and (λx:num f):num->bool
-----
l:bool+num |- (Match((bool+num)->bool) l (λx:bool t) (λx:num f)):bool
-----
(λl:(bool+num). (Match((bool+num)->bool) l (λx:bool t) (λx:num f))):((bool+num)->bool)
*((λv:num (ToRight(bool+num) v)) 13):(bool+num)
-----
(λl:(bool+num). (Match((bool+num)->bool) l (λx:bool t) (λx:num f)))
((λv:num (ToRight(bool+num) v)) 13)

v:num |- v:num
-----
v:num |- (ToRight(bool+num) v) : (bool+num)
-----
(λv:num (ToRight(bool+num) v)):(num->(bool+num)) and 13:num
-----
*((λv:num (ToRight(bool+num) v)) 13):(bool+num)

evaluate: ((λl:(bool+num). (Match((bool+num)->bool) l (λx:bool t) (λx:num
f))) ((λv:num (ToRight(bool+num) v)) 13))
-->v
((λl:(bool+num). (Match((bool+num)->bool) l (λx:bool t) (λx:num f)))
(ToRight(bool+num) 13))
-->v
(Match((bool+num)->bool (ToRight(bool+num) 13) (λx:bool t) (λx:num f)))
-->v
((λx:num f) 13)
-->v
f

```

14.4

```

x:T |- x:T
-----
(λx:T x):(T->T)
-----
(fix (λx:T x)):T

```

(fix (λx:num x)) is an infinite loop.