Refinement Reflection: Complete Verification with SMT

Friday @13:40

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How to turn Haskell* into a theorem prover

*your favorite refinement typed programming language

```
-- math
{-@ fMono :: f:(Nat -> Int)
          -> (z:Nat -> {f z < f (z + 1) })
          -> x:Nat -> y:{Nat | x < y}
          -> {f x < f y}
          / [y]
  @-}
fMono f thm x y
  | x + 1 < y
  = f x <. f (x+1) ==. f y
  *** QED
  | otherwise
  = f x <. f (y-1) ? fMono f thm x (y-1)
        <. f y     ? thm (y-1)
  *** QED
```

```
-- list laws
{-@ assoc :: xs:[a] -> ys:[a] -> zs:[a]
          -> {xs ++ (ys ++ zs) == (xs ++ ys) ++ zs}
  @-}
assoc []     _  _  = trivial
assoc (_:xs) ys zs = assoc xs ys zs
```

```
--  allDistr ≡  (∀x.p x ∧ q x) ⇒ ((∀x.p x) ∧ (∀x.q x))
{-@ allDistr :: p:(a -> Bool) -> q:(a -> Bool)
             -> (x:a  -> ({p x}, {q x}))
             -> ((x:a -> {p x}), (x:a -> {q x}))
  @-}
allDistr _ _ andx = (pf, pf)
  where pf x = case andx x of (px,py) -> px && py
```