T (28 pts)

read3Ints : IO (M (Int × Int × Int))

R Escolha 6 dos 10. (6 × 12 pts)

unit , (**) ⊦⊢ pure , ⊛
fmap , join ⊢ (>>=)
fmap , join ⊣ (>>=), pure

Functor instance para __um__ dos :⟨ $(\delta \to)$
                                    $(\to \gamma)$

Uma fmap que respeita a lei de (∘) mas não de id

sequenceAL : Applicative f ⇒ List (f α) ⟶ f (List α)

$$\text{lift} \qquad \text{fmap}_f \;:\; (\alpha \to \beta) \;\longrightarrow\; (f\,\alpha \to f\,\beta)$$

$$\text{ap}_m := (\circledast_a) \;\equiv\; \text{splat}_a \;:\; a\,(\alpha \to \beta) \;\longrightarrow\; (a\,\alpha \to a\,\beta)$$

$$\text{bind} \begin{cases} (=\!\!\ll_m) \;:\; (\alpha \to m\,\beta) \;\longrightarrow\; (m\,\alpha \to m\,\beta) \\ (\gg\!=_m) \;:\; m\,\alpha \to (\alpha \to m\,\beta) \;\longrightarrow\; m\,\beta \end{cases}$$

$$\text{join}_m \;:\; m\,(m\,\alpha) \longrightarrow m\,\alpha$$

$$\text{return}_m := \text{pure}_a \;:\; \alpha \longrightarrow a\,\alpha$$

$$\text{kleisli} \begin{cases} (\ggg_m) \;:\; (\alpha \to m\,\beta) \to (\beta \to m\,\gamma) \longrightarrow (\alpha \to m\,\gamma) \\ (\lll_m) \;:\; (\beta \to m\,\gamma) \to (\alpha \to m\,\beta) \longrightarrow (\alpha \to m\,\gamma) \end{cases}$$

$$(\gg_m) := (\circledast\!\!*_a) \;:\; a\,\alpha \longrightarrow a\,\beta \longrightarrow a\,\beta$$

$$\text{void}_f \;:\; f\,\alpha \longrightarrow f\,\mathbb{1}$$

$$\text{unit}_n \;:\; n\,() \qquad\qquad \text{unit}'_n \;:\; \mathbb{1} \to n\,()$$

$$(*\!*)_n \;:\; n\,\alpha \to n\,\beta \to n\,(\alpha \times \beta) \qquad (*\!*')_n \;:\; (n\,\alpha \times n\,\beta) \to n\,(\alpha \times \beta)$$