Session-Typed Concurrent Programming

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1 Recap

1.1 Weakening

$$\frac{\Gamma \vdash C}{\Gamma, A \vdash C}$$

1.2 Contraction

$$\frac{\Gamma, A, A \vdash C}{\Gamma, A \vdash C}$$

2 Connections

Curry-Howard correspondence between intuitionistic linear logic and session-typed π-calculus.
Logic:

- Linear Propositions
- Proofs
- Cut reduction

Programming:

- Session Types
- Programs
- Communication

2.1 Logical Connectives

$A, B, C ::=$
$A \multimap B$ mult impl
$A \otimes B$ mult conjunction
$A \& B$ additive conjunction
$A \oplus B$ additive disjunction
$!A$ Of course, persistent

2.2 Examples

$x_1 : A_1, \ldots, x_n : A_n \vdash P :: (x : A)$
Process P offers a session of type A along channel x, using sessioins of types $A_1, \ldots, A_n$ offered along channels $x_1, \ldots, x_n$

$$\frac{\Delta \vdash P_1 :: (x : A) \quad \Delta \vdash P_2 :: (x : B)}{\Delta \vdash \texttt{case}\ x\ \texttt{of}(P_1, P_2) :: (x : A \& B)}(\& R)$$

$$\frac{\Delta, x : A \vdash Q :: (z : C)}{\Delta, x : A \& B \vdash \texttt{inl}(x); Q :: (z : C)}(\& L_1)$$

$$\frac{\Delta, x : B \vdash Q :: (z : C)}{\Delta, x : A \& B \vdash \texttt{inr}(x); Q :: (z : C)}(\& L_2)$$

$$\frac{\Delta \vdash Q :: (x : A)}{\Delta \vdash \texttt{inl}(x); Q :: (x : A \oplus B)}(\oplus R_1)$$

$$\frac{\Delta \vdash Q :: (x : B)}{\Delta \vdash \texttt{inr}(x); Q :: (x : A \oplus B)}(\oplus R_2)$$

$$\frac{\Delta, x : A \vdash P_1 :: (z : C) \quad \Delta, x : B \vdash P_2 :: (z : C)}{\Delta, x : A \oplus B \vdash \texttt{case}\ x\ \texttt{of}(P_1, P_2) :: (z : C)}(\oplus L)$$

$$\frac{\Delta, y : A \vdash P :: (x : B)}{\Delta \vdash y \leftarrow \texttt{recv}(x); P :: (x : A \multimap B)}(\multimap R)$$

$$\frac{\Delta \vdash Q :: (y : A) \quad \Delta', x : B \vdash Q' :: (z : C)}{\Delta, \Delta', x : A \multimap B \vdash \texttt{send}(x)(y \leftarrow Q); Q' :: (z : C)}(\multimap L)$$

$$\frac{\Delta \vdash Q :: (y : A) \quad \Delta' \vdash Q' :: (x : B)}{\Delta, \Delta' \vdash \texttt{send}(x)(y \leftarrow Q); Q' :: (x : A \otimes B)}(\otimes R)$$

$$\frac{\Delta, x : B, y : A \vdash P :: (z : C)}{\Delta, x : A \otimes B \vdash y \leftarrow \texttt{recv}(x); P :: (z : C)}(\otimes L)$$

$$\frac{}{\cdot \vdash \texttt{close}\ x :: (x : 1)}$$

$$\frac{\Delta \vdash P :: (z : C)}{\Delta, x : 1 \vdash \texttt{wait}\ x; P :: (z : C)}$$