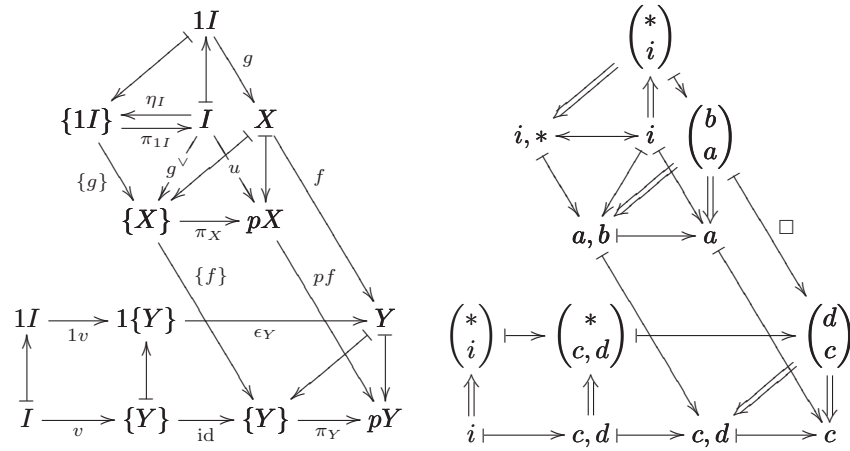
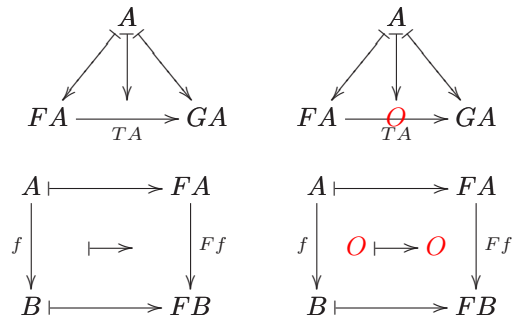


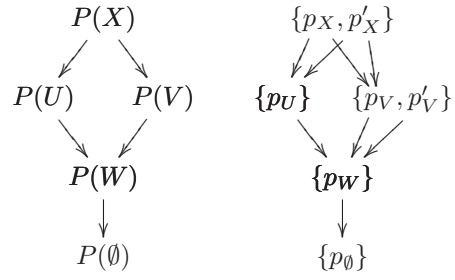
A construction from Bart Jacobs' "Categorical Logic and Type Theory" book (sec. 10.4.7, pp.616–617):



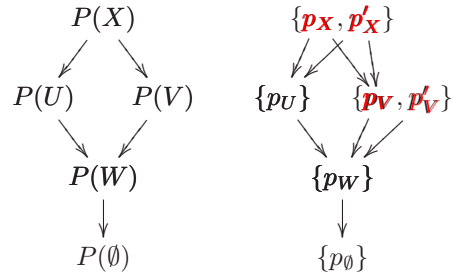
Two examples of diagrams with phantom nodes:



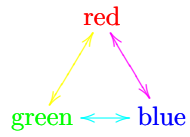
A diagram with relative phantom nodes:



Same, but with the relative phantom nodes in red:



Colored nodes and arrows:



Some β -reductions from Bierman and de Paiva's
 "On an intuitionistic modal logic" paper:

$$\begin{array}{c}
 [x : A]^1 \quad \Gamma \\
 \vdots \\
 M : B \\
 \hline
 N : A \quad (\lambda x : A.M) : A \rightarrow B \quad \supset \mathcal{I}; 1 \\
 \hline
 (\lambda x : A.M)N : B \quad \supset \mathcal{E}
 \end{array}
 \quad
 \begin{array}{c}
 N : A \quad \Gamma \\
 \vdots \\
 M[x := N] : B
 \end{array}$$

$$\begin{array}{c}
 M : A \quad N : B \\
 \langle M, N \rangle : A \times B \quad \wedge \mathcal{I} \\
 \hline
 \text{fst} \langle M, N \rangle : A \times B \quad \wedge \mathcal{E}_1 \quad \rightsquigarrow_{\beta} \quad M : A
 \end{array}$$

$$\begin{array}{c}
 M : A \quad [x : A]^1 \quad \Gamma \quad [y : B]^1 \quad \Delta \\
 \text{inl}(M) : A + B \quad \vee \mathcal{I} \quad N : C \quad P : C \\
 \hline
 \text{case inl}(M) \text{ of } \text{inl}(x) \rightarrow N \parallel \text{inr}(y) \rightarrow P \quad \vee \mathcal{E} \\
 \hline
 \rightsquigarrow_{\beta} \quad \begin{array}{c} M : A \quad \Gamma \\ \vdots \\ N[x := M] : C \end{array}
 \end{array}$$

$$\begin{array}{c}
 \Gamma \quad [\vec{x} : \Box \vec{A}]^1 \\
 \vdots \\
 \vec{M} : \Box A \quad N : B \\
 \hline
 \text{box } N \text{ with } \vec{M} \text{ for } \vec{x} : \Box B \quad \Box \mathcal{I}; 1 \\
 \hline
 \text{unbox}(\text{box } N \text{ with } \vec{M} \text{ for } \vec{x} : \Box B) \quad \Box \mathcal{E} \\
 \hline
 \rightsquigarrow_{\beta} \quad \begin{array}{c} \Gamma \\ \vdots \\ \vec{M} : \Box \vec{A} \\ \vdots \\ N[\vec{x} := \vec{M}] : B \end{array}
 \end{array}$$

$$\begin{array}{c}
 \Gamma \quad \Delta \\
 \vdots \\
 \vec{M} : \Box A \quad N : B \\
 \hline
 P[\vec{x} := \vec{M}, \Diamond y := \Diamond N] : \Diamond C \quad \Diamond \mathcal{I}; 1 \\
 \hline
 \rightsquigarrow_{\beta} \quad \begin{array}{c} \Gamma \quad \Delta \\ \vdots \\ \vec{M} : \Box A \quad N : B \\ \vdots \\ P[\vec{x} := \vec{M}, y := N] : \Diamond C \end{array}
 \end{array}$$

" $P[\vec{x} := \vec{M}, \Diamond y := \Diamond N]$ " is a shorthand for
 "let $\Diamond y \leftarrow \Diamond N$ in P with \vec{M} for \vec{x} ".