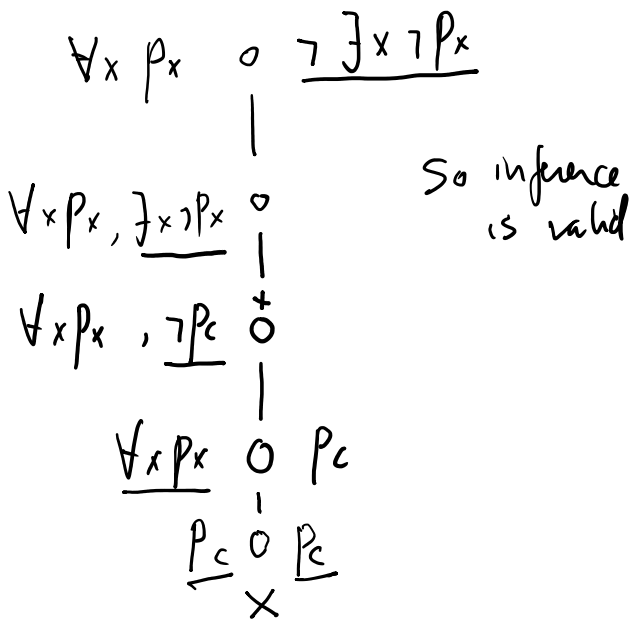


$$\forall x (P_x \rightarrow Q_x) \models \exists x (P_x \wedge \neg Q_x)$$



$$\forall x (P_x \rightarrow Q_x) \models \exists x (P_x \wedge \neg Q_x)$$

$$\frac{\forall x (P_x \rightarrow Q_x) \circ \exists x (P_x \wedge \neg Q_x)}{}$$

$$\frac{P_c \rightarrow Q_c \circ \exists x (P_x \wedge \neg Q_x)}{}$$

$$\frac{P_c \rightarrow Q_c \circ P_c \wedge \neg Q_c}{}$$

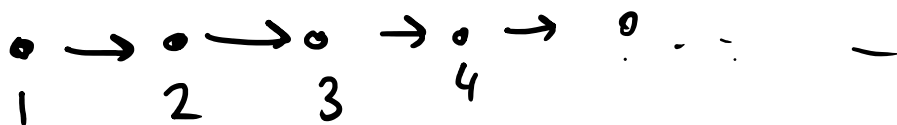
$$\frac{\circ P_c, P_c \wedge \neg Q_c}{\circ P_c, P_c} \quad Q_c \circ P_c \wedge \neg Q_c$$

open

first time, introduce constants;

already a constant, so no introducing new ones!

counter example:
 P_c does not hold
 (Q_c doesn't matter)
 $M = (D, \mathcal{I}, g) \quad D = \{c\}$



$$R \times (x+1)$$

$$\forall y \exists x Rxy \models \exists x \forall y Rxy$$

$$\forall y \exists x Rxy \circ \exists x \forall y Rxy \quad \text{universal step}$$

$$\exists x Rxc \circ \exists x \forall y Rxy \quad \text{existential step}$$

$$\forall y \exists x Rxy, Rdc \circ \exists x \forall y Rxy \quad \text{universal step}$$

$$" " \circ \forall y Rcy, \forall y Rdy \quad \text{existential}$$

$$\forall y \exists x Rxy, Rdc \circ Rce, \forall y Rdy, \exists x \forall y Rxy \quad \text{exist.}$$

$$\forall y \exists x Rxy, Rdc \circ Rce, Rdf, \exists x \forall y Rxy \quad \text{univ}$$

$$\exists x Rxc, \exists x Rxd, \exists x Rxe, \exists x Rxf, Rdc \circ Rce, Rdf, \exists x \forall y Rxy$$

you need extended rules to solve this.

$$\exists x \forall y Rxy \models \forall y \exists x Rxy$$

$$\begin{array}{c}
 \exists x \forall y R_{xy} \models \forall y \exists x R_{xy} \\
 \hline
 \exists x \forall y R_{xy} \quad \circ \quad \forall y \exists x R_{xy} \quad) \text{ exist.} \\
 \quad \quad \quad | \\
 \forall y R_{cy} \quad \overset{+}{\circ} \quad \forall y \exists x R_{xy} \quad) \text{ exist.} \\
 \quad \quad \quad | \\
 \forall y R_{cy} \quad \overset{+}{\circ} \quad \exists x R_{xd} \quad) \text{ univ} \\
 \quad \quad \quad | \\
 R_{cc}, R_{cd} \quad \circ \quad \exists x R_{xd} \quad) \text{ univ} \\
 \quad \quad \quad | \\
 R_{cc}, \underline{R_{cd}} \quad \circ \quad \underline{R_{cd}}, R_{dd} \\
 \quad \quad \quad \times
 \end{array}$$

So inference is valid.

$$\underline{\exists x \forall y (p_x \rightarrow q_y)} \quad \circ \quad \forall x \exists y (p_y \rightarrow q_x)$$

$$\forall y (p_c \rightarrow Q_y) \quad 0 \quad \frac{}{} \quad "$$

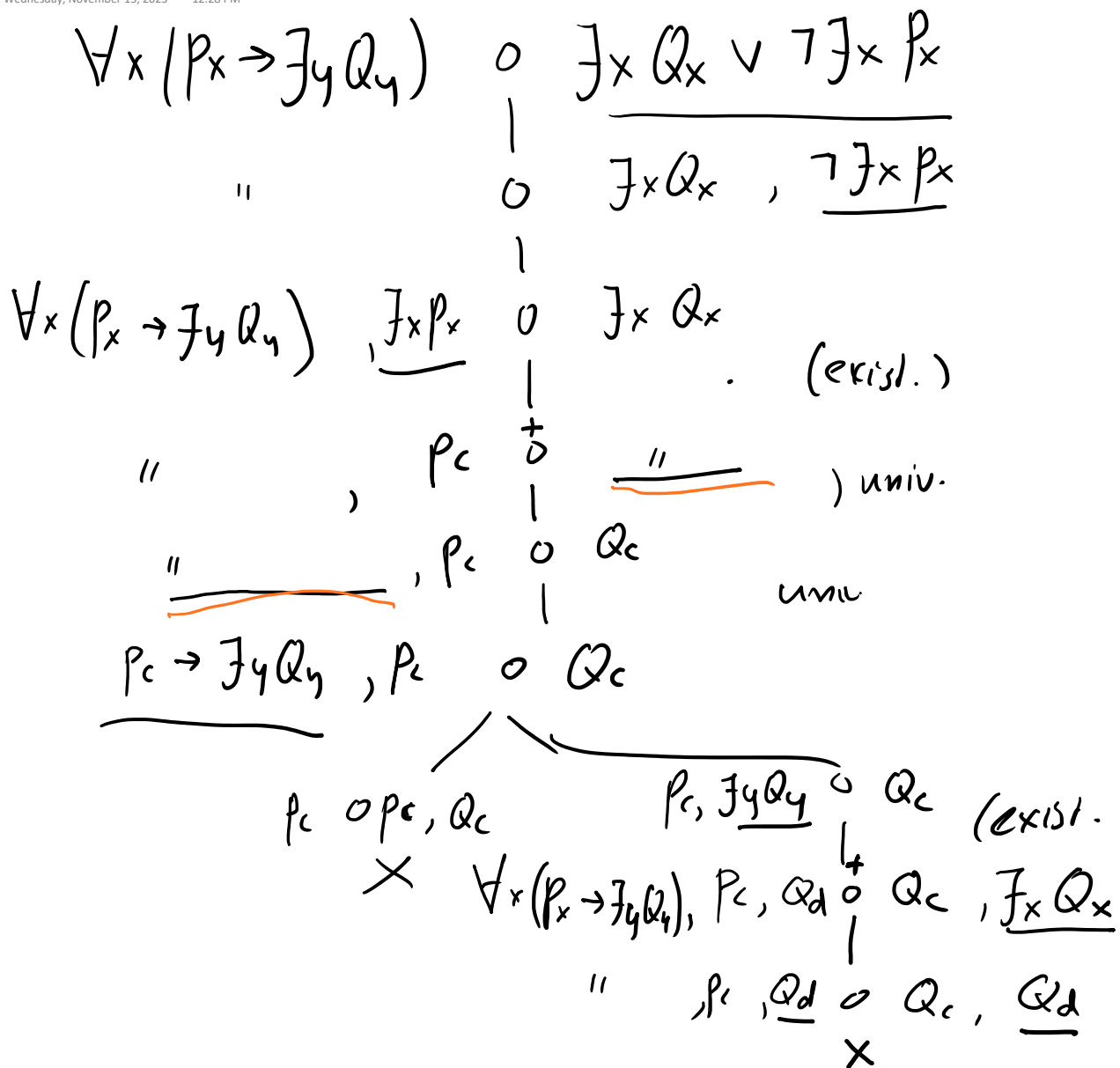
$$\forall y (p_c \rightarrow Q_y) \overset{+}{O} \quad \exists y (p_y \rightarrow Q_d)$$

$$P_c \rightarrow Q_c, P_c \rightarrow Q_d$$

11. $P_c \rightarrow Q_d$

X

$P_c \rightarrow Q_d, P_d \rightarrow Q_d$



So:
valid

↓

$$\begin{array}{c} \circ \quad \forall x \, p_x, \quad \underline{p_c \Rightarrow Q_c} \\ | \\ p_c \circ \quad \underline{\forall x \, p_x}, \quad Q_c \\ | \qquad \qquad \qquad (\text{exist}) \\ p_c \circ p_d, \quad Q_c \\ \text{open.} \end{array}$$

$$\begin{aligned} D &= \{c, d\} \\ P &= \{c\} \\ Q &= \emptyset \end{aligned}$$