

LING4400: Problem Set 3

Due via Carmen dropbox at 11:59 PM 10/10.

1. For the following first-order logic expression:

$$\forall_{x:e} \text{Volcano } x \wedge \exists_{y:e} (\text{Country } y \wedge \text{In } y \ x) \rightarrow \text{Erupt } x$$

- (a) [3 pts.] draw a **derivation tree** for the above expression that identifies its type,
- (b) [3 pts.] translate the above expression into an equivalent expression using **generalized quantifiers** instead of first-order quantifiers, and
- (c) [3 pts.] draw a **derivation tree** for your translated expression that identifies its type.

2. For the following lambda calculus expression:

$$\text{Some } (\lambda_{x:e} \text{Person } x) (\lambda_{x:e} \text{All } (\lambda_{y:e} \text{Booth } y) (\lambda_{y:e} \text{Not } (\text{In } y \ x)))$$

- (a) [3 pts.] draw a **derivation tree** for the above expression that identifies its type,
- (b) [3 pts.] translate the above expression into an equivalent expression using **first-order logic** instead of lambda calculus, and
- (c) [3 pts.] draw a **derivation tree** for your translated expression that identifies its type.

3. Using the set notation defined in the lecture notes, draw **derivation trees** that identify the type of each of the following:

- (a) [2 pts.] $\{\text{True}\}$
- (b) [2 pts.] $\{\{\text{True}\}\}$
- (c) [2 pts.] $\{s:\langle e, t \rangle \mid s = \emptyset\}$
- (d) [2 pts.] $\{x:e \mid x \in \{\text{Mali, Togo}\}\}$
- (e) [2 pts.] $\{\text{True}\} \subseteq \{\text{True}\} \cup \{\text{False}\}$

4. Label the following as **true or false**:

- (a) [2 pts.] $\{\text{Laos}\} \not\subseteq \{\text{Mali, Togo}\}$
- (b) [2 pts.] $\{\text{Laos}\} \supseteq \{\text{Mali, Togo}\}$
- (c) [2 pts.] $\text{Mali} \in \{\text{Laos}\} \cap \{\text{Mali}\}$
- (d) [2 pts.] $\text{Mali} \in \{\text{Laos}\} \cup \{\text{Mali}\}$

5. (a) [3 pts.] Translate the following expression in set notation into **lambda calculus**:

$$\{\{\text{True}\}\}$$

- (b) [3 pts.] Draw a **derivation tree** for your translated expression that identifies its type.
6. To which **classes** (relating to reflexivity, symmetry, and transitivity) do the following relations belong? (Note that there will be more than one for each.)
- (a) [3 pts.] *is a direct supervisor of*
 - (b) [3 pts.] *is a co-worker of*
 - (c) [3 pts.] *outranks*