Work on these exercises before the tutorial. You don’t have to come up with complete solutions before the tutorial, but you should be prepared to discuss them with your TA.

### Proving Equivalence

1. Prove that \( P \implies (Q \implies (R \implies S)) \) is equivalent to \( (P \land Q \land R) \implies S \).

2. Prove that \( ((P \implies Q) \implies R) \implies S \) is equivalent to \( (\neg P \land \neg R) \lor (Q \land \neg R) \lor S \).

### Negation

1. Every dog has its day, or perhaps its cat.

2. \( \forall x \in X, \exists y \in Y, x > y \land y > x \)
Guarantees

Consider the statement:

(S1) A and B are both guarantees that C is true.

1. Write (S1) symbolically. Use parentheses “(” and “)” to make your answer precise.

2. Choose some appropriate phrases to replace A, B and C. Use these to write (S1) in English. Does this cause you to reconsider your answer to (1)?

3. Suppose (S1) is true and A is false. What, if anything, can be determined about B and C? Briefly justify.

4. Suppose (S1) is true and C is false. What, if anything, can be determined about A and B? Briefly justify.