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## Tutorials for “Formal methods for Java” Exercise sheet 6

### Exercise 1: Proofs of propositional formulas in sequent calculus

Give proofs for the following sequents in sequent calculus.

- (a)  $\Longrightarrow p \rightarrow q \rightarrow p.$
- (b)  $\Longrightarrow (p \rightarrow q) \rightarrow (\neg q \rightarrow \neg p).$
- (c)  $\Longrightarrow \neg(p \wedge q) \rightarrow (\neg p \vee \neg q).$
- (d)  $\Longrightarrow (\neg p \vee \neg q) \rightarrow \neg(p \wedge q).$
- (e)  $\Longrightarrow (p \rightarrow q \rightarrow r) \rightarrow (p \rightarrow q) \rightarrow p \rightarrow r.$

### Exercise 2: Proofs of first-order formulas in sequent calculus

Give proofs for the following sequents in sequent calculus.

- (a)  $\Longrightarrow (\exists x \neg P(x)) \vee (\forall x P(x)).$
- (b)  $\Longrightarrow \forall x \exists y (P(x) \rightarrow P(y)).$
- (c)  $\Longrightarrow (\exists y \forall x R(x, y)) \rightarrow (\forall x \exists y R(x, y)).$
- (d)  $\Longrightarrow \exists x \forall y (P(x) \rightarrow P(y)).$