- 73 (whodunit) Here are ten statements.
- (i) Some criminal robbed the Russell mansion.
- (ii) Whoever robbed the Russell mansion either had an accomplice among the servants or had to break in.
- (iii) To break in one would have to either smash the door or pick the lock.
- (iv) Only an expert locksmith could pick the lock.
- Anyone smashing the door would have been heard. (v)
- Nobody was heard. (vi)
- (vii) No one could rob the Russell mansion without fooling the guard.
- (viii) To fool the guard one must be a convincing actor.
- No criminal could be both an expert locksmith and a convincing actor. (ix)
- (x) Some criminal had an accomplice among the servants.
- (a) Choosing good abbreviations, translate each of these statements into formal logic.
- Here are some abbreviations. Ş

Cx = (x is a criminal)

Rx = (x robbed the Russell mansion)

Sx = (x had an accomplice among the servants)

Bx = (x broke in)

Dx = (x smashed the door)

Px = (x picked the lock)

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Fx = (x fooled the guard)

Ax = (x is a convincing actor)

Now the stater after the spring of the state of the state

- $\exists x \cdot Cx \land Rx$ (i)
- (ii) $\forall x \cdot Rx \Rightarrow Sx \vee Bx$
- ∀x· Bx And PxWeChat powcoder (iii) (iv)
- $\forall x \cdot Dx \Rightarrow Hx$
- (v)
- $\neg \exists x \cdot Hx$ (vi)
- $\neg \exists x \cdot Rx \land \neg Fx$ (vii)
- $\forall x \cdot Fx \Rightarrow Ax$ (viii)
- $\neg \exists x \cdot Cx \land Lx \land Ax$ (ix)
- $\exists x \cdot Cx \land Sx$ (x)
- (b) Taking the first nine statements as axioms, prove the tenth.
- Lemma:

$$\begin{array}{lll}
\mathsf{T} & & & & & & & \\
& \neg \exists x \cdot Rx \land \neg Fx & & & & \\
\exists & \forall x \cdot \neg (Rx \land \neg Fx) & & & & \\
\exists & \forall x \cdot \neg Rx \lor \neg \neg Fx & & & \\
\exists & \forall x \cdot \neg Rx \lor Fx & & & \\
\exists & \forall x \cdot \neg Rx \lor Fx & & & \\
\exists & \forall x \cdot Rx \Rightarrow Fx
\end{array}$$
(vii)

duality (deMorgan)

double negation

material implication

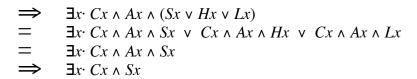
Now the main proof:

$$T = \exists x \cdot Cx \land Rx \qquad \text{idempotence}$$

$$= \exists x \cdot Cx \land Rx \land Rx \qquad \text{lemma and (ii)}$$

$$\Rightarrow \exists x \cdot Cx \land Fx \land (Sx \lor Bx) \qquad \text{(viii) and (iii)}$$

$$\Rightarrow \exists x \cdot Cx \land Ax \land (Sx \lor Dx \lor Px) \qquad \text{(v) and (iv)}$$



distribute (vi) and (ix) specialize

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