

## A Syntactic Proof Guide for Epistemic Logic

The strategy that Guanaco employs is building proofs bottom-up. This means that users start with the formula that they wish to derive. If this formula can only be derived by a rule, then Guanaco exploits the properties of this formula to extract new formulas the relevant rule is applied to. If the formula is an instantiation of an axiom, no new formulas are extracted. The same process is then applied until each formula has a justification and no new ones are produced. At that point, the proof is complete. Currently, axiom A1 for propositional tautologies is not yet validated automatically.

1	$\vdash (f \rightarrow g) \rightarrow (\neg g \rightarrow \neg f)$	A1	
2	$\vdash K1 (f \rightarrow g) \rightarrow K1 (\neg g \rightarrow \neg f)$	KD	1
3	$\vdash (K1 (f \rightarrow g) \wedge K1 \neg g) \rightarrow (K1 (\neg g \rightarrow \neg f) \wedge K1 \neg g)$	LR	2
4	$\vdash ((K1 (f \rightarrow g) \wedge K1 \neg g) \rightarrow (K1 (\neg g \rightarrow \neg f) \wedge K1 \neg g)) \rightarrow ((K1 (f \rightarrow g) \wedge K1 \neg g) \rightarrow (K1 \neg g \wedge K1 (\neg g \rightarrow \neg f)))$	A1	
5	$\vdash (K1 (f \rightarrow g) \wedge K1 \neg g) \rightarrow (K1 \neg g \wedge K1 (\neg g \rightarrow \neg f))$	R1	3, 4
6	$\vdash ((K1 (f \rightarrow g) \wedge K1 \neg g) \rightarrow (K1 \neg g \wedge K1 (\neg g \rightarrow \neg f))) \rightarrow ((K1 (f \rightarrow g) \wedge \neg \neg K1 \neg g) \rightarrow (K1 \neg g \wedge K1 (\neg g \rightarrow \neg f)))$	A1	
7	$\vdash (K1 (f \rightarrow g) \wedge \neg \neg K1 \neg g) \rightarrow (K1 \neg g \wedge K1 (\neg g \rightarrow \neg f))$	R1	5, 6
8	$\vdash (K1 \neg g \wedge K1 (\neg g \rightarrow \neg f)) \rightarrow K1 \neg f$	A2	
9	$\vdash (K1 (f \rightarrow g) \wedge \neg \neg K1 \neg g) \rightarrow K1 \neg f$	HS	7, 8
10	$\vdash ((K1 (f \rightarrow g) \wedge \neg \neg K1 \neg g) \wedge \neg K1 \neg f) \rightarrow (K1 \neg f \wedge \neg K1 \neg f)$	LR	9
11	$\vdash (((K1 (f \rightarrow g) \wedge \neg \neg K1 \neg g) \wedge \neg K1 \neg f) \rightarrow (K1 \neg f \wedge \neg K1 \neg f)) \rightarrow (((\neg K1 \neg f \wedge K1 (f \rightarrow g)) \wedge \neg \neg K1 \neg g) \rightarrow (\neg K1 \neg f$	A1	
12	$\vdash ((\neg K1 \neg f \wedge K1 (f \rightarrow g)) \wedge \neg \neg K1 \neg g) \rightarrow (\neg K1 \neg f \wedge K1 \neg f)$	R1	10, 11
13	$\vdash (\neg K1 \neg f \wedge K1 \neg f) \rightarrow \perp$	A1	
14	$\vdash ((\neg K1 \neg f \wedge K1 (f \rightarrow g)) \wedge \neg \neg K1 \neg g) \rightarrow \perp$	HS	12, 13
15	$\vdash (\neg K1 \neg f \wedge K1 (f \rightarrow g)) \rightarrow \neg K1 \neg g$	NC	14

System S5 Agents (m)

Goal  
 $(!K1!f \ \& \ K1(f \rightarrow g)) \rightarrow !K1!g$