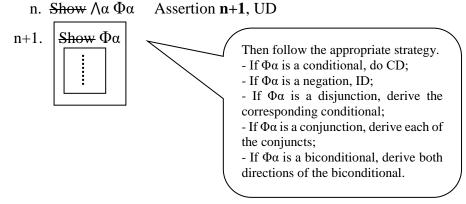
## 

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Office Hours: W 1pm-2pm
F 10:50am-11:50am

→ New form of derivation:

<u>Universal Derivation - UD</u> (K&M, p. 143)



- → New Rules of Inference (K&M, p. 141)
- proper substitution (K&M, p. 139):  $\Phi\beta$  comes from proper substitution of  $\beta$  for  $\alpha$  if  $\Phi\beta$  is just like  $\Phi\alpha$  except for having <u>free occurrences</u> of  $\beta$  <u>whenever</u>  $\Phi\alpha$  has <u>free occurrences</u> of  $\alpha$ .

\*\* Where  $\Phi\beta$  comes from  $\Phi\alpha$  by proper substitution of the term  $\beta$  for the variable  $\alpha$  in  $\Phi\alpha$  \*\*

$$\underline{EG}$$
 n.  $\underline{\Phi\beta}$   $V\alpha \Phi\alpha$  n, EG

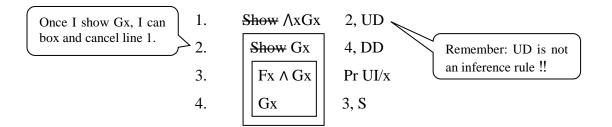
\*\* Where  $\Phi\beta$  comes from  $\Phi\alpha$  by proper substitution of the term  $\beta$  for the variable  $\alpha$  in  $\Phi\alpha$  \*\*

- \* Where  $\Phi\beta$  comes from  $\Phi\alpha$  by proper substitution of the term  $\beta$  for the variable  $\alpha$  in  $\Phi\alpha$ ; AND
- \* β is a variable; AND
- \*  $\beta$  is a new variable, i.e., doesn't occur anywhere in the derivation.

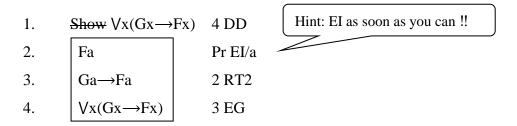
## - Examples:

\*\* In order to follow a derivation, you have to read carefully the annotation. Make sure you know which lines and inference rules are being used to justify a line \*\*

Deriv 3.001:  $\bigwedge x (Fx \land Gx) : \bigwedge xGx$ 

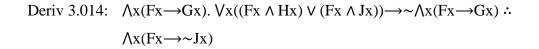


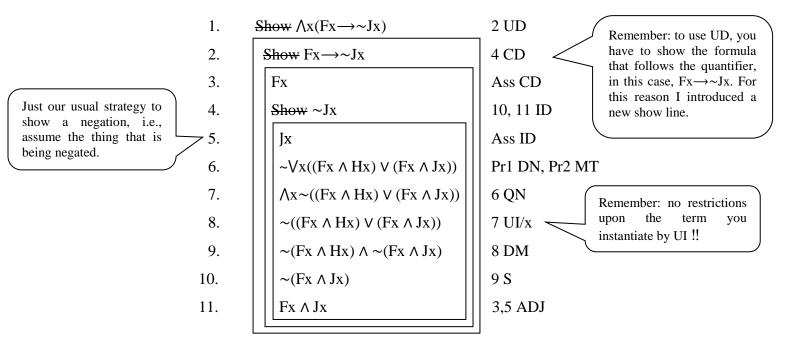
Deriv 3.002:  $\forall x Fx : \forall x (Gx \rightarrow Fx)$ 



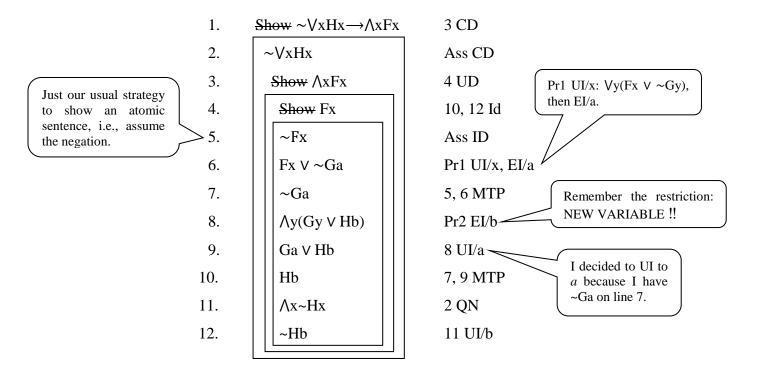
Deriv 3.004:  $\bigwedge x(Fx \rightarrow Gx)$ .  $\bigwedge x(Gx \rightarrow Hx) :: FA \rightarrow \bigvee x(Gx \land Hx)$ 

1.	$\frac{\text{Show } FA \longrightarrow Vx(Gx \land F)}{\text{Show } FA \longrightarrow Vx(Gx \land F)}$	4x) 3, CD
2.	FA	Ass CD
3.		10, 11 ID
4.	$\sim Vx(Gx \land Hx)$	Ass ID
5.	$\bigwedge x \sim (Gx \wedge Hx)$	4, QN
6.	FA→GA	Pr1, UI/A
7.	GA	2, 6 MP
8.	GA→HA	Pr2, UI/A
9.	HA	6, 7 MP
10.	~(GA ∧ HA)	5 UI/A
11.	GA ∧ HA	7,9 ADJ





Deriv 3.715:  $\Lambda x \vee y(Fx \vee Gy)$ .  $\forall x \wedge y(Gy \vee Hx) : \sim \forall x Hx \longrightarrow \Lambda x Fx$ 



## 

\* For each of the following expression, state whether or not it is a well formed formula. If an expression is a symbolic formula, give the tree of formation. (Examples: K&M, p.121)

Pars $3.002$ : $\forall x \sim (Fx)$	Pars 3.011: $\forall x(E \rightarrow Fx)$
Pars 3.012: $\Lambda A(FA \rightarrow \sim GA)$	Pars 3.017: $\Lambda a(Hx \leftrightarrow Gy)$
Pars 3.026: $\sim \Lambda x \sim VyFx \land \sim Gy$	Pars 3.027: $\bigwedge x(FGx \longrightarrow Gy)$
Pars 3.028: $\forall x Fx \land \forall x Gx \longrightarrow \forall x (Fx \land Gx)$	Pars 3.030: $\forall x (P \rightarrow \land x \sim Qx)$

\* Determine which inference rule, if any, the following arguments instantiate:

Recog 3.001: 
$$\bigwedge x(Fx \rightarrow Gy)$$
 Recog 3.002:  $Gx$ 
 $\bigwedge xGx$ 

Recog 3.004:  $\bigvee yGy$ 
 $GA$ 

Recog 3.006:  $\bigvee xGy$ 
 $Gz$ 

Recog 3.007:  $\bigwedge x \bigvee y(Fx \rightarrow Gy \lor Hx)$ 
 $\bigvee y(FA \rightarrow Gy \lor HA)$ 

Recog 3.011:  $FA \rightarrow GA$ 
 $\bigvee y(Fy \rightarrow Gy)$ 

Recog 3.018:  $(\bigwedge xFx \rightarrow \bigvee y(Hy \lor Hx))$ 
 $FB \rightarrow \bigvee y(Hy \lor HB)$ 

Recog 3.020:  $\bigvee x(FA \land Gz) \rightarrow \bigvee xHx \lor GA$ 
 $\bigvee x(\bigvee xFx \rightarrow FA \lor \bigwedge xGx)$ 

Recog 3.030:  $\bigwedge x(Fx \rightarrow \bigvee y(FB \land Gy))$ 
 $\bigvee x(\bigvee xFx \rightarrow FA \lor \bigwedge xGx)$ 

Recog 3.030:  $\bigwedge x(Fx \rightarrow \bigvee y(FB \land Gy))$ 
 $\bigwedge x(Fx \rightarrow \bigvee z \lor y(Fz \land Gy))$ 

→ Do as many derivations as you can on the software !!