Logic (PHIL 2080, COMP 2620, COMP 6262) *Chapter:* Propositional Logic — Recap on Proof Strategies (and some System Support)

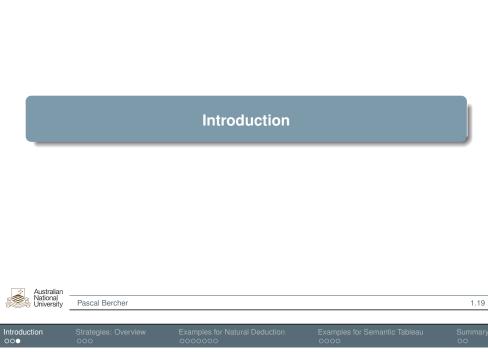
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15 March 2022



Introduction				
Recap	: Sequents, Validity	, Proof Systems		
٠	You know how to	prove $X \vdash A$ via ND		
٩	You know how to	prove $X \vdash A$ via ST		
۲		D is only a semi-decisi	on procedure, as you c I.	an
٥	So, to show inval	<i>lidity</i> , you have to rely o	on ST.	



So, when to use which?

Introduction

- In assignments/an exam:
 - We tell you what to use. :)
 - If we don't tell whether it's valid or invalid:
 - If you think the sequent is invalid: You must use ST
 - If you think the sequent is valid: Choose what you are stronger in!
 - ▶ If you don't know either way: Use ST and *let it tell you*!
- In real life:
 - Neither. 'Use a SAT-solver like FINDER / Logic for Fun
 - Different solvers rely on different techniques, and there are competitions on identifying the quickest ones.

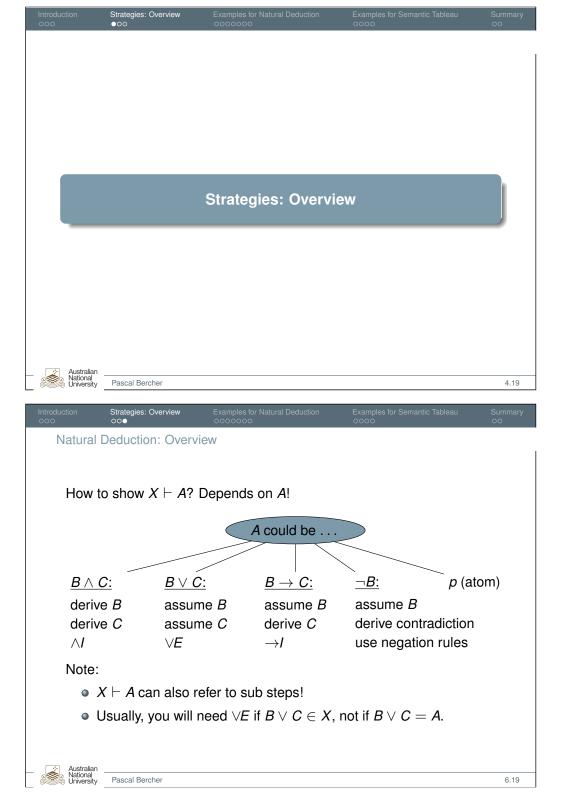
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Strategies for Semantic Tableau and Natural Deduction

Semantic Tableau:

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Strategies: Overview

- Always apply rules first that don't branch.
- In case of invalid sequents you could follow down branches leading to an open branch more quickly - which requires "seeing" which interpretation proves invalidity.

Natural Deduction:

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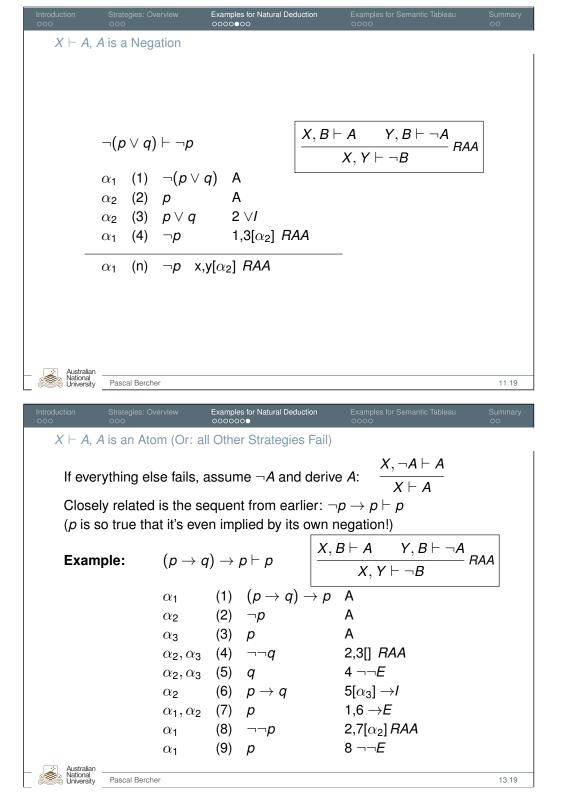
- Our standard strategy:
 - Write down all assumptions
 - Start with the sequent to prove as last line and apply rules until no more rule applies
 - Fill the gap!

• Fall-back strategy: Assume negation of final derivation and exploit contradiction.

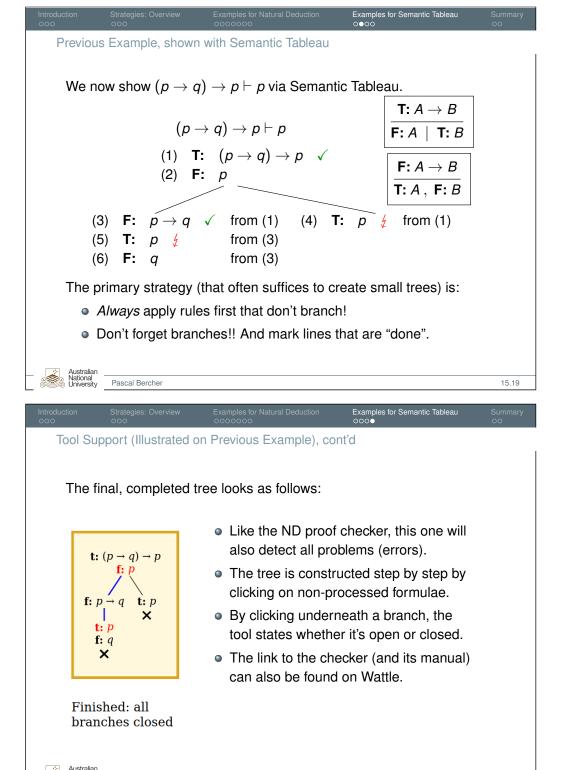
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	, A is an Implic					
	$ ho ightarrow ((q \wedge$	r) ightarrow s	$(p \land q \to ((p \land q \to q)))$	$(r) \rightarrow $	s)	
	$lpha_1$	(1)	$p ightarrow ((q \wedge r)$	$) \rightarrow c)$	Δ	
	α_1 α_2	(1)	,	, 73)	A	
	α_3		$p \wedge r$		A	
-	$\alpha_1, \alpha_2, \alpha_3$	(n-2)	S			
			$(p \wedge r) \rightarrow s$		$(n-2)[\alpha_3] \rightarrow I$	
	α_1		$q \to ((p \wedge r))$			
	_					
۰		'	0		A! (p is part of X)	
	•	-			see where to go!	
٩	Now we can	not go i	further via regr	ression,	, so fill the gap!	
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		Examples for Natural Deduction	Examples for Semantic Tableau	Summary 00
$X \vdash A$, A is an Implication			
	$ ho ightarrow ((q \wedge r) -$	$(p \wedge s) \vdash q \rightarrow ((p \wedge r) \rightarrow $	· s)	
	(1)	$p \rightarrow ((q \wedge r) \rightarrow s)$	γ γ	
		$p \rightarrow ((q \land r) \rightarrow s)$, А А	
	α_3 (3)	•	A	
	α_3 (4)	•	3 ∧ <i>E</i>	
	α_1, α_3 (5)	$(q \wedge r) ightarrow s$	1,4 $ ightarrow E$	
	α_3 (6)) r	3 ∧ <i>E</i>	
	α_2, α_3 (7)	-	2,6 <i>∧I</i>	
	$\alpha_1, \alpha_2, \alpha_3$ (8)		$5,7 \rightarrow E$	
		$(p \wedge r) \rightarrow s$		
_	α_1 (10	$q \to ((p \land r) \to s)$	ן שנמ₂ן <i>→ו</i> _	
	, ,	2) <i>s</i>		
		$) (p \wedge r) \to s$		
	α_1 (n)	$q \rightarrow ((p \wedge r) \rightarrow s)$) (n-1)[α ₂] →/	
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$X \vdash A, A$	is a Dis	sjunction (here:	in one of the Subste	eps)	
$\neg p$	$\wedge \neg q$	$\vdash eg (p \lor q)$	$X \vdash A \lor B$	$Y, A \vdash C Z, B \vdash$	- C
α_1	(1)	$ eg p \land eg q$	A	$X, Y, Z \vdash C$	<i>∨E</i>
α2		$p \lor q$	Α]] –	
α_3	(3)	p	A <i>X</i> , <i>B</i>	$\vdash A \qquad Y, B \vdash \neg A$	
α_4	(4)	-	Α	$\frac{\vdash A \qquad Y, B \vdash \neg A}{X, Y \vdash \neg B} RAA$	4
α_1	()	1	1 ∧ <i>E</i> ∟	,	
α_3			3,5[α ₁] <i>RAA</i>		
α_1	• • •				
			4,7[α_1] RAA	_	
α_2		· · /	2,6[α ₃],8[α ₄] ∀E 1,9[α ₂] <i>RAA</i>	Ξ	
α ₁	(10)	$\neg(p \lor q)$	Τ,9[α ₂] ΚΑΑ		
α_1	(n)	$\neg(p \lor q)$ x,y	$[\alpha_2]$ RAA		
	()				
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Introduction	Strategies: Overvi	ew Examples for Natural Deduction	Examples for Semantic Tableau $OO \oplus O$	Summary 00
Tool	Support (Illustra	ted on Previous Example)		1
	t: $(p \rightarrow q) \rightarrow p$ f: p	Trees get step-wise refined by clicking on formulae that are to be extended next.	\rightarrow \leftrightarrow	
	The marked formula was expanded in a wrong way here!	Enter left formula and truth value false v	+ + CANCEL DONE	
Fo	formula still requin or more information, Developing a true in makin	h split does not correctly develop any ing analysis in the selected branch. click the formula you intend to develop. nplication $(p \rightarrow q) \rightarrow p$ splits between g $p \rightarrow q$ false and p true rom the menu on the right:	select v	
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Australian National University

Pascal Bercher

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