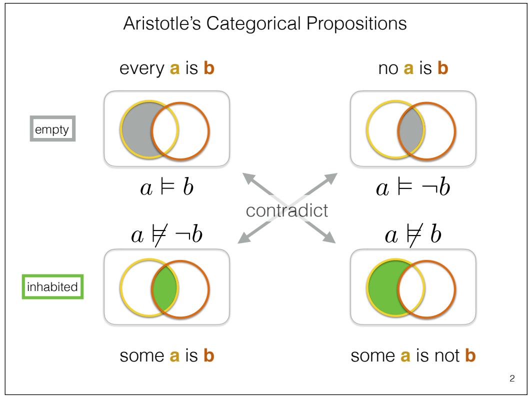
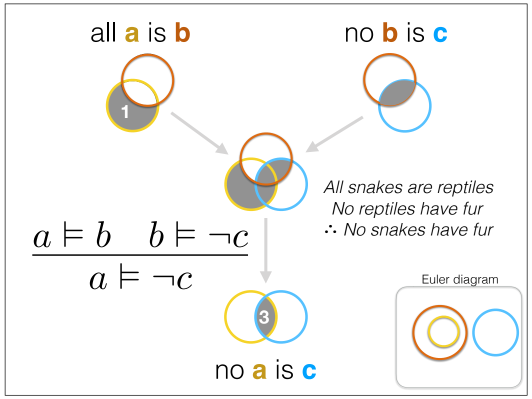
INF1a-CL

Syllogisms & Arrow Rule



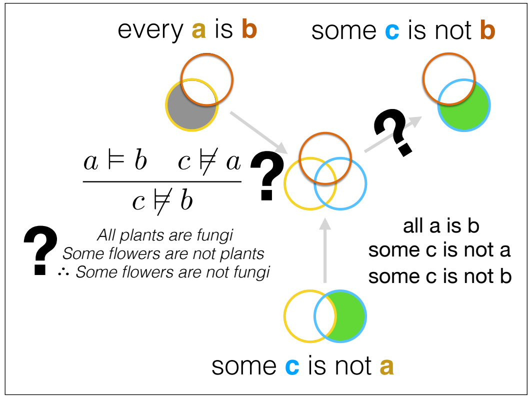


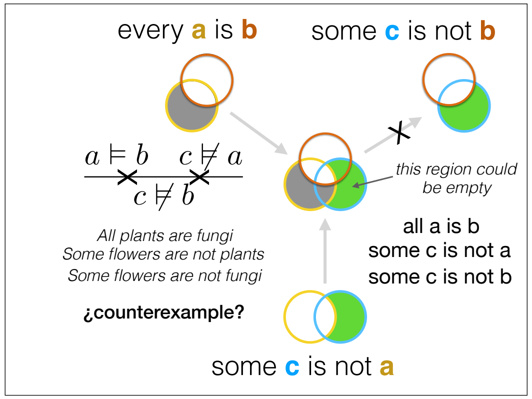
The argument looks bit different.

? *All plants are fungi*
Some flowers are not plants
∴ *Some flowers are not fungi*

Is this a valid argument?

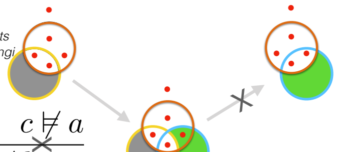
Give it as a syllogism, and use Venn diagrams
either to show it is valid,
or to produce a counterexample.



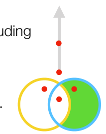


every **a** is **b** some **c** is not **b**

All plants are fungi
Some flowers are not plants
∴ Some flowers are not fungi



$$\frac{a \models b \qquad c \not\models a}{c \not\models b}$$



plant	fungus	flower
✓	✓	✓
✓	✓	×
×	✓	✓
×	✓	×
×	×	×

A counterexample can be given by including
things of five different kinds
corresponding to the red dots
as shown in the table.
We only actually need the third row.

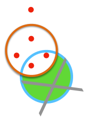
some **c** is not **a**

---

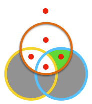
some **c** ~~is not~~ **b**

All plants are fungi
Some flowers are not plants
Some flowers are not fungi

every **a** is **b**



$$\frac{a \models b \qquad c \not\models a}{c \not\models b}$$



plant	fungus	flower
✓	✓	✓
✓	✓	×
×	✓	✓
×	✓	×
×	×	×

A counterexample can be given by including
things of five different kinds
corresponding to the red dots
as shown in the table.
We only actually need the third row.

some **c** is not **a**

$$\frac{a \models b \qquad b \models \neg c}{a \models \neg c}$$ celarent

all snakes are reptiles
no reptiles have fur
∴ no snakes have fur

all humans are mammals
no reptiles are mammals
∴ no humans are reptiles

$$\frac{a \models b \qquad c \models \neg b}{a \models \neg c}$$ cesare

$$\frac{a \models b \qquad c \models \neg b}{c \models \neg a}$$ camestres

all humans are mammals
no reptiles are mammals
∴ no reptiles are humans

all humans are mammals
no mammals are reptiles
∴ no reptiles are humans

$$\frac{a \models b \qquad b \models \neg c}{c \models \neg a}$$ calemes

a	e	i	o
$a \vDash b$	$a \vDash \neg b$	$a \nvDash \neg b$	$a \nvDash b$

barbara $\dfrac{m \vDash p \quad s \vDash m}{s \vDash p}$	bocardo $\dfrac{m \nvDash p \quad m \vDash s}{s \nvDash p}$	baroco $\dfrac{p \vDash m \quad s \nvDash m}{s \nvDash p}$
celarent $\dfrac{m \vDash \neg p \quad s \vDash m}{s \vDash \neg p}$	disamis $\dfrac{m \nvDash \neg p \quad m \vDash s}{s \nvDash \neg p}$	festino $\dfrac{p \vDash \neg m \quad s \nvDash \neg m}{s \nvDash p}$
cesare $\dfrac{p \vDash \neg m \quad s \vDash m}{s \vDash \neg p}$	datisi $\dfrac{m \vDash p \quad m \nvDash \neg s}{s \nvDash \neg p}$	ferio $\dfrac{m \vDash \neg p \quad s \nvDash \neg m}{s \nvDash p}$
camestres $\dfrac{p \vDash m \quad s \vDash \neg m}{s \vDash \neg p}$	ferison $\dfrac{m \vDash \neg p \quad m \nvDash \neg s}{s \nvDash p}$	fresison $\dfrac{p \vDash \neg m \quad m \nvDash \neg s}{s \nvDash p}$
calemes $\dfrac{p \vDash m \quad m \vDash \neg s}{s \vDash \neg p}$	darii $\dfrac{m \vDash p \quad s \nvDash \neg m}{s \nvDash \neg p}$	dimatis $\dfrac{p \nvDash \neg m \quad m \vDash s}{s \nvDash \neg p}$

This is the traditional presentation of the syllogisms.
For each syllogism, the conclusion is a categorical proposition relating a *subject* s to a a *predicate* p The assumptions are categorical propositions relating p and s to a middle predicate, m.
The three aeio vowels in the name of each syllogism (each name includes 3 of these vowels)
signify the forms of the three categorical propositions.

The names are in a code that tells how the syllogism in question is derived from one of the following four syllogisms: barbara, celarent, darii, ferio. The first letter of the name of each syllogism matches the name of the syllogism it is derived from.
When one of the consonants smc follows one of the vowels aeio, it tells us how the corresponding proposition should be changed:
The c in bocardo and baroco corresponds to our contrapositive construction of these rules
The s in festino relates it to ferio via a local contraposition, and the two occurrences of s in fresison show it is derived from ferio using two local contrapositions, ferison again uses one local contraposition.
The letter m means that we swap s and p — observe that each name with an m ends with s, which represents the contraposition required to put s and p back in the correct order. When we swap s and p we also have to change the order of the premises, but first we must apply any the further contrapositions required if there is another s in the name.

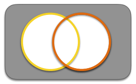
$$\text{celarent}\ \frac{a \vDash b \quad b \vDash \neg c}{a \vDash \neg c} \qquad \frac{m \vDash \neg p \quad s \vDash m}{s \vDash \neg p}$$

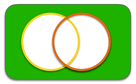
$$\text{cesare}\ \frac{a \vDash b \quad c \vDash \neg b}{a \vDash \neg c}$$

$$\text{camestres}\ \frac{a \vDash b \quad c \vDash \neg b}{c \vDash \neg a}$$

$$\text{calemes}\ \frac{a \vDash b \quad b \vDash \neg c}{c \vDash \neg a}$$

What do these mean?





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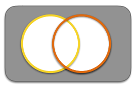
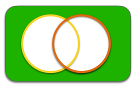


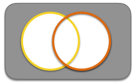


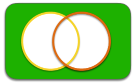
$\vDash a \vee b$

$\neg a \vDash b$

$\neg b \vDash a$

What do these mean?





$\models a \vee b$

$\neg a \models b$

$\neg b \models a$

every thing is a or b
every not a is b
every not b is a

$\not\models a \vee b$

$\neg a \not\models b$

$\neg b \not\models a$

some thing is neither a nor b
some not a is not b
some not b is not a

The first rule of boolean algebra

$$\neg\neg a = a$$

The second rule of boolean logic
the first is *barbara*

$$\dfrac{\dfrac{\dfrac{a \models b}{\neg b \models \neg a}}{\neg\neg a \models \neg\neg b}}{a \models b}$$

$$\frac{a \models b}{\neg b \models \neg a}$$

$$\frac{a \models b}{\neg b \models \neg a}$$

contraposition

Here we derive the 2-way rule from the single rule.

Contraposition

$$\frac{a \models b \quad b \models c}{a \models c}\ \text{barbara}$$

$$\frac{b \models c \quad a \not\models c}{??}$$

$$\frac{a \models b \quad a \not\models c}{??}$$

What can we deduce in each case?

What does this mean?

$$a \not\models c$$

$$
\overset{\text{a}}{a \models b} \qquad \overset{\text{e}}{a \models \neg b} \qquad \overset{\text{i}}{a \nvDash \neg b} \qquad \overset{\text{o}}{a \nvDash b}
$$

$$
\text{barbara}\ \frac{a \models b \quad b \models c}{a \models c} \qquad \text{bocardo}\ \frac{a \models b \quad a \nvDash c}{b \nvDash c} \qquad \text{baroco}\ \frac{b \models c \quad a \nvDash c}{a \nvDash b}
$$

$$
\text{celarent}\ \frac{a \models b \quad b \models \neg c}{a \models \neg c} \qquad \text{disamis}\ \frac{a \models b \quad a \nvDash \neg c}{b \nvDash \neg c} \qquad \text{festino}\ \frac{b \models \neg c \quad a \nvDash \neg c}{a \nvDash b}
$$

$$
\text{cesare}\ \frac{a \models b \quad c \models \neg b}{a \models \neg c} \qquad \text{datisi}\ \frac{a \models b \quad a \nvDash \neg c}{c \nvDash \neg b} \qquad \text{ferio}\ \frac{c \models \neg b \quad a \nvDash \neg c}{a \nvDash b}
$$

$$
\text{camestres}\ \frac{a \models b \quad c \models \neg b}{c \models \neg a} \qquad \text{ferison}\ \frac{a \models \neg b \quad a \nvDash \neg c}{c \nvDash b} \qquad \text{fresison}\ \frac{b \models \neg c \quad c \nvDash \neg a}{a \nvDash b}
$$

$$
\text{calemes}\ \frac{a \models b \quad b \models \neg c}{c \models \neg a} \qquad \text{darii}\ \frac{a \models b \quad c \nvDash \neg a}{c \nvDash \neg b} \qquad \text{dimatis}\ \frac{c \models b \quad a \nvDash \neg c}{b \nvDash \neg a}
$$

$$
s \nvDash \neg s \qquad \text{darii}\ \frac{s \models p \quad s \nvDash \neg s}{s \nvDash \neg p}
$$

$$
\text{barbara}\ \frac{m \models p \quad s \models m}{s \models p} \qquad \text{bocardo}\ \frac{m \nvDash p \quad m \models s}{s \nvDash p} \qquad \text{baroco}\ \frac{p \models m \quad s \nvDash m}{s \nvDash p}
$$

$$
\text{celarent}\ \frac{m \models \neg p \quad s \models m}{s \models \neg p} \qquad \text{disamis}\ \frac{m \nvDash \neg p \quad m \models s}{s \nvDash \neg p} \qquad \text{festino}\ \frac{p \models \neg m \quad s \nvDash \neg m}{s \nvDash p}
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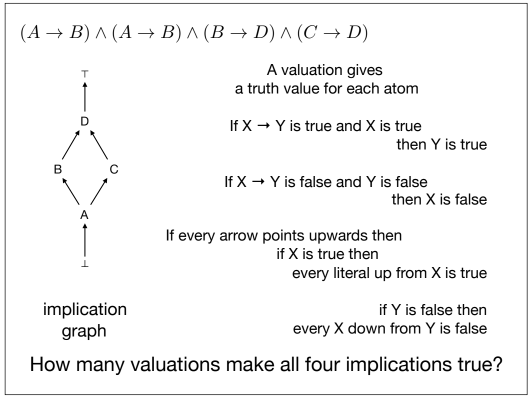
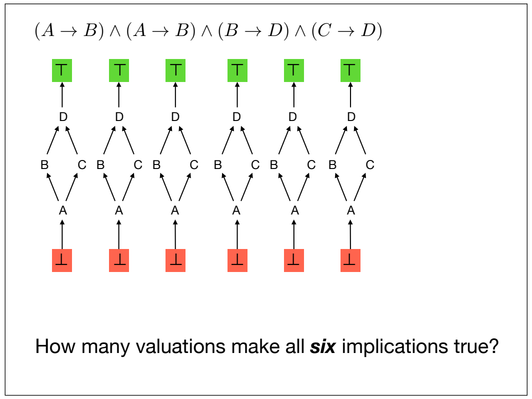
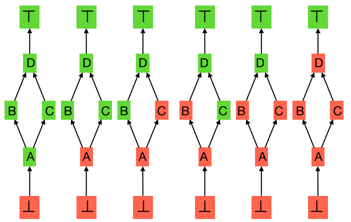




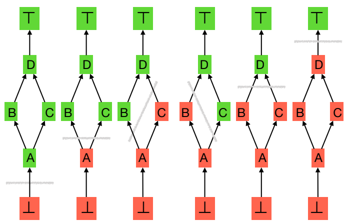
$(A \to B) \wedge (A \to B) \wedge (B \to D) \wedge (C \to D)$



implication
graph

How many valuations make all four implications true?

$(A \to B) \wedge (A \to B) \wedge (B \to D) \wedge (C \to D)$



implication
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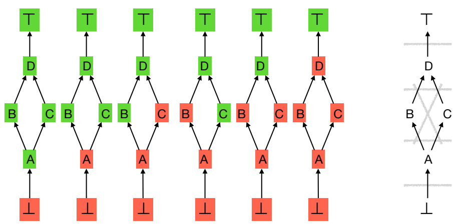

implication
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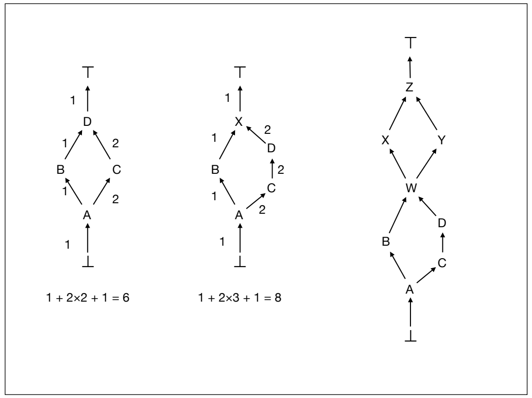
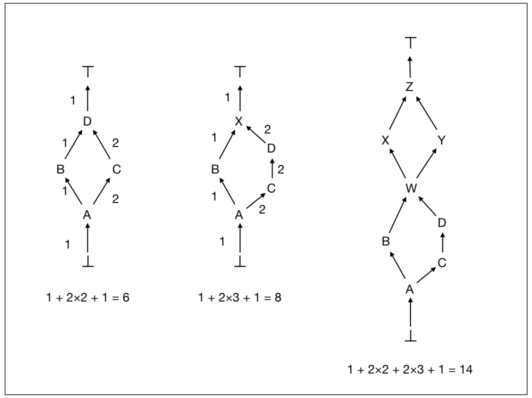
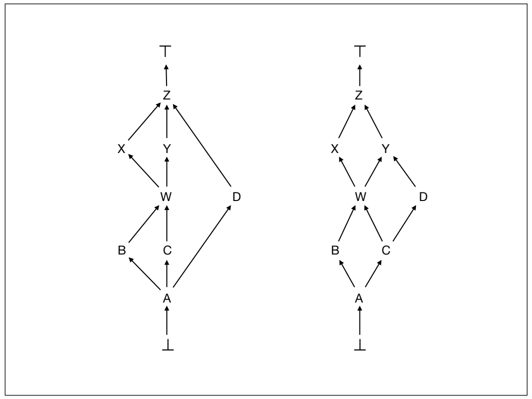
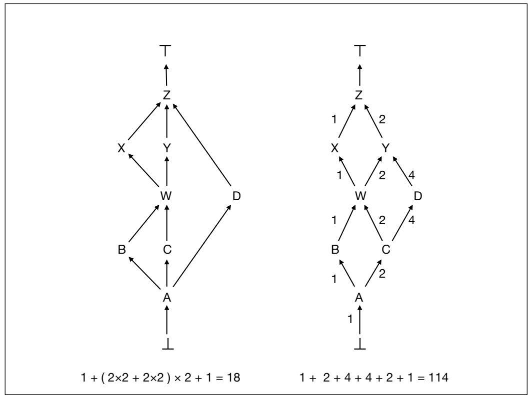
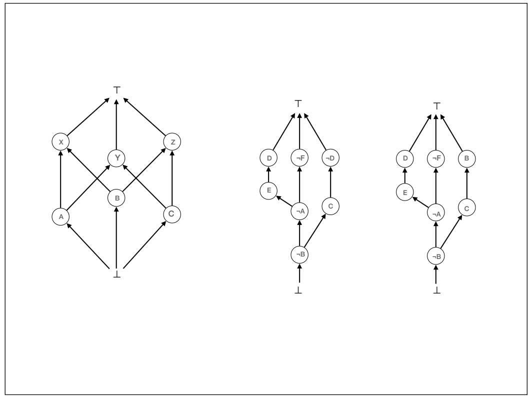
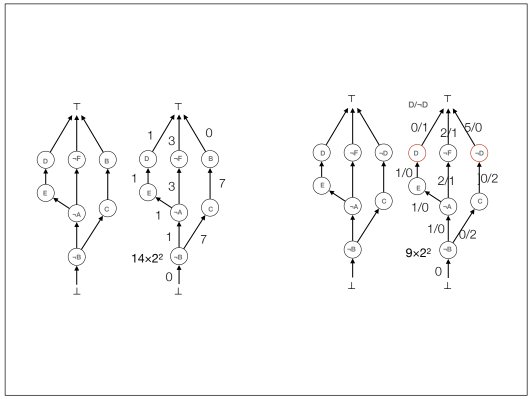

1 + 2×2 + 1 = 6
1 + 2×3 + 1 = 8

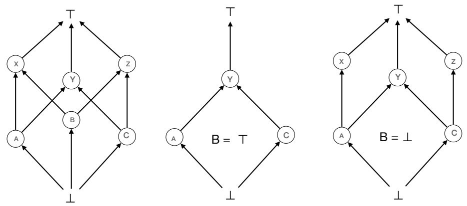

1 + 2×2 + 1 = 6
1 + 2×3 + 1 = 8
1 + 2×2 + 2×3 + 1 = 14

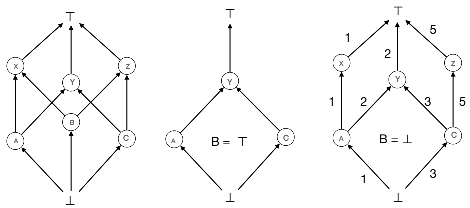



⊤
Z
X
Y
W
D
B
C
A
⊥
1 + (2×2 + 2×2) × 2 + 1 = 18
1 + 2 + 4 + 4 + 2 + 1 = 114

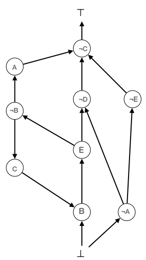

⊤
X
Y
Z
B
A
C
⊥

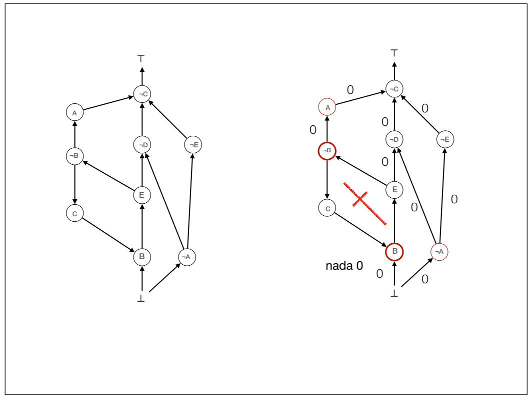

14×2²
D/¬D
9×2²





5 + 13 = 18





nada 0