Chapter I
Four Basic Topics in AI

SEARCH

Content

Chapter 1 - Four Basic Topics:

1.1 Intelligent Agents

1.2 Representation

1.3 Search

1.4 Learning


1.3 Inference and heuristic Search

"MORE KNOWLEDGE MEANS LESS SEARCH"

P. H. WINSTON, 1977

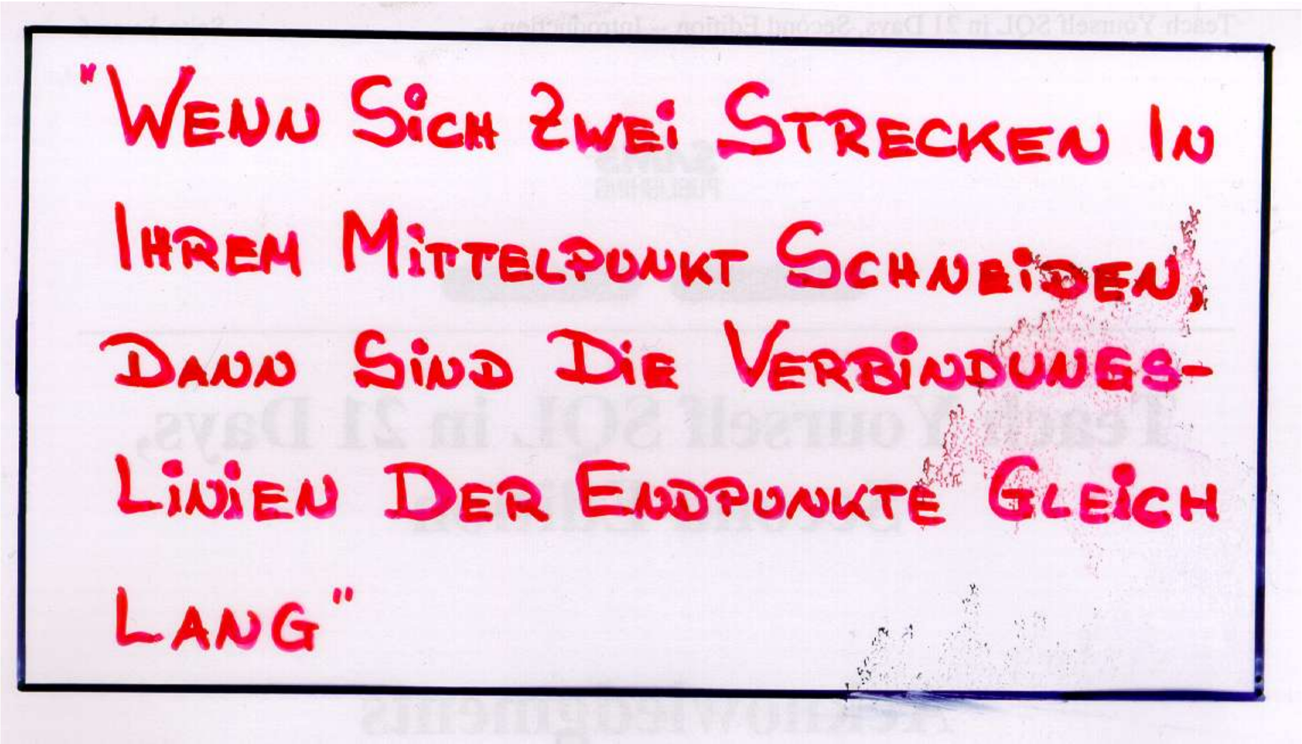
… using Euclidian Geometry as a case study!

Reference:

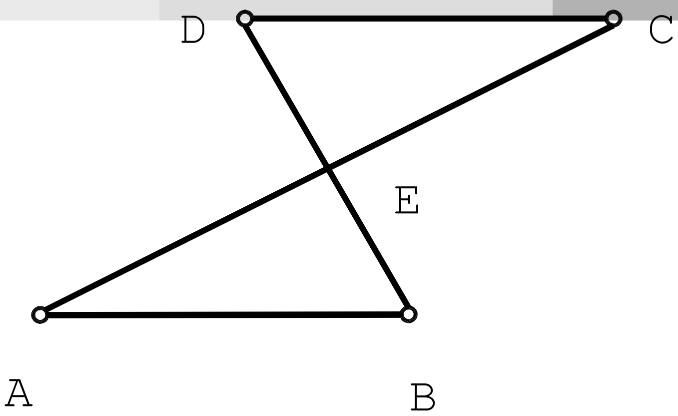
H. Gelernter: "Realization of Geometry Theorem Proving Machine"

in: M. Minsky, Semantic Information Processing MIT-Press, 1968

"If two line segments intersect at their centre point, the two lines connecting the endpoints are equidistant."



Example



<u>definition:</u> [X,Y] ≡ line segment X Y

<u>theorem:</u> CTR (E,[A,C]) ∧ CTR (E,[D,B])

⇨ [A,B] = [D,C]

<u>diagram:</u>

coordinates: (A, B, C, D)

line segments: [A,B], [D,C], [A,C], [D,B]

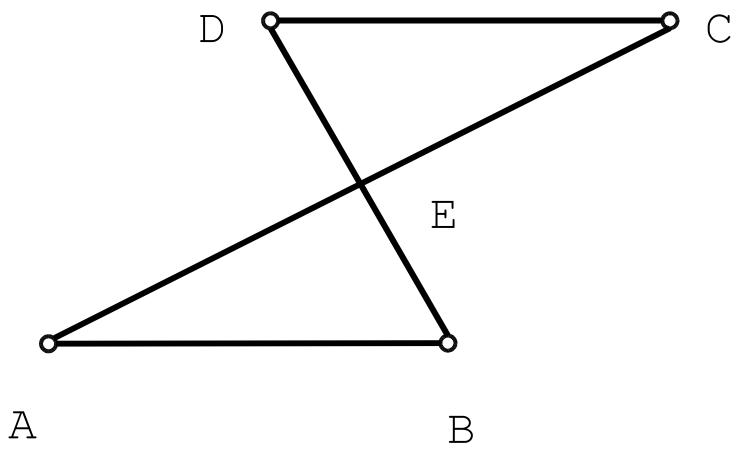
co-linear: COL(A,E,C)
COL(D,E,B)

Database entries

CTR (E,[A,C])
CTR (E,[D,B])
} hypothesis

[A,E]= [E,C]
[D,E]= [E,B]
} definition of centre

COL(A,E,C)
COL(D,E,B)



Database (I)

Theorems

1. $[x,y] = [u,v] \wedge [z,w] = [u,v] \Rightarrow [x,y] = [z,w]$
2. ▱ $(x,y,z,w) \Rightarrow [x,y] = [z,w]$

   ▱ $(x,y,z,w) \Rightarrow [x,z] = [y,w]$
3. $\Delta(x,y,u) \approx \Delta(z,w,v) \Rightarrow [x,y] = [z,w]$
4. $[x,z] = [u,w] \wedge \measuredangle(z,x,y) = \measuredangle(w,u,v) \wedge \measuredangle(x,y,z) = \measuredangle(u,v,w)$

   $\Rightarrow \Delta(x,y,z) \approx \Delta(u,v,w)$
5. $[x,z] = [u,w] \wedge \measuredangle(z,x,y) = \measuredangle(w,u,v) \wedge \measuredangle(x,z,y) = \measuredangle(u,w,v)$

   $\Rightarrow \Delta(x,y,z) \approx \Delta(u,v,w)$
6. $[x,z] = [u,w] \wedge [z,y] = [w,v] \wedge \measuredangle(x,z,y) = \measuredangle(u,w,v)$

   $\Rightarrow \Delta(x,y,z) \approx \Delta(u,v,w)$
7. $COL(x,y,z) \wedge COL(u,y,w) \Rightarrow \measuredangle(w,y,z) = \measuredangle(x,y,u)$

Database (II)

Definitions

$CTR(x,[y,z]) \Rightarrow [y,x] = [x,z]$

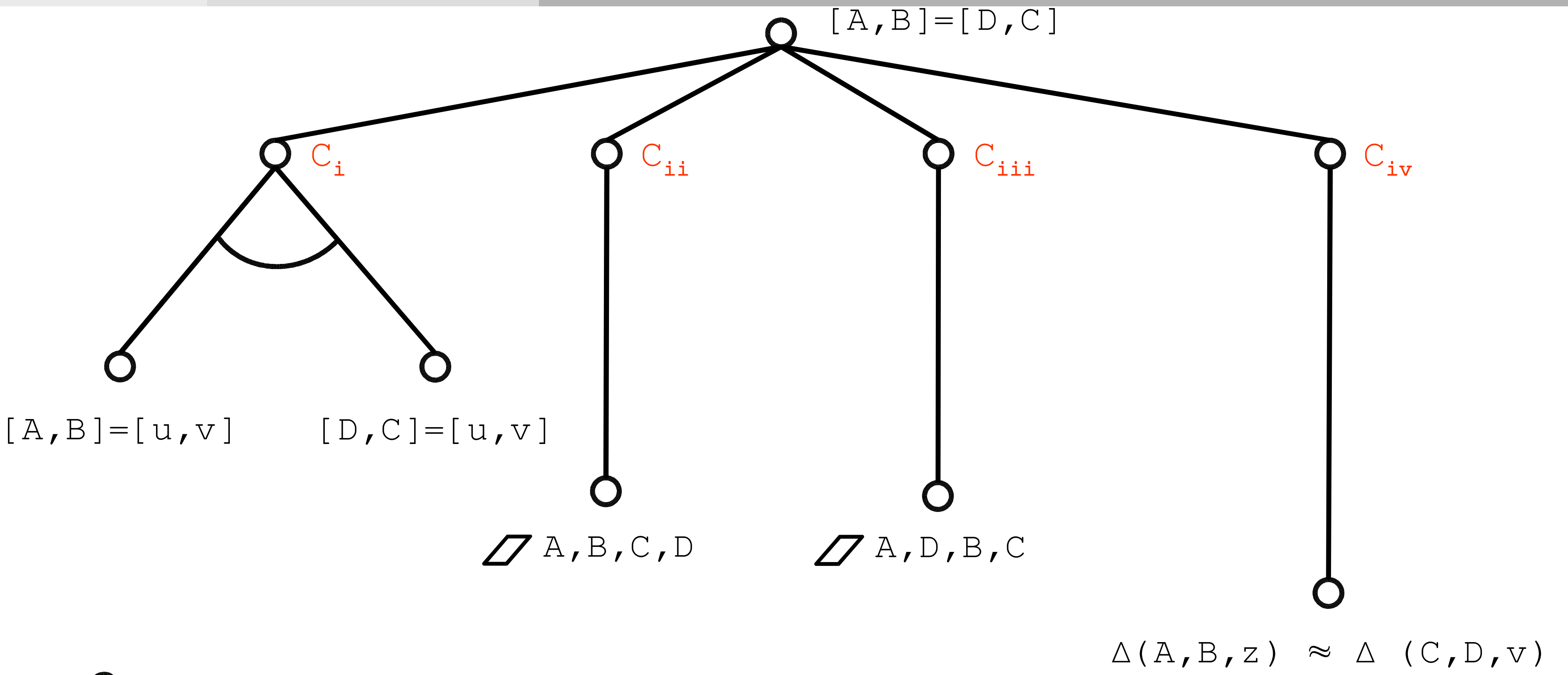
Facts

NIL

Symmetries

NIL

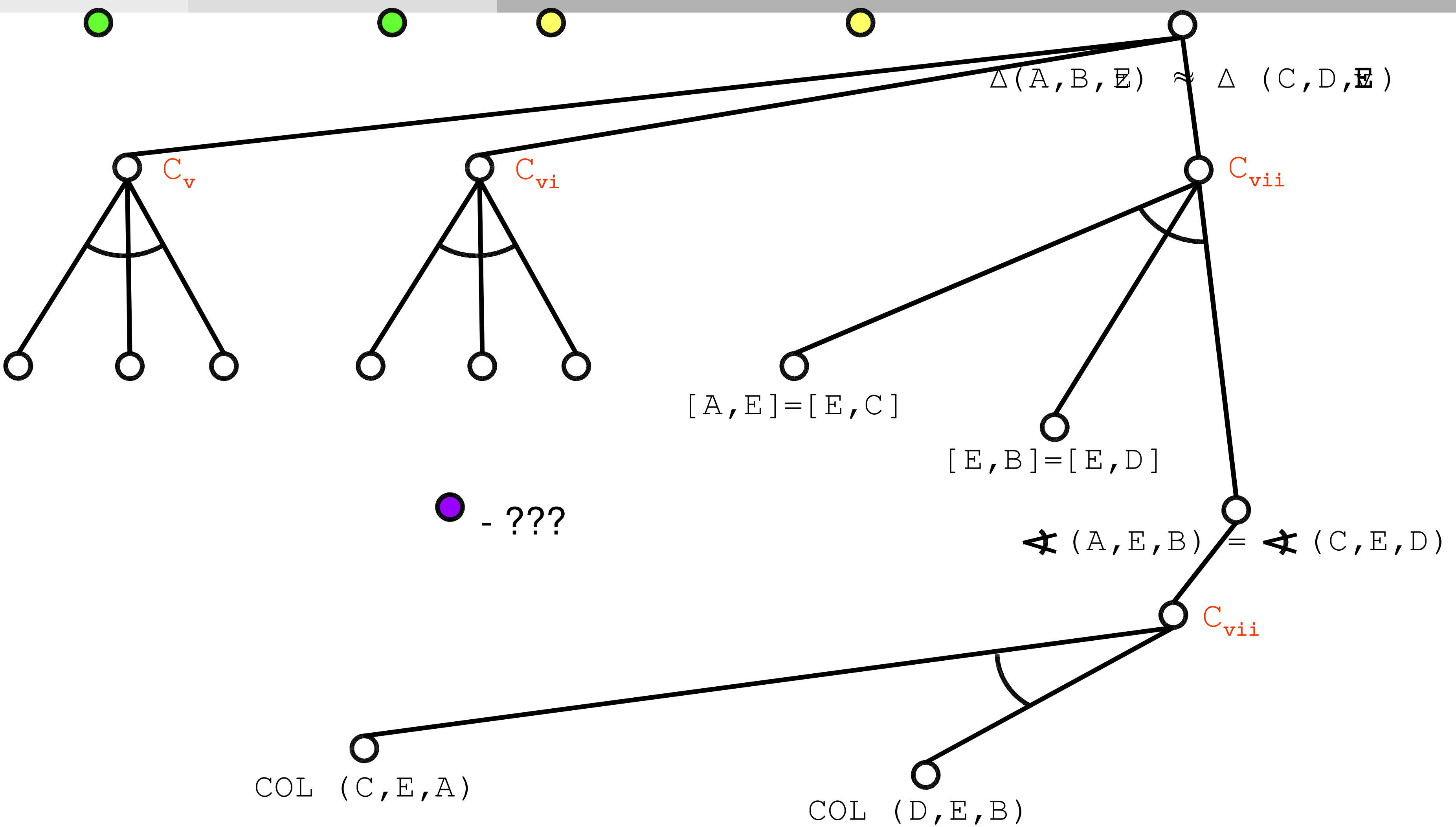
Proof (I)



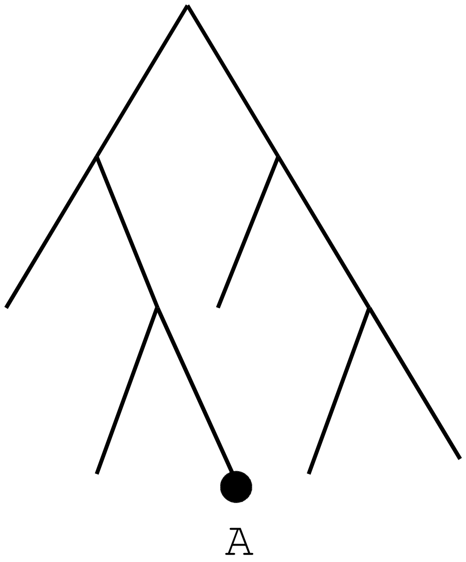
- closed

- unsolvable

Proof (II)



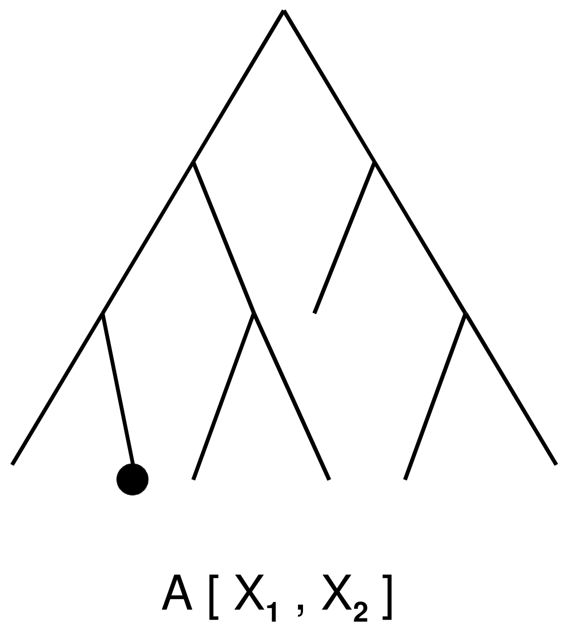
Heuristic 1:



Is one of the assertions false in the model?

A = “false” in the model

Heuristic 2:



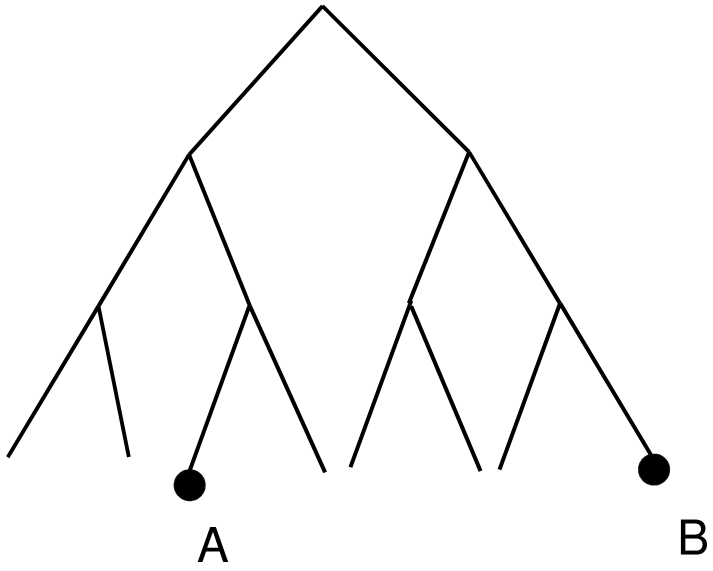
Contains one of the assertions a free variable?

Example Heuristic 2

(a)	[A, B]	=	[A, B]	$\wedge$	[D, C]	=	[A, B]	-
(b)	[A, B]	=	[A, C]	$\wedge$	[D, C]	=	[A, C]	√
(c)	[A, B]	=	[A, D]	$\wedge$	[D, C]	=	[A, D]	√
(d)	[A, B]	=	[A, E]	$\wedge$	[D, C]	=	[A, E]	√
(e)	[A, B]	=	[B, C]	$\wedge$	[D, C]	=	[B, C]	√
(f)	[A, B]	=	[B, D]	$\wedge$	[D, C]	=	[B, D]	√
(g)	[A, B]	=	[B, E]	$\wedge$	[D, C]	=	[B, E]	√
(h)	[A, B]	=	[C, D]	$\wedge$	[D, C]	=	[C, D]	-
(i)	[A, B]	=	[C, E]	$\wedge$	[D, C]	=	[C, E]	√
(j)	[A, B]	=	[D, E]	$\wedge$	[D, C]	=	[D, E]	√

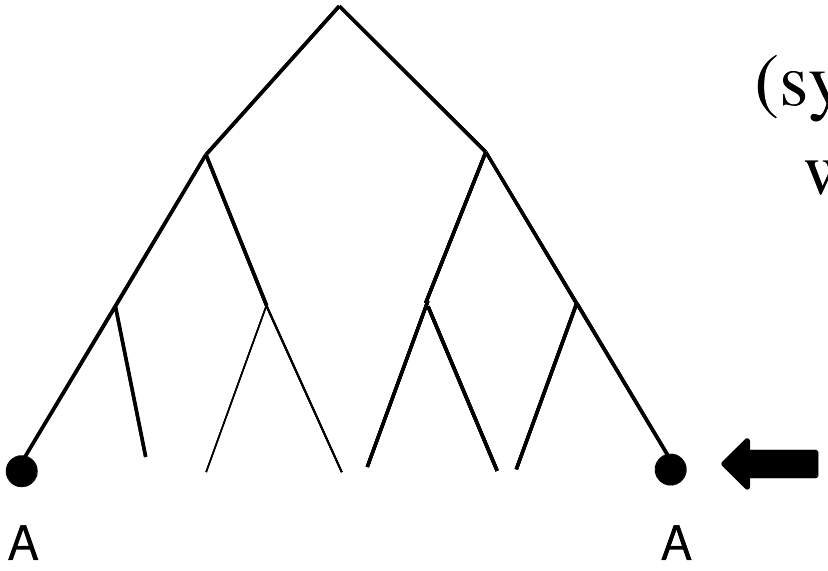
Heuristics

Heuristic 3:



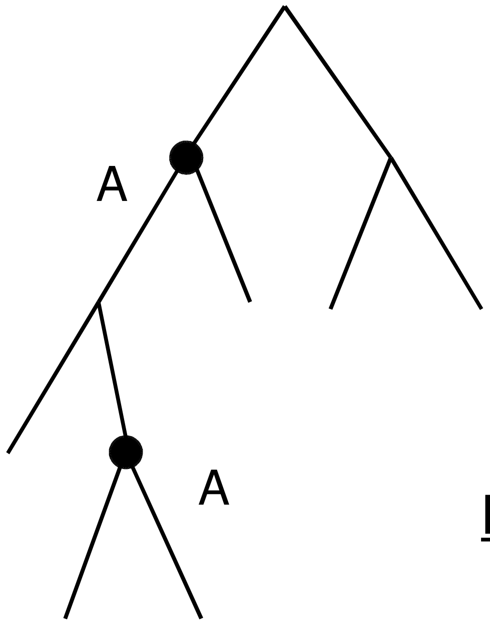
Nodes with "simple" assertions will be closed by special procedures

Heuristic 4:



Nodes with assertions that are (syntactically) equal will be evaluated only once

Heuristic 5:



A branch with two identical assertions will be closed

<u>But</u>: watch out for
AND- and OR-Nodes

Heuristic 6:

Weights for Nodes