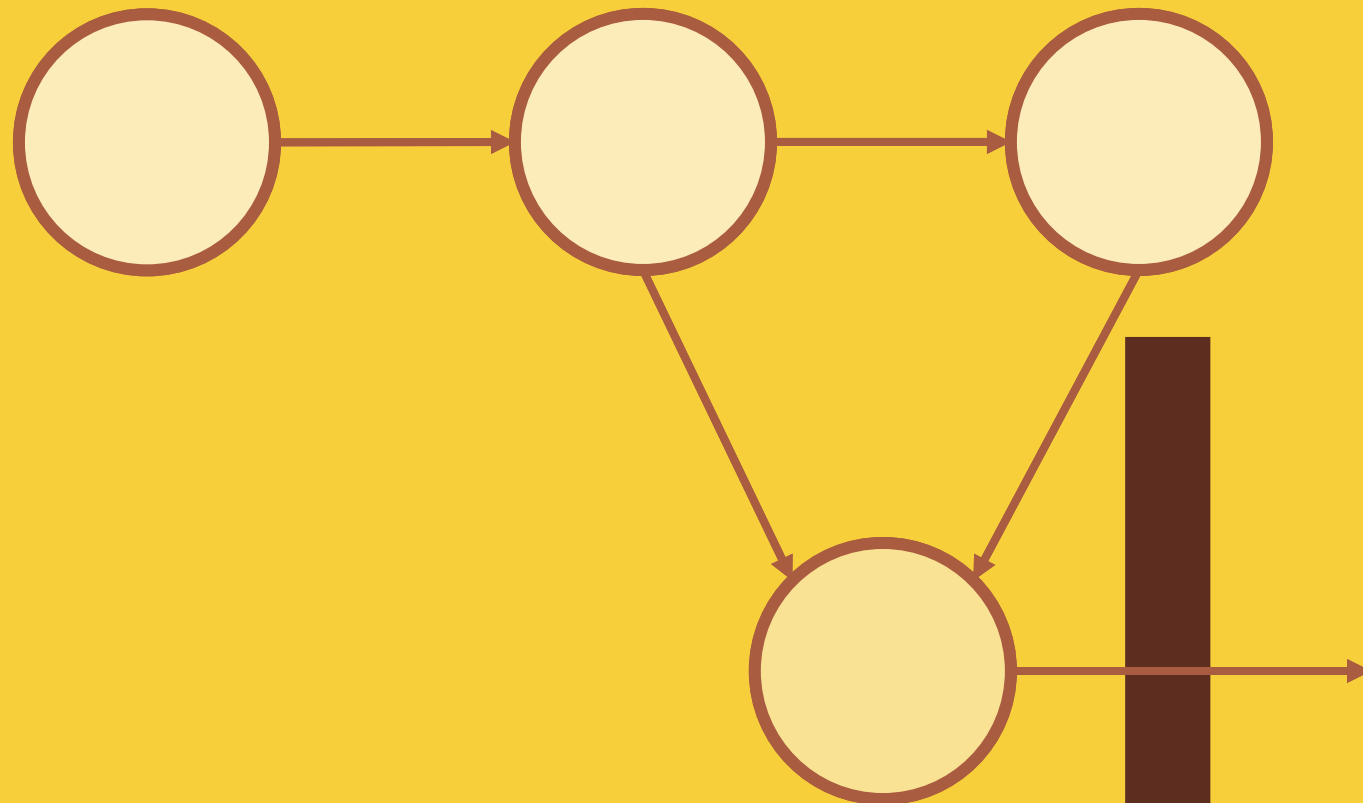




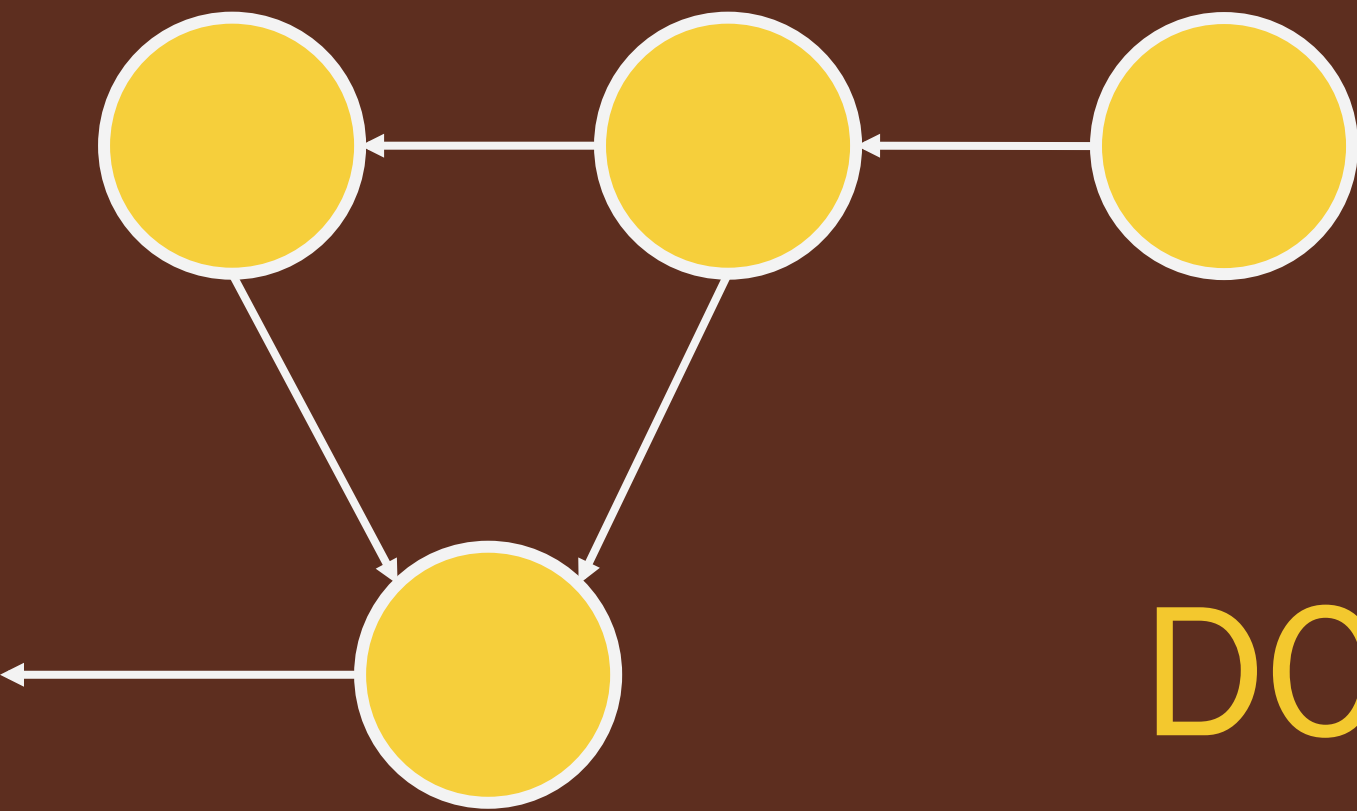
AAAI-16 Tutorial

CP-nets

- Thomas E. Allen
- Judy Goldsmith
- Francesca Rossi



UNIVERSITÀ
DEGLI STUDI
DI PADOVA



DOMINANCE

Judy Goldsmith



Simple CP-net: Monday Reception Food

controls

Add Root Node

Delete Selected Node

(Un)Link Selected Node to...

Affix Selected Node

options

☐ Allow Cycles

☒ Show CPTs in Graph

5 Max In-Degree

loading and saving
currently UNSAVED

pasta

New CP-Net

Load CP-Net from File

Save CP-Net as XML

Save CP-Net as SVG

utilities

Visualize Flipping Sequence

Pasta

Penne > Bowtie

Sauce

B: White > Red
P: Red > White

Cheese

R: Yes > No
W: No > Yes

no selected node

Node Name

domain - one per line

parents

conditional
preference table

Bowties, Red, NoCh < Penne, Red, Cheese

Exit Flipping Sequence

1

Cheese: No
Pasta: Bowtie
Sauce: Red

2

Cheese: No
Pasta: Penne
Sauce: Red

3

Cheese: Yes
Pasta: Penne
Sauce: Red

Pasta

Penne > Bowtie

Sauce

B: White > Red
P: Red > White

Cheese

R: Yes > No
W: No > Yes

no selected node

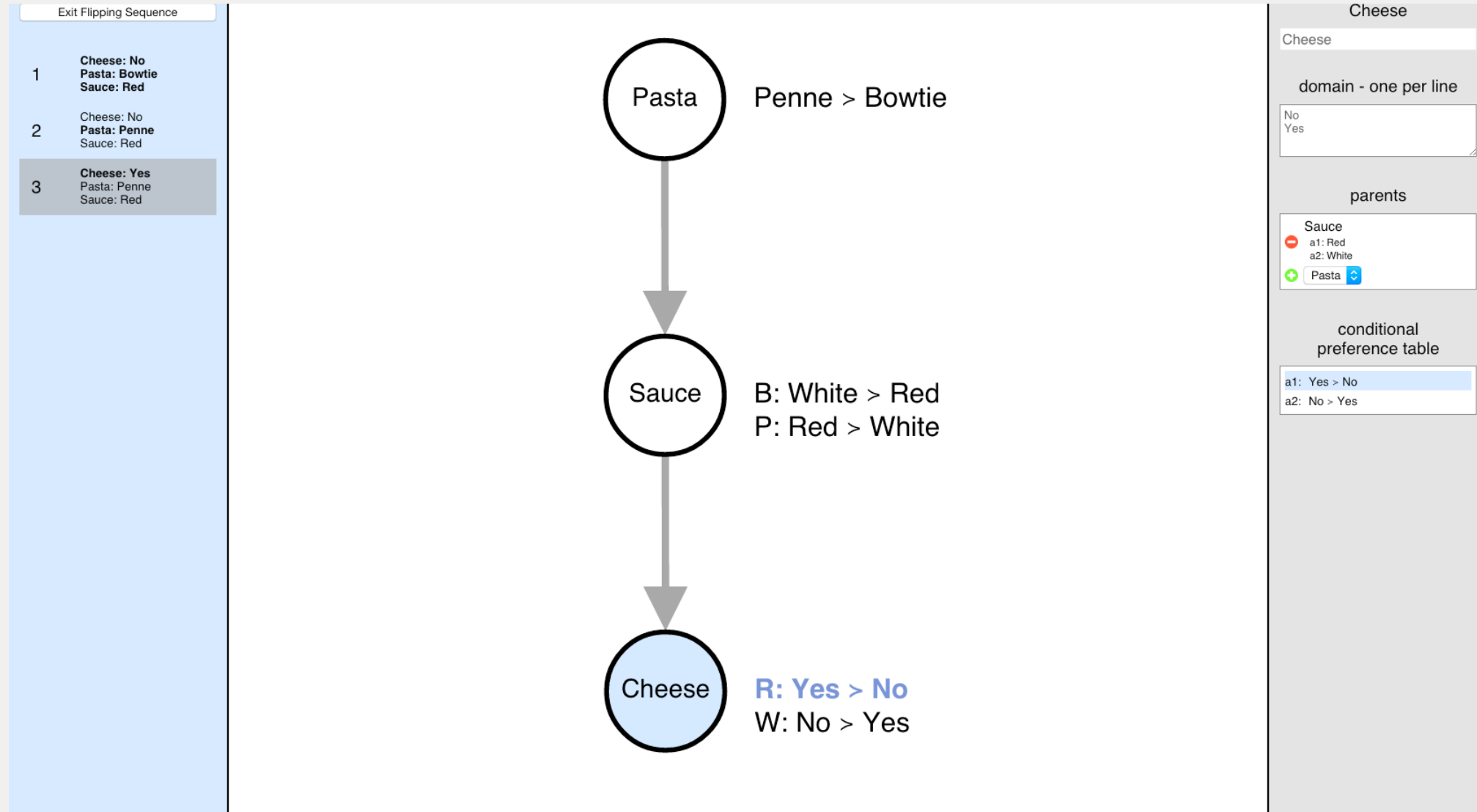
Node Name

domain - one per line

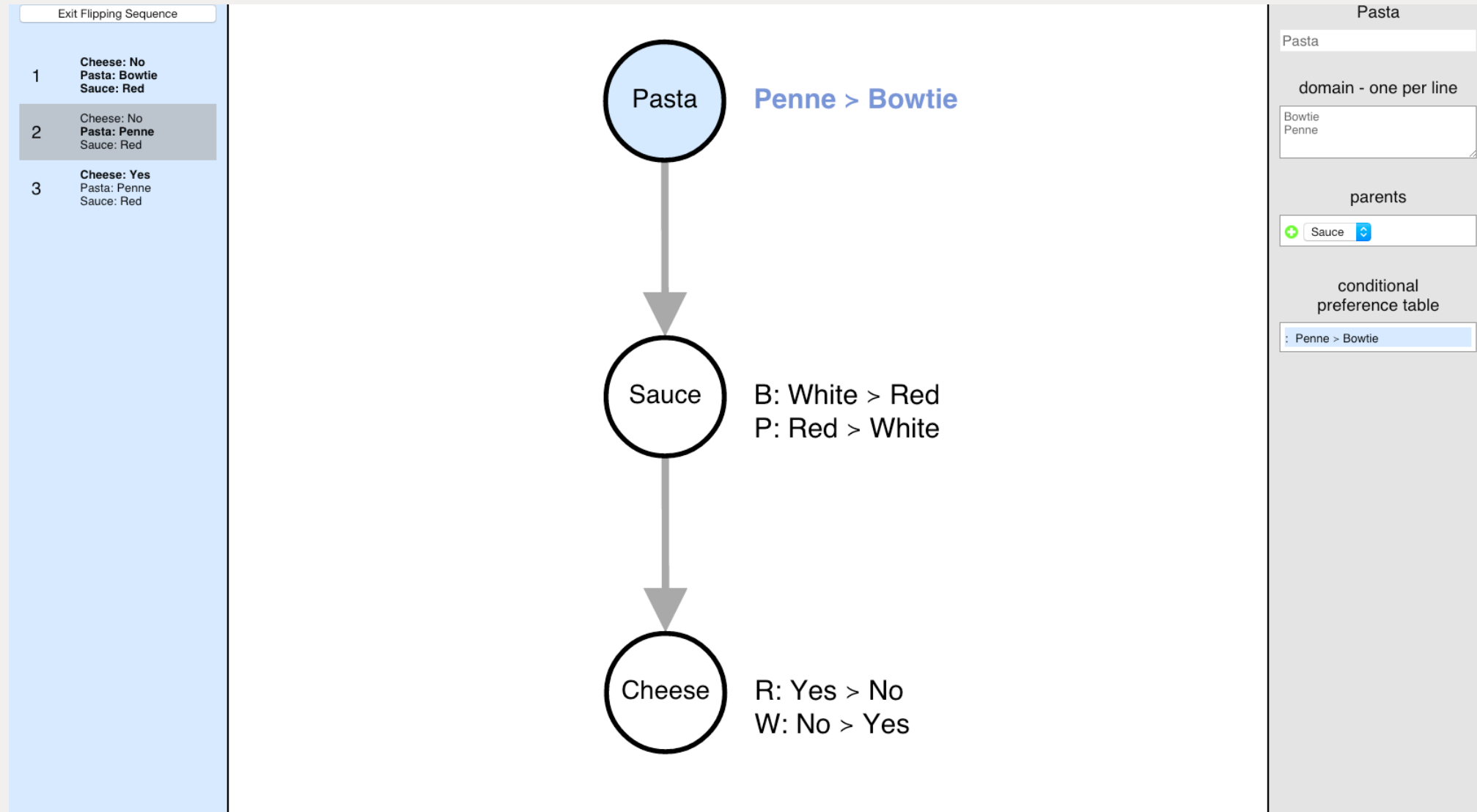
parents

conditional preference table

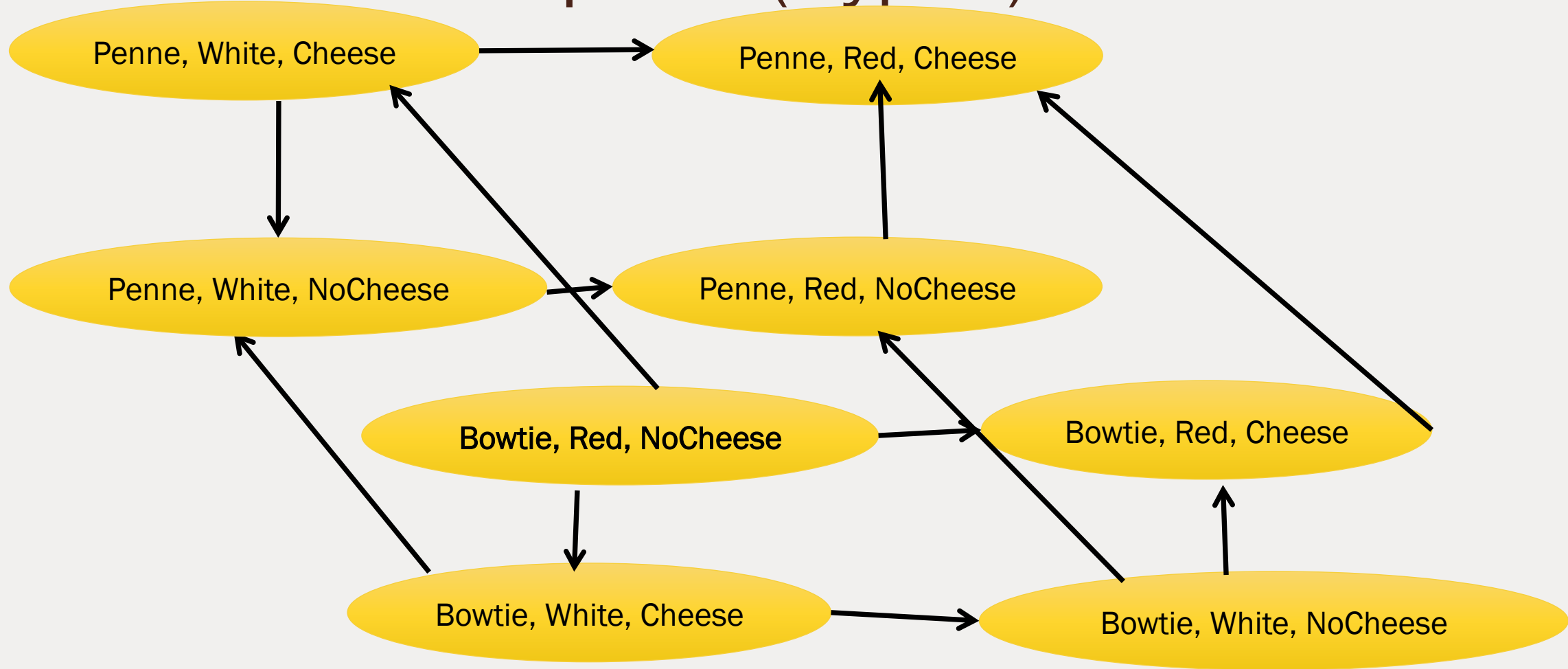
Bowties, Red, NoCh < Bowtie, Red, Cheese



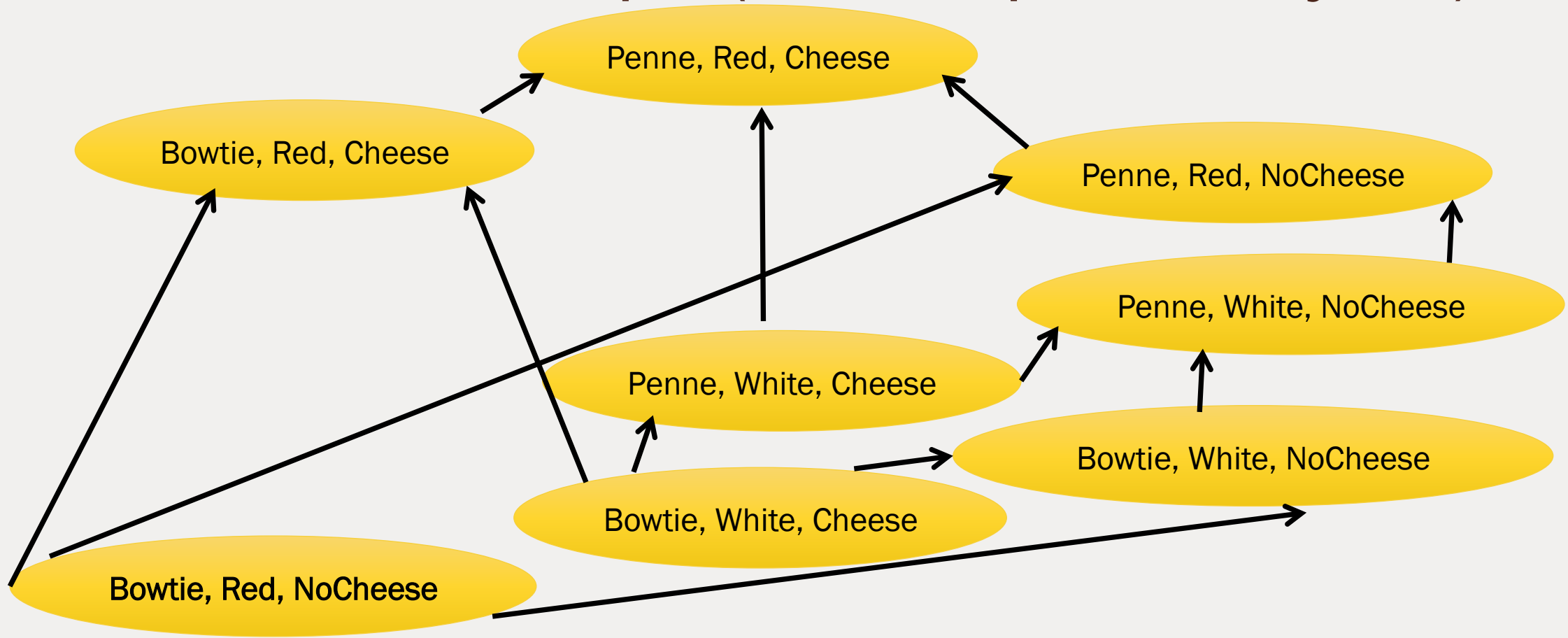
Bowties, Red, Cheese < Penne, Red, Cheese



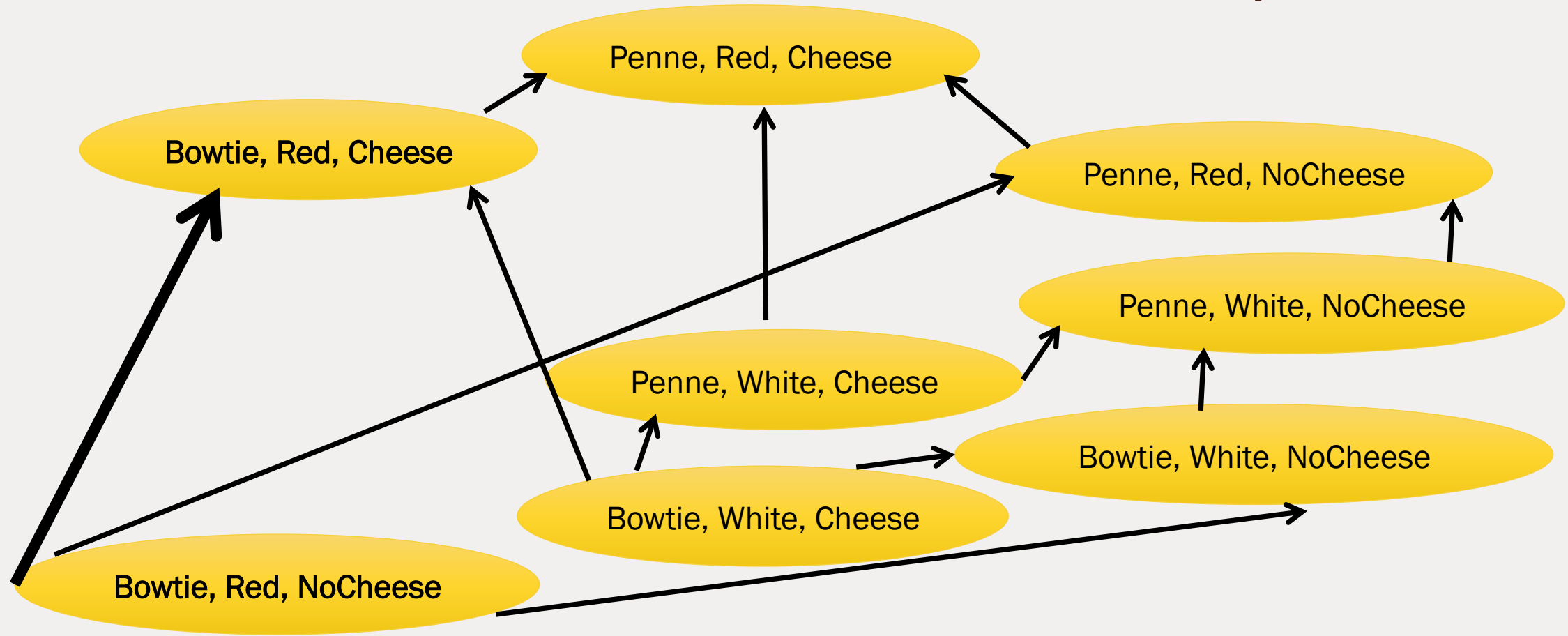
Preference Graph as (Hyper-)Cube



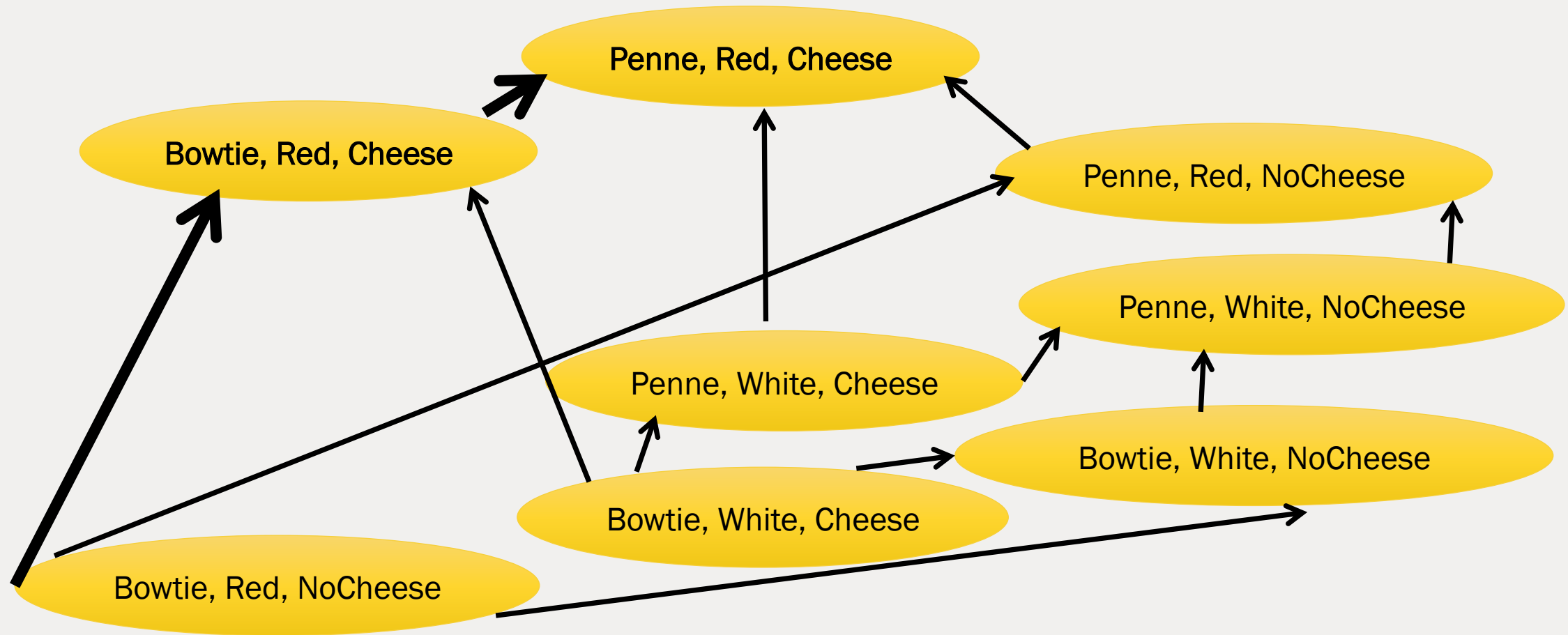
Preference Graph (almost planar layout)



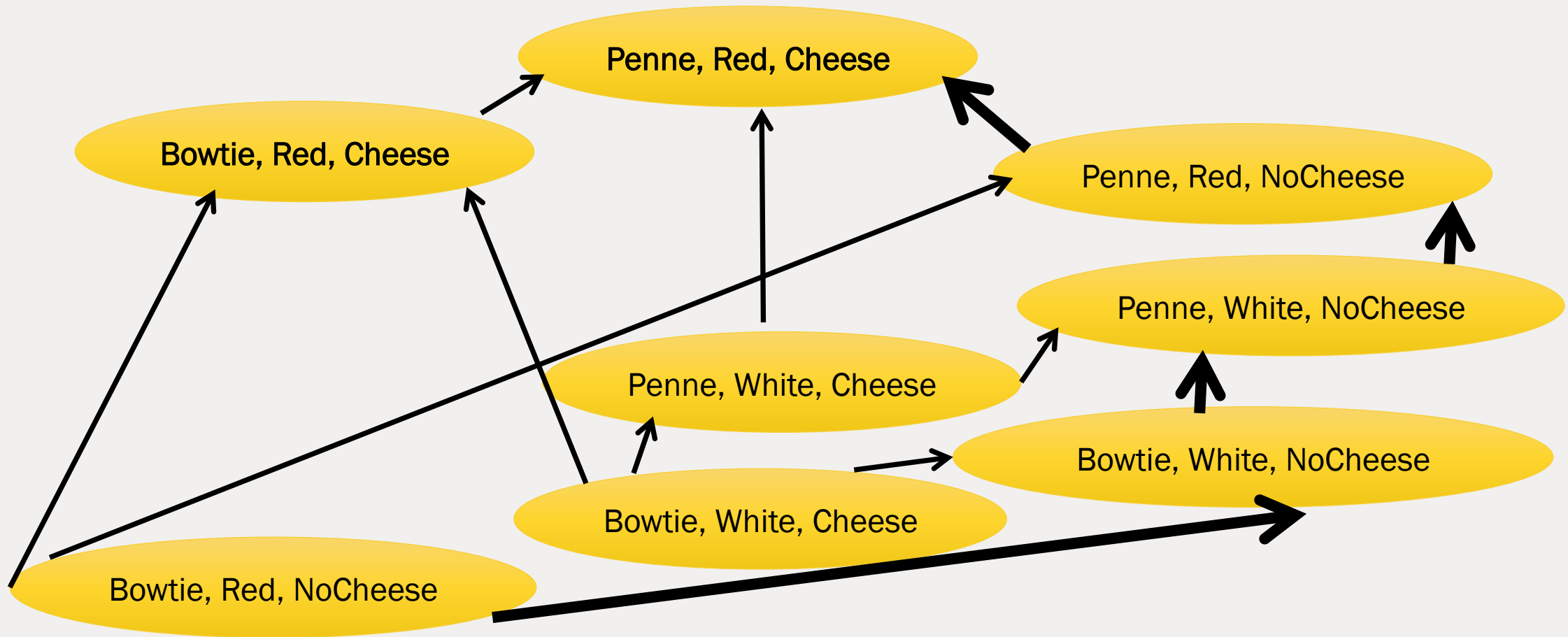
Dominance in the Preference Graph



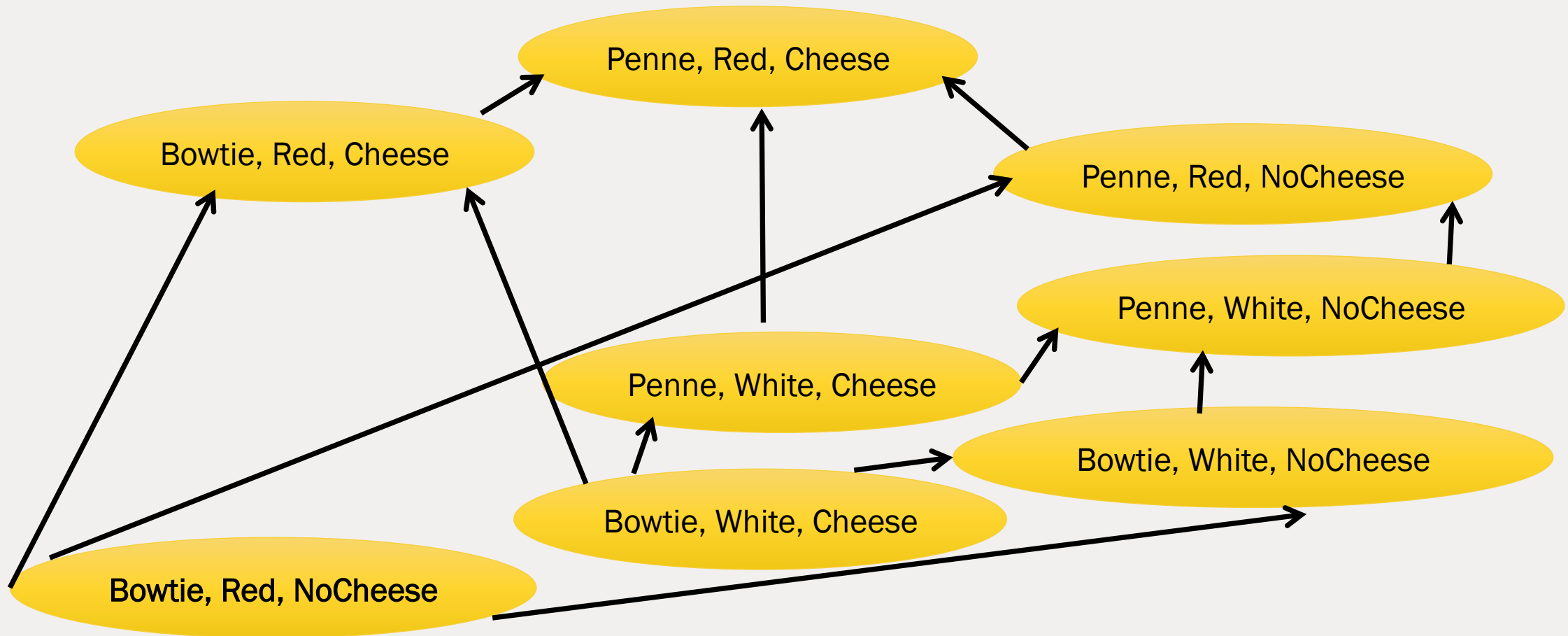
Bowties, Red, NoCh < Penne, Red, Cheese



Bowties, Red, NoCh < Penne, Red, Cheese



Notice that B,R,N is incomparable to B,W,C



Finding Flipping Sequences

- Dominance as graph search

Complexity

- Dominance is NP-hard
 - *Boutilier, et al. 2004*
- For trees and polytrees, Dominance is in P
 - *Boutilier, et al. 2004*
- In fact, for trees, it's linear
 - *Bigot, Zanuttini, Fargier, Mengin, UAI, 2013*

Complexity

- Flipping sequence search over multi-valued CP-nets with partially specified preferences is not in NP.
 - *Boutilier, et al. 2004*
- In generalized CP-nets, Dominance is PSPACE-complete
 - *Assumes cycles allowed, multi-valued variables, succinctly represented CPTs; Goldsmith, Lang, Truszczynski, Wilson, JAIR, 2008*

Boutilier, Et Al. Heuristics

- “Ordering queries”: $o >_d o'$ iff for every x , if
 - $o[Pa(x)] = o'[Pa(x)]$ and
 - $o[x] \neq o'[x]$
 - $O[Pa(x)]: o[x] > o'[x]$
- If $o > o'$ then $o >_d o'$
- $o >_d o'$ can be determined in polynomial time

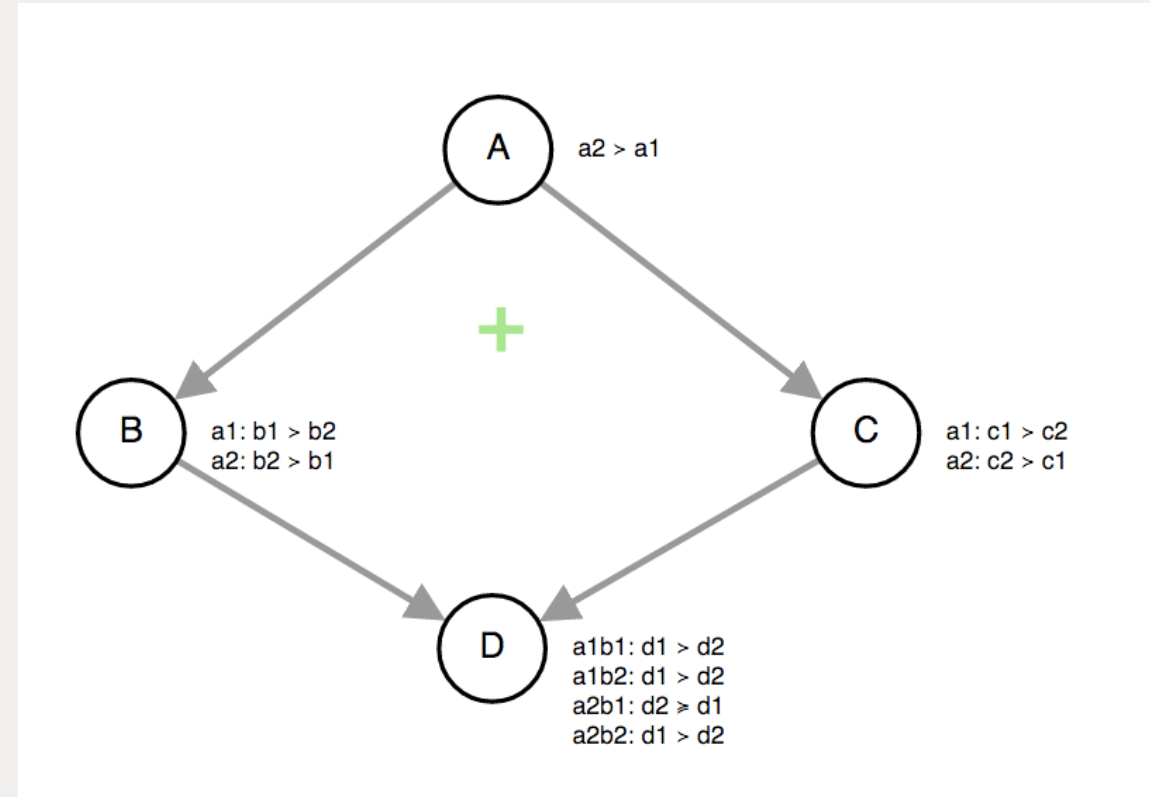
Ordering Query Example

- Hunh?

- Consider the comparison

$a_2b_1c_1d_1, a_2b_2c_1d_2$. We know that we can't have $a_2b_1c_1d_1 > a_2b_2c_1d_2$ because $a_2: b_2 > b_1$.

- Thus, this the ordering query returns “No.”



Boutilier, Et Al. Heuristics

- Suffix fixing (leveraging topological ordering of nodes)
- Least-variable flipping
- Forward pruning

Reduction to Planning

Sauce	Mushrooms	Cheese
Red	Yes	No
Red	No	Yes
White	Yes	No
White	No	No

BECOMES 4 STRIPS OPERATORS:

Red and Mush



Not(Cheese)

Red and not(Mush)



Cheese

White and Mush



Not(Cheese)

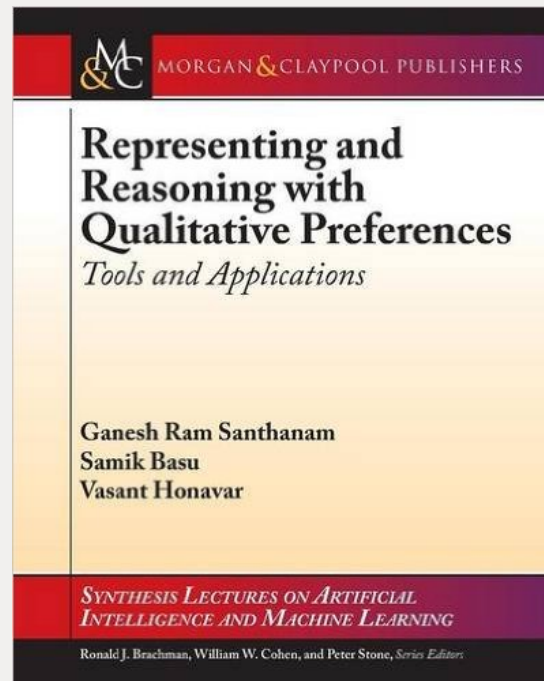
White and not(Mush)



Not(Cheese)

Ganesh Ram Santhanam's Approach

- Reduction to model checking: CRISNER
 - *Santhanam, Basu, Honavar, AAI '10; KR '10; AAI '14 tutorial*



Li, Vo, and Kowalczyk's Approach

- DT*: an A*-like search algorithm
 - *Li, Vo, and Kowalczyk, AAMAS 2011*

Domshlak, Prestwich, Rossi, Venable, and Walsh

- Soft constraints (for acyclic CP-nets)
 - *Domshlak, Prestwich, Rossi, Venable, and Walsh, Journal of Heuristics, 2006*

Dominance Testing Contest

- Coming soon, to an AI meeting near you
- <http://cs.uky.edu/~jcsi225/dtcompetition.html>
- Cory Siler will be managing the contest

