EXERCISES - 2

Topics

- Search strategies
- Constraint satisfaction problems
- Soft constraint satisfaction problems
- CP-nets
- Stable matching problems
- Multi-agent decision making:
  preference reasoning and voting theory
- Bayesian networks
- Planning

Ex 6

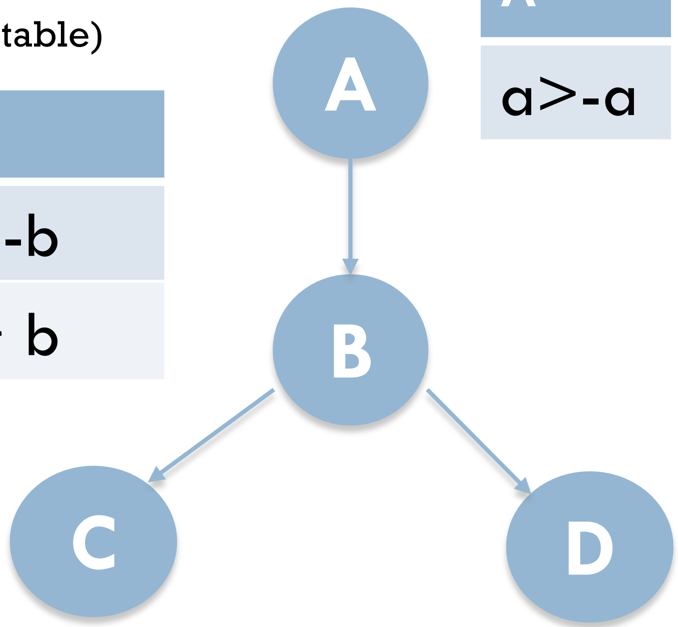
CP-net

- Consider a CP-net with 4 variables (A,B,C,D) where
  - domain of A is {a,-a}, domain of B is {b,-b}
  - domain of C is {c,-c}, domain of D is {d,-d}
  - Conditional preference tables (CPTs) are defined below
- Compute the optimal solution

A
a>-a

conditional preference table (CP-table)

A	B
a	b > -b
-a	-b > b



B	C
b	-c > c
-b	c > -c

B	D
b	d > -d
-b	-d > d

Review: How to find an optimal solution in an acyclic CP-net?

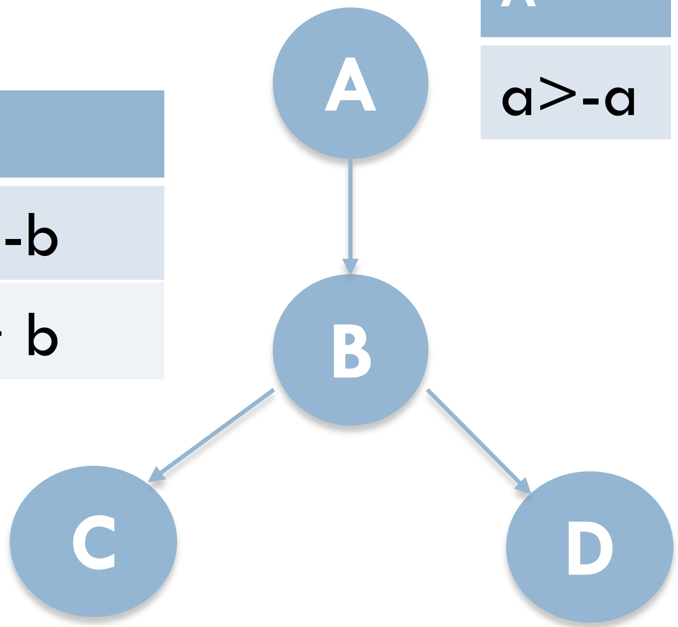
- First consider **independent variables**
  - Assign them their **most preferred values**

- Then consider **dependent variables**, **that directly depend** on the **assigned variables**
  - Assign them their **most preferred values** that are **consistent** with the **values previously assigned** to their **parents**

- **And so on** until we **assign a value to all the variables**

CP-net

A
a>-a



A	B
a	b > -b
-a	-b > b

B	C
b	-c > c
-b	c > -c

B	D
b	d > -d
-b	-d > d

The optimal solution of this CP-net is (a, b, -c, d)

Ex 7

Voting rules

- Assume there are three agents: a1, a2, a3
- Assume there are three candidates: A, B, C
- Assume the agents' preferences are shown below
- What is the winner if we apply the Borda rule to this preference profile?

a1: A > B > C
a2: B > A > C
a3: A > C > B

Voting rules

a1: A > B > C
a2: B > A > C
a3: A > C > B

- Borda winner?
- We need to compute for each candidate the Borda score, that is the number of candidates that it beats in the agents' preferences

Bscore(A) = 2 +1+ 2 = 5
Bscore(B) = 1+2 = 3
Bscore(C) = 0+0+1 = 1

- The candidate with the highest Borda score wins. Therefore in this example A is the winner

Ex 8

Stable matching problem

- Consider a stable matching problem with
  - Three men: Adam, Bob, Carl
  - Three women: Amy, Betty, Cindy
  - The preferences profile is on the right

Men

Adam: Cindy >Amy> Betty

Bob: Betty> Amy > Cindy

Carl: Cindy > Betty > Amy

Women

Amy: Adam > Bob > Carl

Betty: Carl > Bob > Adam

Cindy: Adam > Carl > Bob

- Is the following matching stable?

  {(Adam,Amy), (Bob,Betty), (Carl,Cindy)}. Explain why, why not.

- Apply Gale-Shapley (GS) algorithm and describe the steps of GS. What is the obtained matching?

Stable matching problem

- Is the following matching stable?

  { (Adam,Amy), (Bob,Betty), (Carl,Cindy) }.

- NO, since there is a blocking pair (Adam, Cindy)

Men

Adam: Cindy >Amy> Betty

Bob: Betty> Amy > Cindy

Carl: Cindy > Betty > Amy

Women

Amy: Adam > Bob > Carl

Betty: Carl > Bob > Adam

Cindy: Adam > Carl > Bob

Stable matching problem

- Apply Gale-Shapley (GS) algorithm and describe the steps of GS. What is the obtained matching?

Men

Adam: Cindy >Amy> Betty

Bob: Betty> Amy > Cindy

Carl: Cindy > Betty > Amy

Women

Amy: Adam > Bob > Carl

Betty: Carl > Bob > Adam

Cindy: Adam > Carl > Bob

Review: Gale Shapley algorithm

- **Initialize** every person to be **free**
- **While** exists **a free man**
  - Find **best woman** he hasn't proposed to yet
  - **If** this **woman is free**, declare them **engaged**
  - **Else**
    - If this **woman prefers this proposal** to her current fiancee then declare them **engaged** (and "free" her current fiancee)
    - Else if this woman **prefers her current** fiancee and she **rejects the proposal**

Stable matching problems

- GS steps:
  - Adam proposes to Cindy and Cindy accepts
  - Bob proposes to Betty and Betty accepts
  - Carl proposes to Cindy and Cindy does not accept
  - Carl proposes to Betty and Betty accepts, thus Bob is free
  - Bob proposes to Amy and Amy accepts

Men

Adam: Cindy >Amy> Betty

Bob: Betty> Amy > Cindy

Carl: Cindy > Betty > Amy

Women

Amy: Adam > Bob > Carl

Betty: Carl > Bob > Adam

Cindy: Adam > Carl > Bob

Obtained matching:

M={(Adam, Cindy), (Bob, Amy), (Carl, Betty)}