

# Prep for exam 1

November 27, 2018

## 1 What we learned

- Search
  1. Single agent
  2. 0 - sum games (+stochastic)
- KB (logic)
  1. propositional
  2. FOL

## 2 Note on CNF and DNF

CNF:  $(A \vee B) \wedge (\neg B \vee C)$

DNF  $(x \wedge y) \vee (\neg x \wedge z)$

Transformation from DNF to CNF is NP-hard

## 3 Every bird has 2 wings mistake

$\forall x Bird(x) \Rightarrow [\exists w, z \quad Wing(w) \wedge Wing(z) \wedge (Has(x, w)) \wedge Has(x, z) \wedge \neg(w = z) \wedge \forall y (NOT \exists y)(wing(y) \wedge Has(x, y))] \Rightarrow y = w \vee y = z$

## 4 Exercise

$$\forall x \quad Syrian(x) \Rightarrow \exists y \quad Missile(y) \wedge Owns(x, y) \quad (1)$$

$$\exists x, y \quad Owns(Assad, y) \wedge Owns(Assad, x) \wedge M(x) \wedge M(y) \wedge \neg(x = y) \quad (2)$$

$$\forall x (Owns(Assad, x) \wedge M(x)) \Rightarrow Chemical(x) \quad (3)$$

$$\forall x \quad (\exists y \quad Chemical(y) \wedge Weapon(y) \wedge Owns(x, y)) \Rightarrow Evil(x) \quad (4)$$

$$\forall x \quad M(x) \Rightarrow W(x) \quad (5)$$

#### 4.1 CNF:

Can remove EI since there are no negations. To remove EI need to make Skolem function (just say skolem function, don't define). In (1) its  $MM1()$

$$\forall x \quad \neg Syrian(x) \vee Missile(MM1(x)) \wedge Owns(x, MM1(x))$$

Apply distributive rule

$$\forall x \quad \neg Syrian(x) \vee Missile(MM1(x)) \quad (6)$$

$$\forall x \quad \neg Syrian(x) \vee Owns(x, MM1(x)) \quad (7)$$

From (2) - remove 2 EI

$$O(A, M1) \quad (8)$$

$$O(A, M2) \quad (9)$$

$$M(M1) \quad (10)$$

$$M(M2) \quad (11)$$

$$\neg(M1 = M2) \quad (12)$$

From (3) we get (recommended not to use x but use x1 to avoid mistakes)

$$\neg O(A, x) \vee \neg M(x) \vee C(x) \quad (13)$$

From (4) we get

$$\begin{aligned} \forall x \quad & \neg(\exists y \quad Chemical(y) \wedge Weapon(y) \wedge Owns(x, y)) \vee Evil(x) \\ & \neg Chemical(y) \vee \neg Weapon(y) \vee \neg Owns(x, y)) \vee Evil(x) \end{aligned} \quad (14)$$

From (5) we get

$$\neg M(x) \vee W(x) \quad (15)$$

#### 4.2 Query:

Evil(Assad) Q'. :  $\neg E(A)$

### 4.3 Resolution:

Resolve (13), (8),  $\theta = (x/M1)$

$$\neg M(M1) \vee C(M1) \quad (16)$$

Resolve (16), (10),  $\theta = ()$

$$C(M1) \quad (17)$$

Resolve (17), (14),  $\theta = (y/M1)$

$$\neg W(M1) \vee \neg O(x, M1) \vee E(x) \quad (18)$$

Resolve (18), (8),  $\theta = (x/A)$

$$\neg W(M1) \vee E(A) \quad (19)$$

Resolve (15), (10),  $\theta = (x/M1)$

$$W(M1) \quad (20)$$

Resolve (19), (20),  $\theta = ()$

$$E(A) \quad (21)$$

Resolve (21), Q',  $\theta = (x/A)$

$$Square \quad (22)$$

### 4.4 Can use backward chaining?

Yes. All CNF are Horn clauses.

For Horn clause

- At INF should be only one implication.
- At CNF should be at most only one positive.

### 4.5 Can you prove Assad is Syrian?

$S(A)$

$\neg S(A)$

From the knowledge base it is impossible to prove that  $\neg S(A)$  is true since there is no  $S(A)$ !

To prove  $S(A)$ , resolution with (6) will give  $M(MM1(A))$ . It is impossible to continue from hereon. Therefore, can't prove that Assad is Syrian.

Knowledge base with contradiction resolves everything!

## 5 games - search

Play a two player game, non 0-sum. The game is in figure:

a.

How can I play to get best performance given that every player wants to maximize numbers.

Expand, and left branch is best: (50, 40)

Can you use branch trimming? No

b.

There is a 0.84 that the opponent plays randomly

## 6 True or False

$h(n)$  is more optimistic than  $h(n)/5$ ? False

$h(n) = -g(n)$  - is admissible? False.  $h(n)$  has to be 0 at the goal state!

Can you play Go with on a 19 x 19 board with a truth table? False.  $3^{308}$

$C \wedge B \Rightarrow A$ , num of models is 7? True