UCLA Samueli School of Engineering

CS161 WEEK6 DISCUSSION 1C

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Contributed by Shirley and Yewen’s course materials

Agenda

FIRST-ORDER LOGIC

First-order Logic

Jack, Apple, LBJ

x, y, z ...

SENTENCES

Atomic Sentences:

- Objects(Constants, Variables, Complex) → Color(Apple)
- Predicates(T/F Evaluation) IsBasketballPlayer(LBJ)
- Connectives $\Rightarrow \Leftrightarrow \vee \wedge = \neq$
- Quantifiers(Universal & Existential)

$\forall$ (any/all) $\exists$ (exist)

First-order Logic

QUANTIFIERS

Practice

Guess what they mean:

$(\forall x)$ CaptainAmerica$(x) \Rightarrow$ HasShield(x)

$\forall x$ CaptainAmerica$(x) \wedge$ HasShield(x)

$\exists x$ (IronMan$(x) \wedge$ Alive(x))

$\exists x$ (IronMan$(x) \Rightarrow$ Alive(x))

$\Updownarrow$

$\neg$ IronMan$(x) \vee$ Alive(x)

Love(x, y)

x loves y

$\forall x \exists y$ loves(x,y)

$\exists y \forall x$ Loves(x,y)

$\forall y \exists x$ Loves(x,y)

$\exists x \forall y$ Loves(x,y)

First-order Logic

QUANTIFIERS

$$
\begin{aligned}
\forall x\ \neg P &\equiv \neg \exists x\ P \\
\neg \forall x\ P &\equiv \exists x\ \neg P \\
\forall x\ P &\equiv \neg \exists x\ \neg P \\
\exists x\ P &\equiv \neg \forall x\ \neg P
\end{aligned}
$$

First-order Logic

$Sister(x, Shirley)$

Represent using FOL:

① Shirley has at least two sisters $\exists x \exists y\ Sis(x, Shirley)\ Sis(y, Shirley) \land (x \neq y)$

② Shirley has only one sister $\exists x\ Sis(x, Shirley) \land (\forall y\ Sis(y, Shirley) \Rightarrow (x = y))$

$\Updownarrow$

$(\forall y\ \neg Sis(y, Shirley) \lor (x = y)))$

③ You can always fool someone

$(\exists x \forall t) Fool(x, t)$

④ Sometimes you can fool everyone

$(\exists t \forall x) Fool$

Midterm

STILL IN PROGRESS

Depth First Search (DFS) can always be improved to become complete with ____?

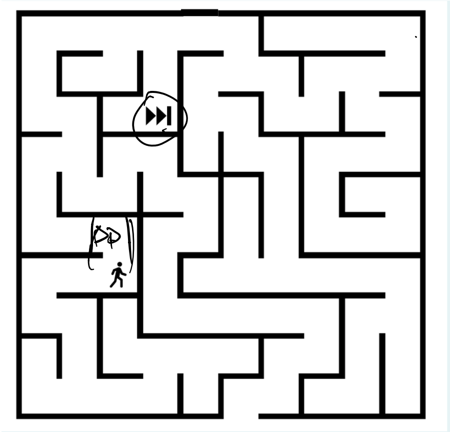
Midterm

STILL IN PROGRESS

Admissible heuristics

0

Manhattan distance between the player and the exit
Half of Manhattan distance between the player and the exit



Midterm

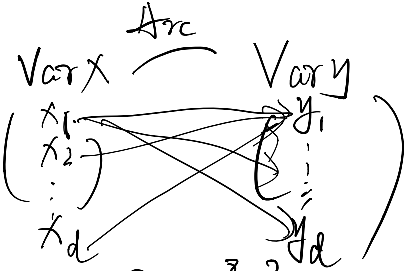
- In the minimax algorithm for 2-player games, the optimal action may change when the utility values of leaf nodes change, even if the order of those utility values is preserved.

  sorted(nodes)

- In A* search, one should seek an admissible heuristic which values are as large as possible.

  O

- For binary CSPs, Arc Consistency can be applied in (O(n^2 d)), where n is the number of variables and d is the largest number of values that any variable can take.



$O(d^2 n^2)$

Midterm

$\alpha = F \quad \beta = F \quad \gamma = F \vee ?$

$((\alpha \vee \beta) \wedge (\gamma \vee \neg\beta))$ F

$(\alpha \vee \gamma)$

- The inference rule of resolution is refutation complete.

$\Delta \models \alpha$ iff [$\neg\Delta \wedge \alpha$ is unsatisfiable].

The following inference rule is sound: $\frac{\neg\alpha,\gamma}{\beta\Rightarrow\neg\alpha}$

$\neg\alpha, \gamma$

$\neg\beta \vee \neg\alpha$

Q&A