Faculty of Computers and Artificial Intelligence

Cairo, Egypt

Course Name: CS361 Artificial Intelligence

Course ID: 202102.FCI.CS361

AI Sheet

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1. Write the following propositions using P, Q, and R and logical connectives.

Solution:

a. $R \wedge \neg Q$
b. $P \rightarrow R$
c. $R \leftrightarrow Q \vee P$
d. $P \wedge Q \rightarrow R$

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2. For each of the following pairs of terms, give the most general unifier if they unify or else explain why unification would fail (note that variables are in small letters, values/constants in capital letters)

Solution:

i. MGU = {y/G(z)}
ii. MGU = {r/B, y/F(r), z/S}
iii. Can't unify S with B and can't unify Z with C

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3. Express the following in predicate logic

Solution:

i. $\forall x$ (bought(Maryam, x) $\rightarrow$ bought(Susan, x))
ii. $\forall x$ (bought(Maryam, x) $\rightarrow \forall x$ bought(Susan, x)
iii. $\exists x$ (computer(x) ^ $\forall y$ (student(y) $\rightarrow$ $\neg$ uses(y,x)))
iv. $\exists x$ (with(Ahmad, x) ^ $\forall y$ (with(Ahmad, y) $\rightarrow$ x=y))

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4. Consider the following sentences:

- The members of Giza Club are Mohamed, Amir, and Iman.
- Mohamed is married to Mona.
- Amir is Iman's brother.
- The partner (husband/wife) of every married person in the Club is also a member in the Club.
- The last meeting was at Mohamed's house.

Solution:

a. Translate these sentences into Predicate Logic.

Solution:

1. Member(Mohamed) ^ Member(Amir) ^ Member(Iman)
2. Married(Mohamed, Mona)
3. Brother(Iman, Amir)
4. ∀x ∀y (Married (y, x) ^ Member(y) →Member(x))
   4.1 ∀x ∀y (Married (y, x) ^ Member(x) →Member(y))
5. LastMeetingAtHouse(Mohamed)

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b. Prove, by using resolution, the following statement:
The last meeting of the Club was at Mona's house.

Solution:

- First, I will Transform these predicates to CNF

1) Member(Mohamed) ^ Member(Amir) ^ Member(Iman)
2) Married(Mohamed, Mona)
3) Brother(Iman, Amir)
4) ¬ Married (y, x) ∨ ¬ Member(y) ∨ Member(x)
   4.1) ¬ Married (y, x) ∨ ¬ Member(x) ∨ Member(y)

5) LastMeetingAtHouse(Mohamed)

Note: If two persons are married then the last meeting in house of any of them is true .So, I will add this predicate:
∀x ∀y (Married (y, x) ^ LastMeetingAtHouse(y)⍰LastMeetingAtHouse(x))

And I will teransform it to CNF:

6) ¬ Married(y,x) ∨
   ¬ LastMeetingAtHouse(y) ∨ LastMeetingAtHouse(x)

- Second,I will proof that LastMeetingAtHouse(Mona)

From 2 and 6, I will substitute y with Mohamed and substitute x with mona

7) So, {y/Mohamed, x/Mona}: ¬ LastMeetingHouse(Mohamed) ∨ LastMeetingHouse(Mona)

From 2 ,6 and 7, I conclude that LastMeetingHouse(Mona).

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5. Determine whether (P → Q) OR (Q → P) is a tautology.

Solution:

(¬ P ∨ Q) ∨ (¬ Q ∨ P)
(¬ P ∨ P) ∨ (Q ∨ ¬ Q)
T ∨ T = T

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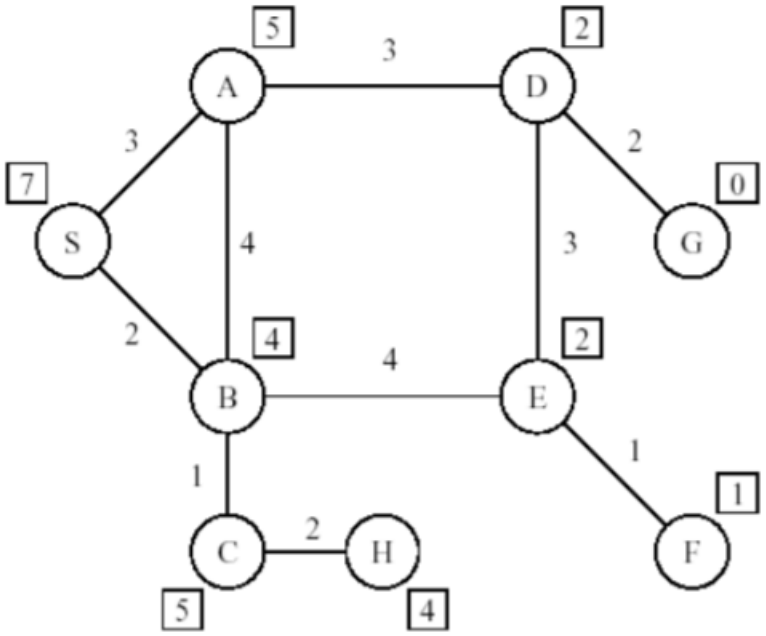
6. Consider the following graph representing the state space and operators of a navigation problem:



The path cost is shown by the number on the links; the heuristic evaluation is shown by the number in the box.

- What is the order that Greedy search will expand the nodes?

Solution:

Expanded Node	Open list	Close list
-	{S(7)}	{}
S	{B(4),A(5)}	{S(7)}
B	{E(2),A(5),C(5)}	{S(7),B(4)}
E	{F(1),D(2),A(5),C(5)}	{S(7),B(4),E(2)}
F	{D(2),A(5),C(5)}	{S(7),B(4),E(2),F(1)}
D	{G(0), A(5),C(5)}	{S(7),B(4),E(2),F(1),D(2)}
G	{A(5),C(5)}	{S(7),B(4),E(2),F(1),D(2),G(0)}

The order of expanded nodes (Path) is: S(7)→B(4)→E(2)→F(1)→D(2)→G(0)

- What is the order that uniform cost search will expand the nodes?

Solution:

Expanded Node	Open list	Close list
-	{S(0)}	{}
S	{B(2),A(3)}	{S(0)}
B	{A(3),C(3),E(6),A'(6)}	{S(0),B(2)}
A	{C(3),E(6),A'(6),D(6)}	{S(0),B(2),A(3)}
C	{H(5),E(6),A'(6),D(6)}	{S(0),B(2),A(3),C(3)}
H	{E(6),A'(6),D(6)}	{S(0),B(2),A(3),C(3),H(5)}
E	{A'(6),D(6),F(7),D'(9)}	{S(0),B(2),A(3),C(3),H(5),E(6)}
A'	{D(6),F(7),D'(9)}	{S(0),B(2),A(3),C(3),H(5),E(6),A'(6)}
D	{F(7),G(8),D'(9)}	{S(0),B(2),A(3),C(3),H(5),E(6)),A'(6),D(6)}
F	{G(8),D'(9)}	{S(0),B(2),A(3),C(3),H(5),E(6),A'(6),D(6),F(7)}
G	{D'(9)}	{S(0),B(2),A(3),C(3),H(5),E(6),A'(6),D(6),F(7),G(8)}

The order of expanded nodes (Path) is:
S(0)→B(2)→A(3) →C(3)→H(5)→E(6)→A'(6) →D(6) →F(7) →G(8)

- What is the order that A* search will expand the nodes?

Solution:

Expanded Node	Open list	Close list
-	{S(7)}	{}
S	{B(6),A(8)}	{S(7)}
B	{A(8),C(8),E(8),A'(11)}	{S(7),B(6)}
A	{C(8),E(8),D(8), A'(11)}	{S(7),B(6),A(8)}
C	{ E(8),D(8),H(9), A'(11),D'(11)}	{S(7),B(6),A(8),C(8)}
E	{ D(8),F(8),H(9), A'(11),D'(11)}	{S(7),B(6),A(8),C(8),E(8)}
D	{F(8),G(8),H(9), A'(11),D'(11)}	{S(7),B(6),A(8),C(8),E(8),D(8)}
F	{G(8),H(9), A'(11),D'(11)}	{S(7),B(6),A(8),C(8),E(8),D(8),F(8)}
G	{H(9), A'(11),D'(11)}	{S(7),B(6),A(8),C(8),E(8),D(8),F(8),G(8)}

The order of expanded node (Path) is:
S(7) →B(6) →A(8) →C(8) →E(8) →D(8) →F(8) →G(8)

- What is the order that hill-climbing search will expand the nodes?

Solution:

The order of expanded node (Path) is: S(7) →B(4) →E(2) →F(1)
Solution (Path) not found.
