Q. 1

1) If Daniel goes to party then Bob and cody come too.

→ $D \Rightarrow (B \wedge C)$

2) $D \Leftrightarrow (C \wedge \neg A)$

3) $(\neg D \Rightarrow C) \wedge (D \Rightarrow \neg B)$

4) $A \Rightarrow (\neg B \wedge \neg C \Rightarrow D)$

5) $(A \wedge B \wedge C \Rightarrow \neg D) \wedge (\neg A \wedge \neg B \Rightarrow (D \Rightarrow C))$

A => Andy comes to party

B => Bob comes to party

C => cody comes to party

D => Daneil comes to party

(2) CONVERT TO CNF :→

(1) $(A \Rightarrow \neg B) \Rightarrow C$

Step 1 :→ $(\neg A \vee B) \Rightarrow C$ Eliminate $\Rightarrow$ by transforming $\alpha \Rightarrow \beta$ to $(\neg \alpha \vee \beta)$

Step 2 :→ $\neg(\neg A \vee B) \vee C$ Eliminate $\Rightarrow$ by transforming $\alpha \Rightarrow \beta$ to $(\neg \alpha \vee \beta)$

Step 3 :→ $(A \wedge \neg B) \vee C$ De morgan's law $\neg(\neg A \vee C) \Rightarrow (\neg A \wedge C)$

Step 4 :→ $(A \vee C) \wedge (\neg B \vee C)$ ~~De morgan's law.~~

~~Step 5 :→ $(A \vee C), (\neg B \vee C)$~~

(2) $(P \Rightarrow (Q \Rightarrow R)) \Rightarrow (P \Rightarrow (R \Rightarrow Q))$

Step 1 :→ $(P \Rightarrow (\neg Q \vee R)) \Rightarrow (P \Rightarrow (\neg R \vee Q))$

Step 2 :→ $(\neg P \vee (\neg Q \vee R)) \Rightarrow (\neg P \vee (\neg R \vee Q))$

Step 3 :→ $\neg(\neg P \vee \neg Q \vee R) \vee (\neg P \vee \neg R \vee Q)$

Step 4 :→ $(P \wedge Q \wedge \neg R) \vee (\neg P \vee \neg R \vee Q)$

Step 5 :→ $(P \vee \neg P \vee \neg R \vee Q) \wedge (Q \vee \neg P \vee \neg R \vee Q) \wedge (\neg R \vee \neg P \vee \neg R \vee Q)$

Step 6 :→ $\neg P \vee Q \vee \neg R$

(3) Languge => r: "~~Fo~~ m is behind red door"
b: "10m is behind blue door"
g: "10m is behind green door"

(1) axiom1: behind one door is 10m and other 2 doors is waupus.
Logic => $(r \land \neg b \land \neg g) \lor (\neg r \land b \land \neg g) \lor (\neg r \land \neg b \land g)$

(2) atleast one of three is true.

$r \lor \neg b$

(3) atleast one of three is false

$\neg r \lor b$

solution =>

r	b	g	$\overset{2}{r \lor \neg b}$	$\overset{3}{\neg r \lor b}$	$2 \land 3$
T	F	F	T	F	F
F	T	F	F	T	F
F	F	T	T	T	$\boxed{T}$

From truth table, Formillian is behind the green door.

Q.4 Let A - Alan goes for scuba diving
B - Brianna goes for scuba diving
C - Cody goes for scuba diving
D - Daneil goes for scuba diving.

Solution, only 2 can go, we have $(A \wedge B) \vee (C \wedge D) \vee (B \wedge D)$
any 2 can go but there are constraints are.

1) Alan will go only if Banana goes too.

$A \Rightarrow B$

2) Daneil will go only if Cody goes too $D \Rightarrow C$

3) Briana had found that she did not complete 6150 home, so she could not go. $B = \text{false}$, So $\neg B$.

$\boxed{B}$ we have $B \equiv \text{false}$, $(A \wedge B) \equiv \text{false}$, $(B \wedge C) \equiv \text{false}$, $(B \wedge D) \equiv \text{false}$.

Any literal and false gives false. Now, we have possible pairs. $(A \wedge C) \vee (A \wedge D) \vee (C \wedge D)$

Also, $A \Rightarrow B \Rightarrow \neg A \vee B$ put $B \equiv \text{false} \Rightarrow \neg A$

$\neg A$ means Alan does not go for scuba diving Hence $(A \wedge C) \vee (A \wedge D)$ not possible.

So, only one pair is possible that is $(C \wedge D)$.

$\boxed{\text{Cody and Daneil go for scuba diving.}}$

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1) No leader is higher than itself.

$\forall x$ leader $(x) \rightarrow \neg$ higher (x, x)

2) Every person who buys a stocks is smart.

person (x) : x is person. stocks (y) : y is policy.

Buys (x, y): person x buys policies y.

Smart (x) : person is smart,

$\forall x \exists y$: (person (x) $\wedge$ stocks (y)) $\wedge$ (Buys (x, y)) $\Rightarrow$ Smart (x)

3) Every student who takes. Algorithm passes it.

Student (x): x is student | Takes $(x, algo)$: x takes Algorithm.

passes $(x, Algo)$: x passes algorithm. .

$\forall x$: (student (x) $\wedge$ Takes $(x, Algo)$) $\Rightarrow$ passes $(x, Algo)$

4) Only one student took CCN in spring 2021.

student (x) : x is a student.

TakeInspring2021 (x, CCN) student x takes CCN in spring 2021

$\exists x \forall y$: student (x) $\wedge$ TakesCCNInSpring2021 (x, CCN) $\wedge$

((student (y) $\wedge$ TakesInspring2021 (x, CCN)) $\Rightarrow$

$x = y$)

(5) There is atleast two temples in USA.

$\exists x \forall y$ Temples $(x) \wedge$ Temple (y) InUSA $(x) \wedge$ InUSA $(y) \wedge x \neq y$

(6) No coat is waterproof, unless it has been specially treated

coat(x) : x is a coat, waterproof (x) : x is waterproof.

s(x) : x has been specially treated.

$\forall x$ (Coat $(x) \rightarrow \neg$ waterproof $(x) \vee s(x)$)

(7) All students get good grades if they study.

$\forall x$ student$(x) \wedge$ study$(x) \rightarrow$ GetGoodgrade (x).

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6.a

→ Vehicle Routing :→ Intially one Route may be assigned to the vehicle, by considing the current traffic scenario. It will now be iterated again and again to find the best route at every instance.

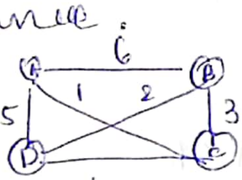
→ Traveling salesman problem → First of all, a solution that visits each city can be obtained. In furthure iterations. the first solution can be revisited to obtain the shortest path for Travelling salesman problem.

6.b.

Problem statement :→ The main idea of TSP is the problem faced by a salesman who has to travel to a number of cities or towns in an area by visiting every cities exactly once.

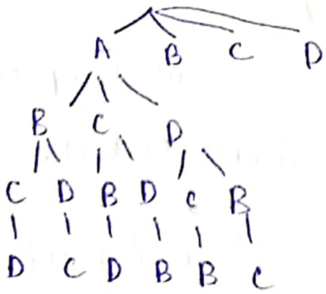
GOAL: Find the optimal Route in terms of lowest cost, lowest distance.

Example :→



goal is to visit n-cities In above example 4. with minimum tour cost.

Solution using Hill climbing :→ solutions are generated. For every state and it is checked to see if the goal is reach. Legicographic order: Part of tree is represented below.



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Next state is generated based on the value returned by the heuristic function. The state which is better then current is selected.

State space: → The above figure shows state space as a set of tours.

Heuristic function: → Distance between the cities is the heuristic function. minimum distance heuristic is the value returned by the heuristic function.

ABCD

BACD ACBD ABDC DBCA

CABD ACDB.

The hill climbing solution for TSP generates all possible routes. for each state -

Actions: → Travel to any city adjacent to current city.

succesor state are all possible combinations of the cities,
the state with smallest value, smaller than current is selected
for expension. the process continues until we get back to start.
Algorithm creates larger number of successor states for
small cities. Hence the time complexity is sufficiently
large for the traveling sales man problem

7) FOL to CNF :→ 1) Eliminate ⇔ $B_{1,1} \Leftrightarrow (P_{1,2} \vee P_{2,1})$

1) Replace $\alpha \Leftrightarrow \beta$ with $(\alpha \Rightarrow \beta) \wedge (\beta \Rightarrow \alpha)$ → $(B_{1,1} \Rightarrow (P_{1,2} \vee P_{2,1})) \wedge (P_{1,2}) \vee P$ $\Rightarrow B_{1,1})$

2) Eliminate ⇒, Replace $\alpha \Rightarrow \beta$ with $\neg\alpha \vee \beta$

$(\neg B_{1,1} \vee P_{1,2} \vee P_{2,1}) \wedge ((\neg P_{1,2} \wedge \neg P_{2,1}) \vee B_{1,1})$

3) move ¬ inwards using de morgen rule double negation.

$(\neg B_{1,2} \vee P_{1,2} \vee P_{2,1}) \wedge ((\neg P_{1,2} \wedge \neg P_{2,1}) \vee B_{1,1})$

4) Apply distributivity law (∨ over ∧) and flatten.

$(\neg B_{1,1} \vee P_{1,2} \vee P_{2,1}) \wedge (\neg P_{1,2} \vee B_{1,1}) \wedge (\neg P_{2,1} \vee B_{1,1})$

5) Drop universal quantiers and disribute ∧ or ∨

Example (1) eliminate ⇔ Eg. convert $p \Leftrightarrow q$ to $(p \Rightarrow q) \wedge (q \Rightarrow p)$

(2) eliminate ⇒ Eg convert $p \Rightarrow q$ to $\neg p \vee \neg q$

3) move ¬ inwards using De morgen law. convert $\neg\neg p$ to p.

convert $\neg(p \wedge q)$ to $\neg p \vee \neg q$, $\neg(p \vee q)$ to $\neg p \wedge \neg q$, $\neg \forall x P$ to $\exists x \neg$

4) standraize variable part :→ Each quantifier must have a uniq vairable name to avoid confusion while elimating quantifi

5) Eliminate Existential qualifiers.

Convert $\exists x P(x)$ to $P(c)$

convert $\forall x y \exists z\ P(x, y, z)$ to $\forall x y\ P(x, y, f(x, y))$ → skolem funct

Example Everyone has a surname.

$\forall x\ Person(x) \Rightarrow \exists y\ Surname(y) \wedge Has(x, y)$

6) Drop quantifier :→ All variables are only universally quanti after eliminating existantial quantifier.

Eg. convert $\forall x P(x) \vee \forall y Q(y)$ to $P(x) \vee Q(y)$

7) Distribute ∧ over ∨ to get conjuctions of disjunctions.

Eg. convert $(P \wedge Q) \vee R$ to $(P \vee R) \vee (Q \wedge R)$

$A \vee (B \vee (C \wedge D)) \Rightarrow (A \vee (B \vee C)) \wedge (A \vee ($