AI Assignment -1

Theory

1. (a) In the given comprehension, we have a set of sentences which can be listed separately as -

- The Universe simply exists. → A
- The Univers will end in heat death. → B
- There was no Big Bang. → C
- The Universe is Expanding. → D
- The Universe is Expanding with acceleration. → E

Now, we can write the sentences using logical connectives.

* The Universe either ... heat death :- $A \vee B$
* If there was no ... simply existed :- $C \Rightarrow A$
* If and only if ... big bang :- $D \Leftrightarrow \neg C$
* If the Universe is ... heat death :- $D \wedge E \Rightarrow B$

(b) Using the same notations A, B, C, D, E -

* If there was no big bang ... simply existed :- $\neg A \Rightarrow \neg C$
* If and only if ... big bang :- $C \Leftrightarrow \neg D$
* If the Universe is ... heat death :- $\neg B \Rightarrow \neg(D \wedge E)$
  $\equiv \neg B \Rightarrow (\neg D \vee \neg E)$

(c) **Inferred :**

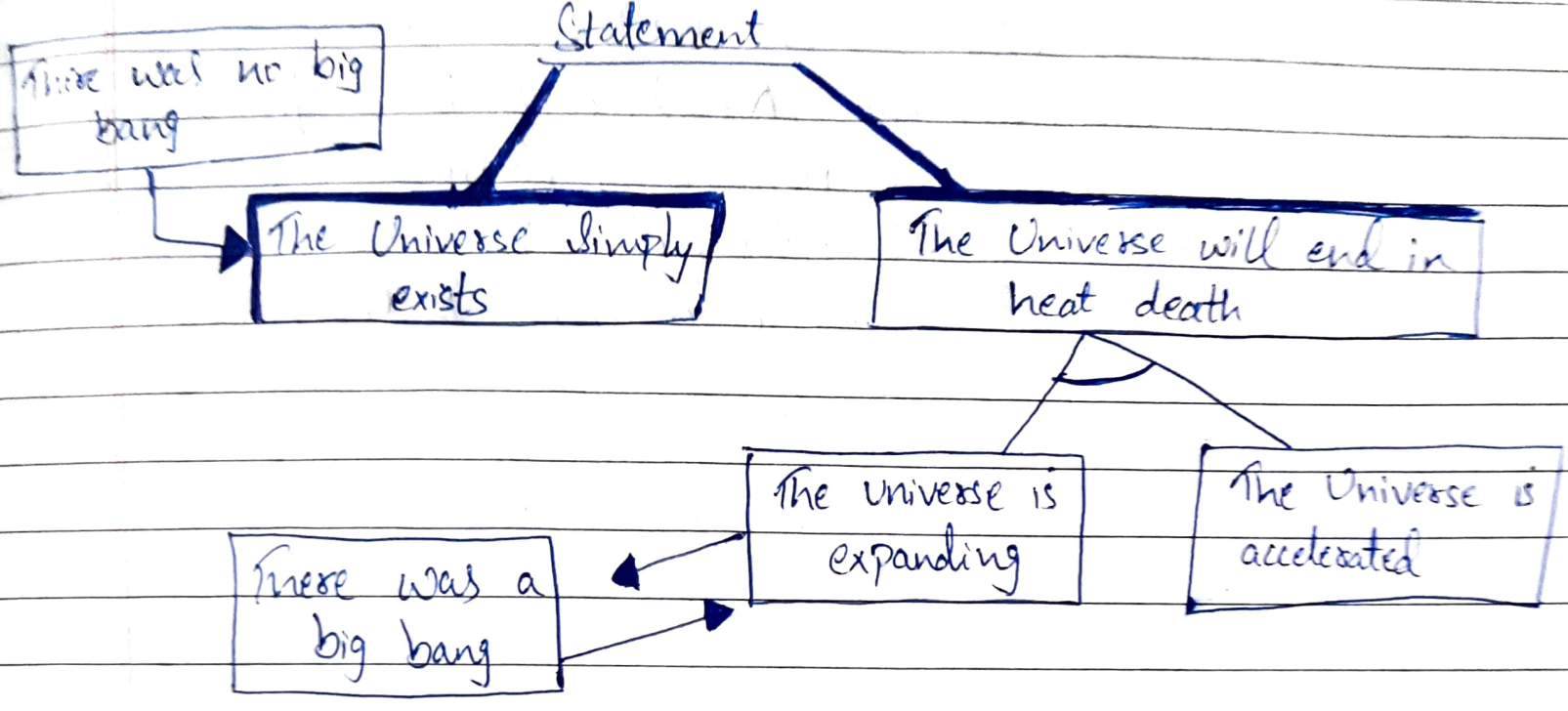
* The Universe will either exist or end in heat death.
* If there was a big bang, the Universe is expanding.

- The Universe is either expanding and accelerating, or it simply exists and there was no big bang.

Not Inferred:

- There was no big bang and the Universe is expanding.
- The universe simply exists and expands.
- The universe simply exists and will end in heat death.

1d) AND-OR Graphs



2. Three people -

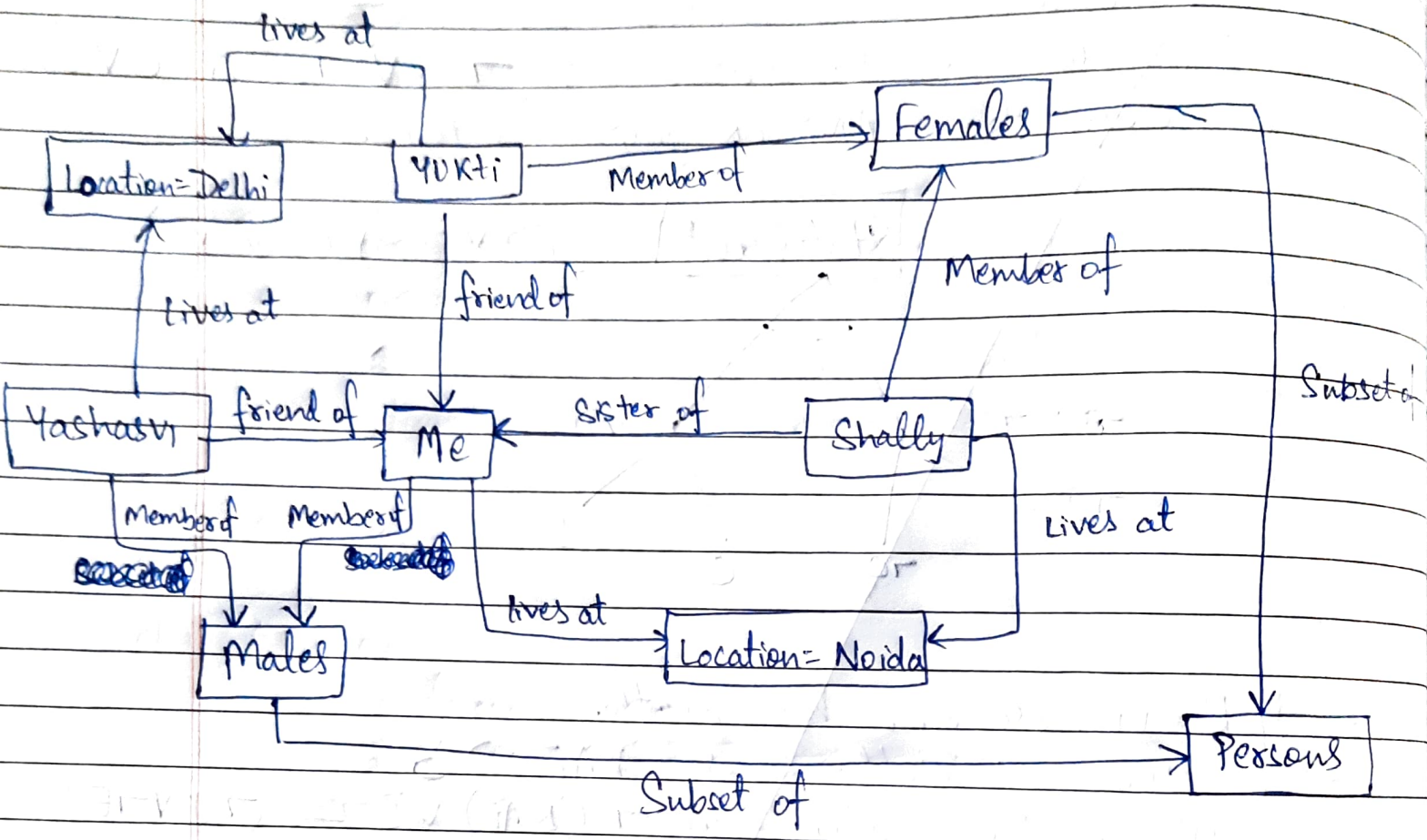
(a) Shally → Location: Noida , Gender : Female

(b) Yashasvi → Location: Pitampura (Delhi), Gender: Male

(c) Yukti → Location: Rohini (Delhi) Gender: Female.

(d) Shivansh (Me) → Location: Noida , Gender : Male

Semantic Network:



→ **Inheritance**: Inheritance makes it easy to identify the properties an entity will possess.

For example-

- Males is a subset of Persons. Also, Females is a subset of Persons. So, Males and Females will have all properties that a person will have.
- Since "Yashasvi" and "Me" are members of Males, they will possess characteristics of males.
- Since "Shally" and "Me" live in Noida, they will share location with everyone who lives in Noida.

→ **Multiple Inheritance**: When a class or object is having inheritance from multiple classes, it is called multiple inheritance.

For example:

* Let us take the object "Yukti". Here Yukti is a friend of "Me", lives at Delhi, and is a member of females. Thus, Yukti is inheriting characteristics from multiples classes, i.e., females and location = Delhi.

  ∴ Yukti is having multiple inheritance.

* Let us take the object "Me". Heretoo, "Me" is a member of Males and lives at Noida. Thus, "Me" has multiple inheritance.

3. Proof by resolution is a technique in which we use the expressions / statements, find clauses inside them and use these clauses and arrive at a new expression which is a logical inference of the original expression.

Let us take an example from the 1st question.

(i) If the Universe ends in a heat death, then there was a big bang.
(ii) If there was a big bang, then the Universe is expanding.

Here, clauses are →

(a) The Universe ends in a heat death. → A
(b) There was a big bang. → B
(c) The Universe is expanding. → C

∴ (i) can be written as: $A \Rightarrow B \equiv \neg A \vee B$
(ii) can be written as: $B \Rightarrow C \equiv \neg B \vee C$

From these statements, we can infer by cancelling the conflicting statements B and ¬B.

B and ¬B = null.

∴ We get $\rightarrow \neg A \vee C$, ie., $A \Rightarrow C$

This can be written as — If the Universe ends in heat death, it is expanding.

We also have the resolution rule :

$$\frac{l_1 \vee \dots \vee l_k ; \; m_1 \vee \dots \vee m_n}{l_1 \vee \dots \vee l_{i-1} \vee l_{i+1} \vee \dots \vee l_k \vee m_1 \vee \dots \vee m_{j-1} \vee m_{j+1} \vee \dots \vee m_n}$$

Soundness of Proof by Resolution –

This can be seen by observing l_i. We know that l_i is complement to m_j. So, if l_i is true, m_j is false and vice versa. Therefore,

For l_i = true → $m_1 \vee \dots \vee m_{j-1} \vee m_{j+1} \vee \dots \vee m_n$ is true

For l_i = False → $l_1 \vee \dots \vee l_{i-1} \vee l_{i+1} \dots \vee l_k$ is true

∴ For both values of l_i (true or false), one or other conclusion is true.

∴ It is Sound.

Completeness of Proof by Resolution:-

Let 'S' be a set of clauses and R(S) be the set of all clauses derivable by repeated application of the resolution rule on the set S.

We can see the R(S) will be a finite set, because there are a limited number of distinct clauses that can be constructed from the set (S).

∴ Proof by resolution is Complete.