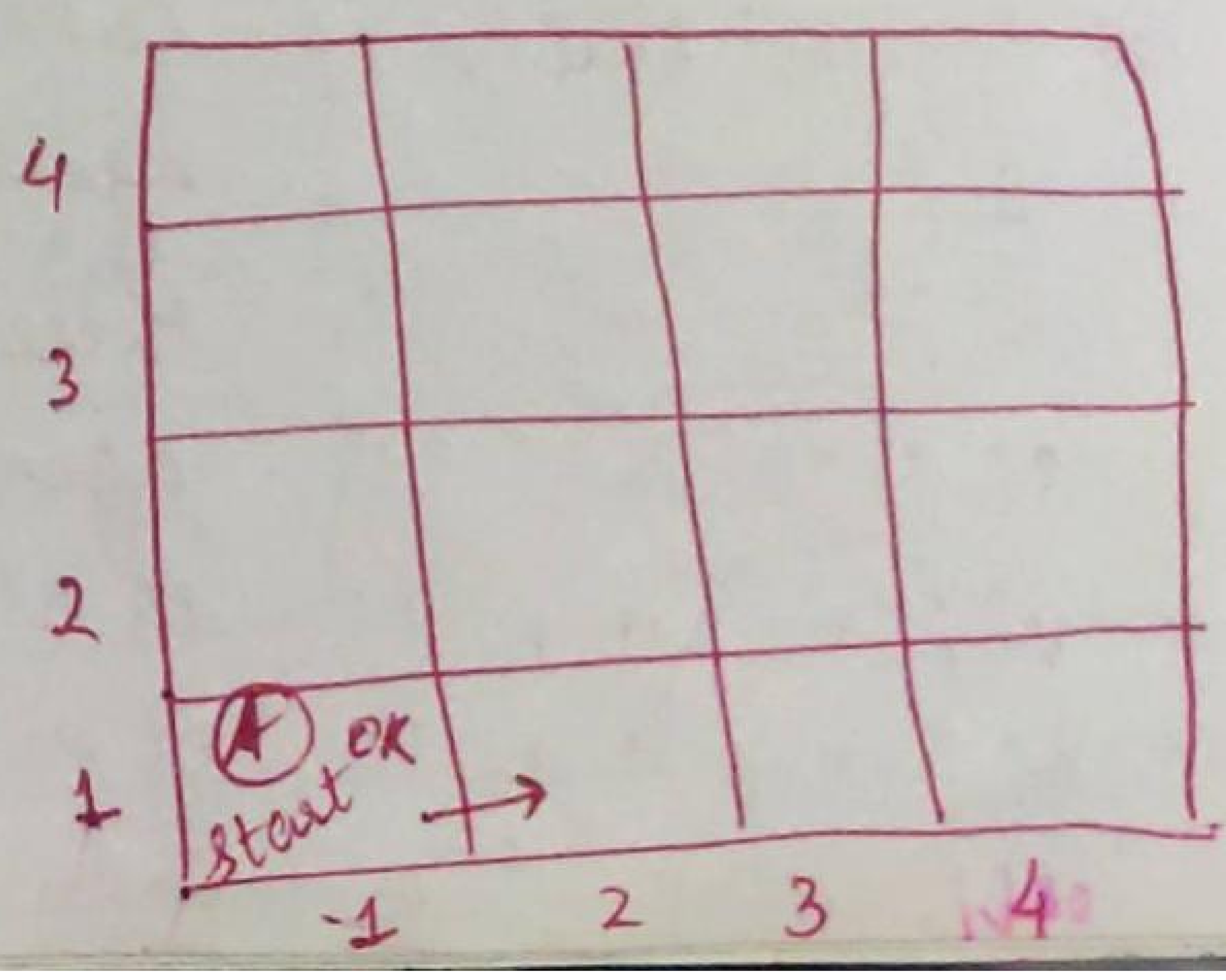
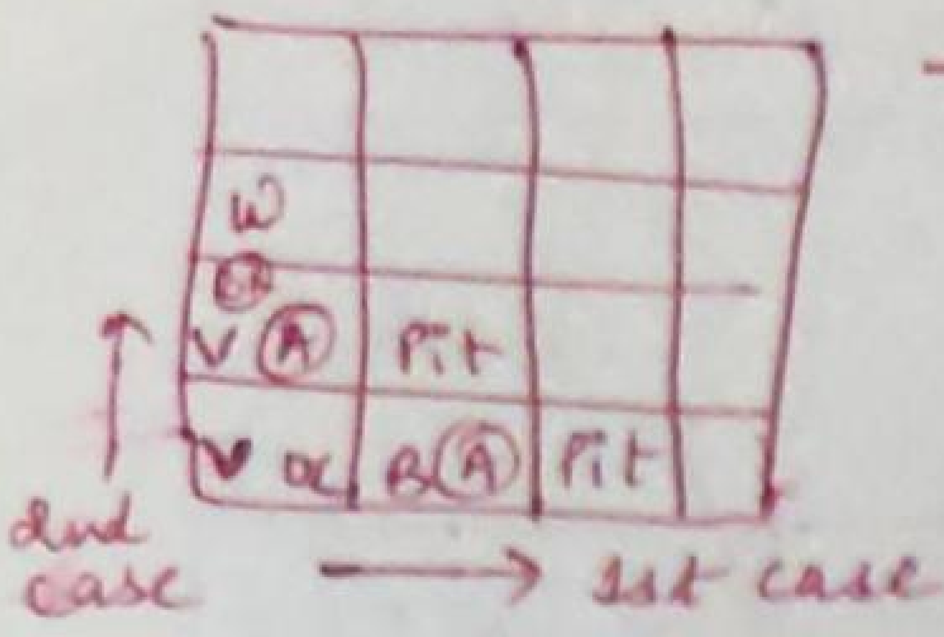
The Wumpus World Problem:

→ Initially, Agent starts from (1, 1)
→ TASK - To find 'Gold' in the cave & return back to (1, 1) & get out of the cave.
→ Ignore the pits while moving.
→ Say, a monster / Wumpus needs to be taken care of otherwise it'll eat you.

→ Conditions using which person / agent can navigate:
1) The rooms adjacent to the wumpus are smelly (stench)
2) The rooms adjacent to pits has breeze.
3) There'll be a glitter in the room iff; the room has gold.
4) The wumpus can be clear by the agent ~~with the~~ ~~help of~~ by facing it directly
5) With the help of horrible scream wumpus can be recognised in the cave
→ Actuators: L, R, F, Release, Shoot, Grab
→ Movement in all direction & sense breeze, glitter, smell.

→ Agent's 1st step:
(A)
1) Either in any direction agent 'll move.
→ No Stench / No Breeze; Room 1 = OK
→ 2nd Step: @ Enter in next room.





→ 2nd room has breeze smell, so it is not safe there might be Pit, nearby.

B - Breeze	P - Pit
A - Agent	V - visited
G - Glitter	W - wumpus
OK - Safe	S - stench

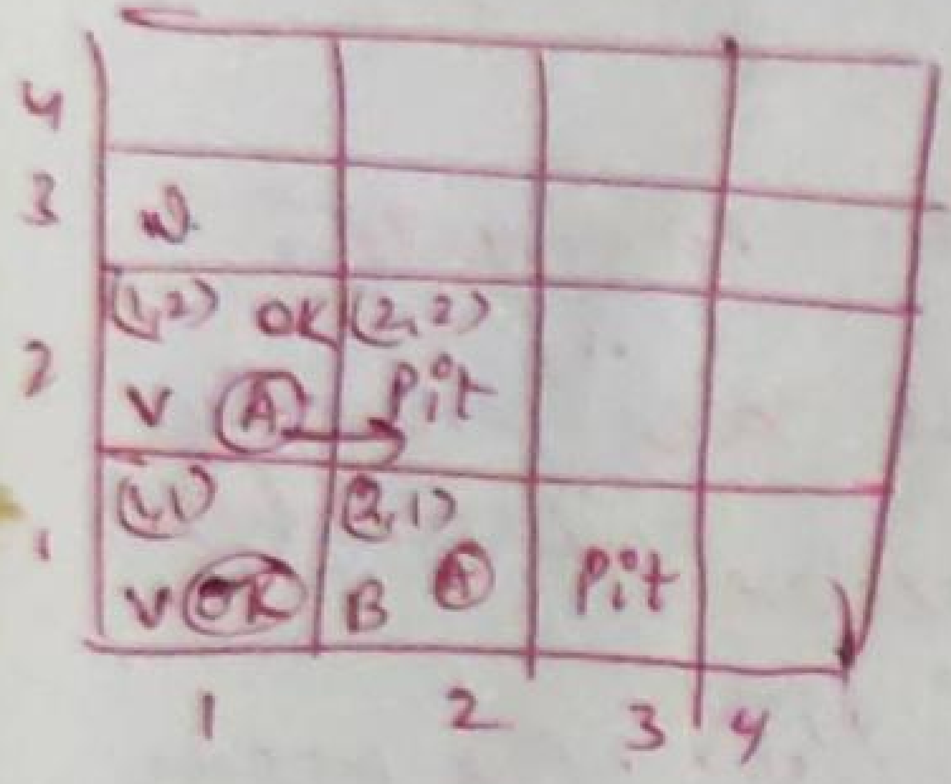
→ so, go back again (1, 1) and now he'll move vertically

2nd case: Here he is ok, safe & marked as visited in the room (1,2) and smells stench. so, he concludes wumpus is nearby.

→ 3rd step:

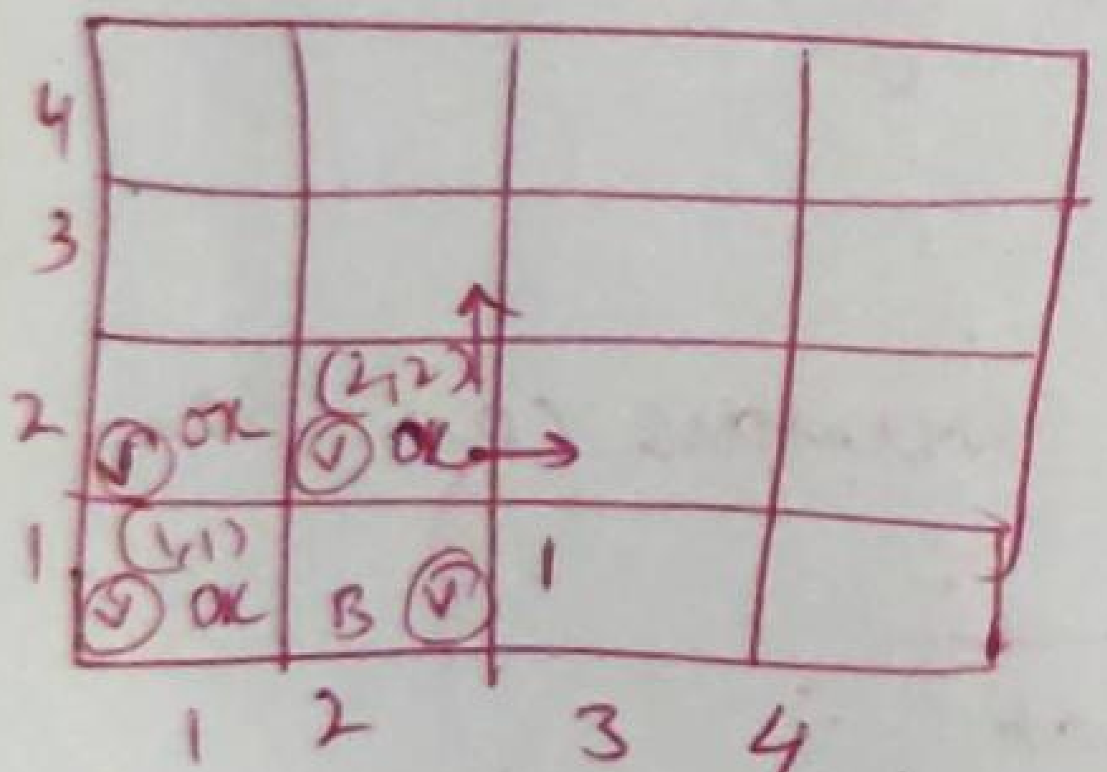
Enter (2,2) - smell no stench / no breeze so, no pit / no wumpus.

→ ok, safe (2,2) room.



→ 4th step: Either in (2,3) or (3,2).

→ But here in (2,2) he can smell glitter & then he grabs the gold & came out of cave.



Knowledge Base (Wumpus World)

1. Let $P_{i,j}$ be true, if there is a pit in the room $[i,j]$
2. " $B_{i,j}$ " " , " agent perceives breeze in $[i,j]$
3. " $W_{i,j}$ " " , " there is a wumpus in square $[i,j]$
4. " $S_{i,j}$ " " , " agent perceives stench smell in $[i,j]$
5. " $V_{i,j}$ " " , " that square $[i,j]$ is visited
6. " $G_{i,j}$ " " , " there is gold in room $[i,j]$
7. " $OK_{i,j}$ " " , " the room is safe.

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Propositional Rules for Wampus World Problem :

$R_1 = \sim S_{11} \xrightarrow{\text{implies}} (\sim W_{11}) \wedge (\sim W_{12}) \wedge (\sim W_{21})$

$R_2 = \sim S_{21} \rightarrow (\sim W_{11}) \wedge (\sim W_{21}) \wedge (\sim W_{22}) \wedge (\sim W_{31})$

$R_3 = \sim S_{12} \rightarrow (\sim W_{11}) \wedge (\sim W_{12}) \wedge (\sim W_{22}) \wedge (\sim W_{13})$

$R_4 = S_{12} \rightarrow W_{13} \vee W_{12} \vee W_{22} \vee W_{11}$

No stench smell

Yes there is stench smell which means it has Wampus for the nearby blocks

→ Prove that Wumpus is in [1, 3] room using Propositional Rules.

* Apply Modus Ponens with $\sim S_{11}$ and R_1.

→ we first apply MP Rule with R_1 which is -

$\sim S_{11} \rightarrow (\sim W_{11}) \wedge (\sim W_{12}) \wedge (\sim W_{21})$ which will gives the output as $\rightarrow (\sim W_{11}) \wedge (\sim W_{12}) \wedge (W_{21})$

$\boxed{\cancel{\sim S_{11}} \rightarrow \sim W_{11} \wedge \sim W_{12} \wedge \sim W_{21}}$ $\boxed{\cancel{\sim S_{11}}}$

on applying elimination Rule,

$\boxed{\sim W_{11} \wedge \sim W_{12} \wedge \neg W_{21}}$

* Now, apply Modus Ponens rule to $\sim S_{21}$ and R_2 :

$\boxed{\cancel{\sim S_{21}} \rightarrow (\sim W_{21}) \wedge (\sim W_{22}) \wedge (\sim W_{31})}$ $\boxed{\cancel{\sim S_{21}}}$

on applying elimination rule

$\boxed{(\sim W_{21}) \wedge (\sim W_{22}) \wedge (\sim W_{31})}$

③ Apply Modus Ponens Rule to S_{12} & R_4

$\boxed{S_{12} \rightarrow W_{13} \vee W_{12} \vee W_{22} \vee W_{11}}$ $\boxed{\cancel{S_{12}}}$

$\boxed{W_{13} \vee W_{12} \vee W_{22} \vee W_{11}}$

→ Now, apply unit resolution on:

$\boxed{W_{13} \vee W_{12} \vee W_{22} \vee \cancel{W_{11}}}$ $\boxed{\neg \cancel{W_{11}}}$ → as there is no Wumpus in W_{11} room already given

on applying elimination

$\boxed{\underbrace{W_{13} \vee W_{12} \vee W_{22}}}$ → Wumpus may be in any room

→ Now again apply unit resolution on:

$\boxed{W_{13} \vee W_{12} \vee \cancel{W_{22}}}$ $\boxed{\neg \cancel{W_{22}}}$ → It is also SAFE, no Wumpus is here in this block

on applying elimination

$\boxed{\underbrace{W_{13} \vee W_{12}}}$

Wumpus may be in either of these

→ On applying Unit resolution on $W_{13} \vee W_{12}$ and $\neg W_{12}$ then it is found that W_{12} is also safe and has no Wumpus. So,

$\boxed{W_{13} \vee \cancel{W_{12}}}$ $\boxed{\neg \cancel{W_{12}}}$

on applying elimination

$\boxed{W_{13}.}$

Hence, Proved

First Order Prepositional/Predicate Logic or (FOL) (FOPL)

→ Another way of representation – extension of propositional

→ It is a powerful language that develop info. logic about the objects in a easier format. & can also express the relationship b/w those objects.

→ FOL doesn't assume that the world contains facts like propositional logic but also assume.:

① Objects: A, B, people, colors, etc ---

② Relations: can be unary Relations such as n-ary relation – sister of brother of --

③ Functions: father of, Best friend, end of --

→ Syntax
→ Semantics

Basic Elements: constant, quantifiers, variables, predicate, equality, fns, connectives.

COMPLEX & ATOMIC SENTENCES

* Basic sentences of FOL. – Atomic
* Formed from a predicate symbol, followed by [] with sequence of terms.

Predicate (term 1, term 2, ---, term n)

Eg: Hari & Raghu are brothers
⇓
Atomic sentences: Brothers (Hari, Raghav)

Tommy is a dog
⇓
dog (Tommy)

→ Complex sentences: combination of atomic + connectives.

FOL
- Subject – main part of statement.
- Predicate – A predicate is a relation which binds 2 atoms together in a statement.

Eg: consider the statement: " x is an integer"
subject + predicate

QUANTIFIERS.

→ A quantifier is a lang. element which generates quantification,
→ These are the symbol that permit to determine identify the range and scope of the variable in the logic expression.

→ Types of Quantifier : a) Universal Quantifier, $\forall$
b) Existential " , $\exists$

a) It is a symbol of logical representation which specifies that the statement within its range is true for everything of every instance of particular thing.
→ Represented by $\forall$; implication is " → "
→ If x is a variable, then $\forall x$ is read as for all x
for every x, for each x

b). It is a type of quantifier which expresses that statement within its scope is true, for atleast one instance of sth.
→ Represented by $\exists$ (use AND or $\wedge$)
→ $\exists(x)$ will be read as - there exists a 'x',
for some 'x'
atleast for one 'x'.

Ex: All man drink coffee.
let x is variable
x_1 drink coffee $\wedge$ x_2 drink coffee ---

so, $\forall x$ man(x) → drink (x, coffee) - atomic sentence.
There are all x, where x is a man who drinks coffee.

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* Some examples of FOL (First Order Logic) using Quantifiers.

① All birds fly → Quantifier, Subject, Predicate

$\forall x \; bird(x) \rightarrow fly(x)$

Predicate is fly(bird).

② Every man respects his parent

Predicate is respect(x, y) — x → man, y → parent

$\forall x \; man(x) \xrightarrow{\text{implies}} respect(x, parent)$

③ Some boys are intelligent

x_1 is intelligent $\vee$ x_2 is intelligent $\vee$ ---

$\exists x : boy(x) \underset{\text{and}}{\wedge} intelligent(x)$

→ There are some boys x, where x is a boy who is intelligent

NOTE: The main connective for $\forall$ is "$\rightarrow$"
" " " " $\exists$ " "$\wedge$"

INFERENCE

* Inference is used to deduce new fact or sentence from the existing sentence.

* Terminologies: ① Substitution: It is a fundamental operation performed on terms & formulas. It occurs in all inference system in FOL.

– Substitute a constant 'a' in place of variable 'x'.

② **Equality:** FOL doesn't use on

for making atomic sentences bu

another way of representation i.e

[Brother (John) = Smith

The object referenced by brother

obj referenced by Smith.

NOTE: The equality symbol ca

negation to represent tha

the same objects.

Ex: $\neg(x=y)$; which

INFERENCE RU

- Universal Generalization •
- " Instantiation •

1) Universal Generalization: It

rule states that, " if premi

any arbitrary element 'c'

discourse, then we can have

$\forall x\, P(x)$ - It can be repres

Ex: A byte contains 8 bits.

$\forall x\, P(x)$ - " All bytes con

be true for all

2) Universal Instantiation / Elimination: It can be applied multiple times to add new sentences.

The rule states that. any premise $P(c)$ by substituting a ground term c (a constant within domain x) for any object in the universe of discourse.

$$\frac{\forall x\ P(x)}{P(c)}$$

Ex: If "Every person likes ice-creame" $\Rightarrow \forall x\ P(x)$

so we can infer that "John likes ice-creame" $\Rightarrow P(c)$

③ Existential Instantiation: It can be applied only once to replace the existing sentence.

→ This rule states that, " one can infer $P(c)$ from the formula given in the form $\exists x\ P(x)$ for a new constant symbol c.

$$\frac{\exists x\ P(x)}{P(c)}$$

④ Existential introduction: Also generalization.

→ The rule states that, " if there is some element 'c' in the universe of discourse which has a property 'p' then we can infer that there exist something in the universe which has property p.

$$\frac{P(c)}{\exists x\ P(x)}$$

Ex: Pinky got good marks in maths.

∴ some one got good marks in maths.

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