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B

CS 499 Topics in Artificial Intelligence Programming

Midsem Exam: Sep 15, 2022 (13:30 - 15:30)

No books, calculators, mobiles, laptops.

Do rough work (using **very small font**) on back sides only. Then plan and write *concise clear* answers within the space provided. No doubts allowed.

Qn. No.	1	2	3	4	5	6	Total
Marks	22	23	4	10	11	10	80

1. (25 marks) Bhima lives with his wife Hidimba, son Ghatotkacha and mother Kunti. Of these four persons, only one cooks well and only one sings well. The good cook and good singer are not the same person. Assume parents are older than their children and spouses are not blood relatives. The following statements all hold.

   12+6+4 ⇒ 22

   (a) If the good cook is male, then the good singer is also a male.

   (b) If the good singer is female she is a blood relative of the good cook.

   (c) If the good singer is younger than the good cook, then the good singer and good cook are not blood relatives.

   Who is the good singer? Who is the good cook? Rough work showing how you obtained the answer is compulsory.

(H) (W) (S) (M)

⇒ Bhima, Hidimba, Ghatotkacha, Kunti

(i) only 1 cooks well
(ii) only 1 sings well.
(iii)

They are exclusive i.e distinct.

(a) (good cook → male) ⇒ (good singer → male)

(b) (good singer → female) ⇒ (good singer → blood relative of the good cook)

(c) (good singer is younger than good cook) ⇒ (they are not blood relatives)

they ↓ good singer and good cook.

Assumption 1: Good cook is male

(a) applies ⇒ good singer is also male.

So, if Bhima → good cook then Ghatotkacha → good singer. — (i)

else Bhima → good singer then Ghatotkacha → good cook. — (ii)

(b) cannot be applied

(c) applies in (i) as Ghatotkacha is younger than Bhima

⇒ good singer and good cook are not blood relatives.

(Contradiction) why?

∵ Ghatotkacha is Son of Bhima.

∴ (ii) sustains in this assumption

Assumption 2 :- ~~Good~~ Good ~~cook~~ singer → female

then (b) applies which states good cook → blood relative

∴ If Good singer → Hidimba

then Good cook → Ghatotkacha (Not possible

∵ then statement (a) would be applied and we would reach contradiction ∵ Hidimba ≠ male)

∴ If Good singer → ~~A~~ Kunti

then good cook → Bhima (Not possible due to a similar argument as given above i.e. statement (a) gets applied ∴ good cook is a male and hence good singer must be male but Kunti ≠ male)

Note :- In both the above cases of assumption (2), statement (c) ~~so~~ could not be applied as in both, the good singer is older (not younger) that the good cook.

Final answer

⇒ Bhima → good singer ✓

Ghatotkacha → good cook ✓

TA's Note : Hidimba can also be good cook

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2. (25 marks) Consider the following set of 6 propositional logic clauses using 6 propositions n, p, q, r, s, v.

2 1 0 2 2 2
0 1 1 2 1 0

$$C = \{q \vee r,\ \neg r \vee \neg v,\ p \vee \neg v,\ \neg p \vee s,\ \neg s \vee \neg r \vee \neg n,\ \neg n \vee r \vee \neg s\}$$

10+10+3
⇒ 23

An assignment of values (*true* or *false*) to each propositional variable is called a satisfying assignment if all clauses in C evaluate to *true*. Show rough work neatly on the back side and answer the following questions.

Give one satisfying assignment with least number of propositions having value *true*.
n → False, p → False, q → True, r → False, s → False, v → False ✓ (Count of true = 1)

Give one satisfying assignment with maximum number of propositions having value *true*.
r → false, q → true, p → true, s → true, n → false, v → true ✓ (Count of true = 4)

How many different satisfying assignments are possible?

⇒ 2×1×1×2×2×2

~~[illegible]~~

⇒ 16. ✗

TA's Note: 13 different satisfying assignments are possible

3. (4 marks)

(a) Do you have your own idea for course project? If yes, give brief description.
Our final end goal would be to Implement a Slither Link solver using clingo with python wrapping. To be able to do this properly, we have decided to first get our hands dirty by writing a magic number solver and understanding how python can used for wrapping.

(b) Who is your project partner? Bivek Saha

(c) Which language have you chosen for coding the project? Clingo for ASP (answer set programming) and Python for wrapping

(d) Which is your favourite movie (any language)? Interstellar

(e) Do you line the hostel food? Rate on scale 1-100. Yes. 60. ~~[illegible]~~

(f) Have you read any novel (any language) in last 2 years? If yes, give title.
Yes. Atomic Habits by James Clear.

✓ 4

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(2). (a) $C = \{q \vee r,\ \neg r \vee \neg v,\ p \vee \neg v,\ \neg p \vee s,\ \neg s \vee \neg r \vee \neg n,\ \neg n \vee r \vee \neg s\}$

where $\vee \rightarrow$ or

$\neg \rightarrow$ not

$, \rightarrow$ and

For $q = T$

$n = F$

$p = F$

$r = F$

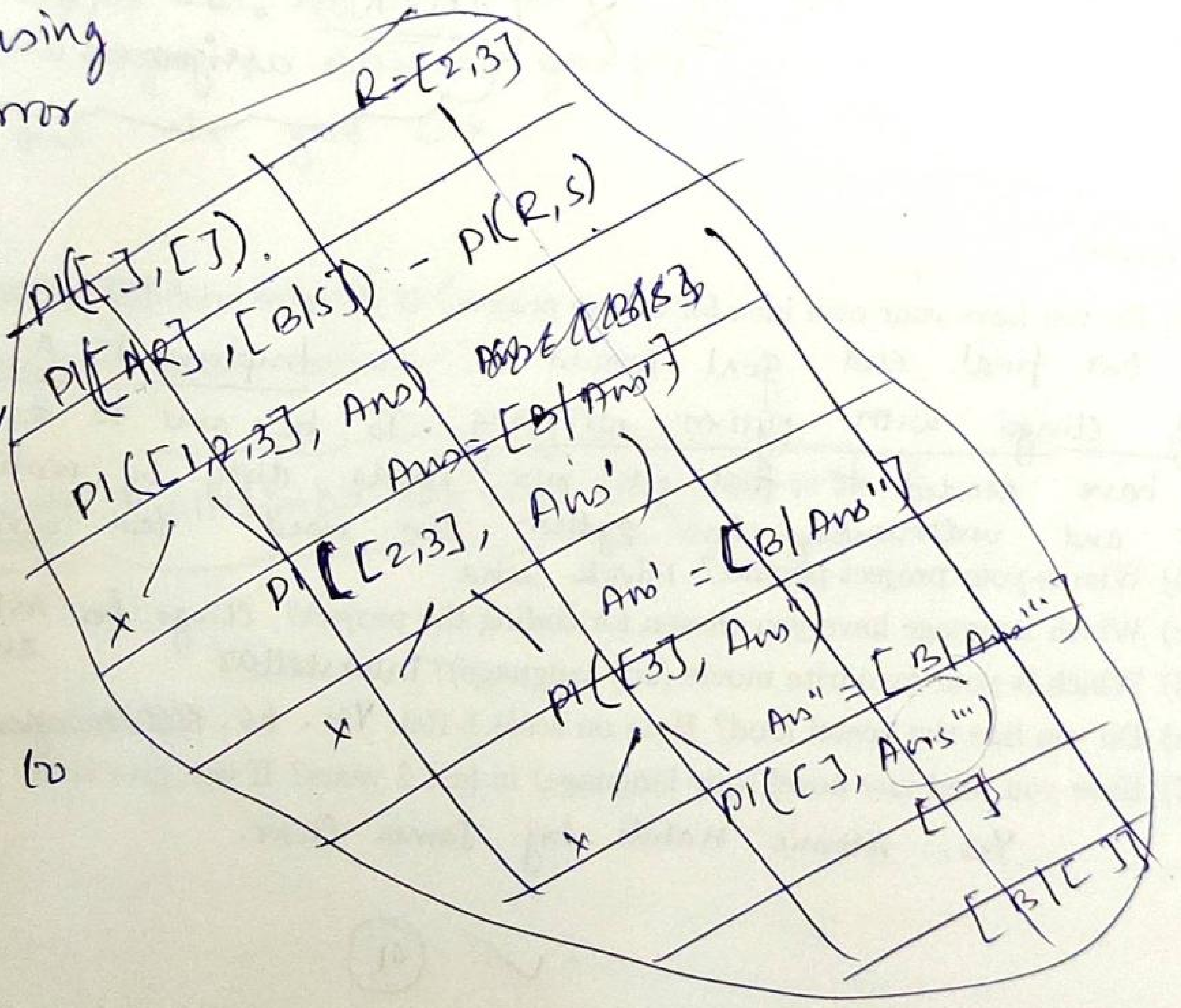
$s = F$

$v = F$

All the clauses in C evaluate to true. This was found out using trial and error and by noting the occurrences of $\neg q, \neg n, \neg p, \neg r, \neg s, \neg v$ across all the clauses in C.

$\quad\;\; 0 \quad\; 2 \quad\; 1 \quad\; 2 \quad\; 2 \quad\; 2$

(b) Again using trial and error and by noting down the occurences of q, n, p, r, s, v across all clauses in C, I was able to get down to



$q \rightarrow$ True

$n \rightarrow$ False

$p \rightarrow$ True

$r \rightarrow$ False

$s \rightarrow$ True

$v \rightarrow$ True

(c) Total # of satisfying assignments =

$$\prod_{x=\{q,n,p,r,s,v\}} \max(\text{count of occurrence of } x,\ \text{count of occurrence of } \neg x)$$

$= 1 \times 2 \times 1 \times 2 \times 2 \times 2 = 16$

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4. (24 marks) Consider the following Prolog code defining 3 predicates p1, p2 and p3. For every query below assume you repeatedly backtrack by typing ";" after each answer.

```
p1([],[]).
p1([A|R],[B|S]) :- p1(R, S).
```

```
p2(A,[],[A]).
p2(A,[B|R],[A| [B | R]]).
p2(A,[B|R],[B|R1]) :- p2(A,R,R1).
```

0 + 6 + 2 + 2 ⇒ 10

```
p3([],[]).
p3([A|R],[B|S]) :- p1(R, S), p2(A, S1, [B|S]), p3(R,S1).
```

The query p1([1,2,3],Ans) will succeed ~~3~~ 4 ✗ times and give the following values for *Ans* in this order

[ ]
[[ ]]
[[[ ]]]
[[[[ ]]]]

✗

TA's Note: p1 is checking if the two lists have same length.
So, it will succeed 1 time and give
Ans = [_,_,_] → Any list of size 3

The query p2(7, [3,1,4],Ans) will succeed 4 ✓ times and give the following values for *Ans* in this order

[7,3,1,4]
[3,7,1,4] ✓
[3,1,7,4]
[3,1,4,7]

The query p3([1,2,3],Ans) will succeed 4 times and give the following values for *Ans* in this order

Final answer 2
[3,2,1] ← one of the possible permutation

TA's Note: P3 is finding all the possible permutations of [1,2,3]. Thus there will be 6 permu. for the query

The query p3(Ans, [1,2,3]) will succeed 4 times and give the following values for *Ans* in this order

Final answer 2
[3,2,1]

TA's Note: Same as above

P3([1,2,3], Ans)
↓
P1([2,3], S') and P2(1, S1, Ans) and P3([2,3], S1)
↓
P1([3], S') and P2(2, S2, S1) and P3([

p2(7, [3,1,4], Ans)

2: Ans = [7,3,1,4]

3: Ans = [3|R1]

p2(7, [1,4], R1)

2: R1 ~~Ans~~ = [7,1,4]

An = [3,7,1,4]

3: R1 = [1|R2]

p2(7, [4], R2)

2: R2 ~~Ans~~ = [7,4]

R1 = [1,7,4]

Ans = [3,1,7,4]

3: R2 = [4|R3]

p2(7, [ ], R3)

1: ~~Ans~~ $R_3 = 7$

$R_2 = [4,7]$

$R_1 = [1,4,7]$

Ans = [3,1,4,7]

×

×

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5. (11 marks) Consider the integer variables X, Y, Z. X is known to be between 1 and 10 (both inclusive), Y between 5 and 15 (both inclusive) and Z between 5 and 20 (both inclusive). The following constraints also hold $C_1 : X > Y$, $C_2 : Y + Z = 12$, $C_3 : X + Z = 16$.

5 7 12. 9 7 = 16.

(a) There are 2 feasible solutions to this problem.
One of them is X = 9, Y = 5, Z = 7.

~~10~~ 11

Show rough work below.

$1 \le X \le 10$
$5 \le Y \le 15$
$5 \le Z \le 20$

C_1:- $X > Y$
$\Rightarrow 6 \le X \le 10$
$5 \le Y \le 9$
$5 \le Z \le 20$

C_3:- $X + Z = 16$
$9 \le X \le 10$
$6 \le Z \le 7$
$5 \le Y \le 7$

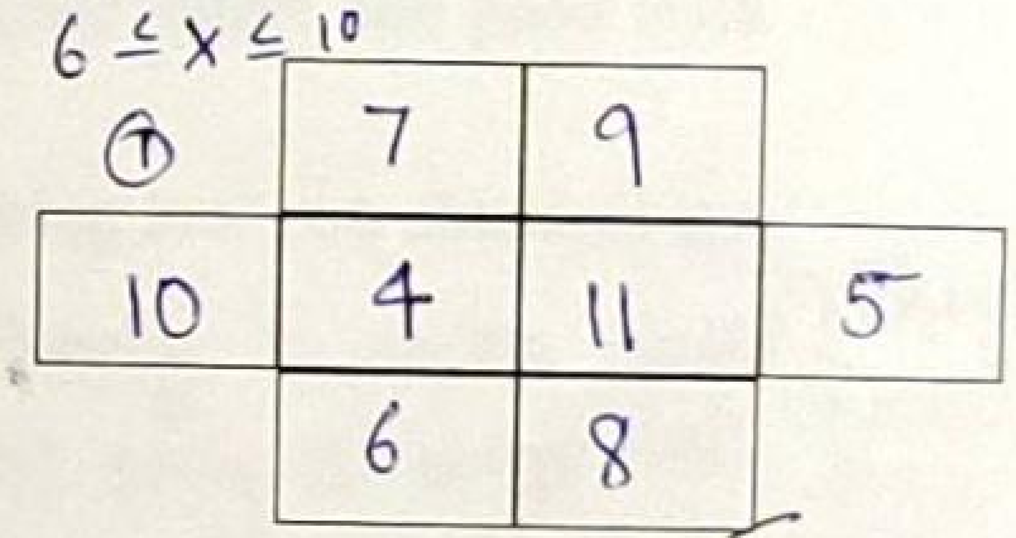
So, $X = \{9, 10\}$
$Z = \{6, 7\}$
$Y = \{5, 6, 7\}$

C_2:- $Y + Z = 12$
$5 \le Y \le 7$
$5 \le Z \le 7$
$6 \le X \le 10$

① $X = 9, Z = 7, Y = 5$
② $X = 10, Z = 6, Y = 6$ } feasible set.
③ ~~X = 11, Z = 5, Y = 7~~ ×
③ $\boxed{Y = 7, Z = 5, X = 11}$ ×

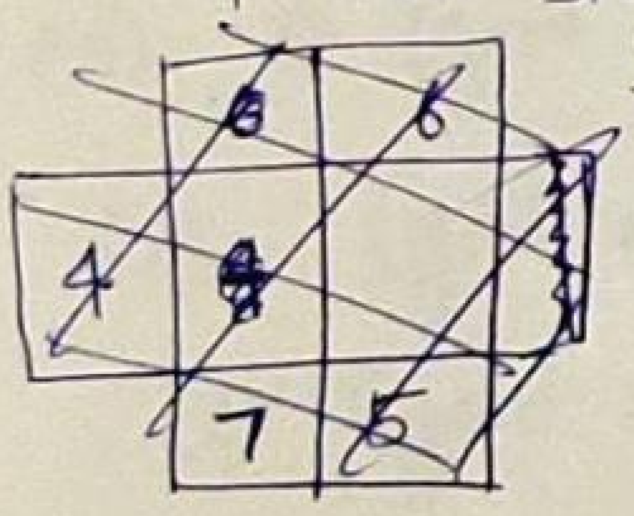
6. (10 marks) Fill the 8 boxes in the figure shown on the right with different numbers from 4 to 11 (both inclusive) so that any two adjacent boxes (horizontal, vertical or diagonal) differ by at least 2.

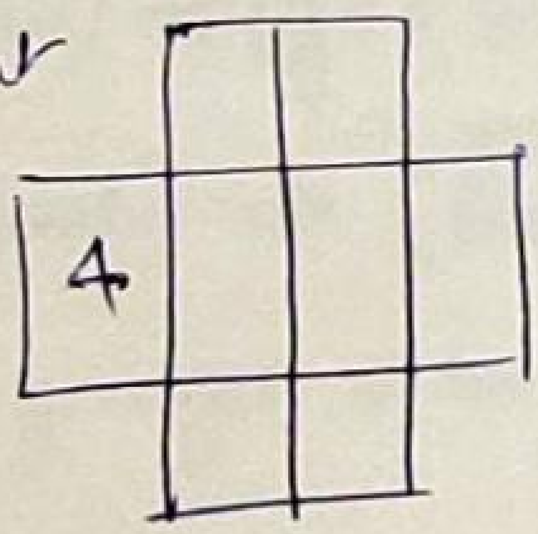
①

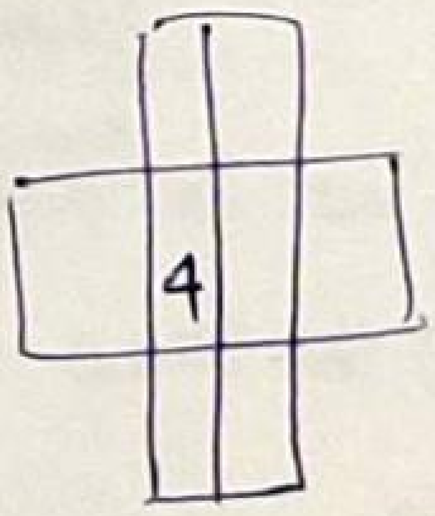


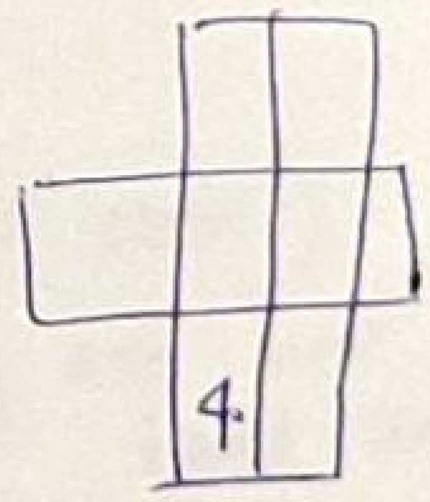
How many different solutions are possible? 4.

4 can start in 3 different positions









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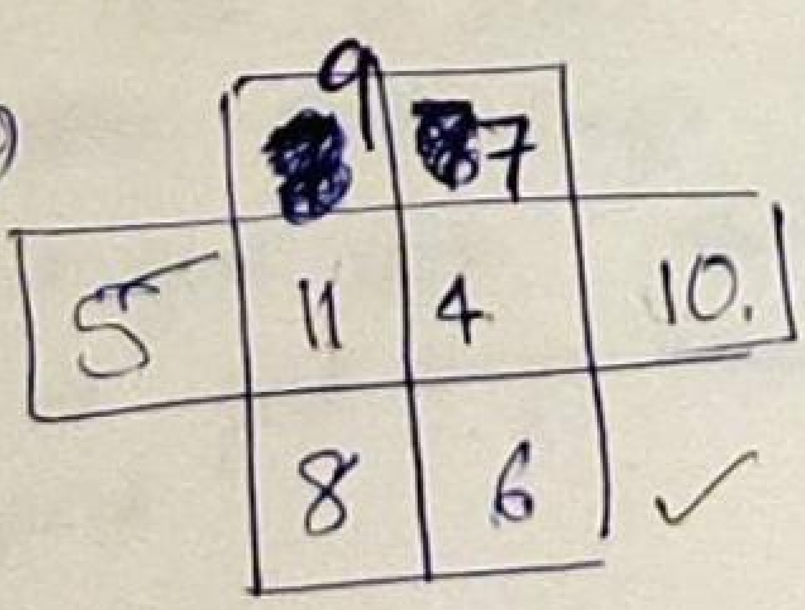
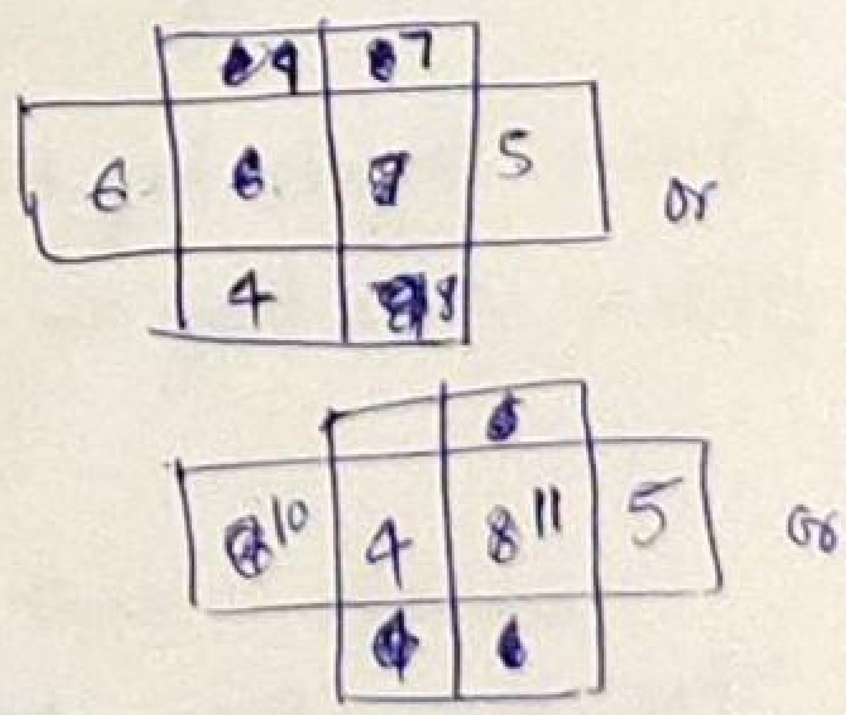
②





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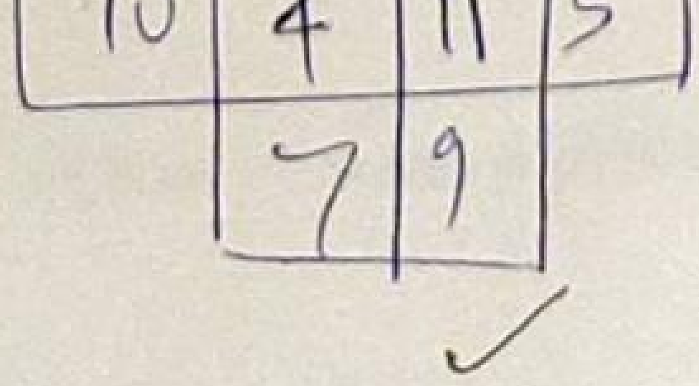

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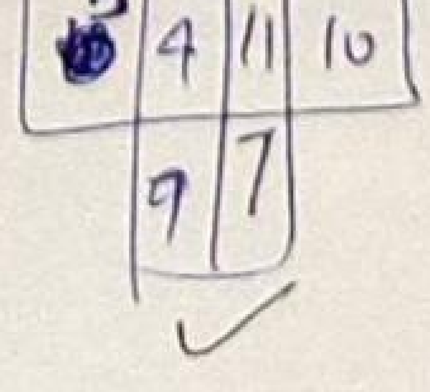

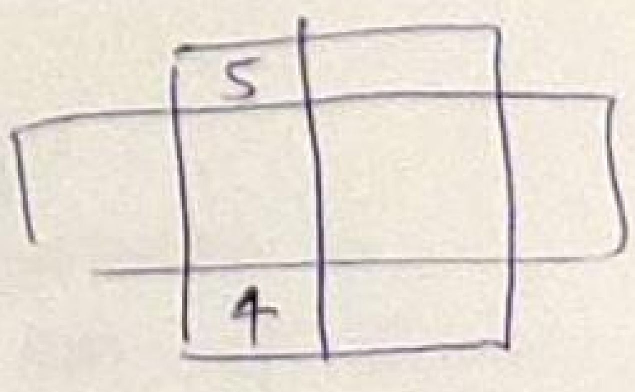

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