

TRUTH PUZZLES

METHOD OF ASSIGNING VALUES PUZZLES

TECHNIQUE

1. Symbolise statement
2. Put 1 or 0 under main operator, as directed
3. Circle symbol whose truth value you require for answer
4. Use M.A.V. to obtain correct value under main operator
5. Truth value under main operator is the answer.

Example

Mary and Sue both go to school and Tim truants only if Mary doesn't go to school. Does Tim truant?

Symbolise: $(M \& S) \& (\boxed{T} \supset \sim M)$
1 1 1 1 0 1 0 1
5 2 4 1 ↑ 3 7 6

Ans: Tim does not truant

Always assume statements are true unless puzzle states otherwise.

1. Bob said, "If I study and pass, then passing implies that I haven't studied." Bob was wrong. Did he pass?
2. The shepherd said "If the sheep are not restless then they'll be grazing normally, and if they are grazing normally then they'll be around the lake right now!" He looked at the lake but there were no sheep there. Are the sheep restless?
3. If Tom is in the bathroom then either Fred is in the kitchen or Sam is in the laundry. But it's true that Tom is in the bathroom and Sam is not in the laundry. Where is Fred?
4. If the current flows and the switch is working then the light will go on. The light has not come one, but the switch is working. Is the current flowing?
5. The Principal looked out into the quadrangle and thought: "If the students behaved, they would be let out early. If the students are let out early, the tuckshop would be crowded." He gazed at the tuckshop which was deserted. What did the principal deduce about the students' behaviour?
6. Anne said, "If both Bob and Donna come to the party, then if Bob comes Colin will also come to the party." Anne's reasoning was incorrect. Who came to the party?
7. Jane will win Trivial Pursuit or Andy doesn't cheat, but not both, and either Andy cheats or Cathy wins. If Andy cheats, then Jane will sulk. Jane is not sulking. Who won?
8. Either, if Mary reads War and Peace then Brian will have an overdue book, or either Brian has an overdue book or Cameron pays the fine. This statement is false. Is Brian's book overdue?
9. Sue said, "I'll go with John to the movies and, if I go to the B.B.Q. with Peter or Karl (but obviously not both) then, I won't go with Peter to the B.B.Q. but I'll still go with John to the movies!" Sue's statement was incorrect but she did go to the movies with John. With whom did she go to the B.B.Q.?
10. Captain Morgan is plotting to win the race. He says "If I sabotage my opponents rigging and my opponents don't sabotage my rigging then I'll win the race, if and only if my crew stays awake." If the Captain was correct in his thinking and his crew did not stay awake, find out if the Captain won the race.
11. Margery wishes to find out the class that Alphonse is in. She says "Alphonse is either in 11.7 or 11.9. If Alphonse's best friend Melvin is in 11.9 so is Alphonse." But Melvin isn't in 11.9. Is it possible for Margery to discover which class he is in from these facts alone?

TRUTH TABLE PUZZLES

TECHNIQUE

1. Symbolise statements (facts)
2. Do MATRIX and truth table for required number of symbols
3. Do truth columns for each fact
4. Check if all facts are true or how many are false
5. Find horizontal line consistent with /4)
6. Mark this line with arrow and read off answer in the matrix

Example

During an investigation into the mysterious disappearance of a Mr Lickit ice-cream van, the following statements were made by the prime suspects.

Alan: I wouldn't steal ice-cream unless Charlie helped me.
Bill: Me? Steal ice-cream? Of course not! I'm too honest for that. Besides, I hate the stuff.
Charlie: If I pinched it then either Alan or Bill was in it too.
Des: Neither Charlie nor I were involved.

Given that exactly one of the four suspects is lying, and that exactly two of them were involved in the theft, determine who stole the ice-cream and who is lying.

Solution

First of all we symbolise the alternative propositions.

Dictionary: A Alan stole the ice-cream
 B Bill stole the ice-cream
 C Charlie stole the ice-cream
 D Des stole the ice-cream

Next we symbolise the four claims made by the suspects.

$\sim A \vee (A \& C)$
 $\sim B$
 $C \supset (A \vee B)$
 $\sim (C \vee D)$

Note that we did not bother to try to symbolise the irrelevant part of Bill's reply.

Now a truth table is drawn up for the above formulae, with the alternative propositions heading the common matrix.

A	B	C	D	$\sim A$	\vee	(A & C)	$\sim B$	$C \supset$	(A \vee B)	\sim	(C \vee D)
1	1	1	1	0	1	1	0	1	1	0	1
1	0	1	1	0	1	1	1	1	1	0	1
0	1	1	1	1	1		0	1	1	0	1
0	0	1	1	1	1		1	0	0	0	1
1	1	0	1	0	0	0	0	1	1	0	1
1	0	0	1	0	0	0	1	1	1	0	1
0	1	0	1	1	1		0	1	1	0	1
0	0	0	1	1	1		1	1	0	0	1
1	1	1	0	0	1	1	0	1	1	0	1
1*	0	1	0	0	1	1	1	1	1	0	1
0	1	1	0	1	1		0	1	1	0	1
0	0	1	0	1	1		1	0	0	0	1
1	1	0	0	0	0	0	0	1	1	1	0
1	0	0	0	0	0	0	1	1	1	1	0
0	1	0	0	1	1		0	1	1	1	0
0	0	0	0	1	1		1	1	0	1	0

The fact that exactly one of the four suspects is lying means that three of the formulae should be true and one should be false. This is the case on and only on rows, 2, 8, 10, 14 and 15; hence all the other

rows may be eliminated. The fact that exactly two suspects were involved in the theft means that we must have two 1's and two 0's in the matrix row; of the five remaining rows the only row which satisfies this is row 10. Hence row 10 is our answer. Reading off the information contained in it, we conclude:

Alan and Charlie stole the ice-cream
Des was lying

The example above is fairly typical of many of the puzzles suited to truth table analysis. The solutions usually involve setting up a dictionary, eliminating irrelevant information, translating various conditions into PL, and using a bit of common sense in applying any extra facts to pick out which row (or rows) is (or are) in agreement with all the information supplied. Often, a *shortened truth table* method results in a much faster solution. For example, if all the formulae are required to be true, as soon as at least one 0 appears on a row it may be dropped from consideration. Again, if you are told that there is exactly one correct matrix constant, you may draw up a table with only those matrix rows which satisfy this condition; for example, in the above worked solution if you had been told instead that exactly one of the suspects was involved in the theft you could have got away with just the following matrix:

A	B	C	D
1	0	0	0
0	1	0	0
0	0	1	0
0	0	0	1

1. Mrs Q.T. Pie doesn't always tell the truth about her age. Over the past month she made the following statements:

- (a) I'm either thirty or forty
- (b) I'm not forty
- (c) If I'm thirty then I'm not forty
- (d) I'm forty
- (e) I'm thirty

What can you deduce about Mrs Pie's age for each of the following cases taken separately?

- (a) Exactly two of her statements are true
- (b) Exactly three of her statements are true
- (c) Exactly four of her statements are true

2. Major Colorado is distraught about the theft of his fried chicken recipe. There are three suspects: Mr Avarice, Ms Belcher and Ms Crafty. Inspector Hemlock deduces from the footprints that exactly two people are involved in the theft. Further investigations reveal the following facts:

- (a) Mr Avarice was involved only if Ms Crafty was not involved
- (b) Ms Crafty and Ms Belcher are sworn enemies and would never join each other in any venture.

Who are the thieves?

3. Exactly two out of Aagatha, Boris, Carveruppa and Draculena murdered Egor and silenced his baying hounds. In his investigation into the crime, Inspector I.D. Duce discovered the following facts:

- (a) Boris was involved only if either Carveruppa or Aagatha was
- (b) Carveruppa would not take part in the murder if his ghoul friend Draculena (who has a dental problem) was involved
- (c) Aagatha murders only on Sundays, and Egor was killed on a Tuesday.

Who are the murderers?

4. A battle between four exponents of the martial arts is under way. The following facts are known:

- (a) The good Lord Alpha will not survive if the evil Count Gamma survives
- (b) Either the evil Count Delta will die or the good Lord Beta will die
- (c) Lord Alpha is the master of Kung Fu, while none of the other three are masters, and it is a fact that a master can only be beaten by another master
- (d) Count gamma will die only if either Lord Alpha dies or Count Delta dies.

Exactly two survive. Who are they?

5. The Smiths have four puppies for sale: Bubbles, Pooch, Snoozy and Widdle. The following facts are known:
- (i) If Snoozy is sold then Bubbles won't be
 - (ii) Either Bubbles or Pooch will be sold
 - (iii) Pooch won't be sold if and only if Widdle is
 - (iv) If Pooch is sold then Widdle is.

Which two pups were sold?

6. In the Year 3001, the first Galactic Beauty contest is held, and female entrants from various planets compete for the position of 'Miss Galaxy'. Preliminary tests are completed and four entrants are left in the finals:
- (i) Eartha Ekberg from Earth
 - (ii) Marilyn Marvellous from Mars
 - (iii) Barbra Beautiful from Barnard II
 - (iv) Tina Terrific from Trantor

These entrants may elect to wear either a swimsuit or an evening gown (but not both) in the final contest. The following facts are known:

- (a) Eartha gets good pimples when cold, and will wear a swimsuit only if all the others do
- (b) Barbra has a fabulous figure, and is certain to wear a swimsuit
- (c) Marilyn will wear a swimsuit if and only if both Tina and Barbra do
- (d) Tina will not wear a swimsuit if Eartha does.

To minimise prejudice from the judges, the rules require that three people must wear a swimsuit. Determine by means of a Truth Table who will wear the swimsuit and who will wear an evening gown in the final contest.

GRID PUZZLES TECHNIQUE

1. Draw and label Grid
2. Tick and cross squares according to given facts (Tick for year, cross for no)
3. Go back to facts and discover further information by putting facts together
4. Finish grid and write down answer

Exercise 1. Three pupils (among others) ran on the school sports day.
Can you identify who wore what gear, in which race?

Clues

1. Sam ran in the race that had more runners than the pupil who ran in spikes, but not more than the race which included the runner who wore a singlet.
2. Jim Colman who did not wear a singlet was in a race of seven runners
3. The sneakers were worn by the pupil named Smith. He did not run in the race with the most runners.

	Colman	Flinders	Smith	singlet	spikes	sneakers	7 runners	8 runners	9 runners
Jim									
Len									
Sam									
7 runners									
8 runners									
9 runners									
singlet									
spikes									
sneakers									

2. Four married friends are eating in a restaurant. The husbands' names are Gerald, John, Michael and Tom. The wives are Ann, Betty, Carol and Pat. Ann is married to Michael. John is Carol's brother. Pat's husband is an only child. Who is married to Betty?
3. Barbara, Debbie, Lyn and Freda all attend the same school and each has a different position. Work out who has which position. Barbara is not the Student President and has never met the Editor. The Captain and Debbie have known each other for a long time while Fred and the Vice Captain travel to School together and often gossip about Barbara. Lyn comes to School from the opposite direction to Freda. Lyn always tells Barbara what the Vice Captain has said about her.
4. Of Ann, Bill, Cathy and Don, one is Hindu, one a Christian, one a Buddhist and one a Moslem. The following facts are known. Interested in learning about another religion, both Ann and Bill attended a lecture given by the Hindu. Either Cathy or Don is the Buddhist. The Moslem has a long beard. Don and Ann have never met each other.
5. Jones, Robinson and Smith all work at different jobs on the railway. One is the Engineer, one the Brakeman, and one the Fireman. Which is which?
 1. Smith once beat the Fireman at golf
 2. The Brakeman lives in London
 3. Mr Jones cannot play golf
 4. Mr Smith's favourite golf course is in his home town of Glasgow.
6. The members of a Loan Company are Mr Black, Mr White, Mrs Coffee, Miss Ambrose, Mr Kelly and Miss Earnshaw. The positions they occupy are manager, assistant manager, cashier, stenographer, teller and clerk. The assistant manager is the manager's grandson; the manager is married; the cashier is the stenographer's son-in-law; the stenographer is married; Mr Black is a bachelor; Mr White is 22 years old; Miss Ambrose is the teller's step sister; and Mr Kelly is the manager's neighbour.

Who holds what position?

7. Five men are having a reunion. They are Mr White, Brown, Peters, Harper and Nash, who by occupation are a printer, writer, barber, neurologist and heating contractor. By coincidence they live in the cities of White's Plain, Brownsville, Petersburg, Harpers Ferry and Nashville. No man lives in a city having a name similar to his own nor does the name of his occupation have the same initial as his name. The barber does not live in Petersburg, and Brown is neither the heating contractor nor the printer, nor does he live in Petersburg or Harpers Ferry. Mr Harper lives in Nashville and is neither the Barber nor Writer. White is not a resident of Brownsville, nor is Nash (who is not the Barber), nor a heating contractor. White is the Barber.

In which city does Nash reside?

REDUCTIO AD ABSURDUM PUZZLES TECHNIQUE

1. Note how many in answer
2. Note how many statements are true or false
3. Assume first speaker is your answer. If this assumption is not consistent with number of true and false statements, then first speaker is not in your answer. If this assumption works then first speaker is probably your answer.
4. Assume second speaker – then as above. Assume next speaker etc.
5. You should eliminate all speakers except the answer as this demonstrates you are correct.

Example

Who kidnapped the tortoise? There are 3 suspects and they each made two statements, one of which is true and one of which is false.

- A: It wasn't me and it wasn't Bert
 B: It wasn't me and Claude's not guilty either
 C: It was Bert and Agnes helped him.

	A's statement			B's statement			C's statements		
Assume A is guilty	F	T		T	T	X			
Assume B	T	F		F	T		T	F	✓
Assume C	T	T	X						

Only the assumption that Bert is guilty is consistent with the fact that each made one true statement and one false statement.

1. Who robbed the National Bank? Inspector Malone knows that the guilty criminal is one and only one of the following: Duke, Fingers, or Slim. He interrogates them. Each makes two statements.
 D: It wasn't me. Fingers done it.
 F: Listen, Duke did it. So did Slim.
 S: I didn't do it. Neither did Duke.

Each criminal has made one true statement and one false statement. Who did it?

2. Suppose two criminals were involved in the robbery above. The same statements were made, and the same number were true and false. Who did it?
3. Someone has been chewing the lettuce in Mrs Wigg's garden patch. It is one and only one of the following three bunnies: Flopsy, Mopsy and Cottontail. Under pressure the bunnies crack and each makes three statements. Only one statement made by each bunny is true.

- F: Please, I didn't do it. Cottontail didn't do it. It was Mopsy.
 M: Cottontail is the guilty one. It wasn't me. Flopsy wasn't involved either.
 C: No, it was Mopsy. Flopsy didn't do it. It wasn't me.

Which Bunny did it? Does Cottontail like lettuce?

4. Four children were in the backyard when a garage window shattered.
 "John did it" said Anne
 John grinned, "It was Gail" he said.
 "It wasn't me", Sally declared.
 Gail exclaimed, "John's a liar when he said I did it."
 Only one of them spoke the truth. Who broke the window?
5. Only one crook robbed the bank but Chester, Gerald and Frank were questioned. Each told two lies and two true statements.

- F: Chester did it. I'm innocent. Gerald didn't do it. Chester was once a burglar.
 G: Frank is your man. I saw Chester near the bank. He was once a burglar. I didn't do it.
 C: I wasn't near the place. Gerald is the thief. I didn't rob the bank. I've never been a burglar.
 Who did it?

TRUTH-TELLER – LIAR PUZZLES

In a certain village there are only two families: Blacks and Whites. Whites always lie and blacks always tell the truth. I met two people in the park on the following separate occasions and asked them who they were. I received the following replies. To which family did each belong? (Each problem is about two different people)

- (i) (a) We are both Blacks
 (b) No, that's not right
- (ii) (a) We are both Whites
 (b) No, that's not right
- (iii) (a) I am the only Black
 (b) Yes, that's right
- (iv) (a) I am the only White
 (b) That's right
- (v) (a) No, (b) is the only Black
 (b) That is correct
- (vi) (a) We are both Whites
 (b) Only one of us is a White

TECHNIQUE

Assume first speaker (a) is a Truth Teller. Can he, as a Truth Teller, say the statement he says? If not, then (a) is a Liar. Work out 2nd speaker's (b) status in relation to this. (Liars agree. A Truth teller disagrees with a Liar). If (a) can say what he says, then assume what he says is the truth and use 2nd speaker's answer to confirm or deny this. If statement can't be true, then (a) is a Liar. Use (b)'s statement to ascertain (b)'s status.

eg. with (i)

If (a) is a T.T. he can say "We are both truth tellers" and there is no contradiction.

If this statement is the truth, then (b) should (as a T.T.) agree. But he doesn't.

So, what (a) said is a lie.

So (a) is a liar & (b) (who disagrees with (a)) is a T.T.

TRUTH PUZZLES REVISION

1. Fred visited the ice cream parlour where they had a special on four ice cream flavours: Apple, Berry, Coconut and Daisy. Fred wants a double cone so he chose two different flavours. The following facts are known:

- (a) Fred will have apple only if he has berry
- (b) He will have either berry or daisy, but not both
- (c) If he didn't have coconut then he would have daisy
- (d) He would not have daisy if and only if he had apple
- (e) He would have either apple or coconut

Which flavours did he choose? Use a truth table.

2. Use the Method of Assigning Values to work out if it has hailed. 'If it hails or rains then the farmers crops will be destroyed.' The crops have not been destroyed.
3. Use a Grid to find out the name of the baker.

Amos, Brian and Chris follow the trades of gardener, bricklayer and baker – though not necessarily in that order. Amos, the shortest, has never met Chris, the tallest. Yesterday, the baker popped over to his golf partner, the bricklayer, to borrow a scoop of cement. But he learned that the layer had gone to an art gallery with the gardener – who by the way is taller than the bricklayer. What is the baker's name?

4. Use a Truth Table to discover who is backing the drug ring. Only one of the four suspects is guilty. The following facts are known:

- (a) Bill Brutal is involved if and only if don Dastard is involved
- (b) If Carl Callous is guilty then Bill Brutal is not
- (c) If either Rob Robber or Don Dastard is involved than Carl Callous is involved
- (d) If Carl Callous is not involved then Bill Brutal is involved.

5. Use Reductio Ad Absurdum technique

Benno Torelli, genial host at Hamtramck's most exclusive nightclub, was shot and killed by a racketeer gang because he fell behind in his protection payments. After considerable effort on the part of the police, five men were brought before the District Attorney, who asked them what they had to say for themselves. Each of the men made three statements, two true and one false. Their statements were as follows:

Lefty: I did not kill Tortelli. I never owned a revolver. Spike did it.
Red: I did not kill Tortelli, I never owned a revolver. The other guys are all passing the buck.
Dopey: I am innocent. I never saw Butch before. Spike is guilty.
Spike: I am innocent. Butch is the guilty man. Lefty lied when he said I did it.
Butch: I did not kill Tortelli. Red is the guilty man. Dopey and I are old pals.

Who did it? There is only one person guilty.

6. Smith, Jones and Robinson, are the engineer, brakeman and fireman on the train, but not necessarily in that order. Riding the train are three passengers with the same three surnames, to be identified below by including a Mr. in their names. Use a grid. The following facts are known:

- (a) Mr Robinson lives in Brisbane.
- (b) The brakeman lives in Toowoomba
- (c) Mr Jones is hopeless at mathematics
- (d) The passenger whose surname is the same as the brakeman's lives in Caboolture
- (e) The brakeman and one of the passengers, a mathematics professor, attend the same church.
- (f) Smith beat the fireman at chess.

Who is the engineer?

7. Use Truth-teller-Liar Technique
In a certain college, students always lie and lecturers always tell the truth. A visitor meets three people in the college (each of which is either a student or a lecturer) and asks the first of them if he is a student. The first person answers the question. The second person then says that the first person denied being a student, and the third person says that the first person is a student.

How many of the college persons are students?

8. Use a Truth Table to work out the following puzzle. Limpy Spiv has been told that the Doomben Cup race has been fixed. He knows that only one horse will win and that four horses have a chance: Amorous Ann, Frisky Fred, Biting Ben and Never Ned. Jockeys give him the following information.
- (a) Either Amorous Ann doesn't win or Frisky Fred does.
 - (b) Either Biting Ben or Never Ned will win.
 - (c) Frisky Fred won't win only if either Biting Ben or Amorous Ann does.
 - (d) Neither Never Ned nor Amorous Ann will win.

Limpy suspects that one of the jockeys is lying. He is correct in suspecting this.

- (i) Which horse wins?
- (ii) Which statement is a lie?

9. Use 2 Grids to fill in the following information and find out what exactly VALERIE does.

My four daughters are very clever. Each plays a different musical instrument and each speaks a foreign language. Mary plays the cello. The girl who speaks French plays the violin. Valerie is not the organist and knows no French. Lorna does not speak German and does not play the harp. Mary knows no Italian. Anthea does not play the violin and does not speak Spanish. The organist cannot speak Italian.

What instrument and what language does Valerie possess?

10. Truth-teller – Liar Puzzle
In a certain school, students always lie and teachers always tell the truth. I meet three people at the school and ask them whether they are teachers or students. Their replies were:
A: We are all students
B: That's not true
C: What B said was a lie

Is C a teacher or a student? Give full reasoning for your answer.

11. There are five boys in a family, Bernard, John, Vincent, Terry and Paul. More than two of them are married and the following facts are known.
- (a) Bernard is married if and only if Paul is not
 - (b) Paul and Vincent are married only if John is
 - (c) Either Vincent is married or Terry is not
 - (d) Terry is married if and only if Bernard is
 - (e) Exactly one of John and Vincent is married.

Who are married? Use a truth table.

12. The ministry has two industrial projects before it and five towns in which to place them. They are Allora, Bell, Clifton, Dalby and Pittsworth. Only two towns can have the projects. It is clear that:
- (a) If one is Dalby then non will be in Bell
 - (b) If one is in Clifton then none will be in Allora
 - (c) There will be a project at Bell if and only if there is one at Pittsworth, and there will be one at Allora if and only if there is one at Dalby
 - (d) If there is no project in either Dalby or Allora, then there is one at Clifton.

Name the two towns that will get the project. Use a truth table.

13. In a certain village, everyone is a Washington or a Longbow. Washingtons always tell the truth and Longbows always lie. Three villagers were questioned. (Truth-teller-Liar Puzzle)

“Are you a Washington or a Longbow?”

The first answered, “Two of us are Washingtons”
 The second said, “Only one of us is a Washington”
 The third said, “Yes, that is quite true”

What are the surnames of the three villagers?

14. Driven to action by the state of the logic rooms, a student breaks into the school at the weekend and wallpapers the rooms. Four students are suspected and when questioned, each makes the following claim.

Deb: If Bob did it then either Con didn't or Anne didn't
 Con: If Anne didn't do it then Don did it only if Bob did
 Bob: Anne did it if and only if Con did it
 Anne: Bob did it if and only if Con did it.

Only one student told the truth, but two students did the wallpapering. Who were they? Use a Truth Table.