

Explorations in Logic: Patterns of Truth and Deception

Session Date: February 4, 2026

Session: ICTS Maths Circle

Part I: The Island of Knights and Knaves

On the island of **Godelistan**, Knights always tell the truth and Knaves always lie. Every inhabitant is one or the other.

Problem 1: Once when you visit Godelistan, you come across two of the inhabitants resting under a tree. You asked one of them, "Is either of you a knight?" He responded, and I knew the answer to your question. What is the person to whom you addressed the question: is he a knight or a knave; And what is the other one? You can be assured that you have enough information to solve this problem.

Problem 2: The Spies and Suspects:

In Zermeloland, there are three kinds of people: Knights, Knaves and Normals. Knights always speak the truth, Knaves always lie, and Normals occasionally lie and occasionally speak the truth.

You meet A and B in Zermeloland, who say the following:

A: B is a knight.

A is a knave,

Prove that either one of them is telling the truth but is not a knight, or one of them is lying but is not a knave.

Part II: Alice in Wonderland Land

Problem 3: When Alice entered the Forest of Forgetfulness, she did not forget everything; only certain things. She often forgot her name, and the one thing she was most likely to forget was the day of the week. Now, the Lion and the Unicorn were frequent visitors to the forest. These two are strange creatures. The Lion lies on Mondays, Tuesdays, and Wednesdays and tells the truth on the other days of the week.

The Unicorn, on the other hand, lies on Thursdays, Fridays, and Saturdays, but tells the truth on the other days of the week.

One day Alice met the Lion and the Unicorn resting under a tree. They made the following statements:

Lion :Yesterday was one of my lying days.

Unicorn: Yesterday was one of my lying days too.

From these two statements, Alice (who was a very bright girl) was able to deduce the day of the week. What day was it?

Problem 4:

- a. On which days of the week can the Lion make the following statement:
 - (1) I lied yesterday.
 - (2) I will lie again tomorrow.
 - b. On what days of the week is it possible for the Lion to make the following single statement: "I lied yesterday and I will lie again tomorrow. " Warning! The answer is not the same as that of the preceding problem! Explain the difference.
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Part III: Treasure Hunters

Problem 5:

A treasure hunter came across three treasure chests with chests made of Gold, Silver and Bronze with inscriptions on them. Only one of the three treasure chests has the treasure. She is however told by the guardian of the treasure that the sentence on at most one of the three labels is true. Guardian of the treasure will handover the treasure to the hunter if she guesses which one has the treasure in it. Following are the inscriptions on each of the treasures:

Gold: This chest has the treasure.

Silver: This chest does not have the treasure.

Bronze: Gold chest does not have the treasure.

Which chest has the treasure?

Problem 6:

The treasure hunter gets greedy again and finds another treasure with similar three chests made of Gold, Silver and Bronze, except that each treasure chest now has two inscriptions on them. Exactly one chest contains the treasure. The guardian of this treasure tells the hunter that no treasure contains more than one false statement. Inscriptions on each of them are as follows:

Gold	Treasure is not in here	Treasure chest was made in Persia
Silver	Treasure is not in the Gold chest	Treasure chest is made in Samarkhand
Bronze	Treasure is not in here	Treasure is in the Silver treasure chest

Which chest has the treasure?

Problem 7:

If the hunter guessed the right chest, the guardian has another puzzle for the hunter. If the hunter answered this correctly, they would be entitled to the lost treasure of Aristotle. This time again, there were set of chests (Gold, Silver and Bronze again), and another set of inscriptions (2 on each of them). Exactly one of the chests contains the lost treasure of Aristotle. Now the conditions is that: on one of the chests, both the inscriptions are true, on one of them both are false, and one chest has one true and one false inscription. Can you guess which chest has the treasure?

Gold	Treasure is not in here	Treasure is in the Silver Chest.
Silver	Treasure is not in the Gold chest	Treasure is in the Bronze chest
Bronze	Treasure is not in this chest.	Treasure is in the Gold chest

Part IV: Crime and Deduction

Problem 6: Mr. McGregor, a London shopkeeper, phoned Sherlock Holmes that his shop had been robbed. Three suspects A, B, C were rounded up for questioning, since they were the only people to be in the vicinity of the store during the robbery. The following facts came about from the questioning:

- (1) Each of the men A,B,C had been in the shop on the day of the robbery, and no one else (apart from Mr. McGregor himself) had been in the shop that day.
- (2) If A was guilty, then he had exactly one accomplice .
- (3) If B is innocent, so is C.
- (4) If exactly two are guilty, then A is one of them.
- (5) If C is innocent, so is B.

What did Sherlock conclude?

Problem 7: A, B, C and D are four billionaire executives of a corporation accused of being responsible for releasing toxic wastes into the environment to cut costs. During a court case against four of them, following facts emerge:

- (1) If A is guilty, then B was an accomplice.
- (2) If B is guilty then either C was an accomplice or A is innocent.
- (3) If D is innocent then A is guilty and C is innocent.
- (4) If D is guilty, so is A.

Which ones are innocent and which ones are guilty?

Problem 8: This case took place on the island of knights, knaves, and normals. We recall that knights always tell the truth, knaves always lie, and normals sometimes lie and sometimes tell the truth.

Three inhabitants of the island, A, B, and C, were being questioned for a crime. It was known that the crime was committed by only one of them. It was also known that the one who committed the crime was a knight, and the only knight among them. The three suspects made the following statements to Detective Holmes:

A: I am innocent.

B: That is true.

C: B is not normal.

Which one did Holmes conclude was guilty?

Problem 9: The principal actors in this case were the defendant, the prosecutor, and the defense attorney. The first baffling thing was that it was known that one of them was a knight, one a knave, and one normal, though it was not known which was which. Even stranger, the court knew that if the defendant was not guilty, then the guilty one was either the defense attorney or the prosecutor. It was also known that the guilty one was not a knave. The three made the following statements in court:

Defendant: I am innocent.

Defense Attorney: My client is indeed innocent

Prosecutor: Not true, the defendant is guilty.

These statements certainly seemed natural enough. The jury convened, but could not come to any decision; the above evidence was insufficient. Now, this island was a British possession at the time, hence the government wired to Scotland Yard asking whether they could send Sherlock Holmes to come over to help settle the case.

Several weeks later Sherlock arrived, and the trial was reconvened. Sherlock said to himself, "I want to get to the bottom of this!" He wanted to know not only who was guilty, but also which one was the knight, which the knave, and which the normal. So he decided to ask just enough questions to settle these facts. First he asked the prosecutor, "Are you, by any chance, the guilty one?" The prosecutor answered. Sherlock thought for a while, and then he asked the defendant, "Is the prosecutor guilty?" The defendant answered, and Sherlock knew everything.

Who was guilty, who was normal, who was the knight, and who was the knave?

Fun Question: Can you tell me what is the "*The smallest positive integer not definable in fewer than twelve words.*"?

Another Fun Question: Is the following sentence true or false - "**If this sentence is true, then Santa Claus exists.**"

References:

Smullyan, Raymond M. *What Is the Name of This Book? The Riddle of Dracula and Other Logical Puzzles*. Prentice-Hall, 1978

Suggestions for Further Reading:

Hofstadter, Douglas R. *Gödel, Escher, Bach: An Eternal Golden Braid*. Basic Books, 1979.

Logic: A Very Short Introduction, Graham Priest

All Puzzle Books by Raymond Smullyan