Grade 6 Math Circles
November 11, 2020
Logic Puzzles

Introduction

This week we will be looking at logic puzzles! Logic puzzles are puzzles or games that can be solved with deductive reasoning and logical thinking. Logic puzzles are a great way to practice thinking like a mathematician, as logical thinking is used in mathematics every day.

Warm-up

Let's start with a couple of shorter logic puzzles to help get a feel for what logic puzzles may look like. Try to solve both problems on your own and when you think you have the answer, click on the link to watch a video that briefly goes through the solutions.

Warm-up 1. Flower Gardens

Three neighbours, Lily, Petunia and Rose are all growing flowers in their gardens. One is growing lilies, another is growing petunias and the third is growing roses. Lily notes that none of the three are growing the flower that corresponds with their name. The person who is growing petunias looks around at the gardens and agrees with Lily. Who is growing which flower?

Warm-up 2. Filling Water

Felix needs 4L of water to water his garden. However, he only has a 3L and a 5L container. He can fill each as many times as he needs, empty them or pour from one container to the other. How can Felix get exactly 4L of water? This online activity *https://www.geogebra.org/m/vc6vje74* may help to visualize the problem.

Warm-up Problem Solutions Video: *https://youtu.be/5zYNRfOIWWE*

Strategies

Although logic puzzles can vary greatly, there are some strategies that are useful for many puzzles. Below, a few such strategies are listed on how to approach logic puzzles. Please read through the following strategies. We will put some of them into use this week.

- Read through the question and clues multiple times. Information that you weren't able to use earlier may become usable or you may notice something that you hadn't before.

- Draw a chart or diagram to help organize the given information and what you can learn from it.

- Break the puzzle into pieces. Focus on one clue or step at a time.

- Check your solution to ensure that it satisfies all given conditions.

- Have fun! Some of these problems may be pretty tricky and take persistance. Don't forget that logic puzzles are meant to be fun!

River-Crossing Puzzles

River-crossing puzzles are puzzles which ask the solver to carry people or objects between two places. Often, there are certain constraints to the crossing, such as the number of objects able to be transported at once or objects that can't stay together.

Example 1. Carrying a Tune

While exploring in the woods, you have found and captured five *Pure Tones*: magical objects that each produce a single, pure musical note. You have put these Tones in glass jars labelled 1, 2, 3, 4, and 5, organized from lowest note to highest note. In order to take these Tones home, you have to transport them across a river, from the south side to the north side. However, your boat only has storage space for two Tones at a time, plus a seat for you, the driver.

The problem is that these Tones only stay quiet while you are watching them. If they are left alone on one side of the river, they will start making noise. If Tones that are one note apart are left together (like 1 and 2, or 4 and 5), their combined noise will shatter their glass jars, and they will escape.

Design a set of trips back and forth across the river so that you and the five Tones end up on the north side together, without any of them escaping. The table below may help organize your thinking.
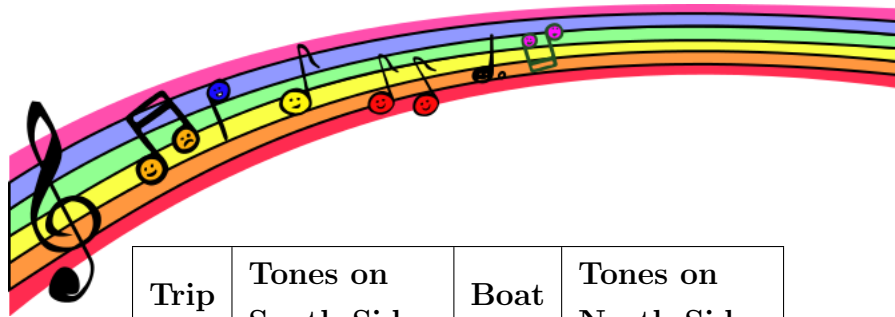
Trip	Tones on South Side	Boat	Tones on North Side
	1, 2, 3, 4, 5		None
1		→	
2		←	
3		→	
4		←	
5		→	
6		←	
⋮			

Carrying a Tune Solution Video: *https://youtu.be/3YgJh9OC_pA*

Grid Puzzles

Many logic puzzles are in the form of grid puzzles. In a grid puzzle, the solver is given clues and asked to find certain information, given those clues. They are called grid puzzles as one of the most common ways to solve them is to organize the information into a grid. Try the below grid puzzle. Once you have tried it, click on the link to see a video solution, along with some strategies for solving these types of problems.

Example 2. Out for Dinner
Four friends, Alex, Blake, Jess and Quinn decide to go out for dinner at a new restaurant in town. They each order a different food (pizza, a burger, pasta or a sandwich) and drink (water, apple juice, hot cocoa or milk). They all also have different last names, Baker, Miller, Smith or Green. Determine each person's full name, along with what they chose to eat and to drink at the restaurant.

Below, a grid, to organize your work, has been given. When using the grid, each square represents the possibility of a certain matching occuring. For example, in the grid below, the box in the top left would symbolize the possibility of Alex's last name being Smith. If it is possible for Alex's last name to be Smith but we don't know for sure that this is the case, we can leave the square blank. If we know Alex can't have the last name Smith, we typically denote that with an X. If Alex's last name is Smith, we typically use a checkmark.

Clues:

1. Alex Baker does not like pizza.

2. The person who had the apple juice, the one whose last name is Green, Quinn and the one who ate a burger are all different people.

3. Somebody enjoyed a meal with hot cocoa and pizza.

4. Jess, whose last name is not Miller, drank water.

5. The person who had milk, who was not Blake, had the sandwich.

	Smith	Green	Baker	Miller	Water	Apple Juice	Hot Cocoa	Milk	Pizza	Burger	Sandwich	Pasta
Alex												
Blake												
Jess												
Quinn												
Pizza												
Burger												
Sandwich												
Pasta												
Water												
Apple Juice												
Hot Cocoa												
Milk												

Fill in the grid above or use this online activity: *https://www.geogebra.org/m/h6zpygnj*.

Out for Dinner Solution Video: *https://youtu.be/UglhpwabcD8*
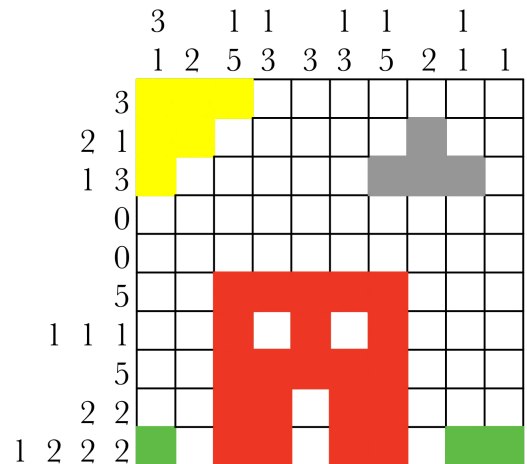
Nonograms

Nonograms are a type of logic puzzle that ask the solver to fill in squares in a box. Often, nonograms will create a picture.
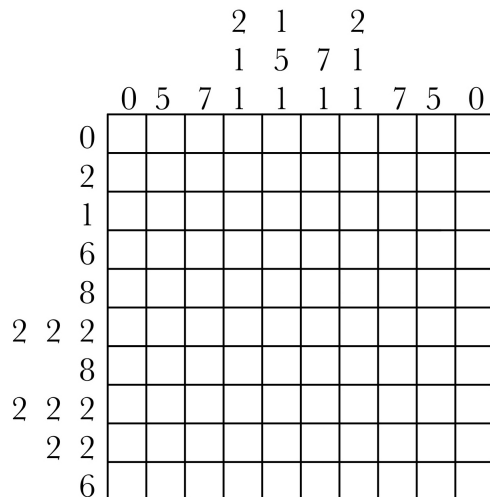
Rules:

- Each square must be either coloured or uncoloured.

- Above each row and column, there is a list of numbers. The numbers represent the groups of coloured squares adjacent to each other in that row or column. For example, in our completed nonogram below, the 2nd row from the top has some number of uncoloured squares, followed by 2 squares that are coloured, at least 1 uncoloured square, 1 square coloured and then the rest of the row is uncoloured.

- There must be at least one uncoloured space between groups of coloured spaces.

On the right is an example of a completed nonogram:

Example 3. Nonogram
Fill in the following nonogram.

Fill in the grid to the left or use this online activity: *https://www.geogebra.org/m/kehztqb8*.

Nonogram Solution Video:
https://youtu.be/54wBjyHRGyc