**Problem 1:** A Cat, a Parrot, and a Bag of Seed

1. **Define the problem** 
   1. Man needs to transport a cat, a parrot and a bag of seed across the river. He can only take one item at a time. Constraints are that the cat and parrot cannot be alone together and parrot and bag of seed cannot be alone together.
   2. Additional insight is that the man can bring items back and forth. It’s okay for the cat and seed to be together.
   3. The overall goal is to figure out the correct order for the man to bring items back and forth that won’t break the constraints.
2. **Break the problem apart**
   1. Constraints are that cat and parrot cannot be left alone together and parrot and seed cannot be left alone together. Man can only take one item at once.
   2. Sub-goals are (1) determine what he takes across first, (2) determine what he takes across second, (3) determine what he brings back if necessary, (4) what he brings across third and so on until all items are across.
3. **Identify potential solutions**
   1. Bring across 1st: Man has to bring parrot since parrot cannot be left alone with cat or seed. Leaves parrot on far shore
   2. Bring across 2nd: Man can bring either cat or seed.
   3. Bring back: Man bring back parrot to near shore and leaves cat or seed from step b on far shore
   4. Bring across 3rd: Man picks up remaining item to take to far shore. Man leaves parrot on near shore. On far shore should be cat and seed.
   5. Bring across 4th: Man leaves far shore with empty boat. Man picks up parrot from near shore and takes to far shore.
4. **Evaluate each potential solution** 
   1. The solution does meet all goals. Parrot is not left alone with either seed or cat at any time. Man only takes one item at a time.
   2. The solution will work for all cases; i.e. if he picks up cat second, the parrot is not left alone with seed or cat.
5. **Choose a solution and develop a plan to implement it.** 
   1. The solution can be broken down into steps as follows: Man picks up parrot from near shore and leaves at far shore. Man returns with empty boat to near shore. Man picks up cat or seed from near shore and drops them off to far shore; Man returns from far shore with parrot. Man leaves parrot at near shore and picks up remaining item (either seed or cat) from near shore. Man drops off remaining item at far shore; man returns to near shore with empty boat. Man grabs parrot from near shore and wearily rows to far shore.
   2. In this test case, I evaluated the Man bringing over the cat second (Step 3 below):

|  |  |  |  |
| --- | --- | --- | --- |
| Step # | Near Shore | Boat | Far Shore |
| 1 (near to far, takes parrot) | Cat, Seed | Parrot | Empty |
| 2 (far to near, leaves parrot & brings back nothing) | Cat, Seed | Empty | Parrot |
| 3 (near to far, takes cat) | Seed | Cat | Parrot |
| 4 (far to near, leaves cat & brings back parrot) | Seed | Parrot | Cat |
| 5 (near to far, bring seed) | Parrot | Seed | Cat |
| 6 (far to near, leaves seed) | Parrot | Empty | Cat, Seed |
| 7 (near to far, brings parrot) | Empty | Parrot | Cat, Seed |

**Problem 2:** Socks in the Dark

1. **Define the problem** 
   1. There are 20 socks in a drawer: 10 Black, 6 Brown and 4 White. You are blindly choosing socks and don’t know what you’ve grabbed until you step into the light.
   2. Additional insight is that this is a probability problem; once a sock is grabbed, you no longer count it in the remaining socks.
   3. Overall goal is (1) to figure out the minimum number of socks to ensure you get a matching pair and (2) to figure out the minimum number to socks to ensure you get a matching pair of each color.
2. **Break the problem apart**
   1. The constraints are that there are 20 socks in total (10 Black, 6 Brown and 4 White). Once a sock has been grabbed from the drawer it can’t be put back in.
   2. Sub-goals for both problems are as follows:
      1. Develop a method for choosing and tracking socks
      2. Iterate a few times to see if there are patterns; try to pick different color socks during iterations
3. **Identify potential solutions**
   1. I used a table (below) to keep track and iterate on potential combinations.
      1. For the single matching pair, the worst-case scenario is you get one of each different color before you draw a match (answer is 4).
      2. For the matching pair of each color, the worst-case scenario is you get all of one color before you draw one of the other colors (answer is 18).
4. **Evaluate each potential solution** 
   1. The solutions of 4 (a single pair) and 18 (a pair of each color) meet the goal of determining the minimum number of socks that will need to be blindly drawn that will meet the criteria.
   2. Each solution will work for all cases. By considering the worst-case scenario for both parts of the problem, we ensure the minimum number needed to guarantee the pair(s) desired.
5. **Choose a solution and develop a plan to implement it.** 
   1. In order to guarantee that a single matching pair is drawn, the worst-case scenario is that one of each color is drawn (1 black, 1 brown, 1 white for a total of 3 socks). Then, the fourth sock does not matter and a matching pair is created. For the second situation of guaranteeing a pair of each color, the worst-case scenario is that all of the black and all of the brown socks are drawn (10 black and 6 brown for a total of 16 socks) before a single white sock is drawn. Only white socks remain; that brings the total number of socks to 18.
   2. Tables were created for the worst-case scenarios for each situation.

Ensure one matching pair (worst case):

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Step** | **Choose** | **Remaining Black (10)** | **Remaining Brown (6)** | **Remaining White (4)** | **Total in Hand** |
| 1 | White | 10 | 6 | 3 | 1 White |
| 2 | Brown | 10 | 5 | 3 | 1 Brown,  1 White |
| 3 | Black | 9 | 5 | 3 | 1 Black,  1 Brown,  1 White |
| 4 | White | 10 | 6 | 2 | 1 Black,  1 Brown,  1 White |

Ensure a matching pair of each color (worst case):

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Step** | **Choose** | **Remaining Black (10)** | **Remaining Brown (6)** | **Remaining White (4)** | **Total in Hand** |
| 1 | 10 Black | 0 | 6 | 4 | 10 Black |
| 2 | 6 Brown | 0 | 0 | 4 | 10 Black,  6 Brown |
| 3 | 2 White | 0 | 0 | 2 | 10 Black,  6 Brown,  2 White |

**Problem 3:** Predicting Fingers

1. **Define the problem** 
   1. I really like tables if you can’t tell! I’m going to use them to help define the problem:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Remainder | Finger | N = 1 | N = 2 | N = 3 | N |
| 1 | Thumb | 1 | 9 | 17 | N\*8 -7 |
| 2 | First Finger | 2 | 10 | 18 | N\*8 - 6 |
| 3 | Middle Finger | 3 | 11 | 19 | N\*8 - 5 |
| 4 | Ring Finger | 4 | 12 | 20 | N\*8 - 4 |
| 5 | Little Finger | 5 | 13 | 21 | N\*8 - 3 |
| 6 | Ring Finger | 6 | 14 | 22 | N\*8 - 2 |
| 7 | Middle Finger | 7 | 15 | 23 | N\*8 - 1 |
| 0 | First Finger | 8 | 16 | 24 | N\*8 |

The girl uses her fingers to count as follows:

Thumb = 1

First Finger = 2

Middle Finger = 3

Ring Finger = 4

Little Finger = 5

Ring Finger = 6

Middle Finger = 7

First Finger = 8

And pattern starts over from the beginning with Thumb = 9, First Finger = 10…

What finger does she stop on 10? On 100? On 1000?

* 1. Additional insight is that you can create a mathematical formula to help figure out what finger she stops on…there’s a pattern!
  2. The true goal of this problem is to determine the mathematical pattern so we are stuck counting fingers all day!

1. **Break the problem apart**
   1. The constraints are that the fingers go in a particular order. She repeats fingers in the pattern.
   2. The sub-goals are to express the counting in a table and then determine the patterns / relationship between iterations and fingers.
2. **Identify potential solutions**
   1. The potential solution can be found be using the table in section 1. Take the total number (TN) and divide by 8 to find the remainder. Use the table to find what finger the remainder corresponds to.
      1. For TN = 10: Remainder is 2. Finger is First Finger
      2. For TN = 100: Remainder is 4. Finger is Ring Finger
      3. For TN = 1000: Remainder is 0. Finger is First Finger.
3. **Evaluate each potential solution** 
   1. The solution meets the goals. It set up a relation between Total Number of Fingers (TN) and the remainder when divided by eight and the particular finger.
   2. It will not work for negatives numbers, zero, irrational numbers, etc! But will work for counting by ones in a positive incremental fashion.
4. **Choose a solution and develop a plan to implement it.** 
   1. To determine which finger she will land on, divide the Total Number of Fingers (TN) by 8 and note the remainder. Use the below table to correspond the remainder to the finger:

|  |  |
| --- | --- |
| **Remainder** | **Finger** |
| 0 or 2 | First Finger |
| 1 | Thumb |
| 3 or 7 | Middle Finger |
| 4 or 6 | Ring Finger |
| 5 | Little Finger (Pinky) |

* 1. Test Cases:
     1. TN = 24. R = 0. Finger = First Finger
     2. TN = 17. R = 1. Finger = Thumb
     3. TN = 13. R = 5. Finger = Little Finger