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SOLUTION TO DICE PROBLEM:

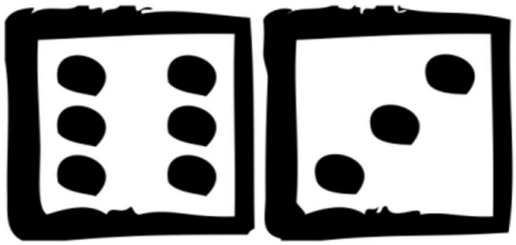
## Problem Statement: The Doomed Dice Challenge

The below problems must be solved & implemented in Python/Java/Ruby/C++/Go

You are given two six-sided dice, Die A and Die B, each with faces numbered from 1 to 6.

You can only roll both the dice together & your turn is guided by the obtained sum.

Example: Die A = 6, Die B = 3. Sum = 6 + 3 = 9



You may represent Dice as an Array or Array-like structure.
Die A = [1, 2, 3, 4, 5, 6] where the indices represent the 6 faces of the die & the value on each face.

**Part-A (15-20 Minutes):**

1. How many total combinations are possible? Show the math along with the code!
2. Calculate and display the distribution of all possible combinations that can be obtained when rolling both Die A and Die B together. Show the math along with the code!

   Hint: A 6 x 6 Matrix.
3. Calculate the Probability of all Possible Sums occurring among the number of combinations from (2).

   Example: P(Sum = 2) = 1/X as there is only one combination possible to obtain Sum = 2. Die A = Die B = 1.

1. **Total Combinations of dice rolls possible: 36**

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(1,1),(1,2),I1,3),(1,4),(1,5),(1,6)

(2,1),(2,2),(2,3),(2,4),(2,5),(2,6),

(3,1),(3,2),(3,3),(3,4),(3,5),(3,6),

(4,1),(4,2),(4,3),(4,4),(4,5),(4,6),

(5,1),(5,2),(5,3),(5,4),(5,5),(5,6),

(6,1),(6,2),(6,3),(6,4),(6,5),(6,6).

**2. All possible sums that can be obtained :**

| Sums | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |

**Function to find the sums:**

```
public static int[][] findcombinations(int combination_distribution[][]){
      for(int i=0;i<6;i++){
         for(int j=0;j<6;j++){
            combination_distribution[i][j]=(i+1)+(j+1);
         }
      }
      return combination_distribution;
   }
```

3.**Probability of all sums occurring among the number of combinations:**
//logic
Probability= Number of occurrences of a sum/ total possibilities;

Probability of 2= 1/36
Probability of 3=2/36
Probability of 4=3/36
Probability of 5=4/36
Probability of 6=5/36
Probability of 7 =6/36
Probability of 8 = 5/36

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Probability of 9= 4/36
Probability of 10=3/36

```
public static double[] probability(int total_combinations,int[][]
combination_distribution){
      int min_sum=2; //1+1; when dice 1 is 1 and dice 2 is 1
      int max_sum=12; //6+6 when dice 1 is 6 and dice 2 is 6

      double[] dp=new double[13];// frequency matrix
      double total=total_combinations;
        for(int i=0;i<combination_distribution.length;i++){
           for(int j=0;j<combination_distribution[0].length;j++){
              dp[combination_distribution[i][j]]++;
           }
        }
        System.out.println("Probablilites for sums :");
        for(int i=min_sum;i<=max_sum;i++){

            double prob=dp[i]/total;

            System.out.println(i+" : "+dp[i]+" / "+total+"  = "+prob);

        }
        return dp;
      }
```

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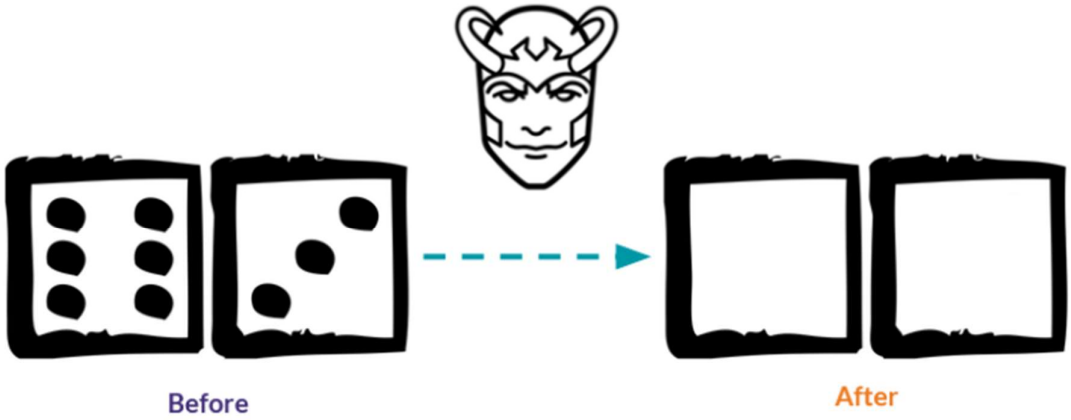
**Part-B (25-30 Minutes):**

Now comes the real challenge. You were happily spending a lazy afternoon playing your board game with your dice when suddenly the mischievous Norse God Loki ( You love Thor too much & Loki didn't like that much ) appeared.

Loki dooms your dice for his fun removing all the "Spots" off the dice.




No problem! You have the tools to re-attach the "Spots" back on the Dice.
However, Loki has doomed your dice with the following conditions:

- **Die A cannot have more than 4 Spots on a face.**
- **Die A may have multiple faces with the same number of spots.**
- **Die B can have as many spots on a face as necessary i.e. even more than 6.**

But in order to play your game, the probability of obtaining the Sums must remain the same!
So if you could only roll P(Sum = 2) = 1/X, the new dice must have the spots reattached such that those probabilities are not changed.

**Input:**

- Die_A = [1, 2, 3, 4, 5, 6] & Die B = Die_A = [1, 2, 3, 4, 5, 6]

**Output:**

- A Transform Function **`undoom_dice`** that takes **`(Die_A, Die_B`**) as input & outputs **`New_Die_A = [?, ?, ?, ?, ?, ?]`**,**`New_Die_B = [?, ?, ?, ?, ?, ?]`** where,
- No **`New_Die A[x] > 4`**

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**LOGIC:**

**Step1:**

This can be solved by generating all arrays of size 6 within {1,2,3,4} and with repetition. And all possible arrays of size 6 within{1,2,3,4,5,6,7,8,9,10,11} without repetition.

```
static List<int[]> generateDiceACombinations() {
        List<int[]> combos = new ArrayList<>();
        generateDiceA(new int[6], 0, combos);
        return combos;
    }
    static void generateDiceA(int[] curr, int index, List<int[]> combos) {
        if (index == 6) {
            combos.add(curr.clone());
            return;
        }
        if (index == 0 ) {
            curr[index] = 1;
            generateDiceA(curr, index + 1, combos);
        }
        else if(index == 1){
            curr[index] = 4;
            generateDiceA(curr, index + 1, combos);}
         else {
            curr[index] = 2;
            generateDiceA(curr, index + 1, combos);
            curr[index] = 3;
            generateDiceA(curr, index + 1, combos);
        }
    }
```

```
static void generateDiceB(int[] curr, int index, List<int[]> combos) {
        if (index == 6) {
            combos.add(curr.clone());
            return;
        }
        if (index == 0) {
            curr[index] = 1;
            generateDiceB(curr, index + 1, combos);
        } else if (index == 1) {
            curr[index] = 8;
            generateDiceB(curr, index + 1, combos);
        } else {
            for (int i = 1; i <= 7; i++) {
                final int finalI = i;
                if (Arrays.stream(curr).noneMatch(x -> x == finalI))
                 }

        }

    }
```

**Step2: Check Probabilities**

Here the generated lists are traversed.
Input: List<int[]> diceacombos,List<int[]> dicebcombos, double[] frequency

For each pair of new dice arrays a[] and b[] a frequency dp1 array is created to store the Frequency of occurrences of different sums.

```
int[] dp1=new int[13];
            int[] a=arr1;
            int[] b=arr2;
            int flag=0;
            for(int n:a){
               for(int m:b){
                  dp1[n+m]++; //frequency is
updated
                }
            }
```

Now the frequency array from new dice a[] and b[] is compared with the original default dice frequency array dp. In original dice minimum sum=1 and maximum sum=12

**Step4:**
Loop from 2 to 12 and check if the frequency array of previous diceA and diceB is similar to new generated arrays.

If yes:
output the newly generated Arrays.
Else:
Exit

```
for(int i=2;i<=12;i++){

    if((int)dp[i]!=dp1[i]){
       flag=1;
       break;

    }
}
    if(flag==0){
     printlist(a,b);
     break;
    }
```

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**OPTIMIZATION:**

Initially, we had sums in frequency :

Sum 2=> 1
Sum 3 =>2
Sum 4=> 3
Sum 5 =>4
Sum 6=> 5
Sum 7=>6
Sum 8=>5
Sum 9=>4
Sum 10=>3
Sum 11=>2
Sum 12=>1

Sum 2 and Sum 12 occurs only once.
Minimum sum=2; Maximum sum=12;

Sum of 2 is possible only when (1,1) combination
Hence

New_diceA[]={1,_,_,_,_,_}
New_diceB[]={1,_,_,_,_,_}

Sum 12 is possible when (4,8),(3,9),(2,10),(1,11) combinations

If we pick (1,11)

New_diceA[]={1,_,_,_,_,_}
New_diceB[]={1,11,_,_,_,_}

But diceA should have only one 1 since 12 is occurring only once . An increase in the instance of 1 will lead to (1,11),(1,11) multiple possibilities of 12.

Other spaces of diceA should be filled with {2,3,4}

But filling with anything greater than 1 will violate the sum combinations.
Will lead to combinations (2,11) = sum of 13; (3,11) =sum of 14; Maximum sum is 12.

If we pick(2,10)

New_diceA={1,2,_,_,_,_}
New_diceB={1,10,_,_,_,_}

Rest of the sides in dice A has to be filled with numbers. But filling it with another 1 or 2 Will violate first frequency rule.
New_diceA = {1,2,1,_,_,_}
New_diceB = {1,10,_,_,_,_}

MinSum 2 has frequency 1. But adding 1 to dice A will lead to (1,1), (1,1)

New_diceA= {1,2,2,_,_,_}
New_diceB= {1,10,_,_,_,_}
Adding another 2 will lead to 2 combinations of 12. (2,10) ,(2,10) .Frequency Violation

Anything greater than 2 cannot be added. As,

New_diceA={1,2,3,_,_,_}
New_diceB={1,10,_,_,_,_}
Adding >2 Eg. 3 will lead to (3,10) =Sum 13. Combination is not permissible.

Similar frequency violations will occur for (3,9)

Hence (4,8) will lead to no frequency violation. As,

New_diceA = {1, 4,_,_,_,_}
New_diceB = {1, 8,_,_,_,_}

Now dice A has to be filled with {2 , 3} in 4 places with repetition.
Dice B has to be filled with {2 to 7} without repetition.

The brute force approach is used to try all possible combinations of dice arrays.

Dice A Combinations:
[1, 4, 2, 2, 2, 2]
[1, 4, 2, 2, 2, 3]
[1, 4, 2, 2, 3, 2]
[1, 4, 2, 2, 3, 3]
[1, 4, 2, 3, 2, 2]
[1, 4, 2, 3, 2, 3]
[1, 4, 2, 3, 3, 2]
[1, 4, 2, 3, 3, 3]
[1, 4, 3, 2, 2, 2]
[1, 4, 3, 2, 2, 3]
[1, 4, 3, 2, 3, 2]
[1, 4, 3, 2, 3, 3]

[1, 4, 3, 3, 2, 2]
[1, 4, 3, 3, 2, 3]
[1, 4, 3, 3, 3, 2]
[1, 4, 3, 3, 3, 3]

Dice B Combinations:
[1, 8, 2, 3, 4, 5]
[1, 8, 2, 3, 4, 6]
[1, 8, 2, 3, 4, 7]
[1, 8, 2, 3, 5, 4]
[1, 8, 2, 3, 5, 6]
[1, 8, 2, 3, 5, 7]
[1, 8, 2, 3, 6, 4]
[1, 8, 2, 3, 6, 5]
[1, 8, 2, 3, 6, 7]
[1, 8, 2, 4, 3, 5]
[1, 8, 2, 4, 3, 6]
[1, 8, 2, 4, 3, 7]
[1, 8, 2, 4, 5, 3]
[1, 8, 2, 4, 5, 6]
[1, 8, 2, 4, 5, 7]
[1, 8, 2, 4, 6, 3]
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[1, 8, 2, 5, 3, 4]
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[1, 8, 2, 5, 4, 3]
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[1, 8, 3, 2, 6, 5]
[1, 8, 3, 2, 6, 7]
[1, 8, 3, 4, 2, 5]
[1, 8, 3, 4, 2, 6]
[1, 8, 3, 4, 2, 7]
[1, 8, 3, 4, 5, 2]
[1, 8, 3, 4, 5, 6]

[1, 8, 3, 4, 5, 7]
[1, 8, 3, 4, 6, 2]
[1, 8, 3, 4, 6, 5]
[1, 8, 3, 4, 6, 7]
[1, 8, 3, 5, 2, 4]
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[1, 8, 4, 5, 3, 7]
[1, 8, 4, 5, 6, 2]
[1, 8, 4, 5, 6, 3]
[1, 8, 4, 5, 6, 7]

The new dice a sides are: [1 4 2 2 3 3 ]
The new dice b sides are: [1 8 3 4 5 6 ]

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# THANK YOU