

APS 2020 Take-Home Class 04

Hello all. While class 03 is the riddles which you all are solving (Do. It has 10 math concepts and you will know them better), in class 04, we shall complete the Catalan Numbers coding.

We have already completed all the required theory for it. We have the equation too. Let us complete the code part. Also make a note of this in your books and upload the codes in you code library. It will be helpful.

The Catalan numbers satisfy the recurrence relation:

$$C_0 = 1 \text{ and } C_{n+1} = \sum_{i=0}^n C_i C_{n-i} \text{ for } n \geq 0$$

We can hence code this as:

```
unsigned long int catalan(unsigned int n)
{
    if (n <= 1)
        return 1;

    unsigned long int res = 0;
    for (int i=0; i<n; i++)
        res += catalan(i)*catalan(n-i-1);

    return res;
}
```

Application Example (using DP)

Question:

How many structurally different binary trees are possible with n nodes?

Example:

If n=3, result=5



DP solution using Catalan numbers:

```
int catalan_binary_trees(int n)
{
    int c[n+1];
    c[0]=1;
    c[1]=1;
    c[2]=2;

    int i,j;

    for(i=3;i<=n;i++)
    {
        c[i]=0;

        for(j=0;j<i;j++)
        {
            c[i]+=c[j] * c[(i-1)-j];
        }
    }

    return c[n];
}
```

Trace with examples. It will be clearer.

Note:

Next class will be an audio class.