← Practice Programming Problems / Candy Distribution 3

Candy Distribution 3

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Combinatorics Math Medium Edit

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Author Solution by Ashish Khatkar

```
/*
ID: ashish1610
PROG:
LANG: C++
*/
#include<bits/stdc++.h>
using namespace std;
#define ll                          long long int
#define vi                          vector<int>
#define vl                          vector<ll>
#define pii                         pair<int,int>
#define pil                         pair<int, ll>
#define pll                         pair<ll, ll>
#define pli                 pair<ll, int>
#define pb(v, a)            v.push_back(a)
#define mp(a, b)            make_pair(a, b)
#define MOD                         1000000007
#define rep(i, a, b)    for(i=a; i<=b; ++i)
#define rrep(i, a, b)   for(i=a; i>=b; --i)
#define si(a)               scanf("%d", &a)
#define sl(a)               scanf("%lld", &a)
#define pi(a)               printf("%d", a)
#define pl(a)               printf("%lld", a)
#define pn                          printf("\n")
ll pow_mod(ll a, ll b)
{
        ll res = 1;
        while(b)
        {
                if(b & 1)
                        res = (res * a) % MOD;
```

```
                a = (a * a) % MOD;
                b >>= 1;
        }
        return res;
}
ll pow2[1000005], pow3[1000005];
void pre_compute()
{
        int i;
        pow2[0] = 1;
        pow3[0] = 1;
        rep(i, 1, 1000000)
        {
                pow2[i] = (2 * pow2[i - 1]) % MOD;
                pow3[i] = (3 * pow3[i - 1]) % MOD;
        }
}
int main()
{
        pre_compute();
        int t, i, n;
        si(t);
        ll ans;
        rep(i, 1, t)
        {
                si(n);
                ans = (pow2[n] * pow2[n]) % MOD;
                ans -= 2 * pow3[n];
                while(ans < 0)
                        ans += MOD;
                if(ans >= MOD)
                        ans = ans % MOD;
                ans += pow2[n];
                if(ans >= MOD)
                        ans = ans % MOD;
                pl(ans);
                pn;
        }
        return 0;
}
```

Tester Solution by Akash Agrawall

```
/******************
        Akash Agrawall
        IIIT HYDERABAD
        **********************/


#include<cstdio>
#include<iostream>
#include<cstdlib>
#include<cmath>
```

```
#include<stdio.h>
#include<string.h>
#include<cassert>
using namespace std;
#define FOR(i,a,b) for(i= a ; i < b ; ++i)
#define rep(i,n) FOR(i,0,n)
#define pln(n) printf("%lld\n",n)
#define sl(n) scanf("%lld",&n)
#define mod (int)(1e9 + 7)
#define ll long long int
ll modpow(ll a,ll n,ll temp){ll res=1,y=a;while(n>0){if(n&1)res=(re
inline ll checkit(ll n)
{
        while(n<0)
                n+=mod;
        if(n>=mod)
                n%=mod;
        return n;
}
ll mod2[1000006],mod3[1000006];
//The final formula after solving the combinatorics is (2^n-1)(2^n
int main()
{
        ll c1,c2,t,n,i;
        mod2[0]=1;
        mod3[0]=1;
        FOR(i,1,1000004)
        {
                mod2[i]=2*mod2[i-1];
                mod3[i]=3*mod3[i-1];
                mod2[i]=checkit(mod2[i]);
                mod3[i]=checkit(mod3[i]);
        }
        sl(t);
        while(t--)
        {
                sl(n);
                c1=mod2[n]-2;
                c1=checkit(c1);
                c2=mod2[n]+1;
                c2=checkit(c2);
                c1=c1*c2;
                c1=checkit(c1);

                c2=mod3[n]-mod2[n]-1;
                c2=checkit(c2);
                c2*=2;
                c2=checkit(c2);

                c1-=c2;
                c1=checkit(c1);
                pln(c1);
        }
        return 0;
```

```
65. }
```

COMMENTS (4)

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Tarun Dutt 9 months ago

Can you please explain how the formula was obtained?

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ankur malik 8 months ago

yes.. Please someone add some link or something, where this thing is explained

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artisticoder 2 months ago

A possible answer can be:
A and B cannot contain neither 0 nor n elements (otherwise conditions does not hold). If A contains k elements, then B can be any subset of n elements apart the subset with n and 0 elements, i.e. 2^n - 2, minus the subsets of A apart the empty set, i.e. 2^k - 1, minus all subsets containing the k elements, that is all subsets with n-k elements, apart from subsets with n-k and 0 elements, i.e. 2^(n-k) - 2. So with A having k elements, the total ways to have A and B are C(n, k)*(2^-2 - (2^k-1) - (2^n-k - 2)) = C(n,k)*(2^n - 2^k - 2^(n-k) +1). If the range of k is 1 <= k <= n-1 then we have to sum the above formula over this range. Let's break the formula into three parts. First is Sum(C(n,k)*(2^n + 1)) = (2^n + 1)*(2^n - 2). (Sum(Cn,k) = 2^n by definition, the minus 2 is because the range of k does not include n and 0, for which C is 1 for each one). The second part is Sum(C(n,k)*2^k) which by definition of the binomial coefficient is (1 + 2)^n - 1 - 2^n. The minus is again for excluding 0 and n from k. The third part Sum(C(n, k)*2^(n-k)) is equal to the second one because C(n, k) = C(n, n-k).
Thus, the final formula is:
(2^n + 1)*(2^n - 2) - 2*(3^n - 2^n -1). In the comments of the 2nd solution the formula has a small error, but the code computes the result correctly.

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himanshu pal 2 months ago

Let A be a set containing k elements (k is non zero quantity and cannot be equal to n as per the condition given in question)
Now nCk is the number of ways of choosing this set A. Now number of ways of choosing B = T - b⊆a - a⊂b where
T(Total number of sets ignoring null and complete set ie 2^n -2)
b⊆a(case when B is a subset of A ie 2^k-1 ignoring null set "note: we are not ignoring complete set of k element because b can have all elements of k")
a⊂b(case when A is a subset of B ie all k elements already present so 2^(n-k)-1(because if B does not contain any extra element other than k elements that ie B=A we have considered that case in 2nd part b⊆a) -1(because if B contains all elements of n=k+n-k than B becomes complete set which we have to ignore))
So the complete formula of B becomes (2^n - 2 - (2^k - 1) - (2^(n-k) - 2)).Now 1<=k<=n-1 we have to sum the series nCk*(2^n - 2 - (2^k - 1) - (2^(n-k) - 2)). Now by using binomial series Sum(nCk) = 2^n-2 , Sum(nCk*(2^k)) = 3^n - 1 - 2^n = Sum(nCk*(2^(n-k))

because C(n, k) = C(n, n-k) so the whole formula reduces to (2^n-2)(2^n+1)-(2*(3^n - 1-2^n)) which is simplified further to 2^(2n) +2^n -2*(3^n)

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Sumit Ku...		1.095	C++
Sumit Ku...		1.1618	C++

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Number Theory - III
written by Boris Sokolov

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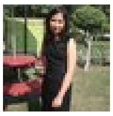

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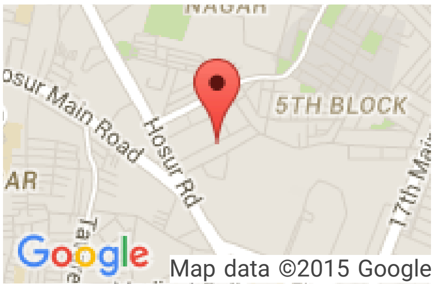

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