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Batch: B2

Subject: CNS Lab

PRN: 2019BTECS00034

Assignment 9.1

Aim: Prime Factorization of large numbers

Theory: We have to factorize a number such that its factors are prime and their product equals a given number.

Code:

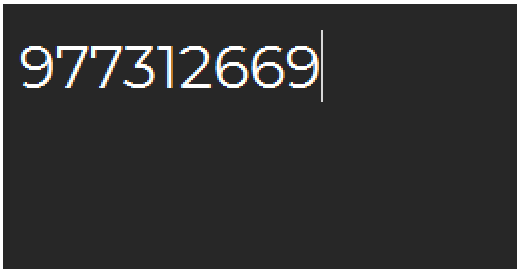
```
#include <bits/stdc++.h>
using namespace std;
typedef long long ll;
typedef vector<long long> vl;
#define pll pair<ll, ll>
#define vpll vector<pll>
#define vb vector<bool>
#define PB push_back
#define MP make_pair
#define ln "\n"
#define forn(i,e) for(ll i=0; i<e; i++
#define forsn(i,s,e) for(ll i=s; i<e; i++)
#define rforn(i,e) for(ll i=e; i>=0; i--)
#define rforsn(i,s,e) for(ll i=s; i>=e; i--)
#define vasort(v) sort(v.begin(), v.end())
#define vdsort(v) sort(v.begin(), v.end(),greater<ll>())
#define arrasort(arr,n) sort(arr,arr+n)
#define arrdsort(arr,n) sort(arr,arr+n,greater<ll>())
#define F first
#define S second
#define out1(x1) cout << x1 << ln
#define out2(x1,x2) cout << x1 << " " << x2 << ln
#define out3(x1,x2,x3) cout << x1 << " " << x2 << " " << x3 << ln
#define out4(x1,x2,x3,x4) cout << x1 << " " << x2 << " " << x3 << " " << x4 << ln
#define out5(x1,x2,x3,x4,x5) cout << x1 << " " << x2 << " " << x3 << " " << x4 << " "
<<x5 << ln
```

```
#define out6(x1,x2,x3,x4,x5,x6) cout << x1 << " " << x2 << " " << x3 << " " << x4 << " "<< x5 << " " << x6 << ln
#define in1(x1) cin >> x1
#define in2(x1,x2) cin >> x1 >> x2
#define in3(x1,x2,x3) cin >> x1 >> x2 >> x3
#define in4(x1,x2,x3,x4) cin >> x1 >> x2 >> x3 >> x4
#define in5(x1,x2,x3,x4,x5) cin >> x1 >> x2 >> x3 >> x4 >> x5
#define in6(x1,x2,x3,x4,x5,x6) cin >> x1 >> x2 >> x3 >> x4 >> x5 >> x6
#define mz(a,val) memset(a,val,sizeof(a))
#define arrin(a,n) forn(i,n) cin >> a[i];
#define arrout(a,n) forn(i,n) {cout << a[i] << " ";} cout << ln;
#define fio ios_base::sync_with_stdio(false);cin.tie(NULL);cout.tie(NULL)
#define mod 1000000007

void file()
{
#ifndef ONLINE_JUDGE
freopen("input.txt", "r", stdin);
freopen("output.txt", "w", stdout);
#endif
}

string longDivision(string number, ll divisor)
{
// As result can be very large store it in string
string ans;
// Find prefix of number that is larger
// than divisor.
ll idx = 0;
ll temp = number[idx] - '0';
while (temp < divisor)
temp = temp * 10 + (number[++idx] - '0');
// Repeatedly divide divisor with temp. After
// every division, update temp to include one
// more digit.
while (number.size() > idx) {
// Store result in answer i.e. temp / divisor
ans += (temp / divisor) + '0';
// Take next digit of number
temp = (temp % divisor) * 10 + number[++idx] - '0';
```

```
}
// If divisor is greater than number
if (ans.length() == 0)
return "0";
// else return ans
return ans;
}
string multiply(string num1, string num2)
{
int len1 = num1.size();
int len2 = num2.size();
if (len1 == 0 || len2 == 0)
return "0";
// will keep the result number in vector
// in reverse order
vector<int> result(len1 + len2, 0);
// Below two indexes are used to find positions
// in result.
int i_n1 = 0;
int i_n2 = 0;
// Go from right to left in num1
for (int i = len1 - 1; i >= 0; i--)
{
int carry = 0;
int n1 = num1[i] - '0';
// To shift position to left after every
// multiplication of a digit in num2
i_n2 = 0;
// Go from right to left in num2
for (int j = len2 - 1; j >= 0; j--)
{
// Take current digit of second number
int n2 = num2[j] - '0';
// Multiply with current digit of first number
// and add result to previously stored result
// at current position.
int sum = n1 * n2 + result[i_n1 + i_n2] + carry;
// Carry for next iteration
carry = sum / 10;
// Store result
result[i_n1 + i_n2] = sum % 10;
i_n2++;
}
// store carry in next cell
if (carry > 0)
result[i_n1 + i_n2] += carry;
// To shift position to left after every
// multiplication of a digit in num1.
i_n1++;
}
// ignore '0's from the right
int i = result.size() - 1;
while (i >= 0 && result[i] == 0)
i--;
// If all were '0's - means either both or
// one of num1 or num2 were '0'
if (i == -1)
return "0";
// generate the result string
string s = "";
while (i >= 0)
s += std::to_string(result[i--]);
return s;
}
ll isPrime(ll n)
{
// Corner case
if (n <= 1)
return 0;
// Check from 2 to square root of n
for (ll i = 2; i <= sqrt(n); i++)
if (n % i == 0)
return 0;
return 1;
}
int main()
{
file();
ll t = 1;
//cin >> t;
```

```
while (t--)
{
string s;
cin >> s;
ll till = 100000;
for (ll i = 1; i < till; i++)
{
//cout << i << endl;
if (isPrime(i) == 0)
{
continue;
}
//cout << i << endl;
ll first = i;
string fs = to_string(first);
string x = longDivision(s, i);
if (multiply(fs, x) != s)
continue;
cout << first << endl;
cout << x << endl;
cout << endl;
break;
}
}
return 0;
}
```

Output:



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977312669
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31013
31513