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COOLGUYS - Editorial

Problem Link:

9 Practice Contest

Difficulty:

Pre-requisites:

Number theory

Problem:

Given an integer N. Two integers A and B are chosen randomly from [1..N]. Find the probability that gcd(A, B) = B as a reduced fraction.

Explanation:

Stating that gcd(A, B) = B is same as saying that B is a factor of A. Therefore, our problem is equivalent to finding

number of ordered pairs (A, B) such that B is a factor of A / N * N

The numerator can be written equivalently in two forms as below:

sum [over A=1 to N] number of factors of A

sum [over B=1 to N] number of multiples of B less than N+1

While it is difficult to find the summands of First sum, the second sum can be written down very simply as

sum
$$_{B=1}$$
 N [N/B]

At this point a very handy fact comes to our rescue.

The sequence [N/i] has at most 2 * JN distinct values.

This is because for i > JN, [N/i] < JN. Therefore for i = JN + 1 to N, it has only JN distinct values.

The above fact can be used to our advantage. We can sum up the series by summing up, for each distinct value in the sequence, its number of occurrences.

```
[ N/i ] = K
\Rightarrow K \leq N/i < K+1
\Rightarrow N/(K+1) < i \le N/K
\Rightarrow \left[ \ N/(K+1) \ \right] < i \leq \left[ \ N/K \ \right]
```

Using the ideas discussed above, here is the psudo code of final solution:

```
sum = 0
K = N
imin = 1
while imin ≤ N
    imax = [ N/K ]
    sum += K*(imax - imin + 1)
   imin = imax + 1
   K = N/imin
g = gcd(N * N, sum)
print sum/g, N * N/g
```

Setter's Solution:

Can be found here

Tester's Solution:

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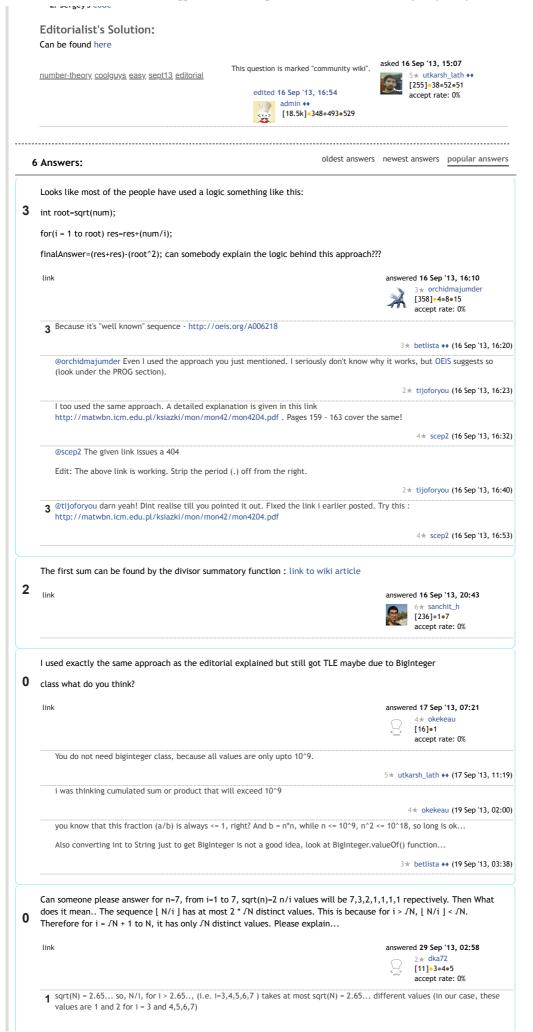
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	for i>sgrt(N), there can be sgrt(N) distinct values. In	n our case, it holds for i = 3,4,5,6,7. So there are only sqrt(N) [=2] distinct
	values for all these i's(these values are 2 and 1).	2, 1,5,1,1 20 and and 311, 54,1(1), [2] distinct
		5* utkarsh_lath ++ (01 Oct '13, 15:18)
	Thank you. Many people have solved it by iterating i (sqrt(n)*sqrt(n)). How did we get this equation?	i over 1 to sqrt(n) taking sum of (n/i) and then 2*sum-?
		2* dka72 (02 Oct '13, 02:10)
	Please read the thread, it's already written here	
		3* betlista ++ (02 Oct '13, 15:17)
	great work guys	
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