← Notes

Wilson's theorem

23 Number Theory Math

2 LIVE EVENTS

In number theory, Wilson's theorem states that a natural number n is a prime number if and only if

((n-1)!) mod n =(n-1)

That is, it asserts that the factorial (n - 1)! = 1 * 2 * 3 * ....*(n - 1) is one less than a multiple of n exactly when n is a prime number.

for example :

for n= 4
(n-1) ! = 6
(n-1) ! mod n =2

for n= 5
(n-1) ! = 24
(n-1) ! mod n = 4

for n=6
(n-1) != 120
(n-1) ! mod n =0

for n=11
(n-1) ! = 3628800
(n-1) ! mod n = 10

for n =12
(n-1)! = 39916800
(n-1) ! mod n = 0

Proof: It is easy to check the result when n is 2 or 3, so let us assume n > 3. If n is composite, then its positive divisors are among the integers 1, 2, 3, 4, ... , n-1 and it is clear that gcd((n-1)! , n) > 1, so we can not have (n-1)! = -1 (mod n).

However if n is prime, then each of the above integers are relatively prime to n. So for each of these integers a there is another b such that ab = 1 (mod n). It is important to note that this b is unique modulo n, and that since n is prime, a = b if and only if a is 1 or n-1. Now if we omit 1 and n-1, then the others can be grouped into pairs whose product is one showing

2.3.4.....(n-2) = 1 (mod n)

(or more simply (n-2)! = 1 (mod n)). Finally, multiply this equality by n-1 to complete the proof.

Note: Wilson theorem holds only for prime numbers .

Problem for practice : Factorial Again

AUTHOR

Chandan Singh
Software Developer at Hac...
Bangalore, Karnataka, India
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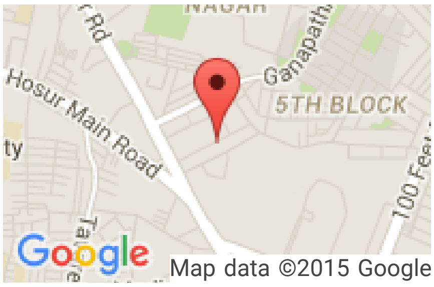

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IIIrd Floor, Salarpuria Business Center,
4th B Cross Road, 5th A Block,
Koramangala Industrial Layout,
Bangalore, Karnataka 560095, India.

contact@hackerearth.com

+91-80-4155-4695

+1-650-461-4192