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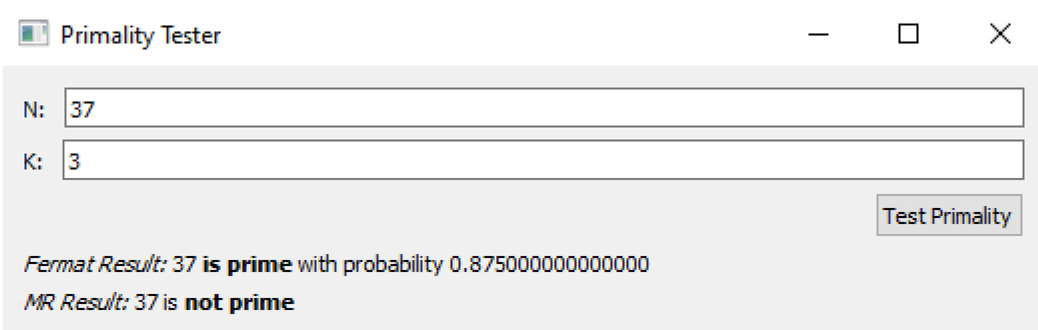
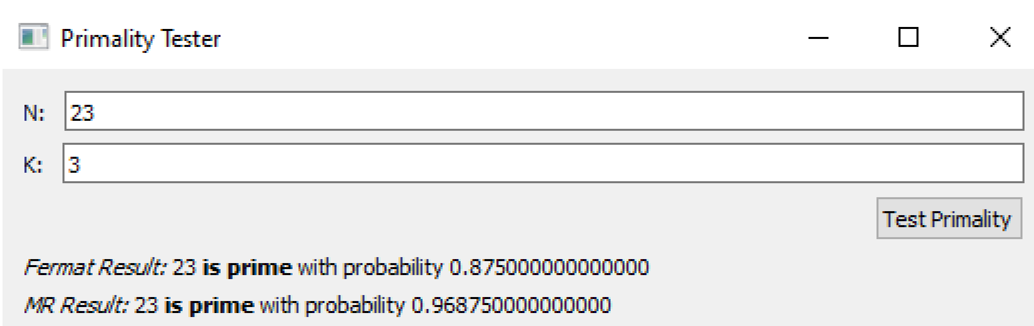
CS 4412

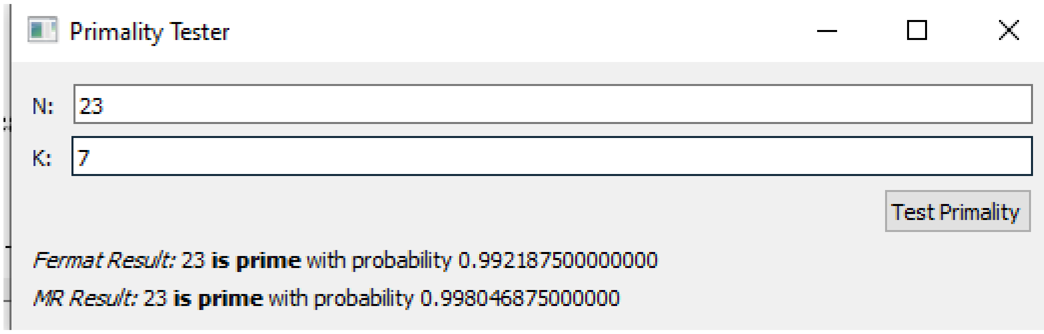
9/5/22

Project One Report

1. Working Examples:



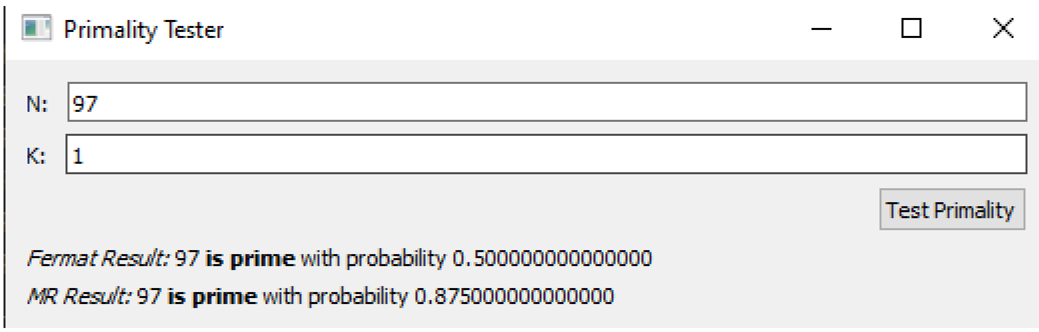


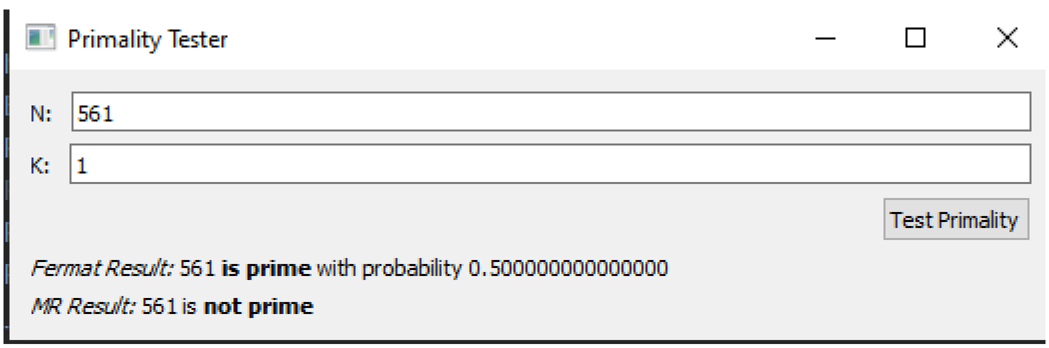

Primality Tester
N: 23
K: 7
Test Primality
Fermat Result: 23 **is prime** with probability 0.992187500000000
MR Result: 23 **is prime** with probability 0.998046875000000

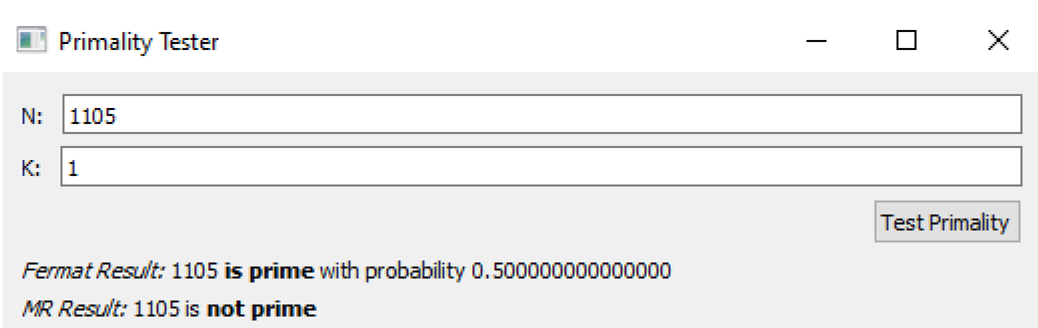
Discussion experimentation.

There were several bugs that I almost didn't catch. The Miller-Rabin method was confusing and I did not read some edge case text properly at first. I had the number 293 causing problems for a while, but now it should all be working properly.

The following images demonstrate requirements passing. I chose 1105 for my unique Carmichael number.







Complexity:

The complexity and space of the probability calculations was O(1) for both functions.

The complexity of the modular exponentiation function was O(log(N)), and the space requirements was O(n) where n was the number of operations that the function completed. Normally space requirements for this equation can be O(1) but I decided to store intermediate values instead of run cleanup operations that removed nodes from the end of my list.

Note that I decided to use an iterative approach instead of a recursive approach because I don’t like recursion and thought it would be interesting.

The time complexity of the Fermat function was O(k) * the complexity of the modular exponential function, where k was the number of trials. The space complexity was O(k) as I stored an array of random numbers instead of generating as needed.

The complexity of the Miller-Rabin function was O(k) * O(log(N)) where k was the number of trials and O(Log(N)) represents that there was a repeated square root operation happening where N was the size of the prime input, ie. The bigger the input the proportionally more time the function took.

Probability equations:

I documented both of my probability equations. In short, the Miller-Rabin method captured ¾ of the numbers that Fermat wouldn’t. In short, the Miller-Rabin method was 4x more likely to solve a given number, and so its probability of failure was 25% of what the Fermat’s formula was.

The base equation for each was (1/2^k) where k is the number of tests.