## Optimizing the Search for Mersenne Primes

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Mersenne Primes are prime numbers of the form $2^{\wedge} p-1$ where $p$ is prime. These numbers have been studied for over 2,000 years and continue to mesmerize mathematicians today with a number of unsolved problems. It was the goal of this project to incorporate number theory and higher mathematics into a program to find Mersenne Primes. The Lucas-Lehmer test is the only primality test designed specifically for Mersenne Numbers. However, it is time consuming; so, this project worked to incorporate quick fails which would limit its use. The quick fail of this project involved the existing theorem that only prime numbers of the form $2 \mathrm{kp}+1$ can possibly divide the Mersenne Number, $2^{\wedge} \mathrm{p}-1$. By incorporating this property, the program performed fewer operations and consequently consumed less time when testing for the primality of a Mersenne Number. The time and the number of operations required to divide each Mersenne Number, $2^{\wedge} p-1$, for $2 \leq p \leq 50,000$ by every prime less than $50,000,000$ using both the brute force method and the $2 k p+1$ method were recorded. The brute force times increased linearly to over two minutes while the $2 \mathrm{kp}+1$ times remained constant at around 0.4 seconds. The number of operations required for brute force increased to a constant $3,001,134$ while the operations required for $2 k p+1$ quickly decreased to under 1,000 and less than 100 for larger $p$.

Awards Won:<br>National Security Agency Research Directorate : Honorable Mention in Mathematics

