On The Great Internet Mersenne Prime Search (GIMPS)

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Abstract

This article is regarding the author's experiences and opinions on the project GIMPS. This is a personal memo and also an appeal to educational institutes.

1 Introduction

The GIMPS (Great Internet Mersenne Prime Search) project was started in 1996 by George Woltman. If anyone has been aware of recent math news, one would know that, **the current biggest known prime number** which is exactly:

$$2^{136279841} - 1$$

is a behemoth with **41,024,320 digits**. This was recently discovered by Luke Durant on Oct 21 2024. One can see about this on their official website of the GIMPS project `https://www.mersenne.org/`.

1.1 The Math, Introduction

OK, But what are these $2^n - 1$ numbers? (They are.. well known formally as Mersenne Numbers) Why did we only know about this one? Not something different? Why not $a^b + k$? To learn this, one must know about **Mersenne Numbers and Mersenne Primes**.We will list some important theorems, without proof of course, as finding proofs to these theorems is not that hard by using the internet.

- If $2^p - 1$ is **PRIME** implies p is also **PRIME**.
- Every even perfect number is of the form: $N = 2^{p-1}(2^p - 1)$

Okay.. So, one might ask? What is a perfect number? Well, certainly must be *perfect?* Yes there is something "perfect". See, take the sum of positive

factors/divisors of a number, and exclude the number itself.... Take this sum as "D" Then: any Perfect Number N has this property

$$N = D$$

For example, take N = 6. Divisors? 1,2,3,6... D? 1+2+3=6! So its a perfect number! Ok, by theorem 2 that we listed, $N = 2^{p-1}(2^p - 1)$... Ok, so take p = 2.. we easily see that, $N = 2^1(2^2 - 1) = 2 \cdot 3$, hence, our first Mersenne prime is 3!

Ok, so... we know, now, what are mersenne numbers and perhaps one reason why we are working to find them, to obviously get our sweet perfect numbers!

1.2 Suggested Reading

We suggest the reader to read these to gain more insights on the math behind Mersenne Numbers:

- `https://en.wikipedia.org/wiki/Mersenne_prime#Perfect_numbers`
- `https://www.mersenne.org/various/math.php` For Research strategy of GIMPS
- Elementary Number Theory by David M. Burton for more Number theory!

2 Why should I care?

This section, we work to answer this question and perhaps convince the reader, to why should they care. We will put our favorite answers from this source `https://www.mersenne.org/why_join/`:

- Mersenne primes, which are usually the largest known primes, are both rare and beautiful. Since Euclid initiated the search for and study of Mersennes approximately 300 BC, very few have been found. Less than fifty in all of human history—that is rare!

  But they are also beautiful. Mathematics, like all fields of study, has a definite notion of beauty. What qualities are perceived as beautiful in mathematics? We look for proofs that are short, concise, clear, and if possible that combine previous disparate concepts or teach you something new. Mersennes have one of the simplest possible forms for primes, 2(power)n-1 The proof of their primality has an elegant simplicity. Mersennes are beautiful and have some surprising applications.

- Why do athletes try to run faster than anyone else, jump higher, throw a javelin further? Is it because they use the skills of javelin throwing in their jobs? Not likely. More probably it is the desire to compete (and to win!). This desire to compete is not always directed against other humans. Rock climbers may see a cliff as a challenge. Mountain climbers can not resist certain mountains.

Look at the incredible size of these giant primes! Those who found them are like the athletes in that they outran their competition. They are like the mountain climbers in that they have scaled to new heights. Their greatest contribution to mankind is not merely pragmatic, it is to the curiosity and spirit of man. If we lose the desire to do better, will we still be complete?

These are the non technical reasons one could pick out... But, still the author resonates with this one more. Anthropomorphic personification. We highly recommend the reader to check the link out. (the why join one). This one reason we highly resonate with, may feel weird to a comparatively non mathematical audience, but its surely weirdly personal.

3 Anthropomorphic personification. Math and Emotions.

This section is a simple personal memo, but this displays that math is not always about rigor and dryness, its also about emotions. So, before starting, we quote other lines from `https://www.mersenne.org/why_join/`

"GIMPS is a different sort of project for it is slow and deliberate. The work units are so unlike most others projects' that we don't even call them work units at all. We call them exponents or assignments because the term 'work unit' isn't personal enough."

"All the while you watch it slowly mature. The exponent ceases to be a mathematical representation of an integer but instead takes on a life all its own. It is a life that you and your computer nourish with CPU cycles. Even though you know that only a tiny fraction of the Lucas-Lehmer test could possibly have been performed, you check on it several times a day just in case something goes wrong. You get to know it like a friend. "

Sure enough, in our experience, its true. Lets see my example. I've taken the **solo** testing (PRP - Probable Prime Test) of M830986829. `https://www.mersenne.org/report_exponent/?exp_lo=830986829&full=1` That is, whether:

$$M_n = 2^{830986829} - 1$$

is prime or not. Its surely a huge number.. With **250,151,962 digits**. So, with my intel i5 processor. This will probably take, **7 years**. But why? One can ask? Why work on this one? 7 years is too much time.. Sure enough, you are right! But I can't explain why I am doing this?Probably, something personal and solitude environment.

4 Appeal to Educational Institutes

In this section, we present an appeal to educational institutes, and ask them to donate their idle CPU cycles to GIMPS. I am quite sure, there are a quite lot of idle, and unused desktops in some educational institutes. Atleast, in our school we can see quite some.

4.1 1. Why should the institute care?

Simple reasons!

- For schools, develop interest in students for mathematical research and actually allow them to participate in it.
- For other higher level universities, contributing to mathematical research!
- For all, Having a chance to find a Mersenne prime! And a perfect number too.

As far as we think, I would do suggest that the first reason is quite important, but is overlooked. Sometimes we forget school's primary purpose, "to develop interest in a field/subject in the minds of the student" and focus on Marks and grades and CGPAs and boards and...

4.2 2. It will take too much resources?

Simple answer, No. It will not. GIMPS software is primarily designed to use idle CPU cycles, so it doesnt interfere with regular work. Even one system is enough to make a difference.. As far as electricity costs go... To be frank, they can be considered trivial. As they too add, but as we mentioned, a single system can make the difference, and its costs should be manageable.

4.3 3. It would be hard to setup?

No, GIMPS software is not at all hard to setup, and would take less than 10 min/20min for any individual.

4.4 4. Overheating? No internet in all the PCs? No modern OS?

We answer these questions too.. 1. For the issue of overheating, if persisting, one can use simple software like BES (Battle Encoder Shriase)

`https://mion.yosei.fi/BES/` which is a free open source software to limit and target any application and limit its run time to lower overall CPU usage. Both GIMPS's prime95.exe and BES.exe are super simple to install. And both can run in the background.

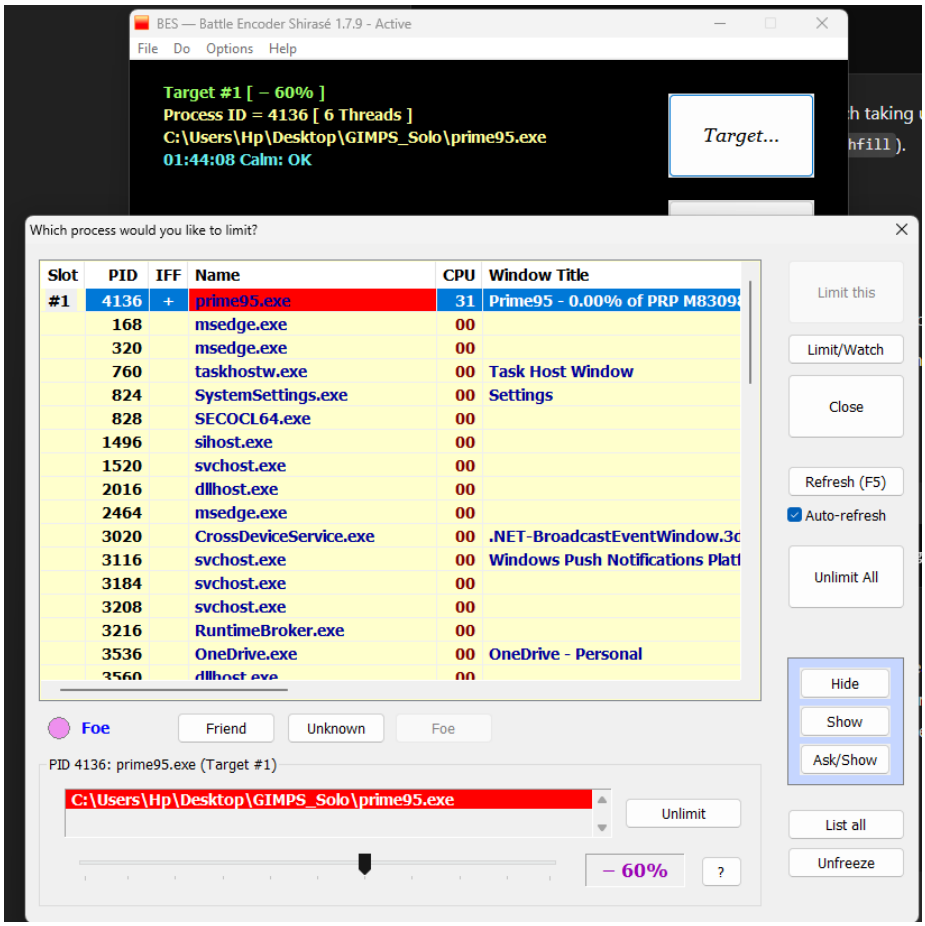

Figure 1: Images of BES software.

2. About No internet? Simple, it only requires one pendrive and only one system with internet. See `https://www.mersenne.org/manual_assignment/`. One can install GIMPS on the system with no internet, and can run either solo PRPs which take time, or can run GIMPs Manual assignments to be an active member!

3.No modern Os? NO problem! GIMPS will run on many of these OS, (it started in 1996, so they know it)

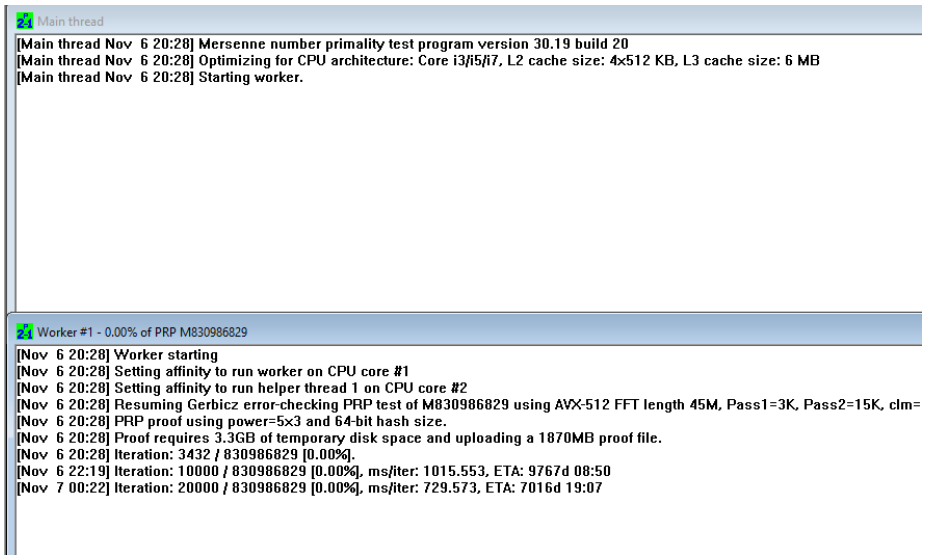

Figure 2: Images of GIMPS prime95.exe software, with our previously mentioned PRP test running

4.5 5. It will take up too much time?

No, with a bit of luck, anything is possible! See:
" 51st Known Mersenne Prime Found! December 21, 2018 — The Great Internet Mersenne Prime Search (GIMPS) has discovered the largest known prime number, 282589933-1, having 24862048 digits. A computer volunteered by Patrick Laroche from Ocala, Florida made the find on December 7, 2018. The new prime number, also known as M(82589933), is calculated by multiplying together 82589933 twos and then subtracting one. It is more than one and a half million digits larger than the previous record prime number.

GIMPS has been on amazing lucky streak finding triple the expected number of new Mersenne primes – a dozen in the last fifteen years. This prime was even luckier for Patrick Laroche, **striking pay dirt on just his fourth try**. For years, Patrick had used GIMPS software as a free "stress test" for his computer builds. Less than four months ago he started prime hunting on his media server to give back to the project. **By way of comparison, some GIMPS participants have searched for more than 20 years with tens of thousands of attempts but no success. This proves that, with luck, anyone can find the next new Mersenne prime.** "

5 Conclusion

We hope we convinced you to donate your CPU cycles to the GIMPS project.. We would like to end off with..

In fifty words or less... Idle hands are the devil's playground, as too are idle CPU cycles. If you are still reading this then you must agree. The only choice left is where to put your allegiance. Please consider joining GIMPS today.