ColAUMS Space

ADELAIDE UNIVERSITY MATHEMATICS SOCIETY

Newsletter of the AUMS | Issue 1, 2020

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SCAN ME

Welcome to ColAUMS

Hello everyone and welcome back to another year of ColAUMS Space, I hope to continue the brilliant work of Alex Schutz and present to you everything from puzzles out of 60 year old maths books I bought for $1, to great articles and hopefully even contributions by you guys, the AUMS community. This newsletter will also have information about upcoming AUMS events so stay posted online at the AUMS website or grab yourself paper copy from AUMS activities. Also check out our new INSTAGRAM! (click the link in the Contact details section). - *George Savvoudis, ColAUMS Space Editor*

President's Address

Hey People! ColAUMS is here to stay for 2020. For anyone reading this for the first time, ColAUMS is the one thing you've always wanted, if that one thing is a newsletter frequently serving up amazing maths trivia and puzzles.
If you've never heard of AUMS before, then let me blow your mind for a second. With an AUMS membership, you'll receive free food our BBQs which we hold 4 times a year. We also have an a large pub crawl coming up, with later in the year a fiercely competed quiz night and a fancy cocktail night (that gets significantly less fancy as the night goes on). Members receive discounts to these events, which involve the amazing AUMS community. You'll be able to meet them at our board games nights and our student talks. Both events involve free pizza which, let's face it, is a reason to go on its own.
All of this comes with the AUMS membership for only $5, which according to the Australian Governments standards on minimum wage, is worth only 15 minutes of your time. So you just gotta ask yourself, did you spend the last 15 minutes having as much fun as you could with AUMS?
But in all seriousness, the AUMS family has been the coolest group of people during my uni experience, and I want to thank them all for being welcoming and helpful. 2020 should be a great year for all of us, and for those new to AUMS, we'd love to have you along for the ride. - *Josh Price, AUMS President*

Optimising Cookie Clicker - and Getting it Wrong

Do you remember Cookie Clicker? For those that don't, back in 2013 Julien "Orteil" Thiennot created a simple browser game that took the world by storm. The game is all about producing as many cookies as possible, and with those cookies, buying "buildings" and upgrades to help increase your CPS (Cookies per Second) and get even more cookies. On the surface it does not appear incredibly complicated, in fact, the first version of the game was coded in a night, however it does present us with an interesting optimisation problem. "Should I wait, to buy a factory? or should I buy a private army of Grandmas?"

My first attempts were somewhat promising. Suppose you are initially producing m CPS and you can only chose to pick one of two options: "A" which costs "a" cookies and increases your CPS by Δm_a or "B" which costs "b" cookies and increases your CPS by Δm_b. Let $a < b$ and $\Delta m_a < \Delta m_b$ Assuming a and b are constant (They aren't) I could show that continuously buying A outperforms B if (but not only if)

$$b > a\left(\sum_{i=0}^{\frac{\Delta m_b}{\Delta m_a}} \frac{m}{m+i\Delta m_a}\right)$$

. The cracks in my attempt begin to show. If aiming for a certain value of cookies, x, as quickly as possible the method changes. Assuming you are only buying one type of building, you should buy the largest number of buildings, n such that

$$n \leq \frac{x}{a} - \frac{m}{\Delta m_a} + 1$$

. Beyond those two findings, I was stumped. Eventually I found a reddit page and a comment by u/Bobshayd in which he reasoned that the optimal building order at any time, when comparing two buildings, is the one that would buy both the buildings quickest. Which is to say, a is the optimal choice if

$$\frac{a}{m} + \frac{b}{m+\Delta m_a} < \frac{b}{m} + \frac{a}{m+\Delta m_b}$$

This can be re-arranged to give the formula

$$a\left(\frac{m}{\Delta m_a}+1\right) < b\left(\frac{m}{\Delta m_b}+1\right)$$

This problem embodied two of the things I love most about maths.

Firstly, I love how seemingly simple problems can become challenging extraordinarily quickly until that moment of clarity which brings the whole thing together.

Secondly, I love how sometimes I pick up a problem, don't know quite how to solve it at the time, and then one day I either see a solution to it, or I hear that one piece of information that unlocks the whole thing. Yes, occasionally I wonder why I didn't think of the solution, but nobody derived all of mathematics alone.

- George Savvoudis

Puzzle: The 6 Beetles This puzzle is a modified version of one that appears in *"Mathematical Puzzles and Diversions"* by Martin Gardner. 6 beetles are placed at the corners of a regular hexagon. Each beetle chases the beetle adjacent to it, such that no two beetles are running directly towards each-other, and all the beetles paths trace a spiral towards the centre. Assuming that each beetle travels at the same constant speed, how long will the spiral path be relative to the length of each side of the hexagon? Can this be generalized for an n-sided shape?

Historical Profile: Niels Henrik Abel

Best known for proving that the general quintic equation cannot be solved in radicals, Niels Henrik Abel was Born in 1802 in Finnøy, Norway. Abel spent most of his life struggling financially despite letters from Legendre, among others, to King Charles XIV of Sweden and Norway. He died aged 26 from pulmonary tuberculosis. Many at the time blamed the lack of financial support by the scientific and mathematical institutions of the time for Abel's death. His image briefly appeared on the Norwegian 500-kroner banknote from 1978-2984.