1. Finance:
    - Write a 500-word explanation of Bitcoin stock-to-flow model and make an argument for why it is a bad model?

The Stock to flow model quantifies scarcity by taking the total global supply of a commodity and dividing it by annual production. A higher value would mean that less supply is entering the market. It translates into more scarcity and less inflation. In other words, it is a way to measure the abundance of a particular resource.

PlanB, author of the stock to flow model's paper "Modeling Bitcoin Value with Scarcity" states that certain precious metals have maintained a monetary role throughout history because of their unforgeable costliness and low rate of supply. For example, gold is valuable both because new supply (mined gold) is insignificant to the current supply and because it is impossible to replicate the vast stores of gold around the globe. PlanB then argues this same logic applies to bitcoin, which becomes more valuable as new supply is reduced every four years, ultimately culminating in a supply of 21 million bitcoin.

The stock to flow model attempts to value bitcoin in a way similar to other scarce assets like gold and silver. Gold and silver are often called store of value resources because they should be able to retain their values in long term due to scarcity and low flow. Bitcoin is a similar resource, it is scarce, costly to produce and its maximum supply is 21 million coins.

Also bitcoin's supply is defined on a protocol level, which makes the flow completely predictable and also the amount of new supply entering the system is halved every 210,000 blocks (about 4 years) is known as bitcoin halvings.

According to advocates of this model, these properties combined create a scarce digital resource with compelling characteristics to retain value over the long term. There's an assumption that there's a statistically significant relationship between stock and flow and market value. According to the stock to flow model, bitcoin's price should see a significant rise over time due to its continually reduced stock to flow ratio.

WHY IT IS A BAD MODEL

While the stock to flow has received a lot of praise and it is the leading valuation for model for bitcoin it has several limitations.

According to coin desk, from a theoretical point of view, the model is based on the rather strong assertion that the USD market capitalization of a monetary good (e.g. gold and silver) is derived directly from their rate of new supply. No evidence or research is provided to support this idea, other than the singular data points selected to chart gold and silver's market capitalization against bitcoin's trajectory.

For measuring scarcity, it doesn't take into account for all parts of the picture. The model relies on the assumption that scarcity should drive value but according to critics of the model, it fails if bitcoin doesn't have any other useful qualities other than supply scarcity.

Models are only as strong as their assumptions, and it doesn't take into account all aspects of bitcoin's valuation. Since the model is a long term valuation model, one might argue it needs larger dataset for reliable accuracy because at the time of writing the model bitcoin has only been around for 10 years.

- Yara Inc is listed on the NYSE with a stock price of $40 - the company is not known to pay dividends. We need to price a call option with a strike of $45 maturing in 4 months. The continuously-compounded risk-free rate is 3%/year, the mean return on the stock is 7%/year, and the standard deviation of the stock return is 40%/year. What is the Black-Scholes call price?

Given C = Call option Price, S = Current Stock Price, X = Strike Price, r= Risk-free interest rate, t = time to maturity, N = a normal distribution, δ = standard deviation

$$C = S_t\,(N_{(d1)}) - Xe^{-rt}(N_{(d2)})$$

$$\text{Where } d_1 = \ln(S_t/X) + (r + \delta^2/\ 2)t\ /\delta^*\ \sqrt{t}$$

$d_2 = d_1 - \delta * \sqrt{t}$

S = $40, X = $45

δ= 40% = 0.4

t = 4/12 = 1/3,

r = 3% = 0.03

$$d_1 = \frac{\ln(40 / 45) + (0.03 + 0.5(0.4)^2)\ (1/3)}{0.4 * \sqrt{1/3}}$$

$$d_1 = \frac{-0.1178 + (0.03 + 0.08)\ (0.3333)}{0.4 * 0.5773}$$

$$d_1 = \frac{-0.1178 + (0.11)\ (0.3333)}{0.2309}$$

$$d_1 = \frac{-0.1178 + (0.03666)}{0.2309}$$

$d_1 = -0.08114 / 0.2309$

$d_1 = -0.3514$

$d_2 = d_1 - \delta\sqrt{t}$

$d_2 = -0.3514 – 0.4 * \sqrt{1/3}$

$d_2 = -0.3514 – (0.4 * 0.5773)$

$d_2 = -0.3514 – 0.2309$

$d_2 = -0.5823$

To get the standard normal distribution table, we approximate d_1 and d_2 to 2 decimal points

$N_{(d1)} = 0.3632$

$N_{(d2)} = 0.2810$

$C = S_t (N_{(d1)}) – Xe^{-rt}(N_{(d2)})$

$e^{-rt} = 1/e^{rt}$

$C = 40(0.3632) – ((45) / (e^{0.03 * 0.3333}) (0.2810)$

$C = 14.528 – (45/ e^{0.009999}) (0.2810)$

C = 14.528 – (45/1.01) (0.2810)

C = 14.528 – (44.55) (0.2810)

C = 14.528 – 12.519

C = 2.009

Therefore, the Black-Scholes call price is $2.009.

2. Computer Science

    - Why is it a bad idea to use recursion method to find the Fibonacci of a number?

Using the recursion method to find the Fibonacci would give us a clean code but it is inefficient.

Recursion may cause memory overflow if your stack space is large, and is also inefficient in cases where the same value is calculated continuously.

When using recursion to find the fibonacci of a number, passing integers like 0,1,2,3,4,5 will give us the answer in a timely fashion, but when we start passing numbers like 50, 67, 100 and we try to run the function with the given numbers in our IDE. To run a space complexity (how much memory is needed at any point in the algorithm) analysis will be a tricky thing to do because of a lot of things happening behind the scenes of this recursive function.

So, it is a bad idea to use recursion method because the heavy push-pop of the stack memory in each recursive call causes poor performance.

3. Maths

   y = sqrt ((x+6)^2 + 25) + sqrt((x-6)^2 + 121)

   Solution

   $y = \sqrt{((x + 6)^2 + 25)} + \sqrt{((x - 6)^2 + 121)}$

   Square both sides to remove the square root

   $y^2 = ((x + 6)^2 + 25) + ((x - 6)^2 + 121)$

   Expand the brackets

   $y^2 = ((x+6)(x+6) + 25) + ((x-6)(x-6) + 121)$

   $y^2 = (x^2 + 6x + 6x + 36 + 25) + (x^2 - 6x - 6x + 36 + 121)$

   $y^2 = (x^2 + 12x + 61) + (x^2 - 12x + 157)$

   $y^2 = x^2 + 12x + 61 + x^2 - 12x + 157$

Simplify the above by collecting like terms

$y^2 = x^2 + x^2 + 12x - 12x + 61 + 157$

$y^2 = 2x^2 + 218$

Make Y the subject of formula by simplifying the above

$y = \sqrt{2x^2} + \sqrt{218}$

$y = x\sqrt{2} + \sqrt{218}$

The above equation is the simplest form, therefore the above has no minimum value