

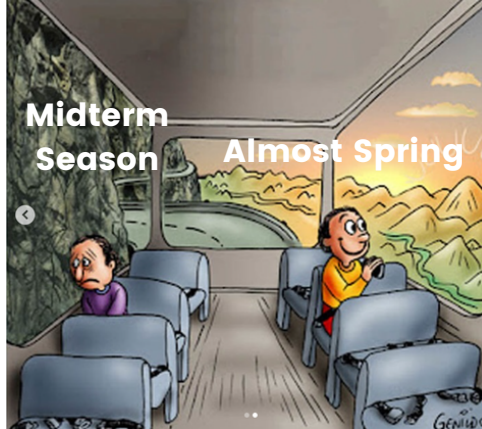


Queen's Gazette. (2015). Queen's embarks on two-year accessibility audit. <https://www.queensu.ca/gazette/stories/queens-embarks-two-year-accessibility-audit>

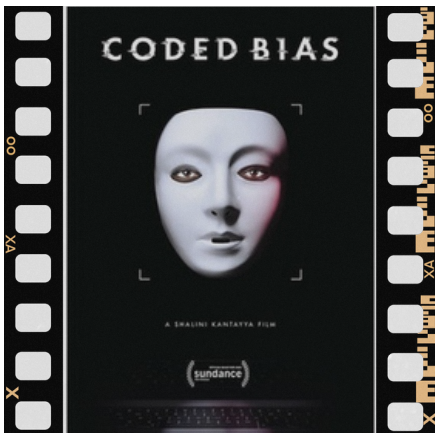
Quote of the Month

"Mathematics reveals its secrets only to those who approach it with pure love, for its own beauty." - Archimedes

Math Meme of the Month:



Math Show Recommendation



Coded Bias

In a change from previous month's recommendations, Coded Bias is a documentary. It details how biases can be encoded into AI and how this in turn means we need specific AI laws to avoid perpetuating this type of discrimination. Although it came out in 2020, and technology progresses fast, it is still relevant today, to learn how to avoid these biases ourselves, and what regulations we are still lacking.

Upcoming Events

Pi(e) sale
March 11th
12-3

Escape Jeffery
March 11th

Check our instagram
@queensmastdsc for
specific dates and
continuous updates

IGN. (2025). <https://www.ign.com/tv/prime-target>

Concept of the Month

In this month's newsletter, I will deviate from my trend of discussing pure math and instead discuss an applied math problem from Game Theory. At its core, Game Theory is the study of multi-player games in which all players want to play optimally while assuming that their opponents also want to play optimally. Let us establish the basic framework for a normal-form game. Consider a game with $k \in \mathbb{N}$ players. Let $N = \{1, \dots, k\}$ be the set of players. For each player $i \in N$, let $S_i = \{s_i^1, \dots, s_i^{n_i}\}$ denote player i 's strategy set. The set of strategy profiles is $S = \prod_{i \in N} S_i$, and each player has a payoff function

$$u_i : S \rightarrow \mathbb{R}.$$

A normal-form game is therefore $G = (N, (S_i)_{i \in N}, (u_i)_{i \in N})$. It is important to note that all players know each others strategy sets and associated payoffs. This definition is heavy on notation and confusing at first so we will solidify it with an example, the **Prisoner's Dilemma**. Two players (Player 1 and Player 2) simultaneously choose either Cooperate (C) or Defect (D). We have the set of players $N = \{1, 2\}$ and $S_1 = S_2 = \{C, D\}$. Our payoff functions for both players can be defined clearly in a payoff matrix (payoffs displayed as (player 1, player 2)):

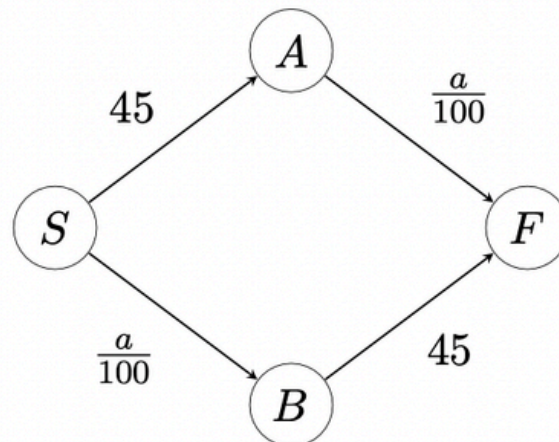
	<i>C</i>	<i>D</i>
<i>C</i>	(2, 2)	(0, 3)
<i>D</i>	(3, 0)	(1, 1)

Here we see that, $u_1(C, C) = 2, u_2(C, D) = 3$, etc. Now, I will introduce the most important idea in game theory, the **Nash Equilibrium**. Put simply, a **Nash Equilibrium** is a state where no one can improve their payoff by changing only their own strategy. Formally, a strategy profile $s^* = (s_1^*, \dots, s_k^*) \in S$ is a Nash equilibrium if no player can gain by unilaterally deviating.

Formally, for every player $i \in N$,

$$u_i(s_i^*, s_{-i}^*) \geq u_i(s_i, s_{-i}^*) \quad \text{for all } s_i \in S_i.$$

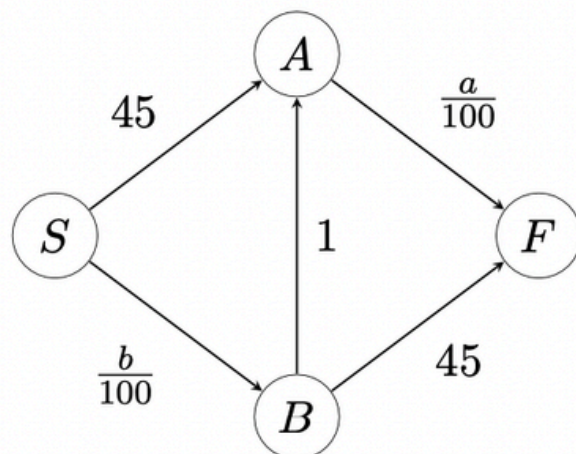
Nash equilibrium need not be unique. In our example we see that $s^* = (D, D)$ is a unique Nash equilibrium. Under s^* , we see that if either player were to deviate from their strategy and play *C*, they would decrease their payoff from 1 to 0. Now, although (C, C) may also seem like an optimal solution, if either play deviates to play *D*, their payoff would increase from 2 to 3. Since these profitable deviations exist, (C, C) is not a Nash equilibrium. We think of a Nash equilibrium as an outcome that naturally arises when rational, self-interested players each choose their best response to the others. We now should have sufficient machinery to introduce and tackle **Braess's paradox**. Here is the setup: We have 4000 commuters ($N = \{1, 2, \dots, 4000\}$) traveling from city *S* to city *F*. They may travel through city *A* or city *B* to reach *F*. Roads *SA* and *BF* have travel times of 45 minutes, roads *SB* and *AF* have travel times $\frac{b}{100}$ and $\frac{a}{100}$ respectively. Since commuters can only either travel along *SBF* or *SAF*, it must be that $a + b = 4000$. The diagram should make this setup clear.



Since travelers can either choose *SBF* or *SAF* we have the payout functions, for any player i , $u_i(SBF) = -(45 + \frac{a}{100})$ (player i chooses *SBF*) and $u_i(SAF) = -(45 + \frac{a}{100})$ (player i chooses *SAF*). We define payoffs as the negative of travel times so that better outcomes correspond to higher payoff values. Since shorter travel times are preferable,

taking the negative allows us to model preferences in the standard “higher is better” framework. Now, for this traffic scenario to be in a Nash equilibrium, it must be such that $u_i(SAF) = u_i(SBF)$ for every player i . This is because if one travel time were to be shorter, players would always profitably deviate to the faster route. Since players have no profitable deviations in a Nash equilibrium, neither route can be quicker than the other, thus both routes have the same travel time. Therefore we have $45 + \frac{a}{100} = 45 + \frac{b}{100}$ which implies $a = b$. Since $a + b = 4000$, we have $a = b = 2000$. Thus 2000 people choose to travel on SAF and 2000 people choose to travel on SBF . Every player will have the same travel time of $45 + \frac{2000}{100} = 65$.

Now, let’s suppose city officials wish to improve commute times from S to F . As such, a super highway that allows travel from B to A is built with a constant travel time of 1. See our new diagram.



With our new setup, travelers now have three different route options: SAF , SBF , and $SBAF$. For each route and player, we have associated payoffs (i.e negative travel times) of $u_i(SBF) = -(45 + \frac{b}{100})$, $u_i(SAF) = -(45 + \frac{a}{100})$, $u_i(SBAF) = -(1 + \frac{a+b}{100})$. Notice that it is no longer that $a + b = 4000$ because if travelers take $SBAF$, they contribute to a and b . Our previous Nash equilibrium of $a = b = 2000$ no longer holds because in this case, a player taking SBF could deviate to $SBAF$ to reduce their travel time from 65 minutes to $\frac{2000}{100} + 1 + \frac{2001}{100} = 41.01$ minutes. In fact, AB is such a fast highway that every rational commuter will choose to take it. This occurs because at worst, SBA will take $\frac{4000}{100} + 1 = 41$ minutes but SA will always take 45 minutes. Similarly, BAF take $\frac{4000}{100} + 1 = 41$ at it’s worst but BF always takes 45 minutes, thus no one will take BF . Thus we have a Nash equilibrium at $a = b = 4000$ (everyone take $SBAF$). If any commuter deviates to SBF or SAF , their travel time would increase by around 4 minutes, thus no profitable deviations exist. Paradoxically, we see that with the addition of our BA highway, our travel time for every player has now increased to $\frac{4000}{100} + 1 + \frac{4000}{100} = 81$ minutes. Now this paradox is not just theoretical, it has arisen in many cities. In Seoul South Korea in 2003, the Cheonggye Expressway was demolished and traffic around the city lessened. In 1990 the 42nd Street in Manhattan, New York City, was temporarily shutdown for Earth Day and it actually reduced the amount of congestion in the area. More recently, In 2009, New York experimented with closures of Broadway at Times Square and Herald Square. These closures improved traffic flow and have led to permanent pedestrian plazas. One may be tempted to frame Braess’s Paradox in a negative light; people’s selfish nature results in sub-optimal traffic congestion.

While people are undoubtedly self-interested, I would argue that this is inevitable when dealing with such a traffic situation. Communication between drivers is simply impossible and thus cooperation is impossible. I instead view Braess’s Paradox in a very positive light: we as a society have been able to use math to discover Braess’s paradox and then institute top-down solutions (i.e closing streets) to force “cooperation” between drivers, yielding optimal traffic solutions.

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Professor Spotlight: Thomas Barthelmé

Professor Thomas Barthelmé got into mathematics early and in the simplest but purest way, “I just always liked it.” He explained from the beginning in school he always liked math, and year after year he kept on enjoying math so there was never any reason to change.

Growing up in France Barthelmé, unlike many of us in math in Canada, was exposed to proofs and the character of what math really is in high school. As such, he did not experience the sudden shift from calculations in high school to proofs in university. Another testament to his natural enjoyment and commitment to mathematics.

After completing his undergraduate studies at the Université de Strasbourg, he continued there to receive both his master’s and Ph.D.

To us undergraduates, the thought of choosing a field of research is a daunting thought and quite frankly, feels like an impossible task. It’s overwhelming as we do not know enough math to make a choice. Because of this, Professor Barthelmé’s answer to how he got into his field of research was quite comforting. He notes that “... in other sciences, sometimes it’s easier to hear about a problem and get very interested in a specific type of problem.”, for example blackholes or quantum mechanics can be interesting and understood at an earlier stage. In math, however, Barthelmé explains as undergraduates we don’t yet know the kind of questions. As a result, he said he chose his research largely because of the people he met and did math with in at the Université de Strasbourg. Often, he explained you discover your direction through conversations and mentors. “If I had met different people” he admitted, “I might have ended up in different field.”. Ironically, math may be a much more social subject than the world perceives it as.

Today, Professor Barthelmé works in the intersection of geometry, topology, and dynamical systems. In simple terms, one area of his research is studying motion on curved spaces. A manifold, he explained, is a space that looks flat when you zoom in close enough, like the surface of the Earth. Standing in a field, the ground seems flat, but globally the Earth curves back onto itself. Mathematicians study spaces that behave like this in higher dimensions. Dynamical systems ask what happens when something moves on such a space over time. If you pick a starting point and let it evolve according to a rule, what does its path look like? Does it settle into a pattern? Does it wander unpredictably? One phenomenon that fascinates him is chaos, systems where extremely small differences in starting conditions lead to dramatically different outcomes. This “butterfly effect” behaviour is not rare and in fact, common.

Professor Barthelmé studies particularly structured examples of chaotic systems known as Anosov flows. These systems exhibit sensitive dependence everywhere in the space yet are governed by strong underlying geometric rules. One of the major open questions in his field asks which three-dimensional spaces can support such flows.

A recurring theme in his work is classification. When mathematicians encounter a new type of object, they ask: when are two of these objects essentially the same, and when are they fundamentally different? Developing tools to distinguish between systems, or to show that seemingly complicated systems all reduce to a single model helps bring order to complexity. Some conjectures in his field suggest a striking rigidity: under certain conditions, systems that appear wildly diverse may actually all fit into one simple framework. The possibility that apparent chaos hides hidden structure is



one of the ideas that drives his research.

When asked the classic question of math being invented or discovered, his answer was brutally short and honest. He claims he doesn’t know, nor does it matter, he said “... the key thing is I am having fun, increasing my knowledge...”, an evasive but honest and beautiful answer.

Later in the interview, Professor Barthelmé reflected on the balance between rigour and understanding in mathematical proofs. While mathematics ultimately requires complete justification, he noted that this is not how ideas first appear. The initial stages of research are often intuitive: you see why something should be true before every detail has been fully written down. What follows is a process of refinement. Arguments are clarified, gaps are filled, and the reasoning is strengthened, often through discussion within the mathematical community. Rigour is essential, but he emphasized that it must serve understanding.

It is possible to make a proof so technically detailed that the central idea becomes difficult to see. If every step is expanded to its most granular level, the mechanism that makes the argument work can disappear under layers of formalism. A good proof, he suggested, does more than verify correctness. It makes clear why something is true.

For him, mathematics is not entirely about being correct, but about presenting arguments in a way that others can follow, check, build upon and are beautiful.

For undergraduates considering research, his advice is simple, use the time to learn. Although undergraduates may not feel it now, Barthelmé says “... you’re very lucky to be fed the knowledge now.” And in the future, after undergrad, if you want to learn something “You have to do it on your own. It’s much harder.”. Although he made it clear the reward of the hard work after undergrad is profound. He articulated that “it is not that many times in life you can spend several years solving a problem.”, and few experiences compare to it.

For Professor Barthelmé, mathematics is not just a collection of results. It is the pursuit of structure within complexity, clarity within chaos, and beauty within logic. Whether studying motion on abstract spaces or exploring the boundaries between geometry and dynamics, the motivation remains the same: follow the question, the people, and see where it leads.

Industry Spotlight: Market Analyst

When exploring careers for after a Math or Statistics degree, there are such a variety of options. Our majors can be used to support so many other topics. This month, we'll be focusing on the business applications of Stats, specifically as it pertains to working as a marketing analyst.

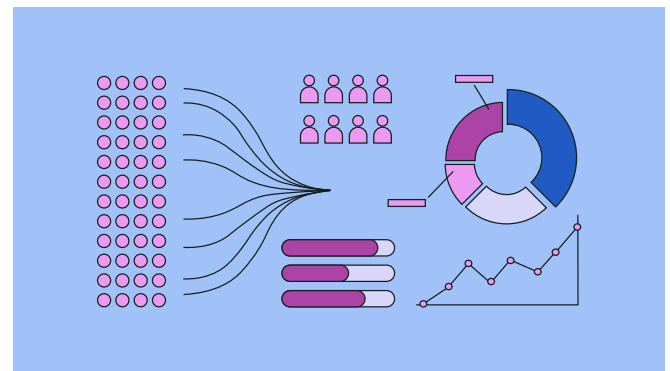
Market Analysts have a pretty self explanatory name. They work for an organization to analyze market data and customer trends, so that they can see what works, and make recommendations to the company that will help them improve their marketing.

A degree in statistics or even mathematics would work for a job like this. This is because many of the things you learn in a statistics degree are applied during this job. Data analysis and creating data visualizations using different programming platforms is essential. Then you have to turn these analyses into easily communicable company recommendations. Market Analysts also require research skills to stay current with trends and technologies. It also uses soft skills many Math and Stats students have like team work - especially when collaborating with other departments - and problem solving skills.

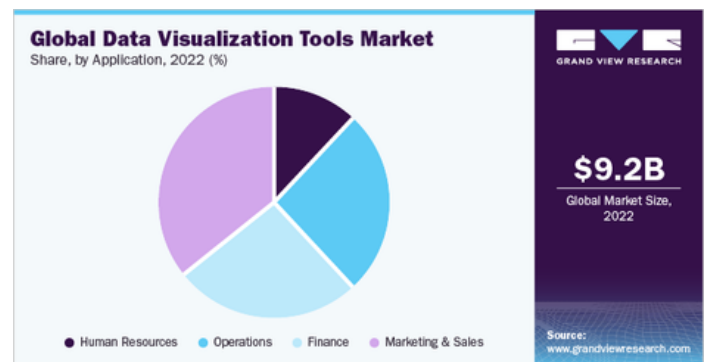
When progressing your career as a market analyst there is a pretty clear progression. To get a foot in the door it's good to have some marketing or research experience. Then you can start as a junior analyst where you will learn the ropes. Afterwards, you can move into a Marketing analyst position where you have more freedom, however, some of these positions may also require a graduate degree.

From there you can chose between many different paths, like growing into a senior analyst and supervising your own people, or becoming more freelance as a market consultant.

The Government of Canada predicts that the demand for market analysts is only growing, as companies rely more and more on predicting what people want in this rapidly changing world. If anything described above sounds interesting to you, from learning a bit more about business, to getting to put your analysis skills to the test, you may want to consider being a market analyst as a future career. Start brushing up on some economics and get out there!

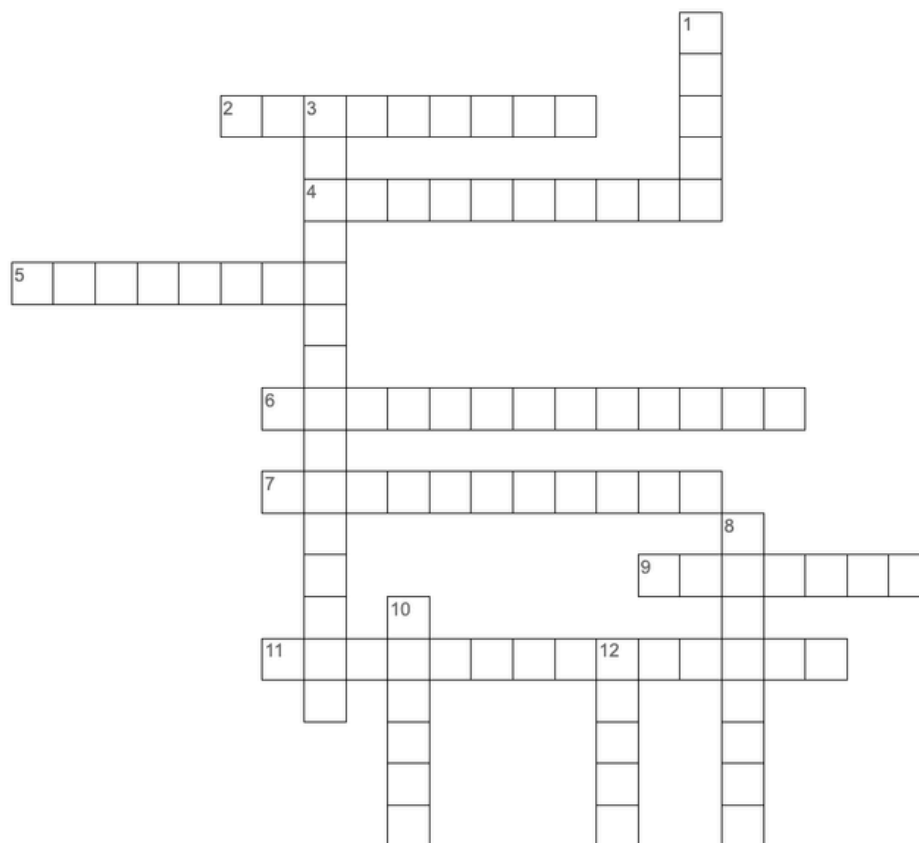


Zote, J. (2026). Unlocking Insight: the power of data visualization. <https://sproutsocial.com/insights/data-visualization/>



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Puzzle of the Month



Across

- 2 !
- 4 class of algorithms; also a famous casino
- 5 distribution used for statistical analysis of coin flips
- 6 type 1 error
- 7 critical value that is neither a local max or local min
- 9 unit of measurement for an angle, not degrees
- 11 a Canadian award for research in number theory

Down

- 1 a regression analysis method; also a cowboy's accessory
- 3 the follow up class to real analysis
- 8 opposite of subtraction
- 10 national survey happening this year (by StatCan)
- 12 month of pi day