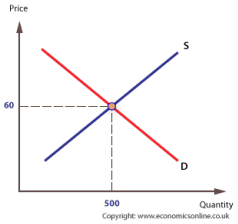
November 2016



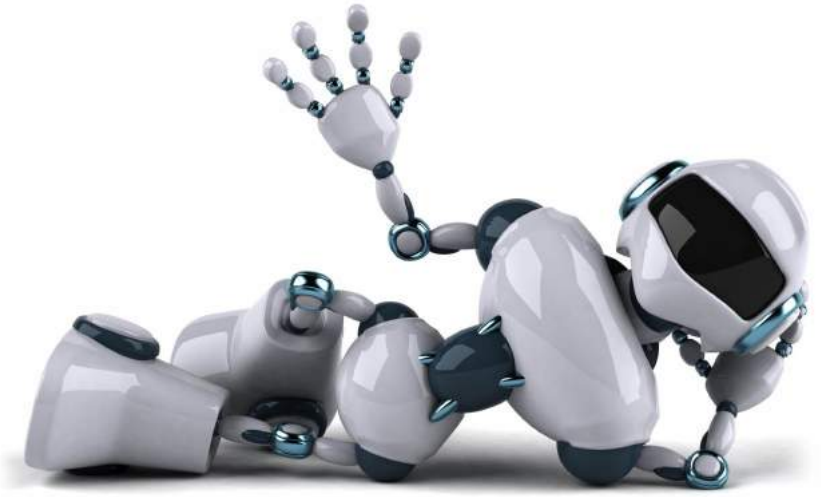
ECONOMIC EQUILIBRIUM

SLEEP AND ITS EFFECTS

HUMAN COLONISATION OF SPACE

S T E M

SCIENCE TECHNOLOGY ECONOMICS MATHEMATICS



Impact of Artificial Intelligence and Robots

Today, machines can indeed not only think based on the lines of what humans program them to think but also have their own creative skill set and think as to what is best for them. This coupled with their innumerable advantages over humans has positioned them as the backbone of the human industry. This is will cause a drastic change on humans and their work environment. This article explores some of these.

The Design of Penalty Shootouts

Question Everything

Contents:

From the Editors Desk:

Dear Readers,
Welcome the October 2016 Edition!!!!
This edition brings to you a number of interesting and informative articles. We begin with discovering the meaning of the most well known scientific equation ever and later follow on with the article that in points presents the challenges to human colonisation of space. Also in this section do not miss the informative essays on sleep or the dwarf plants.

On the technology side we have an interesting topic that explores the multidimensional impact of Robots and AI. This is also the cover article for the month. In the Economics Section football fans must not miss the article on the design of penalty shootouts and everyone must go through the economic equilibrium to get a basic understanding of economics.

This time in the maths section we explore some crazy mathematical theories and some even crazier scientists.

Lastly, do not miss the though provoking extra session that questions everything.

A little about me, I am currently the Academic Prefect of Daly College and am studying in Grade 12 CIE Science Stream.

I have changed the "E" from Engineering to Economics to accommodate my passion for Economics.

Lastly, I would like to thank my team without whose support none of this none of this would have been possible.

Hope You Enjoy the Magazine,
Tanmay Khandelwal,
Editor-In Chief and Founder,
STEM Magazine: The Daly College, Indore

S-SCIENCE

Einstein's Mass Energy Equivalence Equation

If You Knew This, Would You Feel Any Smarter ?

E=mc^2

E stands for energy. Energy is measured in joules (J), a unit for measuring energy like using inches or pounds to measure other things. How much energy is one joule? Not very much really. If you pick up a large apple and raise it above your head you will have used about one joule of energy. On the other hand, we use up huge amounts of energy every time we switch on a light. A 100 watt light bulb uses 100 joules of energy every second. Joule is named after the English physicist James Prescott Joule (1818–1889).

m stands for mass. For our purposes we can think of mass as the amount of matter (stuff) in an object like a rock or ball or even you! Mass is a measure of a body's resistance to acceleration. The greater the mass the greater the resistance to acceleration, as anyone who has ever tried to push a heavy object knows. So for everyone, the harder it is to push the object, the greater the mass and the greater the energy it would turn into.

c **stands for the speed of light in a vacuum**, like space. It probably comes from a Latin word *celeritas* that means speed. As far as we know, the speed of light never changes, so it's always the same or a "constant". *(we could be wrong)* The speed of light is very close to 300,000 kilometres per second. That's really fast.

2 stands for "square", a math symbol of multiplication. Since it comes after the speed of light, it mean we have to multiply the speed of light times the speed of light. So that would be 300,000 X 300,000. You can do that on your calculator. If I wanted to know how much energy is in an object...any object like metal, plastic, wood, rock or even a pizza, I would use this equation.

FAMOUS EQUATIONS

Maxwell's Equations: Explain all the known behaviours of electricity and magnetism and show the relationship between the two forces.

Certain Uncertainty Schrodinger Equations: illustrate how subatomic particles change with time when under the influence of a force.

Euler's Identity: Links together geometry, algebra, and five of the most essential symbols in math -- 0, 1, i, pi and e -- that are essential tools in scientific work.

Friedmann Equations: describe the life of the entire universe, from fiery Big Bang birth to chilly accelerated expansion death.

Boltzmann Entropy Formula: describes the tight relationship between entropy (S), and the myriad ways particles in a system can be arranged

Sleep and Its Effects

Sleep is something on which we nearly spend a third of our lives doing. However, the exact reason behind it is something that has baffled scientist for eternity. Sleep as defined the Oxford dictionary is, "to take the rest afforded by a suspension of

voluntary bodily functions and the natural suspension, complete or partial, of consciousness; cease being awake". This definition gives us the physical meaning of sleep but what is the really at the psychological level?

A good way to look at what sleep really does with us is to see **what would happen if we did not sleep.** Lack of sleep would cause our brain's ability to function to reduce. Just after we go through a night with no sleep we are irritable, forgetful and we have serious concentration issue. And if we continue this lack of sleep then the part of the brain that controls the language, memory and planning is severely affected.

Studies have indeed proven that staying awake for one night leads to a decrease in performance equivalent to being drunk. It has also been noted that sleep deprived individuals have slower congregative function and may also lead to high stress levels, obesity and high blood pressure.

What Happens when we Sleep: Sleep is divided into REM (Rapid Eye Movement) and non-REM sleep, occur in recurring cycles of 90 to 110 minutes each. During the first stage, we are half awake and half asleep and our body functions are normal. In the second stage our heartbeat decreases and our breathing slows, we are now asleep. This is followed by the fourth and fifth stages, which occur for about 50 minutes in which we are in deep sleep with minimal heart rate, muscle activity and breathing pattern that is why when we are woken from deep sleep, we feel groggy and disorientated for a few minutes. Sleepwalking, bed-wetting and night terrors occur during this stage. At about 70 to 90 minutes into sleep we go into REM sleep, which as the name suggests is a period when our eyes dart around while our body is paralysed, effectively preventing us from acting out our dreams. This occurs 4 to 6 times a night and after which the whole cycle begins.

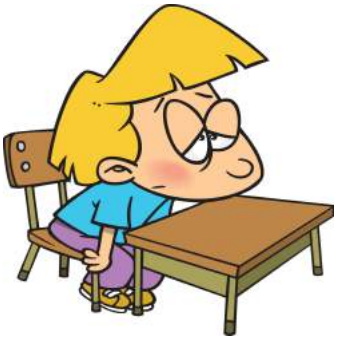
FUN FACT AND ANIMAL SLEEP

- Man is the only mammal that willingly delays sleep.
- The current world record for the longest period without sleep is 11 days, set by Randy Gardner in 1965
- Napoleon, Florence Nightingale and Margaret Thatcher got by on four hours a night.
- The animal that sleeps the most is the Koala (22 hours a day) and the animal that sleeps the least is the giraffe with only 1.9 hours of sleep a day.
- We naturally feel tired at two different times of the day: about 2:00 AM and 2:00 PM. It is this natural dip in alertness that is primarily responsible for the post-lunch dip.

Sleep and the Brain: During the time we are asleep our brain activity reduces and the brain uses this time to process information helping us make decisions the next day. It also creates and consolidates the memories, makes surprising creative connections and remembers the physical tasks performed during the day. The brain also

uses this time to clear out toxins and repair the damaged nerve damaged connections.

How much Sleep: People sleep from 5 hours a day to 11 hours a day with the average human sleeping 7.75 hours a night.



Human Colonisation of Outer Space

Ever since humans have walked on the surface of Earth, they have always tended to travel the lands and voyage the seas; in search of new lands, for the basic need of survival, colonise, trade, and to establish intercultural dialogue. With conflicts raging across the planet with multiple sides armed with nuclear weapons, the existence of human life on earth does not seem to be very safe. As the population keeps on booming, it would keep on depleting the resources, widening the span of poverty and crimes each day.

Even if our civilisation magically survives the next 5 billion years, the Sun would swell into a red giant star and raise the temperature on Earth to inhabitable levels. And thus there is a contemporary need to explore outer space, essential for the survival of human race; after Earth. It thus becomes all the more important to trigger exploration of humanity beyond Earth and give wings to inter planetary travel. Space travel, however, is a difficult, dangerous, and maybe an impossible project I have listed out the 6 greatest challenges in space travel.

Challenge 1: Gravity and Fuel Costs

Just to launch the Mars Curiosity Rover, it cost NASA $200 million. This was nearly a tenth of the mission's cost. When a spacecraft blasts off, the gravity of Earth works against its flight. In fact, Earth's escape velocity is roughly 11.2 km/s (33 Mach). To obtain such a velocity, tremendous amounts of the expensive rocket fuel is needed. And when humans travel into outer space, the spacecraft's weight will be hugely increased to accommodate even the most basic means of life support forget about utilities and amenities of daily life.

Challenge 2: Enormous Distances

India's Mars Orbiter Mission took approximately 11 months to reach Mars. The challenge is that with present day technologies, space travel takes immense amounts of time. Just to give you an idea of the size of our cosmic neighbourhood, the distance between Jupiter and the Sun is roughly the same as between Jupiter and Saturn; and we aren't over with the solar system yet.
And with humans onboard, a space voyage beyond,

SOME COMPARATIVE COSTS

- The cost of Apollo 11, the mission that put man on the moon, was estimated to be $ 135 Billion in today's money.
- One ExtraVehicular Mobility Unit or in simple terms SpaceSuit costs over $ 12 Million to make.
- NASA spent $ 2.4 Million in making a special space pens that would work in a vacuum with zero gravity under extreme temperatures.

something like Neptune only could potentially be multi-generational.

Venus	25.8MILLION
Mars	48.6MILLION
Mercury	57MILLION
The Sun	93MILLION
Jupiter	390.6MILLION
Saturn	777MILLION
Uranus	1.69BILLION
Neptune	2.7BILLION

Challenge 3: Space Debris

Now imagine this, you've finally launched a rocket into orbit. You are about to wander into outer space and a sharp piece of broken satellite comes out of nowhere and destroys your fuel tank. End of the space program! The problem of space debris can't be neglected. The US Space Surveillance Network identifies 17,000 objects—each one of them of the size of a basketball and larger and roughly 500,000 objects enough to inflict noteworthy damages—hurtling around Earth at speeds of more than 28,000 kmph. Spacecraft systems are so delicate that even a small piece of paper can cause major systems to go down.

Challenge 4: Food and Water

To our misfortune, McDonalds never thought of setting up an outlet in the outer space. It is extremely expensive to stock up space-food in rockets for the astronauts. Not that food is costly but because it can take up a lot of the valuable space in a space-craft. More importantly, the increased weight of craft because of the supplies can greatly increase the amount of fuel needed, especially for long distance journeys.

For extensive colonisation of outer space, large-scale crop production on other planets is essential. In micro-gravity, water doesn't penetrate the soil. It instead floats away in bubbles. Space farming is one of the greatest challenges we will face. There is however, some good news too. Thanks to the water reclaimer, urine can be directly converted to drinking water, recycling to amazing efficiencies.

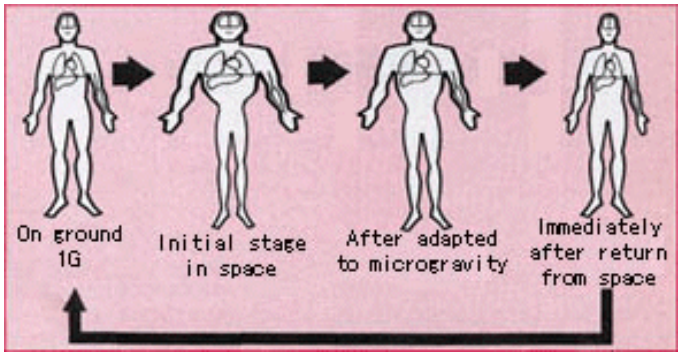
Challenge 5: Harmful Radiation

Earth is safe; credits to the atmosphere and the magnetosphere. But outer space lacks both of them. The Sun (like all stars) emits ionising, sub-atomic particles moving close to the speed of light; this is what we call the cosmic radiation.

Moreover, the spacecraft's hull is made from Aluminium. When such deadly particles collide with the hull, the nuclei of the particles split and cause them to emit secondary radiation, which is deadlier. Such radiations are directly linked to cataracts, cancer and Alzheimer.

Challenge 6: Micro-Gravity and Weakness

Space is a harsh environment that affects the body in many ways. Prolonged exposure to weightlessness increases the risks of kidney stones and bone fractures, and both are associated with bone demineralisation.
There is loss of muscle mass, strength and endurance, especially in the lower extremities. Changes in muscle performance, coupled with the effects of microgravity on connective tissues and the

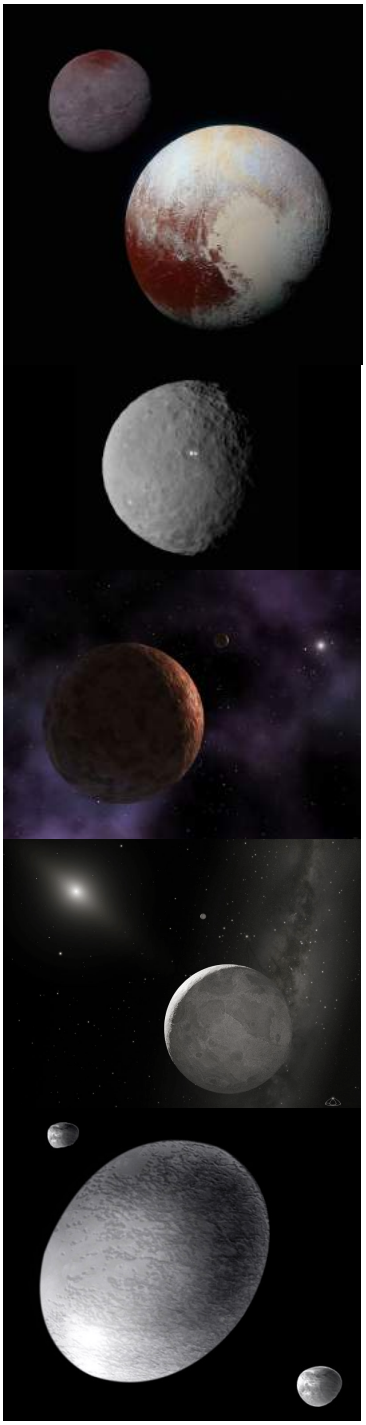


demands of activities of varying intensities, place astronauts at risk of fatigue and injury.

Thus, it is true that one day, due to uncontrolled exploitation of resources, human will have to leave Earth as a whole, in search of life elsewhere. Eventually, Earth will become overcrowded and overextended. And if that day has to come, we must brace ourselves.

"Humanity is a butterfly, Earth is its cocoon".

THE DWARF PLANETS



From Top: Pluto, Ceres, Eris, Makemake and Haumea

In 2006 the International Astronomical Union adopted the term 'dwarf planet' for solar system objects that were bigger than small solar system bodies such as comets and asteroids but not quite planets. The definition of a dwarf planet is an object orbiting the Sun that is large enough to be rounded by its own gravity but is not gravitationally dominant in its orbital area and is not a moon.

As of 2008, there are five recognized dwarf planets: Pluto, Ceres, Eris, Makemake & Haumea.

There are a number of other candidates for the status of dwarf planet. Some of these classifications could be resolved as NASA's Dawn and Horizon missions venture towards Pluto in the coming years.

Pluto: Pluto hit the headlines in 2006 when it was demoted from a planet to a dwarf planet by the International Astronomical Union. While most astronomers agreed with the new classifications, some disagreed and still refer to Pluto as the ninth planet. It is 1187 KM wide and is thus the largest Dwarf Planet. Pluto has a moon called Charon that has a mass similar to Pluto thus

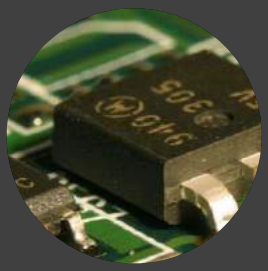
Ceres: It is located in the asteroid belt between the orbits of Mars and Jupiter. It was discovered in 1801, well before Pluto and 45 years before Neptune. Ceres was considered a planet for around 50 years before being reclassified as an asteroid and once again in 2006 as a dwarf planet.

Eris: Discovered in 2005 and was referred to as the tenth planet until it was reclassified in 2006. It is the largest of the dwarf planets. It has a highly elliptical orbit and takes about 1.5 Earth Years to complete one orbit.

Makemake: Discovered in 2005 and the third largest dwarf planet behind Eris and Pluto. It is the largest object and the second brightest after Pluto in the Kuiper Belt. With a diameter of over 2/3 of Pluto, it is visible from Earth with a standard telescope.

Haumea: Located beyond the orbit of Neptune and 1/3 the size of Pluto, Haumea was discovered in 2004 and named a dwarf planet in 2008. It has two moons, Hi'iaka and Namaka.

T -TECHNOLOGY



IMPACT OF ARTIFICIAL INTELLIGENCE AND ROBOTS

Impact of Artificial Intelligence and Robots

Artificial Intelligence (AI) has recently revealed its tremendous impact on the human civilisation. In the span of the last 100 years, humans have technologically advanced more than probably in the previous 5000 years. This is hence the exponential age of technology and science. Today, robots are everywhere, functioning, rather helping humans in day-to-day tasks. Today we have we have various mainstream AI software such as Apple's Siri, Amazon's Alexa, Google's Google Now, IBM's Watson, Microsoft's Cortana, as well as independent developers like Robin. But with very boon (and boom), a bane comes along. Robotic technology and related development bring along potential dangers to human society; the entire civilisation at large. Let's analyse these prospective threats to humans as AI increases its footprint in our everyday life.

Impact 1: Human Unemployment
Since the Industrial Revolution of the 19th century when the cotton handlooms of India were hit, advancement into a higher state of technology has often resulted in the escalation of unemployment. Especially in mass production industries, machines have often proven to be cheaper, faster and more efficient than thousands of workers. The introduction of AI in such industries has resulted in hundreds of thousands of workers losing their jobs. The worst case is when in many cases, they are the sole earners of their families. With further advancement in AI, the toll could rise to hundreds of millions.

Impact 2: Human Health
The next threat we have is even more existential. Humans have lesser physical activity and average fitness levels than probably they ever had. With the robot industry slowly flexing its muscles in the commercial sector, in the next 50 years, we could see complex, interactive machines doing the tasks we would have normally done. We would be one the verge of becoming so lethargic our everyday inertia could intensify into causing obesity, diabetes, hypertension and heart diseases, covering most of the human population. When covering economics, such indolence can be linked to skill degradation among the population, over dependence on machines and a shrink in human creativity.

Impact 3: Hacking
Today we have a heavy reliance on the internet. All of this has caused us to be prone to hacking, bugs and compromised privacy. If internet servers can be hacked and altered, why can't robot software be prone to such malpractices? Whether it be a small prank by a kid next door, or it may be well-organised software

hacks; using robot technology at large scale can cause widespread damage. Even if unintended (and unanticipated), one error in the programming of a machine used in the production industry, could bring the large scale production to a standstill and cause a crash in economic growth.

Impact 4: Human Creativity

Robots are known to have the capability of faster problem solving. Supercomputers are known to be able to perform complex mathematics calculations (calculus, fractals etc.) with much efficiency. But we can't intermingle memory and skills with intelligence and creativity. We could programme the computer to solve all problems. But can it solve problems that haven't yet occurred? Can it deal with the unexpected? The answer is short and sweet; no. The human brain has a unique ability to be able to derive solutions to abstract problems. Humans can be creative in their approach, and find unconventional ways to solve any problem that probably a computer can never do. Creativity is what drives the passion in a person's life. A machine can never reach that level.

Impact 5: Waste

All other things aside, we can never forget the environment. Given the rapid pace of technological development and the increasing average spending capacity, when new machines (with better technologies) come, where will the old ones go? They will be dumped. Many of these contain harmful substances like Lead,Mercury, Arsenic, rare earth metals as well as radioactive elements like Americium. When in use, many machines produce CFCs which deplete the ozone blanket over Earth and potentially put us at a great risk.



The Solutions

There are many reputed people who have voiced their concern for uncontrolled expansion into AI technology. Some of them include Stephen Hawking (physicist and astronomer), Elon Musk (chief SpaceX and Tesla Motors), the co-founders of DeepMind, Vicarious, Peter Norvig (Google's director of research), IBM's Watson Supercomputer team Microsoft Research Team, Jaan Tallinn (co-founder of Skype) others. The original signatory count was over 150 people, including academics from Cambridge, Oxford, Stanford, Harvard, and MIT. Bill Gates also has agreed to a recent interview, to the threats posed by artificial intelligence if left uncontrolled.

Together they signed "Research Priorities for Robust and Beneficial Artificial Intelligence: an Open Letter" on artificial intelligence calling for research on the societal impacts of AI. The letter affirmed that society can reap great potential benefits from artificial intelligence, but called for concrete research on how to prevent certain potential "pitfalls": artificial intelligence has the potential to eradicate disease and poverty, but researchers must not create something which cannot be controlled

E-ECONOMICS

DESIGN OF PENALTY SHOOTOUTS

ECONOMIC EQUILIBRIUM

Design of Penalty Shootouts

Does the Design of Penalty Shootouts Really Influence the Success of the Teams Involved ?

The interesting question that holds us tight is that is shoot-outs just a lottery or are there any factors that significantly influence their outcome?

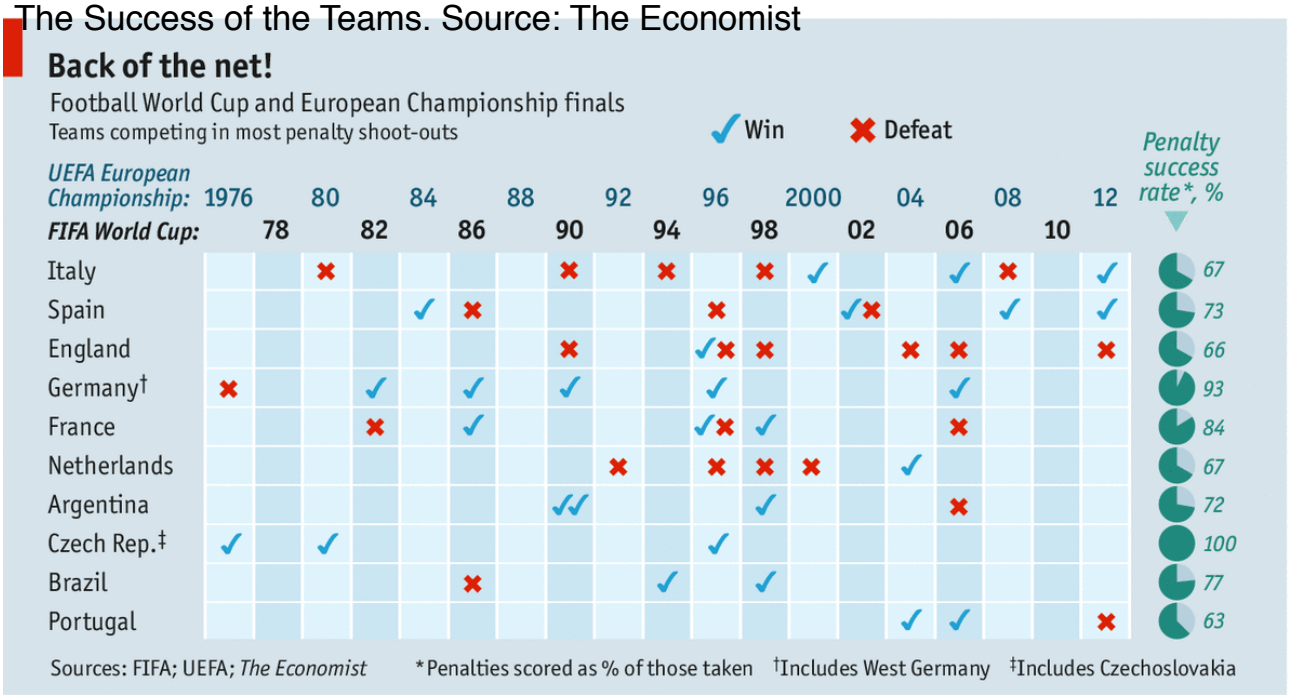
The penalty shoot-out was first introduced in June 1970 and has become an important part of competitions such as the World Cup and European Championships for national teams and The Champions League, UEFA Cup and FA Cup for club teams. English fans have suffered more than most with victory in only one out of the seven penalty-shoot outs they have been involved in at major tournaments. On average only three out of every five penalties taken were scored. Germany has a very different record. They have won six out of the seven shoot-outs they have participated in and have a scoring rate of 93%. The Czech Republic has an even better record as their players have not missed a single penalty in the three shoot-outs they have been involved in – including beating West Germany in 1976.

Each individual penalty can be thought of as an example of an interdependent or game theoretic situation. The penalty taker (PT) has to choose from one of three different strategies: shoot to the right, shoot to the left or shoot down the middle. The success of the penalty does not just depend on which of these strategies is chosen. It also depends on the choice made by the goalkeeper (GK) i.e. dive to the left, dive to the right or stay where they are.
In the jargon of game theory there is strategic interdependence. It can also be thought of as an example of a simultaneous game. After the ball is struck it takes approximately 0.3 seconds until it hits the back of the net!!!! Therefore it is impossible for the GK to observe the shot and respond. Instead they simply have to guess which way they think the PT will kick the ball and respond accordingly.
The same reasoning applies to the PT. They cannot observe which way the keeper will dive before they strike the ball. A penalty shoot-out is also an example of a zero sum game. If one teams scores they are better off by one goal while the other team is worse off by one goal.

There is also a sequential element to the shoot- outs as in each round one team always follows another. Is there either a first or second mover advantage? Is there any advantage from always shooting first or second? This was a question investigated by some economists who analysed the data from 129 shoot-outs in ten different tournaments taken between June 1970 and June 2003. This cut-off was chosen because up

until this point it could be argued that a penalty shoot-out was an example of a truly randomised field experiment. The team that won the coin toss was required to shoot first. Teams were not given a choice of whether to shoot first or second until the rules were amended in June 2003.

The Success of the Teams. Source: The Economist



The economists found that the teams who took the first shot won in 78 (60.5%) cases while the team that shot second won in only 51 cases (39.5%). This evidence suggests that there is a significant first mover advantage. One explanation for this finding is that there is greater psychological pressure on the PTs who go second in each round of the shoot-off and this has a significantly negative effect on their performance. The researchers also found that in 19 of the 20 shoot-outs they observed after June 2003 the team that won the toss decided to kick first. They concluded that not only is there a first mover advantage, but that teams/ players are aware of it.

If there is currently a first mover advantage, which provides teams with an unfair advantage, then is there anything that the football authorities could do to help reduce the bias? One suggestion is to change the order in which the teams shoot in each round. A similar approach could be taken to that used in tennis in order to determine the order of the server in a tiebreak. Imagine a penalty shoot-out between England and Germany. The sequence below provides one possible alternative to the current structure of the contest.

Penalty 1: Germany England
Penalty 2: England Germany
Penalty 3: England Germany
Penalty 4: Germany England
Penalty 5: England Germany
Penalty 6: Germany England

This would involve increasing the number of penalties from 5 to 6 so that both teams get to shoot first in three rounds of the contest. Interestingly the authors also found any first mover advantages fell dramatically if the shoot-outs reached the sudden death stage.

It will be interesting to see if first mover advantages occur in the remaining games in the tournament.

Economic Equilibrium

We all frequently come across people who are great economic decision makers. Some of them claim that their 'solid instincts' or 'reasoning' guides them. Well the processes involved in this instinctive decision making are named, in economics, the parameters and direct and indirect consequences of certain decisions are also gauged.

The factors a consumer/ buyer considers before buying a product are varied and often subjective but revolve around certain objectives. These are:

- Price of the Given Commodity
- Price of Related Goods
- Your Income
- Your Tastes and Preferences
- Your Expectations of Change in the Price in Future

Although price of the commodity, to a large extent helps determine it favourability, it is often actually the supply and demand that set the price of a commodity.
To understand this better think about how the products that have a high demand are often priced above the ones that have a lower clientage exemplifying the law of demand. For e.g. when the demand for the winter clothes goes down, they are often sold at a lower price.

To understand how these factors interact and affect our decisions lets search housing facilities in Mumbai. Well of course hypothetically.

In a city like Mumbai the demand of property is high mainly because of the unbalanced ratio of land to people and the fact that the land available can only be expanded in most extraordinary circumstances. While the former one is an example of wants exceeding resources, the latter is the issue of fixed resources. Together they give rise to what economists call the "Fundamental Problem of Economics", the problem of 'scarcity'.

Following the aforementioned 'law of demand' we can deduce that the property rates are skyrocketing due to the excess demand and limited land.
To use the land available more efficiently, multi-story buildings have become a common sight in Mumbai.

Now when you look for land you'll first decide upon your budget which is largely determined by your income. If you think buying a bungalow would break the bank, you might want to consider buying an apartment or renting one. Buying bungalows and/ or apartments and/ or renting them provides an example of related goods. You as consumer might consider from one good to another based on its closeness and convenience.

Next come in your preferences: neighbourhood, facilities, travel time etc. which are largely subjective.

You start thinking about the profitability of your purchase i.e. how would you derive maximum satisfaction out of the least possible value. If you are ready to pay more for certain additional benefits, you might have to cut back on some weekend gateways and shopping sprees. This would then be called the 'opportunity cost' of the benefits you bought for the sum you could have used for being these alternatives.

FACTORS AFFECTING DEMAND

1. Taste and Preference of Consumers
2. Income of the People
3. Change in Price of Related Goods
4. Number of Consumers in the Market
5. Change in Propensity to Consume
6. Customers Expected Future Prices
7. Income Distribution of the Consumers

You then also ponder upon the future returns of your purchase. In this case, you might want to check the expected rate change and opportunities for advancement in your selected location.

This was the consumer's side of the picture. The suppliers side, in this case the land lord, of the story often differs and involves certain other factors at play which if not the same, work on similar principles.Supply is determined by:

- Costs of production
- Number of producers
- Expansion in capacity of existing firms productivity
- Climatic conditions (mainly agricultural goods)
- Government policies

Now since economists assume that both consumers and buyers are motivated purely by self-interest, it's implicit that buyers will aim to maximise their profit through a sale.

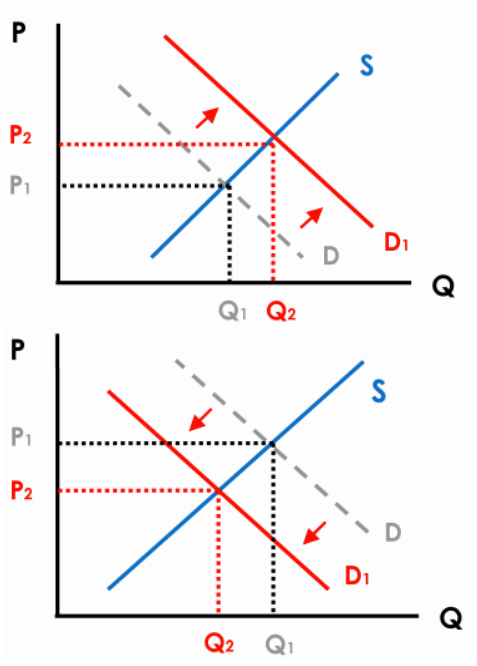
Whenever the factors affecting supply are favourable, they'll tend to increase supply.The pivotal point being price, landlords will try to sell/rent the land/ apartment at the highest possible price. Additionally, they'll look for the consumer willing to pay the most. In case they owns housing societies, they will increase the supply when: labour is cheap, raw materials are cheap, and better technology completes the work more efficiently. When there are more people involved in this business, there will be rapid development of numerous housing societies. When more people are willing to sell/rent their properties, supply will automatically increase. When a firm/ individual buys better machinery which expedites construction process/ hires more labourers/ increases its budget, supply will surge.

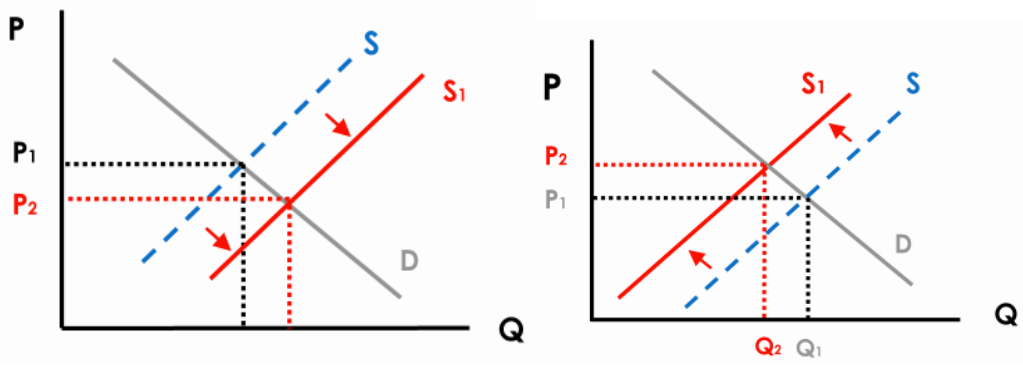
Similarly when the demand is high, there will be competition among the buyers to buy/rent the same limited land. This will give the seller an upper hand where he/she can sell it's products at a higher price.

The point where the consumers and suppliers come to an agreement, i.e. demand and supply are equal, is called 'Equilibrium'.

FACTORS AFFECTING SUPPLY

1. Price of Good
2. Cost of Production
3. Technology of Production
4. Transport Conditions and Costs
5. Government Policies
6. Price of Related Goods
7. Factor Prices and Their Availability





Picture Credits: piieco.com
From Top:
Increase in Demand
Decrease in Demand
From Right:
Decrease in Supply
Increase in Supply

M-MATHEMATICS

UNEXPECTED MATHEMATICAL RESULTS

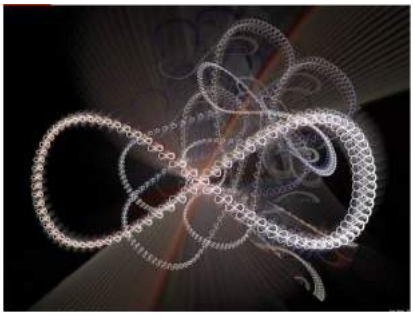
UNEXPECTED MATHEMATICAL RESULTS

1. Godel's Incompleteness Theorums

In 1931, Austrian mathematician Kurt Gödel proved two theorems. Gödel showed that there are certain true statements about the system which cannot be proven by the system itself. Fundamentally, he showed that it is impossible for a system to be completely self-contained, which went against all previous mathematical assumptions. Systems that get bigger and bigger as we unsuccessfully try to make them complete.

2.Different Levels of Infinity

In the latter half of the 19th century that Georg Cantor developed the branch of math known as Set Theory (read Russell's paradox). As it turns out, whenever we imagine infinity, there's always a different type of infinity that's bigger than that. The lowest level of infinity is the amount of whole numbers (1,2,3…), and it's a countable infinity. Cantor determined that there's another level of infinity after that, the infinity of all Real Numbers (1, 1.001, 4.1516…basically any number you can think of). That type of infinity is uncountable.



3. Turing's Universal Machine

MathematicianAlan Turing developed a theoretical object called a Turing Machine which is like a very basic computer: it uses an infinite string of tape and 3 symbols (say 0, 1, and blank), and then operates given a set of instructions. Instructions could be to change a 0 to a 1 and move a space to the left, or to fill in a blank and move a space to the right (for example). In this way a Turing Machine could be used to perform any well-defined function and thus Turing created Computer Science without ever having a computer!

4. Eulers Formula

Euler's Formula manages to combine five of the most important numbers in all of math (e, i, pi, 0, and 1). For those that don't know, both e and pi are mathematical constants which come up in all sorts of unexpected places, and i stands for the imaginary unit, a number which is equal to the square root of -1

$$e^{i\pi}+1=0$$

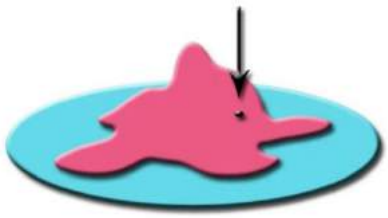
5. Fermat's Last Theorem

Pythagoras' theorem says that the sum of the squares of the two shortest sides are equal to the square of the longest side (x squared + y squared = z squared). French Mathematician Pierre de Fermat's most famous theorem is that this same equation is not true if you replace the squared with any number greater than 2 (you could not say x cubed +y cubed = z cubed, for example), as long as x, y, and z are positive whole number. While Fermat posed this problem in 1637, it went unproven for quite a while. And by a while, I mean it was proven in 1995 (358 years later) by a man named Andrew Wiles.

6. Russell's Paradox

At the turn of the 20th century, a lot people were entranced by a new branch of math called Set Theory. Basically, a set is a collection of objects. The thinking of the time was that anything could be turned into a set: The set of all types of fruit and the set of all US Presidents were both completely valid. Additionally, and this is important, sets can contain other sets (like the set of all sets in the preceding sentence). In 1901 famous mathematician Bertrand Russell made quite a splash when he realised that this way of thinking had a fatal flaw: namely, not anything can be made into a set. Russell decided to get meta about things and described a set that contained all those sets which do not contain themselves. The set of all fruit doesn't contain itself (the jury's still out on whether it contains tomatoes), so it can be included in Russell's set, along with many others. But what about Russell's set itself? It doesn't contain itself, so surely it should be included as well. However, now it contains itself, so naturally we have to take it out. But we now we have to put it back…and so on. This logical paradox caused a complete reformation of Set Theory, one of the most important branches of math today.

7. Brouwer's Fixed Point Theorem



This theorem comes from a branch of math known as Topology, and was discovered by Luitzen Brouwer. Let's say we have a picture (for example, the Mona Lisa) and we take a copy of it. We can then do whatever we want to this copy—make it bigger, make it smaller, rotate it, crumple it up, anything. Brouwer's Fixed Point Theorem says that if we put this copy overtop of our original picture, there has to be at least one point on the copy that is exactly overtop the same point on the original. It is also true for 3 dimensional objects.

8. The 4 Colour Theorem

It was discovered in 1852 by a man named Francis Guthrie. It states that only 4 distinct colours are required to colour any map of any number of countries, states of districts without having regions of similar colour next to one another.

9.The Doomsday Argument

If one considers the complete lifetime of the human species to be a timeline from birth to death, then we can determine where on that timeline we are now. Since right now is just a random point in our existence as a species, then we can say with 95% accuracy that we are within the middle 95% of the timeline, somewhere. If we say that right now we are exactly 2.5% into human existence, we get the longest life expectancy. If we say we are 97.5% into human existence, that gives us the shortest life expectancy. So there's a 95% chance that human beings will die out sometime between 5100 years and 7.8 million years next.

QUESTION EVERYTHING???

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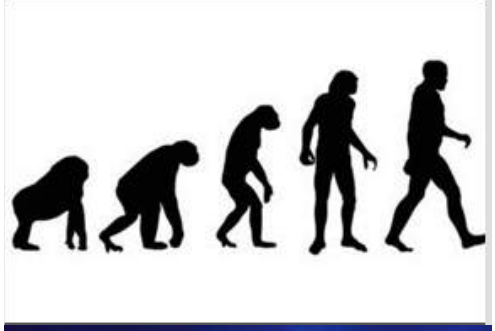
For thousands of years, most of the science that was taught to students was wrong. Just some examples:

700 B.C.: **fact** - the earth is flat. w*rong*

600 B.C. : **fact** - the sun revolves around the earth. w*rong*

1838: Darwin evolutionary theories. We have no idea and no evidence or "missing link".



1915: Einstein's General theories of Relativity. Some evidence, some guessing. Einstein's theories continue to be adjusted as.

Before 1917: **fact**- the atom is the smallest particle in the universe. *Wrong*

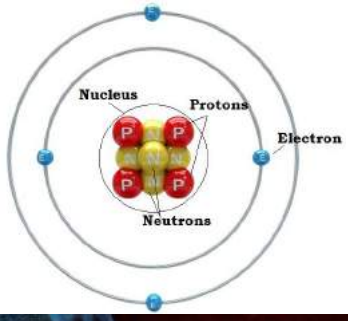
About 1917: **fact** - Electrons are round. *Wrong* (string theory...still in progress)

Before 1920: Einstein theory - **fact** - the universe was static. w*rong ?*

1929: **fact**- the universe is expanding. "The Big Bang", (Expansionism Theory) *maybe....*

Recent theories: the universe is contracting..."The Big Crunch" theory. *Maybe....*

1947. **fact**- nothing can travel faster than sound. *Wrong*



1959. **fact** - the neutrino exist and is the smallest particle in the universe able to travel faster than light. *Maybe....*

Common myth: **fact** - Lighting doesn't strike the same place twice. *Wrong*

Today: Black holes the world's foremost physicists agree, *"We just don't understand this, and black holes may not even really exist, but observations say they probably do".*

Current theory: Black holes are not really holes but solid objects of incredible density with no external features.

Before 2008 - Nothing can escape a black hole: *Wrong*. Radiation particles DO escape a black hole constantly, but they have no physical information, almost like they don't exist as we think of existence.

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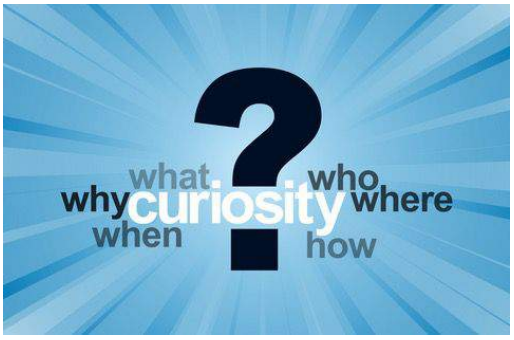
Predictions based on theories.....that's about the best we can do our side of our Earthly confines. Everyday we're told about a new study or research that completely reverses our previous notions on a subject, only to have it reversed again a month later.



Mankind has this insatiable curiosity to further our understanding of ourselves, our world and universe around us. Throughout history there have been theories that were considered "fact" for generations and were discovered to be false by those who "questioned". Some of their "facts" may seem ridiculous now, but it was only through human curiosity, exploration, and ingenuity that groundbreaking discoveries altered our understanding of everything.

Try to imagine several thousand years ago what it must have been like to try and comprehend what all of those pretty shiny lights in the night sky were. It makes sense that many "primitive" cultures revered stars as deities or at least objects of religious importance.

Given the technology of 600 B.C. the observation that the sun appeared to "move" around Earth is not really that far-fetched of an idea...that Earth was the centre of the universe.

This idea of an Earth centerer universe was widely accepted until the 1500's when a man by the name of Nicolas Copernicus went against this idea that had been considered fact for hundreds of years. He developed the heliocentric (spiral) model for our solar system. The reason he is most credited with the heliocentric model is due to his total inclusion of mathematics and physics together to formulate theories.

Copernicus still feared persecution. His works titled "De Revolitionibus Orbium Celestial" were not published until the day of his death in 1543. Because there was nobody to persecute, it was passively accepted until banned in the year 1616. It wasn't until 1835 when the support for the theories written by Copernicus had become seriously considered that the ban on the book was lifted. While much of the groundwork from his discoveries had been laid down years beforehand, Copernicus was the first to write the theory in such a complete way, combining many different scientific disciplines.

It is clear that our curiosity, and our wonder of the world around us leads to the advancement of knowledge.

Edwin Hubble (Hubble Telescope), allowed us to observe an increase in the wavelengths of radiation coming from an extraterrestrial sources. The significance was that Hubble was actually able to observe relatively close nebula. It wasn't until Hubble had applied the theory of relativity to his equation that he considered the influence of gravity.

Without constant movement and expansion, he considered that the universe as we know it might collapse in on itself, which just so happens to be a recent theory of serious consideration, (the Big Crunch Theory). Edwin Hubble was a lawyer by the way, who became fascinated with astronomy and lead us to today.

Exploration, discovery, theory and opinion about the nature of the universe, our planet, the human body, brain and society itself zoom ahead as never before, so we must logically and responsibility question what is fact versus theory and then question the theory.

Most questions regarding the universe will never fully be answered correctly but these questions must be asked and considered and there is a good chance that we will be wrong.

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