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V-Tech

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PREFACE



I am pleased to present the first issue of V-Tech, the technical magazine by the Department of Information Technology of VSIT, for academic year 2019-20. Teachers contribute articles in their field of interest as well as current/upcoming areas which help in expanding the knowledge base of faculty members.

Continuing with this tradition, this issue deals with different aspects of IT field. Starting from journey of established technologies like Data Mining, Artificial Intelligence, and the way forward, to current trending topics in the field such as Machine Learning, Cryptocurrency, Ethical Hacking. This issue also talks about some of the advances in IOT and embedded technologies like Smart helmets, smart dust, Zigbee technology. Some current VLSI technologies like FinFET and DNA storage are also discussed in the issue. Last but not the least; it also covers some areas of general interest like payments without swiping and PIN, Vertical Farming, etc.

I hope you will find this issue as interesting as I did. It will help all the readers in enriching their IT knowledge and hopefully strike a chord in at least one area where they can take a deep dive for their research activities.

Prof. Makarand Deshpande
Adjunct Professor

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A cryptocurrency is a digital currency that is created and managed through the use of advanced encryption techniques known as cryptography. Cryptocurrency made the leap from being an academic concept to (virtual) reality with the creation of Bitcoin in 2009. While Bitcoin attracted a growing following in subsequent years, it captured significant investor and media attention in April 2013 when it peaked at a record \$266 per bitcoin after surging 10-fold in the preceding two months. Bitcoin sported a market value of over \$2 billion at its peak, but a 50% plunge shortly thereafter sparked a raging debate about the future of cryptocurrencies in general and Bitcoin in particular. So, will these alternative currencies eventually supplant

conventional currencies and become as ubiquitous as dollars and euros someday? Or are cryptocurrencies a passing fad that will flame out before long? The answer lies with Bitcoin.

Alternatives to Bitcoin

Despite its recent issues, Bitcoin's success and growing visibility since its launch has resulted in a number of companies unveiling alternative cryptocurrencies, such as:

- ▶ *Litecoin* – Litecoin is regarded as Bitcoin's leading rival at present, and it is designed for processing smaller transactions faster. It was founded in October 2011 as "a coin that is silver to Bitcoin's gold," according to founder Charles Lee. Unlike the heavy computer horsepower required for Bitcoin mining, Litecoins can be mined by a normal desktop computer. Litecoin's maximum limit is 84 million – four times Bitcoin's 21-million limit – and it has a transaction processing time of about 2.5 minutes, about one-fourth that of Bitcoin.
- ▶ *Ripple* – Ripple was launched by OpenCoin, a company founded by technology entrepreneur Chris Larsen in 2012. Like Bitcoin, Ripple is both a currency and a payment system. The currency component is XRP, which has a mathematical foundation like Bitcoin. The payment mechanism enables the transfer of funds in any currency to another user on the Ripple network within seconds, in contrast to Bitcoin transactions, which can take as long as 10 minutes to confirm.
- ▶ *MintChip* – Unlike most cryptocurrencies, MintChip is actually the creation of a government institution, specifically the Royal Canadian Mint. MintChip is a smartcard that holds electronic value and can transfer it securely from one chip to another. Like Bitcoin, MintChip does not need personal identification; unlike Bitcoin, it is backed by a physical currency, the Canadian dollar.

The Future of Cryptocurrency

Some economic analysts predict a big change in crypto is forthcoming as institutional money enters the market. Moreover, there is the possibility that crypto will be floated on the Nasdaq, which would further add credibility to blockchain and its uses as an alternative to conventional currencies. Some predict that all that crypto needs is a verified exchange traded fund (ETF). An ETF would definitely make it easier for people to invest in Bitcoin, but there still needs to be the demand to want to invest in crypto, which some say may not automatically be generated with a fund.

Should You Invest in Cryptocurrencies?

If you are considering investing in cryptocurrencies, it may be best to treat your “investment” in the same way you would treat any other highly speculative venture. In other words, recognize that you run the risk of losing most of your investment, if not all of it. As stated earlier, a cryptocurrency has no intrinsic value apart from what a buyer is willing to pay for it at a point in time. This makes it very susceptible to huge price swings, which in turn increases the risk of loss for an investor. Bitcoin, for example, plunged from \$260 to about \$130 within a six-hour period on April 11, 2013. If you cannot stomach that kind of volatility, look elsewhere for investments that are better suited to you. While opinion continues to be deeply divided about the merits of Bitcoin as an investment – supporters point to its limited supply and growing usage as value drivers, while detractors see it as just another speculative bubble – this is one debate that a conservative investor would do well to avoid.

Conclusion

The emergence of Bitcoin has sparked a debate about its future and that of other cryptocurrencies. Despite Bitcoin’s recent issues, its success since its 2009 launch has inspired the creation of alternative cryptocurrencies such as Litecoin, Ripple and MintChip. A cryptocurrency that aspires to become part of the mainstream financial system would have to satisfy very divergent criteria. While that possibility looks remote, there is little doubt that Bitcoin’s success or failure in dealing with the challenges it faces may determine the fortunes of other cryptocurrencies in the years ahead.

Aasha Chavan
Assistant Professor

DNA STORAGE - FUTURE OF DATA MANAGEMENT



A lot can happen in a minute. Every minute in 2019, a huge amount of data was accessed and transferred on internet. The following table shows the amount of data used per minute in 2019.

TYPE OF DATA ACCESSED	AMOUNT PER MINUTE
E-mails sent	188,000,000
Mobile messages sent	41,600,000
Text messages sent	18,100,000
GIFs served by GIPHY	4,800,000
Videos watched by YouTube users	4,500,000
Search queries via Google	3,800,000
Snaps created by Snapchat users	2,100,000
Swipes on Tinder	1,400,000
Facebook logins	1,000,000
Views on Twitch	1,000,000
Hours of Netflix watched	694,444
Apps downloaded	390,030
Users scrolling on Instagram	347,222
People tweeting	87,500
Smart speakers shipped	180
Music streaming subscriptions	41

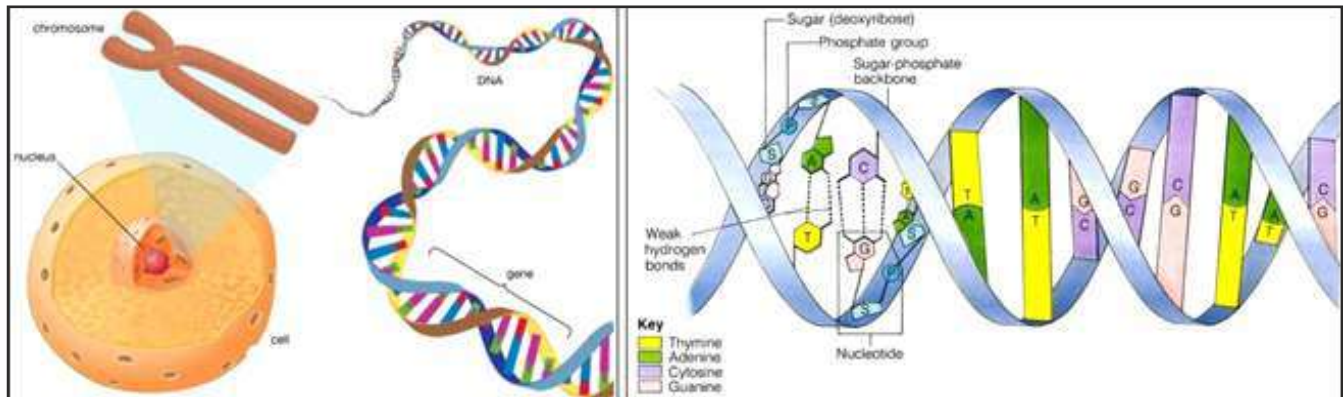
(Credit: www.statista.com)

By 2020 an estimated 1.7 megabytes of data will be created per second per person globally, which translates to about 418 zettabytes in a single year, assuming a world population of 7.8 billion. The magnetic or optical data-storage systems that currently hold this volume of 0s and 1s typically cannot last for more than a century. Further, running data centres takes huge amounts of energy. In short, we are about to have a serious data-storage problem that will only become more severe over the time.



DNA STORAGE - FUTURE OF DATA MANAGEMENT

An alternative to hard drives is progressing now and that is DNA-based data storage.



DNA—Deoxyribose Nucleic Acid, which consists of long chains of the nucleotides A, T, C and G—is life's information-storage material. Data can be stored in the sequence of these letters, making DNA into a new form of information technology. It is already routinely sequenced (read), synthesized (written to) and accurately copied with ease. DNA is also incredibly stable, as has been demonstrated by the complete genome sequencing of a fossil horse that lived more than 500,000 years ago. Storing it also does not require much energy.

DNA can accurately stow massive amounts of data at a density far exceeding that of electronic devices. The prospect of DNA data storage is not merely theoretical. In 2017, Church's group at Harvard adopted CRISPR DNA-editing technology to record images of a human hand into the genome of *E. coli*, which were read out with higher than 90% accuracy. Researchers at the University of Washington and Microsoft Research have developed a fully automated system for writing, storing and reading data encoded in DNA. A number of companies, like Microsoft and Twist Bioscience, are working to advance DNA-storage technology.

Meanwhile DNA is already being used to manage data in a different way, by researchers who grapple with making sense of tremendous volumes of data. Recent advancements in next-generation sequencing techniques allow for billions of DNA sequences to be read easily and simultaneously. With this ability, investigators can employ bar coding (use of DNA sequences as molecular identification “tags”) to keep track of experimental results. DNA bar coding is now being used to dramatically accelerate the pace of research in fields such as chemical engineering, materials science and nanotechnology.

The challenges to make DNA data storage commonplace are the costs and speed of reading and writing DNA, which need to drop even further if the approach is to compete with electronic storage. Even if DNA does not become a universal storage material, it will almost certainly be used for generating information at entirely new scales and preserving certain types of data over the long term.

Amraja K. Shivkar
Asst Prof, VSIT

ZIGBEE WIRELESS TECHNOLOGY



In this present communication world there are numerous high data rate communication standards that are available, but none of these meet the sensors' and control devices' communication standards. These high-data rate communication standards require low-latency and low-energy consumption even at lower bandwidths. The available proprietary wireless systems' Zigbee technology is low-cost and low-power consumption and its excellent and superb characteristics makes this communication best suited for several embedded applications, industrial control, and home automation, and so on.

What is Zigbee Technology?



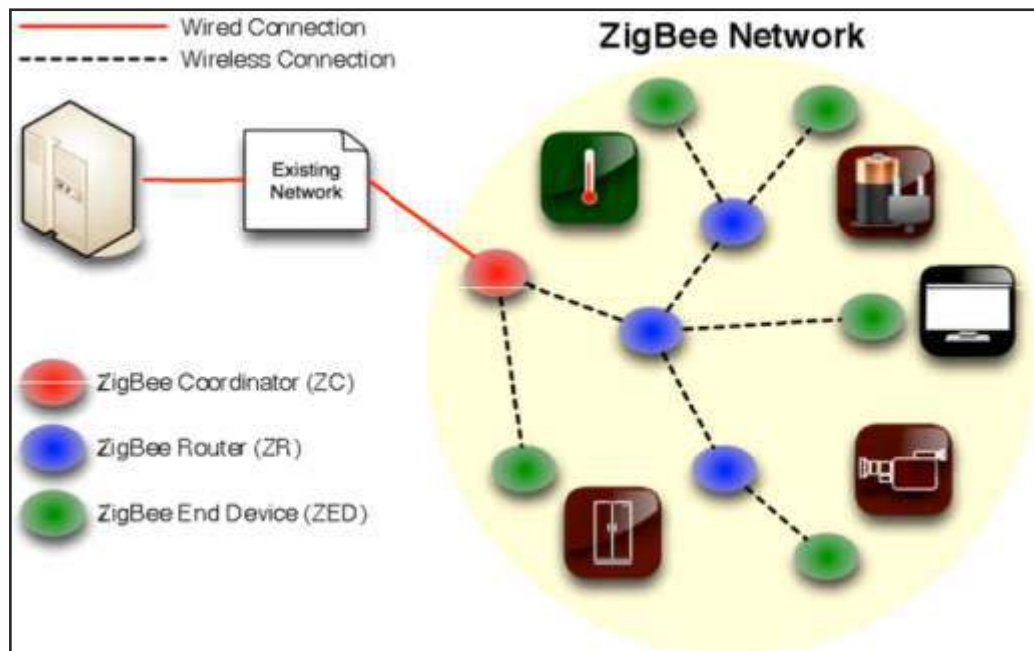
Zigbee communication is specially built for control and sensor networks on IEEE 802.15.4 standard for wireless personal area networks (WPANs), and it is the product from Zigbee alliance. This communication standard defines physical and Media Access Control (MAC) layers to handle many devices at low-data rates. These Zigbee's WPANs operate at 868 MHz, 902-928MHz and 2.4 GHz frequencies. The data rate of 250 kbps is best suited for periodic as well as intermediate two way transmission of data between sensors and controllers.

Zigbee is low-cost and low-powered mesh network widely deployed for controlling and monitoring applications where it covers 10-100 meters within the range. This communication system is less expensive and simpler than the other proprietary short-range wireless sensor networks as Bluetooth and Wi-Fi.

Zigbee supports different network configurations for master to master or master to slave communications. And also, it can be operated in different modes as a result the battery power is conserved. Zigbee networks are extendable with the use of routers and allow many nodes to interconnect with each other for building a wider area network.

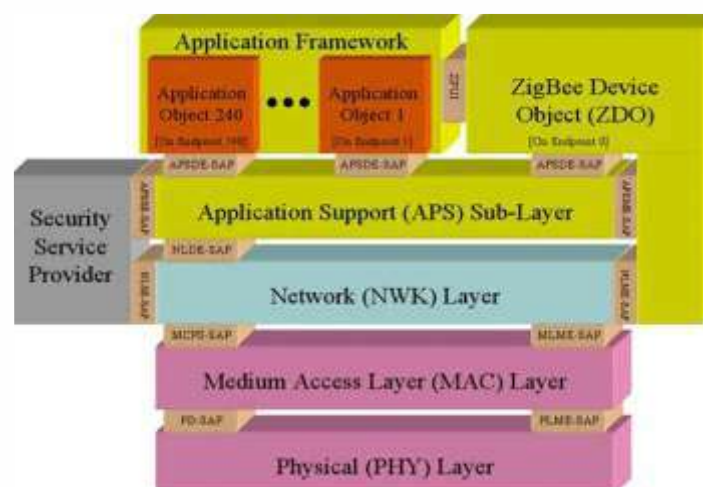
ZIGBEE WIRELESS TECHNOLOGY

Zigbee Architecture



Zigbee system structure consists of three different types of devices such as Zigbee coordinator, Router and End device. Every Zigbee network must consist of at least one coordinator which acts as a root and bridge of the network. The coordinator is responsible for handling and storing the information while performing receiving and transmitting data operations. Zigbee routers act as intermediary devices that permit data to pass to and fro through them to other devices. End devices have limited functionality to communicate with the parent nodes such that the battery power is saved as shown in the figure. The number of routers, coordinators and end devices depends on the type of network such as star, tree and mesh networks.

Zigbee protocol architecture consists of a stack of various layers where IEEE 802.15.4 is defined by physical and MAC layers while this protocol is completed by accumulating Zigbee's own network and application layers.



Zigbee protocol architecture

Physical Layer : This layer does modulation and demodulation operations up on transmitting and receiving signals respectively. This layer's frequency, data rate and number of channels are given below.

MAC Layer : This layer is responsible for reliable transmission of data by accessing different networks with the carrier sense multiple access collision avoidance (CSMA). This also transmits the beacon frames for synchronizing communication.

Network Layer : This layer takes care of all network related operations such as network setup, end device connection and disconnection to network, routing, device configurations, etc.

Application Support Sub-Layer : This layer enables the services necessary for Zigbee device object and application objects to interface with the network layers for data managing services. This layer is responsible for matching two devices according to their services and needs.

Application Framework : It provides two types of data services as key value pair and generic message services. Generic message is a developer defined structure, whereas the key value pair is used for getting attributes within the application objects. ZDO provides an interface between application objects and APS layer in Zigbee devices. It is responsible for detecting, initiating and binding other devices to the network.

In a beacon mode, when there is no data communication from end devices, then the routers and coordinators enter into sleep state. Periodically this coordinator wakes up and transmits the beacons to the routers in the network. These beacon networks are work for time slots which means, they operate when the communication needed results in lower duty cycles and longer battery usage. These beacon and non-beacon modes of Zigbee can manage periodic (sensors data), intermittent (Light switches) and repetitive data types.

Applications of Zigbee Technology

Industrial Automation : In manufacturing and production industries, a communication link continually monitors various parameters and critical equipments. Hence Zigbee considerably reduce this communication cost as well as optimizes the control process for greater reliability.

Home Automation : Zigbee is perfectly suited for controlling home appliances remotely as a lighting system control, appliance control, heating and cooling system control, safety equipment operations and control, surveillance, and so on.

Smart Metering : Zigbee remote operations in smart metering include energy consumption response, pricing support, security over power theft, etc.

Smart Grid monitoring : Zigbee operations in this smart grid involve remote temperature monitoring, fault locating, reactive power management, and so on.

ACCIDENT PREVENTION USING SMART HELMET



Introduction

Wearing helmets are made compulsory by the government. Most of the two wheeler riders are neglecting it. Most of the accidents are occurring cause severe deaths due to rash driving as well as not wearing helmets. Due to this, even small accidents are becoming fatal. Also, accidents occurring at remote places are becoming fatal due to the slow reach of treatment. Hence keeping these things in mind a proposed system is designed where a helmet won't allow the rider to ride the two wheeler if he doesn't wear the helmet. The ignition will only start when the rider wears the helmet. After wearing if any accident takes place it will send the information and location via GPS and GSM to the family member whose contacts is saved.

Objectives

To design a smart helmet, this will act as a security system and also a monitoring system for the two wheeler and its rider. This proposed system will consist of sensors networked with communication modules, which helps to stop the drive or not to allow the driving at the critical or abnormal situations.

Working

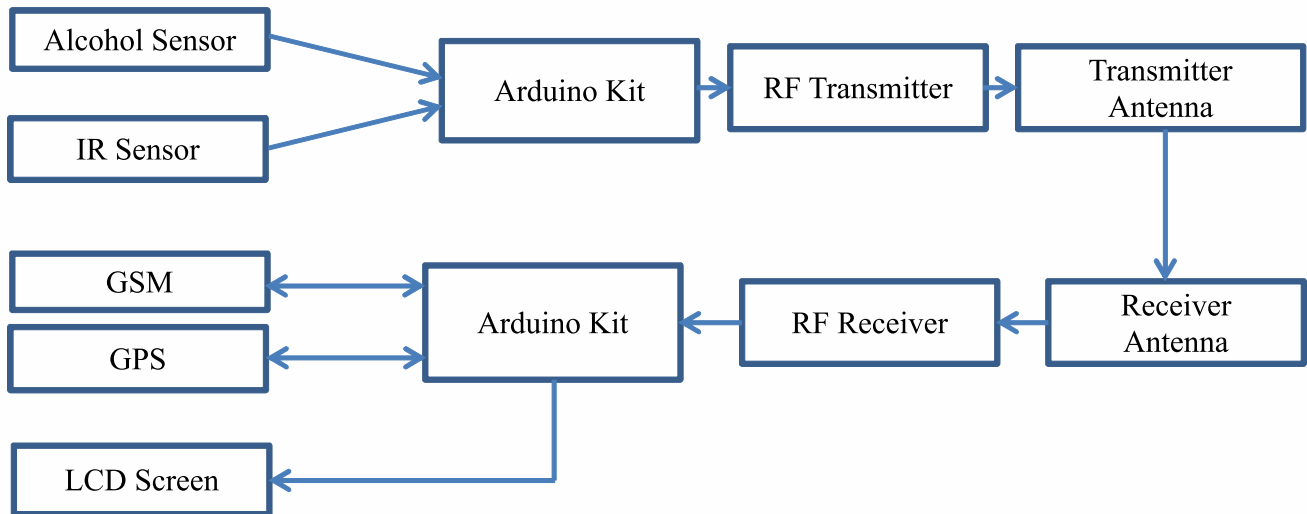
In this project, the two wheeler starts only when the rider puts on his/her helmet. Here, the radio frequency transmitter is present inside the helmet and only when the person wears it, the connection is established and the signal is sent to the radio frequency receiver present in the two wheeler which starts the ignition or starts the two wheeler. So the two wheeler will not start unless the person puts on the helmet.

This module contains different sensors and a transmitter. These sensors are alcohol sensor, and IR sensor. Alcohol sensor will be used to recognize the alcohol content taken by the rider. The alcohol sensor will be put close to the mouth of the rider, inside the helmet. A RF transmitter which can transmit information from any controller. The RF transmitter transmits information from the microcontroller on the helmet side to the recipient on the vehicle side through transmit antenna.

Receive antenna receives information from the transmit antenna then sends to the radio frequency receiver which gets the information and sends it to the microcontroller for processing. GPS sensor will be used to identify the exact location of the accident. GSM will help to get the message registered under that. LCD is used to display the conditions of sensors activities. GPS and GSM module are also installed in the helmet which helps us to know when a sudden accident occurs and sends the location to the family member via sms. In this way, the person will never ignore or forget to wear the helmet and ensures his safety.

ACCIDENT PREVENTION USING SMART HELMET

Flow chart



Conclusion

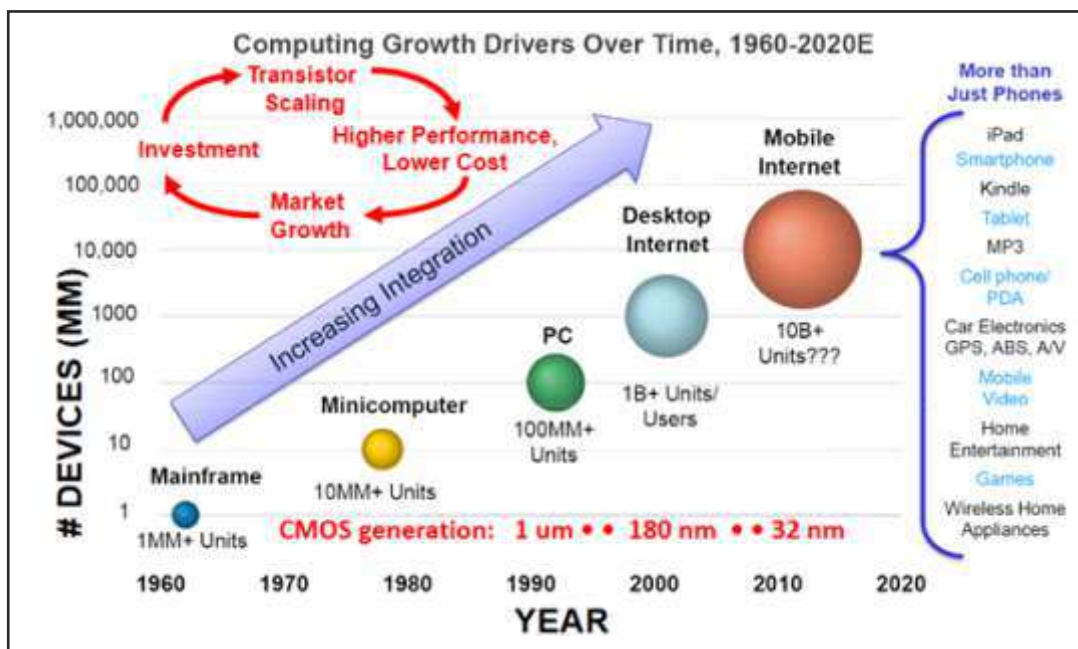
Helmet can prevent the damage occurred to the vehicle by the accident. After wearing the helmet the alcohol sensor will sense the consumption of alcohol, if it is very high then the two wheeler will not start and hence can curb road accidents and saves the life of a person.

Geeta Sahu
Assistant Professor



Background

All the electronic devices we use, have Transistors. Transistors are everywhere in daily life. There are billions of transistors in a cell phone and computer, and at least a few in almost every modern electrical or electronic device that we use in our day-to-day life. Transistor is used as a switching device. In the integrated circuit transistor is used to control the pulses. It makes the circuit on and off.



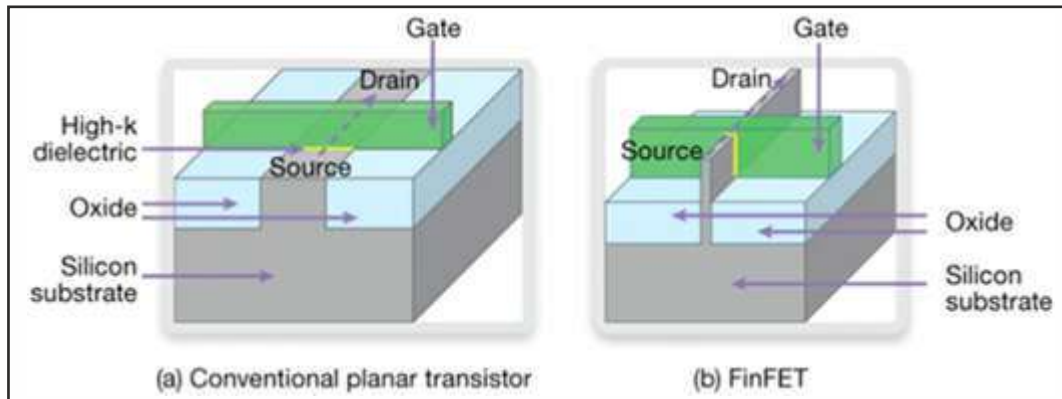
A transistor has two basic states: on and off. A transistor works as a switch just like an old-fashioned light switch. FET uses an electric field to control the electrical conductivity through a channel. Similar to the way a gate in a fence permits or blocks the passage of people, a FET gate permits or blocks the flow of electrons between the source and the drain. In one common type (n-channel), electrons flow easily from source to drain when a positive voltage is applied to the gate. If the gate-to-source voltage is negative, then the conductive channel is blocked and electron flow in the transistor is switched off.

As per Moore's law, the number of transistors on a given area of silicon doubles every two years. To achieve the large increases in levels of integration, many parameters have to be considered. Fundamentally the feature sizes have reduced to enable more devices to be fabricated within a given area. However other figures such as power dissipation, and line voltage have reduced along with increased frequency performance.

FinFET structure

FinFET, also known as Fin Field Effect Transistor, is a type of non-planar or "3D" transistor used in the design of modern processors. FinFET designs also use a conducting channel that rises above the level of the insulator, creating a thin silicon structure, shaped like a fin, which is called a gate electrode. This fin-

shaped electrode allows multiple gates to operate on a single transistor.



FinFETs are 3d structures that rise above the substrate and resemble a fin. The 'fins' form the source and drain, effectively and in this way they enable more volume than a traditional planar transistor for the same area. The gate wraps around the fin, and this gives more control of the channel as there is sufficient length for the control. Also as the channel has been extended there is very little current to leak through the body when the device is in the 'off' state. This also allows the use of lower threshold voltages and it results in better performance and lower power dissipation.

The gate orientation is at right angles to the vertical fin. And to traverse from one side of the fin to the other it wraps over the fin, enabling it to interface with three side of the fin or channel.

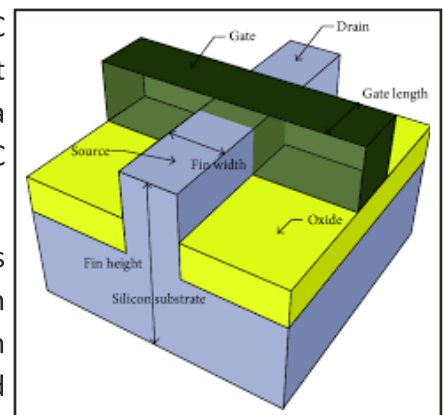
This form of gate structure provides improved electrical control over the channel conduction and it helps reduce leakage current levels and overcomes some other short-channel effects..

The term FinFET is used somewhat generically. Sometimes it is used to describe any fin-based, multigate transistor architecture regardless of number of gates.

Advantages and Applications

FinFET technology is being adopted in a variety of forms by IC manufacturers who need to increase the density of their ICs without using such small feature sizes that the device performance falls. As a result, FinFET transistor technology has enabled the development in IC technology to continue to follow Moore's law.

The FinFET architecture has helped extend Moore's Law, with designs currently stretching to the 10 nm technology node. World leader in smartphones Samsung, Apple, Intel, TSMC are set to ship 10 nm technology. This technology will benefit all smartphones as it will speed up the phone.



FinFET technology is used to design SoCs that are implemented in smartphones. Even the technology is used to design CPUs, GPUs, FPGA, MCU and network processors.

Maitreyi Joglekar
Assistant Professor



Smart Dust devices are trivial wireless microelectromechanical sensors (MEMS) that can sense everything from light to vibrations. It is a tiny dust size device with unexpected capabilities. It incorporates nano-structured silicon sensor which can instinctively assemble, orient sense and report on their local environment. This new but old technology combines sensing, computing, wireless communication capabilities and autonomous power supply within the bulk of only a few millimetres. It is very hard to detect the existence of the Smart Dust and it is even harder to get rid of them once deployed. Smart Dust is useful in nursing real world phenomenon without alarming the original process.

SMART DUST APPLICATION AREAS

In Bridges

Smart dust can be embedded in bridges when we pour the concrete. The smart dust could have a sensor on it that can discover the salt concentration within the concrete. Then once a month we could drive a truck over the bridge that sends a powerful magnetic field into the bridge. The magnetic field would allow the smart dust, which are concealed within the concrete of the bridge, to power on and transmit the salt concentration. Salt concrete and corrodes the steel rebar that strengthens the concrete. Salt sensors would let bridge maintenance personnel gauge how much damage salt is doing. Other possible sensors embedded into the concrete of a bridge might detect vibration, stress, temperature swings, cracking, etc., all of which would help looking after personnel spot problems long before they become life-threatening.

In Power Meters

A building manager could attach smart dusts to every electrical wire all over an office building. These smart dusts would have induction sensors to detect power consumption on that individual wire and let the building manager see power consumption down to the individual outlet. If power consumption in the building seems high, the building manager can track it to an individual tenant. Although this would be possible to do with wires, with smart dusts it would be far less expensive

For Tracking Climate

A farmer, vineyard owner, or ecologist could equip smart dusts with sensors that detect temperature, humidity, etc., making each smart dust a mini weather station. Scattered throughout a field, vineyard or forest, these smart dusts would allow the stalking of micro-climates.

To Monitor Traffic

Smart dusts placed every 100 feet on a highway and equipped with sensors to detect traffic flow could help police identify where an accident has stopped traffic. Because no wires are needed, the cost of installation would be comparatively low.

For Biological Studies

A biologist could equip a scarce animal with a collar containing a smart dust that senses position, temperature, etc. As the animal moves around, the smart dust collects and stores data from the sensors.

In the animal's surroundings, the biologists could place zones or strips with data collection smart dusts. When the animal walks into one of these zones, the smart dust in the collar would dump its data to the ad hoc network in the zone, which would then convey it to the biologist.

For Exploration of Planets

Tiny smart dusts that can be borne on the wind like dust particles could be carried in space probes to explore other planets. The devices would consist of a computer chip covered by a plastic sheath that can alter shape when a voltage is applied, enabling it to be steered. Details were presented at the National Astronomy Meeting in Preston. Smart dust could be filled into the nose cones of planetary probes and then released into the atmospheres of planets, where they would be carried on the wind. For a planet like Mars, smart dust particles would each have to be the size of a grain of sand. By applying a voltage to alter the shape of the polymer sheath surrounding the chip, dust particle could be directed towards a target, even in high winds. Wireless networking would allow these particles to form swarms. Dr Barker and his team in University of Glasgow has carried out mathematical simulations and have found that a swarm of 50 dust particles can organise themselves into a star formation, even in turbulent wind. The ability to fly in formation would allow the processing of data to be spread, or "distributed" between all the chips, and a cooperative signal to be beamed back to a "mothership".

In Hospitals

Another typical application scenario is dusting a hundred of these sensors around a building or around a hospital to monitor temperature or humidity, track patient movements, or notify of disasters, such as earthquakes.

In Military

In the military, they can perform as a remote sensor chip to track enemy movements, detect poisonous gas or radioactivity. All of these ideas are good; some allow sensors to move into places where they have not been before (such as embedded in concrete) and others reduce the time needed to read sensors individually.

Mithila Chavan
Assistant Professor

MAKE PAYMENTS WITHOUT SWIPING AND PIN



EMV chip technology is the latest global standard for card payments. EMV is an acronym for Europay Mastercard and Visa, who developed this technology. EMV cards are chip-based payment cards with enhanced safety features that are designed to prevent fraudulent practices such as card skimming and cloning.

Contactless card : These cards are called contactless cards as the cards need not be swiped or dipped in a POS machine. Rather a new technology has been used in the contactless cards, which is not wi-fi, but is based on NFC (near field communication) and RFID (radio frequency identification).

How it works : As explained by experts, the card contains a chip and an antenna (which is a super thin metal wire) and gets electricity through induction via a radio frequency field sent by the POS terminal, in proximity of which the card is placed for payment. Induction is the physical phenomenon through which the wired antenna will convert the radio frequency field emitted by the terminal, into electricity to power on the chip. Then this chip and POS terminal will exchange information in an encrypted way, in a fraction of a second, to enable the transaction.

Safety : According to Visa, a contactless card is as secure as any other Visa chip card, because it carries the same multiple layers of security. Multi-layer security ensures that you are safe from fraudulent or unauthorised transactions.

Security : A contactless card, according to Visa, would only work when the card is within 4 cm of the card reader. Moreover, a contactless payment terminal can only process one transaction at a time. So, there will be no chance of cross payment or payments in duplicate or more.

Advantage : According to Visa, the advantage of using a contactless card is that you remain in control of your card at all times as the card doesn't leave your hand during the transaction. So, the chance of misusing your card through cloning or otherwise would be minimised.

Disadvantage : As the wi-fi signal is transmitted freely and may activate any authorised POS machine or device, unauthorised payments may also be initiated easily through fraudulent use of any such device. However, declining that the signal may be picked up in an unauthorised way, SBI card customer care executive Hemant said, "Any unauthorised transaction up to Rs 2,000 may only be done when the card is misplaced and used intentionally by a person, who has got possession of the card." When asked, who will be liable to pay the bill in case of such an unauthorised transaction, Hemant said, "The liability would be ascertained after an investigation by the concerned fraud control department of SBI."



Moreover, a contactless payment terminal can process signal of a card only once at a time. So, if the transaction gets cancelled while processing, payment cannot be made contactless through the same payment terminal again. So, you have to either cancel your transaction or pay by swiping or dipping your card in a POS machine, thus sacrificing the contactless advantage of the card.

MAKE PAYMENTS WITHOUT SWIPING AND PIN

Despite these security measures, there are misconceptions about this technology. Let's take a look at the myths and the realities of contactless payments:

MYTHS	REALITIES
A thief can easily electronically pickpocket your contactless card/device.	While smart phone applications that enable the phone to read some of the data from a contactless enabled card or device do exist, they can only read the account number and expiration date. Plus, the thief would need to be physically close to the card in order to get this information.
If a thief does intercept your contactless information, they can create a counterfeit card to use in a store.	When a contactless transaction takes place the card or device provides the reader with a dynamic, one-time-only number that uniquely and securely identifies each specific transaction. It would be extremely difficult for a fraudster to copy the advanced encryption technology that is used to generate this dynamic number and create a functioning counterfeit version of a contactless card.
Even if a thief can't counterfeit your card, they can make purchases online or by phone.	For a purchase to be authenticated and authorized via phone or online, typically several pieces of information must be presented – including the three-digit code on the back of a card and the cardholder's name and billing address. Since the card or device does not send the code, billing address or zip code information or name over the contactless interface, the thief won't have the information typically needed to conduct payment transactions, either in person, on the phone or online.
You are responsible for purchases made by thieves if they steal your card information	Mastercard protects consumers against fraudulent charges with a global zero liability policy. That means you are not held liable for unauthorized fraudulent transactions.
In addition to stealing your card data, thieves can also steal your identity.	There is a clear distinction between identity theft, where a consumer's identity is assumed by another individual for criminal purposes, and payment card fraud, where a consumer's card information is compromised and used to make unauthorized purchases. Mastercard contactless cards and devices do not transmit information about the cardholder such as name or address, so there is very little risk of actual identity theft. But, knowing that identity theft is a concern for many people, Mastercard does offer an ID Theft Alert service to consumer credit and debit cardholders in the U.S. who can sign up at the following link: https://www.mastercard.us/en-us/consumers/payment-technologies/id-theft-protection.html

Hopefully, knowing all of the facts (and seeing through the fiction) helps ease your mind if you have a contactless card.

Payal Shah
Assistant Professor

ETHICAL HACKING



Yes! Prevention is better than cure. This is not the James Bond 007 film like “License to Kill”. This is “License to Hack”. But the theme is same. Where in the Bond film the James Bond the hero fight against the villain. Here the Computer Experts as “Ethical Hackers” fight against the Computer-savvy criminal's malicious attack. We must protect our Network, confidential information, bank accounts, and even an identity. We are in the time to fight against these malicious hackers who breach the most secure bank accounts, corporate information or even government website to mischief, damage or even sabotage. Many companies are nowadays employing these experts as “Ethical Hackers” to test by attacking their own Computer Networks. They

attempt to detect potential weak systems or servers to intrude or crash their own security systems and suggest changes to increase the safety. These steps are made effective in such technical methods and procedures to test the effectiveness and quality of their own network systems and prevent the attack of intrusions before they happen.

Here we are using the term “Ethical hackers” as a legal profession for Computer Networks Experts to keep the bad things out. These experts use the same tactics and techniques to violate the security protocols as their vigorous counterparts, but in an ethical manner.

These ethical hackers test the systems in the company for a secured network quantitatively and evaluating weakness, flaws and threats.

Career Wise Now this kind of jobs leads to make a team of these experts in a company as a bright career option to do the intrusion testing or penetration testing as “Ethical Hackers”. There is a worldwide demand for information security professionals up to 60,000 and many of the multinational companies such as IBM, Infosys, Wipro, Reliance and Airtel looking for good ethical hackers as reported by a survey made by the International Data Corp.

Scope As the free lancers are not preferred by the reputed companies in India, you can work as the full-time company employee in the post of Information Security Specialist / Consultant. These kind of jobs opens the door for the professionals as an entry level job positions like Network Security Administrator, Network Defence Analyst, Web Security Administrator, Application Security Tester, Penetration Tester / Ethical Hacker, Security Auditor, otherwise you can choose for Secured Programmer, Cryptographer, or Forensic Professional.

The job responsibilities include Authorised Security Hacking to LAN Assessment, Application Testing, Security Tools Installation and Security Surveillance. There is an immense scope for a career growth and progression up the ladder up to the level of Chief Information Security Officer

Remuneration in India the scale of pay starts from Rs. 4-6 laks per annum and it can even rise to Rs.40 Lakhs. Top companies like IBM, Infosys, Wipro, Dell, Cap Gemini, Google etc with employment opportunities primarily in Chennai, Bangalore, Mumbai and Pune.

There is a belief that the information security professionals are have a chance to earn 20-30% higher than for most other professionals who are in the same positions in IT field.

ETHICAL HACKING

Skills The field is clearly open to Computer Science graduates, skilled computer experts or even to the talent of malicious hackers for a good reason. A high college level background, excellent computer programming talent and good networking skill in IT is required.

Qualification A degree in Computer Science/IT with good programming and network skills with a training certificate in a reputed training centre. You are suggested to update your knowledge through workshops, Seminars, and Trade Shows which gives you the latest tools, techniques and technologies. The training period can vary from a fast track of week time course up to 3 months course of fee starts from Rs. 10, 000 onwards.

Rajendra Ramesh Patole
Assistant Professor



What is 5G Technology?

The 5G technology is expected to provide a new (much wider than the previous one) frequency bands along with the wider spectral bandwidth per frequency channel. As of now, the predecessors (generations) mobile technologies have evidenced substantial increase in peak bitrate. Then, how is 5G different from the previous one (especially 4G)? The answer is it is not only the increase in bitrate made 5G distinct from the 4G, but rather 5G is also advanced in terms of:

- ▶ High increased peak bit rate
- ▶ Larger data volume per unit area (i.e. high system spectral efficiency)
- ▶ High capacity to allow more devices connectivity concurrently and instantaneously
- ▶ Lower battery consumption
- ▶ Better connectivity irrespective of the geographic region, in which you are
- ▶ Larger number of supporting devices
- ▶ Lower cost of infrastructural development
- ▶ Higher reliability of the communications.

As researchers say, with the wide range of bandwidth radio channels, it can support the speed up to 10 Gbps, the 5G Wi-Fi technology will offer contiguous and consistent coverage - "wider area mobility in true sense."

The key features of 5G are as follows:

FEATURE	BENEFITS
Higher throughput	Higher individual-user peaks, but more importantly increased overall system capacity to handle growth in users, devices, and resulting traffic demands
Reduced latency	Ability to handle time-bounded traffic for VoIP, streaming video, and applications with low tolerance for latency
Advanced management & OSS	Reduced operating expense for carriers and operators
High-motion mobility	Ability to support users on rapidly-moving modes of transportation
Improved security	Always a requirement
New spectrum	Utilization of millimeter-wave bands, radio carrier aggregation
New enabling technologies	Massive MIMO, small cells, SDN and NFV implementations, improved power efficiency
Universal applications support	Support for every application from low-data-rate/ high latency to demanding, real-time graphical applications
Industry growth	Provides new incentives to attract customers and increase revenues

Rohini Desai
Assistant Professor

MACHINE LEARNING APPLICATIONS IN FINANCE



Machine learning in finance may work magic, even though there is no magic behind it (well, maybe just a little bit). Still, the success of machine learning project depends more on building efficient infrastructure, collecting suitable datasets, and applying the right algorithms.

Machine learning is making significant inroads in the financial services industry. Let's see why financial companies should care, what solutions they can implement with AI and machine learning, and how exactly they can apply this technology.

Machine Learning Applications in Finance

1. Security : The number of transactions, users, and third-party integrations and machine learning algorithms are excellent at detecting frauds.

Banks can use this technology to monitor thousands of transactions. Such model spots fraudulent behavior with high precision and identifies suspicious account behavior.

Machine learning algorithms need a split second to assess a transaction. The speed helps to prevent frauds in real-time, not just spot them after the crime has already been committed.

2. Financial Monitoring : Data scientists train system to detect a large number of micropayments and flag. Money laundering techniques as smurfing is one such case which can be prevented by financial monitoring. Machine learning algorithms can significantly enhance network security. There is a huge possibility that these technology power the most advanced cybersecurity networks in the near future.

Companies like Adyen, Payoneer, Paypal, Stripe, and Skrill are notable fintech companies. These companies invest heavily in security machine learning.

3. Fraud Detection and Prevention : Do you remember 'Freedom 251'? It was a smartphone that was offered for sale in India at the promotional price of ₹251 by Ringing Bells Private Limited. Though it marketed itself as the world's cheapest smartphone, later it turned out to be the opposite of what it promised.

The company planned to sell 5 million phones in June 2016. Because of major bookings, the website crashed. It took bookings for 30,000 at Rs 251 price. Needless to say more, but it was a fraud scheme that the company tried to do.

I am not saying that in future doing such frauds are not possible. But, with, machine learning, Fraud Detection Software war against financial fraud, can be curbed.

4. Investment Predictions : Machine learning gives Advanced Market Insights. Using machine learning, the fund managers identify market changes earlier than possible with traditional investment models.

In no time, machine learning technology will disrupt the investment banking industry. Major institutions like JPMorgan, Bank of America, and Morgan Stanley have developed automated investment advisors. These are powered by machine learning technology. But, if you think that with investment prediction your

MACHINE LEARNING APPLICATIONS IN FINANCE

risk will be minimized, then it is never happening. Someone has rightly said it that someone's loss is someone's gain.

5. Risk Management : Lehman Brothers Holdings Inc. was a global financial services firm. It was the fourth-largest investment bank in the United States (behind Goldman Sachs, Morgan Stanley, and Merrill Lynch). Its operations were in the field of investment banking, equity and fixed-income sales and trading research, investment management, private equity, and private banking. But, the sad part is that its operations closed in 2008.

The reason for it getting collapse is that the global markets were hit and other banks were in precarious positions. They became heavily involved in the mortgage market and owed the subprime mortgage seller BNC Mortgage. The investor lost confidence in the bank. Thus the lack of risk management led to the subprime mortgage crisis.

6. Robo-advisory : Robo-advisors are now commonplace in the financial domain. In the advisory domain, there are two major applications of machine learning. They are:

- ▶ Portfolio management - It is an online wealth management service which uses algorithms and statistics to allocate, manage and optimize the clients' assets. Here, users enter their present financial assets and goals. For example - if Mr. X saves a million dollars by the age of 50, then a Robo-advisor will allocate the current assets across investment opportunities based on his risk preferences and the desired goals.
- ▶ Recommendation of financial products - You don't face a dilemma here, because many online insurance services use Robo-advisors to recommend you the personalized insurance plans. So, customers choose Robo-advisors over personal financial advisors to sort out the confusion. Robo-advisors can assist in lower fees, as well as personalized and calibrated recommendations are provided by them.

7. Customer Service : The problem with the financial institutions is that they want to achieve the targets and therefore try to lead the customer in the wrong direction. To gain maximum profits, they sometimes try to exploit the customer. So with the help of virtual assistants, biases can be reduced. The only true picture will be shown to the prospective investors and they can get accurate information and fast solutions to their problems.

Chatbots : Robots that do the talking

Though chatbots existed before also, their effectiveness was not that great. Now, with machine learning, they are enabled to learn. They adapt their approach based on the behavior of each customer. Rather than simply following a prescribed set of instructions, they can help a user address his query just like a normal human being.

8. Loan Underwriting : Machine learning helps in identifying risks and set high premiums. With historical patterns and current trends, it is the perfect vehicle for insurance companies to improve profitability. Machine learning reduces underwriting risks.

MACHINE LEARNING APPLICATIONS IN FINANCE

This risk can be handled in any field related to money protection. Be it a loan, health, mortgage, or life insurance, machine learning can help manage every risk.

9. Trade Settlements : Trade settlement means the process of exchanging payment and completing the settlement. A number of issues can cause hindrance in trade settlement. But, machine learning makes sure that this is not the case and there is no Trade Fails.

With modern trading platforms, regulatory requirements have reduced. This has reduced trade failures. The controlling of inefficiency solved manually. Now, with machine learning, not only the cause of failure be known, but a solution for the same can be provided. That too within a fraction of a second. Even better, by identifying exceptions to normal trading patterns, ML can predict which trades are likely to fail.

10. Marketing : Marketing helps corporate finance and banking domain people. With Predictive Analytics in marketing, the ability to make predictions based on past behaviors has become easy.

Web activity can be properly monitored, mobile app usage can be understood to find trends and patterns. Also, the response to previous ad campaigns can be analyzed. With machine learning software, accurate predictions are made and the effectiveness of a marketing strategy enhances.

11. Network Security : Computer Virus, Worms, Trojan Horses, Zombies, and Botnets are the viruses existing for a long time. The major challenge was to identify modern sophisticated cyberattacks, as it cannot be relegated to yesterday's security software.

With advanced technology, machine learning security solutions are capable of securing the world's financial data. Power of intelligent pattern analysis, combined with big data capabilities, provides ML security technology an edge over traditional, non-AI tools.

12. Algorithmic Trading : It is automated pre-programmed trading where instructions account for variables such as time, price, and volume send small slices of the order out to the market over time. With automation in the trading process, predefined criteria are set. This is done by the trader or the fund manager.

They make trade predictions and are especially curated to analyze historical market behavior and determine an optimal market strategy.

13. Content Creation : Gone are the days where the content writers, artists, and other content creators have to stress their brains out (Creative people :P). With the advancement in Natural Language Processing (NLP) and machine learning, the machine is able to generate content.

Content written by financial institutions is repetitive. There is little need to create new content or add to the new one. Financial summaries(Balance sheet and P/I) company profiles, and even stock reports can easily be written by ML software. Time is money, Machine learning knows it better than humans.

Sanjeela Sagar
Assistant Professor



Introduction

Natural Language Processing is a branch of artificial intelligence that deals with the interaction between computers and humans using the natural language.

The ultimate objective of NLP is to read, decipher, understand, and make sense of the human languages in a manner that is valuable.

The Process of Natural Language Processing

In the NLP process, a text is composed of speech, speech-to-text conversion is performed.

In this mechanism, it involves two processes :

1. Natural Language Understanding (NLU)

We use natural language understanding to learn the meaning of a given text. For NLU, we must understand the nature and structure of each word.

- i. Lexical Ambiguity : words have multiple meanings
- ii. Syntactic Ambiguity : the sentence having multiple parse trees.
- iii. Semantic Ambiguity : the sentence having multiple meanings
- iv. Anaphoric Ambiguity : In this phrase or word are presents. That is previously mentioned but has a different meaning.

2. Natural Language Generation (NLG)

Basically, automatic text produced from structured data. That is in a readable format with meaningful phrases and sentences.

Natural language generation divided into three proposed stages:

- i. Text Planning : ordering of content in structure data.
- ii. Sentence Planning : Generally, from structured data, we have to combine sentences to represent the flow of information.
- iii. Realization : to represent text we use a grammatically correct sentence.

NLP tools and libraries

Natural language processing helps us to understand the text receive valuable insights. NLP tools give us a better understanding of how the language may work in specific situations. Moreover, people also use it for different business purposes. Such proposes might include data analytics, user interface optimization, and value proposition.

1. NLTK - entry-level open source NLP Tool

Natural Language Toolkit (AKA NLTK) is an open-source software powered with Python NLP. From this point, the NLTK library is a standard NLP tool developed for research and education.

NLTK provides users with a basic set of tools for text-related operations. It is a good starting point for beginners in Natural Language Processing.

Natural Language Toolkit features include :

- ▶ Text classification
- ▶ Part-of-speech tagging
- ▶ Entity extraction
- ▶ Tokenization
- ▶ Parsing
- ▶ Stemming
- ▶ Semantic reasoning

2. Stanford Core NLP - Data Analysis, Sentiment Analysis, Conversational UI

We can say that the Stanford NLP library is a multi-purpose tool for text analysis. Like NLTK, Stanford CoreNLP provides many different natural language processing software. But if you need more, you can use custom modules.

The main advantage of Stanford NLP tools is scalability. Unlike NLTK, Stanford Core NLP is a perfect choice for processing large amounts of data and performing complex operations.

With its high scalability, Stanford CoreNLP is an excellent choice for:

- ▶ Information scraping from open sources (social media, user-generated reviews)
- ▶ Sentiment analysis (social media, customer support)
- ▶ Conversational interfaces (chatbots)
- ▶ Text processing, and generation(customer support, e-commerce)

This tool can extract all sorts of information. It has smooth named-entity recognition and easy mark up of terms and phrases.

3. Apache OpenNLP - Data Analysis and Sentiment Analysis

Accessibility is essential when you need a tool for long-term use, which is challenging in the realm of Natural Language Processing open-source tools. Because while being powered with the right features, it could be too complex to use.

Apache OpenNLP is an open-source library for those who prefer practicality and accessibility. Like Stanford CoreNLP, it uses Java NLP libraries with Python decorators.

While NLTK and Stanford CoreNLP are state-of-the-art libraries with tons of additions, OpenNLP is a simple yet useful tool. Besides, you can configure OpenNLP in the way you need and get rid of unnecessary features.

Apache OpenLP is the right choice for :

- ▶ Named Entity Recognition
- ▶ Sentence Detection
- ▶ POS tagging
- ▶ Tokenization

You can use OpenNLP for all sorts of text data analysis and sentiment analysis operations. It is also perfect in preparing text corpora for generators and conversational interfaces.

4. SpaCy - Data Extraction, Data Analysis, Sentiment Analysis, Text Summarization

SpaCy is the next step of the NLTK evolution. NLTK is clumsy and slow when it comes to more complex business applications. In the same time, SpaCy provides users with smoother, faster, and efficient experience.

SpaCy, an open-source NLP library, is a perfect match for comparing customer profiles, product profiles or text documents.

SpaCy is good at syntactic analysis, which is handy for aspect-based sentiment analysis and conversational user interface optimization. SpaCy is also an excellent choice for named-entity recognition. You can use SpaCy for business insights and market research.

SpaCy is also useful in deep text analytics and sentiment analysis.

5. AllenNLP - Text Analysis, Sentiment Analysis

Built on PyTorch tools & libraries, AllenNLP is perfect for data research and business applications. It evolves into a full-fledged tool for all sorts of text analysis. This way, it is one of the more advanced Natural Language Processing tools on this list.

AllenNLP uses SpaCy open-source library for data preprocessing while handling the rest processes on its own.

6. GenSim - Document Analysis, Semantic Search, Data Exploration

Sometimes you need to extract particular information to discover business insights. GenSim is the perfect tool for such things. It is an open-source NLP library designed for document exploration and topic modeling. It would help you to navigate the various databases and documents.

The main GenSim use cases are :

- ▶ Data analysis
- ▶ Semantic search applications
- ▶ Text generation applications (chatbot, service customization, text summarization, etc.)

7. TextBlob Library - Conversational UI, Sentiment Analysis

TextBlob is the fastest natural language processing tool.

TextBlob is an open-source NLP tool powered with NLTK. It could be enhanced with extra features for

more in-depth text analysis. Other TextBlob notable feature is a machine translation.

TextBlob also provides tools for sentiment analysis, event extraction, and intent analysis features.

8. Intel NLP Architect - Data Exploration, Conversational UI3

Intel NLP Architect is the newer application in this list. Intel NLP Architect uses Python library for deep learning using recurrent neural networks.

You can use it for :

- ▶ text generation and summarization
- ▶ aspect-based sentiment analysis
- ▶ and conversational interfaces such as chatbots
- ▶ One of its most exciting features is Machine Reading Comprehension.

Ms. Seema Murkar
Assistant Professor

MICROARRAY TECHNOLOGY



Molecular Biology research evolves through the development of the technologies used for carrying them out. It is not possible to research on a large number of genes using traditional methods. DNA Microarray is one such technology which enables the researchers to investigate and address issues which were once thought to be non traceable. One can analyze the expression of many genes in a single reaction quickly and in an efficient manner. DNA Microarray technology has empowered the scientific community to understand the fundamental aspects underlining the growth and development of life as well as to explore the genetic causes of anomalies occurring in the functioning of the human body. A typical microarray

experiment involves the hybridization of an mRNA molecule to the DNA template from which it is originated. Many DNA samples are used to construct an array. The amount of mRNA bound to each site on the array indicates the expression level of the various genes. This number may run in thousands. All the data is collected and a profile is generated for gene expression in the cell.

Microarray Technique

An array is an orderly arrangement of samples where matching of known and unknown DNA samples is done based on base pairing rules. An array experiment makes use of common assay systems such as microplates or standard blotting membranes. The sample spot sizes are typically less than 200 microns in diameter usually contain thousands of spots. Thousands of spotted samples known as probes (with known identity) are immobilized on a solid support (a microscope glass slides or silicon chips or nylon membrane). The spots can be DNA, cDNA, or oligonucleotides. These are used to determine complementary binding of the unknown sequences thus allowing parallel analysis for gene expression and gene discovery. An experiment with a single DNA chip can provide information on thousands of genes simultaneously. An orderly arrangement of the probes on the support is important as the location of each spot on the array is used for the identification of a gene.

The DNA microarray is a tool used to determine whether the DNA from a particular individual contains a mutation in genes like BRCA1 and BRCA2. The chip consists of a small glass plate encased in plastic. Some companies manufacture microarrays using methods similar to those used to make computer microchips. On the surface, each chip contains thousands of short, synthetic, single-stranded DNA sequences, which together add up to the normal gene in question, and to variants (mutations) of that gene that have been found in the human population.

DNA microarray used for

DNA microarrays were used only as a research tool. Scientists continue today to conduct large-scale population studies - for example, to determine how often individuals with a particular mutation actually develop breast cancer, or to identify the changes in gene sequences that are most often associated with particular diseases. Today, DNA microarrays are used in clinical diagnostic tests for some diseases. Sometimes they are also used to determine which drugs might be best prescribed for particular individuals, because genes determine how our bodies handle the chemistry related to those drugs.

MICROARRAY TECHNOLOGY

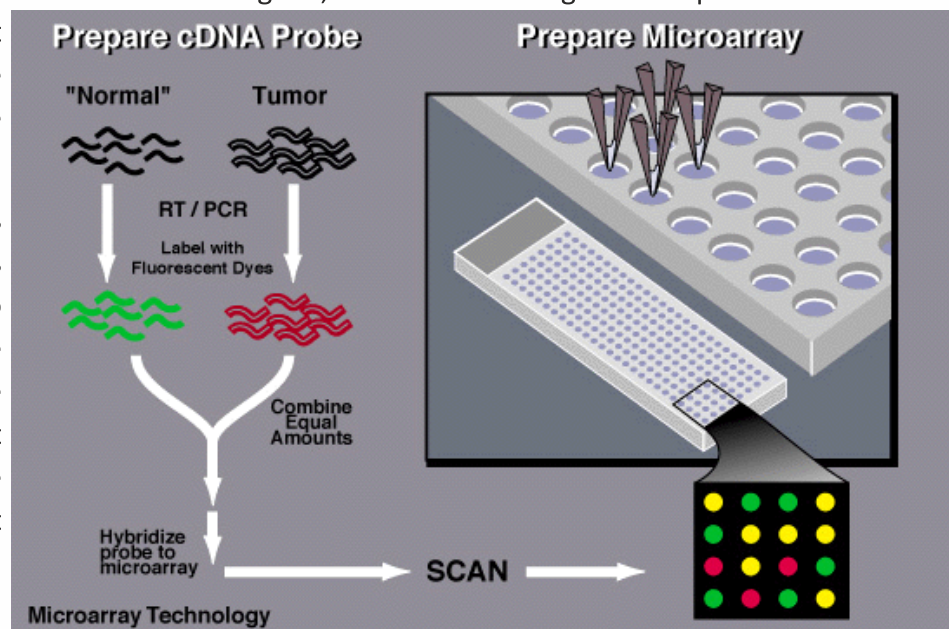
How does a DNA microarray work ?

To determine whether an individual possesses a mutation for a particular disease, a scientist first obtains a sample of DNA from the patient's blood as well as a control sample - one that does not contain a mutation in the gene of interest.

The researcher then denatures the DNA in the samples - a process that separates the two complementary strands of DNA into single-stranded molecules. The next step is to cut the long strands of DNA into smaller, more manageable fragments and then to label each fragment by attaching a fluorescent dye (there are other ways to do this, but this is one common method). The individual's DNA is labeled with green dye and the control - or normal - DNA is labeled with red dye. Both sets of labeled DNA are then inserted into the chip and allowed to hybridize - or bind - to the synthetic DNA on the chip.

If the individual does not have a mutation for the gene, both the red and green samples will bind to the sequences on the chip that represent the sequence without the mutation (the "normal" sequence).

If the individual does possess a mutation, the individual's DNA will not bind properly to the DNA sequences on the chip that represent the "normal" sequence but instead will bind to the sequence on the chip that represents the mutated DNA.



Types of Microarrays

1. Microarray Expression Analysis : In this experimental setup, the cDNA derived from the mRNA of known genes is immobilized. The sample has genes from both the normal as well as the diseased tissues. Spots with more intensity are obtained for diseased tissue gene if the gene is over expressed in the diseased condition. This expression pattern is then compared to the expression pattern of a gene responsible for a disease.

2. Microarray for Mutation Analysis : For this analysis, the researchers use gDNA. The genes might differ from each other by as less as a single nucleotide base. A single base difference between two sequences is known as Single Nucleotide Polymorphism (SNP) and detecting them is known as SNP detection.

3. Comparative Genomic Hybridization : It is used for the identification in the increase or decrease of the important chromosomal fragments harboring genes involved in a disease.

Applications of Microarrays

Gene Discovery : DNA Microarray technology helps in the identification of new genes, know about their functioning and expression levels under different conditions.

Disease Diagnosis : DNA Microarray technology helps researchers learn more about different diseases such as heart diseases, mental illness, infectious disease and especially the study of cancer. Until recently, different types of cancer have been classified on the basis of the organs in which the tumors develop. Now, with the evolution of microarray technology, it will be possible for the researchers to further classify the types of cancer on the basis of the patterns of gene activity in the tumor cells.

Drug Discovery : Microarray technology has extensive application in Pharmacogenomics. Pharmacogenomics is the study of correlations between therapeutic responses to drugs and the genetic profiles of the patients. Comparative analysis of the genes from a diseased and a normal cell will help the identification of the biochemical constitution of the proteins synthesized by the diseased genes. The researchers can use this information to synthesize drugs which combat with these proteins and reduce their effect.

Toxicological Research : Microarray technology provides a robust platform for the research of the impact of toxins on the cells and their passing on to the progeny. Toxicogenomics establishes correlation between responses to toxicants and the changes in the genetic profiles of the cells exposed to such toxicants.

Shobha Nalavade
Assistant Professor

VERTICAL FARMING



Cyber-Agriculture, or more generally Vertical farming, is a plant-growing format that employs contained environments where light, water, nutrients, temperature, and other climate variables are provided artificially under computer control. With cyber-agriculture, in principle it may be possible to increase quality and quantity of food production, minimize waste and cost, and grow food with optimized climate recipes anywhere including locations otherwise unable to support agriculture.

Why is conventional farming frustrating us?

Field farming requires labour, amenable weather conditions, adequate sunshine for photosynthesis, irrigation, and often pesticides to protect crops. That hasn't changed, but the reasons why conventional farming is no longer working are as follow :

1. **Demographic and social changes** : The global food supply cannot keep up with the growing global population. Urbanization is taking over arable land while simultaneously pushing people away from farming as a profession.
2. **Resource scarcity** : Agriculture utilizes major percent of our global water consumption, adding to its total cost.
3. **Inequality** : The costs of agriculture continue to rise, the prospect of improving health and nutrition conditions are dire for low-income families in industrialized and developing countries.
4. **Volatility** : Agriculture remains one of the most vulnerable industries when it comes to natural disasters. Climate change has caused more frequent extreme weather events, which can damage an entire season's worth of harvest.

Vertical farming born out of challenges

Vertical farming is really the answer to the shortage of food in the world. This method is especially handy for challenging environments such as deserts, mountainside towns.

These “farms” make use of enclosed structures like warehouses and shipping containers to provide a controlled environment to grow crops in a hydroponic or aeroponic system.

Electronic sensors ensure that crops receive the right amount of LED light, nutrients, and heat.

Vertical farming is more suitable method of agriculture for following reasons-

1. Hydroponics – Growing Plants Without Soil

It involves around the growth of plants in solutions of nutrients that are essentially free of soil. In this vertical farming innovation, the roots of the plants are submerged in a solution of nutrients. This is frequently circulated and monitored in order to ensure that there is the maintenance of the correct chemical composition in the nutrient solution.

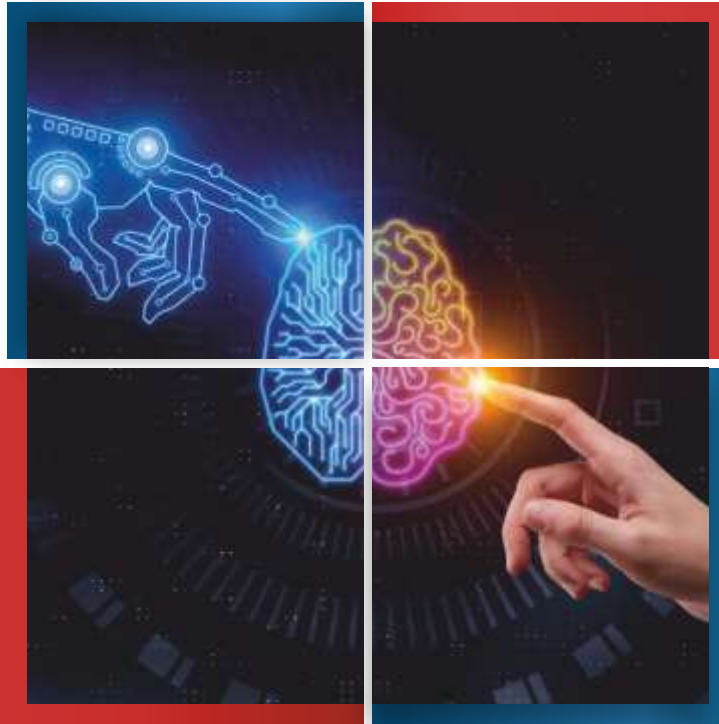
2. Aeroponics - Growing Plants with No Soil and Very Little Water

It is undoubtedly the most efficient way in vertical farming as it uses a staggering 90% less amount of water than the most efficient hydroponics systems too. It has also been observed that the plants that are grown with the aeroponics system uptake more vitamins and minerals, thus making the plants potentially healthier and more nutritious.

Vertical farming system is capable of producing 10 times more yield compared to traditional farms. Vertical farming is definitely an attractive option for farmers these days. It promises a much more sustainable way of farming in addition to not just producing quality produce but also cutting down on costs and making agriculture eco-friendlier.

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