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Chapter - 1

Smart City

Y. Sudha, P. Pooja, P. Kamalakar and P. Ganesh

Abstract

A smart city is a municipality that uses information and communication technologies (ICT) to increase operational efficiency, share information with the public and improve both the quality of government services and citizen welfare. In practice, the Smart Cities challenge in India not only seeks technological leapfrogging but a giant leap of faith. Unlike smart phones and smart card technology, smart cities could neither be imported nor transplanted, they probably need to be adapted to the local context and assessed for their value to urban sustainability. The development of a country depends on the City and village's development. A part of the smart colony concept, we need a system that helps in development of city in the areas. Funding is the biggest challenge to implementing a smart city strategy. Making cities smart means deploying smart, complex infrastructure for implementing digital technologies. Besides, tons and tons of smart devices have to be integrated for data collection. Smart another most-pressing challenge for smart cities is the lack of skilled professionals. Cities should be taken as a logical opportunity to realize this challenge, with sustainable urbanization as the over-arching goal.

Keywords: smart city, ICT, urban, challenges and development

1. Introduction

The concept of smart city was first addressed in 1990s with an aim to centre the implications of information communication technology for superior infrastructures and upgradations in networks [1]. The widespread use of information technologies also enables cities to empower the advancement of indispensable services for safety, health, governance and delivery.

Smart cities are filled with connected devices acting as sensors and replacing standard city services. Cameras, street lights, motion sensors, parking meters and other devices are all collecting data to improve situational awareness.

In Figure 1, smart cities use intelligent solutions to optimize infrastructure and smart and responsive governance to engage citizens in the management of their city. A system of sensors, networks, and applications collect useful data, like traffic congestion, energy use, and CO_2 levels [2].

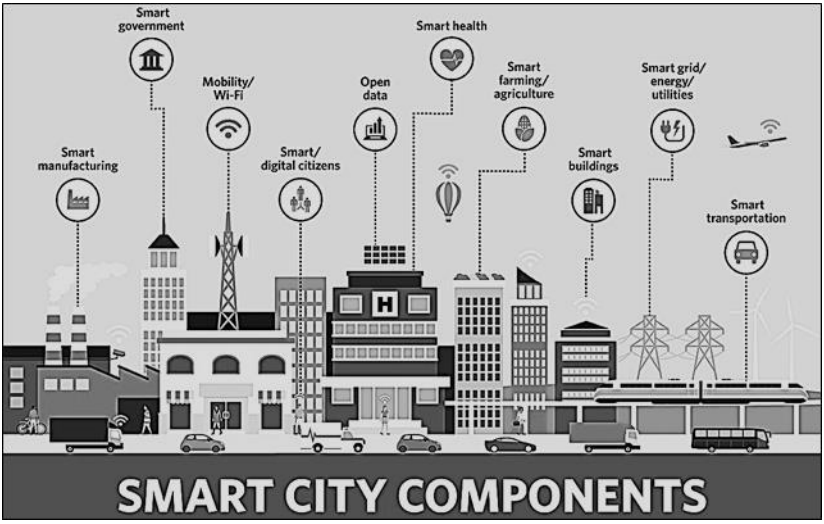

Fig 1: Components of Smart City

Smart cities utilize their web of connected IoT devices and other technologies to achieve their goals of improving the quality of life and achieving economic growth.

Successful smart cities follows

- **Collection:** Smart sensors throughout the city gather data in real time
- **Analysis:** Data collected by the smart sensors is assessed in order to draw meaningful insights
- **Communication:** The insights that have been found in the analysis phase are communicated with decision makers through strong communication networks
- **Action:** Cities use the insights pulled from the data to create solutions, optimize operations and asset management and improve the quality of life for residents

1.1 Features of smart cities

- Adequate water supply
- Assured electricity supply

- Sanitation, including solid waste management
- Efficient urban mobility and public transport
- Affordable housing, especially for the poor
- Robust IT connectivity and digitalization
- Good governance, especially e-Governance and citizen participation

2. Challenges

In Figure 2, a new generation of community and technology leaders, managers and solutions providers is needed to build this smart city ecosystem [3]. These architects think broadly and work across layers. They operate in the intersection of technology, innovation, business, operations, strategy and people. This is the "no man's" land where traditional boundaries, processes, policies and rules fail. This is where the hardest problems are. And this is where the real smart city begins.

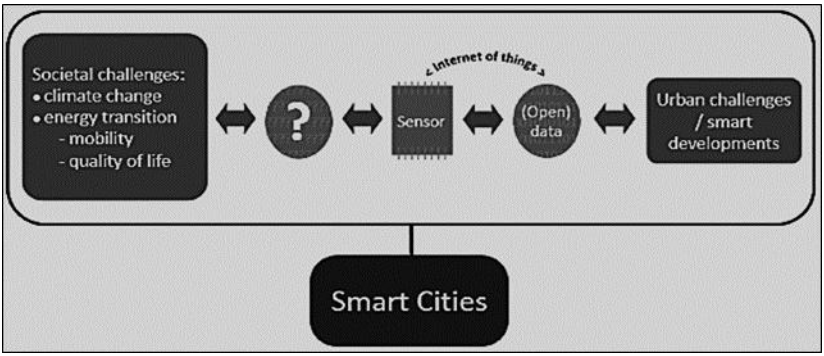

Fig 2: Challenges in Smart City

A smart city is a novel solution to make efficient use of natural resources, improve the citizens' standard of living, and also achieve economic development. However, to achieve success, challenges for smart cities should be addressed first.

- In building the cities of tomorrow, these smart city ecosystem architects must focus on these areas:

1) Break silos and build bridges
2) Focus on outcomes that matter
3) Engage a broader community of innovators
4) Develop mastery in policymaking and partnerships
5) Enable "city data", not open data

6) Modernize the infrastructure
7) Design trust into the smart city

1. Break silos and build bridges

A sustainable and well-functioning smart city is a tight orchestration of people, processes, policies and technologies working together across the entire smart city ecosystem. These architects unify teams across municipal departments. They build bridges to connect public and private organizations within the ecosystem. They build consensus to co-create the new city.

2. Focus on outcomes that matter

A smart city is not about technology, but about using technology together with the various ecosystem layers to create the results residents, businesses, municipal organizations and visitors care about. These results, or outcomes, are aligned around the needs of the city-government efficiency, sustainability, health and wellness, mobility, economic development, public safety and quality of life.

3. Engage a broader community of innovators

Within the smart city, innovation and value creation comes not only from municipal agencies, but, from businesses, communities (business districts, "smart" buildings, housing complexes), and individual residents. Smart city ecosystem architects unify the various layers to enable, incentivize, facilitate and scale this larger community to co-create the smart city together.

4. Develop mastery in policymaking and partnerships

Policies and partnerships are the catalysts of the smart city. They augment and amplify limited city resources and capabilities, scale faster, while minimizing risk. Effective smart city ecosystem architects unite the needs of policymakers, technologists and innovators to create sensible policies that create the right outcomes. They proactively seek out public and private collaborators and build sustainable and synergistic partnerships.

5. Enable "city data", not open data

Data is the lifeblood of the smart city. Open data, generated by municipal organizations, is only one source of data. When supplemented with data created by businesses and private citizens, it yields richer insights and better outcomes. Smart city ecosystem architects utilize the full extent of the ecosystem to create "city data". They plan and build data marketplaces, robust data sharing and privacy policies, data analytics skills, and monetization models that facilitate the sourcing and usage of "city data".

6. Modernize the infrastructure

Today's smart city infrastructure is a hodge-podge of legacy systems, purpose built departmental technology and smart city point solutions. Cities must modernize their digital infrastructure, while expanding integration to the broader external ecosystem. Cyber-security and technology policies, processes and systems must be revised to be smart city centric, not IT centric. Digital skills, from data analytics, machine learning to software engineering, must be the new competencies of the smart city.

7. Design trust into the smart city

The smart city is only as smart as the trust its stakeholders have in it. Right from the start, smart city architects must design in trust across the entire ecosystem. The technology infrastructure must be secure. Information collected must be protected, and used in accordance with its owners' wishes. Policies, legislation and technology must be continuously aligned to maintain the right balance of protection, privacy, transparency, and utility. The infrastructure must be robust, resilient and reliable.

3. Opportunities

Making cities smart, connected, and resilient has been the mission of developed and developing countries worldwide. By using digital technologies, city functions are streamlined and optimized while keeping negative ecological impact to a minimum [4-5]. Along with this, smart cities boost financial gains and improve the citizen's quality of life.

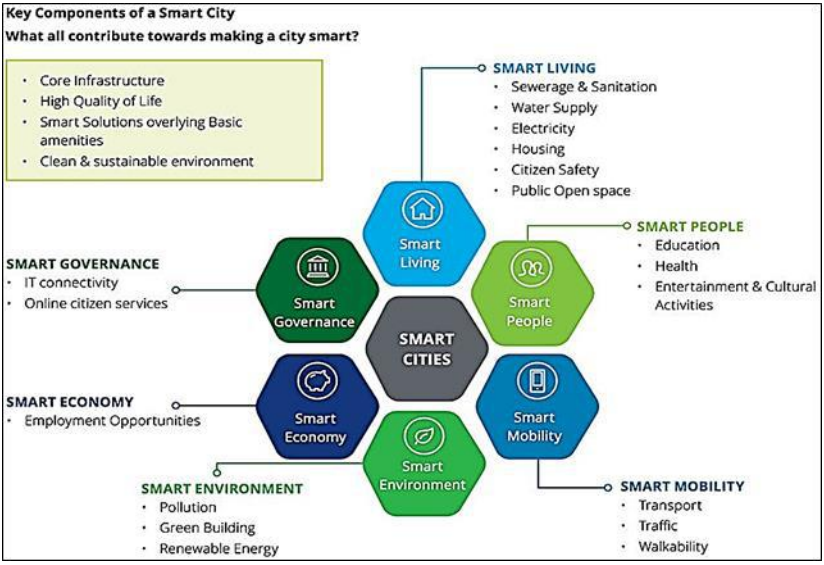

Fig 3: Opportunities in Smart City development

In Figure 3, smart cities use a combination of the internet of things (IoT) devices, software solutions, user interfaces (UI) and communication networks. However, they rely first and foremost on the IoT. The IoT is a network of connected devices-such as vehicles, sensors or home appliances-that can communicate and exchange data. Data collected and delivered by the IoT sensors and devices is stored in the cloud or on servers. The connection of these devices and use of data analytics (DA) facilitates the convergence of the physical and digital city elements, thus improving both public and private sector efficiency, enabling economic benefits and improving citizen's lives.

Smart cities security issues

Security challenges in smart cities are the reason why many people are skeptical about smart city projects. IoT devices are essentially security loopholes. The growing number of IoT sensors and the increased interconnectivity of mutually interdependent siloes of city infrastructure raises rightful concerns. If the security standards remain unchanged, cybercriminals could one day shut down an entire city [6].

Fortunately, tech companies are creating security solutions based on big data analytics, blockchain and encryption technologies which are designed to handle increasingly more sophisticated cyber-attacks. Smart city developers are investing in these new generation security systems to eliminate threats.

Other smart city technologies include

- Application Programming Interfaces (APIS)
- Artificial Intelligence (AI)
- Cloud Computing
- Dashboards
- Machine Learning (ML)
- Machine to Machine (M2M)
- Mesh Network

The use of ICT in cities in various forms for different city activities has led to the increased effectiveness of city operations and these cities have been labeled using many terms such as “cyberville”, “digital city”, “electronic city”, “flexicity”, “information city”, “telicity”, “wired city” and “smart city”. Smart city is the largest abstraction among the labels used as it encompasses other labels used for cities [7].

The smart city is a concept and there is still not a clear and consistent definition of the concept among academia and practitioners. In a simplistic

explanation, a smart city is a place where traditional networks and services are made more flexible, efficient, and sustainable with the use of information, digital and telecommunication technologies, to improve its operations for the benefit of its inhabitants.

4. Conclusion

Every city is different but here are a couple of broad initiatives that can lead to better cities: Reduce local control over development in favor of regional or city based zoning laws. Kill the nimby threat and allow the free market to provide the housing stock needed for residents at the price points they want. Smart cities use data and technology to create efficiencies, improve sustainability, create economic development, and enhance quality of life factors for people living and working in the city. Amongst these things, energy is paramount; this is why utility companies play a key role in smart cities.

Drawbacks of smart city

- Cities lack technology related skills and capacity
- Cities find it difficult to work across departments and boundaries
- There are concerns about data privacy and security

The "smartness" of a city describes its ability to bring together all its resources, to effectively operate with maximum possible efficiency to fulfil the purposes it has set itself. The future smart city will include a host of clean energy sources to power its city. Energy in smart cities is efficient, using less energy because of the constant real-time data collection and analysis.

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Chapter - 2
Deep Learning (DL) Techniques in Enhancing the Security of IoT Devices

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Chapter - 2

Deep Learning (DL) Techniques in Enhancing the Security of IoT Devices

Mahmoud Ahmad Al-Khasawneh

Abstract

The advancement of the Internet of Things (IoT) paradigm has led to advancements in connectivity of the embedding computing technologies along with their decreasing costs and rising performance. Now, many billion Internet-connected devices fall under the Internet of Things. IoT devices have become an integral part of many devices infrastructure which supports many of our daily activities. In recent years the protection of these IoT devices has received a great deal of attention. Another big recent trend is the amount of data generated daily that has reignited interest in technology like machine learning and artificial intelligence. We are investigating the ability of deep learning (DL) techniques to improve the safety of IoT apps.

1. Introduction

Internet of Things (IoT) allows users easy utilization of Internet-connected devices in addition to a smooth connectivity to complete their day-to-day cyberspace activities. The amount of devices connecting to the IoT ecosystem is increasing, leading to the increase in the size of possible attack surfaces. In fact, the presence of countless of devices of IoT being interconnected into the IoT environment has increased the likelihoods of further attacks, while providing security to IoT devices within the cyberspace is a highly challenging task. As an example, with the utilization of IoT search engine like Shodan, countless of other devices, for instance, home security cameras with crucial ports (e.g., port #143 for the Internet Message Access Protocol or #445 the Microsoft Directory Services), are now becoming common. Somehow, it should be noted that a lot of these devices are still utilizing default login authorizations. As IoT usage is rapidly spreading, the use of insecure protocols like Telnet is becoming common again. Also, a lot of these Internet-enabled devices involve the use of wireless communication technologies, and therefore, without proper measure of security, they can be accessed accessible beyond the perimeter of conventional wired network.

The recent data exfiltration performed via an Internet-connected aquarium thermostat device was a type of such attack reported in [1]. Interestingly, the device was located on an Intranet belonging to a casino, and the assailants utilized it in obtaining access to the internal network and they then transported the data amounting to more than a few gigabytes from the high- roller database belonging to the casino out of the network. The database keeps private information on the casino's richest high-roller guests. The impact of infiltrated IoT devices expands beyond individuals or organizations that hold them on their networks. As explained in [2-5], IoT devices that have been compromised are usable as fragment of a botnet in the sendoff of attacks of large-scale denial-of-service (DoS) on other networks as well as systems. The attacks incur cost to both organizations and society [6] and according to a recent report, for small firms in USA, the cost of IoT hacks was worth 13% of the firms' yearly revenue [7].

Security of IoT that is solid and cost-effective is desirable but harder to achieve as opposed to the traditional information security. A number of reasons have been linked to this situation [8]. Firstly, it is common for IoT devices to involve the use of wireless connections, and parties outside of the organization's internal network perimeter may again access to them. Another point worth noting is that update of firmware and patching of vulnerability are commonly carried out on customary IT systems, but to assure security of IoT, the automatic updates of firmware/software and mechanisms of patching have not been implemented successfully. In fact, users of IoT devices have been found to perform updates or patching that is ineffective most of the time. Also, IoT devices are generally small in terms of size, and have inadequate storage and computing power. For this reason, it is difficult to apply similar security controls used on the traditional networked computing systems [9-17].

2. IOT characteristics and common attacks

There are countless of environments that IoT devices operate in, and this situation is different for the traditional computing devices. It is common for IoT to carry specific functions and objectives backed by their distinctive characteristics. IoT devices have been found to be vulnerable against the traditional types of attacks, and these attacks generally target the unique properties IoT devices. The following section will present several common characteristics associated with IoT devices and the common attacks these devices have been facing.

3.1 Characteristics of IoT devices

A number of characteristics specific to devices of IoT are identified and deliberated as follows:

3.1.1 Sensing

There are many kinds of sensors implementable into IoT devices, and among these sensors, some can possibly be used in a device according to the area of usage. Vehicle sensors, body sensors, and environmental sensors are among the examples of sensors available [18]. However, sensors can misread or fail in reading at certain interval, and this contribute to error rates of measurement or missing data completely. Such is a common limitation of sensors, and in order to rectify these anomalies of data, various statistical methods have been proposed [19].

3.1.2 Dynamic states

As opposed to other computing device, IoT devices function as finite-state automata (this is at the device- level), and the anticipation is that these devices will change between states, for instance, sleeping states and active state, in accordance with the changes in the environment and their protocol of programming. Also, such changes form distinctive circumstances associated with that of data availability. To illustrate; when the device is 'sleeping,' the sensor may not be reading. Hence, there are no documented data for that specific time period. In other words, there are missing data.

It should be noted that the traditional approaches cannot replaced the missed data, and hence, a daily average cannot be used in filling the missing values. As a solution, an analyst who monitors certain device would provide verification if the data deficiency accords with the device condition, and class the event as a false positive. In the application of algorithms of machine learning to have this process automated, the models of learning have to include all sorts of network traffic behavior specifically associated with the condition of a device, for instance, during 'sleep' state, the transmitted network packets are significantly lower, by 80% [20].

3.1.3 Connectivity

Wired network connection is commonly used by traditional networked devices. Among such devices include those utilized in the environments of industrial control [21-22]. Nonetheless, the applications of wireless technologies including Zigbee and 802.11-based networks (among others) are becoming more common within the aforementioned industrial control systems. The use of Zigbee in IoT devices has been observed, and such use requires low amount of power, expanding the battery life [23-24]. However, in regards to their throughput, these protocols are much slower, at specifically 250 Kbit/s., with shorter range. Moreover, 802.11 communications interfere with those of Zigbee, causing more and more loss of packet [25].

3.1.4 Limited hardware resources

The reduction of the cost associated with IoT devices in addition to their consumption of power resulted in the limited computing resources of these devices. In some devices of IoT, memory appears to be the least accessible resource, whereby some of these devices have memory capacity of just a few Kilobytes. Furthermore, limitations of CPU restricts the obtainability of services which can operate on these devices. Such drawbacks that are associated with hardware directly affect the type of machine learning that can be appropriately used in securing these devices of IoT.

3.1.5 Heterogeneity

Configurations of IoT are extensive and this is regarded as a limiting factor. Hence, each implementation of IoT may need customized solutions. As an example, lightweight protocols are being applied in countless of devices including in Message Queuing Telemetry Transport (MQTT). MQTT encompasses a transport protocol known as publish- subscribe messaging [26] that distributes throughput that is higher than that of HTTP, at considerably smaller amount of resources. Notably, the application of MQTT requires a designated broker device playing the role of collector from the entire devices of IoT. During sensor information retrieval, user accesses the broker device, rather than the IoT devices.

3.2 Common attacks on IoT devices

The present section briefly discusses several common attacks on IoT devices-detailed discussions on these attacks can be referred in the relevant literature [27-28]. The brief discussion of these attacks will help increase the understanding of the advantages of different machine learning defense. DOS attacks result in IoT device failure, or the attacks can use an infected IoT device in launching other DoS attacks [31]. IoT involves the use of lightweight communication channel and the attacks overwhelm the channel, causing failure to the device. In addition, there are weak security and maintenance as in the use of default authorization credentials that vendor of IoT device has set and failure of IoT device owner in regularly updating the firmware and software of the device.

Attacks of DOS can also be in a form of bad packets creation for the purpose of disabling the device. This can be exemplified by the replacement of a selected domain within a packet which describes the length of payload with an unsuitable value, leading to an overflow of buffer within the system of the device or causing exhaustion to the system resources in dealing with such situation. Likewise, an attacker can reiterate past packets, and this can

cause disruption to the device operation or the network communications. Another type of attack is spoofing which involves an imitation of an existing device within the IoT network. The purpose of spoofing is to gain access to the communication channel. Another aim of spoofing is to establish the platform for an upcoming attack known as man-in-the-middle.

An attack called 'Man- in- the- middle' involves eavesdropping and alteration of transmitted information over a channel of communication. During the attack, the attacker would usually mimic the gateway of IoT that links various IoT devices [27]. An attack known as eavesdropping is usually launched to obtain information from channels of IoT. For most attacks, surveillance appears to be their initial step. Hence, attackers generally would target the communication channels that are easily accessible. In IoT communications, the locally or remotely exchanged data is usually unencrypted either owing to dearth of options or owing to carelessness by the administrators of the system. In other forms of attacks, viruses, Trojans, and worms have been used to compromise, control, and gather information from IoT devices [27, 30]. For instance, during a Trojan installation, an attacker may benefit from the vulnerability of remote execution service on an IoT device; the use of Trojan allows the attacker access to the device.

Owing to their problem solving abilities, algorithms of learning have been expansively applied in various real-life applications. These learning algorithms manage the formation of machines that advance automatically by way of experience [33]. The growth of new algorithms, and the presence of low-computation-cost algorithms and big data have been the key factors driving the progression of learning algorithms [33]. The last few years have shown the significant progression of both ML and DL, beginning from laboratory inquisitiveness to hands-on machinery with important and comprehensive noteworthy applications [33]. Notably, DL is a sub-field of ML. ML methods require engineered features. On the other hand, DL methods, which encompass current developments of learning methods, use a number of non-linear layers of processing for abstraction of discriminative or generative feature and transformation for analysis of pattern [34].

The use of learning algorithms is for performance improvement, and for completing certain task facilitated by training and learning from experience. This can be exemplified by the detection of learning intrusion whereby the task is to perform classification to the behavior of the system as normal or abnormal. Appositely, the improvement of classification accuracy will lead to better performance. Further, the experiences gained by the algorithms learn encompass a group of behaviors of normal system. There are three major

classes of learning algorithms as follows: supervised, unsupervised and reinforcement learning (RL).

In methods of supervised learning, the model of classification or prediction is formed via learnt mapping [33] and observation of input parameters. Hence, supervise learning portrays the associations between the parameters of input (features) and the mandatory output. Hence, learning examples are needed at the beginning stage in order to train the algorithms which are then applied in the prediction and classification of the new input [35]. The application of deep networks is the new development of supervised learning. As highlighted in [33], the networks can be regarded as multilayer networks comprising units of threshold. As mentioned in [36-37], the threshold units compute the function of its input.

Evidently, countless of practical insights of DL come from methods of supervised learning for depictions of learning. Somehow, current works have demonstrated their ability in enhancing DL systems that acquire the important input representations without pre-labelled training data [38]. Meanwhile, these algorithms of learning encompass methods of unsupervised learning that are usually employed in the analysis of unlabeled data. Through examination of similarity between input data, unsupervised learning algorithm classes the input data into unique groups.

RL is another common type of ML [39-40] and RL algorithms are trainable using the data obtained from a given environment. As mentioned, RL cognizes an environment and finds the most ideal approaches to specific agent in various environments [41].

Within the context of RL, the training data are partly supervised and partly unsupervised learning data. For training samples, the right output is made available for certain input. On the hand, RL assumes that the training data signify if an action is appropriate (or not), and if it is inappropriate, then, the issue remains until the appropriate one is found [33]. RL is therefore is a trial-and-error learning.

Accordingly, the present section highlights the most encouraging ML and DL algorithms within the context of IoT security. The first part of this section presents the customary ML algorithms, their benefits, shortcomings and uses in assuring the security of IoT, while the second part of this section presents DL algorithms, their benefits, shortcomings and uses in assuring the security of IoT.

Deep learning (DL) methods for IoT Security

DL applications to IoT systems are now a significant topic of study [42]. DL has been shown to be superior to the traditional ML in terms of performance in large datasets. Methods of DL are appropriate for the aforementioned systems considering that some IoT systems generate data in large amount. Additionally, DL has the ability in automatically extracting complex representations from data [42] aside from allowing the deep linking of the environment of IoT [43]. This deep linking encompasses a combined protocol which allows automatic interaction between IoT-based devices and their applications with no intervention from man. To illustrate, within a smart home, IoT devices allow automatic interaction for creating a full hundred percent smart home [42].

Methods of DL presents a computational structural design which incorporates several levels of layers of processing for data representations learning using a number of abstraction levels and the mechanisms of DL follow those of human brain and neurons in signals processing. DL is actually an ML sub-field, and for pattern analysis, DL employs a number of non-linear layers of processing for discriminative or generative abstraction as well as transformation of feature. Furthermore, since DL methods are capable in capturing hierarchical representations in deep architecture, methods of DL are likewise called hierarchical learning methods. Meanwhile, deep networks are created for supervised, or discriminative learning, and unsupervised learning, or generative learning, and both of the aforesaid learning types are combined to generate hybrid DL. The applications of DL methods have proven to be significantly more advanced when compared to those of the traditional ML methods [34].

The following subsections present four of the common DL algorithms. These include supervised DL, unsupervised DL, semi-supervised DL and deep reinforcement learning (DRL) methods.

1) Supervised DL (discriminative learning)

Among the common types of supervised or discriminative DL approaches are Convolutional Neural Networks (CNNs) and recurrent neural networks (RNNs). Details of each are presented as follows:

a) Convolutional neural networks (CNNs)

Convolutional neural networks (CNNs) decrease the data parameters that are utilized in the customary artificial neural network (ANN). In decreasing the parameters of data, CNNs employ three concepts as follows: sparse

interaction, parameter sharing and equivariant representation [44]. When the links between layers are decreased, the scalability is increased, and a CNN is improved in terms of its complexity of training time.

A CNN has two interchanging forms of layers; one is convolutional layer while the other is pooling layer. Through the assistance of various filters (kernels) of identical size, convolutional layers convolute data parameters [45]. Meanwhile, using max (average) pooling, the pooling layers execute the down-sampling in order that the sizes of the succeeding layers are reduced. As explained in [46-47], max pooling splits the input to become non-overlapping clusters and determines the maximum value of each of the clusters within the preceding layer. On the other hand, average pooling averages the values of each of the clusters within the preceding layer. The activation unit is equally a vital CNN layer. This layer executes a non-linear function of activation on each of the elements within the feature space, and the non-linear activation function is chosen as the corrected linear unit (ReLU) function of activation comprising the nodes with the activation function $(5) = (0,)$ [48].

The use of CNN in training approaches in DL has been expansive, and this is considered as an advantage of CNN. Furthermore, CNN enables automatic features learning based on raw data with high performance. Somehow, the computational cost of CNN is high, and for this reason, the implementation of CNN on devices with limited resource in supporting on-board systems of security is difficult. Somehow, this issue is resolvable through distributed architecture which involves the implementation and training of a light deep neural network (DNN) using just a subset of vital classes of output on-board [49]. However, for deep classification, the algorithm is fully trained at cloud level [49].

CNNs are formed primarily for the advancement of image recognition advancement. The application of CNNs has been expansive, resulting in the development of successful and effective models to classify and recognize image utilizing large public sources of image including Image Net [50-51]. Also, the stoutness of CNNs has been reported in countless of other applications. In regards to IoT security, the use of CNN-based malware detection method was demonstrated in [52] for Android. CNN allows the spontaneous learning of significant features associated with the detection of malware. The features are obtained from the raw data. This ability of spontaneous learning of CNN means that no manual feature engineering is needed. In CNN application, the training is provided to the network to learn appropriate features while also performing classification task. As mentioned in [52], such ability eradicates the requirement of performing the process of extraction that is required in the

traditional ML. The end product of CNN is an end-to-end model. Somehow, for attackers, the robustness of CNNs in their learning performance can benefit them. For instance, in was reported in [53] that a CNN algorithm has the capacity in successfully breaking the cryptographic implementations.

b) Recurrent neural networks (RNNs)

Recurrent neural networks (RNNs) which are an integral class of DL algorithms, have been recommended in handling sequential data. For some applications, the existing output is projected using the analysis of relations from a number of past samples. Hence, the present and past inputs will determine the output of neural network. In this setting, a feed-forward NN is unsuitable since the link between the layers of input and those of output are discretely upheld [54]. For this reason, the training of RNNs becomes the most outstanding application of back propagation algorithm [34, 55]. The use of RNNs is suitable for uses that comprise sequential inputs as in text, speech, and sensor data as well [34, 55].

In RNN, a temporal layer is included for capturing sequential data, and by way of concealed units of recurrent cell, multifaceted variations are learned [56]. Modifications are made to the hidden units, and the modification follows the data presented to the network. For demonstrating that the current condition of the network, updates are consistently made to the data. The current concealed state is processed by RNN and the process involves the estimation of the succeeding concealed state to function as an activation of the earlier concealed state. In this situation, the use of RNNs is appropriate as RNNs are able to effectively manage the sequential data. Hence, RNNs are appropriate for many tasks including detecting threat, in which the patterns of threat are subject to time. As such, the utilization of recurrent connections can enhance neural networks while also revealing the important patterns of behavior. Meanwhile, vanishing or exploding gradients have been reported as the major shortcomings of RNNs [57].

Together with their variations, RNNs have been showing outstanding performance in various uses involving sequential data, which can be exemplified by speech recognition and machine translation [58-60]. The application of RNNs for IoT security has also been demonstrated. Enormous amounts of sequential data are generated by IoT devices from sources including traffic flows of network, which are regarded as among the main features in the detection of a number of possible network attacks. As an example, the viability of an RNN in investigating the traffic behavior of network has been examined in [61] in detecting possible attacks in the form of

malicious behavior. From the results, it was affirmed that RNN is able to class the network traffic for correct detection of malicious behavior. Hence, for real life situations, RNNs offer a practical solution, and in the context of IoT system security, it is useful to explore RNNs and their variations, especially in regards to time series-based threats.

2) Unsupervised DL (generative learning)

Unsupervised DL or generative learning is discussed in the present section. Specifically, this section discusses three commonly used unsupervised DL approaches namely deep autoencoders (AEs), deep belief networks (DBN), restricted Boltzmann machines (RBMs), as described as follows:

a) Deep autoencoders (AEs)

Deep autoencoders (AE) encompasses an unsupervised learning neural network that trained to regenerate its input to its output. AE contains a concealed layer called h, and h expresses a code that is used in representing the input [35]. There are two parts to an AE neural network; the first part is the encoder function $h = (5)$ and the second part is the decoder function; these two parts are for reproducing the input $5 = (h)$. Specifically, the encoder attains the input and transforms it into an abstraction-this process is commonly called a 'code.' Next, the decoder obtains the constructed code which was originally created to signify the input, for the purpose of rebuilding the original input. As explained in [62], the process of training in AEs ought to be executed with smallest amount of error related to reconstruction. Somehow, AEs are not able to learn to faultlessly copy the input.

AEs merely copy the inputs identical to the training data which means that they can only produce an estimated copy. Hence, AEs are limited. As indicated in [44], the model needs to prioritize the inputs characteristics to be copied; as a result, the worthwhile data characteristics are recurrently learned. AEs are promising in the domain of feature extraction. Also, AEs have proven to be of value in representation learning for learning features to be an alternative for the physically engineered features that are applied in conventional ML. Equally, AEs can decrease dimensionality without preceding data knowledge. It should be noted however, that AEs have high computational time. Further, AEs can efficiently learn to seize the training data characteristics, but this can cause the learning process to become complicated. Hence, it is not representative of the characteristics of the dataset if the dataset of training does not represent the testing dataset.

In [63], AEs have been applied in the detection of network-based malware whereby AEs were trained in learning the latent representation of countless of feature set. Specifically in [63], AEs were feature vector trained as well. The feature vector was obtained from the cybersystems. The results demonstrate the superiority of AEs in detection performance to the conventional ML algorithms of SVM and KNN [63]. Relevantly, the combination of AE and DBN was presented in [64] for the purpose of constructing a method of malware detection. This method was used in reducing data dimensionality through the application of non-linear mapping. Here, only the weighty features were extracted. Learning algorithm of DBN was subsequently trained for malicious code detection.

b) Restricted Boltzmann machines (RBMs)

Restricted Boltzmann machines (RBMs) entail deep generative models devised for unsupervised learning [65]. Accordingly, an RBM entails a fully undirected model that has no linkage between any two nodes within similar layer. Accordingly, visible layer and hidden layer are the two types of layers of RBMs, where the former carries the known input, while the latter carries multiple layers comprising latent variables. Relevantly, RBMs hierarchically cognize features detected from data. Further, features that are seized within the first layer are utilized as latent variables in the ensuing layer.

A network anomaly detection model was proposed in [66] with the purpose of dealing with the in-built challenges in its formation. The production of labelled data that are needed for the effective model training is one of these challenges, owing to the irregularity and the multi-part feature of a network traffic dataset. The continual evolution of anomaly behavior with time is another challenge, and hence, it is important to dynamically adapt the model in order that any new form of attacks can be detected, and that the model can be generalized in order that it is able to detect anomaly within diverse environments of network. As a solution, a learning model grounded on a discriminative RBM was proposed in [66]. This model can merge generative models with fitting accurateness of classification in detecting network anomaly in semi-supervised manner, even with the utilization of inadequate training data. Nonetheless, the results were showing that the discriminative RBM's performance in classification was impacted when tests were carried out on the classifier involving different network dataset, that is, the network dataset that the classifier was not trained on. Hence, the manner in which a classifier can be generalized for anomaly detection within different environments of network should be examined further.

Single RBM appears to be limited in terms of its capacity in feature representation. Still, it is possible to effectively apply RBM by stacking RBMs, two or more of them, to create a DBN, as discussed next.

c) Deep belief networks (DBNs)

Deep belief networks (DBNs) have been classed as generative methods [67] and a DBN is made up of stacked RBMs. These stacked RBMs perform greedy layer-wise training with the aim of achieving a vigorous performance in an environment that is unsupervised. Training within a DBN is executed from one layer to the next, and each training layer is performed as an RBM trained on top of the previously trained layer-DBNs comprise a group containing layers of RBMs that are utilized for the phase of pre-training and consequently transformed into a feed-forward network for weight fine-tuning using varied convergence [56]. As explained in [59], the initial features are trained during the pre-training phase, and the training is executed via a greedy layer-wise unsupervised approach, whereas in the fine-tuning phase, a softmax layer is applied to the top layer to refine the features associated with the labelled samples.

The applications of DBNs in detecting malicious attack have been fruitful. Relevantly in [68], the application of a DL-based approach for automatic detection of malicious attack in mobile edge computing was presented. The obtained results showed that the proposed DBN-based model is more accurate than ML-based algorithms in malware detection [68]. Thus, in malware detection, DL is generally superior to the traditional manual feature engineering methods, especially DBNs. Appositely, an AE was coalesced with a DBN in [64] as a method for detecting malware, and for reducing the dimensionality of data, and AE DL algorithm was applied to extract just the important features through non-linear mapping. In this study, DBN learning algorithm was consequently trained for malicious code detection.

DBNs are methods of unsupervised learning, and for significant feature representation, DBNs are iteratively trained with unlabeled data. For reducing computational time, these methods utilize contrastive convergence. Still, these networks could not be applied to on-board devices that have restricted resources.

3) Semi-supervised or hybrid DL

Details on the common hybrid DL approaches are presented in this subsection. Among the approaches include Generative adversarial networks (GANs) and sets of DL networks (EDLNs) as discussed below.

a) Generative adversarial networks (GANs)

Generative adversarial networks (GANs) were first proposed in [69] and have been considered as promising DL frameworks. Two models specifically generative model and discriminative model, are trained simultaneously in GAN framework through an adversarial process. Specifically, generative model acquires the data distribution and produces samples of data while discriminative model forecasts the likelihood that a sample comes from the training dataset as opposed to the generative model. Discriminative model thus assesses the authenticity of the sample generated. As mentioned in the study, generative model is trained to increase the likelihood that the sample is wrongly classed by the discriminative model [69]. Generative model functions as the generator, and in each stage, this model is equipped to mislead the discriminator by forming a sample dataset from random noise. On the other hand, the discriminator is raised with a number of actual data samples from the training set, together with the samples produced by the generator. Real samples from the training dataset and unreal samples from generative model are distinguished and classed by discriminator model. The number of correctly and incorrectly classed samples will determine the level of performances of both discriminative and generative models. Both models are then updated for the forthcoming iteration. As reported in [62], the output discriminative model facilitates generative model in improving the samples produced for the succeeding iteration.

The implementation of GANs in IoT security has been recently reported. In [70] for instance, GAN algorithms were included in a proposed architecture to achieve a secure cyberspace of IoT systems. This architecture includes the training of DL algorithms in the classification of the system behavior, either as normal behaviour or abnormal one. For initial study, algorithms of GAN were incorporated into the construction, and as deduced from the results, GAN-based architecture can effectively detect abnormal system behavior [70].

Within the context of IoT security, GANs appear to be promising considering that this approach may have the ability in learning diverse scenarios of attack to produce samples that mimic a zero-day attack. Also, GANs are able to present algorithms that comprise a group of samples beyond the prevailing attacks. Via a semi-supervised approach, GANs have proven their aptness in training classifiers.

As opposed to the fully discernible DBNs, GANs have the ability to produce samples more quickly. Such ability is attributed to the non-requirement of sequentially producing diverse entries in the samples,

especially in the use of GANs. In fact, in forming a sample, GANs require only one pass across the model, as opposed to RBMs that call for an unknown number of iterations from a Markov chain [69, 71]. Still, it should be noted that GAN training is difficult aside from unstable. As also reported in [69, 71], it is challenging to learn to produce discrete data (e.g., text) with a GAN.

b) Ensemble of DL networks (EDLNs)

As shown by the literature, the use of several DL algorithms in combination can generate superior performance as opposed to the use of single algorithm. Relevantly, through combining generative, discriminative or hybrid models, EDLNs can be formed. The application of EDLNs is common in dealing with intricate issues associated with vagueness and high-dimensional features. As described in [72], an EDLN contains stacked discrete classifiers, either homogenous, that is, the classifiers are from similar family, or heterogeneous, that is, the classifiers are from distinct families. The use of EDLN improves diversity, accuracy, performance and generalization.

In [73], the use of leverage SAE was demonstrated for feature extraction in addition to regression layer with softmax function of activation for classifier. From the obtained results, the semi-supervised approach proposed in this work for the detection of intrusion appears to be able to detect attack more accurately, as opposed to the previous work. The remarkable success of EDLNs have been evidenced in various applications, as exemplified in activity recognition. However, within the context of IoT security, the application of EDLNs needs to be examined more, especially in regards to the potential of applying light homogenous or heterogeneous classifiers within a distributed setting in order to increase the performance and accurateness of security system of IoT while also solving the challenges associated with computational complexity.

4) Deep Reinforcement learning (DRL)

Reinforcement Learning (RL) can effectively enable an agent of learning to modify its policy while achieving an optimal solution through trial and error in order to attain the most ideal long-term aim even though there is no prior environment knowledge [74]. Meanwhile, methods of Deep Reinforcement Learning (DRL) including deep Q-network (DQN) is regarded as a robust alternative in the resolution of high-dimensional problems and in the formation of scalability and offloading efficiency in countless of applications associated with mobile edge computing [75]. DQN is one of effective RL methods [39] and additions of deep Q networks have also been proposed, for instance, double Q-learning [76], constant control utilizing deep RL [66] and prioritized replay of experience [68].

Relevantly, access control and computation offloading were examined in [75] within the context of mobile edge-cloud computation offloading systems within networks of IoT. In this study, blockchain and DRL were used in combination. DLR has also been applied in the fortification of cyber-security as in [79] whereby a number of DRL approaches devised for cyber security were examined. Among the examined approaches were: security methods grounded upon DRL for cyber-physical systems, multi-agent DRL-based simulations of game theory for strategies of defense against cyber-attacks, as well as autonomous intrusion detection techniques. Within the context of IoT eco-system, the exploration of the aforementioned approaches holds prospective future direction.

4. Conclusion

Learning algorithms are generally used for obtaining the patterns from the accessible partial training dataset, followed by the formation of a model that allows the classification of the new inputs following the learnt patterns. As explained in [80], this process involves the investigation of the volume of required training data to adequately train the algorithms of learning in order that the aforementioned algorithms can be generalized for new input within the extent of interest. In terms of DL application for security of IoT, the extraction or generation of a representative and high-quality training dataset comprising numerous likely attack types has become the major challenge, especially for supervised methods of DL. Accordingly, algorithms of DL require high-quality, complete and varied training datasets for accurate training. Considering that these training datasets become the foundation for the attainment of model knowledge, they need to carry information that echoes just about all of the strategies of actual life attacks. Also, this can directly affect the model in terms of accurateness. Furthermore, as IoT systems produce data in large volumes, real-time data streaming and maintenance of data quality will always be a challenging matter.

In general, the proposed representations of DL are for high-quality data [59]. On the other hand, IoT systems contain heterogeneous linked devices in addition to large-scale streaming, which means that data of high-noise and those that are corrupted are likely to be generated by such systems [62-63]. As such, safeguarding IoT systems needs effective DL models with the ability in handling and learning from low-quality data, especially in the situation where high-quality training data cannot be attained. Hence, multi-modal and effective DL models are needed for securing the systems of IoT with streaming of large scale, and heterogeneous and high-noise data.

As highlighted in [82], the richness level of the data that both ML and DL algorithms are obliged to learn from will determine the accurateness of the algorithms, whereby richer data means more accurate algorithms. In data augmentation, the main hurdle is in the generation of fresh data samples that uphold the fitting distribution of data for each class, as this generally requires domain knowledge [56, 83]. As such, the right methods for IoT security augmentation have to be examined in order to increase the accurateness of classification of learning methods.

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Chapter - 3
Data Science Tools and Applications

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Chapter - 3

Data Science Tools and Applications

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Abstract

The term Data Science became widely used, in this chapter will define what means by data science, also a comprehensive review of data science and applications will be provided. Through the chapter Role of a Data Scientist will be discussed also Pros and Cons of Data Science. At end of chapter Future of Data Science will covered.

Keywords: data science, data scientist, data science applications, data science tools

1. Introduction

Data Science concerns with activities that involve information, for instance, information extraction, information preparation, information analysis, information visualization, and information maintenance. Data science entails a cross-disciplinary field that utilizes scientific methods and processes in drawing insights from data. It combines mathematics, statistics, and computer science.

The rise of new technologies has led to exponential data increase, consequently leading to the prospect of analyzing and drawing significant insights from these data. However, such attempt will need special expertise of a 'Data Scientist' with the ability to utilize numerous statistical and machine learning tools in data comprehension and analysis. In this regard, a Data Scientist who is a data expert analyzes the data and to forecast future occurrences of an event, machine learning algorithms are used. Data Science is essentially a domain that handles data processing and analysis, and extraction of insights from the data with the use of numerous statistical methods and computer algorithms.

Data are important to industries today, and therefore, data science has become vital. It is important that companies understand the value of data as they need data to function, expand and create better business. In this regard, Data Scientists handle data in facilitating companies in making the right

decisions. Using the data-driven approach facilitated by the Data Scientists who produce meaningful insights, companies could analyze themselves and their performance in the market. The use of Data Science is also evident in healthcare industries, especially in the identification of microscopic tumors and deformities during early diagnosis.

Year 2012 saw the growth of the number of Data Scientists by 650%. Meanwhile, the U.S. Bureau of Labor Statistics reported that there will be approximately 11.5 Million new jobs by 2026. Furthermore, on Linkedin, the position of Data Scientist is among the top emerging jobs. The demand for Data Scientists has been growing [1-11].

2. Role of a data scientist

A Data Scientist is the person who handles data, both unstructured and structured ones. Specifically, unstructured data come in a raw format which needs comprehensive data pre-processing, cleaning and organization so that the data could give consequential structure to a dataset. The structured data are then comprehensively investigated and analyzed by the Data Scientist utilizing numerous statistical methodologies, to extract information. Accordingly, the statistical methods are used for describing, visualizing and theorizing information from the data. The data scientist then predicts events occurrence using progressive machine learning algorithms, before making the appropriate decisions.

In the identification of redundant patterns within the data, the Data Scientist uses tools and practices of various types such as SQL, Python, Hadoop, Weka and R. In general, Data Scientists play the role of consultants to companies by taking part in the processes of making decision and in creating strategies. In this regard, the Data Scientist utilizes the derived meaningful insights to help companies to make better and smarter business decisions. Amazon, Google and Netflix are among the organizations that utilize Data Science in their construction of robust recommendation systems for their users. Correspondingly, predictive analytics and forecasting methods are used by many financial companies in predicting the stock prices. With Data Science, smarter systems with the ability to take autonomous decisions using historical datasets. Combined with evolving technologies such as Computer Vision, Natural Language Processing and Reinforcement Learning, Data Science becomes part of advanced Artificial Intelligence [12].

3. Solving problems with data science

The application of Data Science in the resolution of real-world problem begins with Data Cleaning and Preprocessing. During this situation, it is not

uncommon for Data Scientist who is involved in this process to be provided with inconsistent and unstructured dataset. In order to ease the analysis and insight extraction process, the data are organized while erroneous information is removed. Among the tasks performed include redundant data removal, the data format change, and missing values management.

Many statistical procedures are used by Data Scientist to analyze the data and the two major procedures are Descriptive Statistics and Inferential Statistics. As an example, a Data Scientist working for cell phone manufacturing company will perform analysis of customers that use the mobile phones manufactured by the company, by first examining the data comprehensively. Through the examination, trends and patterns can be understood. The data are then summarized and presented in graph or chart format. Descriptive Statistics is used in this situation.

The ensuing process is the drawing of 'inferences' or conclusions from the data. The use of inferential statistics can be exemplified in the attempt of finding out the number of defects that happen during manufacturing. As individual testing of mobile phones can be time consuming, it is more practical to use a sample of certain phones and then use the result to generalize the number of defective phones in the overall number of phones. Meanwhile, prediction can be made using regression algorithms. Hence, combined with the application of historical sales, mobile phone sales over certain period of time can be predicted.

Also, age, gender, annual salary, and credit score of customers can be used in analyzing their likelihood of purchasing certain product. With historical data of customers, it is possible to determine whether or not the customers will make a given purchase, and considering that there are two output classes-purchase or not purchase-a Binary Classification Algorithm can be used. On the other hand, Multivariate Classification Algorithm is used in cases with more than two output classes. All of these types of problems are part of 'Supervised Learning'.

'Unlabeled' data which have no output segregation in fixed classes also exist. Hence, in the situation where clusters of potential customers and leads are to be ascertained following their socio-economic background with no fixed set of classes in the historical data, the use of clustering Algorithm is the most appropriate in the identification of clusters or sets of potential clients. Clustering is classed as an 'Unsupervised Learning' algorithm.

Self-Driving cars which are based on the concept of autonomy are a trending technology. These cars make decisions on their own. Comparatively,

human inputs are needed in the use of conventional computers in order to attain output. Meanwhile, problems related to human dependence are resolvable via Reinforcement Learning which concerns the execution of certain specific actions to accrue the most amount of reward. As an example, a dog can be trained to fetch a ball by giving it reward each time it fetches the ball, and no reward if it does not. This will make the dog realize that it will receive reward if it fetches the ball. This principle underpins Reinforcement Learning. Hence, the agent will perform certain action to achieve reward [13-14]. In dealing with these problems, tools and software are required by Data Scientist. Some of these tools and software are as discussed below:

4. Tools for data science

The traditional statistical methodologies have been used by Data Scientists in establishing the foundation of Machine Learning algorithms. Deep Learning algorithms have also been used in generating robust predictions. Accordingly, the tools and programming languages below have been utilized by Data Scientists:

i. R

As a scripting language, R is specifically for statistical computing. The use of R is common for various tasks including data analysis, clustering, statistical modeling, time-series forecasting, but the use of R is most common for statistical operations. Extensively popular in various industries, R carries object-oriented programming language features, and it is an interpreter based language as well [15].

ii. Python

As an interpreter-based programming language of high level, Python offers ease of use and code readability. This versatile language is primarily used in the Development of Data Science and Software. The use of Python is common in Computer Vision, Natural Language Processing, and Data Analysis. Numerous graphical and statistical packages are included in Python, for instance, in Matplotlib, SciPy, Numpy. There are also more advanced packages of Python for Deep Learning for instance, TensorFlow, Keras and PyTorch. Python is used in this study for data mining, wrangling, visualizations and for constructing the predictive models. Python is hence a highly flexible programming language [16].

iii. SQL

SQL (Structured Query Language) is used by Data Scientists to manage and query the data that are kept in databases. In data analysis, extraction of

information from databases is the first step. In this regard, Relational Databases entail a group of data that are organized in tables, and SQL is used for data extraction, management and manipulation. As an example, banking Data Scientist employs SQL to extract customer information. SQL is appropriate for Relational Databases while 'NoSQL' is appropriate for non-relational or distributed databases. The flexible scalability, dynamic design, and open source nature have made NoSQL a popular choice among Data Scientists, while MongoDB, Redis, and Cassandra are among the popular languages of NoSQL [17].

iv. Hadoop

Big data is a popular concept today, and it is associated with the management and storage of data of large quantity. Data can come in structured or unstructured form, and as Data Scientist, it is important to understand complex data and have the knowledge of tools that regulate the storage of immense datasets such as Hadoop. Hadoop is essentially an open-source software, and it employs a distributed storage system using MapReduce model. Hadoop contains a number of packages including HBase, Apache Pig, and Hive. Hadoop can quickly process large amount of data, aside from possessing scalable architecture and incurring low-cost deployment. Within the context of Big Data Hadoop is the most popular software [18].

v. Tableau

Tableau entails a Data Visualization software associated with graphical data analysis. Using this tool, user can construct interactive visualizations and dashboards, and for this reason, Tableau is appropriate in demonstrating many data trends and insights in interactable charts, for instance, Box plots, Treemaps and Histograms. Tableau could connect with spreadsheets, relational databases, and cloud platforms and therefore this tool can directly process the data directly. This provides ease of use to users [19].

vi. Weka

Weka is a tool that is generally utilized for Data Mining. However, this tool also utilizes many tools that are necessary for Machine Learning operations which is appropriate for Data Scientists who want to familiarize themselves with Machine Learning in action. Weka is a fully open-source software that utilizes GUI Interface. This tool does not need any line of code and therefore, user can easily interact with Weka [20].

5. Pros and cons of data science

Data Science is a considerably domain with both advantages and limitations as discussed below.

a. Advantages of data science

Data Science has various advantages as follows:

1. Data science is in demand

There has been a great demand for Data Science. Relevantly, potential job seekers are endowed with various opportunities associated with data science. On Linkedin, data science related jobs appear to be the fastest growing job. In fact, it was predicted that by 2026, data science domain will generate 11.5 million jobs. Data Science is thus a very employable job sector.

2. Abundance of positions

Individuals possessing the needed skill-set to be an accomplished Data Scientist. Hence, as opposed to other sectors of IT, Data Science appears to be less saturated, making Data Science an immensely copious field with innumerable opportunities. At present time, Data Science is high in demand. However, Data Scientists are low in number.

3. A highly paid career

On average, a Data Scientist makes $116,100 per year, making Data Science a very high paid career. Data Science is thus very rewarding career option.

4. Data science is versatile

Data Science has innumerable applications in numerous sectors including banking, health-care, consultancy services, and e-commerce. Considering its versatility, Data Science allows data scientists to work in many fields.

5. Data science makes data better

Skilled Data Scientists are sought after by companies for data processing and analyses. Such scientists analyze the data and also enhance the data quality. Data Science therefore enriches and improve the company's data.

6. Data scientists are highly prestigious

With the assistance of Data Scientists, companies can make better business decisions. Hence, Data Scientists are important to Companies as companies rely on them in improving company performance.

7. No more boring tasks

Historical data are used by companies in machine training in the execution of repetitive tasks and through Data Science, many industries are able to mechanize redundant tasks. In this regard, grueling jobs which were previously performed by man are simplified.

8. Data science makes products smarter

Machine Learning is utilized in Data Science, and this has allowed the generation of superior products that cater specifically to the requirements of customer. Recommendation Systems in e-commerce websites are a good example. These systems provide personalized insights to users following their past purchases. Through Data Science, computers could comprehend human-behavior and make data-driven decisions.

9. Data science can save lives

Data Science has significantly enhanced the sector of healthcare, and the use of machine learning facilitates the detection of tumors at their early stage. Data Science is also being used by other industries of healthcare in providing assistance to clients.

10. Data science can improve a person

Data Science provides a great career and facilitates personal growth in a person; it fosters a person's problem solving. Also, Data Science brings together IT and Management, and this allows those involved in this domain to reap the benefit of both worlds.

b. Disadvantages of data science

Equally, the shortcomings of Data Science have been discussed, and understanding them is important as well, as it allows one to see the full picture of this concept. Some disadvantages of Data Science are as follows:

1. Data science is blurry term

Data Science has no specific definition; it is actually a broad concept. Hence, it is not easy to provide a specific meaning of Data Scientist. Also, the role of Data Scientist in a company will be dictated by the specialization of the company. Data Science has been regarded by some as the fourth paradigm of Science, but for some, Data Science is nothing more than a rebranding of Statistics.

2. Mastering data science is near to impossible

Data Science combines the fields of Statistics, Computer Science and Mathematics, and simultaneously mastering each of this fields is rather farfetched. In fact, various *online courses* have attempted to fill the skill-gap prevalent in the data science industry but as the field is immense, it is impossible to achieve full proficiency in this domain. Hence, those skilled in Computer Science may lack Statistics skills; as such, it seems impossible to find a proficient Data Scientist. Hence, in order to keep abreast with the

current dynamic environment, it is important to continue learning the many avenues of Data Science.

3. Large amount of domain knowledge required

Reliance on Domain Knowledge is another shortcoming of Data Science. A person skilled in Statistics and Computer Science will find Data Science problem difficult to resolve without its background knowledge, and vice-versa. Hence, a health-care industry will need employees that understand genetics and molecular biology when working on genomic sequences. Data Scientist acquires knowledge and skills related to the industry that he or she is involved in. Hence, for Data Scientist, migrating to other industry may cause difficulties.

4. Arbitrary data may yield unexpected results

In easing the process of decision making, a Data Scientist analyzes the data and makes judicious predictions. However, it is often that the data provided are arbitrary and generate no expected results. Weak management and poor resource usage are among the causes of this problem.

5. Problem of data privacy

Data are backbone to many industries, and Data Scientists facilitate companies in making decisions based on data. Nonetheless, in the process, the used data may violate the privacy of customers. As parent company can have access to personal data of clients, data leaks can occur due to security break. For many industries, their concerns include the ethical issues on the preservation of data-privacy and its usage.

6. Applications of data science

The strong establishment of Data Science has been evident in a number of industries including medicine, banking, transportation, and so forth. In fact, the applications of Data Science is immense and its uses are various, as discussed below:

a. Data science in healthcare

In the Industry of Healthcare, the contribution of Data Science is immense. For instance, doctors have been able to detect tumors and cancer at an early stage through classification algorithms via Image Recognition software. *Data Science has been used in Genetic Industries in the analysis and classification of patterns of genomic sequences*. Also, through virtual assistants, patients are facilitated in resolving their ailments, physical and mental.

b. Data science for medical imaging

In the industry of health, data science has been primarily used in medical imaging, as in X-Ray, MRI and CT scan which visualize the inner portions of human body. Prior to the advent of Data Science, the images were manually inspected by doctors in finding abnormalities within them. Still, discovering microscopic deformities is difficult, preventing doctors from presenting correct diagnosis.

Deep learning technologies in data science have allowed the discovery of microscopic deformities within the scanned images, and image segmentation allows defects within the scanned images to be detected. Other techniques of image processing are also available, including image recognition utilizing Support Vector Machines, edge detection, image enhancement and reconstruction, and so forth.

Images and outcome accuracy can be improved using several methods. In this regard, Big Data platforms including Hadoop utilize MapReduce in discovering parameters usable in many tasks. For those interested in data science, image analysis is the first practical experience. For the purpose, some open datasets of brain imaging can be used.

c. Data science for genomics

Genomics entails a study of sequencing and genome analysis, while a genome comprises DNA and all organism genes. The Human Genome Project has sparked the interest and exploration of genomes and prior to the existence of powerful computation, gene sequence analysis was tedious, time consuming as well as costly. Then, after the emergence of advanced data science tools, the task is now easier, faster and less costly.

Research scientists analyze genomic strands and find irregularities and defects in them. Next, the links between genetics and the person's health are identified. Researchers normally utilize data science in analyzing genetic sequences. The correlation between the parameters within the sequences and the disease is then determined. Genomics research also involves discovering the correct drug; it presents more comprehensive insight on the reaction of drug to a given genetic issue. Relevantly, Bioinformatics is an emergent domain that blends data science and genetics.

Tools of data science include MapReduce, Galaxy, SQL, Bioconductor (just to name a few). Among them, MapReduce processes genetic data and decreases the amount of time needed in processing genetic sequences. Meanwhile, Galaxy encompasses an open-source biomedical research

application that is grounded upon GUI whereby user could conduct many operations on genomes. In terms of SQL, it encompasses a relational database language for data querying and retrieval from genomic databases. On the other hand, Bioconductor encompasses an open-source software to analyze and comprehend genomic data.

The domain of Data Science is immense and many parts of it are yet to be explored. Among the areas worth exploring include computational biology, bioinformatics, genetic risk prediction, and gene expression prediction, just to name a few.

d. Drug discovery with data science

Drug Discovery has been known as a very intricate discipline. Its process takes time and involves heavy expenditures and testing. Among pharmaceutical industries, there has been heavy dependency on data science for problems resolution and for making better drugs for the people. This process has been reformed by Data Science and Machine Learning algorithms, whereby comprehensive insights are provided to optimize and increase the rate of success of predictions.

Information of patient including mutation profiles and patient metadata is commonly used by pharmaceutical companies. Using this information, researchers could construct models and discover statistical relationships between the attributes, which will allow companies to design drugs which handle the key mutations in the genetic sequences. Furthermore, the utilization of deep learning algorithms allows the discovery of potential of disease formation in the system of human.

The workings of drugs in human body can also be simulated using data science algorithms and such ability can avert the lengthy laboratory experimentations. However, the advanced data-science facilitated drug discovery has improved the collection of historical data and this has facilitated the process of drug development. The availability of genetics and drug-protein binding databases allows the development of new innovations within this domain. Also, data science allows the analysis and testing of chemical compounds against a blend of diverse cells, genetic mutations, and so forth. Furthermore, the application of machine learning algorithms allows the formation of models that calculate prediction using the given variables.

e. Predictive analytics in healthcare

As the most popular subject in health analytics, healthcare has become an important field for predictive analytics. In this regard, a predictive model

utilizes historical data, learns from these data, identify patterns, and then based on these patterns, accurate predictions are formed. Correlations, link of symptoms, habits and diseases are identified-all of these make meaningful predictions.

Predictive Analytics, which is a data-driven approach, has significantly improved patient care and management of chronic disease while also increasing the efficiency of supply chains and pharmaceutical logistics. The focus of this approach is on the prevention of common diseases in the society. Within the context of predictive analytics, health management of population is a progressively popular topic.

The use of Data Science in hospitals allows the prediction of deterioration in the health of patients, while also providing preventive measures and initiation of early treatments to help reduce the risk of additional deterioration. Also, predictive analytics greatly assists hospitals in monitoring their logistic supply and pharmaceutical departments.

f. Monitoring patient health

The contribution of Data Science in IoT (Internet of Things) is significant**.** These devices of IoT are wearable devices which could track temperature and heartbeat, and other medical parameters of users. Using data science, the gathered data are then analyzed. Calorie intake, circadian cycle and blood pressure can be tracked using the analytical tools.

Home devices can also be used in monitoring the health of patients. With chronically ill patients, a number of systems can be used in tracking their movements, monitoring their physical parameters and in analyzing the patterns within the data. Real-time analytics is used in the prediction of problem that patient will face. For the purpose, the present condition is referred. Also, these devices assist doctors in making the appropriate decisions in dealing with troubled patients.

g. Tracking & preventing diseases

Data Science has greatly facilitated the monitoring of patient's health and the advice of the needed steps in averting potential diseases. In this regard, potent predictive analytical tools are being utilized by Data Scientists in the early detection of chronic diseases. Notably, negligibility has prevented early detection of diseases.

Late or failure in detection can harm the life of patients, aside from increasing the treatment costs. In fact, the cost of treatment rises as the disease grows. Data science is thus vital in the optimization of the economic

expenditure on healthcare. AI has in fact been shown to greatly assist in early detection of diseases. Relevantly, in Brazil at the University of Campinas, an AI platform with the ability to diagnose Zika virus was developed. In detecting the virus, metabolic markers are used. IQuity is another example; it is a company that utilizes machine learning in the detection of autoimmune diseases.

7. Future of data science

Data Science comprises a large pool of various operations of data involving the use of machine learning and statistics. It should be noted that Machine Learning algorithms are generally data reliant. In the form of training set and test set, the data are fed to the study model. Eventually, the data are used to fine tune the study model using numerous algorithmic parameters. Advancement in Machine Learning highly contributes to the future of data science.

Data Science covers domains including the following:

- Data Integration
- Distributed Architecture
- Automating Machine learning
- Data Visualization
- Dashboards and BI
- Data Engineering
- Deployment in production mode
- Automated, data-driven decisions

There is large amount of data operations and the amount will keep increasing. For this reason, there is no specific definition for Data Science. However, as data science will only include vital fields that outline the core data science, its definition will become more specific and confined.

Data Scientists will soon be able to handle business-critical areas and complex challenges, which will ease businesses in making exponential leaps in the future. However, at present time, data scientists are still very few in number. This is expected to change in the future.

As an example, India is expected to have serious shortage of data science professionals until 2020 and this shortage has been factored by the various sets of skills that are needed in data science operations. On the other hand, the curricula that cater to the prerequisites of data scientists are very few.

Fortunately, changes are under way, and in future, it is expected that there will be more people with sufficient skills as data scientist.

8. Data science future career predictions

IBM had predicted an increase in jobs related to Data science, from 364,000 to 2,720,000 in 2020.

Accordingly, for the future, the trends can be described as follows:

- More complex algorithms of data science will be incorporated in packages. Thus, they are rather easy to deploy. For instance, a simple machine learning algorithm such as decision trees is now easy to use because it no longer needs large resources
- The use of machine learning is increasingly popular among Large Scale Enterprises as it propels their business in many ways. Furthermore, as machine learning allows automation of various tasks, which is among the main future goals of the industries, losses can be averted
- Academic programs and programs of data literacy expose students to disciplines associated with data, which will give them a competitive edge. Hence, students could keep abreast with the changes

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Chapter - 4
A Good Teacher and a Great Teacher: An Overview

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Chapter - 4

A Good Teacher and a Great Teacher: An Overview

Sri Gaurab Pratim Hazarika

Abstract

A Good teacher is the one who is good to his or her students. However qualified is the one having good knowledge of one's subject a good teacher may not always be qualified and vice versa. According to me it is important to be a great teacher rather than being a qualified teacher. A good teacher is a teacher who delivers his/her lesson to his/her student intelligently and effectively while a great teacher is a good teacher who, at the end of his/her class, will never be forgotten by the student. A great teacher is someone who has imparted a good lesson that changes the students' perspective in life. A great teacher like Confucius is a leader and a parent as well. Most impotently a great is one who inspires the learner to learn. They bring a meaning to the learning.

Keywords: great teacher, inspiration, teaching-learning process, motivation

1. Introduction

The heart of the India today search for effective and skilled teachers, capable of playing a significant role in the progress of the nation. The excellent teacher has imagination, uses innovation, and keys his goals to later learning and life needs. He's willing to rewrite the texts. He doesn't let institutional routines get in the way concentrated learning. He doesn't rule out difficult tasks like taking the class to school camp for 3 days and 2 nights, even though it's going to cost him 100 hours of prep time. Field trips are a part of the experience, and you can walk there. As Dr. Sarvepalli Radhakrishnan, one of the greatest teachers once said, "Until and unless we have dedicated and committed teachers who can take teaching as a mission in their lives, we can't have a good educational system. Teachers should be the best minds of the country".

While teaching is a gift that seems to come quite naturally for some, others have to work overtime to achieve great teacher status. Yet the payoff is enormous for both you and your students. Imagine students thinking of

you when they remember that great teacher they had in college. Teachers who bring their students' learning into the real world are often some of the most engaging. But it's important for teachers to bring their own learning into the real world, too. No doubt we have lots of good teachers in this country. What we need are great teachers from the grass root level.

1.1 Need and significance of the study

Teachers are the ultimate role models for students. The fact that students come into contact with many different types of teachers in their academic career. This study helps the students to know about good and great teacher and to keep co-ordination and connection between them. It also helps the teachers to acquire the qualities of good and great teacher

1.2 Who can be considered as a good teacher?

To attend a lecture of a "good teacher" students rush to the class room. For a "great teacher" students are in the classroom much before the teacher arrives. The teacher who learns student well by using suitable methodology and always motivate his students towards learning can be considered as a good teacher. A good teacher has a view of future; prepare his/her students to be the leaders in different specific fields of life. According to Alice wellington Rollins, "The test of a good teacher is not how many questions he can ask his pupils that they will answer readily, but how many questions he inspires them to ask him whom he finds it hard to answer".

1.3 Who can be considered as a great teacher

What makes a great teacher? Teaching is one of the most complicated jobs today. It demands broad knowledge of subject matter, curriculum, and standards; enthusiasm, a caring attitude, and a love of learning; knowledge of discipline and classroom management techniques; and a desire to make a difference in the lives of young people. With all these qualities required, it's no wonder that it's hard to find great teachers.

Becoming a "good" teacher is quite an accomplishment in itself! Meeting curriculum standards while meeting learners' diverse needs is how I define that inviable status. To move to a "great" teacher status requires a commitment to keep learning about all aspects of teaching, including new and emerging areas of pedagogical research plus a commitment to apply such knowledge with your own practice and analyze and interpret results. Great also being "humble" in my mindset, because there comes the recognition and acknowledgment that there is no end to improvement for the teacher's professional growth and the learning of the students. The teachers

who provide a caring and safe environment that encourages students to be creative and take risks and grow and learn for the sake of learning and not merely capturing points can be considered as a great teacher. A great teacher inspires students to learn autonomously, independently, long after the class end.

2. Characteristics or qualities of great teacher

- **A great teacher respects students:** In a great teacher's classroom, each person's ideas and opinions are valued. Students feel safe to express their feelings and learn to respect and listen to others. This teacher creates a welcoming learning environment for all students.
- **A great teacher creates a sense of community and belonging in the classroom:** The mutual respect in this teacher's classroom provides a supportive, collaborative environment. In this small community, there are rules to follow and jobs to be done and each student is aware that he or she is an important, integral part of the group. A great teacher lets students know that they can depend not only on her, but also on the entire class.
- **A great teacher is warm, accessible, enthusiastic and caring:** This person is approachable, not only to students, but to everyone on campus. This is the teacher to whom students know they can go with any problems or concerns or even to share a funny story. Great teachers possess good listening skills and take time out of their way-too-busy schedules for anyone who needs them. If this teacher is having a bad day, no one ever knows-the teacher leaves personal baggage outside the school doors.
- **A great teacher sets high expectations for all students:** This teacher realizes that the expectations she has for her students greatly affect their achievement; she knows that students generally give to teachers as much or as little as is expected of them.
- A great teacher has his own love of learning and inspires students with his passion for education and for the course material. He constantly renews himself as a professional on his quest to provide students with the highest quality of education possible. This teacher has no fear of learning new teaching strategies or incorporating new technologies into lessons, and always seems to be the one who is willing to share what he's learned with colleagues.
- **A great teacher is a skilled leader:** Different from administrative leaders, effective teachers focus on shared decision-making and

teamwork, as well as on community building. This great teacher conveys this sense of leadership to students by providing opportunities for each of them to assume leadership roles.

- A great teacher can "shift-gears" and is flexible when a lesson isn't working. This teacher assesses his teaching throughout the lessons and finds new ways to present material to make sure that every student understands the key concepts.
- **A great teacher collaborates with colleagues on an ongoing basis:** Rather than thinking of herself as weak because she asks for suggestions or help, this teacher views collaboration as a way to learn from a fellow professional. A great teacher uses constructive criticism and advice as an opportunity to grow as an educator.
- **A great teacher maintains professionalism in all areas:** from personal appearance to organizational skills and preparedness for each day. Her communication skills are exemplary, whether she is speaking with an administrator, one of her students or a colleague. The respect that the great teacher receives because of her professional manner is obvious to those around her.

3. Some differences of good teacher and great teacher discuss below

It would be very difficult to differentiate between good teacher and great teacher because in contemporary academic setup, teachers are more interested of their academic development rather than spending time with the students. Those who have good academic impact in terms of publication of papers, articles, books, conferences, having research projects etc are often spend less time in their respective department and with their students. Teaching can be considered as one of the most complicated yet a wonderful job. Teaching is not just a job it is actually helping every child nature and adopts a way successful way of life. Everyone is a Good Teacher but only few are great.

Some different between grate and good teacher are

- A good teacher leads the students in the class but a great teacher lead the class in the whole world
- A good teacher may be appreciated by their students but a great teacher is the idol for the entire world
- A good teacher is the one who only teaches while a great teacher is the one who learn and teaches

- A good teacher is the one who chooses the best for a competition. A Great Teacher is the one who encourages even the weakest to participate without fearing of the outcomes
- A Good teacher is the one who challenges. A Great Teacher is the one who nurture and challenges
- A Good teacher is one who only teacher. A Great Teacher is the one who learns and teachers
- A Good Teacher is the one who explains once. A Great Teacher is the one who explains again and again until she/he is sure her/his purpose has been served
- Good Teacher Teaches. A Great Teacher form strong relationship with students and show that they care about them as people
- Good teachers think they are mostly in the business of teaching stuff and helping students so that it gets learned

Great teachers are in the talent finding and talent development business.

- Good teacher are often threatened or bothered by smart alecks and skeptics. Great teachers delight in smart-alecks and skeptics who clearly have raw but undirected talent
- Good teachers merely know us as students of the subject

Great teachers know as better than we know ourselves, especially in terms of intellectual character.

- Great teachers get more from us than we thought possible to give.

Good teachers have high expectation and passions and think that the rest is up to us.

- Good teachers uphold standards and grade according to the score students earned. Great teachers sometimes bend the rules and fudge the grades on behalf of raw student talent.

4. What makes a "good" teacher "great"

A good teacher can be considered as a great teacher when they acquire some specific qualities.

Some of them are mentioned below

i) Open to learning and improvement: Great teachers will always aspire to be the best teachers they can be. They will be open to learning; they will aspire to excellence and will constantly think

about ways to improve their practice. They will take their professional learning seriously, evaluating those experiences and offerings through the lens of whether it is going to lead them to changing the way they teach for the benefit of their students, that makes them different from other teacher.

ii) **Inspiring questions and fanning the flames of wonder:** A great teacher has the ability to inspire students to ask make questions, not just to answer them. Their role in leading students to knowledge is not be satisfy their desire for knowledge, but exactly the opposite-it is to make them hungrier and thirstier for more and more knowledge, more skills, more understanding. And the nature of their questions will branch out into an ever-widening circle of interests and concerns.

iii) **Understanding the wider purposes of education:** Developing in students a commitment to thoughtful, honest, purposeful human agency, respectful of others and embracing the common concerns of one's communities. This is the wider objective of the calling of a teacher to help young people come to know themselves and the power they have to change the world.

When teachers do these things well their conversations with their students about knowledge and the world under construction will flourish from the creative and critical thinking of a new generation of lifelong learners who understand that they have minds, and that they can use them responsibly for the common good.

Some other points are:

- Enthusiasm
- Managing speed
- Understanding the grasping capability of students
- Not getting irritated by repeating the concepts
- Asking questions in between the lectures
- Knowing where to stop
- Fair evaluation

5. Impact of a great teacher on students

Recent research suggests teachers are those that can dramatically improve the wellbeing of children long after they become adults. And the effects go for beyond a child's ability to read and write. An impact of a great teacher makeover a child's lifetime.

Some impact of a great teacher on students is mentioned below:

i) **Higher expectations, better performance:** A great teacher that believed their students can achieve great things interacts with them in different ways to encourage improvement and actually motivate them to hit higher goals. It turns out that positive behavior from teachers who have higher expectations influence students to perform better. This has the potential to begin a domino effect that touches many areas of their lives, and ultimately helps them to achieve their purpose.

ii) **Consistent teacher performance sways long term student performance:** A great teacher could help improve a student's performance on the moment. However, it turns out that the abilities of an educator carry over and help set the stage for a child's future academic performance no matter how good or bad future teachers may be.

iii) **Inspiration:** Students who are inspired by a great teacher can accomplish amazing things, and that motivation almost always stays with them. Inspiration can also take many forms, from helping a pupil through the academic year and their short term goals, to guiding them towards their future career.

iv) **Shaping the future of students:** Great Teacher can help their pupils purpose higher education, explore career opportunities and complete in events they might otherwise have not through themselves able to student often look their teacher as mentors with experience and knowledge as a great teacher give better advice during their career to mould their future bright.

v) **Track improvement and set performance goals:** Great teacher always remind their students that they have come a long way from where they have started. By setting goals, emphasizing, improvement, keep self-evaluation they monitor every minute progress of the student and act as a confidence booster. Teachers also help them by setting smart goals that can be easily achieved. They create challenging assignments for students that help them in solving difficult conditions in life.

6. Major findings of the study

i) The heart of the country today calls for skilled teachers, capable of playing a significant role in the progress of the nation

ii) All teachers have their own unique mixture of qualities. It is this individually makes a teacher special

iii) Each teacher is different, but nearly every great and good teacher has some function of the essential qualities of passion, inspiration, humors, respect and resourcefulness

iv) A good teacher has a view of future; prepare his/her students to be the leaders in different specific fields of life

v) A great teacher inspires students to learn autonomously, independently long after class end

vi) A great teacher's role in leading students to knowledge is not to satisfy their desire for knowledge, but exactly the opposite it is to make them hungrier and thirstier for more and more knowledge, more skills, more understanding

vii) Quality teaching plays a vital role, and without proper guidance pupils might not be as successfully after they leave the educational institutions which are possible through a good teacher

viii) A good teacher is the one who challenges. A great teacher is the one who nurtures and challenges

ix) Inspiration can also take many forms, from helping a pupil through the academic year and their short goals, to guiding them towards their future career

7. Conclusion

The teacher-student connection is invaluable for some students, who may otherwise not have that stability. Teachers will stay positive for their students even when things can seem grim. A great and good teacher always has compassion for their students, understanding of their student personal lives, and appreciation for their academic goals and achievements. Great and good teacher are role models for children to be positive, always try harder and reach for the stars. A good teacher is prepared for the day. An excellent teacher can adapt to whatever circumstances are thrown his/her way during the day. A good teacher helps students. An excellent teacher provides opportunities for students to learn how to help themselves.

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Chapter - 5
Sustainable Development and Remodeling of Green Economy in India: Its Future Perspectives in the Job Market

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Chapter - 5

Sustainable Development and Remodeling of Green Economy in India: Its Future Perspectives in the Job Market

Dikshita Kakoti

Abstract

The International Labour Organization (ILO) has mentioned in the World Employment and Social Outlook (WESO)-2018 that India could create more than 3 million (1.5 million in renewable sector followed by 4.6 lakhs in construction and 2.8 lakhs in service sector respectively) jobs if it adopts sustainable practices for a green economy in all the sectors excluding mining. Meanwhile, this transition to a green economy would also involve a loss of 2.59 lakh jobs which pushed upon the need for new policy adaptation to facilitate re-allocation of workers and support the displaced workers. Thus from the perspective of jobs, environmental sustainability covers 52% of the employed population in the country, including farming and fishing and forestry, all relies directly on the sustainability of a healthy environment. However the rising temperature leads to the productivity loss in the recent times makes the policy makers to take concern for the environment aspects in a very crucial way. With this back drop, the motivation of this paper is to highlight the advantage of adopting green economy for the sustainable development as well as for the generating employment opportunities.

Keywords: green economy, job market, sustainable development

Introduction

India is home to one-sixth of the world's population and it has the densest population. It also has the second-largest population after China, which it will exceed in less than a decade if current trends go on. It is also the fourth biggest generator of emissions. Despite being the third largest economy in the world, India also has the largest number of people living below the international poverty line (India Economic Summit, 2017). Thus sustainability is a challenge because of this rapid growth. The projected temperature of India has increased about 1.5 °C by the end of the 21st

century that will make heat pressure more frequent and it expected that by 2030 the total hours of work lost will rise to 5.3% leading to a productivity loss corresponding to 30.8 million full-time job workers. So Environmental degradation will not only affect the job opportunities, but will also affect the productivity, reducing the total number of working hours. Sustainability has always been a core component of Indian culture. The yogic principle of aparigraha, a virtue of being non-attached to materialistic belongings, mentioned about keeping only what is necessary at a certain stage of life. Humans and nature share a harmonious relationship, which goes as far as a reverence for various flora and fauna. The National Geographic/Globe Scan Consumer Greendex is a scientifically derived sustainable consumption index of actual consumer behavior and material lifestyles across 18 countries, representing both the developed and developing world (Figure 1).

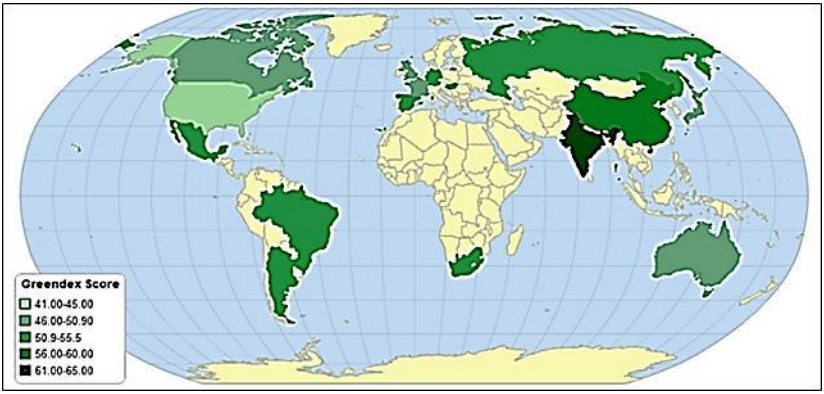

Fig 1: Greendex index by countries (2016)

Source: Green index by country, <<http://chartsbin.com/view/40806>

From the figure 1 it is seen that an exploration of consumers' intentions to improve their habits in 2016. Greendex study also reveals that those in Latin America and India appear to be the most easily influenced to change when informed about their personal impact on the environment.

The term green economy was first coined in a revolutionary 1989 report for the Government of the UK by a group of foremost environmental economists, entitled Blueprint for a Green Economy (Dutta, S., 2015, Markandya and Barbier, 1989). The report was commissioned to advise the UK Government if there was a consensus definition to the term "sustainable development" and the implications of sustainable development for the measurement of economic progress and the assessment of projects and policies. Global transition to a low- carbon and sustainable economy can

create large numbers of green jobs across various sectors and become an engine for development. Current green job creation is occurring in both developed and developing countries. The report defines 'green jobs' as work in agricultural, manufacturing, research and development, administrative as well as service activities that supply substantially to preserving or restoring environmental quality. Specifically, but not solely, this includes jobs that help to protect ecosystems and biodiversity leads to reduce energy consumption, materials, and water consumption through high-efficiency strategies; de-carbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution in future . However, the report also acknowledges the fact that there will be gain and loss in adopting green strategies and therefore public policy should looking for minimizing disparities.

Review of literature

A large part of the empirical works on the economic impacts of environmental policies has so far focussed on competitiveness, productivity and innovation (Dechezlepretre and Sato, 2017). The effect of rigorous environmental policies on firm-and industry-level productivity growth varies across firms and industries. The efficient firms and industries tend to expand more, while the technological laggards lose out in terms of productivity growth (Albrizio *et al*., 2017). In terms of competitiveness, there is a promising evidence signifying that environmental policies can encourage specialization patterns across countries that relatively increase in "cleaner" industries in countries with more tough environmental regulation (Kozluk and Timiliotis, 2016). As far as the innovations are concerned, data indicates that environmental policies redirect innovation towards green sectors, but do not lead to more innovation (Kozluk and Zipperer, 2015). Thus Environmental policies become visible to be one supreme driver for repositioning the decisions of firms across countries (Garsous and Kozluk, 2017; Dlugosch and Kozluk, 2017). There is a huge writing on the modelling of the macroeconomic consequences of environmental policies, but numerical results depend crucially on the type of model and the hypothesis that made with respect to key model parameters.

Substantial improvements in GDP are achievable for many developing countries aimed at restrictive global temperature change to 2 degrees. Thus, the existing evidence on the links between environmental policies and economic growth is not yet certain, even though the impact of existing environmental policies on macroeconomic indicators appears to be relatively small. Moreover, the link between these macro-economic indicators and

employment effects is somewhere very multifaceted (OECD, 2017a). Therefore, strong conclusions on the labour market consequences cannot be drawn without explicitly considering labour market indicators.

There are four basic channels through which market-based green policies can impact economic sectors and labour markets (OECD, 2017b forthcoming).

These areas are-

- **Changes in production modes:** When adapting to green growth regulation, firms will use fewer polluting inputs and pollution-intensive processes. Therefore, each sector will change its labour demand, creating or destroying jobs
- **Changes in demand patterns:** Green policies lower the prices of clean goods relative to polluting products. This change in their relative prices impacts the demand for polluting and non-polluting goods. Therefore, individuals purchase increasingly cleaner goods, as they become cheaper than the polluting goods
- **Changes in aggregate income and macroeconomic conditions:** The implementation of green policies can influence the overall economic activity, may also trigger changes in the government budget e.g. through changes in tax revenues. Importantly, well implemented green policies can achieve multiple dividends: Through the reduction of harmful labour market taxation, they can result in improved environmental quality, better health and wellbeing of citizens, and a more efficient economy
- **Changes in trade and competitiveness:** Producing pollution-intensive goods in a jurisdiction facing green policies can make the good relatively more expensive compared to similar goods produced in jurisdictions without such regulation…

After the Global Financial Crisis, the world has decided to adopt GLOBAL GREEN ECONOMY Concept with the objective of reviving the world economy, saving and creating jobs, and protecting vulnerable groups, promoting sustainable and inclusive growth, reducing risks from carbon dependency and ecosystem degradation and the achievement of the Millennium Development Goals (MDGs), 2000. As governments started devising a new international financial architecture to prevent such crises in future of this scale and ways to jump start economic recovery, they began to recognize and address the risks emanating from climate change. Green Economy is based on a set of transformative actions - determined and far-

reaching. The transition to a Green Economy in the context of sustainable development and poverty eradication must be underpinned by an ethical framework of shared values and principles that extend beyond the traditional technology-based economic system (Sharma, N.K., 2015).

Inter-linkage between green energy and job opportunities in India

Employment opportunities in India's renewable energy sector are going to almost double by 2022, according to the International Renewable Energy Agency (IRENA). The renewable energy sector employed 9.8 million people worldwide, directly and indirectly, in 2016. Employment in renewable energy, excluding large hydropower, increased by 2.8 per cent to reach 8.3 million in 2016, with China, Brazil, the US, India, Japan and Germany being the leading job markets. As India is on its path of high growth, it will create more infrastructures, services and jobs and thus the choices of Indian business will determine the level of sustainable outlook of the country. A more sustainable and cleaner environment in India will see generation of hundreds and thousands of downstream jobs to make it a low-carbon Green Economy, increasing the growth of global carbon markets which will further increase jobs like carbon financial consultants, analysts, financiers, carbon accountants, business risk analysts, etc. Buildings already account for more than 30 per cent of India's electricity use, and two-thirds of the buildings that will exist in India by 2030 have yet to be built. Rise in green and energy efficient buildings will increase the demand for architects, engineers, technicians, plumbers, construction workers, etc.

India has made environmental sustainability a central objective of its development strategy in its twelfth Five-Year Plan (2012-17) and set up a comprehensive framework for skills development for green transition at the national level India is rapidly increasing its share of renewable energy sources but still relies on coal, oil and natural gas and the related carbon emissions for 80 per cent of its electricity. The ILO (International labour organization) report predicts that the transition to a green economy will also lead to the loss of six million jobs in industries that are heavily reliant on carbon-based production. However India and France have launched an International Solar Alliance at the UN Climate Change Conference in Paris on November 30, 2015. The idea was to form a coalition of solar resource-rich countries to collaborate on addressing the identified gaps in their energy requirement via a common approach.

According to Indiaspend, saw a jump of 16% in the number of total jobs created for Indians which reached 432,000 in 2017. As a result, about 37,000

people were employed in various functions such as plant design, construction, commissioning, and operations and maintenance in Solar sector. The rooftop solar segment with just 1.5 GW of installed capacity in FY 2017-18, created employment for about 20,600 people-the highest among the different renewable energy technologies. While, utility scale solar and wind sector created employment for about 15,000 and 1,000 people respectively (figure 2).

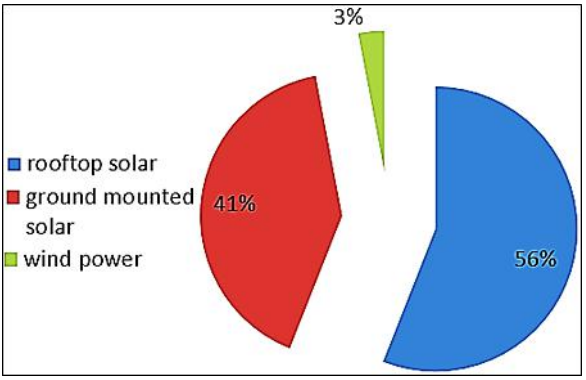

Fig 2: Technology wise employment opportunities (2017-18)

Source: Various Govt. surveys (2017-18).

Sustainable farming practices lead to greening of the small farms which is the most effective way to increase food availability and food security, reduce poverty, increase carbon sequestration and water efficiency, building natural capital stocks and link marginalized farmers with international supply chains as Indian economy still relies on the agriculture sector to feed a huge population. Theoretically, restoring the 2 billion hectares of degraded agricultural land could boost food production by up to 79 per cent. Sustainable agriculture offers opportunities to achieve economic development, save and create jobs, reduce poverty, cut down GHGs emissions, ensure food safety of consumers and offer trade opportunities for developing countries.

The initial step is identifying the necessary skills for development of go green strategy. For effective training programs, companies need to be clearer and report the number of jobs created by companies and the kind of skills required over the course of the go green project. The transition to green jobs can take place along two tracks. The first is a turn down in the number of jobs in various industries, such as those dependent on carbon-based production. Secondly, changes in skill sets can provide workers to continue working in sectors like agriculture and infrastructure as they grow greener.

Conclusion

Environmental sustainability is becoming a growing challenge along the India's projected growth trajectory, and thus, a low-emission, resource-efficient greening of the economic strategy is needed. While it may come at a slightly higher price tag for the economy but it promises to deliver greater benefits with decrease in carbon emissions rates, poverty levels and greater local environmental protection. The new concept of Green Economy is neither to replace the holistic and inclusive idea of Sustainable Development, nor can it be considered independent of that guiding principle, rather the Green Economy needs to be understood as a means to the end of achieving the goals and principles that have been set out within the concept of Sustainable Development. Both developed and developing countries have realized that keeping within global ecological limits is possible by the ability to shape collective action through a rule-based approach and accordingly, the environment concern has been increasingly incorporated in the manufacturing and infrastructure sector. Thus it has become imperative for India to switch to more resource efficient Green Economy where business and industry will be the key driving forces.

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Chapter - 6
Frozen Shoulder: A Physiotherapeutic Evidence Based Practice

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Chapter - 6

Frozen Shoulder: A Physiotherapeutic Evidence Based Practice

Dr. Smita Patil and Dr. Chandrakant Patil

Abstract

Frozen shoulder also called as adhesive capsulitis is a painful condition causing pain and limits range of motion of shoulder. It results in thickening and contraction of shoulder joint capsule which becomes adherent to humeral head. It is a condition affecting 5% of population. Patient has pain, limited range of motion and disability which lasts for 1-24 months. The aim of this chapter is to have a glance over the patho physiology of the condition and give a brief overview of evidence based physical therapy interventions promoting the evidence based practice.

Keywords: frozen shoulder, physiotherapy interventions, evidence based practice

Introduction

The term Frozen Shoulder describes the clinical entity in which a person has restricted passive mobility at Glenohumeral joint, which often results in a loss of active range of motion and pain [2].

In 1896 Duplay [3] was credited with the initial descriptions of the painful and restricted shoulder. He termed the clinical entity of Frozen Shoulder “periarthritis scapulohumeralis”, stating that the pathologic condition was in the periarticular structures. Codman [4] introduced the term “Frozen Shoulder” in 1934 and related the dysfunction to uncalcified tendonitis.

In 1945 Neviaser [5] introduced the concept of “adhesive capsulitis” when he discovered a tight, thickened capsule that stuck to the humerus. He described an inflammatory reaction that led to adhesions, specifically in axillary fold and in the attachment of the capsule at the anatomic neck of humerus.

Evidence has suggested that 'Thickening of the joint capsule and the axillary recess are the main pathological characteristics found in adhesive capsulitis. Other researchers have stated that fibroblast proliferation and thickening of the coracohumeral ligament (CHL) and the capsule at the rotator cuff interval, and the complete obliteration of the fat triangle under the coracoid process are the characteristic pathological changes found through MRI in Adhesive Capsulitis instead of the axillary recess [6, 7].

Adhesive capsulitis is characterized by pain, stiffness, and limited function of the Glenohumeral joint, which adversely affects the entire upper extremity. Patients typically describe onset of shoulder pain followed by a loss of motion [8]. The most common limitations in range of motion are flexion, abduction, external and internal rotation. Approximately 70% of Frozen Shoulder patients are women [9], however, males with Frozen Shoulder are at greater risk for longer recovery and greater disability [9, 10].

Clinical presentation

Adhesive capsulitis is classically characterised by three stages.

Painful stage, Stiffness or "Frozen" Stage, and Recovery or "Thawing" Stage, with the average length of symptoms lasting 30 months.

1. **Stage 1 or freezing stage or painful stage**
    - As described by Reeves [11] typically lasts for 10 to 36 weeks
    - Patient presents with spontaneous onset of shoulder pain which is more severe at night and with activities, associated with a sense of discomfort that radiates down the arm
    - The patient often rests the arm, noting an abatement of pain and contributing to increased stiffness
    - At the end of this phase, the Glenohumeral capsule volume is greatly reduced
2. **Stage 2 or Frozen stage or stiffening stage**
    - It lasts for 4 to 12 months
    - Pain at rest usually diminishes during this stage, leaving the shoulder with restricted motion in all planes
    - Activities of daily living become severely restricted
    - When performing the activities, a sharp, acute discomfort, can occur as the patient reaches the restraint of the tight capsule. Pain at night is a common complaint

3. Stage 3 or thawing stage or resolution stage

- This phase lasts for 5 to 26 months
- This stage is characterized by gradual recovery of range of motion [11]

TYPES

Although the exact pathophysiologic cause of this pathology remains unknown, there are two types identified in the literature: idiopathic and secondary adhesive capsulitis.

Idiopathic frozen shoulder

- Idiopathic ("primary") adhesive capsulitis occurs spontaneously without a specific precipitating event
- Primary adhesive capsulitis results from a chronic inflammatory response with fibroblastic proliferation, which may actually be an abnormal response from the immune system [12]
- Possible causes include immunologic, inflammatory, biochemical, and endocrine alterations [5, 13, 14]

Secondary frozen shoulder

- Secondary adhesive capsulitis occurs after a shoulder injury or surgery, or may be associated with another condition such as rotator cuff injury, cerebrovascular accident(CVA) or cardiovascular disease, which may prolong recovery and limit outcomes [15]

Both Type I and Type II diabetics are susceptible to Frozen Shoulder [16]; unfortunately, diabetics have worse functional outcomes as measured by disability and quality of life questionnaires compared to non-diabetics with Frozen Shoulder [10].

Abnormal biomechanics

Patients with Frozen Shoulder exhibit significant deficits in shoulder kinematics, including increased elevation and upward scapular rotation [17, 18]. Eventually, patients with adhesive capsulitis develop the characteristic "shrug sign" during Glenohumeral joint elevation, where the scapula migrates upward prior to 60 degrees of abduction. This indicates compensation due to lack of capsular extensibility as well as a change in the central nervous system motor patterning due to maladaptive movement. Patients with adhesive capsulitis may also develop adaptive postural deviations such as anterior shoulders or increased thoracic kyphosis as the

function of the shoulder complex remains limited and painful. Adhesive capsulitis is generally related to a shortening and fibrosis of the joint capsule (ligaments) surrounding the shoulder joint. Nevasier [19] was among the first to report thickening and contraction of the shoulder capsule as well as inflammatory changes through histological analysis. The contracture of the shoulder ligaments actually decreases the volume of the capsule, thus limiting range of motion. It is likely that limitations in range of motion and the pain associated with Frozen Shoulder are not only related to capsular and ligamentous tightness, but also fascial restrictions, muscular tightness, and trigger points within the muscles. Physical therapists can address impairments and limitations associated each of these contributors to the pathology of Adhesive Capsulitis with a variety of treatment methods.

Diagnosis

The diagnosis of adhesive capsulitis may be suggested by careful history and physical examination. The findings on physical examination vary depending on the stage at which the patient presents for treatment. Most researchers in this area have suggested a decrease in range of motion of about 50% as a criterion for diagnosis of Frozen Shoulder [20].

Loss of external rotation in abduction would suggest a contracture in the antero-inferior capsule whereas loss of external rotation in adduction is more indicative of a contracture in the rotator interval. Loss of internal rotation in either adduction or abduction suggests posterior capsule contracture. Movements within the examined range of motion should be smooth and free from crepitus [21].

Investigations

No specific hematological tests are diagnostic for Frozen Shoulder. Routine hematological and biochemistry tests, though usually normal, should be performed. A fasting blood glucose assessment is a sensible screening test useful in identifying patients with impaired glucose tolerance presenting with shoulder stiffness [22].

A full series of shoulder radiographs should be obtained including true antero-posterior, scapular lateral and axillary views. These images should show, by definition, a normal joint appearance. Bone scan is also useful in identifying reflex sympathetic dystrophy. If there is any suspicion of the presence of unusual pathology then a bone scan should supplement the plain radiography. Diphosphonate bone scans have demonstrated increased uptake in 90% of patients with Frozen Shoulder [23].

Dynamic ultrasonography has been used in Frozen Shoulder which shows constant limitation in the sliding movement of the supraspinatus tendon against the scapula [24]. Magnetic resonance imaging has been used to demonstrate an increase in the thickness of the capsule in patients with Frozen Shoulder [25].

Physical therapy interventions

Proper examination of the pain and end feel during the shoulder joint movements will help to know about the severity of the condition and accordingly help in planning the treatment for the condition.

If during passive joint movement the pain arises prior to the feeling of end range, the joint is in acute stage and we should not recommend active therapies.

If pain is experienced as the end range is reached, the condition is less acute, active treatment can be recommended.

When the end range is reached without pain, more aggressive, active physiotherapy interventions needs to be implemented [26, 27].

Levine and colleagues stated that a standardized non operative treatment of NSAID's and physical therapy over a duration of 4 months showed 90% successful rates [28].

On an average 4 weeks of physiotherapy intervention showed improvement in pain and strength in frozen shoulder [29, 30]

When it comes to treatment of choice it is always more preferable to give gentle therapy like pain free pendulum and active exrcises rather than selecting intensive therapy like manipulation upto and beyond the pain threshold [31]

Evidences also suggest that inspite of successful treatment the patients with frozen shoulder suffer from some deficiency in their shoulder range of motion [10]

Certain prophylactic measures are also suggested which will help in gaining and maintaining the shoulder range of motion in individuals with frozen shoulder. Measures like practicing passive and active range of motion over the age of 50 years who are at high risk of developing painful shoulder or individuals immobilised due to traumatic conditions of chest and shoulder [32-34].

The individuals developing painful and stiff shoulder should undergo for aggressive physiotherapy treatment so as to prevent further complications of developing contracture within the capsule [35].

A Meta-analysis done by Jewell and Colleagues have suggested that joint mobilization and exercise are the most effective form of physical therapy interventions for frozen shoulder [36].

The frequently used physical therapy interventions to deal with individuals with frozen shoulder includes modalities, manual techniques and therapeutic exercises. There are emerging techniques inculcated in practice of physiotherapy, but not all the clinical interventions have evidences to support their effectiveness. This is the field where physiotherapist needs to work to explore their knowledge over the best possible evidence based practice to treat the individuals with frozen shoulder [37].

Evidence based interventions

1. Joint mobilization

These are passive skilled manual therapy techniques applied to the joints and related soft tissue at varying speed and amplitudes using physiologic or accessory motions for therapeutic purposes [38].

This form of passive exercises are designed to restore joint play motions like roll, glide, slide, spin etc. [39].

A study by Halbach and tank suggested that mobilization is the "first modality of choice" to treat and restore the normal joint play of synovial joint in shoulder complex [40].

Studies have demonstrated that joint mobilization is effective intervention to treat frozen shoulder. Johnson and colleagues randomly assigned 20 consecutive adhesive capsulitis patients to physical therapy intervention including grade III stretch mobilization with distraction at end range of abduction and external rotation using either an anterior or posterior directed linear translation. After 3 sessions, the posterior mobilization group had significantly improved their external rotation range of motion by 31 degrees versus only 3 degrees in the anterior mobilization group. In addition, high-grade joint mobilization techniques were more effective than low-grade mobilization in improving glenohumeral mobility and reducing disability in a recent randomized controlled trial of treatment of patients with adhesive capsulitis. In particular, posterior glide mobilization was determined to be more effective than anterior glide for improving external rotation range of motion in patients with adhesive capsulitis [41, 42].

Nicholson [43] compared the pain and hypermobility of one group treated with joint mobilization and active exercises with that of a control group treated with active exercises alone. The mobilization group demonstrated a

significant decrease in pain and increase in passive abduction relative to the control group.

Abhay K, Suraj K, Aggarwal A, Ratnesh Kumar, and Ghosh P[44] conducted a study on Effectiveness of Maitland Techniques in Idiopathic Shoulder Adhesive Capsulitis. The study concluded that addition of the Maitland mobilization technique with the combination of exercises have proved their efficacy in relieving pain and improving ROM and shoulder function and hence should form a part of the treatment plan.

Vermeulen HM, Rozing PM, Obermann WR, Cessie S, Thea PM [42] conducted study on Comparison of High-Grade and Low-Grade Mobilization Techniques in the Management of Adhesive Capsulitis of the Shoulder: Randomized Controlled Trial. In subjects with adhesive capsulitis of the shoulder, HGMTs appear to be more effective in improving Glenohumeral joint mobility and reducing disability than LGMTs, with the overall differences between the 2 interventions being small.

2. Therapeutic exercise

The most popular and useful therapy for frozen shoulder is therapeutic exercises. The commonly prescribed exercises are active assisted range of motion exercises [45].

The active assisted exercises are given in the form where the patient utilizes the normal side of upper limb or equipment such as rope pulley, wand/T bar or exercise balls. The exercises are performed for flexion, abduction and external rotation ranges of motion.

Griggs and colleagues from their study concluded that physical therapy consisting 4 self stretches (passive flexion, horizontal adduction, internal rotation behind the back with the unaffected arm, and external rotation at 0° using a cane) performed at least twice a day produced a satisfactory outcome in 90 percent of stage 2 adhesive capsulitis patients. There was significant improvement in pain, range of motion and shoulder function [10].

The study conducted by lee *et al*., [46] have also suggested that therapeutic exercise regimens have decreased pain and increased range of motion in frozen shoulder.

The other from of training is resistive exercises which mainly targets the strengthening of scapular stabilizers and rotator cuff muscles. These are incorporated when the range at shoulder joint is enough to undergo for strengthening without pain. There are targeted which are more prone for weakness like lower trapezius, serratus anterior and infraspinatus. The lower

trapezius are more weak in rozen shoulder individuals when compared to an asymptomatic patient of same age [47].

Vigorous and forceful exrcises are contraindicated as it can aggravate pain and produce muscle guarding, thereby increasing the severity of the condition. But obviously it is said “no pain, no gain” when you treat the frozen shoulder patients [48].

When treating the patient with frozen shoulder therapist should be aware about normal biomechanics of the shoulder. There are certain abnormal biomechanical alteration which take place at the shoulder when the patient has frozen shoulder. For example, when the patient is attempting to perform certain resistive exercises and shows a shrug sign, the therapist should stop the exrcises and should make alteration in the resistance given to the individual or ask them to perform in an altered position, while cuing the patient for proper movement patterns.

“Shoulder Sling” exercise can be used to help re-train the initial setting phase of the rotator cuff when initiating abduction The Shoulder Sling exercise for a “rotator cuff set” is considered analogous to a “quad set” exercise in the lower extremity. The elastic band creates an “upward and inward” vector of resistance that the patient must push against in a “down and out” vector. This movement simulates the initiation of abduction as well as the depression and stabilization functions of the rotator cuff, which occur prior to and during abduction. Anecdotally, this exercise helps reduce early activation of the upper trapezius during abduction in patients demonstrating a shrug sign [37].

Griggs SM, Ahm A, Green A conducted a study to evaluate the outcome of patients with idiopathic adhesive capsulitis who were treated with a stretching exercise program. They selected a sample size of 75 and used home exercise program-supine cane flexion, external rotation, internal rotation, pendulum, formal physical therapy. In their results they found that 64 satisfactory-SF 36, 7 not satisfied-SF 36, 5 required manipulation/surgery, ROM increased and pain decreased [10].

3. Modalities

The rationale for using modalities to treat the patients with frozen shoulder is to provide pain relief and loosen the scar tissue [36].

Physical agents can control pain by modifying pain transmission or perception or by changing the underlying process causing the sensation. Physical agents may act by modulating transmission at the spinal cord level,

changing the ratio of nerve conduction, or altering the central or peripheral release of neurotransmitters. Physical agents can change the processes that cause pain by modifying tissue inflammation and healing, altering collagen extensibility. Tissues that contain collagen can become shortened as a result of immobilization or limited range of motion. To return soft tissues to its normal functional length, thereby allowing full motion without damaging other structures, the collagen must be stretched. Collagen must be stretched most effectively and safely when it is more extensible. Since the extensibility of collagen is temperature dependant, increasing in response to increased temperature, thermal agents are frequently applied before soft tissue stretching to optimize the stretching process [49].

It is suggested that deep heating modality should be preferred rather than superficial heating modality. A study done by Leung and Chaing on effect of deep and superficial heating in management of frozen shoulder showed The addition of deep heating to stretching exercises produced a greater improvement in pain relief, and resulted in better performance in the activities of daily living and in range of motion than did superficial heating [50].

Ultrasound

Ultrasound is a deep heating modality that uses high frequency acoustic vibration above the human audible spectrum (i.e. >20000Hz). Therapeutic ultrasound involves the use of high frequency acoustic energy to produce thermal and non thermal effects in tissue. The most commonly used frequency is 1 MHz. A transducer operating at therapeutic frequencies will produce a beam with a greater angle of divergence if the diameter of the transducer is small than if it is large. The World Health Organization and the International Electrical Commission both recommend limiting spatial average intensity to 3 W/cm2. Most clinically used intensities of therapeutic ultrasound are in the 0.1-2.5/3 W/cm2 according to machine. The wave length is approximately 0.15 cm. duration generally over 5 to 10 minutes per site to obtain optimal heating of joint tissues located right in the front of the bone. Temperature reaches up to 460 C (114.80 F) in deep tissues are easily achieved with ultrasound [51, 52].

Hamer and kirk demonstrated that ultrasound combined with passive and active exercises improved pain and shoulder motion in patients with frozen shoulder [53].

Phonophoresis

It is also known as sonophoresis or ultrasonophoresis. This implies the movement of drugs through intact skin into the subcutaneous tissues under

the influence of ultrasound. Many drugs are absorbed through the skin very slowly, using usually high frequency ultrasound. Phonophoresis relies on perturbation of the tissues causing more rapid particle movement through the skin, thus encouraging absorption of the drug. Topical NSAIDs like naproxen/diclofenac gel can be introduced through the skin for relief of pain locally specially in patients who have peptic ulcer disease, bronchial asthma or renal failure. UST it is relieving pain and stiffness by its mechanism of action, but here, with addition of NSAIDs gel, it gives an additional effect of pain relief of that area. Drugs used are steroids, anti-inflammatories and local anaesthetics [54].

Transcutaneous electrical nerve stimulator (TENS)

Transcutaneous electrical nerve stimulation (TENS) is from of non-invasive technique where a low-voltage electrical current is delivered through wires from a small power unit to electrodes located on the skin. TENS is treatment of choice for pain and in variety of acute and chronic musculoskeletal conditions. Recent reports, however, suggest that the absorption of calcific deposits in the shoulder muscle tendons is accelerated by low frequency TENS therapy and may be related to increased microcirculation in the region of the stimulation [55].

A study done by Siddaram *et al*., has suggested that TENS used along with pendular exercises in patients with frozen shoulder helps in reducing pain and improve the functional outcomes. The parameters used for TENS were Pulse duration: 0.2ms. Frequency: 100HZ. Treatment time: 20minutes. Duration: 10 sessions in 1 month [56, 57].

Rizk *et al*., [57] compared a group treated by TENS plus pulley traction in abduction for up to 2 hours a day with a group whose treatment consisted of heat modalities, active-assisted exercise, and rhythmic stabilization manipulation. The TENS-traction group gained significantly more motion in all ranges combined than the heat-exercise-manipulation group. The TENS-traction group also achieved pain-free sleep after 4-6 weeks of treatment, compared to the 4-6 months that passed before sleep was pain-free in the non-TENS group.

Thus from evidences it is suggested that TENS can be used for treating pain in patients with frozen shoulder.

4. Kinesiotaping

The upcoming newer technique to treat frozen shoulder is kinesiotaping. The evidences shows limited studies about its efficacy in frozen shoulder and is becoming newer area for research to work on.

This amazing taping method was developed by Dr. Kenzo Kase over 25 years ago in Japan.

Principle

The Kinesio Taping Method is based on a simple principle that the body has built-in healing mechanisms and healthcare practitioners can help to positively influence their efficiency by removing barriers that impede them. The results are increased fluid flow through an injured area, better control over muscle contractions, reduced pain, and ultimately faster healing. This effect is modulated and coordinated by the nervous system by specifically stimulating the sensory motor system [32].

Physiologic effects

There are five major physiologic effects of the Kinesio Taping Method and its application.

Skin function

Kinesio Tape has expanding and contracting properties which provides gentle sensory stimulation to various types of sensory receptors in the skin during movement. This activates the spinal inhibitory system through stimulation of touch receptors and activates the descending inhibitory system to decrease pain via the Gate Control Theory, proposed by Melzack and Wall. Thus reduced pressure on pain receptors under the skin can provide relief of both acute and chronic pain.

Circulatory and/or lymph

The lymphatic drainage system contains both superficial and deep lymphatic vessels which can become filled in response to localized inflammation. Kinesio Taping takes advantage of the mechanical connection of the anchoring filaments to the endothelial cells. This connection opens the lymphatic channel which is due to the elastic qualities of the tape, creating the characteristic convolutions on the tape. The lymphatic capillary fills towards the areas of decrease pressure under the Kinesio Tape, which allows fluid to move more freely.

Fascia

Fascia is responsible for maintaining structural integrity; for providing support protection; acting as a force dampener. When fascia is too tight, the muscles ability to perform optimally and repair is restricted. This tightness alters biomechanics and cause mechanical compensation in other areas. Fascial tightness restricts the movement and result in loss of range of

motion. If this fascial contraction can be interrupted, then a reorganization of the fascia can occur. Kinesio Taping, when applied correctly, can help to minimize this fascial contraction during soft tissue injury or help to reorganize the fascia during chronic injury.

Muscle

The elastic property of Kinesio Tape replicates and enhances the function of muscle fibres and tendons. Fatigued, overused muscles contain by-products of exercise (such as lactic acid) that contribute to pain and stiffness and limit the ability to continue exercising. When kinesiotaping is used over these areas, enhanced removal of these by-products allows for more rapid recovery. This could translate into improved performance in endurance evenly or more complete recovery between repetitive, high intensity events. Kinesiotape provides support to the weakened muscles, improves muscle activation.

Joint

Joint function can also be improved by stimulating the proprioceptors in the joints passive restraint system by application of Kinesio Tape over the ligaments. The proprioceptors in the ligaments and joints capsules provide information to the nervous system which allows the musculoskeletal system to provide appropriate movement to the injured joint. Free-ending unmyelinated nerve fibres are abundant in joint ligaments and capsules, and in the outer parts of the intraarticular menisci. They mediate pain when a joint is strained, and they operate in excitatory reflex to protect the capsule.

For example, the anterior wrist capsule is supplied by the median and ulnar nerve; if it is suddenly stretched by forced extension, motor fibres in these nerves are reflexively activated and cause wrist flexion. Experiments have shown that, when a joint is inflamed, more free-ending nerve fibres are excited than when a healthy joint capsule is stretched. It seems that some nerve endings are only stimulated by inflammation. Encapsulating nerve endings in and around joint capsules include Ruffini endings that signal tension, lamellated endings responsive to pressure, and the simian corpuscles responsive to vibration.

Practical

Kinesio Tex Tape can be worn 24 hours a day for 3 to 5 continuous days due to its unique physical properties. It can be applied during any phase of injury as it can be clinically utilized to initially reduce inflammation and progress through all phases of rehabilitation. Due to its versatility, it can be used in conjunction with many different modalities as well.

Application of kinesio tape

- Specific cut shapes of KT are designed to allow for optimal responses. An "X" strip, "Y" strip, and 'I" strip all seek various results. The size and shape of the targeted muscles depict which type of KT strip will be applied
- "I" shaped KT application is used for small areas
- "Y" shaped application is used for large areas such as pectoralis major or the deltoid
- The "X" shaped application is used for large and long areas, such as the bicep and triceps muscle

Recently a study done by Kanase SB *et al*. on Effect of kinesiotaping with Maitland mobilization and Maitland mobilization in management of frozen shoulder has shown that kinesiotaping is effective way of reducing pain in patients with frozen shoulder. The possible effects may be due to certain properties of kinesio tape. Kinesiotaping helps in providing tactile cues and thus provide correction of scapular position. Kinesiotaping, when applied correctly, can help minimize fascial contraction during soft tissue injury and help to reorganize the fascia during chronic injury. Kinesio Tape has expanding and contracting properties which provides gentle sensory stimulation to various types of sensory receptors in the skin during movement. This activates the spinal inhibitory system through stimulation of touch receptors and activates the descending inhibitory system to decrease pain via the Gate Control Theory, proposed by Melzack and Wall and help to decrease pain [58].

In conclusion, frozen shoulder is a challenging condition for both physical therapist and patient. To have a maximum benefit and got results in patients with frozen shoulder, their should be accurate diagnosis and assessment of the condition. Through the published evidences, it is suggested that an integrated, multifaceted, evidence based approach is necessary to treat the condition.

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Chapter - 7
Heat and Mass Transfer Analysis of an Unsteady MHD Free Convection Flow of a Casson Fluid Past Over an Oscillating Vertical Plate with Newtonian Heating and Thermal Radiation

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Chapter - 7

Heat and Mass Transfer Analysis of an Unsteady MHD Free Convection Flow of a Casson Fluid Past Over an Oscillating Vertical Plate with Newtonian Heating and Thermal Radiation

Dr. Anjan Kumar Deka

Abstract

In this chapter, an attempt has been made to investigate the boundary layer flow of an unsteady MHD free convection heat and mass transfer flow of a viscous, incompressible and electrically conducting Casson fluid over an oscillating vertical plate with Newtonian heating on the wall under the effects of chemical reaction and thermal radiation. Casson fluid model is used to characterize the fluid behavior. The magnetic Reynolds number is considered to be so small that the induced magnetic field can be neglected. Exact solution of the governing equations is obtained in closed form by Laplace transform technique. The effects of the pertinent flow parameters on velocity, temperature and concentration field are presented graphically and discussed details in this paper. The numerical values of skin friction, the Nusselt number and the Sherwood number are presented in tabular form for various values of pertinent flow parameters. It is found that the fluid velocity increases near the wall (before the crossing over point) but away from the wall (after crossing over point), it decreases with increasing conjugate parameter for Newtonian heating γ and Casson parameter α. Chemical reaction tends to reduce the fluid velocity whereas thermal radiation has reverse effect on the fluid velocity throughout the boundary layer region. The Newtonian heating parameter γ and thermal radiation tend to enhance the fluid temperature throughout the boundary layer region. The Newtonian heating parameter, Casson parameter, chemical reaction parameter and thermal radiation has the tendency to reduce the skin friction at the plate. The Newtonian heating parameter has the tendency to enhance the rate of heat transfer at the plate whereas thermal radiation has reverse effect on it. Mass diffusion and chemical reaction parameter tends to enhance the rate of mass transfer at the plate.

Keywords: nusselt number, skin friction, magnetic field, heat transfer, mass transfer, porous medium, velocity field.

Introduction

The analysis of boundary layer flow of viscous and non-Newtonian fluids has been the focus of extensive research by various scientists due to its importance in continuous casting, paper production, glass blowing, aerodynamic extrusion of plastic sheet, polymer extrusion and several others. Convective heat transfer plays an important role during the handling and processing of non-Newtonian fluid flows. Mechanics of non-Newtonian fluid flows present a special challenge to engineers, physicists, and mathematicians. Because of the complexity of these fluids, there is not a single constitutive equation which exhibits all properties of such non-Newtonian fluids. In the process, a number of non-Newtonian fluid models have been proposed. These simple fluid models have the shortcomings that render results that are not in accordance with the fluid flows in reality. The model predicts shear thinning and shear thickening behavior.

The second grade fluid model is the simplest subclass of viscoelastic fluids for which one can reasonably hope to obtain the analytic solution. Normal stress effects can be expressed in second grade fluid model, a special type of Rivlin-Ericksen fluids, but this model is incapable of representing shear thinning/thickening behavior (Aksoy *et al*. (2007). The non-Newtonian fluids are mainly classified into three types, namely differential, rate, and integral. The simplest subclass of the rate type fluids is the Maxwell model which can predict the stress relaxation. This rheological model, also, excludes the complicated effects of shear dependent viscosity from any boundary layer analysis (Hayat *et al*. (2011). There is another type of non-Newtonian fluid known as Casson fluid. Casson fluid exhibits yield stress. It is well known that Casson fluid is a shear thinning liquid which is assumed to have an infinite viscosity at zero rate of shear, a yield stress below which no flow occurs, and a zero viscosity at an infinite rate of shear, i.e., if a shear stress less than the yield stress is applied to the fluid, it behaves like a solid, whereas if a shear stress greater than yield stress is applied, it starts to move. In all these studies mentioned above, the Newtonian heating condition was neglected at the boundary. The situation where the heat is transported to the convective fluid via a bounding surface having finite heat capacity is known as Newtonian heating (or conjugate convective flows). This configuration occurs in convection flows set up when the bounding surfaces absorb heat by solar radiation. Merkin (1994) in his pioneering work studied the free convection boundary layer flow past a vertical plate with Newtonian heating.

He found the asymptotic solution near the leading edge analytically and the full solutions along the whole plate for free convection boundary layer over vertical surfaces numerically.

Mathematical analysis: Let us consider the unsteady MHD natural convection flow with heat and mass transfer of a viscous, incompressible, electrically conducting, thermal radiative and chemically reactive Casson fluid over an oscillating vertical plate with Newtonian heating on the wall. Coordinate system is chosen in such a way that x'-axis is considered along the plate in upward direction and y'-axis normal to plane of the plate in the fluid. Initially i.e., at time $t' \le 0$, both the fluid and plate are at rest and are maintained at a uniform temperature T'_∞. Also species concentration at the surface of the plate as well as at every point within the fluid is maintained at uniform concentration C'_∞. At time $t' > 0$, the plate starts oscillation in its plane $(y = 0)$ with velocity $V = UH(t)\cos\omega t\hat{i}$, where the constant U is the amplitude of the plate oscillations, H(t) is the unit step function, $\hat{i}$ is the unit vector in the vertical flow direction and ω is the frequency of the oscillation of the plate. The species concentration at the surface of the plate is raised to uniform species concentration C'_w and is maintained thereafter. Geometry of the problem is presented in Fig. 5.1. Since plate is of infinite extent in x' and z' directions and is electrically non-conducting, all physical quantities except pressure depend on y' and t' only. Also no applied or polarized voltages exist so the effect of polarization of

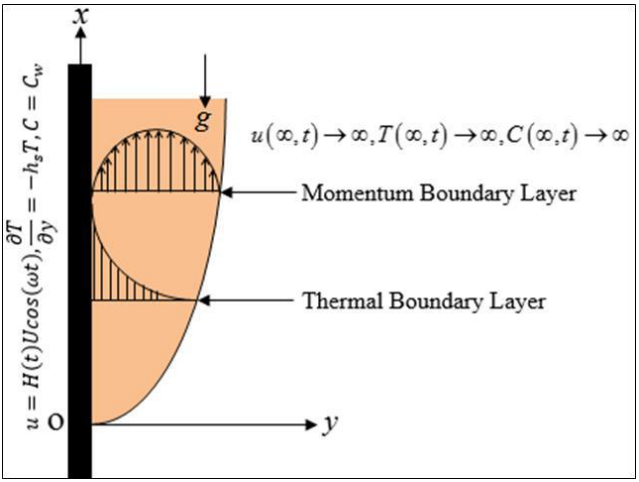

Fig 5.1: Geometry of the Problem

Fluid is negligible. This corresponds to the case where no energy is added or extracted from the fluid by electrical means (1973). It is assumed that the induced magnetic field generated by fluid motion is negligible in comparison to the applied one. This assumption is justified because magnetic Reynolds number is very small for liquid metals and partially ionized fluids which are commonly used in industrial applications (1973). According to Newtonian heating, the heat transfer from the surface to the fluid is directly proportional to the T. In view of the above assumptions and taking into account the rheological equation for an incompressible and isotropic Casson fluid represented by Casson (1959) is

$$\tau = \tau_0 + \mu\alpha^*$$

Equivalently,

$$\tau_{ij} = \begin{cases} 2\left(\mu_B + \dfrac{p_y}{\sqrt{2\pi}}\right)e_{ij}, \pi > \pi_c \\ 2\left(\mu_B + \dfrac{p_y}{\sqrt{2\pi_c}}\right)e_{ij}, \pi < \pi_c \end{cases}$$

Where τ, τ_0, μ and α^* are, respectively shear stress, Casson yield stress, dynamic viscosity and shear rate and $\pi = e_{ij}e_{ij}$ and e_{ij} is the (i, j)th component of deformation rate, π is the product of component of deformation rate with itself, π_c is a critical value of this product based on the non-Newtonian model, μ_B is the plastic dynamic viscosity of the non-Newtonian fluid, and p_y denote the yield stress of the fluid.

Keeping in view the assumptions made above, governing equations for the fully developed hydromagnetic natural convection flow with heat and mass transfer of an electrically conducting, viscous, incompressible, thermal radiative and chemically reactive Casson fluid over an oscillating vertical plate with Newtonian heating on the wall are.

Conservation of momentum

$$\frac{\partial u'}{\partial t'} = \upsilon\left(1+\frac{1}{\alpha}\right)\frac{\partial^2 u'}{\partial y^{2'}} + g\beta\left(T' - T'_\infty\right) + g\beta'\left(C' - C'_\infty\right) \qquad (5.2.1)$$

Conservation of energy

$$\frac{\partial T'}{\partial t'} = \frac{k}{\rho Cp}\frac{\partial^2 T'}{\partial y^{2'}} - \frac{1}{\rho Cp}\frac{\partial q_r'}{\partial y'} \tag{5.2.2}$$

Conservation of species concentration

$$\frac{\partial C'}{\partial t'} = D\frac{\partial^2 C'}{\partial y'^2} - Kr'\left(C' - C_\infty'\right) \tag{5.2.3}$$

Initial and boundary conditions for the fluid flow problem are given below:

$$u' = 0, T' = T_\infty', C' = C_\infty' \text{ for all } y' \text{ and } t' \le 0 \tag{5.2.4a}$$

$$u' = UH(t)\cos(\omega t'), \frac{\partial T'}{\partial y'} = -h_s T', C' = C_w' \text{ at } y' = 0 \text{ for } t' > 0 \tag{5.2.4b}$$

$$u' \to 0, T' \to T_\infty', C' \to C_\infty' \text{ as } y' \to \infty \text{ for } t' > 0 \tag{5.2.4c}$$

Where $u', g, \alpha, \rho, \beta, \beta', k, C_p, \sigma, \upsilon, D, T', C', Kr', q_r'$ and h_s are, respectively, the fluid velocity in the x'-direction, acceleration due to gravity, Casson fluid parameter, the fluid density, the volumetric coefficient of thermal expansion, the volumetric coefficient of expansion for concentration, thermal conductivity, specific heat at constant pressure, electrical conductivity, the kinematic viscosity, the coefficient of mass diffusivity, the temperature of the fluid, species concentration, chemical reaction parameter, radiative heat flux vector, and heat transfer coefficient.

For an optically thick fluid, in addition to emission there is also self absorption and usually the absorption co-efficient is wavelength dependent and large so we can adopt the Rosseland approximation for radiative heat flux vector q_r'. Thus q_r' is given by

$$q_r' = -\frac{4\sigma_1}{3k_1}\frac{\partial T'^4}{\partial y'} \tag{5.2.5}$$

Where k_1 is Rosseland mean absorption co-efficient and σ_1 is Stefan-Boltzmann constant.

We assume that the temperature differences within the flow is sufficiently small, then equation (5.2.5) can be linearized by expanding T'^4

into Taylor's series about the free stream temperature T_∞' and neglecting second and higher order terms in $(T'-T_\infty')$. This results of the following approximations:

$$T'^4 \approx 4T_\infty'^3 T' - 3T_\infty'^4 \tag{5.2.6}$$

From (5.2.5) and (5.2.6) we have

$$\frac{\partial q_r'}{\partial y'} = -\frac{4\sigma_1}{3k_1}\frac{\partial^2 T'^4}{\partial y'^2} = -\frac{16\sigma_1 T_\infty'^3}{3k_1}\frac{\partial^2 T'}{\partial y'^2} \tag{5.2.7}$$

Thus the energy equation (5.2.3) reduces to

$$\frac{\partial T'}{\partial t'} = \frac{k}{\rho C_p}\frac{\partial^2 T'}{\partial y'^2} + \frac{16\sigma_1 T_\infty'^3}{3k_1\rho C_p}\frac{\partial^2 T'}{\partial y'^2} \tag{5.2.8}$$

In order to reduce the governing equations (5.2.1), (5.2.3) and (5.2.8), into non-dimensional form, the following dimensionless variables and parameters are introduced.

$$y = \frac{y'U}{\upsilon}, u = \frac{u'}{U}, t = \frac{t'U^2}{\upsilon}, T = \frac{T'-T_\infty'}{T_\infty'}, C = \frac{C'-C_\infty'}{C_w'-C_\infty'}, Gr = \frac{g\beta\upsilon T_\infty'}{U^3}, Gm = \frac{g\beta'\upsilon(C_w'-C_\infty')}{U^3},$$

$$Pr = \frac{\mu Cp}{k}, Sc = \frac{\upsilon}{D}, \gamma = \frac{h_s\upsilon}{U}, N = \frac{16\sigma_1 T_\infty'^3}{3kk_1}, Kr = \frac{\upsilon Kr'}{U^2}, \omega = \frac{\upsilon\omega'}{U^2}.$$

Where $Gr, Gm, Pr, Sc, Kr, \gamma$ and N are, respectively, the thermal Grashof number, the solutal Grashof number, the Prandtl number, the Schmidt number, the chemical reaction parameter, Newtonian heating parameter and radiation parameter.

Equation (5.2.1), (5.2.3) and (5.2.8) reduces to

$$\frac{\partial u}{\partial t} = \left(1+\frac{1}{\alpha}\right)\frac{\partial^2 u}{\partial y^2} + GrT + GmC \tag{5.2.9}$$

$$Pr\frac{\partial T}{\partial t} = (1+N)\frac{\partial^2 T}{\partial y^2} \tag{5.2.10}$$

$$\frac{\partial C}{\partial t} = \frac{1}{Sc}\frac{\partial^2 C}{\partial y^2} - KrC \tag{5.2.11}$$

The corresponding initial and boundary conditions in non-dimensional form become:

$$u = 0, \theta = 0, \phi = 0 \text{ for all y and } t \le 0 \tag{5.2.12a}$$

$$u = H(t)\cos(\omega t), \frac{\partial T}{\partial y} = -\gamma(1+T), C = 1 \text{ at } y = 0 \text{ for } t > 0 \tag{5.2.12b}$$

$$u \to 0, T \to 0, C \to 0 \text{ as } y \to \infty \text{ for } t > 0 \tag{5.2.12c}$$

Here $\gamma = \frac{h_s \upsilon}{U}$ is the Newtonian heating parameter. We note that the equation (5.2.12b) gives T=0 when $\gamma = 0,$ which physically means that no heating from the plate exists when $\gamma = 0.$

Method of solutions

The set of equations (5.2.9), (5.2.10) and (5.2.11) subject to the initial and boundary conditions (5.2.12a)-(5.2.12c) were solved analytically using Laplace transforms. The exact solutions for fluid velocity $u(y,t)$, fluid temperature $T(y,t)$ and species concentration $C(y,t)$ are obtained and expressed in the following form:

$$u(y,t) = \frac{H(t)}{4} e^{i\omega t}\left[e^{y\sqrt{i\omega a_1}} erfc\left(\frac{y}{2}\sqrt{\frac{a_1}{t}} + \sqrt{i\omega t}\right) + e^{-y\sqrt{i\omega a_1}} erfc\left(\frac{y}{2}\sqrt{\frac{a_1}{t}} - \sqrt{i\omega t}\right)\right] +$$

$$\frac{H(t)}{4} e^{-i\omega t}\left[e^{y\sqrt{-i\omega a_1}} erfc\left(\frac{y}{2}\sqrt{\frac{a_1}{t}} + \sqrt{-i\omega t}\right) + e^{-y\sqrt{-i\omega a_1}} erfc\left(\frac{y}{2}\sqrt{\frac{a_1}{t}} - \sqrt{-i\omega t}\right)\right] +$$

$$\frac{a_1 a_3}{a_2^2}\left[e^{\left(a_2^2 t - y a_2\sqrt{a_1}\right)} erfc\left(\frac{y}{2}\sqrt{\frac{a_1}{t}} - a_2\sqrt{t}\right) - erfc\left(\frac{y}{2}\sqrt{\frac{a_1}{t}}\right)\right] - \frac{a_1 a_3}{a_2}\left[2\sqrt{\frac{t}{\pi}} e^{-\frac{y^2 a_1}{4t}} - y\sqrt{a_1} erfc\left(\frac{y}{2}\sqrt{\frac{a_1}{t}}\right)\right] -$$

$$a_1 a_3\left[\left(t + \frac{y^2 a_1}{2}\right) erfc\left(\frac{y}{2}\sqrt{\frac{a_1}{t}}\right) - y\sqrt{a_1}\sqrt{\frac{t}{\pi}} e^{-\frac{y^2 a_1}{4t}}\right] - \frac{a_1 a_3}{a_2^2}\left[e^{\left(a_2^2 t - y a_2\sqrt{\Pr_{eff}}\right)} erfc\left(\frac{y}{2}\sqrt{\frac{\Pr_{eff}}{t}} - a_2\sqrt{t}\right) - erfc\left(\frac{y}{2}\sqrt{\frac{\Pr_{eff}}{t}}\right)\right] +$$

$$\frac{a_1 a_3}{a_2}\left[2\sqrt{\frac{t}{\pi}} e^{-\frac{y^2 \Pr_{eff}}{4t}} - y\sqrt{\Pr_{eff}} erfc\left(\frac{y}{2}\sqrt{\frac{\Pr_{eff}}{t}}\right)\right] + a_1 a_3\left[\left(t + \frac{y^2 \Pr_{eff}}{2}\right) erfc\left(\frac{y}{2}\sqrt{\frac{\Pr_{eff}}{t}}\right) - y\sqrt{\Pr_{eff}}\sqrt{\frac{t}{\pi}} e^{-\frac{y^2 \Pr_{eff}}{4t}}\right] +$$

$$\frac{a_1 a_5}{a_6}\left[erfc\left(\frac{y}{2}\sqrt{\frac{a_1}{t}}\right) - \frac{e^{-a_6 t}}{2}\left\{ e^{y\sqrt{-a_1 a_6}} erfc\left(\frac{y}{2}\sqrt{\frac{a_1}{t}} + \sqrt{-a_6 t}\right) + e^{-y\sqrt{-a_1 a_6}} erfc\left(\frac{y}{2}\sqrt{\frac{a_1}{t}} - \sqrt{-a_6 t}\right)\right\}\right] -$$

$$\frac{a_1 a_5}{2a_6}\left[\left\{ e^{\left(y\sqrt{ScKr}\right)} erfc\left(\frac{y}{2}\sqrt{\frac{Sc}{t}} + \sqrt{Krt}\right) + e^{\left(-y\sqrt{ScKr}\right)} erfc\left(\frac{y}{2}\sqrt{\frac{Sc}{t}} - \sqrt{Krt}\right)\right\} -\right.$$

$$e^{-a_6 t}\left\{e^{\left(y\sqrt{Sc(Kr-a_6)}\right)}\,erfc\left(\frac{y}{2}\sqrt{\frac{Sc}{t}}+\sqrt{(Kr-a_6)t}\right)+e^{\left(-y\sqrt{Sc(Kr-a_6)}\right)}\,erfc\left(\frac{y}{2}\sqrt{\frac{Sc}{t}}-\sqrt{(Kr-a_6)t}\right)\right\}\Bigg] \quad (5.3.1)$$

$$T(y,t)=e^{\left(a_2^2 t-ya_2\sqrt{Pr_{eff}}\right)}\,erfc\left(\frac{y}{2}\sqrt{\frac{Pr_{eff}}{t}}-a_2\sqrt{t}\right)-erfc\left(\frac{y}{2}\sqrt{\frac{Pr_{eff}}{t}}\right) \quad (5.3.2)$$

$$C(y,t)=\frac{1}{2}\left\{e^{\left(y\sqrt{ScKr}\right)}\,erfc\left(\frac{y}{2}\sqrt{\frac{Sc}{t}}+\sqrt{Krt}\right)+e^{\left(-y\sqrt{ScKr}\right)}\,erfc\left(\frac{y}{2}\sqrt{\frac{Sc}{t}}-\sqrt{Krt}\right)\right\} \quad (5.3.3)$$

Note that the solution given by (5.3.1) is valid for $Pr_{eff}\neq a_1$. The solution for $Pr_{eff}=a_1$, can be easily obtained by substituting $Pr_{eff}=a_1$ into equation (5.2.10) and follow the same procedure as discussed above.

Skin-friction, the rate of heat transfer and the rate of mass transfer

Skin friction

The expression for the skin friction at the plate for Casson fluid, is defined as

$$\tau=-\left(1+\frac{1}{\alpha}\right)\left.\frac{\partial u}{\partial y}\right|_{y=0}$$

$$=\frac{1}{2a_1}\left[\sqrt{i\omega a_1}e^{i\omega t}erf\left(\sqrt{i\omega t}\right)+\sqrt{-i\omega a_1}e^{-i\omega t}erf\left(\sqrt{-i\omega t}\right)\right]-\frac{a_3}{a_2}\left(\sqrt{Pr_{eff}}-\sqrt{a_1}\right)\left\{e^{a_2^2 t}\left(1+erf\left(a_2\sqrt{t}\right)\right)-1\right\}+$$

$$2a_3\sqrt{\frac{t}{\pi}}\left(\sqrt{Pr_{eff}}-\sqrt{a_1}\right)+\frac{1}{\sqrt{\pi t a_1}}-\frac{a_5}{a_6}\left\{\sqrt{\frac{a_1}{\pi t}}+2\sqrt{-a_1 a_6}e^{-a_6 t}erf\left(\sqrt{-a_6 t}\right)-\sqrt{ScKr}erf\left(\sqrt{Krt}\right)+\right.$$

$$\left.\sqrt{Sc(Kr-a_6)}e^{-a_6 t}erf\left(\sqrt{(Kr-a_6)t}\right)\right\} \quad (5.4.1)$$

Nusselt number

The Nusselt number Nu, which measures the rate of heat transfer at the plate for Casson fluid is defined as

$$Nu=-\frac{\upsilon}{U(T'-T'_\infty)}\left(\frac{\partial T'}{\partial y'}\right)_{y'=0}=\gamma\left(1+\frac{1}{T(0,t)}\right)$$

$$=a_2\sqrt{Pr_{eff}}\left(1+\frac{1}{e^{a_2^2 t}\left\{1+erf\left(a_2\sqrt{t}\right)\right\}-1}\right) \quad (5.4.2)$$

Sherwood number

The Sherwood number Sh, which measures the rate of mass transfer at the plate, is given by

$$Sh = -\left(\frac{\partial C}{\partial y}\right)_{y=0} = \sqrt{ScKr}\,erf\left(\sqrt{Krt}\right) + \sqrt{\frac{Sc}{\pi t}}\exp\left(-Krt\right) \qquad (5.4.3)$$

Results and discussions

In order to get the physical understand of the problem and for the purpose of analyzing the effect of Casson parameter (α), Newtonian heating parameter (γ), thermal Grashof number (Gr), solutal Grashof number (Gm), Prandtl number (Pr), thermal radiation parameter (N), Schmidt number (Sc), chemical reaction parameter (Kr) and time (t) on the flow field, numerical values of the fluid velocity, fluid temperature and species concentration in the boundary layer region were computed and are displayed graphically versus boundary layer co-ordinate y in Figs 5.2-5.17. The numerical values of skin friction, heat transfer co-efficient in terms of Nusselt number (Nu) and mass transfer co-efficient in terms of Sherwood number (Sh) are depicted in Tables 5.1-5.9. During the course of numerical calculations of the fluid velocity, the temperature and the species concentration, the values of the Prandtl number are chosen for air at 25^{o} C and one atmospheric pressure (Pr=0.71), Mercury (Pr=0.025), electrolytic solution (Pr=1.0) and water (Pr=7.0). To focus our attention on numerical values of the results obtained in the study, the values of Sc are chosen for the gases representing diffusing chemical species of most common interest in air, namely, hydrogen (Sc=0.22), water-vapour (Sc=0.60) and ammonia (Sc=0.78). To examine the effect of parameters related to the problem on the velocity field, the skin friction numerical computation are carried out at Pr=0.71 and Sc=0.22.

Figs. 5.2-5.3 depicts the influence of thermal and concentration buoyancy forces on fluid velocity. It is perceived from Figs. 5.2-5.3 that the fluid velocity increases close to the boundary of the wall with increasing values of Gr but it has reverse effect after attaining certain values of y whereas, it decreases on increasing value of Gm throughout the boundary layer region. Gr represents the relative strength of thermal buoyancy force to viscous force and Gm represents the relative strength of concentration buoyancy force to viscous force. Therefore, Gr decreases on decreasing the strengths of thermal buoyancy force whereas Gm decreases on decreasing the strength of concentration buoyancy force. In this problem, natural convection flow induced due to thermal and concentration buoyancy forces;

therefore, thermal and concentration buoyancy force tends to decelerate the fluid velocity throughout the boundary layer region which is clearly evident from Figs. 5.2-5.3.

Effect of Casson parameter α on velocity profile is clearly exhibited in Fig.5.4. It is observed that initially (near the wall), the fluid velocity increases (before the crossing over point) but away from the wall (after crossing over point), it decreases with increasing α. Overshoot of fluid velocity indicates that the velocity is maximum close to the surface but not at the surface. The effect of increasing values of α is to increase the fluid velocity near the wall, and hence the boundary layer thickness increases near the wall. The increasing values of the Casson parameter i.e., the decreasing yield stress (the fluid behaves as Newtonian fluid as Casson parameter becomes large i.e., for $\alpha \to \infty, \frac{1}{\alpha} \to 0$) increases the velocity field.

For different values of conjugate parameter for Newtonian heating γ, the velocity profiles are plotted in Fig. 5.5. It is observed that initially (near the wall), the fluid velocity increases (before the crossing over point) but away from the wall (after crossing over point), it decreases with increasing γ. An increase in conjugate parameter for Newtonian heating may reduce the fluid density and increases the momentum boundary layer thickness, as a result, the velocity increases within the boundary layer.

The effect of chemical reaction Kr and thermal radiation N are shown in Figs. 5.6-5.7 respectively. From Fig.5.6 it is quite clear that increasing the chemical reaction parameter tends to decrease the velocity of the fluid. This means that, the chemical reaction decelerates the fluid motion. Consequently, less flow is induced along the plate resulting in decrease in the fluid velocity in the boundary layer. It should be mentioned here that physically positive values of Kr implies destructive reaction and negative values of Kr implies generative reaction. We studied the case of a destructive chemical reaction (Kr). From Fig.5.7 it is observed that the fluid velocity increases with an increase in thermal radiation parameter. Physically, the higher radiation occurs when temperature is higher and hence velocity raises.

The influence of Schmidt number (Sc) on the fluid velocity and concentration profiles are depicted in Figs. 5.8 and 5.9 respectively. It is noticed from Figs.5.8 and 5.9 that, fluid velocity and concentration profiles decreases on increasing the values of Sc. The Schmidt number embodies the ratio of the momentum to the mass diffusivity. The Schmidt number therefore quantifies the relative effectiveness of momentum to mass

transport by diffusion in the hydrodynamic (velocity) and concentration (species) boundary layers. As the Schmidt number increases the concentration decreases. This cause the concentration buoyancy effects to decrease yielding a reduction in the fluid velocity. The reductions in the velocity and concentration profiles are accompanied by simultaneous reductions in the velocity and concentration boundary layers. These behaviors are clear from Figs.5.8 and 5.9.

Fig. 5.10 shows that fluid velocity $u(y,t)$ decreases on increasing time t. This implies that, there is a reduction in fluid velocity with the progress of time throughout the thermal boundary layer region.

The velocity for different phase angle ωt is presented in Fig.5.11. The velocity is decreasing with increasing phase angle. The velocity close to the wall is maximum and decreasing with increasing distance from the wall, eventually tends to zero as $y \to \infty$. It is also clearly seen from this figure, that the velocity satisfies the given boundary conditions (5.2.12b) which provide a useful mathematical check on our calculi.

The influence of Prandtl number (Pr) on the fluid temperature is depicted in Fig. 5.12. It is evident from Fig. 5.12 that, fluid temperature θ decreases on increasing Pr. An increase in Prandtl number reduces the thermal boundary layer thickness. Prandtl number signifies the ratio of momentum diffusivity to thermal diffusivity. It can be noticed that as Pr decreases, the thickness of the thermal boundary layer becomes greater than the thickness of the velocity boundary layer according to the well-known relation $\delta T/\delta \cong 1/\mathrm{Pr}$ where δT the thickness of the thermal boundary layer and δ the thickness of the velocity boundary layer, so the thickness of the thermal boundary layer increases as Prandtl number decreases and hence temperature profile decreases with increase in Prandtl number. In heat transfer problems, the Prandtl number controls the relative thickening of momentum and thermal boundary layers. When Prandtl number is small, it means that heat diffuses quickly compared to the velocity (momentum), which means that for liquid metals, the thickness of the thermal boundary layer is much bigger than the momentum boundary layer. Hence Prandtl number can be used to increase the rate of cooling in conducting flows.

Fig. 5.13 illustrates the influence of thermal radiation N on fluid temperature. It is evident from Fig. 5.13 that, the fluid temperature T increases on increasing N. This implies that thermal radiation tends to enhance the fluid temperature throughout the boundary layer region.

From Fig. 5.14 it is observed that an increase in the conjugate parameter for Newtonian heating increases the thermal boundary layer thickness and as a result the surface temperature of the plate increases. It is also observed that there is a sharp rise in temperature with the increase of conjugate parameter.

Figs. 5.15 and 5.16 illustrate the influence of time on fluid temperature and species concentration respectively. It is evident from Figs. 5.15 and 5.16 that, fluid temperature and species concentration are getting accelerated with the progress of time throughout the boundary layer region. Also it may be noted that, unabated mass diffusion into the fluid stream, the molar concentration of the mixture rises with increasing time and so there is an enhancement in species concentration with the progress of time throughout the boundary layer region.

Fig. 5.17 shows the influence of a chemical reaction on concentration profiles. In this study, we are analyzing the effects of a destructive chemical reaction (Kr>0). It is noticed that concentration distributions decrease when the chemical reaction increase. Physically, for a destructive case, chemical reaction takes place with many disturbances. This, in turn, causes high molecular motion, which results in an increase in the transport phenomenon, thereby reducing the concentration distributions in the fluid flow.

The numerical values of the skin friction τ, computed from the analytical expression (5.4.1), is presented in tabular form for various values of Gr, Gm, Kr, N, Pr, Sc, γ, α and t in Tables 5.1-5.5. It is evident from Tables 5.1-5.5 that, the skin friction increases on increasing Sc whereas it decreases on increasing Gr, Gm, Kr, N, Pr, γ, α and t. This implies that, mass diffusion has the tendency to enhance the skin friction coefficient whereas thermal buoyancy force, concentration buoyancy force, chemical reaction, thermal radiation, Prandtl number, conjugate parameter for Newtonian heating, Casson parameter and time has the tendency to reduce the skin friction coefficient at the plate.

The numerical values of heat transfer coefficient in terms of Nusselt number (Nu), computed from the analytical expression (5.4.2), and are presented in tabular form for various values of Pr, γ, N and t in Tables 5.6-5.7. It is noticed from Tables 5.6 and 5.7 that, Nusselt number increases on increasing conjugate parameter for Newtonian heating and time whereas it decrease on increasing Prandtl number and thermal radiation. This implies that, conjugate parameter for Newtonian heating and time tends to enhance rate of heat transfer at the plate whereas Prandtl number and thermal radiation has the tendency to reduce the rate of heat transfer at the plate.

The numerical values of mass transfer coefficient in terms of Sherwood number (Sh), computed from the analytical expression (5.4.3), and are presented in tabular form for various values of Sc, Kr and t in Tables 5.8-5.9. It is revealed from Tables 5.8 and 5.9 that, the rate of mass transfer increases on increasing Sc, Kr and t. This implies that mass diffusion, chemical reaction parameter and time has the tendency to enhance the rate of mass transfer at the plate.

Conclusion

The unsteady MHD natural convection flow with heat and mass transfer of a viscous, incompressible, electrically conducting, thermal radiating and chemically reactive Casson fluid over an oscillating vertical plate with Newtonian heating on the Wallis carried out. Exact solutions of the governing equations were obtained using Laplace transform technique. A comprehensive set of graphical for the fluid velocity, fluid temperature and species concentration is presented and their dependence on some physical parameters is discussed.

Significant finding are as follows:

- The fluid velocity increases near the wall (before the crossing over point) but away from the wall (after crossing over point), it decreases with increasing conjugate parameter for Newtonian heating γ and Casson parameter α
- Chemical reaction tends to reduce the fluid velocity whereas thermal radiation has reverse effect on the fluid velocity throughout the boundary layer region
- The Newtonian heating parameter γ and thermal radiation tend to enhance the fluid temperature throughout the boundary layer region
- Mass diffusion and chemical reaction tends to reduce the species concentration whereas there is an enhancement in species concentration with the progress of time throughout the boundary layer region
- The Newtonian heating parameter, Casson parameter, chemical reaction parameter and thermal radiation has the tendency to reduce the skin friction at the plate
- The Newtonian heating parameter has the tendency to enhance the rate of heat transfer at the plate whereas thermal radiation has reverse effect on it
- Mass diffusion and chemical reaction parameter tends to enhance the rate of mass transfer at the plate

Tables

Table 5.1: Skin Friction when Pr=0.71, Sc=0.22, $\omega t = \pi/3$, Kr=1, N=1, γ=0.5, α=1, t=0.5

Gr ↓ Gm →	τ			
	5	**10**	**15**	**20**
5	-21.4502	-24.5167	-27.5832	-30.6497
10	-41.4551	-44.5216	-47.5881	-50.6546
15	-61.4601	-64.5266	-67.5931	-70.6596
20	-81.4650	-84.5315	-87.5980	-90.6645

Table 5.2: Skin Friction when Gr=5, Gm=5, Pr=0.71, Sc=0.22, $\omega t = \pi/3$, γ=0.5, α=1, t=0.5

Kr ↓ N →	τ			
	1	**3**	**5**	**7**
1	-17.2924	-19.3459	-21.4502	-23.0294
3	-21.0677	-23.1212	-25.2255	-26.8048
5	-26.0682	-28.1217	-30.2260	-31.8053
7	-32.8052	-34.8588	-36.9630	-38.5423

Figures

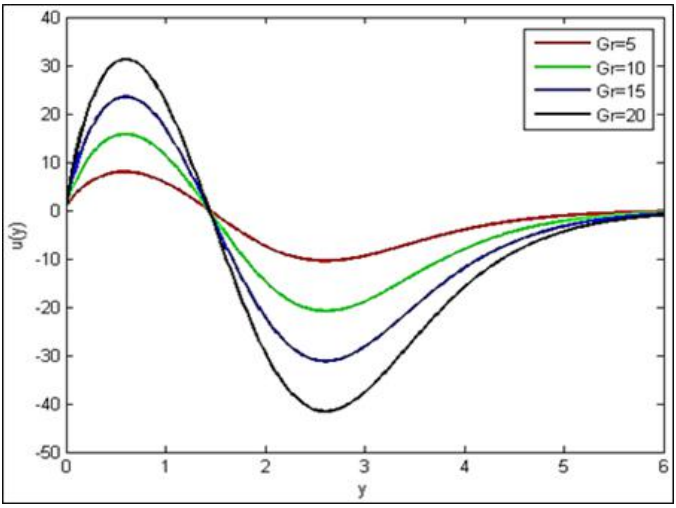

Fig 5.2: Velocity u against y for Gm=5, Kr=1, Pr=0.71, Sc=0.22, γ=0.5, N=1, α=0.5, t=0.7

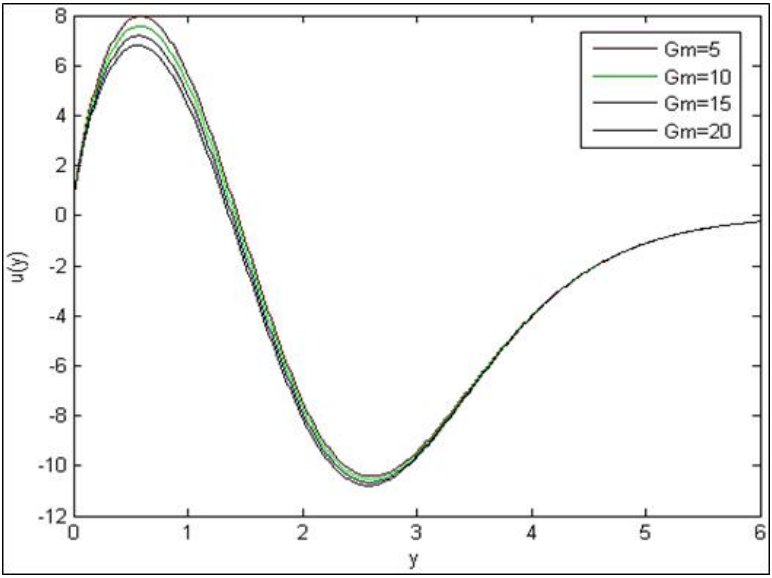

Fig 5.3: Velocity u against y for Gr=5, Kr=1, Pr=0.71, Sc=0.22, γ=0.5, N=1, α=0.5, t=0.7

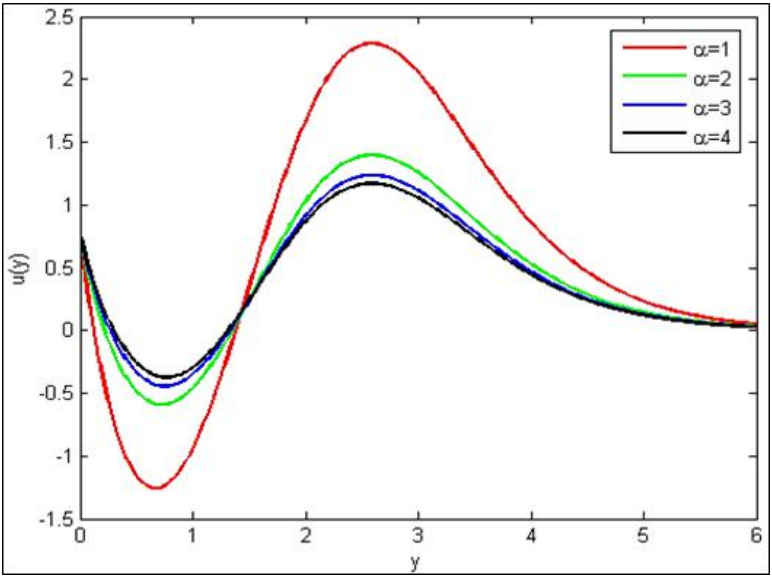

Fig 5.4: Velocity u against y for Gr=5, Gm=5, Kr=1, Pr=0.71, Sc=0.22, γ=0.5, N=1, t=0.7

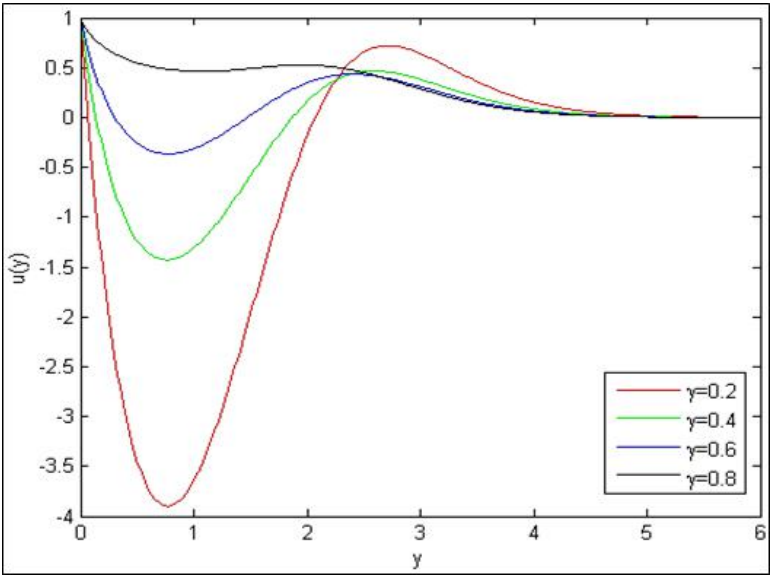

Fig 5.5: Velocity u against y for Gr=5, Gm=5, Kr=1, Pr=0.71, Sc=0.22, N=1, α=0.5, t=0.7

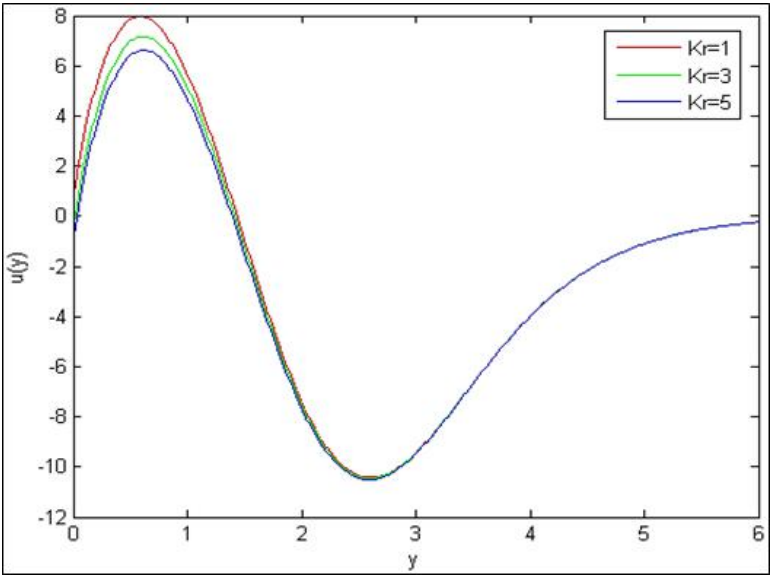

Fig 5.6: Velocity u against y for Gr=5, Gm=5, Pr=0.71, Sc=0.22, γ=0.5, N=1, α=0.5, t=0.7

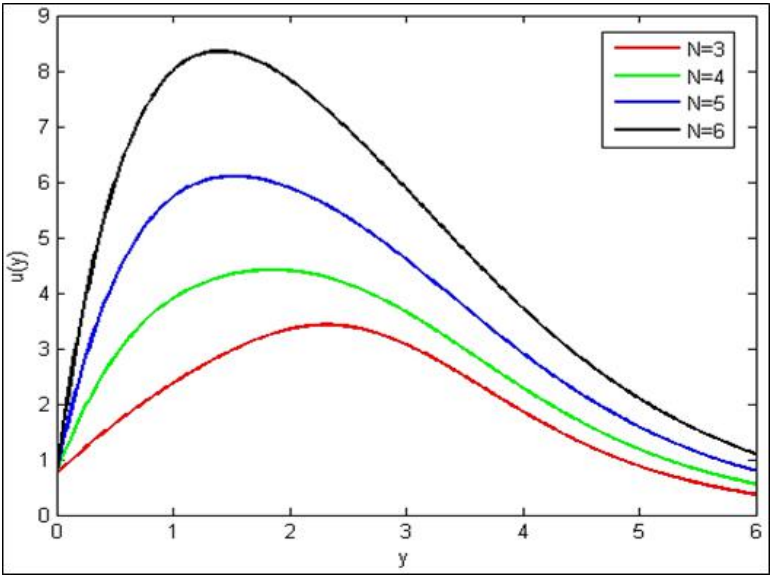

Fig 5.7: Velocity u against y for Gr=5, Gm=5, Kr=1, Pr=0.71, Sc=0.22, γ=0.5, α=0.5, t=0.7

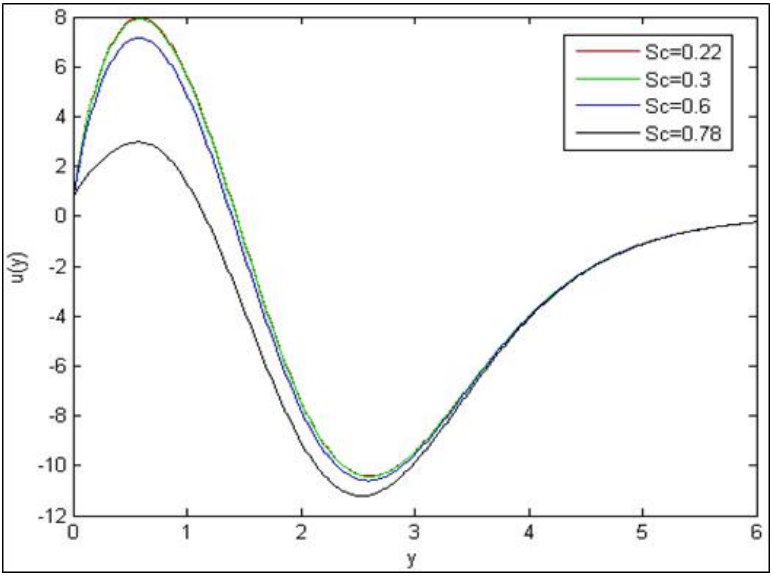

Fig 5.8: Velocity u against y for Gr=5, Gm=5, Kr=1, Pr=0.71, γ=0.5, N=1, α=0.5, t=0.7

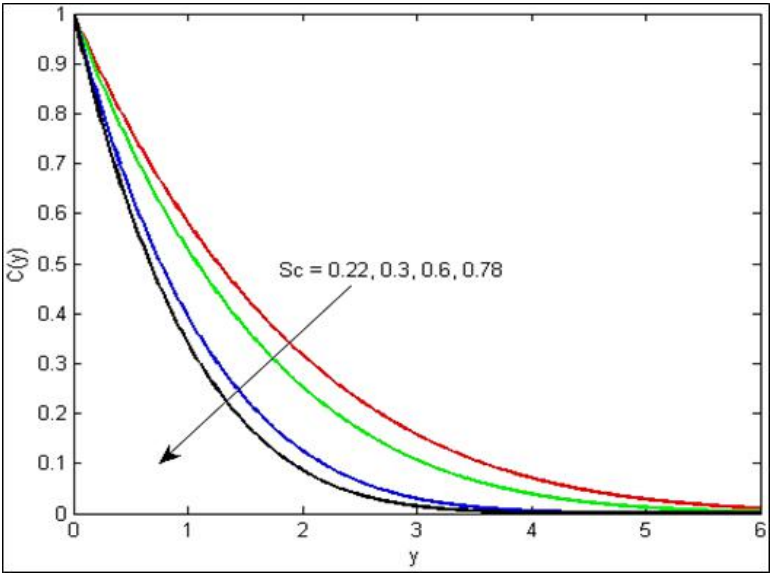

Fig 5.9: Concentration C against y for Kr=1, t=0.7

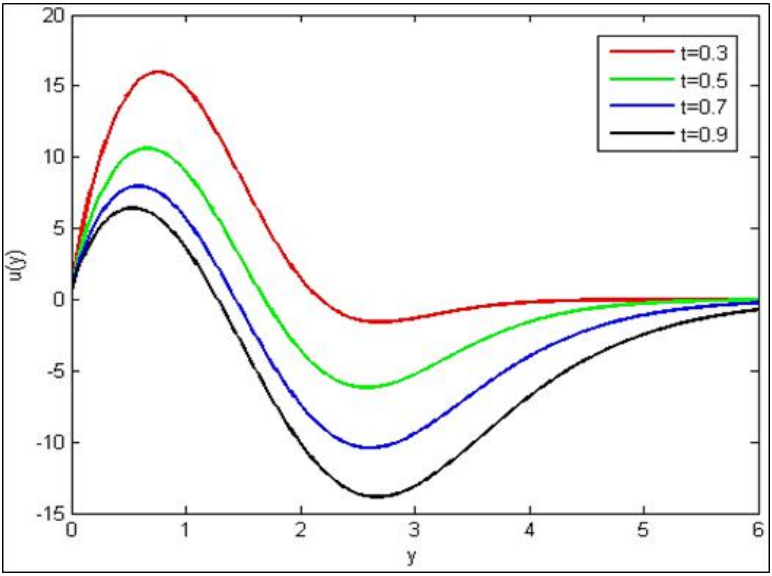

Fig 5.10: Velocity u against y for Gr=5, Gm=5, Kr=1, Pr=0.71, Sc=0.22, γ=0.5, N=1, α=0.5

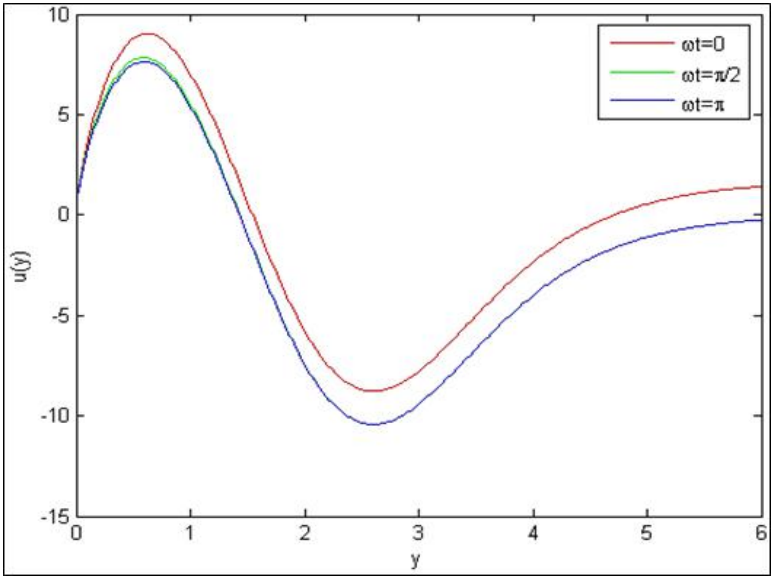

Fig 5.11: Velocity u against y for Gr=5, Gm=5, Kr=1, Pr=0.71, Sc=0.22, γ=0.5, N=1, α=0.5, t=0.7

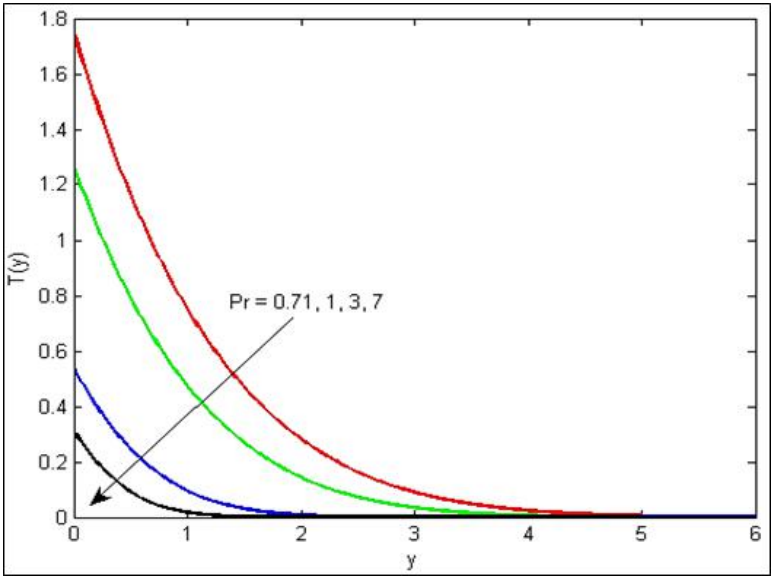

Fig 5.12: Temperature T against y for γ=0.5, N=1, t=0.7

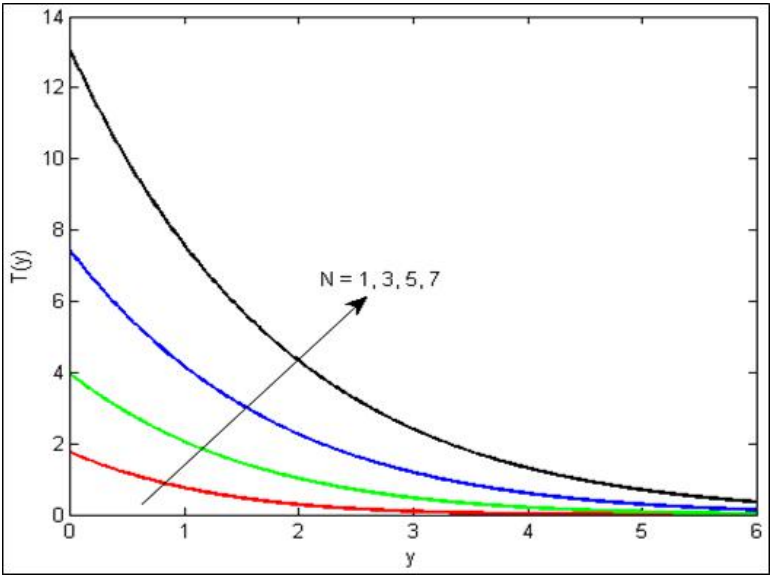

Fig 5.13: Temperature T against y for Pr=0.71, γ=0.5, t=0.7

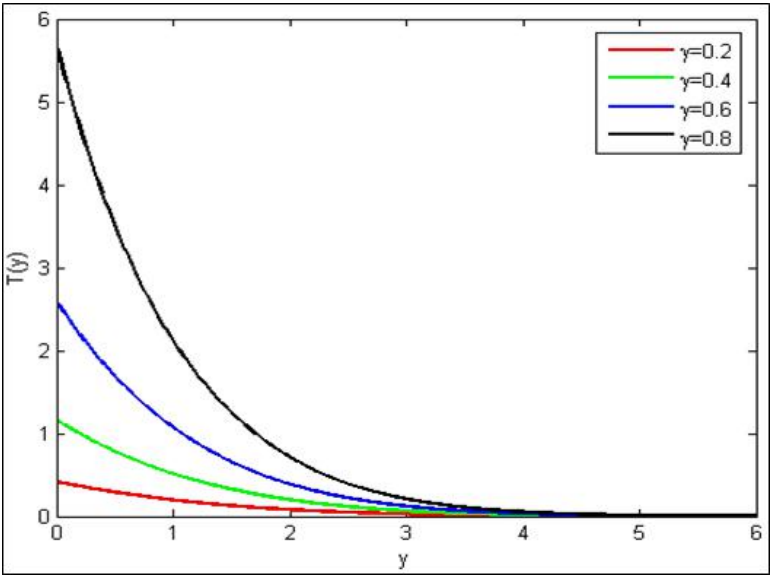

Fig 5.14: Temperature T against y for Pr=0.71, N=1, t=0.7

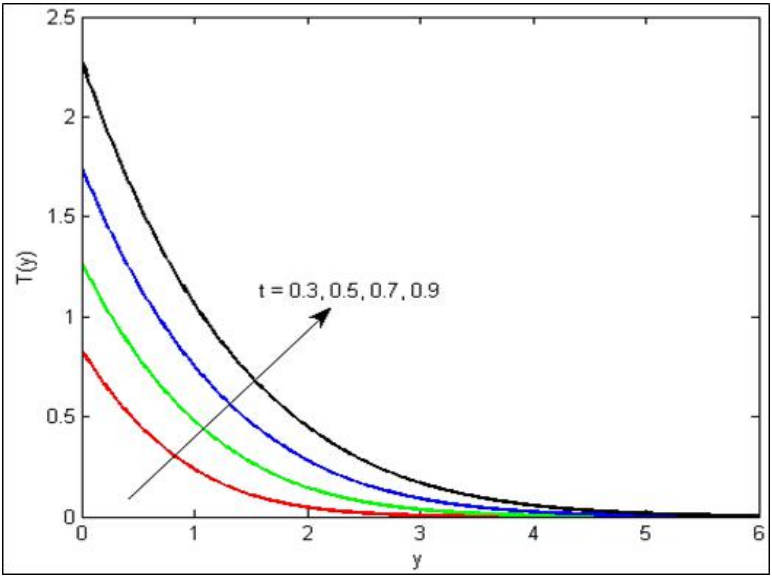

Fig 5.15: Temperature T against y for Pr=0.71, γ=0.5, N=1

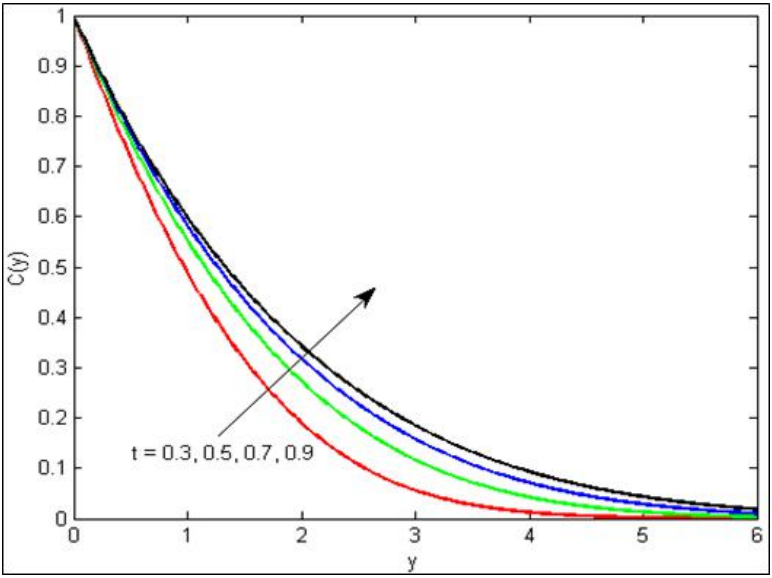

Fig 5.16: Concentration C against y for Sc=0.22, Kr=1

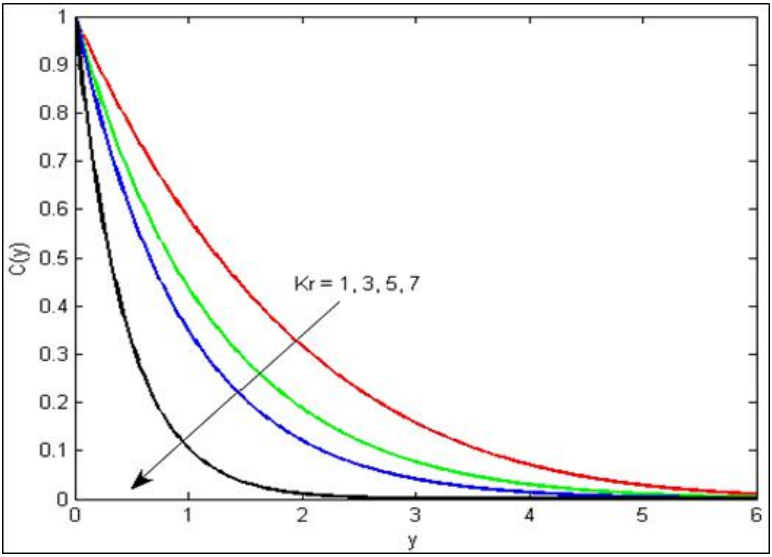

Fig 5.17: Concentration C against y for Sc=0.22, t=0.7

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