Foundation University Journal of Engineering and Applied Sciences

Aims of the Journal

The Foundation University Journal of Engineering and Applied science (FUJEAS) is a bi-annual peer-reviewed research journal published by Foundation University Islamabad, Pakistan. The Journal aims to be a leading cornerstone for researchers , academicians and practitioners who are interested in high quality new knowledge, product development, issues and challenges in the field of Engineering, Applied Sciences and Computer Science, FUJEAS welcomes research in relation to (but not limited to) the following areas:

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- Context-A ware Computing
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Editorial Board

Perspective

About Research in Engineering

Prof. Dr. Muhammad Shaheen

Editor-in-Chief, FUJEAS

The concept of research always remained a well-argued but contested wrangle in the research communities in various fields. Differences in research design can be seen from multiple perspectives. One perspective challenges the nature of assumptions, inputs and outputs in research problems; do they differ across domains? Another perspective calls into question the type of contribution that should be made to the body of knowledge of a particular area to categorize certain work as research. Some argue about having the same or different considerations for university and industrial research. In short, it is inevitable for many reasons to define research and to clarify the various research classifications if they exist.

The research linguistically means careful or diligent search [Webster] and to study a subject in detail with due care [Cambridge, oxford]. It is defined as a systematic survey of sources and materials to determine facts and draw new conclusions. The definition opens many ends that have in fact emerged from the aforementioned debates. For a work, to be considered as research, publishability [1-2], substantial contribution to the body of knowledge [3-4], reshaping materials and information [5], generating evidence for an old issue [6] and creative work [7] are considered determinants. The existing literature is evident of the fact that the following questions still needs further deliberations.

1. Is contribution to the body of knowledge a uniform criterion for classifying some work as research?
2. Can contribution to the body of knowledge be defined in consistent and measurable terms for all domains?
3. Is the notion of research different from one field to another?
4. Is there good agreement on the definition of research?
5. Are the results of every type of research the same?

In order to address the above questions, there is an urgent need for a holistic framework that can determine the direction to be taken to work on the above lines. Engineering as an application area of science emerged a few centuries ago but it is practiced at the dawn of civilizations. Humans were still conceptualising theories about plants, humans, the earth and its objects and life on earth, materialized these theories to bring them to the psychomotor domain and internalized them at the affective level. The process of materializing these theories in applications has always been there, but is formalised as an engineering field a few centuries ago. This formalisation is today reached to the extent that the methods used in this process now exist in a generalized form. The field of engineering is specialized by its nature and covers measurable and quantified facts. With the efforts made, the engineering of many sciences has developed their body of knowledge including related and unrelated specific terminologies. Research may also be part of human wisdom since the dawn of civilizations. People have always tried to find a solution to an existing problem by investigating existing related solutions and suggesting a new one. With all the advances in academic structures, research is now a well-defined process that follows a discrete number of steps and is widely used. Any work that even contributes to a micro-level knowledge set of a field is research. But the more important question is, what is not research? After formalizing the concepts in research, the ab initio desire to find facts will no longer be formally categorized as research. What cannot be define d as a contribution to overall knowledge of engineering should not be classified as research. This will lead to the need of defining formally, the body of knowledge (BoK) of each engineering domain. Today, there are sure fields of engineering that have explicitly characterized BoKs that address the issue to some degree while for others, the BoKs should be derived from the essential principles of that engineering domain. These principles cannot breach the basic assumption of an engineering discipline which is the measurability and figurability of its content. Likewise, this should be remembered that the foundation of every engineering discipline is a science, the principles of which will be taken care of while contributing a substance to the BoK. A definitive answer for this would in any case be to characterize BoK so that a domain makes any contribution evaluable. When the BoK is set, the subsequent stage would be to determine whether a contribution is made to it or not. Contribution to a BoK can be progress in the present state of the BoK, the degree of which can be defined in the circumstances in which such contribution is made. As mentioned before, the engineering's BoK will represent the application of existing scientific theories so the progression might incorporate a new application, an altered application or a redundant application of existing scientific theory. Whatever progression is asserted should not exist in any form in the existing body of knowledge.

This seems that the contribution of research to the body of knowledge is not uniform across the domains. The BoK of each knowledge base must reflect its nature of contents that might vary. An entire taxonomy of the knowledge domains with a higher depth of tree is required. The taxonomy may represent the nature of contents and core characteristics of a domain. General standards for setting up originality in a piece of work can be outlined that should then be taken as core values for deciding the value of a contribution. The impact, hypothesis, research method and research questions are often covered under certain principles yet the flimsy line for contribution not set in stone on the specificities of that particular area. Some of the time the value of research work is assessed by the granularity of the research problem that appears to be not substantial. This may be impractical to characterize the granularity of the research problem. Some of the problems in the engineering domain become useful for a bigger populace yet at the same time bears a tiny worth in the substance of the BoK while some other problems might open prospects for a large set of problems yet appear to address a tiny populace. An exact component in regards to the BoK of a specific area ought to be characterized to assess the worth of a research.

Another extensive angle while discussing research in the engineering domain is an unrealized but significant polarity of the research performed in scholarly settings to earn a degree or certificate and the research attempted to tackle a real industrial problem. Are the models for assessment for both ought to be something similar or unique? The definitions and nomenclature of the research terms might continue as before in the two of them, still, some distinction that is not well realized, should be there. On the off chance that a mechanical problem does not track down an exact method in the current BoK of the domain then an answer presented might be considered as an expansion to the current BoK. Expanding the hypothesis of the field on a numerical premise, supposition premise or in any case may not give an immediate answer for the current issue yet may help to tackle that issue otherly. The research that is not performed in response to an industrial problem might add to the BoK on hypothetical assumptions and still stand substantial. Such research should guarantee a higher value of generalization and address a class of problems instead of resolving a solitary issue raised in particular industrial settings. Moreover, the execution of theories in special setting of an industry can likewise be considered as research. “Industry” here is used in its broadest sense, clouding everything where a hypothesis proposed in the BoK is applied.

The above-mentioned concept of research in industrial settings might cover with the overall idea of research in the engineering field. This is a direct result of the similarity between an industrial research problem and a research problem in the engineering domain. Industrial research has a surprising similarity with the research problems tended to in any engineering domain. The vast majority of them are identified with the problems with existing designs and structures, the protocols characterized for maintenance of the products and quality-related issues that also is the case in engineering research problems. That is the reason, the contribution to engineering BoK frequently remains a hot wrangle in scholastic and industrial networks.

At last, why it is important to bifurcate research from non-research. Research produces original contents that if not conveniently dealt with will make the realm die without arriving at its possible point in knowledge. The industry will get the hang of taking care of problems in an imperfect manner without investigating every one of the potential outcomes. The innovation would not thrive at the application layer of the BoK. Theoretical contributions to the BoK would not be changed over to the requirements of humankind. Put differently, every kind of research whether scholastic or industrial, basic or applied, scientific or non-scientific ought to be done under the defined ethics of research, considered equally significant and each one of them is supplementary for the others.

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Foundation University Journal of Engineering & Applied Sciences
Vol. 2, Issue. 1. June 2021

Research Article

Artificial Intelligence Potential Trends in Military

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Abstract:

Artificial intelligence (AI) is trending in the military and safety-critical application sectors.The private sector is currently helping the government sector implement advanced techniques to revolutionize different government and public sector management. It also helps to provide sustainable accountability in the accounting field; AI is bringing a revolution in concept building. It is bringing potential revolutions by usingnovel approaches in such directions. This paper is a new approach along the same lines; Our research focuses on AI in the military, the latest trend, and usages recently used for AI applications. This paper discusses the usage of AI applications in the military and the civil defense and health industry. We review and discuss the potential advantages of AI in military applications, HRMS, decision-making, disaster prevention and response, GIS and service personalization, interaction, big data analysis, pattern recognition and anomaly, intrusion detection, and discovery of new solutions using a highly configurable system and simulation in real-time.

Keywords: Artificial intelligence; UAVs; HCS; Military Technologies

1.Introduction

AI is depicted in the real world in films full of passion and fantasy[1]. When it comes to developing artificial intelligence in today's world, the task is becoming increasingly difficult to accomplish. In the military, space exploration, medicine, and other fields, artificial intelligence (AI) have already been developed or implemented. Viewers can confidently predict that an IA will be developed soon and that a complex machine will soon decide the fate of humanity in light of the cult films "The Matrix," "Terminator," and "I, Robot." What if I'm wrong about this? Do you think it's theoretically possible to create artificial intelligence, and how long do you think you'll have to wait? Using the term "artificial intelligence" to describe what we are talking about is a bit misleading. Microchips are not built into most products today, except light bulbs, and manufacturers of virtually everything go to great lengths to convince us that their products contain artificial intelligence [2] (AI). Simply put, artificial intelligence (AI) copies the human behavior line on an artificially created object to achieve a variety of goals, such as lowering costs and saving time [3], which is the general thinking of mankind about its creation. As you assert [2,3], artificial intelligence will partially or completely replace humans in various fields (astronautics, work specialties, organically inspired communication, and so forth). Apart from that, artificial intelligence (AI) will assist a person in performing tasks that they are incapable of performing themselves (complex analysis and calculations) and increasing their overall intelligence. Starting with the fundamentals [4] will help us see the big picture.

1.1.Artificial Intelligence

Intelligence is derived from the Latin concept of intellectus, which means "mind, reason, and understanding.". Intellect and thinking are linked by many tasks and goals: recognition, logical analysis, behavior planning, synthesis of new concepts, and knowledge. Characteristics of the intellect When it comes to problem-solving, the ability to learn, generalize, accumulate experience, and adapt to changing conditions are all important. [3,5]. Solving problems entails the ability to learn from experience, generalize what has been learned, accumulate knowledge, and adapt to changing circumstances [3,5] Proceeding from the very definition of AI, the main problem in creating intelligence arises from the possibility or impossibility of modeling a person's thinking or at least a child. If this question is answered negatively, then the idea of AI itself loses its meaning in the root [6].Generally, AI is a research area that creates models and appropriate software tools that allow computers to solve creative, non-computational problems that, in the process of solving, require recourse to semantics (a problem of the meaning). Research in the field of artificial intelligence includes formal problems (mathematics, games); universally significant tasks (natural language perception, situational behavior, reasoning based on common sense); expert tasks (scientific analysis, financial analysis, medical diagnostics, etc.) [7]. The first researcher of artificial intelligence is considered to be Alan Turing (born mathematician).

 DOI: https://doi.org/10.33897/fujeas.v2i1.380

2.Literature Review

The very first intellectual tasks in which AI began to be used (more precisely, some kind of its similarity) were logical games (checkers, chess) and arithmetic operations (solving equations, proving theorems), as well as some simple toys [3,6]. An example of the latter was an electronic mouse, capable of exploring a maze and finding a way out of it (based on the simplest relay circuit). The first serious research on the creation of AI was undertaken almost immediately after the appearance of the first computers. In 1954, the Americans A. Newell, J. Shaw, G. Simon, and the Dutchman A. De Groot jointly created the first IPL1 symbolic programming language in the history of mankind and 1957 wrote a program for playing chess on it [8]. In 1960, the same group wrote the GPS program (General Problem Slover) - the universal task solver. The program was able to cope with several puzzles, the solution of integrals, and some other tasks. In 1962, cybernetics A. Samuel created a program for playing checkers [9]. She was so successful that she was able to win against the strongest USA drafts player R. Neely. In the late 60s, The first game programs appeared in systems for elementary text analysis and problem-solving in mathematics [8, 9]. Even then, the main problem with artificial intelligence became apparent: a program that can play chess will never be able to play checkers or dominoes. One more thing became clear to the programmers: all of the written programs lacked the most important element of all: knowledge in the relevant fields. The researchers sought to resolve these issues in the next decade. In 1974 an international electronic chess tournament took place. Machines become proud! The Soviet machine won it with the Kaissa chess program. Later, a program with a similar AI defeated world grandmaster G. Kasparov. The computer's configuration was 256 processors with 4 GB of disk memory and 128 MB of RAM each [10].By the mid-1970s, the first intellectual programs using various knowledge representation methods for solving problems appeared - expert systems. One of the first was the expert system DENDRAL, designed to compile formulas of chemical compounds based on spectral analysis [11]. According to the perceptron model, developed by the American F. Rosenblatt in 1957, visual perception and recognition are controlled by the brain's visual cortex. In addition to learning, Perceptron was capable of working in two modes: recognition and recognition learning. The person presented the objects in the training mode and explained which class each belongs to (object description) [11,12]. Then, in the process of recognizing the machine, new objects were presented, and the machine had to classify them correctly of great interest from AI presented the program of mathematics Hao Wang, which worked on an IBM-704 for 3 minutes and 8.5 minutes to derive 220 relatively simple lemmas and theorems from a fundamental mathematical monograph, and then in 8.5 minutes worked on another IBM-704. Gave proof of another 130 more complex theorems, some of which had not yet been derived by mathematicians [13]. Later, other expert AI systems were created: MYCIN (intended for the diagnosis and treatment of infectious blood diseases), PROSPECTOR (predicts mineral deposits), SIMER (water quality assessment system), CASENET (diagnosis and treatment of glaucoma), etc. [14]. Today, the development of AI systems continues at an even faster pace. The world's largest institutions are working on this problem. Research laboratories of molecular biologists all over the world use the fruits of complex AI development automatic PCR techniques (polymerase chain reaction for DNA research), ELISA (enzyme immunoassay for protein analysis), and automakers development of AI for diagnostics and fine-tuning of engines and other parts of cars [15]. In short, the story of creating artificial intelligence continues.

2.1. Robotics and Autonomous Weapons

The capabilities of autonomous systems are still limited. Even though “shot-and-forget” systems have been created for decades, the people should still always be “in the loop” and directly make decisions on the use of weapons. This also applies to heavy aircraft, where, despite the autopilot, sensors, automatic opening of bomb-holes, guidance, and target tracking systems, pilots are still present, and the work of the drone UAV is monitored by operators [16]. But an ordinary person, compared to the capabilities of modern military equipment, is a weak, fragile and stupid creature, and in the chain of combat, decision making is also the slowest link. Artificial intelligence is designed to eliminate a person from the decision-making system, and at the same time to save the lives of servicemen. The possibilities of using tactical weapons with artificial intelligence are numerous. According to industry experts, considering the advantage that those who make decisions faster and hit first have in combat situations, fully autonomous systems will see significant advancement shortly. Unmanned aerial vehicles, armored vehicles, and rocket boats are examples of autonomous vehicles that can independently locate targets and decide whether or not to destroy them [4,16]. Furthermore, the concept of "contra-autonomy" has already emerged, which states that artificial intelligence that has been attacked but not destroyed will quickly learn and draw conclusions, after which it will deal a fatal blow to the adversary. There is a rapid reduction in the cost of UAVs and drones, and their production is becoming widespread. Until recently, the cost of the fifth-generation fighter F-35 company Lockheed Martin was $100 million. A high-quality quadcopter costs $1000. This means that the US military can order hundreds of thousands of small UAVs for the price of one fighter [17]. Drones will be coordinated into a massive controlled "swarm" capable of launching a massive attack with the help of artificial intelligence (AI). The enemy will find it nearly impossible to deal with the massive number of drones loaded with explosives that will be launched simultaneously. The Soviet Union and the Russian Federation have already put into practice the concept of combining several missiles from a single volley to form a "wolf pack" capable of exchanging information about targets among themselves, formulating a strategy for their actions, and independently selecting targets for an attack. These are the anti-ship missile systems P-500 Basalt, P-700 Granit, and P-1000 Vulkan. Our technology has great promise [18]. The US Navy creates a system that unites unmanned patrol boats in the "pack." This is the so-called CARACaS technology (Control Architecture for Robotic Agent Command and Sensing) or the “Management Architecture of a Team of Robotic Agents and Recognition,” plus a system based on an independent platform that is being developed by the Naval Research Authority and can be installed on various types of small ships. By turning them into autonomous unmanned vehicles [19].

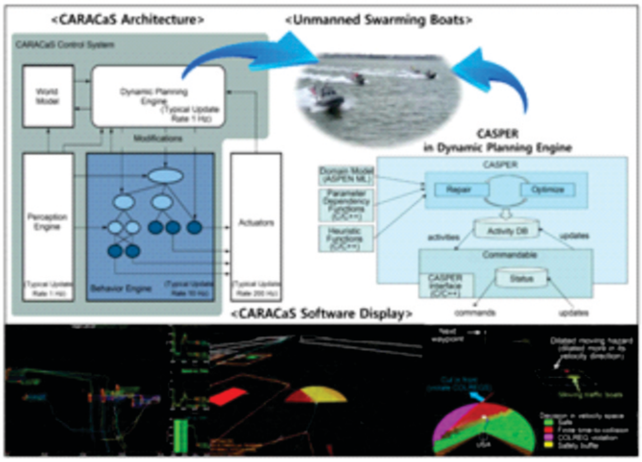

Fig. 1.CARACaS System Software

Fig. 2.Artificial intelligence in Military

The CARACaS system software is based on NASA technology created for rovers. A soldier using a portable device with CARACaS will be able to quickly and easily turn aircraft, armored vehicles, and boats into a single automated combat pack. Even more promising for artificial intelligence in space. You can create autonomous groups of tracking satellites or fighter satellites that do not require constant monitoring and special commands from control centers on Earth [17,19]. In the future, with the help of artificial intelligence, we can significantly improve the effectiveness of special forces and amphibious units. Even a small size group, using unmanned platforms, will be able to control large areas of the enemy's territory similarly and attack various targets with the help of autonomous interacting combat vehicles or prevent enemy units from entering a certain territory, thus holding the bridgehead. They can also fire at the enemy, deliver ammunition to special forces, and prepare bridgeheads for landing forces. Perhaps a tank with artificial intelligence would shoot its parachutists. Surprisingly, this can be avoided by equipping the machine with a “library of targets,” as well as a facial recognition system. Taking into account that modern warfare strategies imply a change in the way troops are deployed. Modern warfare will be fought simultaneously throughout the enemy's territory: on the ground, in the air, in near-Earth space, and the information field and cyberspace are autonomous robotic fighter support systems will be developed very shortly. It will also accelerate the transition from manned combat missions to unmanned. As priorities of the near future, the Pakistan army should pay attention to autonomous weapons technology with network support, systems for human and machine interaction, including when making decisions, autonomous learning systems with artificial intelligence functions, to advanced unmanned systems. As for the robots themselves, it is hardly worth waiting for humanoid droids in the foreseeable future; most likely, they will look like rovers or turn out to be similar to the Astro droid R2-D2 from Star Wars [20]. A small autonomous robot can become an ideal sniper and wait for your goal in a position as long as necessary. Some types of flying or crawling robots will be able to penetrate the premises, inject a lethal dose of poison to the victim, or spray nerve gas and remain unnoticed. And again, a logical question: If hackers break into a combat vehicle with AI to disable it or even direct it against soldiers or civilians, what happens? Unlike machine intelligence or even supercomputers, artificial intelligence generates behavior algorithms for itself, and instead of permanent memory on discs or RAM of ordinary computers, it instantly arises and disintegrates chains of neural connections.

2.2. Use of AI in the Military-Industrial Complex

Artificial intelligence (AI) is used in warfare. The artificial intelligence market is expected to grow at a compound annual growth rate (CAGR) of 36.62 percent, from USD 21.46 billion in 2018 to USD 190.61 billion in

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2.3.Use of AI in the Military-Industrial Complex

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2.4.Artificial Intelligence in Military

AI in military affairs is characterized by a lack of ability to distinguish the most important, low morale and volitional qualities (lack of systemic will and internal incentives), unprincipledness (no goal setting), illiteracy (there are no algorithms for working in an unfamiliar environment and a drastically changing situation), primitiveness (no experience of combat actions and the possibility of self-education), indecision (no criteria for making atypical military decisions), low persistence (the degradation of functions goes faster than the degradation of funds and carriers) and stupidity (inability to set tasks, military art rests).There are no military programs capable of at least to some extent corresponding to a real person to conduct a rational thinking and communication process, and it is not foreseen shortly (there are too many obstacles and unsolvable problems). Today, the computer performs only the exact instructions that it will give people. Since the computer itself is incapable of thinking in principle, but high-level programs for solving individual problems are relatively “intelligent,” we can and only need to speak about tools for solving military-applied tasks and not flatter ourselves with the sonorous name of AI [22]. Unfortunately, no matter how sophisticated the device is in a modern program, no matter how complex algorithms are incorporated into it, in the end, it will not be able to do anything other than what is provided by its author. Perhaps in the future, something will change, but not today Scientists are trying to lift the veil of a distant future. Is it possible to create artificial intelligence? Is it possible to create such human-like systems that can think in abstract images, teach themselves, respond correctly to changes in the environment, have feelings, will, desires? Is it possible to create appropriate algorithms? Can humanity control such objects? Unfortunately, there are no answers to these questions because the person has not yet decided what AI is and its place and role. Military application artificial intelligence technology has broad application prospects in the military, and hundreds of successful application projects have appeared in this field.

Fig. 3.Military Robots

Fig. 4.Robotics development in China

Given the level of development of robotics and artificial intelligence, it would be naive to assume that the security agencies of different countries bypass this area with their attention. Fig 3 shows that Military robots are created in the USA, Russia, Japan, China, South Korea, Israel, and other countries. Of course, like other military equipment, the exploited and promising robots seem to the general public quite metered - some projects are made public, others are kept secret [23]. Such devices can play a variety of roles: scouts, infantry, sappers, etc. To many, military robots in the army seem to be super movers, alone capable of putting whole units, or, on the contrary, as some cannon fodder, to which you can shift the most dangerous work on the front line. At the same time, the reality

 DOI: https://doi.org/10.33897/fujeas.v2i1.380

does not meet these expectations and scenes from science fiction films. In what direction does modern military robotics develop? Fig 4, China is very reluctant to demonstrate its military developments in robotics. However, it is reliably known that they are being conducted - and quite actively.

2.5.Military Robots: Features of Development

Anyway, robots in armies have been used for quite some time. For example, in the Russian armed forces, military robots are counted from the late 30s - early 40s of the last century, when the Teletank (remote-controlled tanks) were used in the Finnish war. The history of robot sappers has been around for more than 40 years, and now a few people can be surprised by reconnaissance (Fig 6) or combat UAVs (Fig 5). Of course, the latest military robots are superior in their capabilities to other generations of such devices, but there is an interesting trend [22,23].At this time, most of the most advanced robots are not being developed to completely replace soldiers on the front lines of battle. Reconnaissance, work in the rear, and technical assistance in the conduct of hostilities are the primary functions of such vehicles. The reason is quite simple: while the works are not perfectly finished, they are still vulnerable, and their repair in the field is difficult, if not impossible, due to the conditions. As a result, law enforcement agencies do not want to dispatch vehicles to locations that are likely to be quickly disabled. Directly combat military robots are also being created, but many of them are either more primitive from a technological point of view or so far appear, rather, as potential designs and promising projects. At the present stage of the development of military robotics, most of the machines need to be controlled by an operator. If domestic and industrial devices can act independently, even new military robots lack such capabilities or are very limited. As a rule, the operator is away from the controlled robot, although there are projects where he sits inside. For example, one of the most famous Japanese combat robots, Kuratas (2012), has a cockpit in its upper body. However, the device can be controlled remotely [24].

Fig. 5.Combat UAVs

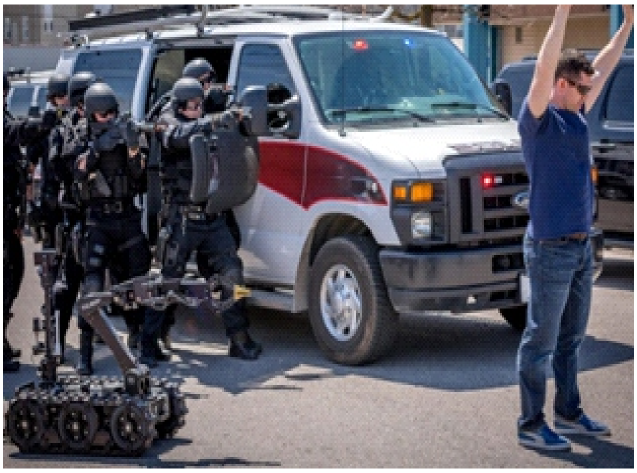

Fig. 6.Reconnaissance UAVs

2.6.Self-propelled Universal Systems

The first self-propelled system can be considered the teletank mentioned above or the more famous German "Goliaths" used in World War II. This is a good example, perhaps not of the most advanced but quite efficient and effective technologies created directly for military operations. Nowadays, self-propelled systems have become one of the most developed areas of military robotics. Such robots are equipped with various weapons (from machine guns to mortars), video cameras, night vision devices, manipulators, etc. Depending on the equipment, the purpose of the vehicle changes: it can serve as a scout, a sapper, or perform other combat missions. It can patrol territory or transport cargo, mine or clear mines, shoot or interfere with shooting (due to a smokescreen). From the outside, it seems that the use of the robot is limited, rather, to the owners' imagination. In particular, propaganda management was mentioned among the examples of use: a loudspeaker is mounted on the robot, after which the device is launched along the required route. Among similar complexes, we note "Argo" (2013), which can swim, or "Nerekhta" (2015), which is considered one of the most promising developments. More than 10 modules have been developed for it, including anti-tank and medical. "Uranium-6" is a robot-sapper, which is used for mine clearance. It can withstand the explosion of a 60-kilogram charge of TNT, and thanks to an intelligent e-filling, it can detect and neutralize various types of shells, bombs, etc. Uran-9 is a multifunctional complex, which can withstand infantry, tanks, helicopters, and fight in urban conditions. Depending on the modification, this machine can carry a machine gun, a flamethrower, anti-tank missiles, a smoke screen system, etc. The heaviest family member - "Uranium-14" - is designed to extinguish fires (it has a water tank and a foam tank, a pump, etc.). The military also uses it to

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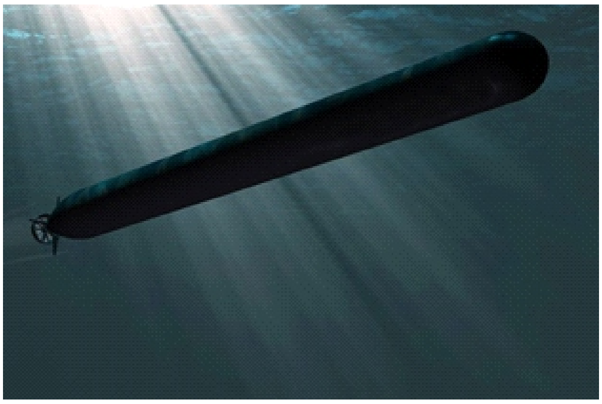
dismantle barricades, blockages, etc. [25]. complex, which can withstand infantry, tanks, helicopters, and fight in urban conditions. Depending on the modification, this machine can carry a machine gun, a flamethrower, anti-tank missiles, a smoke screen system, etc. The heaviest family member - "Uranium-14" - is designed to extinguish fires (it has a water tank and a foam tank, a pump, etc.). The military also uses it to dismantle barricades, blockages, etc. [25].

Fig. 7.Self-propelled universal systems

Fig. 8.Robo Snake (Israel 2009)

2.7.Intelligence Robots

Drones with a good camera and a long range are now available to almost everyone. And began the development of these devices in the depths of the military departments. At the moment, these machines are used by defense departments of 70 countries. Of course, military UAVs are more advanced than civil ones, plus new projects appear regularly, although the very principle of their work does not change much at the same time. Therefore, we suggest contacting other types of robots. An interesting development looks like a robot snake (Israel, 2009), as shown in fig 8. The robot is equipped with a thermal imager, camera, microphone. It can crawl quietly in the countryside, even with very difficult terrain. Invisible, nosy, and very attentive - in short, an excellent intelligence officer. A few years later, the United States also had its own "snake" - it knows how to climb trees, twist objects around and thus shoot from more than secluded places [24,25]. Another Israeli development is the miniature Dogo. He has a good cross, including the ability to climb stairs. However, it would be wrong to call him only a scout since such robots can be equipped with stun grenades, a blinding laser, or a Glock-26 pistol. An important advantage of Dogo is that he can fight even in the conditions of the city (and, accordingly, of the constrained space).The scouts embraced not only air and land but the water sphere. In 2017, the United States announced an Orca unmanned aircraft, which will operate underwater. It is expected that the Orca will have two major differences from other similar machines. The first is size. Dimensions novelty will correspond to a full-fledged submarine, while other complexes are quite compact. The second is maximum autonomy. It will be enough for the operator to give Orca a command (not only for reconnaissance, but also, for example, for cargo delivery), and the submarine (as shown in fig 9) will execute it and return to the base itself [26].



Fig, 9.Self-operated submarine

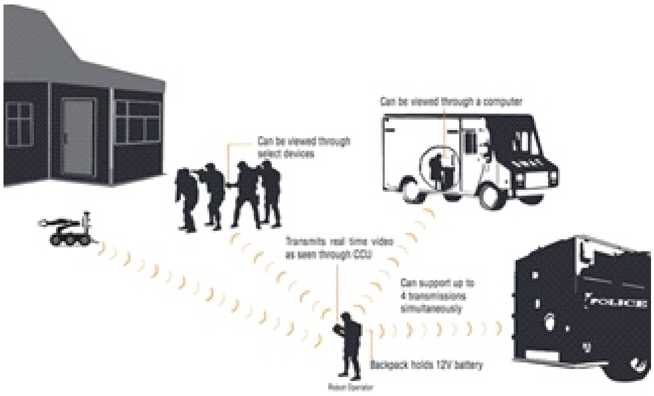


Fig. 10.Robot Engineers

 DOI: https://doi.org/10.33897/fujeas.v2i1.380

2.8.Mine Clearance

In a separate group, select the robot engineers (fig 10). The military has used them for quite a long time, and in many films, you can see how an operator works from a relatively safe distance with an explosive device carefully, and his machine is his hands. Such robots, of course, are used to this day. The basic principle of their work has not changed, although they have become more perfect. For example, the Russian Bogomol-3, created back in 2004, climbs the steps 20 cm high and works with charges attached to the bottom of the car. The minimum required "Mantis 3" clearance is 10 cm [23,26]. Fig 11 shows an interesting robot sapper that was introduced in the USA in February 2017. It is designed to work underwater and can demine any water bodies - from boats to bridges. This system, called the Underwater Dual Manipulator, really has two hands, and their design and materials are used to ensure proper maneuverability, accuracy, and accuracy of movements. The robot should be mounted on unmanned swimming vehicles to make the complex completely autonomous [25,26].

3.The Main Applications Available For Military

3.1. A.Autonomous Multi-Role Combat Robot System.

Among its primary capabilities are the ability to identify terrain and features and choose the best course of action, to determine the enemy's situation, to penetrate deeply into the enemy's position, and to independently complete reconnaissance tasks such as transporting ammunition and minesweeping, shooting and bombing, and transporting injured personnel.

3.2. Military Aircraft "co-pilot" System.

A few of its most notable characteristics are the ability to identify terrain and features and choose the best course of action, to determine the enemy's situation, to penetrate deeply into the enemy's position, and to independently complete reconnaissance tasks such as transporting ammunition, minesweeping, shooting and bombing, and transporting wounded personnel.

Fig 11. Robotics Border Surveillance

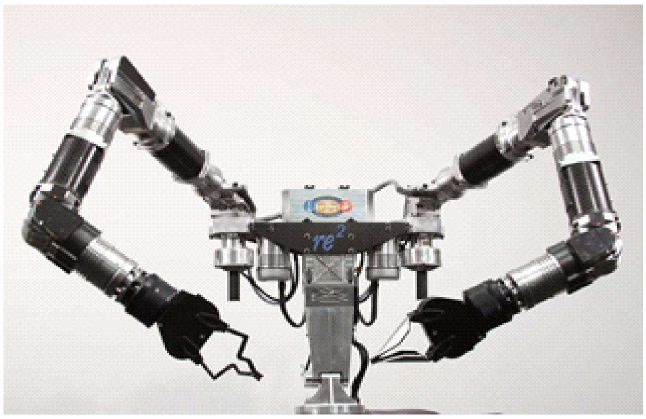


Fig. 12.Robot sapper

3.3. Independent Multi-Purpose Military Spacecraft Control System.

It can autonomously adjust and maintain the normal attitude of the military spacecraft's flight attitude during operations. At the same time, satellite faults can be detected and eliminated automatically using advanced algorithms. A real-time command to return to the base or destroy the satellite is issued when the satellite is in an emergency.

3.4. Automatic Fault Diagnosis and Elimination System for Weapon Equipment

A computer system with an artificial intelligence expert system as the main program and a robot system for executing commands are installed in the weapon equipment. The expert system is equipped with a software package that automatically diagnoses various faults and reflects expert knowledge. After the expert system determines the fault, an instruction is issued to the robot maintenance system to eliminate the fault (or potential fault) in time.

3.5.Military Artificial Intelligence Machine Translation System.

It can collect intelligence, decipher passwords, handle combat texts, coordinate operational command, and provide tactical decision-making. A system is a smart machine for language analysis, synthesis, recognition, and natural language understanding, storing basic vocabulary and grammar rules in multiple languages.

3.6. Ship Combat Management System.

It can be used for local sea operations command, assisted tactical decision-making, maritime target enemy and enemy identification, shore-to-ship integrated operations management, etc.

3.7. Intelligent Electronic Warfare System.

It automatically analyzes and masters the search, interception, and tracking sequence of enemy radars, issues warning signals about enemy missile launches, and determines the best defense and interference measures.

3.8. Automatic Intelligence and Image Recognition System

It uses intelligence analysis and image processing technology to identify, classify and process enemy intelligence and images. At the same time, automatic decision-making opinions are provided.

3.9. Artificial Intelligence Weapons.

Artificial intelligence technology is rapidly developing. Its control system can identify, judge, and make decisions. The application of intelligent machines, intelligent weapon equipment, And the development of artificial intelligence and intelligent robots will significantly impact military equipment development and the strategy and tactics of future wars. Such as: after the launch, "do not care" automatic guided intelligent missiles, intelligent mines, intelligent torpedoes and mines, underwater military operating systems.

3.10. Artificial Intelligence Robotics Border Surveillance

Recently Israel using robots for border security. These robots are armed with firearms and equipped with the latest technology thermal cameras and high-resolution cameras. These robots not only detecting the live being but also identified the object. It can recognize that the coming object is a Human or a Car. It also identified the human or a cat or dog. It also detects the human is armed or just a visitor. It will warn the human before hitting him. Powerful infrared cameras make them enable to see the object at night or in the darkness. This was a good project in no men's land or border security.

3.11. Military Aircraft "co-pilot" System.

Many countries, including Israel and India, spent most of their assets in the robot army. They form an army that will intelligently hit the target, make strategy according to the ground condition, and make its way by itself.

4.Robot Army

There are several unresolved challenges to be addressed before developing and deploying an artificial intelligence application for military purposes. The most pressing issues facing artificial military intelligence are Transparency, vulnerabilities, and learning are all important factors to consider, even with limited training data. This paper does not cover other important but less critical challenges related to optimization and generalization, such as architectural design, hyper-parameter tuning, or production-grade deployment.

Fig 13. Robot Army

5.Ethics Issues

Machines do not experience moral torment, fear, doubts about the correctness of their actions. In a way, this makes them more executive soldiers than people, and at the same time, more dangerous. That is why many famous people and organizations oppose giving robots the ability to use lethal weapons independently (without orders from humans). For example, Elon Musk and another 115 experts in 2017 appealed to the UN to ban such developments. Corresponding communities also appear, such as the Campaign to Stop Killer Robots organization, created in 2012 [27].

6.Discussion

It's impossible to prevent artificial intelligence from being used in warfare. Social technologies like talent management, which involves military personnel in the innovation process and develops officers' creative potential, have become critical in armaments. Informational, tactical, strategic, and economic tasks are the four responsibilities. Artificial intelligence will vastly increase the number of data collection and analysis options available, as well as the speed and quality of data processing. There will be more opportunities and sources of information in military intelligence and more opportunities to keep the truth hidden from the enemy. Artificial intelligence can add a large amount of artificially created data to the information space, creating a virtual truth that confuses potential adversaries and introduces political risks. Machine learning and artificial intelligence technologies have the potential to ensure national security. Artificial intelligence can also be used to defeat enemy radars by analyzing enemy radar operations and selecting suppressors. Many highly qualified experts are needed to keep track of constantly evolving cyber threats. Artificial intelligence could also aid in the detection of flaws as well as the development of code and machine algorithms. Man-made defenses will be swept up in the hunt for "weaknesses." Cyber-attacks will become more sophisticated and dangerous, posing a greater risk of intruders or competitors gaining access to sensitive information. Artificial intelligence will be tasked with strategic tasks in which people will play unique roles. The emergence of autonomous tactical weapons and colossal computing power in the future for "intellectual" intelligence, analysis of India's actions and troops, and finding optimal solutions means that strategies and methods of deploying and controlling troops will change, according to the General Staff of the Pakistan Armed Forces. Artificial intelligence in conventional weapons will become a factor in strategic deterrence and nuclear weapons, accelerating the innovation race. In the twenty-first century, power rivalries persist, and terrorist organizations have amassed entire armies, so military equipment must evolve and improve regularly. If one state uses artificial intelligence technology to take control of all its rivals' major systems, the conditional "Third World War" could happen in a matter of seconds. Not only the military but also the government should be represented in this way. The value of innovative changes must be understood by policymakers at the state level since there is an opportunity to wage a new type of war and provoke a real conflict between different countries. Artificial intelligence can also be included in the technology of public administration, strengthening power, and becoming a domestic policy instrument. It will also assist government agencies in managing catastrophic risks and preventing man-made disasters. Progress in the creation of artificial intelligence will have a powerful impact on the economy and may lead to a new industrial revolution. The power will be the first to introduce it and gain economic, informational, and possibly military-political superiority over India. The development of artificial intelligence has become a strategic task for superpowers in the 21st century. At the same time, it is extremely important to answer the question: whom will we grow as our assistants - the cynical and inhuman artificial "Mephistopheles" or the electronic Guardian Angel? Suppose Pakistan can create breakthrough technologies, concentrating on the main efforts and resources. In that case, this will ensure the preservation of strategic parity with India, the United States, and China, as well as Russia on a new stage in the development of military technology, especially during a difficult period when the world hegemon realizes that it is losing its power and transforming into one of the great powers, which means that instability emerges in the world, rife with conflicts, including those involving India, the United States, and China. To maintain its hegemony, the US will continue to incite conflicts and, sooner or later, will wage a real war against aspirants to hegemony who will follow the twenty-first century's new rules.Given that our financial and technical capabilities to develop a new generation of missiles, anti-ballistic missiles, attack complexes, and means of protection are now lower than those of potential enemies because of our economic weakness and long-term degradation of Pakistan science and education, artificial intelligence will become our ally in addition to the two (army and navy). He will analyze the actions of our opponents, collect scientific information, and find the best ways to solve complex engineering problems that we could not solve earlier due to the lack of information, data, or scientific knowledge in interdisciplinary areas. He will also assist in making strategic decisions because any strategic and defense task is a tremendous number of man-hours, analysis, and modeling.Artificial intelligence is a strategic project of the future, and the race to create it will be comparable to the nuclear race of the mid-twentieth century, but for now, only certain tasks have been solved on

 DOI: https://doi.org/10.33897/fujeas.v2i1.380

data analysis and pattern recognition, text translation. It is important to understand that artificial intelligence is not a supercomputer; it works on completely different principles. But the arguments about the technical singularity and the uprising of machines - this is still unscientific fantasy. The main task is not solved - creating the same computer comparable in power and capabilities with the human brain. Currently, the leader in the production of military robots in the world is the United States. This trend in the country has been particularly active since the days of the Cold War. However, this statement is true for Russia, which also introduces robot technologies in the armed forces. In 2014, a comprehensive targeted program, "Creating promising military robotics until 2025," was approved. The concept of the use of military robotic systems for the period up to 2030 was also created.

7.Conclusion

Within a relatively short period, the new global technology race will introduce cutting-edge military technology. Because any rival that falls behind increases the vulnerability, which will be extremely difficult to cover with conventional weapons, all the world's leading powers will deal with it. Also, the emergence of new technologies can lead to noticeable changes in the armed forces' strategies, planning, and organization. Therefore, to preserve sovereignty and defense capability, Pakistan should strive to obtain certain advantages or at least parity with likely adversaries in several critical directions as soon as possible to partially compensate for the current weakness of the Pakistan economy and the technological gap between industrial sectors.

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Foundation University Journal of Engineering & Applied Sciences
Vol. 2, Issue. 1. June 2021

Research Article

Comparison of Multiple Deep Models On Semantic Segmentation For Breast Tumor Detection

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Abstract:

The early diagnosis of breast tumor detection is the most significant research issue in mammography. Computer-aided diagnosis (CAD) is one of the highly essential methods to prevent breast cancer. This research work explored the effectiveness of deep-based pixel-wise segmentation models for low energy X-rays (mammographic imagery) to detect tumors in the breast region. For this purpose, various semantic segmentation models were incorporated into the experimental procedure. All the models were analyzed using the medical images dataset, which was gathered and annotated from one of the largest teaching hospitals in the Khyber Pakhtunkhwa province, known as Lady reading hospital. It is coordinated in cooperation with local health specialists, radiologists, and technologists. The comparative analysis of the incorporated segmentation techniques' performance was observed, selecting the most appropriate model for detecting tumors and normal breast regions. The experimental evaluation of the proposed models performs efficient detection of tumor and non-tumor areas in breast mammograms using traditional evaluation metrics such as mean IoU and Pixel accuracy. The performance of the semantic segmentation techniques was evaluated on two datasets (Cityscapes and mammogram). Dilation 10 (global) performed the best among the four semantic segmentation models by achieving a higher pixel accuracy of 93.69%. It reflects the effectiveness of the pixel-wise segmentation techniques by outperforming other state-of-the-art automatic image segmentation models.

Keywords: Semantic Segmentation; Breast Tumor Detection; Mammography.

1.Introduction

Breast cancer is the most common cancer disease for women across the globe. According to statistical analysis, a large number of women each year are diagnosed with breast cancer. Many women die from breast cancer, and a trend of increasing cases has been observed in recent decades. It is observed that breast cancer screening has reduced mortality by around 30% [1].]. If cancer is discovered between screenings, it is called interval cancer (IC). They mostly originate when a woman discovers a lump herself. Interval cancers are more aggressive and result in higher mortality than screen-detected tumors; therefore, we must find ways to improve the screening process and identify which women are at risk. Unfortunately, increased demand for screening resources comes when the supply of qualified radiologists is low, and their duties are over-stretched. To start with, success in developing a competent model for semantic segmentation on mammographies could help improve the process of generating and revising mammographies in hospitals. For example, it could be used for quality control, automatically detecting mammographies that need to be repeated due to low quality or artifacts. This research work helps recognize early signs of breast cancer perform semantic segmentation in mammographies. It focuses on the region of interest (tumor) and a non-region of interest (background) in the grayscale images. It discovers a reliable model to perform semantic segmentation on mammographic images after statistical analysis of the results. Success in this task could improve posterior detection and risk assessment networks' quality, ultimately increasing cancer control quality via mammographic images. The task of performing semantic segmentation on mammographic imagery is motivated by several factors. Secondly, semantic segmentation provides spatial information that could be potentially useful for cancer risk prediction networks. Cancer risk prediction is a relatively new path of investigation. It aims at predicting the risk of developing cancer in the future, given some medical data. Thus, a model attempting to predict the risk of developing cancer from mammographies could extract useful insight. It can be achieved by providing the semantic segmentation of mammography. In addition to the mammogr aphy itself, it focuses only on some areas of interest while ignoring the areas with no relevant information (like the image's background). Furthermore, a pre-trained model on semantic segmentation could boost the performance of current tumor classification/detection

 DOI: https://doi.org/10.33897/fujeas.v2i1.424

approaches, as proposed in [2]. Finally, it is a research question that, for the moment, remains unexplored. Up to the best of my knowledge, this research area is less focused on the literature reporting results on this specific task. Contrarily, most of the current research related to mammographies attempts to locate tumors directly. Most of them doesn't show the comparison of extensive experimental analysis to identify the outperformance of specific segmentation technique [3] [4] [5]. However, this work's scope of this study is limited todetermining the viability of adopting such models rather than their implementation as a market solution that is optimized and practical. Furthermore, during training, testing more models was emphasized over a thorough search of the hyper-parameter space. As a result, a more thorough hyper-parameter tuning could result in a marginal improvement in the performance measures described in this paper for any given model.The risk of cancer prediction in mammographies could provide a significant improvement in the early diagnosis of cancer. It can be achieved using semantic segmentation techniques to focus on the region of interest while ignoring the areas with no relevant information (like the image background). A pre-trained model may be utilized to diagnose current tumor classification using semantic segmentation with ground truth labeling. In [17], a deep convolutional neural network strategy is implemented to detect micro-calcification in mammograms obtained from three different manufacturers. The two CNNs were trained on the training set to detect the micro-classification candidates. The deep CNN was compared to the state-of-the-art cascade classifier, where the CNN outperforms the cascade classifier. Xiaobo Lai et al. [18] presented the automatic segmentation method using a U-Net architecture to work on digital breast tomosynthesis (DBT) images. It achieved the automatic segmentation accuracy of breast masses. In [3, 24], a multi-scale convolutional neural network (CNN) is proposed and trained for mammogram classification. It is based on feature learning with a curriculum learning strategy to provide a labeled mammogram image as an outcome to facilitate early diagnosis. According to Deszo et al. [4], A CAD system is proposed, which outperforms the INbreast database classification. It is capable to automatically detect benign and malignant lesions in mammography on the object detection frameworks, Faster R-CNN. Li Shen [5] introduced an end-to-end training algorithm using a convolutional design that outperformed the previous methods. It is utilized for mammogram images to detect early breast cancer based on lesion annotations for training. Image level labels are applied for image classification. A DDSM is used as a benchmark to prove its good performance.In recent years, a few of the approaches utilizing semantic segmentation for specific tasks or subtasks, such as segmenting region-of-interest (ROI) [17] and mass segmentation [19, 20]. Some of the deep learning techniques in Mammography are highlighted in [21, 22, 23]. The other attempts show the high significance of designing approaches for detecting cancer status based on mammogram images to classify for possible cancer detection**.** Table 1 highlights the state-of-the-art literature about the common deep learning models, benchmarks, and their noted accuracy levels to highlight their performances. It is significant because of the relevance to the work in this

Table 1. Common Deep Learning Benchmarks

(Long et al., 2015)[7]	PASCAL VOC 2012	FCN32, FCN16 FCN8	94.3%	62.2%
(Ronneberger et al., 2015)[8]	ISBI 2015 Challenge (PhC-U373)	U-Net (2015)	92%	77.5%
(Zhou et al., 2018)[9]	Liver Dataset (MICCAI 2018 LiTS Challenge)	U-Net ++	90.4%	82.90%
(Yu & Koltun, 2016)[10]	VOC 2012	Dilation 10	71.3%	69.8%
(Hamaguchi, 2017)[11]	Cityscapes	LFE+ Dilation	63.6%	50%
(Chen et al., 2017)[12]	Cityscapes 2015	DeepLabv3 (ASPP Pooling)	79.30%	81.3%
(Simon et al., 2017)[13]	CamVid 2015, Gatech 2015	FCN-8 Dense-Net	91.5%	66.9%
(Nedra et al., 2018)[14]	Drive 2012	FCN32	91%	64%
(Lin et al., 2016)[15]	PASCAL VOC 2012	FCN	71.5%	53.9%
(Badrinarayanan et al., 2015)[16]	Cam-Vid road scenes dataset	SegNet, FCN	90.40%	60.10%

2.Proposed Segmentation Model

Many different neural network architectures have been proposed in recent years to tackle semantic segmentation within the scope of deep learning. It is intended to use some of the most relevant ones to be trained in segmenting mammographic imagery. In this work, semantic segmentation is performed to detect the tumor and non-tumor regions in breast mammograms. The positive feature of the Cityscape benchmark is that it can perform semantically and object segmentation as well. It returns pixels with class labeling, and the objects (anatomical regions) are separately segmented. At first, the Cityscapes dataset is used to train the model. It is used for the semantic segmentation of the breast Mammogram dataset based on the ground truth annotations obtained from radiologists and clinical experts. The detail of the architecture of the models that have been considered are following;

2.1 Fully Convolutional Network

The Fully Convolutional Network (FCN) is a semantic segmentation model used to execute any images without using fully connected layers. At first, an encoder is used to obtain contextual information about an image. The encoder architecture with alternating sequences of 2 or 3 convolutional layers with max-pooling layers is deployed. It is almost similar to VGG16 [7], except in the original VGG16 architecture, the convolutional layers are used instead of fully connected layers. Each of the convolutional operations is followed by the activation function as a rectified linear unit (ReLU). The details of the encoder architecture are described in table 2. Each layer of the network includes convolution strides, feature map dimensions, kernel sizes, and receptive fields. T input and output layers' sizes are based on calculations concerning the input patches of 256 x 256 pixels. It is the size initially used for FCN without any change.

Table 2. FCN Encoder Architecture

Name:	Layer	Kernel Size	Stride	Padding	Input Size	Output Size	Input Feature Maps	Output Feature Maps	Receptive Field
conv1_1	1	3	1	SAME	256	256	3	64	3
conv1_2	2	3	1	SAME	256	256	64	64	5
max_pool1	3	2	2	SAME	256	128	64	64	6
conv2_1	4	3	1	SAME	128	128	64	128	10
conv2_2	5	3	1	SAME	128	128	128	128	14
max_pool2	6	2	2	SAME	128	64	128	128	16
conv3_1	7	3	1	SAME	64	64	128	256	24
conv3_2	8	3	1	SAME	64	64	256	256	32
conv3_3	9	3	1	SAME	64	64	256	256	40
max_pool3	10	2	2	SAME	64	32	256	256	44
conv4_1	11	3	1	SAME	32	32	256	512	60
conv4_2	12	3	1	SAME	32	32	512	512	76
conv4_3	13	3	1	SAME	32	32	512	512	92
max_pool4	14	2	2	SAME	32	16	512	512	100
conv5_1	15	3	1	SAME	16	16	512	512	132
conv5_2	16	3	1	SAME	16	16	512	512	164
conv5_3	17	3	1	SAME	16	16	512	512	196
max_pool5	18	2	2	SAME	16	8	512	512	212
conv6_1	19	7	1	SAME	8	8	512	4096	292
conv6_2	20	1	1	SAME	8	8	4096	4096	292
scores	21	1	1	SAME	8	8	4096	num_classes	292

After passing through the encoder, which includes applying five max-pooling layers, the feature maps' spatial dimensions are 32 times smaller than the input image patch. Since semantic segmentation requires generating predictions with the same spatial dimensions as the input, it is necessary to up-sample the encoded logits somehow. The solution proposed by Long et al. [7] involves defining three different sub-models of FCN. These sub-models are trained sequentially, using the weights obtained from training the previous model as initial weights for the following one. The first sub-model, called FCN32, takes the feature maps of size 8 x 8 obtained after max_pool5 and applies a bilinear up-sampling step to resize them back to 256 x 256 pixels (the input size). The second sub-model, referred to in the original paper as FCN16, uses a transposed convolutional layer to learn the best strategy to upsample max_pool5 outputs from size 8 x 8 to 16 x 16. The 16x16 upsampled version of max_pool5 and the 16 x 16 output of max_pool4 are summed up and finally resized to 256 x 256 pixels with a bilinear upsampling layer. The last sub-model on the decoding strategy is called FCN8 and goes a step further than FCN16. The result of summing the 16 x 16 version of max_pool5 to the 16 x 16 output of max_pool4 is up-sampled again utilizing another transposed convolution to size 32x32. This 32 x 32 feature map is summed up with the 32x32 output of max_pool3 and finally up-sampled to 256 x 256 pixels with a bilinear up-sampling layer first 2 cases. Transposed convolutions are followed by ReLU activation functions, just like any other convolution on the model. The exact details of the decoder are shown in table 3.

Table 3. FCN Decoder Architecture

Name:	Layer	Kernel Size	Stride	Padding	Input Size	Output size	Input Featur Maps	Output Featur Maps	Receptive Field
t_conv_1	1	4	2	SAME	8	16	Num Classes	Num Classes	
t_conv_2	1	4	2	SAME	16	32	Num Classes	Num Classes	

During training, FCN32 will be initialized using VGG16 ImageNet pre-trained weights. Following FCN16 will be trained using FCN32 weights as initial weights. Finally, FCN8 will be initialized with FCN16 weights, trained, and used for inference.

2.2 U-Net

The U-Net [8] is a Semantic segmentation model that follows an encoder-decoder architecture. The name U-Net comes from the fact that the encoder and the decoder are symmetric. It is helpful to identify the region of interest. The encoding path, which aims to capture the image's context information, resembles most image classification models, alternating between convolutions and max-pooling operations. The encoder's specific details are defined in table 4, where input and output layer sizes are calculated using 572 x 572 pixels. The decoding path tries to retrieve localization information lost during pooling operations. It follows an architecture symmetric to the encoding path but replacing max-pooling steps with transposed convolutions. Besides, at several points along the decoding path, the feature maps are concatenated to the ones coming from the same stage at the encoder before proceeding. It is important to note that U-net convolutions are not padded. This is why the decoder's output size is 388 x 388, corresponding to the 388x388 central patch of the input image. Furthermore, each convolution or transposed convolution along the network is followed by a rectified linear unit (ReLU) activation function.

Table 4. U-Net encoder architecture

Name:	Layer	Kernel Size	Stride	Padding	Input Size	Output Size	Input Feature Maps	Output Feature Maps	Receptive Field
convl_1	1	3	1	VALID	572	570	3	64	3
convl_2	2	3	1	VALID	570	568	64	64	5
max_pool1	3	2	2	VALID	568	284	64	64	5
conv2_1	4	3	1	VALID	284	282	64	128	10
conv2_2	5	3	1	VALID	282	64	128	128	14
max_pool2	6	2	2	VALID	280	140	128	128	16
conv3_1	7	3	1	VALID	140	138	128	256	24
conv3_2	8	3	1	VALID	138	136	256	256	32
max_pool3	9	2	2	VALID	136	68	256	512	36
conv4_1	10	3	1	VALID	68	66	512	512	52
conv4_2	11	3	1	VALID	66	64	512	512	68
max_pool4	12	2	2	VALID	64	32	512	1024	76
conv5_1	13	3	1	VALID	32	30	1024	1024	108
Conv5_2	14	3	1	VALID	30	28	1024	1024	140

2.3 Dilation 10

Unlike the preceding models, the dilation10 [10] model does not use an encoder-decoder architecture. It can be separated into two distinct components, however: the front-end module and the context module. Like an encoder, the front-end module is designed to extract the "what" information from the images. Encoder architectures, like image classifiers, typically alternated convolutional layers with max-pooling operations to provide a field of view that covered the entire image or a substantial chunk of it however, the spatial dimensions after the design are much less than the input size. The Dilation10 model eliminates a number of the maximum pooling operations. For compensation, the dilation of posterior convolutions is doubled by two after each eliminated max-pooling. This method maintains the same field of view as traditional encoders while decreasing the amount of detailed information lost during pooling processes. Table 5 shows the dilation10 front module, which is based on VGG16. The crop sizes utilized in the various training phases were used to calculate the input and output feature map sizes. For the first, second, and third training stages, the crop sizes are 632 × 632 pixels, 1024 x 1400 pixels, and 1400 x 1400 pixels, respectively. Because spatial dimensions are still very big after the front module due to the suppression of some pooling steps, an alternative technique to an up-sampling decoder can be used. Dilation10, in particular, employs a module that employs a series of dilated convolutions with increasing dilation factors. This design allows for the systematic aggregation of multi-scale contextual data without sacrificing resolution. Table 6 shows the architecture of the context module in more detail. The sizes of the input and output feature maps were calculated based on the size obtained at the front module's end. As previously stated, the dilation10 network is trained in stages. Network training, in particular, is divided into three stages. Only the front module is trained in the first step. The entire network (front module + context module) is formed in the second stage of the training process. The weights in the front section, on the other hand, are frozen, and only the ones in the context module are modified. The training process concludes with a final stage in which the entire network is trained without any frozen variables. A rectified linear unit (ReLU) activation function follows all convolutions in the network.

Table 5. Dilation10 front module architecture

Name:	Layer	Kernel Size	Stride	Padding	Dilation	Input Size	Output Size	Input Feature Maps	Output Feature Maps	Receptive Field
conv1_1	1	3	1	SAME	1	632/1024/1400	632/1024/1400	3	64	3
conv1_2	2	3	1	SAME	1	632/1024/1400	632/1024/1400	64	64	5
max_pool1	3	2	2	SAME	1	632/1024/1400	316/512/700	64	64	6
conv2_1	4	3	1	SAME	1	316/512/700	316/512/700	64	128	10
conv2_2	5	3	1	SAME	1	316/512/700	316/512/700	128	128	14
max_pool2	6	2	2	SAME	1	316/512/700	158/256/350	128	128	16
conv3_1	7	3	1	SAME	1	158/256/350	158/256/350	128	256	24
conv3_2	8	3	1	SAME	1	158/256/350	158/256/350	256	256	32
conv3_3	9	3	1	SAME	1	158/256/350	158/256/350	256	256	40
max_pool3	10	2	2	SAME	1	158/256/350	79/128/175	256	256	44
conv4_1	11	3	1	SAME	1	79/128/175	79/128/175	256	512	60
conv4_2	12	3	1	SAME	1	79/128/175	79/128/175	512	512	76
conv4_3	13	3	1	SAME	1	79/128/175	79/128/175	512	512	92
dil_conv5_1	14	3	1	SAME	2	79/128/175	79/128/175	512	512	124
dil_conv5_2	15	3	1	SAME	2	79/128/175	79/128/175	512	512	156
dil_conv5_3	16	3	1	SAME	2	79/128/175	79/128/175	512	512	188
dil_conv6_1	17	7	1	SAME	4	79/128/175	79/128/175	512	4096	380
conv6_2	18	1	1	SAME	1	79/128/175	79/128/175	4096	4096	380
scores	19	1	1	SAME	1	79/128/175	79/128/175	4096	num_classes	380

2.4 Deep Lab v3

The Deep Lab v3 semantic segmentation system [12] is an approach that, just like dilation10, moves away from the Encoder-Decoder architecture by limiting the number of downsampling operations used encoding path. Similar to dilation10, it achieves a field of view comparable to models with a higher amount of max-pooling layers using atrous convolutions with increasing dilation factors. The feature extraction path is also based on a reference image classification model pre-trained on the ImageNet dataset. However, instead of using VGG like the previously described models, the authors of deep lab v3 use a ResNet-based architecture. In [12], the author experiments with residual networks with a different number of layers. In this research work, the network implemented is the one with 18 layers, the architecture of which can be found in figure 1.

Table 6. Dilation10 context module architecture

Name:	Layer	Kernel Size	Stride	Padding	Dilation	Input Size	Output Size	Input Feature Maps	Output Feature Maps	Receptive Field
context1	20	3	1	SAME	1	79/128/175	79/128/175	num_classes	num_classes	3
context2	21	3	1	SAME	1	79/128/175	79/128/175	num_classes	num_classes	5
context3	22	3	1	SAME	2	79/128/175	79/128/175	num_classes	num_classes	9
context4	23	3	1	SAME	4	79/128/175	79/128/175	num_classes	num_classes	17
context5	24	3	1	SAME	8	79/128/175	79/128/175	num_classes	num_classes	33
context6	25	3	1	SAME	16	79/128/175	79/128/175	num_classes	num_classes	65
context7	26	3	1	SAME	16	79/128/175	79/128/175	num_classes	num_classes	97
context8	27	3	1	SAME	32	79/128/175	79/128/175	num_classes	num_classes	161
context9	28	3	1	SAME	1	79/128/175	79/128/175	num_classes	num_classes	161
context10	29	3	1	SAME	1	79/128/175	79/128/175	num_classes	num_classes	161

Table 7. 5 Layer Results

Layer Name	Output Size	18-Layer	34-Layer	50-Layer	101-Layer	152-Layer
conv1_x	112 x 112	7 x 7, 64, stride 2				
conv2_x	56 x56	3 x 3 max pool, stride 2				
		[3 x 3, 64 3 x 3, 64] x 2	[3 x 3, 64 3 x 3, 64] x 3	1 x 1, 64 [3 x 3, 64] x 3 1 x 1 256	1 x 1, 64 [3 x 3, 64] x 3 1 x 1 256	1 x 1, 64 [3 x 3, 64] x 3 1 x 1 256
conv3_x	28 x 28	[3 x 3, 128 3 x 3, 128] x 2	[3 x 3, 128 3 x 3, 128] x 4	1 x 1, 128 [3 x 3, 128] x 4 1 1 512	1 x 1, 128 [3 x 3, 128] x 4 1 1 512	1 x 1, 128 [3 x 3, 128] x 8 1 1 512
conv4_x	14 x 14	[3 x 3, 256 3 x 3, 256] x 2	[3 x 3, 256 3 x 3, 256] x 6	1 x 1, 256 [3 x 3, 256] x 1 x 1 1024	1 x 1, 256 [3 x 3, 256] x 2 1 x 1 1024	1 x 1, 64 [3 x 3, 64] x 36 1 x 1 256
conv5_x	7 x 7	[3 x 3, 512 3 x 3, 512] x 2	[3 x 3, 512 3 x 3, 512] x 3	1 x 1, 256 [3 x 3, 256] x 1 x 1 1024	1 x 1, 256 [3 x 3, 256] x 3 1 x 1 1024	1x1, 64 [3x3, 64] x 3 1x1 256
	1 x 1	Average pool, 1000-d fc, SoftMax				
FLOPs		1.8×10^9	3.6×10^9	3.8×10^9	7.6×10^9	11.3×10^9

The only difference to the original ResNet implementation is that the convolutions found in the last two blocks (block3 and block4) are replaced by atrous convolution with dilation rates 2 and 4, respectively. With these changes, the output size is only eight times smaller than the input size, and the output is 16 times smaller, and therefore only the final block contains dilated convolutions. One of the main differences for dilation10 is the module's architecture added at the end of the encoding path. This model employs spatial pyramid pooling to capture context information. With some similarities with the inception module [11], this module combines several parallel atrous convolution layers with different rates to capture multi-scale information. Figure 1 describes the architectural details of the spatial pyramid module. The input size used by the paper authors and also for the experiments in this research work is 769 x 769 pixels. Thus, input and output sizes in figure 1 are computed for 96, the feature map size at the beginning of the spatial pyramid pooling module. A rectified linear unit (ReLU) activation function follows all convolutions in the network. Finally, the original model includes batch normalization layers [12] along with the network. However, due to memory constraints, the mini-batch used in this work during training was of size 2. Therefore, batch normalization layers were replaced by group normalization layers [25], whose performance is not affected by the small batch size.

3.Experiment

The experiment is performed in this work on the two datasets, which are the Cityscapes (benchmark) and a breast mammogram dataset. The Cityscape benchmark is chosen for the experiment because it can achieve class labeled pixels for semantic segmentation of the anatomical regions separately and object segmentation. The Lady reading hospital is one of the largest hospitals in the province in Pakistan. A large corpus of mammography data access was granted to train the models obtained from the local population, recorded between 2011 and 2019. However, none of the screenings had pixel-wise annotations. Consequently, the annotations were created under authorized expert radiologists, technologists, and other clinical experts.

3.1.1 Cityscapes Dataset

A prevalent semantic segmentation benchmark called Cityscapes [6] dataset was used to train and test the model. The images are about the same size as those of the Mammography dataset in the Cityscapes dataset. Moreover, papers on semantic segmentation in the literature also report the performance of the Cityscape dataset, which has proved very helpful in validating the model's implementation. According to the authors, classes were selected based on their frequency, relevance from an application point of view, practical considerations regarding the effort to annotate, and compatibility with existing datasets.

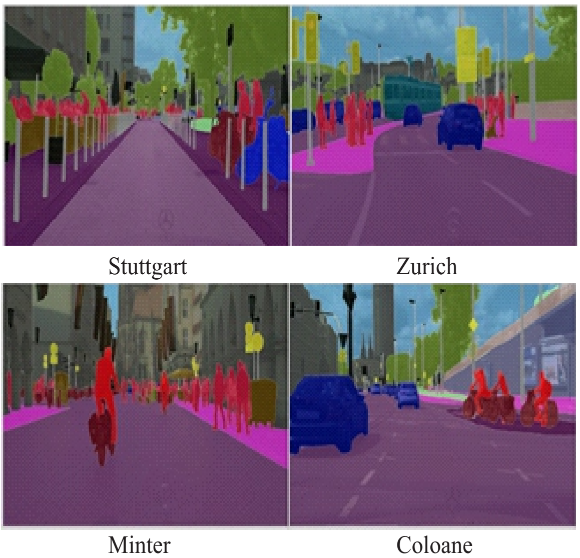


Fig. 1. Cityscapes sample images. [6]

<table>
<tr><th rowspan="2">Breast Anatomical Regions</th><th>Tumo Region</th><th>Non-Tumor Region</th></tr>
<tr><td colspan="2">Nipple
Areola
Calcifications
Skin
Thick vessels
Pectoral muscle
Auxiliary lymph nodes
Calcified vessels
Text
Submammory tissue
Foreign object
Mammary gland
Background</td></tr>
</table>

Table 8. Classes and anatomical regions in

3.1.2 Mammography Dataset

The Mammography dataset is a medical dataset composed of 100 subjects (high-resolution grayscale images) of mammography screenings. Each subject is an image and is replicated ten times using different data augmentation techniques. So the total image amount is 1000. Annotations were generated by clinical experts of the local medical teaching institute as binary pixel-wise maps for different anatomical regions. It was mainly categorized into two regions the region of interest "tumor and non-tumor region. QuPath, a software application specifically designed for bioimage analysis, was used for the task [26]. The ground truth, labeling, and segmented comparisons are made based on two classes' tumor and non-tumor regions. The detailed descriptions of all the anatomical areas of mammography are shown in table 7;. The ranking above indicates the different anatomical regions in the breast mammogram. In extension to this work, for the semantic segmentation of all the anatomical regions, the pixels should superpose other pixels when merging the binary maps into single pixel-wise annotations. All binary maps except calcifications, text, nipple and auxiliary lymph nodes can be smoothed using a Gaussian filter at merging time. It is usually performed to avoid sudden transitions in the annotations. One of the main challenges with this dataset is that it is very imbalanced. Some anatomical regions, such as the background or mammary gland, have a much higher presence than others. It is necessary to create a dataset composed of crops obtained from the original images sampled to mitigate the imbalance problem to prevent model training hurdles. Several crop datasets with different crop sizes may be generated from the original high-resolution images to train different models that require different input sizes. Crop sizes used to generate the datasets are 256 x 256, 700 x 700, 900 x 900 and 1500 x 1500 pixels. Thus, to create a (more) balanced dataset containing crops of a given size x, take each image from the original dataset, and a list of the generated unique labels. Then, categories mammary gland and background are to be removed from the unique label list because one of the two will always be present in any crop generated. From the remaining labels, one is to be selected randomly using a uniform distribution. A pixel of the selected category is to choose randomly with a uniform probability to use as the new crop center .

3.2 Data Augmentation

The augmentation is achieved by applying image processing practices, e.g., rotation, smoothing, mirror effect, sharpening, noise addition, contrast enhancement, etc. The total augmented dataset consists of 1000 images. The replicated samples are displayed in figure 4 below.

 DOI: https://doi.org/10.33897/fujeas.v2i1.424

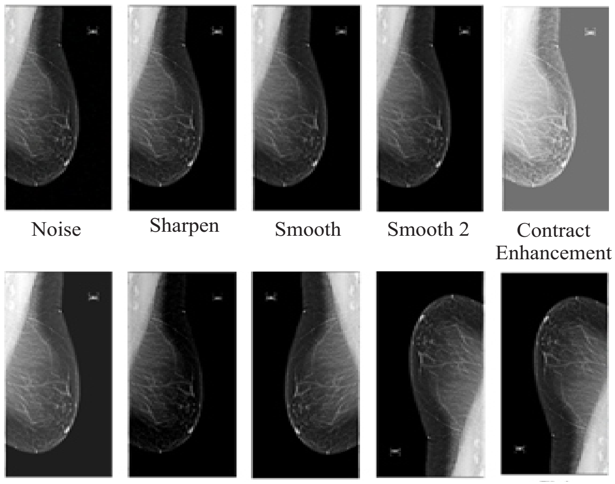


Fig. 2. Image Augmentation replicated samples

Option	Parameters
Optimizer	SGDM
Learn Rate Schedul e	Piecewise
Learn Rate Drop Period	10
Learn Rate Drop Factor	0.3
Momentum	0.9
Initial Learn Rate	0.0001
L2 Regularization	0.005
Validation Data	Yes
Max Epochs	100
Mini Batch Size	64
Shuffle	Every - epoch
Verbose Frequency	10
Validation Patience	4

Table 9. Experimental Parameters for Dilation 10

3.3 Input Pipeline

For all the experiments performed in this work, a unified input pipeline was employed for each of the datasets. For the Cityscapes dataset, which contains RGB images, a random horizontal flipping operation was first applied with a probability of 0.5. Following, with probabilities of 0.5, random distortions of the saturation, the brightness, and the contrast of the images were employed. Finally, a random crop of the desired size (depending on the network to be trained) was generated and normalized to have values between 0.5 and 0.5. For the Mammography dataset, the crop dataset of sufficient size to cover the input size of the network was trained with the crop dataset of sufficient size to cover the network's input size. The network was trained with a crop dataset of adequate size to cover the network's input size. The grayscale images were transformed into RGB images with a Tensorflow function. Data augmentation was limited in this case to random horizontal flipping and random contrast distortion; both applied with probabilities

3.4 Training Procedure

Stochastic Gradient Descent (SGD) optimizer with momentum has been used to reduce the cross-entropy loss function. The loss function is used to measure each label's contribution, which is the weighted value in the percentage of a class label from a dataset. More specifically, if a ' 'label's . class supposes x% of the labels in the dataset, its contribution to the loss function will be weighted by $w = (1 — x/100)$. Also, early stopping have been used during training, with patience factor number of epoch without improvement before stopping) ranging from 20 to 50 depending on the time needed to train an epoch. Moreover, parameter tuning is adapted wherever required to reduce memory size, computational time, and maximum accuracy.The data split is beneficial, depending on the kind of classifier used. In our case, the image data are cross-validated using the hold out technique with a percentage of 70/30, where 70 % of the data is selected for model training randomly. While the remaining 30, which will be by default randomized used for model testing.

3.5 Hyper-Parameters and options for models training

The learning rate is adjusted to learn quickly, adapting to a high initial rate. It follows a schedule piecewise and reduces by a factor of 3 at every ten epochs. It gives a solution nearer to the local optimum with a dropout of learning rate.The validation data parameter is set to test the network's validation data at every epoch, and the 'ValidationPatience' is set as 4 for the early stop of data training with the convergence of validation accuracy to avoid training dataset overfitting issues. Batch size is kept as a mini with the specific value depending on the parameter tuning to minimize memory use during the training phase. The batch size depends on the power capacity of the available system.

4.RESULTS EVALUATION

4.1 Cityscapes Results

All the intentional models have been implemented from scratch, including the current model. Thus, it is an important step to check the validity against a standard benchmark dataset. The following table shows the results obtained on the Cityscapes dataset.

Model	Picxel accurancy	Mean IoU Accuracy	Mean Per Class Accuracy
CN32	91.84	57.35	66.59
FCN16	92.88	59.25	67.86
FCN8	92.57	59.01	67.96
U-Net	91.81	58.87	68.86
Dilation10 - Front	92.98	62.94	72.78
Dilation10 – Context	95.37	63.29	75.16
Dilation10 – Global	96.09	67.87	79.05
DeepLab v3 + ResNet	93.97	63.75	74.53

Table 3. Results on the validation dataset

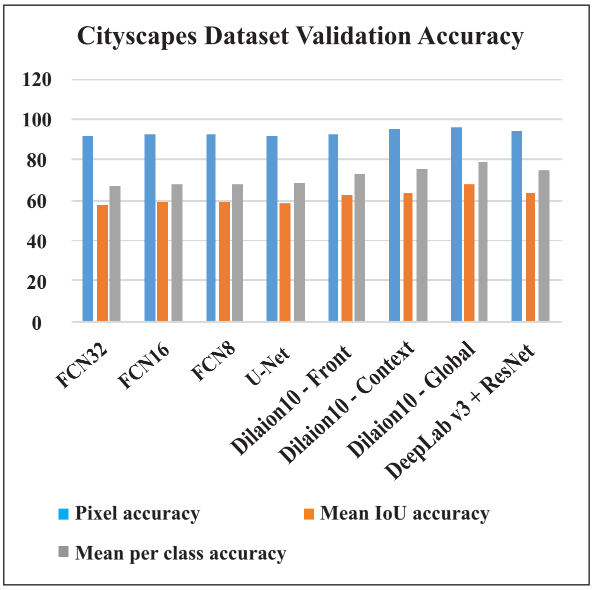


Fig. 5. Cityscapes Dataset Validation Accuracy.

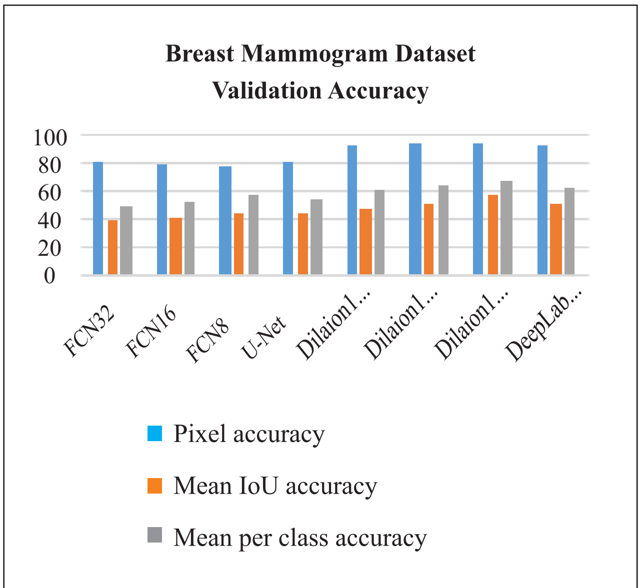


Fig. 4. Breast Mammogram Dataset Validation Accuracy

Model	Pixel accuracy	Mean IoU accuracy	Mean per classaccuracy
FCN32	80.37	40.06	49.20
FCN16	78.90	41.75	53.13
FCN8	78.17	45.12	57.03
U-Net	80.49	43.47	53.78
Dilation10 - Front	93.03	47.65	60.74
Dilation10 - Context	93.46	50.26	64.39
Dilation10 - Global	93.69	57.91	67.97
DeepLab v3 + ResNet	92.17	51.34	62.01

Table 10. Results on the validation dataset

4.2 Breast Mammogram results

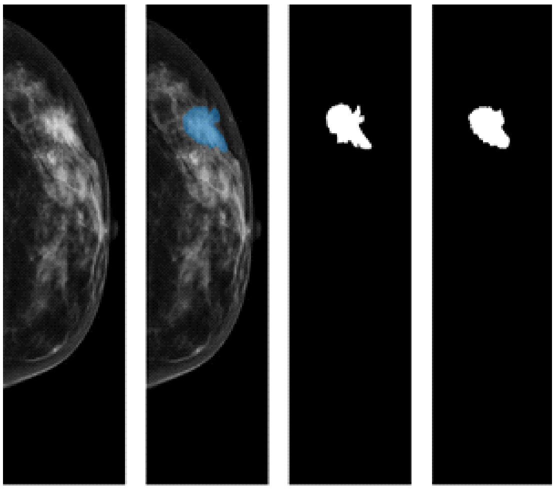
After the validity check for implementation, the next step is to implement it against the Mammography dataset. The results of the validation dataset are reported below in table 10 and the column charts.The proposed model is first trained on the Cityscape dataset and is then applied to the mammogram. The ground truth is added from the clinical experts to generate semantic annotations of breast mammograms. Various classes have been defined for mammography labeling and classification.

4.3 Visual Results

On a newly proposed medical dataset of mammography screenings, the performance of state-of-the-art semantic segmentation deep learning models is examined. All the reference models such as FCN with three variants (FCN 32, FCN 16, and FCN 8), U-Net, Deep Lab v3, Dilation 10 (context, front, global) are re-implemented and validated first on the benchmark dataset Cityscapes. The new medical image corpus for breast mammograms was collected and annotated to show that it is possible to boost segmentation performance by training the models in the classical training framework. The details of the visual results for the semantic

 DOI: https://doi.org/10.33897/fujeas.v2i1.424

segmentation techniques are shown in Figure 7 below shows that image (a) is the original image, consisting of a tumor region. Image (b) is an annotated image. The annotation/ground truth labeling is performed with radiologist collaboration. Image (c) is the binary mask of the ground truth labeled region. The image (d) consists of a segmented mask acquired by applying the dilation 10 (global) semantic segmentation model. In the above figure 8, the image (a) is the ground truth masked by the clinical expert, the image (b) is obtained using Dilation 10 (global) segmentation where it can be observed that the tumor is little under-segmented, the image (c) is the segmented image of DeepLab-v3 which seems to be bit over-segmented, the image (d) is achieved by applying FCN, and in the last image (e) the segmentation is performed using U-Net semantic segmentation model. The (d) and (e) are too much over-segmented, so from the image above, it can be analyzed that Dilation 10 (global) and DeepLab-v3 performed the best in tumor regions segmentation.



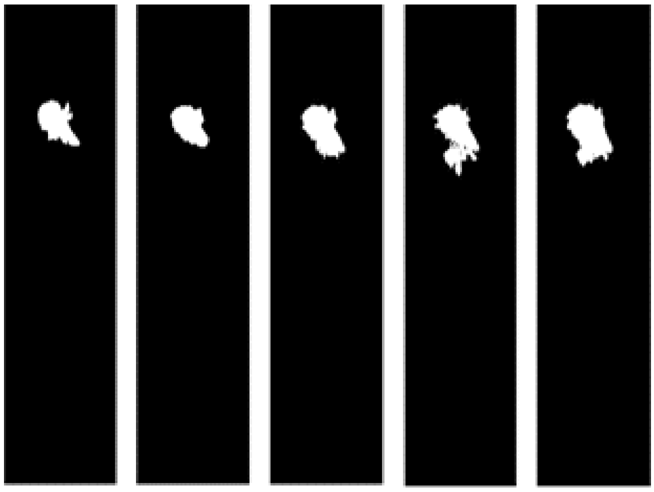


Fig. 5. (a) Ground Truth Mask, (b) Dilation Segmented Mask, (e) DeepLab-v3 Segmented Mask, (d) FCN Segmented mask, and (e) U-Net Segmented Mask.

5.Conclusion

The two annotated datasets, such as Cityscapes a benchmark and a local medical imaging dataset Breastmammogram, train semantic segmentation algorithms. The FCN semantic segmentation model with its three variants FCN 32, FCN 16, FCN 8, U-Net, Dilation 10 (front, context, global) and DeepLab-v3 (network-based on ResNet) are implemented. A competent segmentation model for mammographies is highlighted after the detailed experimental analysis. The Dilation 10 (global) outperform compared to other segmentation models with a higher pixel accuracy of 93.69 %. In this work, the goal is limited to recognize the region of interest (tumor) and a non-region of interest (background) in the grayscale images. It may be extended in the future to segment the other anatomical regions associated with breast mammograms accurately.

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Foundation University Journal of Engineering & Applied Sciences
Vol. 2, Issue. 1. June 2021

Research Article

Kobe Braynt Shot Prediction Using Machine Learning

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Abstract:

Kobe Bryant was one of the best players of Basketball. Data regarding his 20 years of playing games are available on the Kaggle. We transform the categorical features by PCA and normalize the data by the min-max normalization technique. Machine learning techniques (Logistic Regression, Random Forest, Linear Discriminant Analysis,Naïve Bayes, Gradient Boosting, Adaboost, and Neural Network) are applied on pre-processed data to classify whether he made shot or not.The prediction accuracy of LR, RF, LDA, NB, GB, ABC and ANN is 67.84%,64.22%,67.82%,0.61%,67.8%,68% and 67% respectively on hold an out method. The experimental results show that Adaboost has the highest prediction accuracy as compared to other methods with 5 cross-validations. Finally, we have got satisfactory results as compared to our benchmark (Kaggle).

Keywords: Shot Prediction; Machine Learning; Neural Network; Basketball

1.Introduction

Basketball is an internationally renowned game; and National Basketball Association, also known as NBA; is the most popular league of the game. Kobe Bryant was one of the best players in NBA. He denoted his retirement by scoring 60 focuses in his last game for Los Angeles Laker on April 12, 2016. Starting at the age of 17 at NBA, Kobe acquired the game's most noteworthy honours all through his long profession.The aim of the research is to predict every field goal attempted during his 20-year career, whether he made the shot or not. Dataset was taken from Kaggle, where already some of the participants had worked. Data was analysed by different machine learning analysts; use of logistic regression and neural network to predict the shot prediction type [1], running the feedforward NN for the analysis of nonlinear sports data [2], identification of the basketball strategy using player tracking data [4], use of LSTM for Multi-Modal Trajectory prediction of NBA player [11], use of neural network for selection of Most Valued Player of NBA [12], predicting the NBA game results using ANN and decision tree [14], use of mixture density network and bidirectional LSTM for basketball trajectory prediction [15], and classification of the NBA offensive plays using neural network [15].In our work, we first apply PCA for column transformation, followed by minmax scalar normalization and then pass this scaled data to different machine learning algorithms for classification whether he made the shot or not. We applied Logistic Regression, Random Forest, Linear Discriminant Analysis, Naïve Bayes, Gradient Boosting, Neural Network and Adaboost on processed data. The performance of our method is evaluated by subsequent evaluation metrics; accuracy, precision, recall and F-measure. Organization of the remaining paper is as follows: in section 2 we overview the related work about basketball player prediction and shot selection. Section 3 describe the methodology in steps for our shot selection prediction. Section 4 and 5 narrates Results and conclusion respectively.

2. Literature Review

In [1] different features are used to compare contrast the performance of NN, logistic regression gradient boosting models. Accuracies were nearly around 65% ±0.1%. Yet it is concluded that changing the features may also decrease the accuracy. Hence the importance of some features is significant i.e., shot type. Also, good quality data affects the overall performance. Furthermore, deep NN can play a vital role in good shot selection and the accuracies can speak up. Moreover, large data can help and predict better results as it spans over the whole season or even multiple seasons. Here NBA (higher quality league) dataset is being used to run the algorithm. First B Serbia's Men Basketball league dataset of 890 games comprising the 5 seasons from 2005- 2010 is being used by [2] to run the feedforward NN for the analysis of nonlinear sports data. Several analysis are being on the dataset where shooting from different field positions and basic basketball parameters for winning are the most contributed. 11 divisions of the field positions are being analyzed including 6 two-point and 5 three-point positions and the results show that two-point shots are the most important analysis element among all. Moreover, both offensive and defensive approaches are being analyzed, concluded on the fact that it is crucial to winning a game under the hoop. Despite the BSV real-time program, more data and some new software could be a contribution to the future in this

 DOI: https://doi.org/10.33897/fujeas.v2i1.420

regard. SVM is considered a powerful classification algorithm, but as it has no rule generation capability, thus having a limitation. A hybrid FSVM is introduced by [3] that not only includes the quality of classification but also generates rules for decision making using the fuzzy approach. Hence is used to better predict the win and loss outcomes as compared to SVM alone. Furthermore, the work can be extended to predict the win and loss scores, not only for basketball but for some other sports too. Shooting Prediction for NBA: a comparative study of Random Forest XGBoost is conducted using the 203591 shots of the 2014-2015 regular season. XGBoost has the highest accuracy as compared to the Random Forest (RF) but RF is a good classifier too [4]. Theoretical/Mathematical Prediction of shoots under various circumstances is presented and compared with actual/ observed NBA datasets [5]. Two phased DEA (Data Envelopment Analysis)-MLA approach using multiple input multiple outputs is presented in [6] using guard position of 26 players' data. Their efficiency frontier is calculated using NN, linear regression, and SVM, the former one has an error rate of < 1% while the latter except for SVM has an error rate < 2%. The ranking is done through Andersen Petersen's model. Further, the work can be extended using the Distance Based Analysis (DBA) and its comparison with DEA, for the new player prediction too. In [7] the data-driven defensive strategy learning including the analytical and classification model is narrated. The former has the one-on-one relationship of players, while the latter is against the pick-and-roll play. The technique presented is the spatiotemporal pattern recognition; and classification is done for two defensive and one offensive technique. Classifiers being used are SVM, DT, and KNN; amongst all SVM is the best having accuracy of 68.9%. Further, the work can be extended using the alternative methods of labeling instead of the analytical method being widely used. The group learning approach for basketball players' prediction is introduced in [8] using the Mixture of Finite Mixtures model. The process being used is Log Gaussian Cox Process (LGCP) and the algorithm is Markov Chain Monte Carlo (MCMC). The study estimated the groups' number and their configuration along with the qualitative summary of shots played by various players. Data being used is NBA 2017-2018. Further, the work can be extended using a unified approach despite the two-stage grouping, and secondly, the auxiliary information can also be incorporated. Imitation learning method implementation using RNN for soccer is presented in [9] using the top-tier soccer league data (2019). Contributions made so far include the method application on movement traces of soccer, accuracy check, and influence of single to relative behavior. Further, the work can be extended for the multi-agent Intelligent ML framework using Naïve Bayes, ANN, and DT for predicting the results of the game played and are then compared with the previous data. Defensive rebounds (DRB) are the most significant feature of all. Also, Three-Point Percentage (TPP), Free Throws (FT), and Total Rebound (TRB) ensure 2-4% accuracy improvement [10]. Analysis was conducted of NBA player and shot prediction using Random Forest and Xgboost [19].Data being analysed by various analysts using various machine learning techniques, such as; identification of the basketball strategy using player tracking data [4], use of LSTM for Multi-Modal Trajectory prediction of NBA player [11], use of neural network for selection of Most Valued Player of NBA [12], predicting the NBA game results using ANN and decision tree [14],], use of mixture density network and bidirectional LSTM for basketball trajectory prediction [15], and classification of the NBA offensive plays using neural network [15]. But to the best of our knowledge, there isn't any study presented on Kobe Bryant shot prediction dataset; by the transformation of the categorical features and comparing the results of ensemble, traditional and neural network methods on this dataset.

3.Proposed Methodology

In our work we downloaded the Kobe shots data set from Kaggle. We first performed pre-processing on this data and then passed the processed data to machine learning techniques. The machine learning techniques classified whether he made the shot or not. We evaluated the performance of these method using different evaluation metrics. Figure1 shows the workflow of our proposed work. The implementation was performed using python language and Jupyter notebook as a development tool.

3.1.Dataset

Dataset contains more than 30000 data values and 25 columns in which SHOT_MADE_FLAG is the class label; Dataset have missing values and categorical columns to handle, therefore, after handling the missing values and categorical data we finally got 90 columns and 26000 data values. (For categorical we have used One Hot Encoder and for missing values we simply discard them. Detailed sample of the dataset and class distribution bar chart are shown in Figure 2 and 3 respectively.

3.2.Pre-processing

We removed the missing value's row from this dataset and converted the categorical columns into discrete by applying one hot encoding method. In our data set we have some categorical features. We applied one hot encoding

We removed the missing value's row from this dataset and converted the categorical columns into discrete by applying one hot encoding method. In our data set we have some categorical features. We applied one hot

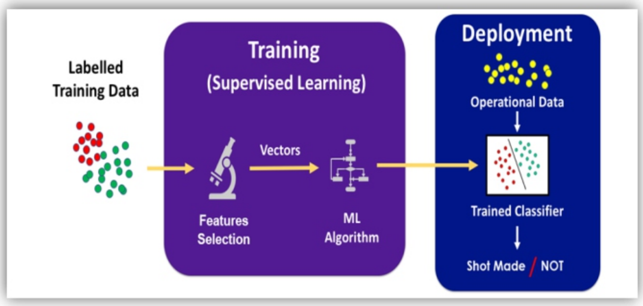

Fig. 1. Workflow diagram

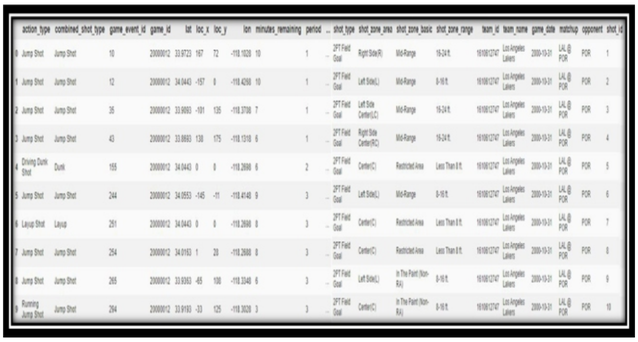

Fig. 2. Kobe shot selection dataset

```
from sklearn.linear_model import LogisticRegression
from sklearn import metrics
from sklearn.metrics import confusion_matrix
LR = LogisticRegression(C=0.01,
solver='lbfgs').fit(X_train,y_train)
yhat = LR.predict(X_test)
print("Accuracy: ",
metrics.accuracy_score(y_test, yhat))
print (classification_report(y_test, yhat))
print(LR.coef_)
```

Fig. 3. Code Script

Dataset Split

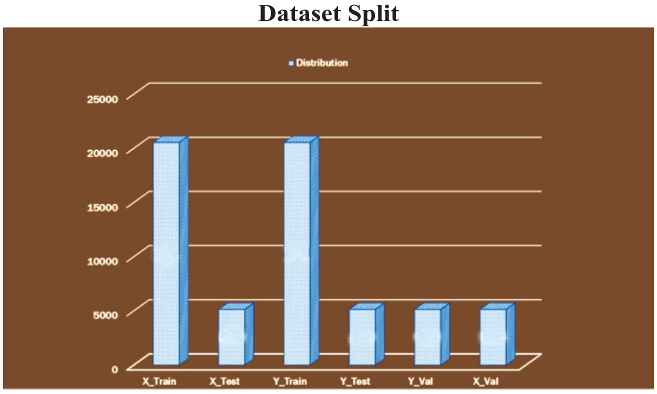

Fig. 4. Train Test Split distribution

3.3. Machine Learning Method

It is a supervised learning model used for classification. It works very well when we have small dataset and have a binary class variable. Logistic regression has a coefficient for each attribute and intercept or bias. These are the parameter of logistic regression. We calculated the weighted sum by multiplying the coefficient with attribute value and added in bias. Then weighted sum was passed to the activation function (for-example; sigmoid) and the output is produced. In our work, we gave scaled data to logistic regression, and it predicted the respected class by the above procedure. Code snippet for shot selection prediction using logistic regression is as follows:

3.3.2 Random Forest

It is an ensemble learning classifier and is used for classification as well as regression models. It constructs multiple trees of decision trees and output the class that is the mode of classes. The random forest has certain hyper-parameters that require tuning for predicting accurate results. We trained Random Forest to predict shot on the parameters given in Table 1.

Hyper parameter name	Values
Bootstrap	True
Criterion	Gini
min_samples_split	2
n_estimators	50
random_state	None
max_features	Auto
min_samples_leaf	1

Table 1 Random Forest Parameter

```
from sklearn.metrics import confusion_matrix
from sklearn.metrics import classification_report
from sklearn.ensemble import
RandomForestClassifier
clf=RandomForestClassifier(n_estimators=50)
clf.fit(X_train,y_train)
yhat4=clf.predict(X_test)
print("Accuracy:",metrics.accuracy_score(y_test,
yhat4))
print("Confusion Matrix:")
print(confusion_matrix(y_test, yhat4))
print("Classification Report")
print(classification_report(y_test, yhat4))
```

Fig. 5. Script

3.3.3 Linear Discriminant Analysis (LDA):

LDA is a technique for dimensionality reduction, and it can also be used for classification problems. In our work, we used LDA to predict shot prediction that estimates the probability of a new instance belonging to each class. Output class is the one with the highest probability. We used solver parameter as svd, Shrinkage as auto.

3.3.4 Naïve bayes:

Bayes theorem is the basis of this classification algorithm. It assumes that particular feature's presence in a class, has nothing to do with any other feature's presence. It is particularly good and performs well on a large dataset.

3.3.5 Gradient Boosting (GB):

GB is a machine learning classifier that creates a strong predictive model by combining many weak learning models. The decision tree is mostly used as a weak learner. It has three main elements: Loss function, Weak Learner, and additive model.

3.3.6 Adaptive boosting (Adaboost):

Adaboost is an ensemble boosting classifier that increases the accuracy of classifiers by combining multiple classifiers. It is a meta-algorithm and may be used at the side of many different gaining knowledge of algorithms to enhance its performance. It is miles bendy within the sense that the construction of subsequent phases is about apart to allow for one's situations divided into preceding phases. Touchy to noisy and outside facts. Adaboost is an algorithm for building "stable" divisions as a linear thing of the "simple" "susceptible" category, very last divisions primarily based on the average vote of susceptible dividers, flexible electricity as opposed to repetition, uses training to reset weight each education sample makes use of weight to determine opportunities.

3.3.7 Artificial Neural Network

Machine learning algorithm Neural Network remains one of the best and most used in the past decade and we considered it for this problem. We have proposed that we will use an artificial neural network with few deep hidden layers. Figure 4 clearly explain the structure of our MLP model. After pre-processing of dataset we have 90 features and 25000 rows and our model has 90 neurons as input. So, the model is now having sequence of layers explained below: Input 90 neurons 64 64 32 8 1 Input and hidden layers have activation function RELU, and the Final output layer has activation of the SIGMOID function.

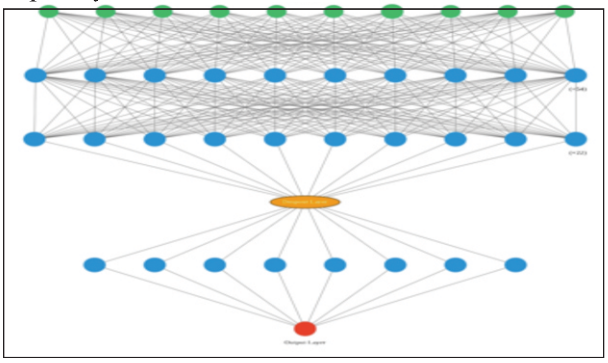

Fig. 6. The architecture of ANN for Shot Prediction

Method	Accuracy	Precision	Recall	F1
Logistic regression	**67.84%**	**69%**	**68%**	**67%**
Random Forest	64.22%	64%	64%	64%
LDA	67.82%	69%	68%	66%
Naïve bayes	0.61%	0.73%	0.57%	0.51%
GB	0.678%	0.69%	0.66%	0.66%
Adaboost	0.68%	0.69%	0.66%	0.66%

Table 2. Results comparison of machine learning method withhold and out for shot prediction

4.Results And Discussion

We perform the comparison between different machine learning techniques to predict whether a shot is made or not. Logistic regression, Random Forest, Linear Discriminant Analysis, Naïve Bayes, Gradient Boosting, Artificial Neural network, and Adaboost are applied using hold an out and 5-fold cross-validation. Table2 shows the results of the hold an out method for shot prediction. Logistic regression has the highest F measure as compared to other methods using the hold an out method. Table2 shows the results of the 5-fold cross-validation method for shot prediction. Adaboost has the highest prediction accuracy as compared to other methods using 5-fold cross-validation. The overall performance of AdaBoost is highest with hold an out and 5 cross-validations. Prediction results of machine learning techniques using hold an out method.We apply machine learning techniques for shots prediction using the hold an out and cross-validation method. Table2 shows that Logistic regression has the highest F score as compared to other methods. Figure 6 shows the accuracy and Figure 7 shows the F1 score of LR, RF and LDA, GB, ABC, and NB on Kaggle Kobe Braynt shots dataset and compare the Prediction results of machine learning techniques using hold an out method.We apply machine learning techniques for shots prediction using the hold an out and cross-validation method. Table2 shows that Logistic regression has the highest F score as compared to other methods. Figure 6 shows the accuracy and Figure 7 shows the F1 score of LR, RF and LDA, GB, ABC, and NB on Kaggle Kobe Braynt shots dataset and compare the performance of these classifiers on this dataset. The experimental results showed that LDA performs very well in term of F measure as compared to LR, RF, GB, ABC, and NB. The performance of NB is low as compared to LR, RF and LDA, GB, ABC, and NB. Figure 8 shows the loss graph of the neural network for shot prediction.

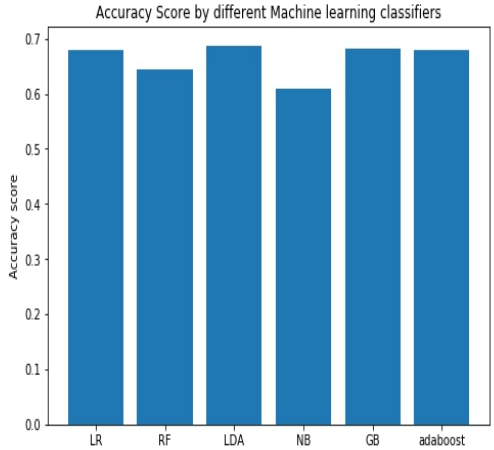

Fig. 7. Accuracy graph of Machine Learning method

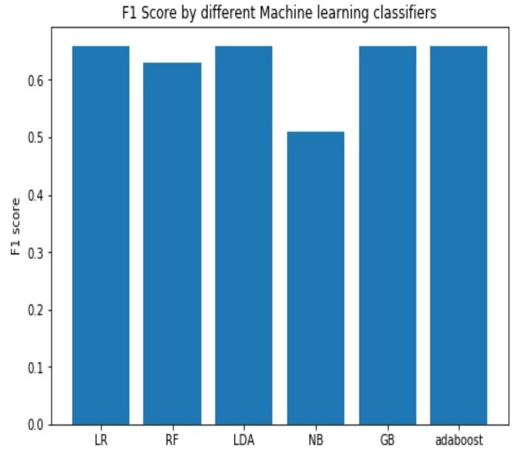

Fig. 8. F1 score graph of Machine Learning method

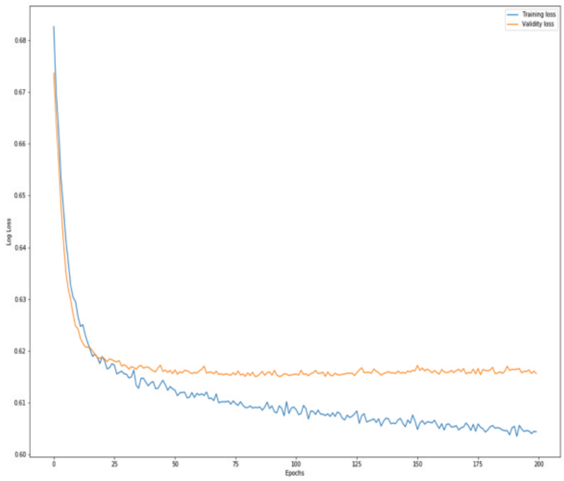

Fig. 9. Training and validation graph of neural network for shot prediction

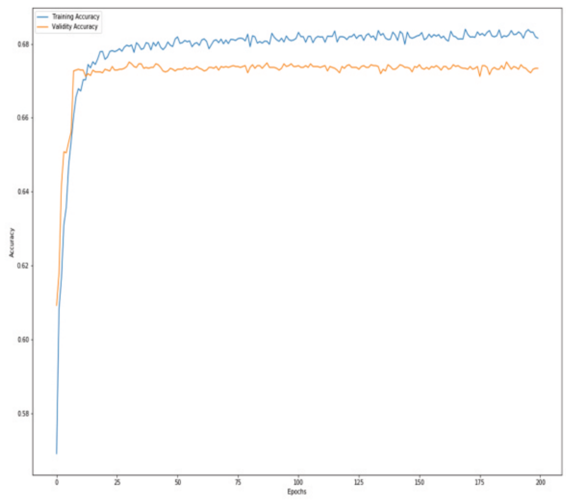

Fig. 10.training and validation accuracy of neural network for shots prediction

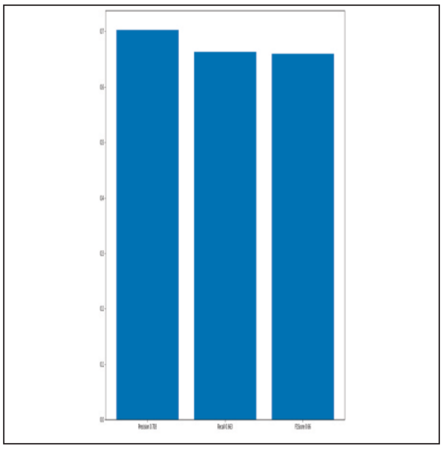

Fig. 11. Precision and recall of neural network for shots prediction

Method	Accuracy
LDA	0.68%
RF	0.657%
Adaboost	0.681%
GB	0.681%
Naïve bayes	0.62%
LR	0.59%

Table 3. Results comparison of machine learning method with 5-fold cross validation for shot prediction

Prediction results of machine learning techniques using 5 fold cross-validation Table3 shows the results of LR, RF and LDA, GB, ABC, and NB using 5-fold cross-validation. Adaboost achieved the highest accuracy as compared to other methods. In our experiment, we concluded that by using cross-validation the result of all methods increases as compared to the hold an out method. The results of our method improved because when we used cross-validation in our case. We have taken the 5-fold of data and 5 different distributions of data. We trained and evaluated a complete model on each fold. Finally, the averaged result of all folds is presented.

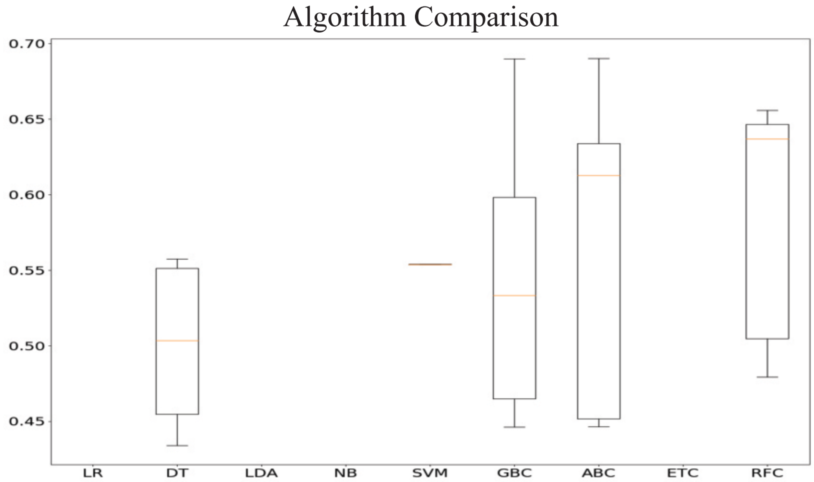

Fig. 12. Accuracy performance comparison using boxplot

5.Conclusion

Predicting games and players performance using Machine Learning is still used and highly recommended. In our work we applied Logistic Regression, Random Forest, Linear Discriminant Analysis, Naïve bayes, Gradient Boosting, Adaboost and Neural Network on Kaggle dataset. We applied these models using hold an out and 5-fold cross validation to predict whether Kobe made the shot or not. The experimental results shows that Adaboost performs best as compared to other methods with both hold an out and 5-fold cross validation. So in conclusion, we understood from the results that the data is truly random, because in most examples with exact same features Kobe had Made and Not Made shots, so getting better results from a random data is quite difficult but still if this dataset trained by a good Deep learning model maybe it will give better results. In the future, we can select relevant features from given features by applying the mutual information feature selection technique. The Voting Ensemble method can also be applied to selected features to improve the results.

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Foundation University Journal of Engineering & Applied Sciences
Vol. 2, Issue. 1. June 2021

Research Article

A Novel Software Layer to Program Arduino over the Air using Bluetooth

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Abstract:

Programming over the air (POTA) is commonly used to update the firmware and configuration of a wireless sensor node without any physical contact with the node. Here we designed a four-wheel student development kit for the remote-controlled car via Bluetooth HC-05 module that was programmed using over the air (OTA). Bluetooth HC-05 module only supports universal asynchronous receive transmits (UART) traffic to communicate with connected slave devices. To implement POTA for robotic cars an additional software layer was written for the HC-05 module and this software layer makes HC-05 able to program Arduino pro mini over serial communication. The written software transfers data over the Bluetooth link to the slave hardware to program Arduino pro mini. This work can be utilized in the swarm of robotics network in which firmware consistently need to update to adapt the surrounding. It can also be utilized in the localization of robots in the indoor environment and similarly can be utilized for student training. Here we designed a four-wheel student development kit for the remote-controlled car via Bluetooth HC-05 module that was programmed using over the air (OTA).

Keywords:Programming over the air; Arduino; Microcontroller

1.Introduction

AI is depicted in the real world in films full of passion and fantasy[1]. When it comes to developing artificial intelligence in today's world, the task is becoming increasingly difficult to accomplish. In the military, space exploration, medicine, and other fields, artificial intelligence (AI) have already been developed or implemented. Viewers can confidently predict that an IA will be developed soon and that a complex machine will soon decide the fate of humanity in light of the cult films "The Matrix," "Terminator," and "I, Robot." What if I'm wrong about this? Do you think it's theoretically possible to create artificial intelligence, and how long do you think you'll have to wait? Using the term "artificial intelligence" to describe what we are talking about is a bit misleading. Microchips are not built into most products today, except light bulbs, and manufacturers of virtually everything go to great lengths to convince us that their products contain artificial intelligence [2] (AI). Simply put, artificial intelligence (AI) copies the human behavior line on an artificially created object to achieve a variety of goals, such as lowering costs and saving time [3], which is the general thinking of mankind about its creation. As you assert [2,3], artificial intelligence will partially or completely replace humans in various fields (astronautics, work specialties, organically inspired communication, and so forth). Apart from that, artificial intelligence (AI) will assist a person in performing tasks that they are incapable of performing themselves (complex analysis and calculations) and increasing their overall intelligence. Starting with the fundamentals [4] will help us see the big picture. Environment, so in such cases, the concept of POTA has a great significance. The significant advantage of POTA is listed below.

1. In critical applications such as electrical metering where downtime is very important, OTA allows us to recover the issues quickly.
2. Enables us to remotely upgrade a system, without having any physical access to the system.
3. Overall its time saving, as in the training phase we often want to reprogram the node.
4. Initially and originally it is used to update firmware for mobile handsets.
5. Update new program in few seconds, due to high uploading speeds.

Due to the advantages offered by the POTA, it has a wide area of applications. POTA was initially developed to allow device manufacturers and network operators to deliver updated firmware for mobile handsets, the growing new concepts of M2M, IOT [6], WSN, use the POTA technology in the same way and it reduces half of their complexity. POTA is a fundamental requirement and servicing technique in the emerging field of wireless sensor networks where both maintenance and management are challenging tasks.POTA is also utilized for one or more mobile devices which are reprogrammed over the air using dedicated control channels. In [7] the authors proposed a method to reprogram a mobile device using a broadcast control channel. The mobile device is configured to accept or reject currently approved channels. In [8,13] author uses POTA to program and update a dual-satellite emergency

 DOI: https://doi.org/10.33897/fujeas.v2i1.458

locator beacon. In [9,11,12] media access control (MAC) address was associated with the device using the MAC address server. While in the production line the device connects to a wireless network, MAC server when detects this connection it determines the available MAC addresses and communicates the MAC address to the device over the wireless network. This address acts as a source address that the device will utilize in the future for further communication sessions. In WSN performing OTAP requires many challenges like flexibility, reliability, and security. This is because when these network nodes are deployed in remote areas they might be reprogrammed to update their firmware. But the environment can make it impossible to reprogram those nodes. So only possibility to reprogram those nodes is to use POTA, but using POTA rises a challenge of security. In [10] authors proposed a cybersecurity protocol to help WSN with proper communication and authentication. So by investigating these design challenges up to the present and keeping in mind the advantages of POTA in sensor networks we implement it in the field of robotics and wireless sensor networks, as in the case of robotics it is often necessary for a beginner to reprogram it as many times while not achieving the desired results. As it is not agreeable to take back the robot from the arena for just the purpose of reprogramming. Similarly, in the case of WSN, a node is usually fixed in a particular location to sense its surroundings and sending back the data to the server-side. To make the sensor node adaptable to surroundings, the firmware needs to be updated so to get good results from the sensor node in robotics it is usually required to reprogram it several times to achieve desired results. So the concept of POTA fits properly in our situations and reduces the overall efforts so we use it.

2.Proposed System

Figure 1 shows the hardware module that was programmed using POTA. As shown in figure 1 the proposed system consist of mainly two parts, one is Arduino pro mini and a pair of HC-05 Bluetooth modules. The other components on the boards are the voltage regulator and ultrasonic sensor used for additional functionalities. The connection between Arduino pro mini and Bluetooth module HC-05 is shown in figure 2 below. To program serially we had to push that reset button before sending configuration setting over bluetooth channel. On the other end the second pair of HC-05 is connected to computer. These devices are paired using standard bluetooth communication and after successful communication same bluetooth which is connected to Arduino pro mini is utilized to program controller unit.

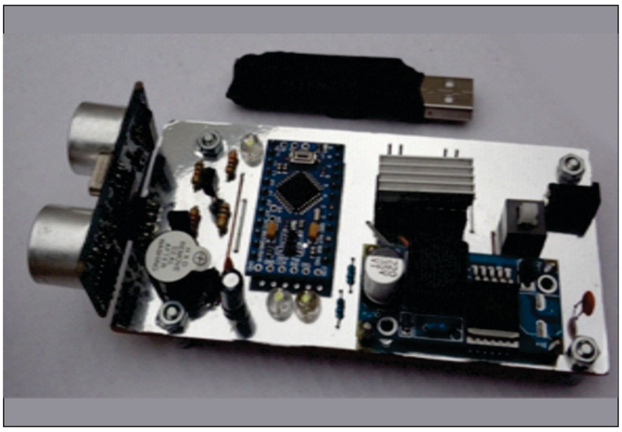

Fig. 1. Hardware module for robotic car

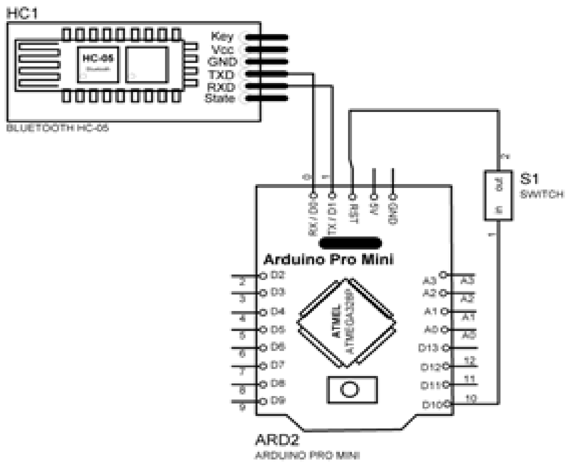

Fig. 2. HC-05 connection with Arduino pro mini

3.Results And Discussions:

This section consists of three parts

1. Hardware
2. Software
3. Experiments

3.1.Hardware

As we know a special programmer is required to program a microcontroller, but after the development of the Arduino board, it was made possible to program a controller using standard universal asynchronous receive transmit (UART). To program a microcontroller via UART we require a bootloader and bootloader is a piece of code that was used to program flash memory of the microcontroller via serial or USB instead of utilizing a special programmer device. Therefore if a bootloader is burned on the chip there is no need for the external programmer, the same idea is implemented for Arduino pro mini as no onboard programmer is available for this kit. To use Arduino

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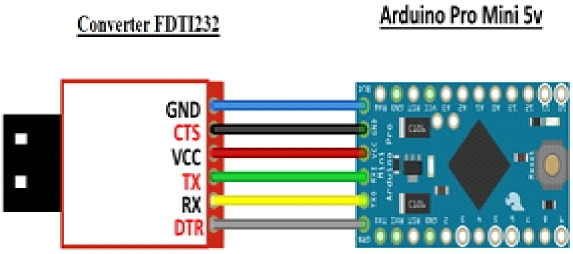

Fig. 3. Arduino pro mini UART programmer

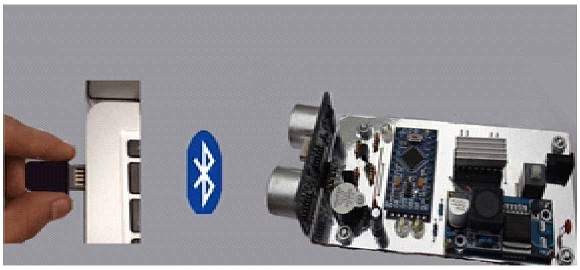

Fig. 4. POTA Hardware Interface

3.2.Software

The software was written in C#, the main purpose of writing this software is to reduce the overall complexity, as we open the software and click the upload button it automatically send the reset command to the Arduino and immediately after trigger the Arduino IDE to upload the code. Figure 5 shows the developed software interface Here the software is programmed and designed in such a way that if specific characters are sent to the Arduino pro it reset itself as it reset itself we immediately upload the code. The software can only be used when the Bluetooth dongle is attached to the computer, otherwise, you are unable to use it, when the software is initiated firstly it checks for the Bluetooth dongle if it is attached then it opens up, otherwise, it quits itself. The uploading speed that is predefined in the bootloader is 57600 bit/sec, it is reasonable enough to upload the code just in few seconds, there was an LED attached with the UART communication pins that blink and provide us the status of the uploading process. The whole working flow is as follow,

1. Connect the Bluetooth to the computer, open the Arduino IDE and write your code and finally verify it,
2. After verifying the code open the POTA software, and make sure the Arduino kit is powered on, and also that the Bluetooth is paired.
3. Now click the upload button of the software, and wait for a few seconds and you will see the uploading done message on the status bar of Arduino IDE.

For security enhancement, the master Bluetooth module only pairs with that specific slave, so that a non-authorized person may not be able to hijack the whole system, as well as on the other side the specific reset command is hidden inside the code of the software so no one can harm the system in anyways.

3.3.Experiment

The proposed system has the ability to wirelessly program the Arduino over the Bluetooth. To test this feature a robot kit is designed as shown in the figure 5. The four wheel drive robot kit as shown includes Arduino pro mini, an ultrasonic sensor, H-Bridge, Bluetooth module, and LEDs as status indicators, the Bluetooth chip is mounted on the back side of the PCB, and this is shown in figure 6. Finally, we power it and connect the Bluetooth dongle to the computer to link them. As the LED turns on giving us the status that the connection is established, so it is ready to be programmed. After that, we opened the Arduino IDE and write a basic starter code for a kit, and after verifying the code is uploaded using POTA software. We just click the upload button and after few seconds the code is successfully uploaded to the Arduino. After successfully uploading the code we click on arrow keys to move the robot.

 DOI: https://doi.org/10.33897/fujeas.v2i1.458

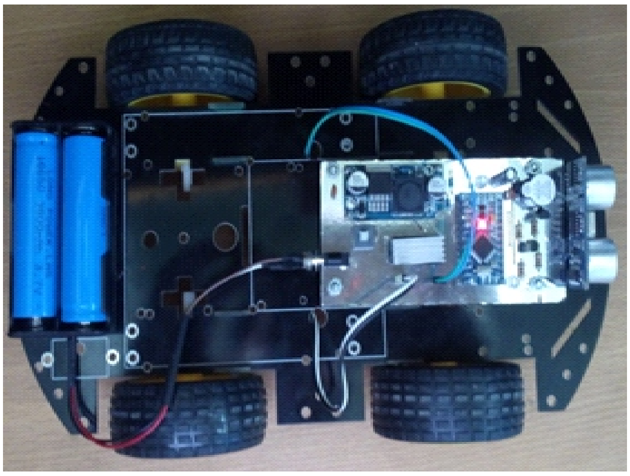

Fig. 5. Four wheel drive Robot kit

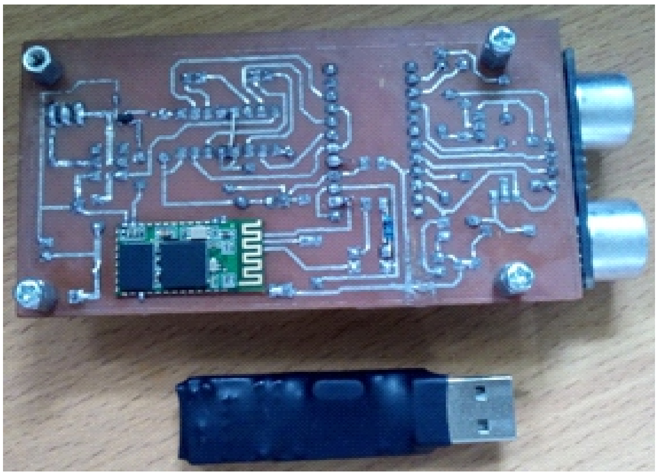

Fig. 6. Back side of four wheel drive PCB with USB dongle

4.Conclusions

This paper presents a method to program Arduino pro mini over the air without any physical interface with the system. This work can be utilized in the swarm of robotics network in which firmware consistently need to update to adapt the surrounding. It can also be utilized in the localization of robots in the indoor environment and similarly can be utilized for student training. Here we designed a four-wheel student development kit for the remote-controlled car via Bluetooth HC-05 module that was programmed using over the air (OTA). Bluetooth HC-05 module only supports universal asynchronous receive transmits (UART) traffic to communicate with connected slave devices. To implement POTA for robotic cars an additional software layer was written for the HC-05 module and this software layer makes HC-05 able to program Arduino pro mini over serial communication. The written software transfers data over the Bluetooth link to the slave hardware to program Arduino pro mini. This kit is optimized in design and can be utilized to teach students about remote control cars.

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Foundation University Journal of Engineering & Applied Sciences
Vol. 2, Issue. 1. June 2021

Research Article

Statistical Analysis of Cricket Leagues Using Principal Component Analysis

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Abstract:

Any sport has statistics and cricket is one of the sports where statistics are significantly important because, based on these statistics, players are ranked. These statistics include individual runs, wickets, and highest scores, etc. Based on statistics, players are selected for any tournament around the world. This research uses Principal Component Analysis by evaluating cricket facts and figures. This analysis tests the precise co-variation among different measurements relating to the batting and bowling abilities of players in the Pakistan Super League PSL T-20 (2016-2019) and IPL T-20 (2016-2019) utilizing the progressed factual system Principal Component Analysis. PCA is applied in this study to rank the PSL batsmen and bowlers based on their contributions to their clubs during these competitive seasons. The results of this research revealed the top ten ranked batters and bowlers who excelled during the series. Principal Component Analysis is widely used in applied multivariate data analysis. In the current investigation, PCA was utilized to rank the top ten best-performing batsmen and bowlers of the PSL and IPL. Principal Component Analysis is a dimension reduction technique that is used to reduce dataset dimensions into smaller variables. Here, principal component analysis is successfully used to rank the cricket batsmen and bowlers. We can presume that batting ability rules over bowling capacity. This exploration is the first report in Pakistan that features the highlights of the PSL and IPL Mathematics Subject Classification (2010) 62H25, 62H86, 62J10.

Keywords: PSL; IPL; PCA; Sports Analysis

1.Introduction

Cricket is a game in which each team has eleven players and it is a bat and ball game between two teams. There is a pitch at the center of which is 20 meters long with a wicket at each end. Each wicket has a bail on it. The batsmen score runs by striking the ball bowled by the bowler, and the bowlers try to take wickets by hitting the ball to the wickets. There are other possible ways to take wickets, such as being caught out by any fielder on the ground when batsmen hit a ball or being stumped out by the keeper behind the batsmen, or by hitting a wicket when batsmen hit their bat to the wicket. Similarly, batsmen score runs by hitting boundaries or by running runs. When ten players are dismissed by the bowling side, the innings of one team that's batting ends, and the bowling team sends their batsman to bat. The first batting team's target is now being chased by the second batting team. Based on the chase or dismissed by the bowling team, win and loss are decided. The game is supervised by two umpires, aided by a third umpire, usually called the TV Umpire, and a match referee in international matches. They communicate with two off-field scorers who record the match's statistical information. This game is currently in three formats. (1).Test-In with 5 days for play and no limits of overs. (2).Twenty-Twenty in which each team plays 20 overs. (3). ODI- One Day International in which 50 cricket players between two teams. Over the last 8 to 10 years, twenty-twenty of international games have gained popularity and audiences are very involved in these limited-overs games as if they finish within 2 hours. Twenty 20 cricket was showcased in 2003 and involved matches between English and Welsh domestic sides "[1]. The T20 cricket format was financially effective and spectators delighted in a shorter variant of the game. In this era, everybody knows about cricket, but for those not aware of this sport, read [2]. These leagues come up with many highly skilled players from all over the world. In our study, IPL and PSL players are from approximately 11 different countries, mostly from Asia and Europe. Based on this data, we quantified the performance through PCA. This research aims to find the rankings of PSL and IPL league bowlers and batsmen using PCA for the last four seasons (2016-2019). From this, we can identify the top batsmen and bowlers in the PSL and IPL competitions to evaluate the batting capabilities over bowling capabilities in the PSL and IPL.

2.Literature Review

In literature, many authors have worked on these types of analysis, but for unique single cricket seasons, some use graphical approaches. Bowling and batting performance comparison is conducted in a graphical methodology by [3]. Furthermore, this investigation can be used to differentiate dissimilar groups of players, for instance, aggressive batsmen, bowling all-rounders, spinners, and other groups. But graphical approaches are not accurate and there is a gap in introducing other techniques for statistical analysis. For selection and comparison[4] suggest a

 DOI: https://doi.org/10.33897/fujeas.v2i1.451

numerical approach through this approach to picking batsmen in the team. [5] Presents a mockup approach for the order of batsmen and batting in one-day cricket. This work was furthermore loosened up by [6]. He created a model which can simulate one-day cricket. For various components of cricket, for instance, player's selection for the team, some advanced logical techniques, including entire number programming and data envelopment assessment, have been used in the composition (see Sharp et al., 2011, Lemmer [7]. '[8] Factor examination just on world T20 data. [9]"A Study on Performance of Cricket Players using Factor Analysis Approach on IPL 9".[9] Purposed situating of captain subject to a couple of parameters using Principal Component Analysis [10] used factor examination of just IPL Players.[11]used progressive head section-based computation for perfect lineup and batting demand assurance in one-day worldwide cricket for Bangladesh. In the wake of looking at composing experts have achieved this work on IPL and World T20, which exhibits that there is an opening for which is filled by giving Asian T20 affiliation Analysis driven by the country boards. For instance, [12]Valadkhani et al. (2008) used a factor assessment approach for worldwide portfolio extension According to the author's research, no one has made arrangements with Asian leagues like PSL and IPL for the last four seasons, and analysis was performed most likely on the PSL. The limited composition of various parts of cricket demonstrates a strong need to improve cricket composition. Statistical Method was used to rank captains based on numerous factors. The weighted average approach was also used to rank captains based on the z score of the team's performance, as well as the captain's performance as a batsman and bowler[13]. During the match, the multiple linear regression model is also used to predict the match outcome[14]. A comparative study of machine-learning methods was applied to predict cricket match outcomes using the opinions of crowds on social networks[15]. The rest of the paper is organized as follows Section III describes the Empirical Statistical Methodology employed in this paper. Section IV Steps Involved in PCA Section V Describes Data and Statistical Analysis and Section VI Introduction to IPL, Section VII Introduction to PSL, Section VIII with Concluding remarks.

3.Empirical Statistical Methodology

PCA is the multivariate data analysis technique devised by Pearson [16] and [17]. This technique uses mathematical principles to convert correlated variables into a smaller number of variables named Principal components. The PCA technique involves the extraction of statics from a dataset and keeping the important statistical information. PCA performs compression, simplifies the data dimensions and, reduces the dimensions of data. PCA is significant because if we perform the elimination of variables, it may cause information loss, but PCA performs extraction which can retain important information and without much loss of information, our dataset represents a more clear view of information. PCA is a technique used for correlated data and it reduces the variables. We aim to break up the set of correlated variables into a smaller number of uncorrelated variables as a linear combination of actual variables [18]. For more information about "Principal Component Analysis Johnson and Wichern (2007)" [19], and [20] are described in detail. In this study, a brief introduction to PCA is presented. PCA is used to the covariance through a set of original variables and reduce set of variables. It is a technique used for dimensionality reduction. PCA is useful when our dataset has some number of useful variables. There has some reasonable redundancy in these variables. Here redundancy refers to variables that are interrelated with one another and in some logic, they measure the similar player performance attribute. PCA's technique reduces these redundant variables to a lesser number also reduces the set of variables and reflects the original variables. Let suppose we have some variables that are correlated to one another PCA reduces the correlated variables and this reduced set is used to provide a sum-up measure of performance. Suppose we have given an arbitrary vector ($\alpha = \alpha_1, \alpha_2, \alpha_3 ... \alpha_p$ consisting of p random variables, having covariance matrix and eigenvalue Eigenvector pairs (μ_1, e_1), (μ_2, e_2), (μ_3, e_3) (μ_p, e_p) where μ_1 μ_2......μ_1 the i^{th} principal component, say Li, is defined as $Li = e^t\alpha = ie_{i1}\alpha_1 + e_{i2}\alpha_2 + ... + e_{ip}\alpha_p$ $for\ i = 1, 2\ p$ where e is the component of Eigenvector e^t it can be shown that PCA is a Linear Combination of original variables. Furthermore, I f we have $Z_i = b^t\alpha = b_{i1}\alpha_1 + b_{i2}\alpha_2 + ... + b_{ip}\alpha_p$ is a linear combination of these actual variables for the first PC $Variable\ (L_1) = \mu_1\ Var\ (Z_i)\ Cov\ (L_i, L_j) = 0$, for i is not equal to j and above three equation gives us the hope that principal component Li can give us the aggregate of the important signals contained in the actual variables α and this can be done without redundancy and provide the mean of each Principal component. Notice the total variability (V_T) $V_T = Var(\alpha_1) + Var(\alpha_2) + ... + Var(\alpha_p)$ (3.1) $V_T = Var(L_1) + Var(L_2) + ... + Var(L_p)$ (3.2) $V_T = \mu_1 + \mu_2 + ... + \mu_p i{=}1$ For the j^{th} principal component, the total percentage of variance is $\mu_j \times\ ^p\mu_i$ if a substantial percentage of the total variance is captured by the first few Principal Component Analysis. Then these reduced sets of new variables are used in place of the actual variable without any loss of information. Firstly, we have to make some adjustments to the variables before performing PCA. If we don't make some adjustments, the results of principal components will not be accurate, and we have variables with extreme variance, which can affect the goal of an overall performance measure. Cricket Data needs fine-tuning. If we do so, the results are accurate and did not affect the goal [21].

4.Steps Involve In Principal Component Analysis

a.Standardization.
b.Co-variance matrix computation.
c.Compute the eigenvectors and eigenvalues of the covariance matrix to identify the principal component.
d.Feature Vector.
e. Replicate the data along with the principal component axes.

5.Data & Statistical Analysis

To demonstrate the proposed model of Principal Component Analysis data is gathered from the ESPN website. For batting analysis, only those player's data is included in our dataset who played at least four innings and for bowling analysis, only those players are included who have bowled at least four overs. After this rule applied to the data set, we have 157 batsmen and 135 bowlers for IPL (2016-2019) and similarly, we have 110 batsmen and 62 bowlers for PSL (2016-2019) are included in our final datasheet.

5.1.Batting Statistics

In this study, we consider eight important measures of batting statistics, such as total runs, highest score, average ball faced, strike rate, number of the 50's, number of 4's and number of 6's. Descriptions of these different parameters of batting performances are given in the table.

No.	Batting Statistics	Description
1	Inning	Total Number of Inning a player played in all season not less than 5.
2	Total Runs (TR)	Sum of all runs in every match
3	Highest Score (HS)	The highest score by a batsman inone match during a tournament
4	Batting Average	The ratio of R/m R denotes Number Runs Score and M denotes
5	Ball Faced (BF)	Total Number of Ball Faced in allseasons and any League
6	Strike Rate	Strike Rate is TR/BF
7	No. of the 50's	Total No. of the 50's
8	No. of 4's	Total No. of 4's
9	No. of 6's	Total number of 6's

Table 1. Batting Statistics

No.	Bowling Statistics	Description
1	Wickets	Total Number of Wickets in Any league
2	Bowling Average	TR/W, where TR is the total runs conceded by a bowler and w is thetotal number of wickets taken by abowler
3	Bowling Economy	TR/O, where TR is the total number of runs conceded by a bowler and O is the total number of overs bowled by bowler
4	Bowler Strike Rate	TB/W, where TB is the total num ber of balls bowled by a bowler and w is the total number of wickets taken by bowler
5	Maiden Overs	Number of Over's which has no run score

Table 2. Batting Statistics

5.2.Batting Statistics

Five measures are taken in Bowling Analysis, e.g. Wickets, Bowling Average, Bowling Economy Rate, Bowling Average, Bowling Strike Rate, and Maidens. Over Sharp et al. (2011) and Lemmer (2011) used three bowling measures, such as the bowler's economy rate, bowling average, and bowling strike rate. Descriptions of these different parameters of bowling performances are given in the table. 2.

6.Introduction to IPL (Season 9-12)

The Indian Premier League (IPL) was introduced by the Board of Control for Cricket in India (BCCI). This league started in the month of April-May and has gained a huge economic and entertainment forum. The IPL is the most-attended cricket league in the world, and in the IPL teams were 9-10 teams participating in the tournament. This team's owner chooses players by auction from the country and a few from other countries. Every team chooses a maximum of four players from foreign countries.

6.1.Empirical Results of IPL

6.1.1. Results of Batting Performance.

For evaluating the batting performance of the players in the IPL, the eight batting parameters: runs, the highest individual score (HS), average batting performance (Ave), strike rate (SR), number of fours (4's), balls faced (BF), number of the fifties (50) and number of sixes (6's) are used. Figure 1 illustrates a matrix plot; it shows that there are noteworthy connections that exist among these measures. Runs and HS, Runs and BF, Runs, and 4s and 6s

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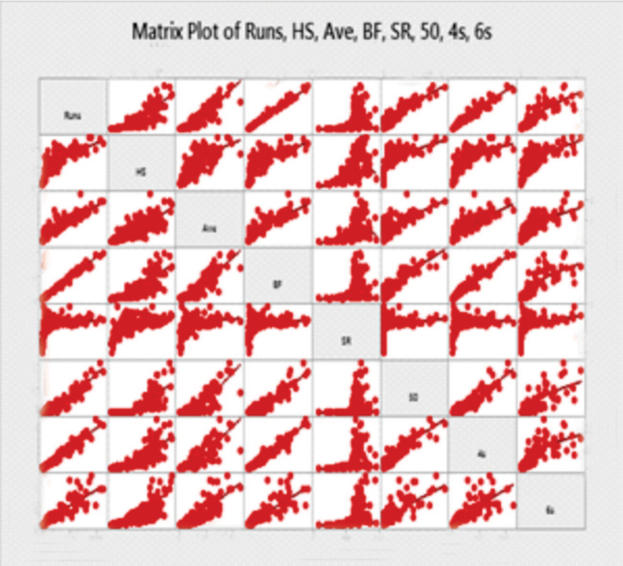

Fig. 1. Matrix plot of eight batting parameters

VAR	RUNS	HS	AVE	BF	SR	50	4s	6s
Runs	1	0.835	0.895	0.993	0.368	0.94	0.976	0.889
HS	0.835	1	0.806	0.822	0.541	0.759	0.816	0.773
Ave	0.895	0.806	1	0.887	0.457	0.81	0.835	0.827
BF	0.993	0.822	0.887	1	0.321	0.93	0.977	0.845
SR	0.368	0.541	0.457	0.321	1	0.296	0.335	0.454
50	0.94	0.759	0.81	0.93	0.296	1	0.936	0.815
4s	0.976	0.816	0.835	0.977	0.335	0.936	1	0.802
6s	0.889	0.773	0.827	0.845	0.454	0.815	0.802	1

Table 3. Sample Correlation Matrix of Batting Statistics

Table 4 shows 80.01 percent and its corresponding Eigenvalue is 6.4014. That is higher than 1 [22] recommends that retain the principal component whose corresponding Eigenvalue is greater than 1. Table 5 below shows the Eigenvector factors for all eight principal components (PC1–PC8). The Eigenvalue Eigenvector pair for the first principal component is shown in Table 5. Figure batting statistics are shown in the scree plot. In the score plot, it is clearly shown at elbow. The point is at 2, which shows that it is used as the first principal component and it explains 80 percent of total variability. Hence, the result for batsmen is shown below:

$$L1 = (0.39 * Runs) + (0.352 * HS) + (0.365 * Ave) + (0.384 * BF) + (0.189 * SR) + (0.368 * 50) + (0.378 * 4s) + (0.358 * 6s)$$

Eigen Values	Total Variability
6.4014	80.0175
0.9039	11.29875
0.2316	2.895
0.2026	2.5325
0.1688	2.11
0.0758	0.9475
0.0145	0.18125
0.0014	0.0175

Table 4. Eigen Values and Corresponding and total Variability

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Runs	0.390	0.138	0.027	0.103	0.014	0.267	0.230	0.833
HS	0.352	0.197	0.544	0.617	0.373	0.147	0.020	0.010
Ave	0.365	0.044	0.227	0.395	0.764	0.211	0.167	0.021
BF	0.384	0.189	0.089	0.089	0.122	0.363	0.627	0.511
SR	0.189	0.906	0.020	0.363	0.074	0.039	0.055	0.012
50	0.368	0.219	0.058	0.445	0.112	0.771	0.077	0.035
4s	0.378	0.180	0.290	0.297	0.011	0.360	0.706	0.155
6s	0.358	0.050	0.746	0.162	0.493	0.072	0.135	0.141

Table 5. Eigen Values and Eigen Vectors for Sample Correlation Matrix Batting Performance IPL

 DOI: https://doi.org/10.33897/fujeas.v2i1.451

6.2. Batting Ranking of IPL

Here, it is referred to as the first principal component, which is the weighted average of all eight variables used. We have seen that the value of the first principal is positive and it is a matter of fact that the higher the value of L1 shows better performance and the lower the value of L1 shows poor performance. This gives us hope of ranking the players based on the first principal component. Table 6 indicates the top 10 batsmen who played at least 4 matches in the IPL (2016-2019) using the first principal component. L1 6 below shows the top ten IPL Batsmen performers. Five bowling measures, such as wickets, bowler's economy rate, bowling average, and bowling strike rate.

6.3. Result of Bowling Performance

Five bowling measures, such as wickets, bowler's economy rate, bowling average, and bowling strike rate, have been used for evaluating the bowling performance of the players in the IPL. The correlation structure of the five "bowling variables" is explained in Table 2. Figure 3 shows the used performance variables in the matrix plot. Average and strike rates are significantly high correlation and other shows below, like maiden over, show negative impact and weaker correlation. However, each one of them shows a different type of bowler. PCA out of 135 bowlers are included from these four seasons and only those are selected that bowl at least four overs. Table 7 shows the sample correlation matrix for the 135 bowling observations. In Table 7, ordered Eigenvalues and their corresponding total variability. While Table 8 shows the factors for all five principal components (PC1 – PC5). The Eigenvalue Eigenvector pair for the first principal component is highlighted in Table 8. The L1 first principal component for bowlers is defined as: $L1 = (Wkt * (-0.461)) + (Ave * 0.553) + (Eco * 0.3) + (SR * 0.519) + (Mnd * (-0.349))$ In Table there total variability in the first entry is 51 percent and Figure shown the scree plot from the scree plot it is clearly shown that the elbow at 2 gives us the first principal component and it is enough evidence for ranking bowler. Its Eigenvalue is 2.5597 and this is the only one that is higher than 1.

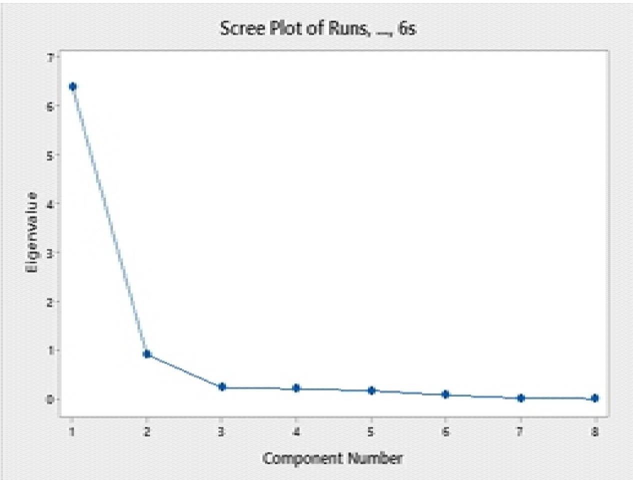

Fig. 2. Scree Plot For Batting Performance IPL

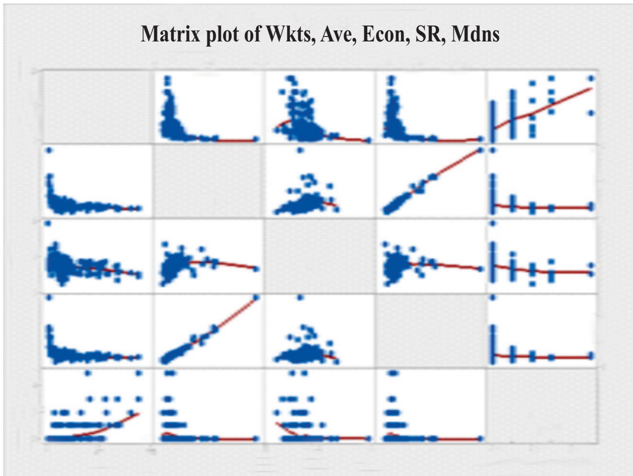

Fig.3. Matrix Plot for five Bowling parameters

Rank	Batsman	Matches	Inns	NO	Runs	HS	Ave	Bf	SR	50	4s	6s	L1
1	V Kohli	54	54	7	2275	113	48.3	1601	142.09	17	204	80	1698.30
2	DA Warma	43	43	8	2181	126	47.01	1493	146.08	21	208	78	1672.29
3	S Dhawan	63	63	9	1998	97	37.08	1552	128.73	16	227	42	1553.92
4	AB de Vilhers	50	49	9	1825	129	128.73	1132	161.21	18	139	109	1336.68
5	SK Raina	61	61	8	1669	84	161.21	1269	131.52	13	172	44	1290.01
6	AM Rahana	59	57	6	1625	105	131.52	1300	125	10	173	32	1285.95
7	RP Pant	54	54	6	1736	128	125	1067	162.69	11	152	94	1270.59
8	KL Rahul	42	40	8	1649	100	162.69	1125	146.57	16	152	73	1270.599
9	RG Sharma	60	59	8	1513	94	146.57	1171	129.20	12	157	47	1241.44
10	SV Samson	55	55	6	1460	102	129.20	1082	134.93	6	110	59	1188.86

Table 6. Top ten Batsmen of IPL Ranked by First Principal Component, L1

Variable	PC1	PC2	PC3	PC4	PC5
Wkts	-0.461	0.333	0.242	0.786	0.001
Ave	0.553	0.398	0.114	0.120	0.713
Econ	0.300	-0.466	0.814	0.123	-0.124
SR	0.519	0.492	-0.032	0.107	-0.690
Maiden Over	-0.349	0.522	0.514	-0.584	-0.005

Table 8 Eigen Values and Eigen Vectors for Sample Correlation Matrix

Variable	Wkts	Ave	Econ	SR	Maiden Over
Wkts	1	-0.425	-0.360	-0.376	0.52
Ave	-0.425	1	0.268	0.982	-0.221
Econ	-0.36	0.286	1	0.099	0.279
SR	0.36	0.982	0.099	1	0.181
Maiden Over	0.52	-0.221	-0.279	-0.181	1

Table 9. Sample Correlation Matrix for Bowling Performance

The L1 first principal component for bowlers is defined as: $L1 = (Wkt \quad (-0.461)) + (Ave \quad 0.553) + (Eco \quad 0.3) + (SR \quad 0.519) + (Mnd \quad (-0.349)$ In Table there total variability in the first entry is 51 percent and Figure shown the scree plot from the scree plot it is clearly shown that the elbow at 2 gives us the first principal component and it is enough evidence for ranking bowler. Its Eigenvalue is 2.5597 and this is the only one that is higher than 1.

Eigen Values	Total Variability
2.5597	51.194
1.2541	25.082
0.7405	14.81
0.4423	8.846
0.0034	0.068

Table 10. Ordered Eigen Values and Corresponding Percentages of Total Variability

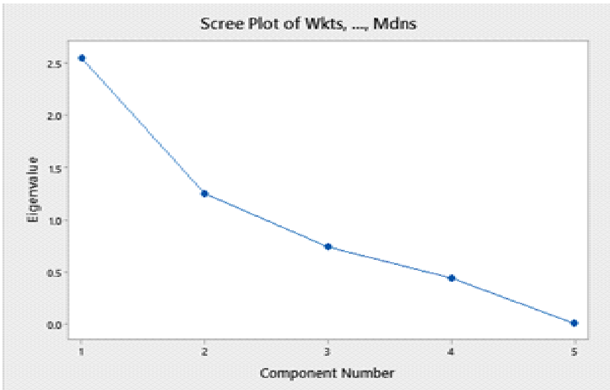

Fig.4. Scree Chart of IPL Bowling

Ranking	Player	Mat	Inn	Overs	Maiden	Wkts	Ave	Econ	SR	L1
1	B Kumar	58	58	223.3	5	71	23.577	7.496	18.870	-9.394
2	JJ Bumrah	60	60	226.6	3	71	22.915	7.180	19.141	-9.013
3	YS Chahal	54	54	191.6	2	65	22.815	7.740	17.686	-6.544
4	Imran Tahir	39	39	147.6	1	55	20.472	7.628	16.101	-3.737
5	Rashid Khan	46	46	182	3	55	21.690	6.554	19.854	-2.135
6	UT Yadav	48	48	164.9	1	55	26.054	8.690	17.989	0.647
7	Sandeep Sharma	50	50	184.4	1	56	25.875	7.857	19.757	0.755
8	MJ McClenaghan	44	44	165.2	1	53	26.735	8.577	18.70	2.282
9	AJ Tye	26	26	99	0	39	21.076	8.303	15.230	4.072
10	K Rabada	18	18	68.2	0	31	17.935	8.152	13.2	4.9238

Table 10. Top Ten Bowlers of IPL Ranked by First Principal Component, L1

Bowling Ranking of IPL

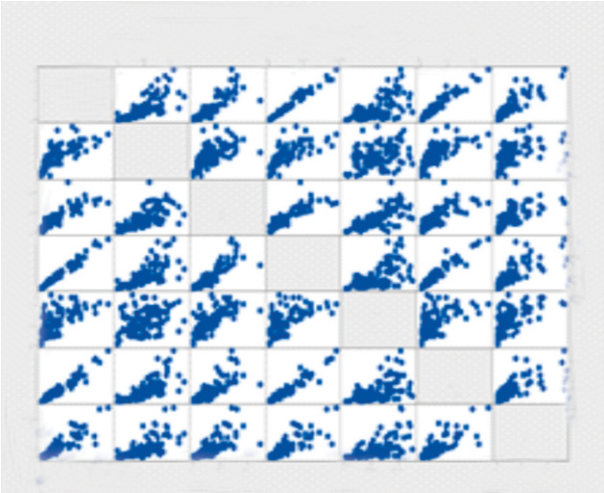

Fig.5. Matrix plots of eight batting parameters of PSL

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
RUMS	1	0.744	0.847	0.986	0.616	0.893	0.968	0.888
HS	0.744	1	0.638	0.719	0.325	0.713	0.741	0.675
AVE	0.847	0.638	1	0.857	0.688	0.687	0.783	0.725
BF	0.986	0.719	0.857	1	0.589	0.885	0.959	0.819
SR	0.616	0.325	0.688	0.589	1	0.402	0.533	0.627
50	0.893	0.713	0.687	0.885	0.402	1	0.927	0.735
4s	0.968	0.741	0.783	0.959	0.533	0.927	1	0.812
6s	0.888	0.675	0.725	0.819	0.627	0.735	0.812	1

Table 11. Sample Correlation Matrix of Batting Performance PSL

Bowling lowers the value of L1 depicts better performance and the higher the value of L1 in bowling Analysis depicts poor performance Based on which bowling ranking is generated. Table 10 shows (IPL 2016-2019) lists the top ten bowlers using the first principal component L1.

7.Introduction To Psl (i To Iv)

The Pakistan Super League (PSL) is a Twenty20 cricket league owned by the Pakistan Cricket Board. It is a commercial professional league similar to IPL and BPL, which started in Sep-2015. This league initially had five teams participating. But with the time now, it comprises six teams. Each team is owned by a franchise. PSL on the world calendar is scheduled for February and March of every year. Each team plays double matches. The first four on the point table qualify for the play-offs and the winner of the play-offs will play the final match. For batting and bowling analysis, a similar strategy is followed as discussed in Table 1 and Table 2. The only difference is we have different players and their data-set is comprised of 110 batsmen and 62 bowlers. From seasons 1 to 4, we have gathered data from the ESPN website. EMPIRICAL RESULTS OF PSL

7.1. Result of Batting Performance

Similarly, in the above, the author applies Principal Component Analysis to eight measures of the Batting dataset, and figure 5 illustrates a matrix plot. It shows that there are noteworthy connections that exist among these measures. Runs and HS We have the following Eigen Values and Eigenvector of the sample co-relation matrix as shown in Table 11. Ordered Eigenvalues and their corresponding percentage total variability are shown in Table 12. Table 12 represents the ordered Eigenvalues and percentage of total variability attributed to each Eigenvalue. This shows that the first PC explains the most variation that is 78.4% against the first Eigenvalue. So, we take the first Principal Component to rank the batsmen. Table 13 shows the eigenvector factors for all eight principal components (PC1 – PC8). The Eigenvalue-eigenvector pair for the first principal component is shown in Table .

Eigen Values	Total Variability
6.2738	78.4127
0.8027	10.0325
0.3572	4.464442
0.2761	3.450819
0.1771	2.213473
0.0799	0.998625
0.0299	0.373703
0.0034	0.042495

Table 12 Eigen Values and Corresponding and total Variability

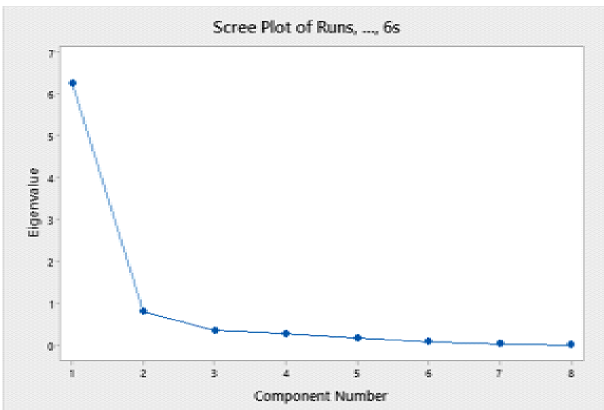

Fig.6. Score Chart of PSL Batting

 DOI: https://doi.org/10.33897/fujeas.v2i1.451

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Runs	0.395	-0.033	0.147	-0.061	-0.110	-0.279	-0.196	0.830
HS	0.315	0.396	0.817	0.054	0.264	0.054	0.043	0.011
Ave	0.351	0.253	0.131	0.649	0.484	0.337	0.161	0.001
BF	0.388	0.047	0.222	0.162	0.086	0.456	0.547	0.507
SR	0.263	0.797	-0.121	-0.086	0.521	0.008	-0.032	-0.015
50	0.357	-0.324	0.382	-0.011	0.381	0.669	-0.169	-0.016
4s	0.384	-0.160	0.261	0.008	0.163	-0.332	0.776	-0.141
6s	0.356	0.096	-0.128	-0.734	-0.484	0.201	0.050	-0.181

Table 13 Eigen Values and Eigen Vectors for Sample Correlation Matrix Batting Performance PSL

	Player	Mat	Inns	NO	Runs	HS	Ave	BF	SR	100	50	0	4s	6s	LI
1	Kamran Akmal	47	46	2	1286	107	28.7375	956	523.27	2	9	8	127	67	1136.14
2	SR Watson	37	37	4	1114	91	33.035	825	534.15	0	7	1	97	65	1003.75
3	Babar Azam	35	34	2	1043	77	27.62	904	407.73	0	9	4	108	18	955.012
4	Ahmed Shehzad	38	36	2	1016	99	31.7325	833	487.95	0	9	3	104	29	948.651
5	Shoaib Malik	39	36	8	849	65	31.63	717	472.83	0	4	2	47	33	800.706
6	Umar Akmal	32	30	5	833	93	37.565	604	518.63	0	7	3	66	42	785.062
7	Mohammad Hafeez	35	33	2	690	77	21.272	605	473.46	0	4	3	69	26	700.711
8	DR Smith	28	25	4	701	73	31.937	611	428.32	0	5	1	67	31	699.365
9	CS Delport	26	25	2	682	117	25.255	519	552.42	1	4	4	66	26	697.796
10	Sarfaraz Ahmed	43	34	10	720	56	30.125	579	496.03	0	3	2	58	14	696.048

Table 14. Top Batsmen of PSL Ranked by First Principal Component Analysis L1

Figure 6 represents the ordered Eigen values in scree plot already discuss in above analysis. Figure 6 shows the Scree plot for the batting statistics, in scree plot line bend at 2 is satisfied that we can use as first PC and it explains 78.4 percent of the total variability:

$$L_1 = (0.395 * Runs) + (0.315 * HS) + (0.351 * Ave) + (0.388 * BF) + (0.263 * SR) + (0.357 * 50) + (0.384 * 4s) + (0.356 * 6s)$$

7.2.Batting Ranking of PSL

We refer to it as the first principal component. It is the average of PC1-PC8. The higher value of L1 indicates better performance and a lower value of L1 leads to poor performance. Based on the highest and lowest value of L1, we rank the players. Table 14 indicates the top 10 batsmen who played at least 4 matches in the PSL (2016-2019) using the first principal component L1. Here is the top ten PSL Bowler's in the Table 15.

7.3.Results of Bowling Performance

As the author applied to the IPL, a similar methodology was applied and here, without going into detail, we will present the final top ten bowlers of the PSL using five performance measures. For a reviewer, the author will provide all the analysis from which the author drives the bowling ranking as L1 is shown in below Table 15.

Ranks	Player	Mat	Inns	Overs	Mdns	Runs	Wkts	Ave	Econ	SR	L1
1	Wahab Riaz	45	44	166.2	0	1130	65	17.38462	6.799037	15.34154	-7.26759
2	Faheem Ashraf	24	24	84.1	1	632	39	16.20513	7.514863	12.93846	2.303702
3	Mohammad Sami	36	36	126.2	1	875	42	20.83333	6.933439	18.02857	6.967331
4	Usman Shinwari	27	26	89.1	0	758	35	21.65714	8.507295	15.27429	9.677215
5	Mohammad Irfan	56	54	187.2	3	1459	51	28.60784	7.793803	22.02353	10.35648
6	Mohammad Nawaz	43	43	150.4	1	1044	43	24.27907	6.941489	20.98605	10.61421
7	Mohammad Amir	37	36	131.5	4	922	39	23.64103	7.011407	20.23077	10.95539
8	Shahid Afridi	37	36	123.4	5	814	35	23.25714	6.596434	21.15429	12.74607
9	Rahat Ali	18	18	65.7	0	498	25	19.92	7.579909	15.768	13.1071
10	Zafar Gohar	10	9	26.2	0	206	13	15.84615	7.862595	12.09231	13.67437

Table 15. Top Ten Bowlers of PSL Ranked by First Principal Component, L1

8.Conclusion And Future Work

Determining a player's performance is an exciting job in any sport. It is especially significant in viable sports like cricket, which is impacted by a player's performance by their runs. Wickets involve many factors. The organization invests a lot of money in these leagues and hopes for advantages. The role of the bowler and batsmen in cricket impacts the result of the match and eventually the profit of the franchise. Here, we have proved by analysis that Principal Component Analysis is useful for correlated, multivariate data. Using IPL and PSL data, we have shown their past individual contributions to their teams and their respective top ten rankings.In the future, we plan to propose a cluster-based prediction for a team. What will be the effect on a team's ranking if a team is moved from one region to another? Similar studies can also be utilized to rank other sports as well. Later, the h-index and PageRank algorithms were extended to rank cricket teams. This statistical analysis can be used for football leagues using different principal component analysis.

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