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Exploratory Study of Artificial Intelligence in Healthcare

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ABSTRACT

The rise of artificial intelligence has brought a positive shift in the sector by providing accurate data-driven decisions. The data from large systems is used for the early detection of chronic illnesses. These illnesses include cancer, diabetes, and cardiovascular diseases, etc. Existing technology is limited in terms of medical diagnosis etc. With the advent of ML/AI in the healthcare system, we expect to see much automation in clinical decision-making. We illustrate popular machine learning algorithms, their applications followed by methodology. This research will focus on the impact of Artificial Intelligence applications on the healthcare sector, its history, challenges, and concerns in the medical field.

BACKGROUND INFORMATION

Fostering trust in AI systems is a tremendous obstacle to bringing the most transformative AI technologies into reality, such as large-scale integration of machine intelligence in medicine. The challenge is to implement guiding ethical principles and aspirations and make the responsible practice of AI accessible, reproducible, and achievable for all who engage with the AI system. Meeting this challenge is critical to ensuring that medical professionals are prepared to correctly leverage AI in their practice and, ultimately, save lives. This research will concentrate on the influence AI applications have on the healthcare sector, its need, and its history in the medical field. Artificial intelligence models will assist doctors in various applications like patient care and administrative operations. (2011, March) Plant, R. et. al.

According to the National Academies of Science, Engineering- diagnostic mistakes lead to roughly 10% of patient fatalities and 6 to 17% of hospital problems. It's crucial to remember that diagnostic errors aren't always caused by poor physician performance. Diagnostic mistakes, according to experts, are caused by a number of causes, including:

- Collaboration and integration of health information technology are inefficient (Health IT)
- Communication breakdowns between physicians, patients, and their families
- A healthcare work system that is designed to be insufficiently supportive of diagnostic procedures.

LITERATURE REVIEW

Machine learning is being increasingly and frequently utilized in the healthcare field in various ways, like automating medical billing, clinical decision support, and establishing clinical care standards. Friedman, C., & Elhadad, N. (2014) et al. There are several significant applications of machine learning and healthcare ideas in medicine. The first medical machine learning system to diagnose acute toxicities in patients getting radiation treatment for head and neck malignancies has been created by researchers. In radiology, deep learning in healthcare automatically detects complicated patterns and assists radiologists in making informed judgments when analyzing pictures such as traditional radiography, CT, MRI, PET scans, and radiology reports. Machine learning-based automated detection and diagnostic systems have been demonstrated to perform as well as an expert radiologist. Google is creating a machine learning platform to identify breast cancer from images. These are only a handful of the numerous applications of machine learning in healthcare Jack Jr, C(2013) et.al.

Natural Language Processing

Nearly 80% of the information kept or "locked" in electronic health record systems is unstructured healthcare data for machine learning. These are papers or text files, not data components that could not previously be evaluated without a human viewing the information. Unfortunately, human language, often known as "natural language," is extremely complicated, lacks consistency, and contains many ambiguities, jargon, and vagueness. Therefore, machine learning in healthcare frequently uses natural language processing (NLP) tools to transform these papers into more usable and analyzable data.

Medical machine learning is required for the majority of deep learning in healthcare applications that employ NLP. NLP technology may now be used to read a patient's record and extract essential data components like the patient's prescriptions, treatment plans, and medical problems. It can be used to evaluate the worthiness of a customer or to analyze sentiment in social media. In healthcare, deep learning-based artificial intelligence is also used for speech recognition, known as natural language processing (NLP). Deciphering the model's output without proper interpretation might be challenging due to characteristics in deep learning models having little significance to human observers. Artificial intelligence and healthcare technology have been attempting to comprehend human language for more than 50 years. Speech recognition or text analyses, followed by translation, are used in the bulk of NLP systems. Artificial intelligence in healthcare is frequently used to create natural language processing (NLP) algorithms to comprehend and categorize clinical papers.

Rule-Based Expert Systems

In the 1980s and subsequent decades, expert systems based on variants of "if-then" rules were the most used AI technology in healthcare. To this day, artificial intelligence is frequently employed in healthcare for clinical decision assistance. The rule-based system often tries to reason like human beings and involves data scientists. One of the limitations of this system is it can only deploy the rules to a certain extent. It is often challenging and cumbersome to implement changes. We can overcome these limitations by implementing AI-based systems here.

Clinical Decision Support System (CDSS)

The main objective of CDSS is to diagnose the disease efficiently by using previous patient data. Musen and his colleagues (2014), the features of a diseased person are matched to a computerized pre-existed medical dataset. The artificial intelligence model will recommend the diagnosis. Clinical decision support systems are most commonly utilized at the point of care today, allowing clinicians to combine their knowledge with information or suggestions supplied by the Clinical decision support system. The clinical decision support system that uses computers date back to the 1970s. They had inadequate system integration, were time-consuming, and were frequently restricted to academic interests. There were also ethical and legal concerns about using computers in medicine, physician autonomy, and who would be responsible if a system with imperfect "explainability" made a recommendation. Clinical decision support system now frequently employs web-applications or interaction with electronic health records (EHR) and computerized provider order entry (CPOE) systems (Acampora, G., et al., 2013). CDSS have been classed and split into various categories depending on the timing of interventions and whether they are delivered actively or passively. CDSS are usually divided into two categories: knowledge-based and non-knowledge-based. Rules (IF-THEN statements) are produced in knowledge-based systems, with the system obtaining data to assess the rule and creating an action or result. Evidence from the literature, practice, or patients can all be used to establish rules. Non-knowledge-based CDSS still require a data source, but instead of being programmed to follow expert medical knowledge, the decision is made using artificial intelligence (AI), machine learning (ML), or statistical pattern recognition. Although knowledge-based CDSS is a fast-increasing use case for AI in medicine, they are fraught with difficulties, such as a lack of understanding of the reasoning used by AI to generate data availability issues. One of the most significant limitations with CDSS based systems is the validation because we might not get similar datasets.

Biomarker

Another tool that uses Artificial Intelligence is biomarker testing. Biomarker testing that can also be referred to as molecular study involves the performance of a group of tests to identify molecular signs of health so that clinicians can provide the best treatment available to the patients (Jack Jr et al.,2013). Machine learning-aided biomarker discovery is on-trend these years (Abeel T, et al.,2010). Machine learning algorithms test various unbiased hypotheses based on the input features we train the model. These algorithms can be classified as classification algorithms and some based on feature selection. Many of these algorithms are applied to gene expression data derived from RNA sequencing data of human cells.

Disease Progression

Through the use of biomarkers, artificial intelligence has been instrumental in documenting the progression of diseases at different stages. It is done by using artificial intelligence algorithms that help come up with disease models. These models use biomarkers of disease severity to characterize the natural disease progression. The disease progression relies heavily on making observations on patients and using cognitive patterns to predict the progression. Using artificial intelligence systems, healthcare facilities find effective ways to record, store, and process the data obtained from patients. When it comes to tracking disease progression, patient data accuracy is essential, and when this process is completely reliant on human being's, errors are bound to occur. After the accurate processing of the data, the response is highly accurate and reliable.

Brain-Computer Interface

Another application of AI in healthcare is the Brain-Computer Interface. It is a system that measures activity that is happening around the central nervous system.

The central nervous system consists of the spinal cord and the brain. The brain-computer interface is used in the healthcare system to measure brain activity and analyze the brain's features that replace, restore, and improve human functions. The use of the brain-computer interface has yielded excellent results; for example, it is known to replace lost functions such as speech and movement. A person who has lost the ability to control their own body may be due to a stroke. The interface has made significant strides in ensuring that they regain control by stimulating their nerves. The interface has also been known to improve functions by repairing damaged pathways and awakening their alertness to their surroundings.

Brain-Computer Interface (BCI) uses different techniques of artificial intelligence for measuring a patient's brain activity. The first way is to use electrical signals; these are detected by the invasive use of charged electrodes strategically placed near the cortex's surface. If the researchers would like to use non-invasive methods, electrodes can be placed on the scalp. Then, medical practitioners can pick the electric signals and determine the diagnosis.

Although the BCI is still in the preliminary stages, there have been reported benefits to health care. The first is that its smart technology enables people living with disabilities to move their prosthetics quickly. Prosthetics is an artificial body part, such as a limb fitted with technology to help the user perform as though they had the real body part. Therefore, prosthetic users can use this technology and hold drinking water as if they had their natural limbs. Second, BCI has helped people who are either deaf or dumb and wish to communicate do so. This is by using controlled communication devices that utilize the brain interface technology.

Arterial Spin Labelling imaging (ASL)

Another automated system that uses Artificial Intelligence in healthcare is Arterial Spin Labelling imaging (ASL). This is a non-invasive and widely available method to monitor cerebral flow (Jill et al.,2015). This system represents a highly possible way of assessing brain perfusion. This application has led to a high yield regarding diagnosis accuracy through its multiple variety mode of functioning software when evaluating data. The ASL system possesses the statistical power to process large amounts of highly accurate data and bear a resemblance to the brain's general functioning. This system has been highly successful when it comes to monitoring Alzheimer's disease. Alzheimer's is one of the most common types of dementia and the number one cause of death in older people aged 65 years and older. In Alzheimer's patients slowly begin losing their memory until they can only remember very little. Arterial Spin Labelling imaging is at the forefront of providing accurate information when diagnosing Alzheimer's disease patients.

Artificial Neural Networks

Artificial Neural Networks is another system in healthcare that makes use of Artificial Intelligence. They are computation simulations that are inspired by the human brain. Artificial Intelligence developments have been made in this system; they include voice recognition, image, and robotics recognition when Artificial Neural Networks are used (Kubat et al.,2015). This system's primary function is to replicate the function of nerve cells in the human brain through its neural network of algorithms and establish the underlying

correlation between a set of data it given that is similar to the human brain. Artificial network neurons used in the system have several advantages over biological neurons. First, when it comes to processing information, artificial neural is much faster. The response is instantaneous for biological neurons; they are slower in processing data, and response takes a bit of time. Second, processing for an artificial neural network is continuous.

Virtual Nurses

Patients can get services from virtual nurses instead of going to the hospital to make long queues time-consuming. That is a win-win situation for the doctor and the patient. Many patients get comfortable with AI virtual nurse assistants instead of making long and expensive trips to healthcare facilities. These virtual assistants provide 24/7 assistance, and they can answer questions quickly, especially about medications and their benefits (Kuilboer, 2014). These virtual assistants have been made interactive, now more than ever, to make patients comfortable using them.

Robot-Assisted Surgery

Robotics usage has increased in healthcare across the globe. The main reason robots are preferred in surgery rooms is because they support non-invasive technology. In other areas, robotic surgeries are minimally invasive because of their high accuracy rates, unlike human surgery, which compels doctors to make huge incisions that take long to heal and are painful. Robots also use miniaturized surgical instruments, unlike human doctors. A robot-assisted surgery could reduce the patient's post-operational stay by 21% because they are more accurate and heal faster than human-made incisions. A surgeon from a computer console controls these machines.

Diagnosis Aid

AI has proven to be better at diagnosing compared to human doctors in some studies. AI is more accurate in detecting diseases like skin cancer, even compared to an experienced doctor. The use of AI is encouraged, especially where very minute or very similar instances of illness are under study (Luxton, 2014). Most doctors rely on their eyes, lab results, and symptoms observed by a patient. AI systems are so much automated now- they take feed all these significant data variables into the model and spit out diagnosis.

Health Monitoring

Patients no longer have to make trips to the hospital for checkups. There are plenty of wearable and fitness gadgets that people can buy to monitor their health. Many applications are used for health monitoring installed on these devices. These gadgets can monitor your health, analyze data collected and present it to the user in a way that can help them determine where they stand.

Diagnosis and Treatment Applications- Electronic Heath Records

For the past 50 years, disease diagnosis and treatment have been at the heart of artificial intelligence AI in healthcare. Early rule-based systems could diagnose and treat the disease properly, but they were not widely adopted in clinical practice. They were no better at diagnosing than humans, and their integration with physician workflows and health record systems was less than optimal. Some EHR software companies are starting to include limited AI-based healthcare analytics functionalities into their product offerings, although they are still in the early stages. To fully benefit from the use of artificial intelligence in healthcare with a stand-alone EHR system, providers must either undertake significant integration projects themselves or rely on third-party suppliers with AI capabilities who can interface with their EHR.

Other areas in the Healthcare Sector

Artificial intelligence is being used in healthcare for several administrative purposes. Large health insurance companies like UHG, Optum, and Aetna have teams comprising machine learning engineers to build pay and provider data frameworks. These frameworks are being utilized to optimize billing prices. Billing fraud is one of the other areas where teams are being used.

METHODOLOGY

The AI algorithms target translating texts into machine-readable structured data, which systems can then analyze. For example, the healthcare system has abundant clinical notes authored by medical practitioners. These notes have a large amount of data. Since it is not structured data, we can deploy machine algorithms like natural language processing to extract data and structure it into data marts and data cubes. Utilizing these data marts, data scientists can advise of data-driven decision processes in clinical and healthcare research.

Another source of unstructured data is medical images, where image processing machine learning algorithms can be deployed to extract data, and this data can be used for screening and diagnosis.

Collection Methods

The collection of an imaging data set is a critical step in building machine learning / artificial intelligence (AI) for the medical diagnosis model. Datasets are used to train the model and test the model to evaluate efficiency. Unfortunately, many datasets for building deep learning models like convolutional neural networks for image identification involve large datasets. Still, smaller data sets are helpful for machine learning models for texture analysis, transfer learning, and other programs. The study data will be collected using previous findings that were conducted in the United States of America.

Moreover, the data analysis will also be instrumental in analyzing the relationship between Artificial Intelligence and the development of the healthcare division between the independent and dependent variables. Numerical data will be collected and evaluated using the statistical approach to understand the relationship between the study's underlying factors. The numerical and statistical data will help the researcher test the hypothesis identified in the first part of the research.

Impact of AI in Healthcare

Expands Access to Healthcare

The human body requires to be handled by a professional to prevent someone from getting worse or even succumb due to misdiagnosis, mishandling, or unfair treatment. Unfortunately, developing nations and under-developed nations have no enough physicians. For instance, most such countries lack enough physicians and radiologists. AI impacts such countries by having machines that can be used for diagnostics. An example of such devices is the AI imaging tools used to conduct chest x-rays to diagnose tuberculosis. Hence, it allows people without access to enough healthcare providers to get even better services.

Improves Record Keeping

Most hospitals use electronic health records (EHR) because it is easier and more reliable than the traditional way of manually writing and storing data. Thus, EHRs play a significant role in the process of digitalization. However, the increased burden of documentation and user burnout. AI technologies such as voice recognition and dictation have been very useful in improving the documentation process, thus reducing user burnout. Also, EHR developers are using AI to automate the entire process, therefore record keeping.

Advances Immunotherapy

AI plays a vital role in improving Immunotherapy for treating cancer. Over the years, cancer incidence have continued to increase and a lot of patients die. Scientists have not yet found the cure for cancer, but Immunotherapy is a promising way of treatment. It uses the body's immune system to attack the disease. However, the method does not help all patients. In addition, oncologists have no particular reliable way to identify the type of patents that benefit from the technique (Noel et al., 2013). AI is a better technology and machine learning algorithm that can use the complex data available to identify the patients.

Improves Quality of Services

Using AI helps in saving time. Machines that some healthcare facilities use are faster than human beings; thus, they hold on time. Also, there are these used in diagnosis and treatment; hence the chances of

misdiagnosis are reduced. Additionally, records kept can be easily retrieved using the new technology. All this helps in saving on time and improving the quality of services offered. Also, they hold on to costs used in hiring a large labor force and subsequently reducing treatment costs.

Issues in Healthcare

Administrative Workflow

Doctors, nurses, and other healthcare industry employees spend most of their time at work handling cumbersome paperwork. This paperwork must be dealt with utmost accuracy. They must also handle large volumes of administrative tasks that are time-consuming. A medical officer who is supposed to be attending to patients should not be put under such circumstances. That increases their chances of burnout and sometimes lose focus when listening to their patients. The records must also be analyzed and statistics drawn from them (Agah, 2013). Technology should be used to handle such bulky paperwork to make the medical world workplace more employee-friendly.

Inadequate Nurses

In many healthcare facilities, people wait long hours in the queue to see a doctor. That makes the patients seeking these services feel bad, worried, and scared of seeing a doctor. Even though the patients are usually not in emergencies in many instances, the anxiety created by such cases is not suitable for them (Bennet & Hauser, 2013). The doctors and nurses also get under a lot of pressure to serve all the patients in a queue within the shortest time possible.

Surgery

There are many forms of surgery. Some are minor, whereas others are major. In today's medical world, there are even non-invasive surgeries. Generally, all forms of surgery must be conducted in a precise and flexible manner following complex procedures (Acampora & Vasilakos, 2013). That makes surgeons take long hours in the surgery rooms, and considering they are human, their expected productivity declines. They could suffer burnouts and sometimes lose focus in those many hours they stand in the surgery rooms.

Diagnosis

Doctors and nurses use signs and symptoms observed from a patient to diagnose diseases. Most of the information they rely on is in their memory of a few books they have around them. They might also rely on results generated after conducting some tests on the patients (Dilsizian & Siegel 2014). Generally, the use of human capabilities is slow and limited in the diagnosis of a disease. More quick and accurate alternatives should be considered to improve the diagnosis process.

Health Monitoring

Routine health monitoring in many healthcare facilities requires patients to make frequent trips to the hospital to check their health progress (Farrugia & Lamb, 2013). Other times, patients are left to monitor their health and are only expected to report to the healthcare facility when their health issues escalate. All these techniques are slow and not accurate. There is a need to incorporate AI to solve these issues.

Ethical Concerns

Informed Consent

There are many applications of AI in healthcare, such as imaging, surgery, and diagnostics. That has a direct impact on the patient-clinician relationship. There is still an issue of how the AI is expected to assist the patient's side interface by implementing informed consent. It is still unclear about the circumstances under which informed consent should be used in the medical space. Guidelines need to be established on patient education regarding AI application in the healthcare field (Narula, 2014). Some of these AI programs use black-box testing algorithms that are very complicated to understand, even for clinicians themselves. Few physicians and nurses are cautious about the usage of AI in healthcare. Health apps and chatbots also trigger concerns about bioethicists, especially on user agreements about informed consent. Unlike traditional informed consent, the patient and the doctor conduct a face-to-face dialogue before agreeing on something.

When AI is being used, most users are likely to ignore it (Neill, 2013). The kind of information that should be delivered to patients on chatbots is also a major ethical issue. Some medical notifications should be restricted to be delivered by a professional, not via a DIY application.

Safety and Transparency

Safety is paramount in healthcare, and there should be no compromise about it. AI is heavily used in assessing patients' medical records and exploration of treatment options for the patients. If the algorithms are faulty or not adequately trained, the chances are that they could generate unsafe and incorrect treatment recommendations (Riccardi, 2014). The ethical concerns here are about how we need to ensure AI keep their promise. These issues majorly revolve around transparency and the reliability and validity of datasets. High-quality data must be used to train these AI algorithms so that their performance will ensure reliable and valid results. After analysis, data sharing in AI needs to be very confidential. There is also an issue about putting the algorithms used in the public domain while still maintaining the intellectual property and not exposing the AI to cybersecurity risks. Transparency also reveals the data types used and shortcomings of the software when in use. Most medical AI uses black-box testing, which makes it challenging to establish transparency in this context.

Algorithmic Fairness and Biases

AI is capable of improving healthcare across all levels to ensure the globalization of healthcare. However, an algorithm's integrity and trustworthiness directly depend on the quality of the trained data. Therefore, AI bears the risk of being bias. The kind of technology used and the form of datasets deployed must also be an issue of concern (Salih & Abraham, 2013). Algorithms that have bias majorly arise problems about ethnic discriminations based on gender or skin color. Other bias features may include disabilities. The AI systems that primarily address skin diseases are likely to face this challenge of bias more than different software types. Sometimes, it is difficult to test whether algorithms are biased because many algorithms are sophisticated and non-transparent. It is even more complex when using black-box testing because it makes things very complicated. Any AI in healthcare must be tested across all demographics equally to give the best results.

Data Privacy

Healthcare information of patients is very private, and it needs to be protected from becoming public. United States has some strict guidelines established in the form of HIPPA. Not even a single medical record from their file can be revealed to a third party unless informed and agree to that request. Also, clinicians must be trained to trust these AI technologies and integrate them into their practice successfully. Patients must also be informed about how their data will be processed to trust what they agree. Data collected from patients could amount to billions of dollars in value (Piorunkiewicz, 2014). There is a huge ethical concern that governments and medical institutions might sell this data to make money. Sometimes, AI makers agree with other partners to use patients' data to train and test their algorithms. The kind of data and degree of privacy invasion is also a big issue of concern.

RESULTS & DISCUSSION

This article presented the importance of artificial intelligence in the healthcare field. In the health care sector, we reviewed medical diagnosis, patient monitoring, and administrative applications. In addition, we looked at and assessed the most common diseases for which AI has been used. A sound AI system must include both a machine learning (ML) and a natural language processing (NLP) component to handle un unstructured (images, EP data). Before the system can aid clinicians with illness diagnosis and treatment, the complex algorithms must first be taught using healthcare data. The advantages of AI are vast, and there is medical literature to prove so. AI is known to use algorithms to identify features in a large volume of healthcare information (Acampora et al.,2013). This data is then used to obtain vital insights that help in clinical training. Data obtained from running the algorithms are then used in making informed decisions. One distinguishing factor between AI and human behavior is that AI is free from bias. This means that the decision made is made with the patient's interest or clinical activities by offering the best possible outcome.

Human beings are led by emotion, and more often than not, decisions made may be biased and not created with the best interest in mind.

AI also can equip itself with self-correcting abilities that enable it to improve its predicting and accuracy abilities. This is most important when it comes to identifying biomarkers in a person's molecular structure. If the system did not have self-correcting skills, it would mean that there would be a possibility of a misdiagnosis. The system has also proved to be instrumental in storing knowledge within the healthcare industry. It has done this by providing up-to-date information on the medical history of patients. This is possible through automation; when a patient visits a healthcare facility, their details are logged in every time and stored, making it easy for physicians to trace the data.

AI has also promoted healthcare accessibility by creating an efficient healthcare environment. Applications have been developed that enable patients to understand their symptoms without visiting a healthcare facility; this helps decongest the facilities. The patients do not self-diagnose. Instead, through AI technology, they can communicate with physicians without visiting a facility (Tripathy et al.,2015). Through this, they can receive the necessary treatment that they require. The technology also helps detect early disease risks; that is, the system uses past and present information on health problems, runs it through the system, and can identify if the patient is at the risk of getting a high-risk disease like diabetes.

Artificial intelligence has also been instrumental in the development of radiology tools. Radiology is a treatment that is used to treat cancer and malignant tumors in patients. Radiology treatment done through MRI machines and CT scans is preferred as it is a non-invasive method of getting a diagnosis. The machines are used to find out what is going on in the body of a human being (Kang et al., 2015). Succeeding in the production of these tools will mean that medical doctors can develop a more accurate understanding of how tumors act and decide on the treatment based on a deep understanding and not the small segment that they are used to seeing. It will enable healthcare industry professionals to understand the aggressive type of cancer better and decide on treatment that specifically targets that area, ensuring that the cancer is appropriately dealt with. In addition, artificial intelligence helps in virtual biopsies; this is an innovation that focuses on image-based algorithms to obtain tumors' features.

In the United States, specifically, there are marginalized areas and do not get enough exposure to getting treatment. It is due to shortages of healthcare providers and specialists. Artificial intelligence helps in hedging against the evident deficit in qualified clinicians by controlling some of the diagnostic duties that human beings usually perform. There is enormous untapped potential for the use of technology in improving access to health care. Artificial intelligence is there to bridge this gap and ensure that everyone, despite their economic background, can get the healthcare they deserve, meaning they get quality and appropriate treatment for their conditions (Neill et al.,2013).

The Future of AI in Healthcare

The most challenging problem for AI in healthcare is securing its acceptance in daily clinical practice. These artificial intelligence/machine learning algorithms have played critical roles in critical medical applications. AI systems are expected to be a $6 billion business by 2021, according to Frost & Sullivan.

CONCLUSION

Artificial Intelligence has proven to be immensely beneficial to the American community in regards to healthcare. Although initial deployments cost a lot, in the long run it is quite possible to see the benefits overcoming expenses and therefore be affordable for everyone. As a result, we can infer that AI is most often utilized in healthcare to fulfill the following tasks: 1) help with diagnosis; 2) administration of healthcare businesses. On the other hand, the following are the key barriers to AI use in healthcare: 1) the need for particular business architecture; 2) public perceptions about AI; 3) the need for privacy and information security; and 4) the need for high-quality data. And Services with a high level of dependability and quality.

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