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AIAAS: THE FUTURE OF COMPUTING SERVICES!

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Introduction

The most important breakthrough that humanity is working on currently is AI. 47% of organizations that are "digitally matured" have a defined AI strategy. AI is employed by organizations to perform tasks like humans. In recent times AI performance has surpassed that of humans. Artificial Intelligence as a Service is a solution for companies that do not want to test, build, and implement heavy systems. Focused on increasing profits and decreasing risks, AI as a Service offering can make artificial intelligence more accessible which in turn can automate and accelerate business.

Some applications of AI include - Natural language processing, computer vision, and interpreting medical documents. Owning these capabilities of AIaaS, companies need not have in-house experts. SMEs with scarce time and resources can exploit this opportunity to the fullest. Qualities such as reasoning, learning, thinking for customer service, data analysis, and automation will be handled by AI. With the objective to make AI affordable and accessible, this pay-as-you-go model has significant transparency attached to it. It is a user–friendly service with zero downtime that can be kicked off without any formal training.

This paper intends to cater to the audience with increased awareness about Artificial Intelligence as a Service while capturing the fundamental knowledge of AIaaS, Models of AIaaS, the advantages and limitations of AIaaS followed by its use cases.

Understanding Artificial Intelligence (AI)

Do you know Sophia? The social humanoid robot that can not only emulate more than 60 facial expressions but also strike up conversations like a normal human being. This is AI. It is the answer to how Google maps, self-driven cars, face unlock, voice assistants, etc. work. We stand here unaware that AI has woven itself into our daily lives.

It all began when the first computer, which was invented during World War II cracked the German communication code. The man responsible for this breakthrough, Alan Turing, published the paper Computing Machinery and Intelligence, which begins" I propose to consider the question, can machines think? ". Pondering on this question, the machines have been revolutionized to probe the universe or even understand humanity with a different approach. AI, a subfield of computer science, provides an answer to Turing's query.

The human brain controlling the entire human body is complex. Even to this date, scientists are yet to unravel its full potential. Constantly learning and evolving human beings is analogous to how AI functions at its roots. Artificial intelligence is the intelligence demonstrated by machines. It is the evolution of computer systems that can carry out operations that often require human intelligence, such as decision-making, object detection, solving complex problems, and so on.

Artificial intelligence is self-taught. It works off a simple set of instructions to create a unique array of rules and strategies. The backbone of AI is Machine Learning (ML). Machine learning is the process of feeding vast amounts of data into algorithms that enable the machine to learn how to perform a task without being explicitly programmed. There are many ways to train a machine. It can be broadly classified into 3 types - unsupervised learning, supervised learning, and reinforcement learning. A detailed explanation of the three types is discussed in Figure a.

CRITERIA	SUPERVISED LEARNING	UNSUPERVISED LEARNING	REINFORCEMENT LEARNING
Definition	Learns by using labelled data	Trained using unlabeled data	Works on interaction with environment
Types of data	Labelled data	Unlabeled data	No – predefined data
Type of problem	Regression and classification	Association and classification	Exploitation and exploration
Algorithms	Linear regression, logistic regression etc.	K-means, C-means etc.	Q-means, State-action-reward-state- action (SARSA) etc.
Aim	Calculate outcomes	Discover underlying patterns	Learn a series of actions
Application	Risk evaluation, Spam detection etc.	Recommendation system, customer segmentation etc.	Self-driving car, health care etc.

Figure a: The Three Types of Machine Learning

Training data helps AI models make the right decisions without human interference in the decision-making process. The next stage of the journey is validation. Here we can validate our assumptions as to how the model responds to the new set of data. The final process is where the training wheels come off and the real-world testing begins.

Organizations rely on AI models to solve tasks that would otherwise be too tedious or time–consuming for humans to perform. Though AI comes with its own baggage of security risks, lack of regulations, etc., its importance in today's world is undeniable.

Applications of Artificial Intelligence (AI)

The function of AI is soaring by the day. It is revolutionizing industries to solve complex problems. AI applications have significantly advanced to touch almost every business sector. Let us look at some of its applications.

Transportation: Reducing the human error involved in traffic accidents. AI is not only helping cars, trains, ships, and airplanes to function autonomously for smooth traffic but also transitioning them into a more efficient form.

Manufacturing: The major advantage of using AI here is the increased productivity and quality while reducing the expenses and downtime. Defect checks are very precise.

Healthcare: AI helps to provide more accurate diagnoses and treatment plans. It is a significant tool used to discover new medicines to battle pandemics.

Education: Facial analysis is used to determine inattentive students from the rest to cater the individual needs. Textbooks can be digitalized. Chatbot tutors in educational apps can help students understand difficult concepts.

Media and entertainment: AI helps to detect and filter fake news. The audio-visual content is modified from music applications to OTT platforms based on the user's preferences. AI is also used to create an interactive experience in the gaming world through non-player characters.

Customer Service: Last but not the least, AI models can recommend products based on customers' purchase or browsing history. Google is developing an AI assistant that can make calls that sound human-like to schedule appointments, such as at your favorite restaurant.

Roots of AIaaS

Artificial Intelligence as a Service (AIaaS) can be defined as a subset of cloud computing, through which individuals and/or organizations can commercially outsource AI capabilities as a service to implement & explore AI solutions at a minimal cost. To understand the real-world practices of these services, we need to discuss a little about the general nature of cloud first.

Cloud computing is an on-demand availability, via the Internet, to computing resources over a network. These are frequently provided as "services," be they rented or pay-as-you-go. The computing resources can be thought of as applications – websites, mobile apps, etc. If we go back to the traditional cloud computing services, they included Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service (SaaS), and Anything-as-a-Service (XaaS). IaaS involves the infrastructure being managed by the cloud service provider. PaaS involves the cloud service provider only managing the hardware and platform, and the individual managing the applications that run on it. In the SaaS model, the service provider delivers and manages the software application entirely. XaaS or Anything-as-a-Service, as the name suggests, means that we can access any computing and software infrastructure as a service.
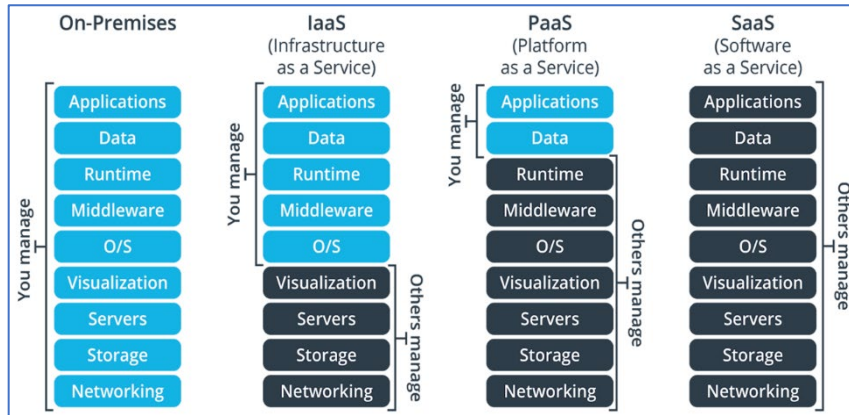
Figure b: Cloud Computing Models

Just like these traditional cloud computing models, AIaaS can also be thought of "as-a-Service" model managed by a third-party provider. Like any other "as-a-Service" solution, AIaaS uses cloud computing models to leverage AI at an economical price. This makes any individual or organization harness the true potential of AI through APIs without writing any complex codes, which makes it different from the SaaS model where the user had to write codes to run applications. To some extent, AIaaS can also be thought of as a form of PaaS. As already discussed, PaaS provided general infrastructure with some supporting functions enabled, for instance, sign-on services. However, AIaaS offers general AI capabilities that support, empower, and explicitly define a specific application's operation.

Now that we have a basic understanding of what AIaaS is, let us talk about its chain of processing. Typically, it has two key entities – the Providers, who offer the services, and the Customers/Tenants, who avail of the said services. There may be a third entity, called Third Parties, where the customer uses AIaaS to either add functionality to applications for the third party to use them, or behavioral analysis of the third parties. This entire chain is handled in four stages – collection stage, transfer stage, analysis stage, and return stage.

Collection Stage: This stage involves the customer inputting the data and processing it, for example, data input for behavioral analysis.

Transfer Stage: This stage involves the transfer of the inputted data (collection stage) by the customers to the providers through APIs. If a third party is involved, the transfer happens from the customer to the third party and then to finally the

provider. However, if a third party is not involved, the transfer simply happens from the customer to the provider.

Analysis Stage: Now that the provider has the transferred data from the customer/third party, what happens here is that the dataset is trained using a machine learning system to improve accuracy or resolve issues. A point to note here is that this stage only involves the provider and has nothing to do with the customer or the third party.

Return Stage: This stage involves the analyzed data being sent back to the customer or the third party over an API network.

 This processing chain handles everything in a loop-like system, in which the data flows from the customer or the third party to the provider, and then back to the customer or third party after the analysis of it.
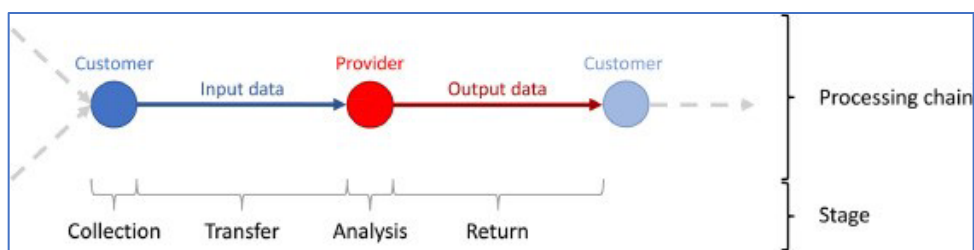

Figure c: AIaaS Chain of Processing

More than AIaaS being a cost-effective approach to implementing AI or it being an improvement over the traditional cloud computing models, there are other reasons to rest the case as to why AIaaS can be the next big thing. It is highly adaptable, flexible, and easily accessible, which can in turn increase the productivity of an organization and even scale it to a great extent. It has the potential to almost change any sector for the better, be it transport, healthcare, social media, gaming, finance, and so on.

AI is everywhere around us. AIaaS is a pay-as-you-go AI technology offering that allows us to harness the true potential of AI without having to invest a lot of money. However, organizations or individuals adapting this model must take care of a few things as to where it can be a disadvantage and so on. Questions related to those are what we try to address in this paper moving forward.

AIaaS Components

The architecture of AIaaS has 3 components: AI Infrastructure, AI Services, and AI tools
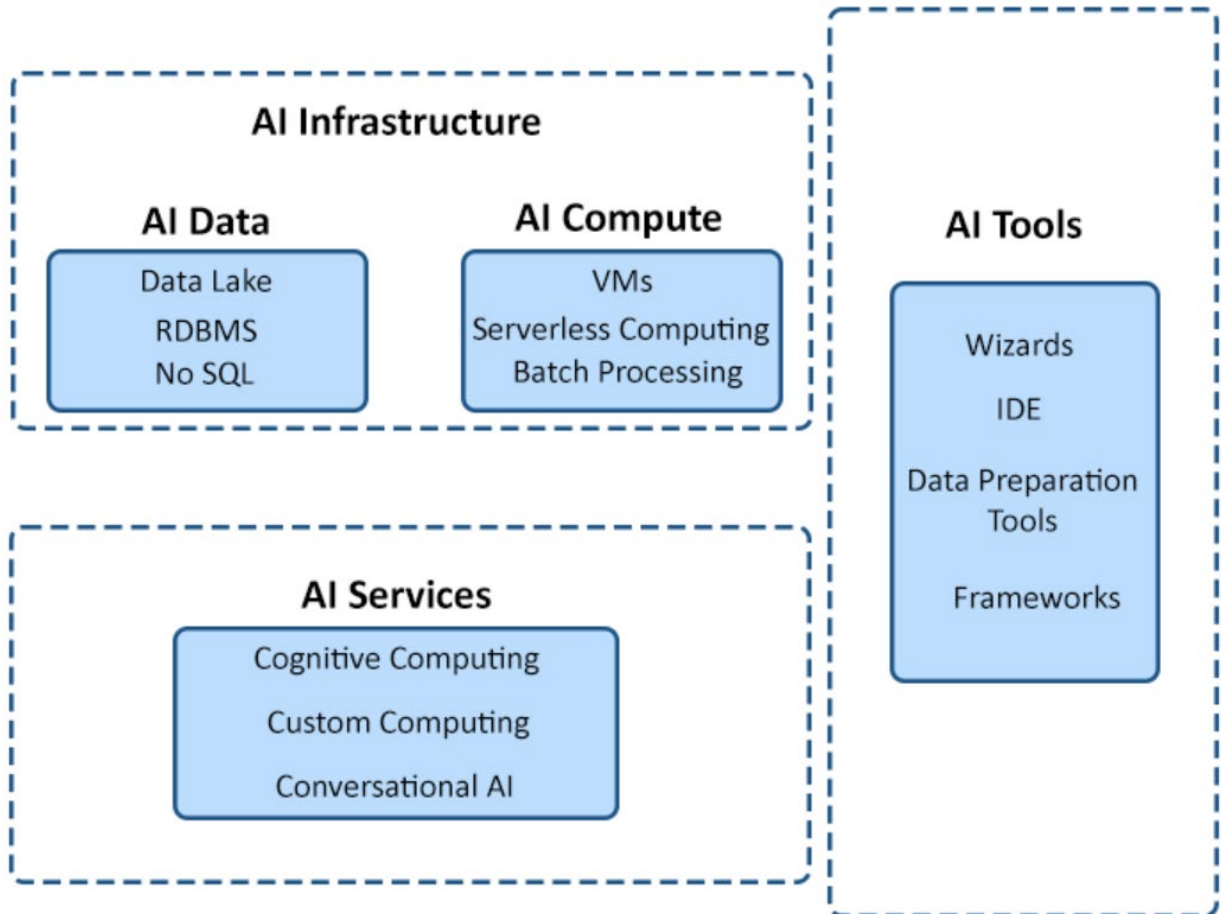

Figure d: AIaaS components

1) AI Infrastructure

AI and ML models are the underlying models supported by AI infrastructure. Data and compute are its anchors.

AI Data: When a vast amount of data is applied to algorithms, it is considered an ML model. Patterns in the data are studied by these models. This input data can be collected from numerous sources such as Relational Database Management System (RDBMS), annotation from No SQL, and raw data from data lakes.

AI Compute: Virtual Machines (VMs), serverless computing, and batch processing are all types of AI compute services. The usage of these computing techniques improves parallel processing and automates machine learning operations. The trained ML models are deployed in VMs and containers after training to carry out calculations.

2) AI Services

Public cloud providers offer readily accessible APIs and services that can be used without the requirement for special ML models. These APIs and services reap benefits from the cloud provider's existing underlying infrastructure.

Cognitive computing: APIs for cognitive computing include search, voice translation, text analytics, and speech. Developers can use a single API call to integrate these services with applications by accessing them as REST endpoints.

Custom computing: Customers employ their own custom data to train cognitive services. This approach leverages cognitive computing using custom datasets while reducing the overhead of algorithm selection.

Conversational AI: As end customers continue to adopt AI effortlessly, virtual assistants are rapidly being acknowledged everywhere. By utilizing bot services, cloud providers are assisting developers in integrating speech and text bots across platforms. Web and mobile app developers can incorporate digital assistants into their applications using this service.

3) AI tools

Tools are provided not only to advance the usage of VMs, storage, and databases but also to help developers and data scientists in the process.

Wizards: This is provided to make the process of training ML models less complicated for amateur data scientists. All tools work together to create a multi-tenant development environment on the backend.

Integrated development environment (IDE): The maintenance and testing of ML models become simple with this tool. It enables its users to create smart applications effortlessly.

Data preparation tools: The quality of data is the key factor in the ML model's performance. This tool is used to perform the extract, transform, and load tasks. The output of this is further fed into the ML pipeline for training and evaluation.

Framework: As setting up, installing, and configuring the necessary data-science environment has become challenging. Cloud providers now supply ready-to-use VM templates with frameworks like TensorFlow, Apache MXNet, and Torch. These GPU-supported VMs train sophisticated neural networks and machine learning models.

AIaaS Characteristics

For organizations to explore and interact with AI technologies in an effective way, AIaaS offers some unique core characteristics which are complexity abstraction, automation, customizability, and inherited cloud characteristics. Let us discuss about each of them one by one in detail.

Complexity Abstraction: There are 3 major attributes to this core characteristic – hardware abstraction, setup, and configuration abstraction, and finally maintenance abstraction. Hardware abstraction means that the AIaaS provider deploys and maintains the AI infrastructure along with dynamic handling of performance peaks. Setup and configuration abstraction implies that the user or organization does not need to have a piece of expert knowledge to setup and configure the AIaaS model, thus saving them from hiring technical experts. Finally, maintenance abstraction refers to the service provider maintaining and handling the entire hardware and software aspect of the AIaaS model for a user/organization. With these features, Small and Medium Business Enterprises (SMEs) benefit the most. Since SMEs always have limited time and manpower, the abstraction feature gives them lesser headaches than needed. This feature can benefit users in many ways, for instance, not having to hire technical experts, focusing on core competencies, and impacting the business with the support of these cloud-based AI services.

Automation: There are 4 major attributes to this – automatic classifier selection, automatic hyper-parameter tuning, server-side hardware tuning, and automatic failure handling. Automatic classifier selection refers to the feature where AIaaS automatically handles the required training algorithm in the analysis phase of the

AIaaS processing chain. The user does not need to know which classifier is being used to train their data since AIaaS takes care of that part entirely, making sure it best suits the business needs. In addition to the classifier being selected, AIaaS also performs hyper-parameter tuning of the AI model since that can have a significant impact on the performance of the AI model and it also improves the accuracy levels of the same. An example of the hyper-parameter tuning approach is Bayesian optimization. Along with the automatic selection of the classifier and the hyper-parameter tuning approach, AIaaS also performs server-side hardware tuning. It means that with the level of data provided by the customer, AIaaS has the ability to adapt and optimize the underlying hardware automatically with respect to the training algorithm needed. It in turn enhances speed, reduces time, and increases efficiency in the training process of the data submitted. AIaaS also automates the process of handling failures by restarting the failing tasks multiple times before completely deeming them as failed. With these automation features of AIaaS, we save time, enhance speed and efficiency, increase the accuracy levels of the trained datasets, and finally do not have to go looking out for technical AI/ML experts since all the expert-level stuff is taken care of by the AIaaS model itself.

Customizability: They have 4 sub-characteristics – Custom classifier selection, custom hyper-parameter tuning, custom algorithms, and customizable infrastructure. Now, AIaaS has the ability to automatically select the classifier necessary for the data provided. However, if we have the knowledge and expertise of the classifiers, AIaaS allows us to custom select which classifier we want our data to train under. We can play with different classifiers as well and pick up which one meets our needs the best. Same with custom hyper-parameter tuning and algorithms, if we have the knowledge about it, we can custom select those as well. Customizable infrastructure here means that we can even incorporate third-party services as was discussed in the AIaaS processing chain. With these characteristics, the benefit that we as users get is knowing about how different classifiers and algorithms change the output of the same data that we provided, enhancing performance and flexibility, and improving the cost-by-benefit ratio as well. One downside to this is time. In real-time situations, experimenting with different classifiers and training algorithms can lead to delays in getting the analyzed data.

Inherited Cloud characteristics: AIaaS offers a pay-as-you-go model through subscriptions, which allows us to pay for only those AI capabilities that we need at that point. In addition to this, AIaaS also offers multiple users running different datasets to train at the same time. Users can access the AI offerings from an AIaaS model through APIs or web interfaces without writing massive complex codes. The primary benefit of this feature is simple, making our lives easier by providing almost everything at our fingertips.

Types of AIaaS

There are many distinct types of AI services, and one can choose based on the business requirement. Let us look at the three most popular types of AIaaS solutions.

Bots

Round the clock, bots can address multiple queries. Chatbots simulate human conversation by using AI algorithms. User queries are addressed best by using Natural Language Processing (NLP) and ML. They not only provide relevant answers to queries but also reduce the response time and enhance the customer satisfaction rate.

This leading customer service assists businesses to automate routine tasks such that the agent can be occupied with other complex tasks.

Application Programming Interface (API)

Applications can communicate with one another using APIs, allowing their various components to carry out a variety of commands. Although APIs make use of a range of protocols and technologies, their main objective is to enable communication between different pieces of software. Simply defined, mobile applications contact an API to retrieve your account and credentials when you sign in, for instance, to social media apps from your phone. After accessing this data from one of its servers, the app would send the information back to the mobile application.

An artificial intelligence API allows programmers to include AI elements into applications. These APIs can be utilized for several business purposes, such as information exchange, spam filtering, facial recognition, and location detection.

Serving as a bridge for communication, this 'as a service' model can be adopted and implemented instantly with just a few lines of code.

Machine Learning

Machine learning algorithms are used by businesses to identify patterns in massive volumes of data, create forecasts, and expedite procedures. Businesses may easily deploy machine learning technology due to AIaaS. To address specific business objectives, one can employ pre-trained models or tools without prior knowledge of machine learning.

AI as a service enables businesses to utilize cutting-edge AI, ML, and cognitive technologies without significant infrastructure, labor, or maintenance expenditures. Instead, it serves as a catalyst for enhancing new features in already-existing goods and services.

Benefits and Drawbacks of AIaaS

Just like all the other "as-a-Service" offerings, AIaaS has its own set of advantages that can add value to a business and some disadvantages that no business should ignore.

The first major advantage of this model is affordability. Large investments are needed to design in-house AI capabilities, not to forget the expertise that will also be needed which will not come at a less cost. AIaaS offers a pay-as-you-go solution to this problem, and with minimal investments, organizations can deploy this model to explore and implement AI capabilities. The other benefit is usability. Even if most AI options are open source, their user experience is not always great. This can lead to companies investing in ML experts, which will both take time as well as money. However, with AIaaS, we get an out-of-the-box solution to this problem, as it provides easy setup and installation, and we do not have to be a technical expert to start implementing it. The third merit is transparency. AIaaS model enables you to pay for only what you need and will be using, much like the XaaS cloud computing model. Finally, one of the most valuable benefits that AIaaS has is flexibility and scalability. AIaaS is flexible with respect to the money, but it also allows you to upgrade or downgrade your package if needed. We can always start small with AIaaS services and upgrade them based on our needs, and vice versa.

If the last paragraph discussed as to why should we use AIaaS, let us now discuss what can be the demerits of using it. The first thought that may click on everyone's mind is how secure it really is. That is not a wrong train of thought to have, because the biggest worry about using AIaaS is security. AIaaS processing chain involves the transfer and return of data between the customer and the provider. With customers sending important datasets to the provider to analyze and run an ML algorithm, it is only natural to be concerned about its security and privacy. We as customers need to be careful that our data goes to the right person and make sure we secure the access medium and transit paths as well. Another drawback to using AIaaS is visibility. Now, one big merit of AIaaS is that it requires minimal capital investment. But that is also a disadvantage if you really think about it. Since we pay less to acquire this model, we never get to fully understand the underlying process, in short, the algorithm. The third demerit of AIaaS is dependency. Now the providers that provide us with the AIaaS service model are third-party vendors and cannot be depended on to always be on time with analyzing and returning our information, which can be a big problem with real-time cases. The final drawback of AIaaS is long-term spending. Just like any as-a-Service model, the deployment and implementation costs of the AIaaS model can pile up. With us getting hooked up with the benefits that it provides, it is only natural that we may end up spending more to explore more. A marketing strategy, perhaps? However, while I say this is a disadvantage, we can turn it into an advantage as well by spending on it wisely and making sure that the organization is scaling in the right direction.

Remember, every coin has two sides to it and so does AIaaS. It is up to us as customers to make sure we make full use of the good side of it to expand, learn, and grow, but also avoid its dark side and use it with utmost care and due diligence to ensure that it impacts us in the right way.

Case Study

The Case study of Amazon acts as the first incumbent study consisting of three different approaches that employ AI. The following case study is an illustration from the book "Digital Entrepreneurship".

Customers of Amazon have access to potential AI applications. Currently, this means that Amazon delivers the necessary infrastructure and development services, giving its clients the opportunity to create AI services at a lower price. These expenses may not only be of a direct financial character but may also be seen in the field of manpower. As a result, businesses employing this offer require less staff with expertise in machine learning or artificial intelligence to carry out their own innovations in this field. As a result, this service from Amazon Web Services should be considered both an IaaS and an AIaaS.

Another illustration of the application of AI is Amazon Go and Amazon Go Grocery. This is an independent Amazon stalwart in the grocery retail industry. The idea behind this business model is to provide a seamless checkout experience for customers. The physical checkout is eliminated by employing AI to keep track of the items the consumer has selected. The so-called checkout-free shopping is made possible using sensors that enable AI to continuously monitor the condition of the products on the market. When a customer exits a store, an invoice is automatically issued to their Amazon account. This method of checkout reduces the customer's transaction expenses and improves customer service. On the other hand, this Business Model (BM) modifies the shop owner's customary operational structure by making it AI-driven.

Lastly, the business produced a patented concept, "anticipatory shipping," which stipulates that a product would be shipped before its actual sale. Products that are anticipated to be desired by the consumer would be sent before they order, according to an AI forecast. The clients might then choose whether to keep the item or return it. Whether the product should be anticipatorily moved into a more convenient venue or delivered right to the customer is subject to diverse interpretations. Regardless of how such a model is interpreted, it demonstrates a phenomenon in the way Amazon might alter its business practices. A purchase would no longer only be executed by the customer; the AI would also execute it. This intends to relieve the stress of the customer.

Thus, business operations are determined by the execution and effectiveness of the AI prediction utilized, and such a business model can be regarded as AI-driven. Additionally, such a BM innovation would result in a substantial shift in the market.

Conclusion

In today's world where AI is such an important aspect of our lives, the question is not if we need or need not use AI. The question should be if not now, then when. With massive vendors providing cloud-based AI services to businesses all over the world, this subscription-based model has become very convenient to adapt to. Although there were obstacles, including the need to hire a specialized team and spend a fortune, AI has always had the potential to revolutionize the industry and serve as the foundation for all future innovations. But with the advent of the AI-as-a-Service concept, all these challenges have essentially been overcome. Given the capabilities and advantages of AIaaS, future growth is most certainly anticipated. Technavio has predicted a 48% market growth for AIaaS globally in the 2020-2024 time period, which is minimal due to the fact that we suffered the Covid-19 pandemic. However, with the pandemic ending, this percentage is expected to soar.

In this encapsulating paper, we aim to provide a holistic view of AIaaS which not only lays a foundation but also kindles the researcher in you. Though AIaaS has numerous advantages, it has its own baggage of drawbacks attached to it. One should carefully weigh all parameters before making decisions, as AI not only assists but also has the potential to drive businesses.

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