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Artificial Intelligence in Practice – Real-World Examples and Emerging Business Models

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Abstract. There are everyday examples of Artificial Intelligence (AI) in different areas. Some of the prominent AI applications are virtual assistants, robots, AI applications related to computer vision and those used in medicine. This paper attempts to examine the recent trend of the real-world applications of AI and also identify the business models for these. The business models are then examined to see if these are existing business models that are used to enhance businesses using AI or if new AI-driven business models have emerged. The emerging AI-driven business models are Federated learning, the triangular partnership model and the use of Emotion AI to come up with new business models. The existing ones enhanced by AI are the freemium model, Rent to Buy model, leverage customer data and the land and expand model.

Keywords: Artificial Intelligence, AI in Practice, AI real-world examples, AI-driven business models.

1 Introduction

Artificial Intelligence (AI) – machine intelligence that enables machines to perform cognitive functions that are mostly associated with human minds is revolutionizing businesses around the world. There are several everyday examples of how AI applications are impacting our lives. The collection and availability of huge amounts of data coupled with improvements in computer technology have made it possible to use AI for various functions. Research shows that AI has applications in numerous areas such as agriculture [18], in autonomous vehicles [1], computer vision [12], in virtual assistants [13], chatbots both in the private firms and in Government [3], in robots [17] and medicine [21]. Research papers present advances made in the medical field using AI in areas such as cardiology [11], drug discovery [6] and ophthalmology [20].

According to the McKinsey Report¹, there has been a substantial increase in the number of companies that use AI in multiple areas of their business with an almost 25 percent increase in the use of AI as compared to the previous year in standard business

¹ <https://www.mckinsey.com/featured-insights/artificial-intelligence/global-ai-survey-ai-proves-its-worth-but-few-scale-impact>

processes. The report also talks about an increase in revenue in the business areas where AI was used and also a reduction in costs. Uses of AI are spread across a wide range of industries and business functions. AI is being used for business process automation, to create intelligent robots, chatbots for customer service, customer segmentation, agricultural process automation, educational learning platforms, virtual assistants, to build medical tools, surgical robots and as radiology assistants.

Considering that AI is still in evolving stage and business models using AI are yet to emerge clearly, in this study we wish to delineate a possible evolution of AI-driven business models. This aspect of AI has remained relatively unexplored in the research papers.

AI is driven by vast data, raw computing power, and complex algorithms. Are organizations using AI to enable and enhance the businesses using existing business models or are they using AI to create new business models? The aim of this paper is to understand the current status of AI in practice and summarize the most recent AI implementations by different organizations as well as to delineate business models emerging in the field of AI. This has been done by analyzing company reports, website articles, and research papers. To the best of our knowledge, there is a lack of systematic study in this area. The specific research questions addressed in this study are: (i) What are the real-world implementations of AI and the business models used? (ii) Is AI being used to enhance businesses by using an existing business model or are there new AI-driven emerging business models?

2 Literature Review

To understand the state of research on AI, we searched for keywords ‘AI in Practice’ in ScienceDirect, Google Scholar, and the Internet. We looked for research articles, review articles and real-world examples of applications of AI. Research papers have been published on AI implementations for use in robots, agriculture, computer vision, cognitive engagement, and in medicine in areas such as cardiology and drug discovery. The real-world examples of AI applications were categorized into different areas, namely, medicine, robotics, agriculture, computer vision, and cognitive engagement. The AI-driven business models were also identified for these areas. Here we present a review of studies on AI applications in various areas as well as the AI business models emerging in these areas.

2.1 Medicine: Cardiology

Echocardiography. AI can be used for automated interpretation of echocardiograms with accurate and consistent results. They will help, especially those with less experience, to treat and diagnose more accurately [2].

Heart murmur detection. A study was done to classify heart sounds into normal and murmur types [8].

Ejection Fraction Calculation. In a research study, ejection fraction (EF) was calculated using ECG image analysis and AI trained pattern recognition. Auto EF could calculate EF in 15 sec. The results showed less variability when compared to the manual process. [5].

Table 1. Real-World AI applications in Medicine

Application	Description	Business/Revenue Model
Apple Watch ECG https://www.apple.com/in/apple-watch-series-5/	It captures heart rhythm irregularities. Users take own ECG and data is passed on to the doctors.	Integrator Business Model- Apple owns it completely with a vertically integrated model integrating operating systems, hardware, application software, and services. On-device Edge AI - Training and Inference done on the device keeping personal data under control ensuring customer privacy.
AI-ECG Platform, Lepu Medical http://www.carewellhealth.com/products_aiecg.html	A diagnostic program that can detect various heart conditions.	Open Business Model/Partnership: Has a strategic agreement with Intel. The goal is to diversify their respective services and capabilities in the medical AI fields thus strengthening both companies.
Cloud-based eMurmur ID Platform. https://emurmur.com	Cloud-based eMurmur ID Platform	Freemium Business Model— eMurmur Primer - free. Core - In-App Purchases, subscription-based. eMurmur University offers comprehensive heart murmur training & testing modules free for instructors and students.
Artery's Cardio AI https://www.acrdsi.org/DSI-Services/FDA-Cleared-AI-Algorithms	For viewing and quantifying cardiovascular MR images. To visualize and quantify MRI data.	Open Business Model/Partnership – Arterys and GE Healthcare have collaborated to combine Arterys's medical imaging technology with GE's magnetic resonance cardiac solutions. The result is a diagnosis that is comprehensive.

The most predominant AI-driven business model in Cardiology is the Open Business Model/Partnership model showing the trend of medical firms and AI startups/technological companies teaming up to innovate and provide end to end solutions. Apple follows the Integrator Business Model and on-device Edge AI to address privacy concerns

and network latencies for individual users. The Freemium model and Community edition vs paid enterprise edition Model are also used where the basic version is offered free and the customers are charged for the premium version which in turn finances the free version.

2.2 Robotics

Humanoid Robots. Several studies have examined the application of AI in the area of humanoid robots. A good example of this would be Sophia – a humanoid robot – which expresses and interacts the way a real human does. Another humanoid robot called the NAO robot was explored in a study where the robot plays the role of an artist. Different techniques were studied to overcome calibration issues [19]. In another study, the walking behaviour of a humanoid robot was studied where the robot walks faster than usual and safe reinforcement learning was proposed [9].

Robotics in Surgery. The application of robotics in surgery has been on the rise. The da Vinci robot was one of the first to be used for minimally invasive surgeries. The da Vinci robot is currently being used in various fields such as urology, general surgery, gynaecology, cardiothoracic, paediatric and ENT surgery” [15]. A study was done to understand how good the robot manoeuvres were when used in laparoscopic surgeries. “A hierarchical intelligent expert system was proposed. The method was constructed based on the integration of a swarm-based clustering approach, modular extreme learning machine (M-ELM) identifier, and Mamdani fuzzy system” [14].

Home Robotics. The robot-integrated smart home (RiSH) with capabilities to monitor and assist elderly residents integrates a home service robot that recognizes “37 human activities with an average accuracy of 88% and detects falling sounds with an accuracy of 80%”, a home sensor and body sensor networks, a mobile device, cloud servers along with remote caregivers [7].

Table 2. Real-World AI applications in Robotics

Application	Description	Business/Revenue Model
Medical Robots - AI-assisted surgery robot. http://microsure.nl/microsure-for-surgeons .	It can suture tiny blood vessels that are as small as 0.03 mm and up to 0.08 mm across.	Rent or Buy Business Model Medical Robots – Revenue model includes “leasing, pay-per-use, bundled payments, rental agreements, and expanded payment terms, among others.”
Sophia by Hanson Robotics https://www.hansonrobotics.com/sophia/	Humanoid robot able to display over 50 facial expressions. Little Sophia is 14” tall and is just like big sister Sophia.	Rent or Buy Business Model - The price of Little Sophia is somewhere between \$99 and \$149. Sophia is available for participation in public events and takes part in topics related to AI and robotics.

Connie, the Hilton Robot Concierge.	The robot uses IBM WATSON. It has speech recognition, interacts with guests, learns and adapts over time.	Open Business Model/Partnership - The robot is based on a humanoid Nao robot made by French robotics company Aldebaran. Software is Watson from IBM, which mostly helps with natural language processing. Travel information is from WayBlazer, an IBM partner that uses Watson for personalized recommendations. ²
1A-TA, Amadeus's travel assistant using Pepper Robot.	Pepper cognitive development kit integrated with some complex deep learning AI algorithms.	Rent or Buy Revenue Model – SoftBank's Pepper and Nao Robots available for rent or purchase. ³

The predominant business model in this area is the Rent or Buy Revenue Model/Rent to Own business model. The robots are available for rent, on lease and for purchase. The other model followed is the Open Business Model. Connie, the Hilton Concierge uses a NAO humanoid robot, IBM Watson for natural language processing and WayBlazer for the travel Information.

2.3 Agriculture

In the field of agriculture, AI has been used for crop protection and weed control. AI is used in precision agriculture to detect and remove weeds by using computer vision to identify potato plants and 3 different kinds of weeds. Image processing was used to train and test the neural network classifiers which were optimized by two metaheuristic algorithms [18]. An AI-based smart sprayer with a machine vision software using deep learning to detect specific weeds was developed and evaluated [16].

² <https://www.theverge.com/2016/3/9/11180418/hilton-ibm-connie-robot-watson-hotel-concierge>

³ <https://www.robot-rentals.com/>

Table 3. Real-World AI applications in Agriculture

Application	Description	Business/Revenue Model
Blue river, weed control – “See and Spray”. www.bluerivertech-nology.com	It uses computer vision to monitor and spray weedicide precisely.	Open Business Model/Partnership-John Deere & Company, which designs, manufactures, and distributes innovative agricultural products, acquired Blue River. Together, there are many opportunities in agriculture beyond spraying. ⁴
Harvest CROO Robotics strawberry harvester https://harvest-croo.com	Helps strawberry farmers in picking and packing their crops.	Rent to Own Business Model-The business model is to “lease machines from HCR on a per box basis. This emulates how they do business now, which is to pay humans a piece-rate.” The objective is to make it easier for the grower and to create a continuous revenue stream for the company. ⁵

2.4 Computer Vision

There has been an enormous growth in computer vision applications. There is a vast amount of data that is generated today and which is used as training data to make computer vision better. The research papers in this area talk about using AI Deep learning algorithms in classifying images for detecting various illnesses. It is also used for face recognition and facial emotion recognition.

Table 4. Real-World AI applications in Facial and Emotion Recognition

Application	Description	Business/Revenue Model
Facebook- DeepFace	It can determine whether two photographed faces belong to the same person.	Leverage Customer Data - Customer data is collected and value created by using data both internally and externally by third parties. Revenue is generated by leveraging it for own purpose by in-

⁴ <https://www.deere.com/en/our-company/news-and-announcements/news-releases/2017/corporate/2017sep06-blue-river-technology>

⁵ https://www.roboticsbusinessreview.com/rbr/harvest_croo_robotics_strawberry_picker/

Google - FaceNet	It can link a face to its owner with almost perfect results.	creasing the effectiveness of advertising or selling it to others [10]. Leverage Customer Data -The primary revenue stream for Google is the search engine which is powered by ads. Google offers this free to online users. Marketers target online users with its ad products. ⁶
Hirevue- Unilever using facial emotion recognition technology HireVue	An AI algorithm measures the facial expressions, emotions and other personality traits making interviews bias-free.	Land and Expand Strategy - As per gowtheverywhere.com , HireVue employs a 'land and expand model' by getting a foot in a business and then works to build credibility and trust to expand and increase their offerings. Tiered Pricing Model- They use a very simple metrics around the scope of usage, whether it is a single site, a single country, or globally, as they work inside of hiring programs, and then scale of hires.
Affectiva Software motion as a Service - Kellogg's is using emotion recognition.	Multiple versions of ads are shown to the viewers and emotions captured using facial recognition.	Emotion as a Service Business Model- Affectiva is now offering the product through its partner iMotions and not directly. ⁷

The predominant business model used is Leverage Customer Data. The other Business Models are Land and Expand Strategy, Tiered Pricing Model and Emotion as a Service Business Model.

2.5 Cognitive Engagement

There are several user-friendly digital assistants such as Alexa, Siri, Google Assistant, and chatbots which use AI and which interact with users in a conversational manner (bi-directional). A study was done to understand the adoption determinants of AI in-home Voice Assistants like Alexa. Results showed that the users are motivated by “utilitarian benefits, symbolic benefits and social benefits” that voice assistants provide.

⁶ <https://www.cleverism.com/google-business-model/>

⁷ <https://www.affectiva.com/what/products/>

Only in smaller households, hedonic benefits were one of the motivating factors. Perceived privacy risks played a moderating role in negatively influencing its use [13]. It is not only the private firms that are implementing and using AI applications, but the Government has also started adopting these by use of AI chatbots that use “natural language processing, machine learning, and data mining technologies” [3]. In the United Kingdom, National Health Service is conducting a non-randomized trial comparing the Babylon chatbot to get advice and information based on the symptoms and the non-emergency telephone number. There is another study that evaluates an ECA Oncology trial advisor on chemotherapy regimens for cancer trials [4].

Table 5. Real-World AI applications in Cognitive Engagement

Application	Description	Business/Revenue Model
Sam, intelligent travel chatbot that uses AI – FCM Travel Solution.	Smart Assistant for Mobile is a pocket travel assistant. It is simple and intuitive due to the chatbot-based interface.	Freemium – The basic version, which offers a comprehensive overview of the travel itineraries, is free for download. However, if corporate travellers want to access the full capability, it needs to be integrated with the FCM Connect technology suite.
Jill Watson, a virtual teaching assistant chatbot	It can reply to questions regarding assignments. Trained on data based on previous questions & answers.	Freemium and Subscription Model – Digital Lite version is free which is capped at 10,000 free API calls. Paid Standard, Plus, Premium and Deploy Anywhere versions available. https://www.ibm.com/cloud/watson-assistant/pricing/
Drift – Conversational Marketing- https://www.drift.com/marketing/	AI-enabled chatbot made for some compelling marketing strategies for connecting businesses to only the best leads in real-time.	Freemium and Subscriptions Models- Free: For sites that want basic chat capability. Standard: Enterprise Partnership Model- Customers can be a strategic partner and Drift can help with its martech experience.

The predominant Business model used in this area is Freemium and Subscription models. The other models used are the Crowd Sourcing Model and the partnership model.

3 Findings

From the data shown above in Tables 1 to 5, we can summarize business models as follows.

Table 6. AI Business Models Summary

Business Models	Description	Emerging AI Models	Remarks
Vertical Integration and On-device Edge AI – Apple	Apple owns it all starting from the chip to run deep learning algorithms on the Edge, to the App store	Federated Learning: A New AI Business Model ⁸	Vertical Integration and On-device Edge AI - Apple
Open Business Model/Partnership – Lepu Medicals, Artery Cardio, Zebra Medicals, Hilton Robot, Blue River weed control	Partnership between companies providing infrastructure and computational services, AI dev companies and companies providing the business knowledge and domain expertise.	Triangular Partnership model	Partnership between 1) Companies that provide infrastructure, computational services and pre-trained models 2) AI development companies, mostly startups. 3) Businesses with domain expertise that can provide the data.
Freemium and subscription Model – eMurmur Id, Buoy Health, Sam Intelligent Chatbot, Jill Watson teaching assistant, Drift and Duolingo.	Subscription model has been the most common for chatbots.	The freemium model is an existing one. In this study, we find it is mainly used for medical tools, chatbots and virtual assistants.	
Rent or Buy/ Rent to own Business Model.	Revenue model mainly used for robots – lease, pay per use, rental agreements etc.	The Rent or Buy model is an existing one. In this study, they have been used mainly for Robots.	Emulates how the companies do business traditionally by paying humans and now Robots.
Leverage Customer Data	Data is central to AI. Customer data is collected and value created for internal and external use.	Leverage Customer Data is an existing one but enhanced by AI	AI has enhanced this by the use of Big Data Analytics and Deep learning algorithms.

⁸ <https://towardsdatascience.com/federated-learning-a-new-ai-business-model-ec6b4141b1bf>

Land and expand model	Getting a foot in a business and then working to build credibility and trust to expand and increase their offerings and revenue.		Land and expand model
Emotion as a service - Affectiva	Emotions captured using AI can be used for marketing dynamically.	Create new Business Models using Emotion AI. Straker et al. 2015	Emotion as a service - Affectiva

The emerging AI-driven business models are Federated learning, the triangular partnership model, using Emotion AI to come up with new business models. The existing ones enhanced by AI are the freemium model, Rent to Buy model, leverage customer data and the land and expand model.

4 Implications for Managers and Researchers and Future Work

This paper has made a systematic study of the real-world applications of AI and has summarized the emerging AI-driven business models. It is important for managers who want to implement AI in their organizations to have a facilitating AI strategy that supports and enables AI. This paper will serve as a knowledge base and a quick guide for the managers to help them come up with the AI strategy using the emerging AI business models that have emerged from the literature review. It will also help the researchers to gain an understanding of the latest AI research trends and how AI has been operationalized from the research labs into the real-world.

The emerging AI-driven business models are Federated learning, the triangular partnership model, and using Emotion AI to come up with new business models. The existing ones enhanced by AI are the freemium model, Rent to Buy model, leverage customer data and the land and expand model.

The most common one is the Open Business Model/ Partnership model. Companies that adopt an open business model find innovative ways of working together with partners to diversify their business [10]. Pursuing an open business model strengthens both companies by diversifying their respective capabilities and programs. Managers can use this business model to implement AI in their companies if they are not able to own it completely and they are dependent on partners willing to collaborate and help with technical skills, infrastructure needs, machine learning algorithms, etc. They can team up with companies in the AI space, partner with key players and have a strategic agreement with companies to diversify their capabilities.

The other most common business models are the *Rent or Buy/Rent to Own Business Models* and the Freemium models. If the customer rents the product, he saves on the capital and the company benefits from higher profit. Product is effectively utilized as the period of non-usage is reduced [10].

In the Freemium business model, there is a basic free version that attracts a high volume of customers and a premium version with additional features/services. The hope is that those customers who start with the free version will, later on, pay for the premium version. Revenue is obtained from the premium customers who cross-finance the free version [10].

An analysis of the research papers and real-world applications were mainly done in the five areas, namely, medicine, robotics, agriculture, computer vision, and cognitive engagement. This can also be extended to other areas. In medicine, most of the examples pertained to cardiology and robotic surgery. Future work can look at other domains in medicine. The paper does not look into the challenges of AI implementations in the different areas and determinants of its adoption. This can also be taken up in the future.

5 Conclusions

The paper gives an insight into the emerging AI-driven business models.

Apple puts AI/machine intelligence at the edge with on-device Edge AI where devices are smart enough to function when they are offline and secure enough to take care of the privacy of the customers. This follows the federated learning business model.

Many companies are using a partnership model to reduce costs and to also help with training the machine learning model on a diverse set of data. Tech giants have been using the strategy of acquiring startups working in AI. Some companies use the Rent or Buy Revenue Model/Rent to Own business Model. Renting a product helps save on the capital for the customers and the company benefits due to higher profits.

Some of the other interesting business models that have emerged are the Emotion as a service model which is used for emotion-based innovation, the 'land and expand model' wherein the organization first gets a foot in a business and then works to build credibility and trust to expand and increase its offerings and revenue.

The findings from this study will provide a road map and serve as a guide for other organizations that are keen on creating value through AI adoption.

References

1. Adnan, N., Nordin, S.M., bin Bahrudin, M.A. and Ali, M., 2018. How trust can drive forward the user acceptance to the technology? In-vehicle technology for autonomous vehicle. *Transportation research part A: policy and practice*, 118, pp.819-836.
2. Alsharqi, M., Woodward, W.J., Mumith, J.A., Markham, D.C., Upton, R. and Leeson, P., 2018. Artificial intelligence and echocardiography. *Echo research and practice*, 5(4), pp.R115-R125.
3. Androutsopoulou, A., Karacapilidis, N., Loukis, E. and Charalabidis, Y., 2019. Transforming the communication between citizens and government through AI-guided chatbots. *Government Information Quarterly*, 36(2), pp.358-367.
4. Bibault, J.E., Chaix, B., Nectoux, P. and Brouard, B., 2019. Healthcare ex Machina: Are conversational agents ready for prime time in oncology?. *Clinical and translational radiation oncology*.

5. Cannesson, M., Tanabe, M., Suffoletto, M.S., McNamara, D.M., Madan, S., Lacomis, J.M. and Gorcsan, J., 2007. A novel two-dimensional echocardiographic image analysis system using artificial intelligence-learned pattern recognition for rapid automated ejection fraction. *Journal of the American College of Cardiology*, 49(2), pp.217-226.
6. Chen, H., Engkvist, O., Wang, Y., Olivecrona, M. and Blaschke, T., 2018. The rise of deep learning in drug discovery. *Drug discovery today*, 23(6), pp.1241-1250.
7. Do, H.M., Pham, M., Sheng, W., Yang, D. and Liu, M., 2018. RiSH: A robot-integrated smart home for elderly care. *Robotics and Autonomous Systems*, 101, pp.74-92.
8. Eslamizadeh, G. and Barati, R., 2017. Heart murmur detection based on wavelet transformation and a synergy between artificial neural network and modified neighbor annealing methods. *Artificial intelligence in medicine*, 78, pp.23-40.
9. García, J. and Shafie, D., 2020. Teaching a humanoid robot to walk faster through Safe Reinforcement Learning. *Engineering Applications of Artificial Intelligence*, 88, p.103360.
10. Gassmann, O., Frankenberger, K. and Csik, M., 2013. The St. Gallen business model navigator.
11. Johnson, K.W., Soto, J.T., Glicksberg, B.S., Shameer, K., Miotto, R., Ali, M., Ashley, E. and Dudley, J.T., 2018. Artificial intelligence in cardiology. *Journal of the American College of Cardiology*, 71(23), pp.2668-2679.
12. Kurup, A.R., Ajith, M. and Ramón, M.M., 2019. Semi-supervised facial expression recognition using reduced spatial features and Deep Belief Networks. *Neurocomputing*, 367, pp.188-197.
13. McLean, G. and Osei-Frimpong, K., 2019. Hey Alexa... examine the variables influencing the use of artificial intelligent in-home voice assistants. *Computers in Human Behavior*, 99, pp.28-37.
14. Mozaffari, A. and Behzadipour, S., 2015. A modular extreme learning machine with linguistic interpreter and accelerated chaotic distributor for evaluating the safety of robot maneuvers in laparoscopic surgery. *Neurocomputing*, 151, pp.913-932.
15. Palep, J.H., 2009. Robotic assisted minimally invasive surgery. *Journal of Minimal Access Surgery*, 5(1), p.1.
16. Partel, V., Kakarla, S.C. and Ampatzidis, Y., 2019. Development and evaluation of a low-cost and smart technology for precision weed management utilizing artificial intelligence. *Computers and electronics in agriculture*, 157, pp.339-350.
17. Rajan, K. and Saffiotti, A., 2017. Towards a science of integrated AI and Robotics. Sabzi, S., Abbaspour-Gilandeh, Y. and García-Mateos, G., 2018. A fast and accurate expert system for weed identification in potato crops using metaheuristic algorithms. *Computers in Industry*, 98, pp.80-89.
18. Sabzi, S., Abbaspour-Gilandeh, Y. and García-Mateos, G., 2018. A fast and accurate expert system for weed identification in potato crops using metaheuristic algorithms. *Computers in Industry*, 98, pp.80-89.
19. Singh, A.K. and Nandi, G.C., 2016. NAO humanoid robot: Analysis of calibration techniques for robot sketch drawing. *Robotics and Autonomous Systems*, 79, pp.108-121.
20. Tan, J.H., Bhandary, S.V., Sivaprasad, S., Hagiwara, Y., Bagchi, A., Raghavendra, U., Rao, A.K., Raju, B., Shetty, N.S., Gertych, A. and Chua, K.C., 2018. Age-related macular degeneration detection using deep convolutional neural network. *Future Generation Computer Systems*, 87, pp.127-135.
21. Toh, T.S., Dondelinger, F. and Wang, D., 2019. Looking beyond the hype: Applied AI and machine learning in translational medicine. *EBioMedicine*.