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Business Information Systems

Bachelor Thesis

OPPORTUNITIES AND CHALLENGES OF DEEP LEARNING IMPLEMENTATION IN SOCIAL MEDIA

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INTRODUCTION

During the last twenty years, artificial intelligence has been experiencing its biggest popularity growth ever. Major changes happened around the year 2000. As mentioned by Yann LeCun (2016), director of AI research at Facebook and professor at NYU, by the year 2000 Convolutional Neural Networks (CNN) processed an estimated 10% to 20% of all written checks in the United States of America. This perfectly shows how important deep learning models were, even in the year 2000. By now this number has grown even more and deep learning networks became an inseparable part of the modern-day business world.

The emergence of deep learning is for the most part a consequence of the increased availability of big data as well as increased capabilities and computational power of hardware. Explosive growth paved way for the creation of new study fields and the expansion of already established research areas related to big data and artificial intelligence. In return, scientists from these fields created and are still creating a vast number of different networks, techniques, and algorithms. The creation of many techniques is necessary in today's world, due to the constantly increasing volume, velocity, and variety of information provided by big data systems.

This increase can partly be accredited to the major popularity increase of many different social media platforms. Every day 1.3 billion people use "Facebook Messenger". This number of users generates around 10 billion messages every day – worldwide (Aslam, 2022). The mass amount of data shared on social media websites promotes and encourages social media companies to invest in the creation of new deep learning networks and algorithms. As some deep learning models are better at specific tasks compare to other networks, social media companies also invest a substantial amount of money and work hours into reworking and updating both modern and more traditional deep learning networks. Customization makes sure these networks are tailored to the specific needs of a social network.

The variety of networks and the possibility of different applications is extremely tempting for most businesses. Technological and social media companies are especially persuaded, because of the endless prospects deep learning can provide for a company's process optimization. But the most exciting opportunity is fascinating product and service creation for businesses' customers. Deep learning models are being used in almost all business sectors, from transportation and medicine to arts and banking

systems. This paper will concentrate on deep learning networks and the application of these networks on social media platforms.

As machine learning or deep learning applications are an ever-expanding topic and are talked about more every day, it is extremely important to understand what this technology is and how it is used. This includes understanding what data is utilized, how it is applied, and how it benefits both companies and customers. Many people do not know this information and most likely they also do not know how to find it. This leads to lowered trust in mentioned technology. Mistrust also carries on to companies gathering data and using it in deep learning networks. This is happening even though there are many opportunities as well as risks deep learning can provide to social media platforms and users.

Topic relevance

Over the last decade, social media usage has grown at an extraordinary pace. In tandem, deep learning practices and application possibilities have also increased significantly. This has led to all sorts of social media platforms incorporating deep learning algorithms into their software and started researching other possibilities for this technology. An increase in research and implementation was done with a variety of goals in mind, from increased marketing revenues, better understanding your customer needs to just providing customers with more useful and interesting functionalities.

Problem

Social media platforms are essential to many everyday users as well as businesses. Many people use vast amount of functions provided by these platforms – marketplaces, messaging, information sharing, content sharing. Because of this, a mass amount of information and data are shared through or stored by these networks. As data is created and shared by the social media users, it is important that involved parties understand how statistics are used or analyzed. Unfortunately, this is not the case and majority of users are unaware how both public and private date is utilized by social media deep learning networks.

Aim

Analysis and presentation of many unique deep learning applications technology and social media companies have developed or are currently developing, demonstration of main opportunities and challenges presented by deep learning research and application.

Objectives

- Analyze and present most popular deep learning neural networks, calcification and working principles.
- Present and explain main opportunities and application presented by deep learning neural networks in social media.
- Present and explain main risks and challenges presented by deep learning neural networks in social media.
- Conduct research regarding social media and deep learning connection (opportunities, risks, etc.) Literature, questionnaire, and interviews.
- Analyze gathered research results and present information regarding demographic statistics about questioned respondents.
- Analyze gathered research results and present information regarding popular neural networks, opportunities, and risks.

Research method

Comparative analysis method was used for this thesis. Main information sources where:

- Questionnaire and interviews
- Literature

During last 10 years many research papers concerning deep learning and social media integration were published. Research and development were primarily conducted by independent researchers or most often by research departments of social media platforms like “Meta AI” and other technological companies.

Theoretical information was predominantly gathered from research conducted by world renowned deep learning specialist. These research papers most often were published by Institute of Electrical and Electronics Engineers (IEEE). IEEE publish around 30% of all research papers concerning electrical and electronics engineering and computer science fields. Popularity, longevity, and relevance of this publisher increase trustworthiness of this information source, making it perfect for final thesis.

Additional source or material was gathered directly from “Meta AI” research. During interviews, a registry of all “Meta AI” current and past research project was mentioned. As thesis concentrates on possible opportunities and applications provided by social media companies to themselves and to customers. This primary source of material is extremely valuable. It provides information about all projects suggested, currently in development and already developed by researchers at “Meta AI”. Some information provided in thesis was also collected from articles and news reports provided by “IBM”, “Meta AI”, “Google” and other top technological companies in the world

More information was gathered during questionnaire and interviews period. Questionnaire and interviews data was utilized during research part of the final thesis.

Structure

First, an explanation of all relevant theoretical information will be presented. This includes information about deep learning network history, classification, and specific relevant networks (small amount of information was used form previous course works). Followed by an evaluation and presentation of the most popular modern business and social media applications of deep learning models as well as the risk and opportunities these applications present. Finally, research structure, process, details, and result will be presented at the end of the thesis.

LIST OF ABBREVIATIONS

AI – Artificial Intelligence

ML – Machine Learning

DL – Deep Learning

CNN – Convolutional Neural Network

LSTM – Long Short-Term Memory

RBM – Restricted Boltzmann Machines

RNN – Recurrent Neural Network

GRU – Gated Neural Unit

GMDH – Group Method of Data Handling

MLP – Multilayer Perceptron

NERF – Neural Radiance Field

NLP – Natural Language Processing

BPTT - Backpropagation Through Time

1. DEEP LEARNING

We can trace the first hints of deep learning back to two scientists Walter Pitts, a logician, and Warren McCulloch, a neuroscientist. In 1943 researcher duo were able to create first ever mathematical model of a neural network. Using a complicated combination of mathematics and algorithms, academics were able, to a certain degree, mimic inner processes of a human brain. Their finding was published in a seminar work "A Logical Calculus of Ideas Immanent in Nervous Activity" (Foote, 2017). Created model is still being used to this day and is called McCulloch-Pitts Neurons.

A decade later, additional advancements were made in the computer science field. The invention of machine learning can be accredited to "IBM" developer Arthur Samuel. In 1952 computer technologies were only beginning to get traction among the general population and compared to today were not up to the standard. Nevertheless, Arthur Samuel was still able to create the first ever rudimental machine learning algorithm. This relatively simple learning program was created to play a game of checkers. The game required a combination of two different systems, a scoring system, and a learning system. The scoring function determents the chance of winning, for both sides, based on checkers' pieces' positions. When it is artificial intelligence's turn, to make the best possible move, the software would make use of the Min-max strategy. This entailed that game software would choose a move that, given the opponent is playing perfectly, results in the best possible outcome. Learning systems comes into play whenever a move is made. By the end of a game, the system has recorded all outcomes and moves made by the player meaning next time it will not do the same mistakes. A combination of the scoring system and learning system made it possible for a computer to constantly learn and improve its strategy.

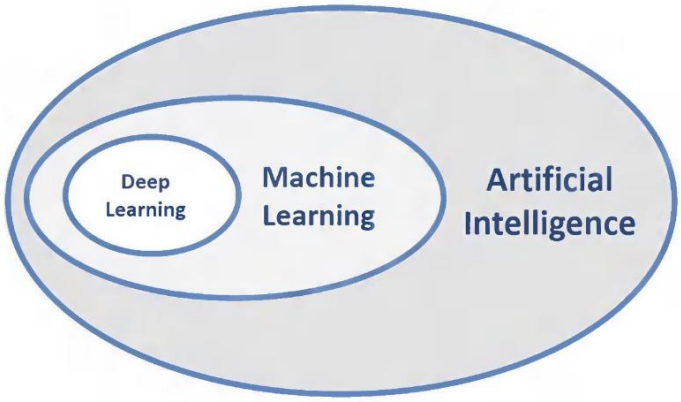
One more decade later first actual deep learning algorithm was created. In 1965 Alexey Grigoryevich Ivakhnenko and Valentin Grigor′evich Lapa developed the Group Method of Data Handling (GMDH). The system worked by utilizing the currently more traditional deep learning network - Multilayer Perceptron (MLP). The network uses statistical algorithms at each hidden layer for categorization or prediction problems. Later in 1971 first eight-layer deep learning model was created by the same creators (Fogg, 2018).

1.1. DEEP LEARNING WORKING PRINCIPLES

When thinking about deep learning, the first few topics that come into mind are artificial intelligence and machine learning. It is not wrong to connect these areas of study, but it is important to understand the difference. By their description, they portray distinct levels of the same study field (IBM Education, 2022). Machine learning is a subcategory of artificial intelligence and deep learning networks are the means to achieve machine learning. A perfect example of how to visualize the difference can be seen in Figure 1. Deep learning networks differentiate themself from traditional machine learning algorithms with multilayer artificial neural network algorithms, sometimes with an enormous number of hidden layers. Due to the complexity and depth of deep learning models, they do not suffer from a reduction of effectiveness over time as do other machine learning algorithms.

FIGURE 1

DEEP LEANING VS MACHINE LEANING VS ARTIFICIAL INTELLIGENCE



SOURCE: HOLZINGER, 2018

1.1.1. ALGORITHM CLASSIFICATION

Deep learning models are specialized to constantly learn and improve on certain tasks. Besides that, being an ever-growing field of study means there are many deep learning classifications and even more different algorithms. Deep learning networks same as other ML networks are classified based on learning style and results, they can produce. During the research, many different learning types of deep learning systems were discovered, ranging from whole fields of study to specific techniques used by

some specialists. For this thesis only the three most relevant and most popular calcifications will be mentioned and explained (Table 2).

TABLE 2

LEARNING MODELS

Learning model	Explanation
Supervised	Most popular and well-known learning system is Supervised. "Applications in which the training data comprises examples of the input vectors along with their corresponding target vectors are known as Supervised Learning problems" (Pattern Recognition and Machine Learning, 2006, p.3). In other words, the system is trained on input and output data and later inquired to make predictions on test sets based only on input data. Subsequently, prototype output variables are compared to the withheld test set output data, this way evaluating the Machine Learning model. These algorithms are referred to as Supervised because they make predictions given input data and are always supervised to alter the algorithm if necessary. Alterations are necessary until the algorithm starts making accurate predictions.
Unsupervised	Unlike Supervised Learning, Unsupervised Learning operates based only on input data, without output information. Meaning there is no teacher to supervise how the learning process is happening "In Unsupervised Learning, there is no instructor or teacher, and the algorithm must learn to make sense of the data without this guide" (Deep Learning, 2016, p.105). The main working principle is that the system analyzes provided data and determines correlations and relationships within that data set. During this process, an algorithm is left to interpret vast amounts of data and make predictions accordingly. This is the reason it is most often used to identify patterns.
Reinforced	The most unique learning type, compared to the other two, is the reinforced learning type. The reason is, that the machine is learning without any input data, only based on supplied results, supplied actions, and feedback it receives for its actions towards reaching the goal. "Reinforcement Learning is learning what to

Table continues in the next page

	do — how to map situations to actions—to maximize a numerical reward signal. The learner is not told which actions to take but instead must discover which actions yield the most reward by trying them" (Reinforcement Learning: An Introduction, 2018, p.1). This forces the Machine Learning algorithm to explore many different options and possibilities to find the most optimal result for a given task. In a way this is a trial and error learning method, learning from past mistakes, and adapting in the future, to reach the best possible conclusions.

SOURCE: PREPARED BY AUTHOR

Different learning methods require different amounts of data and are suitable for different applications. Supervised learning is more beneficial for classification problems and uses labeled data, unsupervised learning for clustering and used unlabeled data and reinforced learning for exploration problems, but do not have preferred learning data type.

1.1.2. DEEP LEARNING NETWORKS

The deep learning algorithm most often used as an example is called Multilayer Perceptron (MLP), which is considered a feedforward artificial neural network and is often referred to as the "Vanilla" model. MLP usually consists of at least three layers - an input layer, a hidden layer, and an output layer (Table 3).

TABLE 3

MLP LAYERS

Layer	Explanation
Input Layer	As the name suggests, this layer is required to provide a deep learning model with the necessary training and testing data.
Hidden Layers	Multiple layers (sometimes up to 150 or even more). Every single node in this layer is assigned a "weight" and "bias". This provides deep learning software with information about the importance of every single node in the system. Using "weights", "biases" and input data, the software calculates complex mathematical equations to provide the user with a guess that has the highest probability.

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Output Layer	Gathers and outputs results calculated by the hidden layer.

SOURCE: PREPARED BY AUTHOR

In all layers except for the input layer, nodes use a nonlinear activation function (meaning that each weighted input is mapped to each output node) (Zhang & Lipton & LI & Smola, 2022). This model utilizes a supervised learning technique called backpropagation – fine-tuning mentioned weighted inputs, based on error rate. MLP learns when provided with vast amounts of structured data, but unlike some machine learning algorithms, it is not explicitly programmed in a specific way and has no prior knowledge of input data (IBM Education, 2022).

To train and increase deep learning model accuracy and reliance, the system requires vast amounts of data. Model is trained on training data by comparing input and output data and rewarding the system for good guesses and punishing for bad guesses. Every training iteration, "weight" and "biases" values are slightly changed, constantly configuring the system, and increasing its accuracy and reliance.

The most challenging part for deep learning specialists is to keep up with available big data's velocity, volume, and variety. Every day available data is becoming more complex, bigger, and harder to analyze. Because of this reason, traditional feed-forward neural networks cannot utilize the majority of noteworthy data. New more advanced networks and models must be created. Deep learning is an extremely fast-growing study field with numerous techniques and networks. For this paper only five top usage networks will be presented - Convolutional Neural Networks (CNNs), Restricted Boltzmann Machines (RBM), Recurrent Neural Networks (RNN), which include architecture variants as Long Short-Term Memory (LSTM), and Gated Recurrent Unit (GRU).

It is necessary to inform that, while technological and social media companies take inspiration from these networks (base technology and theory are the same), finally created networks are highly customized and tailored to specific functions they must perform.

Convolutional neural network

One of the more popular feed-forward networks used for deep learning applications. Over the years used for various purposes. These include speech recognition and natural language processing but are most often used for computer vision systems, because of great two-dimensional data processing. Like

most neural networks it is comprised of the input layer, hidden layer, and output layer. The main difference from a common neural network is that the hidden layer is constructed from one or more convolutional layers and pooling layers (IBM Education, 2022). The purpose of the convolutional layer is to extract details from the input image (edges, color, gradient, shapes). The addition of more Convolutional layers increases extraction accuracy. Pooling layers reduce processed data dimensionality, this in return reduce required processing power and extract image dominant features. Because of the relative simplicity of this network, it is easier to train (Saha, 2018)

Restricted Boltzmann machines

As said by Ruhr University Bochum machine learning professor Asja Fischer – "Boltzmann machines have been introduced as bidirectionally connected networks of stochastic processing units, which can be interpreted as neural network models". Meaning it is all directional and random. The system makes up only two layers (visible and hidden) and restricted connections between these two layers. Restricted means that all nodes in the visible layer are connected to all nodes in the hidden layer, but not to other nodes in the same layer. Besides structure RBM differentiates itself from other networks by the ability to calculate probability distribution over the provided set of inputs. These calculations can be successfully used for classification, regression, and filtering.

Recurrent neural networks

Popular deep neural network for use in natural language processing and speech processing. These applications are possible because of networks' ability to utilize and process sequential and time-series data. Unlike in CNN and other feed-forward networks in RNN networks nodes take information from prior inputs and allow them to influence current calculations. RNN nodes also contain the same parameters across the same layer, unlike feed-forward networks (IBM Education, 2022). The network trains itself by comparing errors from its output layer to its input layer. This is called a backpropagation through time (BPTT) algorithm. With a combination of gradient descent, reinforcement learning is enforced. Because of this algorithm if current results depend on the input made a long time ago network encounters a long-term dependencies problem (IBM Education, 2022). This means that the network stops learning as the slope of the loss function along the error curve decreases to zero.

Three architecture variances exist from RNN, but for this thesis, only the one most often used will be analyzed (Table 4).

TABLE 4

RNN VARIANCE

Variance	Explanation
Long short-term memory (LSTM)	LSTM differentiates itself from all other recurrent neural network models by partially solving long-term dependencies problems (exploding gradient problem has not been solved). The network consists of cells that in turn are formed out of forget gate layer, input gate layer, and output gate layers. All this information can be reviewed in original S. Hochreiter and J. Schmidhuber paper Long Short-term Memory. Data provided by the previous input will influence the current input and output. The system is built to memorize all previous inputs, meaning it is perfect for analyzing sentences and human speech. Long Short-Term Memory networks are most often used in Personal Digital Assistants (Siri, Google Assistant, etc.) and translational software, for example, Google Translate.

SOURCE: PREPARED BY AUTHOR BASED ON IBM EDUCATION, 2022

LSTM is most used RNN network, because of its capabilities to overcome some initial deep learning algorithm problems, increasing its usability and effectiveness.

2. DEEP LEARNING OPPORTUNITIES AND APPLICATIONS IN SOCIAL MEDIA

2.1. COMPUTER VISION

During the last decade, deep learning techniques became a vital part of various computer vision systems used every day by everyone from social media site companies to video-sharing webpages. These techniques can be applied in a variety of ways, including photo and video captioning, face, and body recognition (Table 5).

Image recognition

Most recognizable deep learning application. Usually, CNN algorithms are used for image analysis tasks, but most frequently a combination of different networks is utilized. Because only recognition is not enough and certain actions need to be done by other deep learning algorithms, to provide enough value to the user.

TABLE 5

IMAGE RECOGNITION OPPORTUNITIES

Application / Opportunity	Explanation
Automatic video and picture captioning	Using "Facebook" and "Instagram" as an example, CNN algorithms are used in combination with RNN / LSTM networks. The major advantage of these combinations is the capability to create automatic picture captioning for blind people. This creates additional ways for visually impaired people to use Facebook social media sites. The mentioned deep learning system can identify specific objects and items in the picture, for example - cars, boats, and different foods. The technique can also recognize a specific human face and body characteristics (eyeglasses, beards, smiles, human physique). Images can also be analyzed in a broader sense, for instance, what kind of environment surrounds the principal object of the picture (beach, mountains) (Metz, 2016). More recent development in subtitle creation added functionalities to caption viewed images

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	from the perspective of 215 different personalities. Providing more character and personality to captions presented by the algorithm (Shuster & Humeau & Bordes & Weston, 2019) YouTube uses automatic captioning for the same reason "Facebook" and Instagram does – to aid visually impaired users. YouTube's captioning model is more complex, because of the need to analyze video, but the idea remains the same (video is just an image, which is changed at least twenty-four times per second). YouTubes deep learning software can create natural language conceptional captions, meaning subtitles that describe the environment where the video is made and what actions take place in it (Conceptual Captions, Google AI) (Amirian & Rasheed & Taha & Arabnia, 2020). Text-to-speech system is added later to fulfill the original goal of having automatic video captioning to help blind people.
Face and body recognition	When talking about the face and body recognition, once again perfect example can be taken from "Meta AI". "Meta AI" more publicly known as "Facebook" has the biggest collection of personal photos and videos in the world. Knowing that "Meta AI" uses all this video and photo data to train CNN DL algorithms with the goal of perfect face recognition system. It can be seen in practice when uploading photos on "Facebook". Sometimes the system will recognize people in the photo and automatically caption them. It is even believed that the "Facebook" face recognition system is more accurate than the average user. In addition, "Facebook" has also trained its algorithms to recognize the human body. This was achieved using the same training methods and same training data, with some additions. Goal of mentioned DL network to recognize the nude body and this way automatically prevent people from uploading inappropriate picture and videos on the website.

SOURCE: PREPARED BY AUTHOR SHUSTER & HUMEAU & BORDES & WESTON, 2019 AND AMIRIAN & RASHEED & TAHA & ARABNIA, 2020

Opportunities created using image recognition algorithms are relatively direct. Most often applications that require image analysis or understanding, use CNN algorithms, which are relatively straightforward feed-forward networks. Some complications might come up, when a mashup of different networks is employed, for example applying both CNN and LSTM networks.

Picture and video manipulation

Research area "Meta AI" is currently investigating. These techniques/applications are currently experimental and are still under development. Considering already made advancements, it would make sense to incorporate them into customers' daily lives soon. Using deep learning algorithms there are two main manipulation techniques "Meta AI" is developing: live face de-identification and free-viewpoint video creation (Table 6).

TABLE 6

PICTURE AND VIDEO MANIPULATION OPPORTUNITIES

Application / Opportunity	Explanation
Live Face De-Identification	Non-traditional application tackles privacy and natural self-expression connection. By applying auto-encoder technology and face recognition networks researchers can manipulate how a human face looks on a live video. According to the lead researchers at "Facebook AI Research" and Tel-Aviv University Oran Gafni, Lior Wolf, and Yaniv Taigman it allows, for example, the user to leave a natural-looking video message in a public forum in an anonymous way, which would presumably prevent face recognition technology from recognizing them. Even though the task seems easy, reaching seamless results is extremely hard and at the present even top visual effects studios sometimes fail at this task. Currently, researchers are dealing with distortions in augmented video. Therefore, it could be ready for consumer testing soon.
Free-Viewpoint Video Creation	Currently, most visual media creation devices are only capable of capturing and presenting real-world video as a two-dimensional image. This is exactly the problem free-viewpoint video creation is trying to solve. Using a highly modified, but relatively simple Neural Radiance Field (NERF) algorithm

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	(modified MLP network) researchers can create dynamic three-dimensional videos (Xian & Huang & Kopf & Kim, 2021). Usually, the equipment required for this task is exceedingly costly and convoluted. To be more precise, to create three-dimensional video two high-quality cameras are required. After that, the separate task of editing and creating three-dimensional video comes. MLP algorithm developed by "Meta AI" performs significantly faster and cheaper as can be used on a smartphone. Nowadays created videos look rough, research and development continue for this technology, and might soon be available to the public via "Facebook" app.

SOURCE: PREPARED BY AUTHOR, BASED ON GAFNI &WOLF & TAIGMAN, 2019 AND XIAN & HUANG & KOPF & KIM, 2021

The most interesting opportunities are developed by “Meta AI” research teams. Both face de-identification and free-viewpoint video creation technologies are completely new ideas that are currently under development. It might be some time until these applications reach social media platform users, as they are extensively difficult to develop ant train to the acceptable level.

2.2. AUDIO PROCESSING

Creating a deep learning software for analyzing and processing speech and audio was and still is one of the fundamental goals for researchers in the majority of artificial intelligence fields. Its importance stems from the need to create a perfect natural language communication basis between a human user and a computer (Yu, Deng, 2016). Even though uninterrupted and flawless communication is still impossible, previously created deep learning algorithms, for example, Long Short-Term Memory (LSTM) network are extremely useful. Social media applications and the usefulness of these models can be categorized into two segments:

Human-human communication

Human-to-human communication can be advanced and eased by a variety of deep learning enhanced speech and audio processing applications. For example, automatic real-time translation and speech recognition (Table 7).

TABLE 7

HUMAN-HUMAN COMMUNICATION OPPORTUNITIES

Application / Opportunity	Explanation
Speech recognition	Human interaction can be also enhanced by speech recognition systems. Speech-to-text transcription is just one of many examples that can be provided as an example. LSTM networks are used for this software because of the same reason it is applied in real-time translation. This is the ability to analyze sequences (sentences people speak are just sequences of words) In combination with speech-to-text software it allows for fast and accurate speech recording. Software is most predominantly used in social media platforms to ease and quicken communication speed between two or group users. The same software can be and often is used to transcribe lectures or speeches for faster indexing, resulting in easier future use. Most recent advances concentrate on powering Artificial Reality (AR) applications for more convenient communication and realism (Seltzer, 2022).
Automatic real-time translation	One of the challenges when creating content and sharing it on social media sites like "YouTube" is the huge variety of cultures and languages people interact with. When uploading a video, people used to create subtitles for all their videos just to increase their social reach. This is both tedious and extremely inefficient and limits how and what information can be shared. Nowadays this challenge can be easily ruled out, because of speech-to-speech translational systems. These systems make use of LSTM networks, which are perfect for analyzing speech, because of their capability to remember and analyze sentences. Translation software is widely used by Google in their line of products. These include phones, headphones, and software, like one used by "YouTube" to create automatic subtitles. "Google" also provides help to other technological companies.

SOURCE: PREPARED BY AUTHOR BASED ON SELTZER, 2022

As human-human communication using technology is exceptionally important, especially in today's world, where technology is ever evolving, and influence more and more of people`s daily lives.

Both speech recognition and live translation, are impressively important to expand people's worldview and interconnectivity.

Human-computer communication

Even though the ease of communication between humans is a significant achievement, as mentioned before, the main goal is to create a natural language communication basis with computers. Most interesting applications of human-computer communication are content rephrasing in dialog systems, personal digital assistants (PDA) and chat bots (Table 8).

TABLE 8

HUMAN-COMPUTER COMMUNICATION OPPORTUNITIES

Application / Opportunity	Explanation
Content Rephrasing in Dialog Systems	Content rephrasing opportunity presented by "Meta AI" researchers. At this moment, "Facebook" is not actively developing any personal digital assistant system. Instead, social media company decided to skip development of base digital assistant and concentrate on expanding communication possibilities with already launched PDAs. This development can be presented by analyzing two different research organized by "Meta AI". First software is called MARGE (Multilingual Autoencoder that Retrieves and Generates). Pretrained deep learning system as trained on unsupervised data and applies MLM (variations on masked language model). Main advantage of this system is it capability to paraphrase multi-lingual, multi-documented dialog (Lewis & Ghazvininejad & Ghosh & Aghajanyan & Wang & Zettlemoyer, 2020). Second system is called BART, which is concentrated on making communication with and trough PDA as convenient and natural as possible. Model is capable of rephrasing given passages to better suite message context, without changing words or main message (Einolghozati & Gupta & Diedrick, 2020).
Personal digital assistant (PDA)	The first personal digital assistant was created in 1984 by Psion, a handheld mobile device designer, and manufacturer. PDAs created before the year 2011,

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	including the already mentioned one, lacked any voice interaction with the device and were merely created as a note-taking device. Even though it has already been used by people for almost 40 years, it only became popular in 2011 with the release of Siri – a personal digital assistant created by Apple. Siri revolutionized how people can interact with their mobile device and provided the user with an array of functions, like voice search, and performing certain actions on the phone like calling. Most importantly, Using NLP algorithms Siri was able to interpret sentences said to it and have particularly simple conversations with the user. Now, these functions are just the beginning of what can be performed on your mobile device using current PDAs help (Siri, Google Assistant, Cortana, etc.). At the current stage of PDA development, the software can perform the majority of actions that could be performed manually by the user. This includes calling, messaging, searching, browsing, calculating, etc. "Facebook" used to develop PDA called M, but in January 2018, they discontinued it. "Facebook" stated that M will be utilized in other projects.
AI Chat bot	Some of the best-known technology companies are currently developing Chat Bots. These include "Google" with chat bot called "Meera" and "Facebook" with chat bot called Blender. Both chat bots would not be able to function without training data provided by massive abouts of public social media data. Meera was trained using 341 gigabytes of public social media chatter and Blender with astonishing 1.5 billion public Reddit conversations (Hao, 2020; Heaven). Both systems can answer questions and interact with real humans in an information-dense manner also with some emotion and empathy as well as some personality. Unfortunately, existing chat bot skills are still far away from perfect. For example, Blender is only able to hold conversations for no longer than 14 turns, after that it stops making sense. Moreover, these Chat Bots sometimes start to create fake facts, a result of current state of deep learning algorithms (Hao, 2020). Creating chat bots that would be indistinguishable from real humans and would pass a Turing test is extremely hard. As acknowledged by Stephen Roller (2020), a research engineer at Facebook, you would have to

Table continues in the next

	create an AI to solve robot dialogue, and if you solve robot dialogue, you have created AI.

SOURCE: PREPARED BY AUTHOR, BASED ON LEWIS & GHAZVININEJAD & GHOSH & AGHAJANYAN & WANG & ZETTLEMOYER, 2020 AND EINOLGHOZATI & GUPTA & DIEDRICK, 2020 AND HAO, 2020

Uninterrupted, simple, and trustworthy communication between user and computer systems, might be even more important that human-human communication improvement. As well as being more important, it is also more difficult to train and develop. For this technology to have a significant effect on users, it must be developed, to level of exceptional accuracy and user friendliness.

2.3. SOCIAL NETWORK ANALYSIS

The extreme popularity of social networks like Facebook, Instagram, and Twitter has encouraged people to share immense amounts of data. This data comes in the form of pictures, videos, thoughts, ideas, and opinions. For a long time, all this unstructured data was not utilized to the extent it could be, but the success of other deep learning modes and applications paved a new way to use this unused data. New techniques like semantic evaluation, link prediction, or crisis response, were designed to utilize all big data present on social network sites.

Semantic social media analysis

Semantic evaluation, as the name suggests, is used to teach a machine to understand the semantic meaning behind posts shared by social network users. In a general sense, it is used to understand emotions and attitudes shared in social media posts. Semantic social media analysis has many uses and benefits. This type of analysis has the potential to identify trends in consumer behavior and communities. Technique enables responsible companies or people to understand general views and opinions about products or ideas of interest (Pouyanfar et al., 2018). Semantic evaluations, like most text-based analysis models, use LSTM. Most commonly semantic evaluation is used on Twitter. For example, it is used to evaluate reviews about a certain product or to comprehend views about certain topics. Unlike other social networks, Twitter keeps the information about all the "tweets" shared on the platform as well as how those "tweets" are shared between all Twitter users. This structure provided a deep learning algorithm with all necessary data and metadata about an object of interest (idea, product, etc.).

Beyond consumer behavior, the research potential of social media semantic analysis is enormous. Understanding the meaning behind consumer expressions on social networks is critical for understanding human attitudes, values, and behaviors. New semantic analysis technologies can monitor buying patterns, interactions, and other consumer information to better target prospects.

Link prediction

The technique of link prediction is also extensively used in social networks and other websites like online retail stores or news-related webpages. Using a simple explanation, link prediction does exactly what the name entails – predicts links that might interest the user, based on user preferences, viewing history, and similarities to other people. Facebook uses link prediction in a few interesting ways (Table 9):

TABLE 9

LINK PREDICTION TYPES

Types	Explanation
Friend, group recommendations	Based on current friend list, group lists, interactions with these friends or groups, and shared interests, systems try to predict who user might interact with or are interested in contacting. All information available to the social media platform is processed by a deep learning algorithm which in turn proposes potential friend or group suggestions.
Site or product recommendations	Like the majority of social media sites, Facebook generates most of its revenue by allowing companies and people to advertise products or services on their sites. Unlike showing advertisements on a TV, social network advertisement is based on link prediction algorithms, meaning that all adverts shown to the user are personalized, based on browsing history, interests, hobbies, etc.

SOURCE: PREPARED BY AUTHOR

Crisis responses

In an event of any natural or man-made disaster, authorities and quick response humanitarian teams prioritize data gathering and information extraction about events that transpired during the crisis (Pouyanfar et al. 2018). This is extremely important due to high-risk decision-making and a need to somehow support these decisions. The vast amount of unstructured data present in social networks supplies the majority of necessary data and information regarding the incidents. Because of the immense size of data, specialized deep learning models are used to categorize data, filter out unnecessary information and help support vital decision making.

2.4. RECOMMENDATION ENGINES IN SOCIAL MEDIA

Neural network-centered recommender systems use data to identify relevant products to recommend based on the user's engagement with the products. They also use data collected from multiple channels, such as different web pages and other customer accounts. The data used to train recommendation engines can be both explicit and implicit. This includes customer data, order history, cart events, etc.

A key problem faced by traditional recommendation systems is the issue of synonymy. One product may have multiple names and listings, so the recommender system can't distinguish between them. Another issue is scalability. As datasets grow larger, conventional recommendation systems cannot cope with the increasing volume of clients and products. This makes the overall performance of recommendation engines less than ideal. Deep learning can model a wide range of different user-item interactions with greater accuracy. Even now, deep learning can be used to deliver a more personalized customer experience. It is estimated that 60% of videos on YouTube were viewed through recommendations.

There are two types of recommendation systems (Table 10):

TABLE 10

TYPES OF RECOMMENDATION ENGINES

Types	Explanation
Content-based recommender systems	Based on user attributes.

Table continues in the next page

Collaborative filtering systems	Seek out similar audiences.

SOURCE: PREPARED BY AUTHOR

There are many benefits of using deep learning to create recommendation engines. It can process heterogeneous data sources and recommend diverse items based on textual, visual, and audio features. Traditional recommender systems have their limits, but deep learning allows for tighter integration. Multitasking algorithms can use side tasks and extract richer features from the content. This approach can be seen in Word2vec recommender system. System uses updated NLP network specifically tuned for recommendations, and social network analysis (Chamberlain & Rossi & Shiebler & Sedhain & Bronstein, 2020). With this approach, YouTube can target videos based on a user's most-watched history and improve its recommendations. Deep learning can also improve cross-domain recommendations. For example, a website can target ads to user's preferred interests using a specific domain. Deep learning allows for joint representations of images, text, and interactions. Hence, deep learning is an excellent candidate for social media recommendation engines.

A recent study published in "Meta AI" highlighted the benefits of deep learning in the context of social media recommendation engines. The team proposed a deep learning network – DLRM. An open-source neural network that works with higher-level attributers and works well with sparse data System uses a combination of two techniques (multilayer perceptron and embedding) (Naumov & Mudigere, 2022).

Distinct types of neural networks are used in s deep learning recommendation engine algorithms. For example, Multilayer Perceptron (MLP) is a feedforward neural network that has multiple hidden layers. It is flexible and can be applied to a variety of scenarios. Convolutional neural networks, which are also used to build recommendation engines, are designed to identify objects, while recurrent neural networks can process language patterns and sequences of data and are more suitable for text-based recommendations.

2.5. DEEP LEARNING IN SOCIAL MEDIA ADVERTISING

Deep learning in social media advertising can be effective for predicting consumer behavior based on what customers have said about a brand. The technology can analyze the social media platforms and messengers to predict the type of comments and likes that are relevant to a brand. Deep learning

algorithms can also determine customer sentiment, thereby segmenting the target market. It also provides valuable insight into the performance of existing and new products, as it helps track the behavior of current and prospective customers. The technology works by generating insights from massive amounts of data using multiple layers, allowing marketers to make quick decisions based on current statistics. Currently, marketers must spend endless hours analyzing and evaluating data to make accurate predictions. These efforts are labor-intensive and time-consuming, moreover, information changes every second.

While the use of deep learning is rapidly advancing, it has not completely replaced the human touch. For the most part, these new technologies are improving the quality and quantity of online interactions. Deep learning is especially helpful for companies that use social media advertising to market their products. By leveraging deep learning algorithms, businesses can monitor the social media space around the clock and gain better consumer insights. It is a terrific way to monitor a larger knowledge base and helps companies evaluate the industry holistically. With the help of deep learning, you can gain a better understanding of customers and improve advertising strategy. Deep learning can analyze text, images, videos, and audio files and make recommendations that will be most likely to be relevant to customers and the audience. More recent development made it possible to predict customer purchasing patterns based on advertising conversion rate. Model utilizes LSTM network on large-scale sparse data. (Xia & Lv & Gao & Wang, 2020).

Deep learning is a concept in artificial intelligence that uses large datasets to improve personalized content. It uses algorithms to identify patterns in data, such as browsing patterns and demographics, to make better predictions about users. The goal is to tailor services and content to meet the needs of each user. In social media advertising, deep learning allows brands to create individualized content based on user behavior. This is a powerful method for generating highly targeted advertisements. Using deep learning to make personalized content for social media advertising requires a fast content pipeline, including good customer data and a content management system. The platform must be able to capture customer information, tag posts, and control the entire process of reaching customers. Personalized content can come in a variety of forms, from product recommendations to the creative process. All types of advertising require different approaches and data, but the result can be a more effective, personalized customer experience (Li & Kong & Zhou & Zhang & Geng & Wu, 2021).

The use of machine learning to analyze user-generated content offers a wide range of marketing and business benefits, including the ability to predict which users will be interested in advertisements. With the help of machine learning, you can target your outreach campaign more effectively by displaying ads to people who are more likely to purchase your product or service. This process can also increase the effectiveness of content and increase companies return on investment.

2.6. MENTAL ILLNESS INDENTIFICATION USING DEEP LEARNING

Social media platforms present a unique opportunity to identify individuals at risk for mental illness. Because people create their content and choose whom they share it with, their social media messages can offer insight into a person's digital persona.

Despite the recent advances in the diagnosis and treatment of mental illnesses, many people remain undiagnosed. Identifying mental illnesses in social media is particularly important because the symptoms associated with these conditions are readily observable. Recently, researchers have developed automated methods for detecting these illnesses. These methods have been assessed through screening surveys, public sharing of diagnoses on Twitter, and membership in online forums. In these studies, researchers distinguished mental illness users from those with healthy minds based on patterns in their language and online activities.

The researchers are currently using machine learning (ML) algorithms to collect data on social media. These techniques allow them to analyze vast amounts of social media data and identify individuals with specific mental illnesses. They can also be used to improve traditional screening methods. The best way to learn how to recognize mental illnesses is by reviewing systematic reviews of social media studies that use this technology. The systematic reviews of social media studies can also provide directions for future research and help perfect feature extraction and processing methods (Kim & Lee & Park & Han, 2020).

Researchers have already identified behavioral and linguistic patterns associated with schizophrenia spectrum disorders. However, few studies have explored the application of image analysis to psychiatric care. Image-based social media platforms are widely used and investigating user-generated image data will help to strengthen the association between behavioral health and social media activity (Chen & Xia & Sun, 2020). The authors hope that these techniques will become a routine part of daily clinical practice. If the results are positive, they could improve mental health care and save lives.

3. DEEP LEARNING RISK AND CHALLENGES IN SOCLIAL MEDIA

Artificial intelligence is a powerful tool for analysis, but it also harmful to journalism. For example, the technology behind fake news videos is based on deep learning techniques that can create convincing videos. In 2018, a viral video featuring Barack Obama and Jordan Peele warned against the dangers of deep faking. The technology could allow fake news organizations to augment reporting and blur the line between reality and fiction. It could also put journalists at risk, which is why it must be combated. Fake news producers are nimble and innovative, so countering them requires fast and premature action. Researchers have developed multiple systems to identify fake news by applying a machine learning model. However, this technology cannot stop all the fake news. This technology still has a long way to go, and there is a need for regulation. In the meantime, researchers are developing more sophisticated solutions to this problem.

Deep learning algorithms are vulnerable to data poisoning. Using carefully designed data, malicious actors can feed these algorithms with biased information. The result is a bot that exhibits problematic behavior. Data poisoning is particularly effective against deep learning algorithms that draw their training data from publicly available data generated by external actors. Using this method, researchers were able to fool an AI chatbot created by Microsoft into misclassifying a street sign.

4. METHODOLOGY

The research aims to perform qualitative empirical research to identify the main deep learning applications, discoveries, and ideas in the social media industry. In addition, discover main deep learning networks their working principles, and usability in researched applications. Research results are later evaluated based on literature analysis.

To accomplish the aim of the research, the following objectives were set out:

1. Conduct analysis of literature and determine main networks, how they work and what are the main applications.
2. Create a comprehensive questioner to cover most of research needs. Intent is to learn new deep learning research ideas and perspectives discovered by social media companies.
3. Create a comprehensive questioner for interviews to cover rest of research needs. Intent is to learn new deep learning research ideas and perspectives discovered by social media companies.
4. Conduct empirical research.
5. Evaluate deep learning networks usability and recognition.
6. Evaluate deep learning application and opportunity in social media.
7. Evaluate deep learning challenges and risks in social media.
8. Summarize and analyze research findings.

Research methodology

A descriptive study using qualitative empirical research method was used in this research. A structured questionnaire based on theoretical framework was constructed. In addition, separate research was conducted in a form of interviews.

First part of the survey was oriented towards identifying demographic details of research sample. Information retrieved include, work industry, experience, country, specialization. Main survey included nine open ended questions exploring new and current research ideas, social media and deep learning integration possibilities, and risks. Survey participants were instructed to provide straightforward, simple, but accurate and deep answers. Because research aim is to identify the main deep learning applications, opportunities and risks simple straightforward answers are preferred. Last additional open-

ended question was added to the second section of the survey. Question explores deep learning neural networks and respective popularity of these networks in both social media industry and not.

Survey was chosen because of it being the least costly and most effective research method. In this case, questionnaire was designed which requires minimal investment to develop and administer and is relatively convenient for generalizing.

Additional interviews were need because of complexity of the topic. Even though surveys are enough when trying to understand generalized ideas. To understand topic in more details, gather more intriguing research information, to verify survey and literature findings an interview is necessary.

Aim

Methodical qualitative empirical research to analyze deep learning neural networks popularities and opportunities, risks these networks provide to social media.

Unit of measure

Research was conducted with a specific group of people in mind. For research to be accurate and trustworthy, only people with comprehensive knowledge in artificial intelligence and deep learning must be interviewed and questioned. In addition, an added group of people from social media industry were researched to create a connection between deep learning and social media industry. A prior evaluation of research sample was conducted using social media portal “LinkedIn” (ensuring research sample fits my criteria – deep learning, machine learning, artificial intelligence, data science or social media specialists). Platform was also utilized as a communication tool between researcher and the questioned party.

Sample size

Chosen sample size is relatively small. Original goal for sample size was at least 20 participants in interviews. Original goal was not reached as only 5 people agreed to participate in a live interview. To compensate for unfulfilled sample size a different approach was chosen. Additional 45 people were interviewed using questioners. These sample sizes were chosen because of very specific target group (individuals working with artificial intelligence, machine learning, deep learning, social media, both). As people in the target group are their field experts, a smaller sample size was selected.

Research trustworthiness

Research was performed while questioning and analyzing answers from deep learning, machine learning, artificial intelligence, data science and social media specialist. No additional people from other specialties were interviewed in the survey. Answers gathered from specialists are presented in the deep learning network evaluation part and should prove trustworthiness for this paper.

5. DATA ANALYSIS AND RESULTS

During the period of 1 month a total of 52 people were researched. In total 47 people have participated in the questionnaire and 5 people were questioned during an online interview. Interviewed people provided a comprehensive list of possible deep learning opportunities, neural networks, risks.

Data preparation

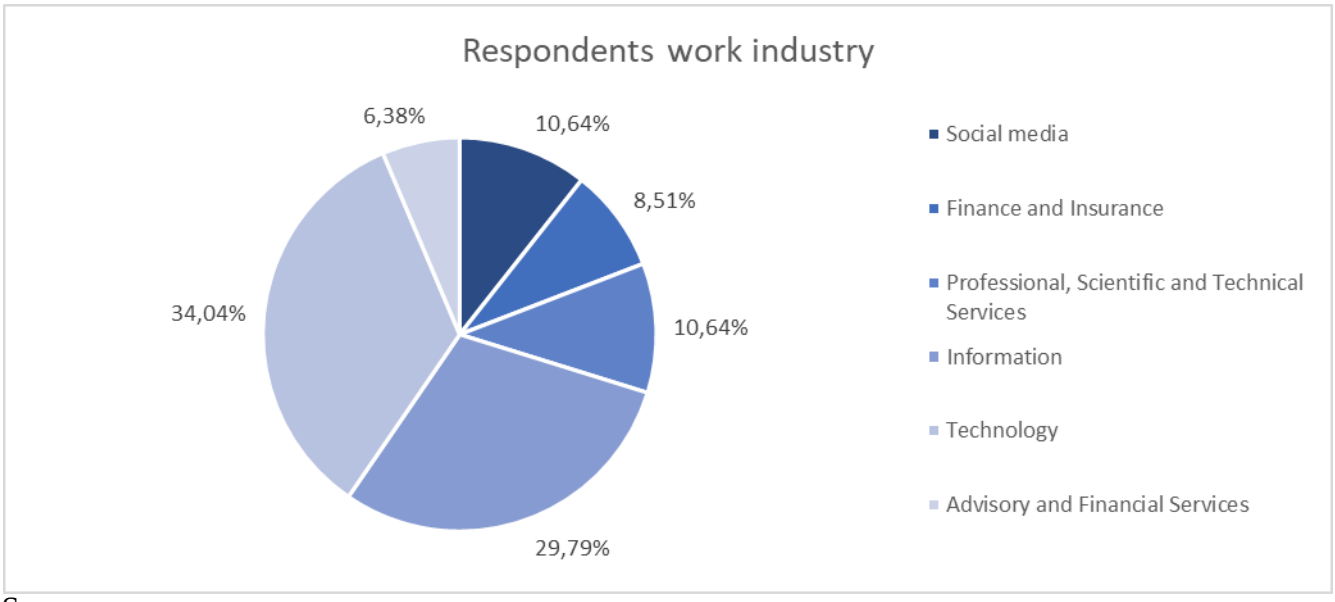
Data gathered during research mostly consisted of answers given in an open-ended format. Respondents were instructed to provide straightforward and simple answers without amplifying the answers. More detailed information was gathered during interviews. Deep learning is a vast subject with many different perspectives, terms, network variations, etc. This means answer data had to be manually adjusted (unify names, delete unnecessary explanations), grouped. Software "Microsoft Excel" was used for structuring data, fixing it, preparing, and evaluating it.

Demographics evaluation

First few questions were related to figuring out basic information about respondents. This was done with a goal of increasing trustworthiness of research. Only few questions were asked in this group of inquiries, and they concentrated on figuring out and presenting respondents professionalism as well as experience in relevant subject.

FIGURE 11

RESPONDENT WORK INDUSTRY



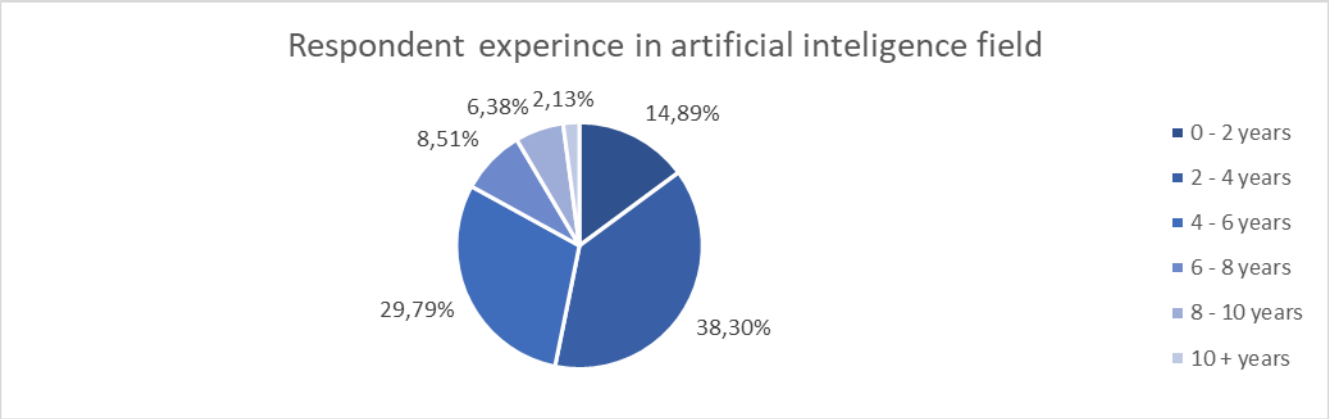
SOURCE: PREPARED BY AUTHOR ON THE BASIS OF THE RESEARCH

Majority of respondents came from information or technology industries (Figure 11). Both comprise 29,79 % and 34,04 % respectively. These two groups made up for more than half of all respondents. Third group based on representation consists of people from social media industries. Rest of respondents consists of people from finance, insurance, and scientific industries.

To increase research trustworthiness additional questions related to experience in artificial intelligence field were asked.

FIGURE 12

RESPONDENT EXPERIENCE IN ARTIFICIAL INTELLIGENCE



SOURCE: PREPARED BY AUTHOR ON THE BASIS OF THE RESEARCH

As seen in the pie chart (Figure 12) overwhelming majority of respondents have artificial intelligence experience from 2 – 6 years (68,09 %). More specifically 2 – 4 years (38,30 %) and 2 – 6 years (29,79 %). Least represented experience group is people with more than 10 years of experience (2,13 %), but as this subject is relatively new and innovation happens every day, experience from 2 - 6 years is enough for high reliability of the research.

Deep learning networks evaluation

To evaluate deep learning network recognition, gather a broad list of networks and assess respective reputation of these networks a significant part of questioner and interview questions were directed towards this goal. A wide range of different networks were mentioned by the questioned parties. Top 6 most mentioned and most relevant networks are present in table 13.

TABLE 13

TOP DEEP LEARNING NEURAL NETWORKS

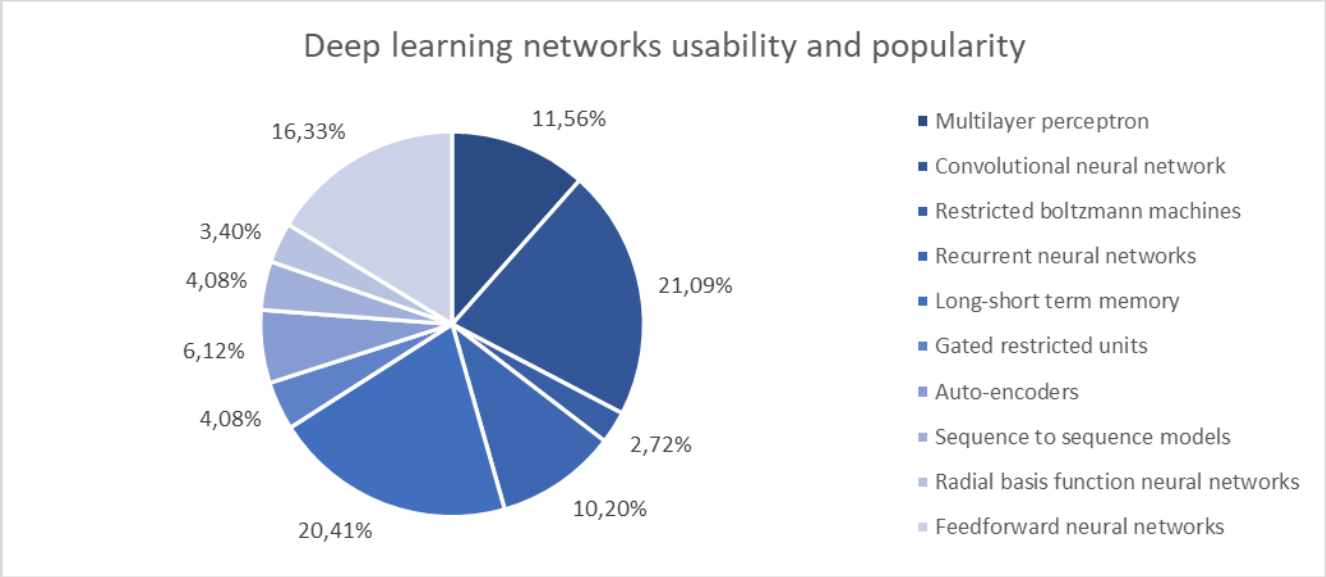
Network	Explanation
Multilayer Perceptron	A traditional "Vanilla" networks. Still used in many applications, but usually modified.
Convolutional Neural Network	Artificial neural networks most used for image recognition, due to great two-dimensional data processing
Restricted Boltzmann Machines	More unusual neural networks, mostly used for prediction problems and tasks.
Recurrent Neural Networks	Artificial neural networks with "memory". Meaning it is great for sequential data (texts, speech, etc.)
Long-Short Term Memory	Variance of RNN. Slightly modified networks, that solves additional problems provided by RNN network.
Gated Restricted Uni	Variance of RNN. Slightly modified networks, that solves additional problems provided by RNN network.

SOURCE: PREPARED BY AUTHOR ON THE BASIS OF THE RESEARCH

Pie chart (Figure 14) provides more detailed information about all mentioned neural networks' popularity, this is calculated based on amount of mentions each network received during the questioning.

FIGURE 14

DEEP LEARNING NETWORK USABILITY AND POPULARITY



SOURCE: PREPARED BY AUTHOR ON THE BASIS OF THE RESEARCH

It can be seen in the chart which networks are used most often and are most popular (Figure 14). Overall, 147 networks combined were mentioned (duplicates). These mentions include multilayer perceptron (11,56 %), convolutional neural networks (21,09 %), recurrent neural networks (10,2 %), long-short term memory (20,41 %) and feedforward neural networks (16,33 %), which can describe other networks in the list like MLP.

Application and opportunity evaluation

Majority of research was concentrating on gathering and evaluating many deep learning neural networks and social media integration possibilities. To connect deep learning networks with corresponding applications respondents were asked to provide few examples of social media applications for all networks provided by researcher (figured out during literature research). Applications were grouped based on functions and applications these opportunities provide (Table 15).

TABLE 15

DEEP LEARNING – APPLICATION GROUPS

Application Group	Explanation
Computer vision	Research related to all deep learning applications concern with how computer "understands" and augments visual data.
Audio processing	Research related to deep learning applications concerned with simplifying and easing human and computer, human and human communication.
Social network analysis	Research related to deep learning applications concerned with deeper understanding and improvement of existing and new social network platforms.
Customer behavioral analysis	Research related to deep learning applications concerned with analyzing and understanding social networks customers behavioral patterns.

SOURCE: PREPARED BY AUTHOR ON THE BASIS OF THE RESEARCH

Table below demonstrates all main mentioned applications and opportunities as well as respected neural networks most often used in these applications / opportunities.

TABLE 16

DEEP LEARNING NEURAL NETWORKS AND RESPECTED APPLICATIONS

Deep Learning Network	Opportunity / Application
MLP	• Free-viewpoint video creation • Recommendation engines • Advertisement
CNN	• Automatic video and picture captioning • Face and body recognition • Live face de-identification • Recommendation engines • Advertisement

Table continues in the next

RBM	• Crisis response • Link prediction
RNN	• Automatic video and picture captioning • Speech recognition • Automatic real-time translation • Personal Digital Assistant (PDA) • Recommendation engines • Advertisement • Mental illness identification • Chat bot • Content Rephrasing in Dialog Systems • Content Rephrasing in Dialog Systems
LSTM	• Automatic video and picture captioning • Speech recognition • Automatic real-time translation • Personal Digital Assistant (PDA) • Mental illness identification Content • Chat bot • Rephrasing in Dialog Systems • Content Rephrasing in Dialog Systems
GRU	• Fake news detection

SOURCE: PREPARED BY AUTHOR ON THE BASIS OF THE RESEARCH

One of the first developed neural networks is still in use. Multilayer perceptron, even though old algorithm, now called a “Vanilla” or traditional algorithms, is still useful in many applications and provide many opportunities for social media companies. These include free-viewpoint video creation, recommendation engine training and creation. MLP can be used in many scenarios and because of its versatility it is also often used in social media advertainment systems. MLP was one of the more

mentioned networks during the research, but it provides minimal potential for application opportunities. Modified MLP networks are extremely adaptable and are used in many unnamed social media applications.

Most applications related to processing visual data will in some way use convolutional neural networks (CNN). Application of single CNN network is most beneficial to functions concerned with analyzing or manipulating simple two-dimensional data. Data that qualifies based on criteria include pictures, paintings, tables, sometimes video. Most popular opportunities provided by this network include face and body recognition, face de-identification, recommendation engines. Network is quite often used in social media advertisement, because of high efficiency while working with pictures, photos, and other visual media. Video and photo captioning often use a combination of both CNN and Long Short-Term Memory Networks (LSTM). Depending on the situation or what needs to be captioned, either a CNN (for visual captioning) or an LSTM (for speech captioning) will be used (Table 16).

All applications connected to the text, speech, or meaning behind speech analysis will most often use LSTM, and only sometimes GRU. LSTM and GRU networks are great at sequential data analysis, meaning that all mentioned data is perfect for this model. For less intense amount of data processing, simple RNN algorithms will most likely be used. LSTM and GRU networks are more beneficial for bigger data sets, because of partial solution to long-term memory problem GRU network is also often used for fake news detection software. All sequence or time series applications can be used with all varieties of RNN model, only differentiator is effectiveness and time. Exception being Personal Digital Assistant. Because of some complex tasks it can perform, PDA most likely contains a combination of different networks, LSTM, CNN, MLP included (Table 16).

Finally, Restricted Boltzmann Machines preferred usage is related to predictions. That is why applications related to these networks are link prediction and crisis response (Table 16).

Challenges and risks evaluation

Secondary objective, compared to compiling an opportunity list, was gathering information regarding challenges and risks provided by deep learning implementation in social media. Method chosen was similar to gathering data about opportunities. Respondents were asked to provide risks and

challenges they imagine are present with this deep learning applications in social media. Three main risks were mentioned (Table 17).

TABLE 17

DEEP LEARNING RISKS

Risk	Explanation
Fake news	Creation and publication of fake news. Today, a lot of fake news generation is performed using deep learning networks. Researchers are currently working on solutions for this problem and are utilizing deep learning methods.
Data poisoning	If deep learning model is trained on manipulated data, final model might perform incorrectly without researcher or developers noticing.
Biased data	In a similar fashion as data poisoning, accidental data manipulation might break or influence deep learning networks, without creators realizing it.

SOURCE: PREPARED BY AUTHOR ON THE BASIS OF THE RESEARCH

All presented risks have connection. Main risk and challenge are inherited problem from deep learning. Like most artificial intelligence systems, deep learning requires vast amount of data. Social media networks are primary source of this data (reason why social media companies invest so many resources into this technology. One drawback of social media data is the fact that data can be and sometimes is manipulated. In all cases from fake news, data poising to biased data, main risk and challenge is uncertain or manipulated data.

Results

After analyzing gathered results certain conclusions can be made about current technological capabilities of deep learning networks in social media industry. Deep learning can provide many opportunities to social media industry. These prospects can be separated into few categories. First, applications can be separated into two categories already applied and still in development ideas. Secondly, all applications influence users or companies in direct or indirect manner.

- Opportunities begin from relatively traditional applications, with updated capabilities, like facial recognition, video / picture captioning, live translation, etc. Most of applications using single type or a simple combination of algorithm fall into this group. These applications directly influence how user interact with social media platform and can be noticed by most of the users.
- Second group of opportunities are non-traditional and are still under development. Substantial part of these ideas applies multiple networks or higley mortified single networks. As seen in the research, these include semantic analysis, mental illness identification, etc.
- Final group can be identified as higley customized applications, using variety of different and mixed networks. Most of opportunities, can directly influence future or current usage of social media platforms. Live face de-identification, free-viewpoint video creation, content rephrasing systems, etc. fall into this category.

CONCLUSION

In the early 21st century many companies were still viewing deep learning technology as a gimmick. This is understandable, because of the limited applications it could provide during that period. However, during the last two decades, humanity has experienced fantastic growth related to the hardware capabilities as well as machine learning algorithm creation and application. Now, the number of companies that recognizes the potential of this technology grows every day. It is correct to assume that deep learning has already or will eventually affect the majority of businesses in all possible sectors. As mentioned in the paper, it can be recognized that one of the sectors interested in deep learning network developed and used is social media. Because of enormous data stream through social networks, these companies can develop, train, and apply complicated DL networks on social network platforms.

Based on functionality, applications are separated into distinct segments. These segments are computer vision, audio processing, social network analysis, and customer behavioral analysis. Besides all applications mentioned in this essay, deep learning algorithms are also used in other sectors, for example, medicine, financial, IT security, and more. Implementation is usually useful for an organization, because of improved processes, improved decision making, or the creation of new products or services.

During research a substantial list of research applications, opportunities, risks, and networks was gathered and presented. An additional information about theoretical side of deep learning was also investigated. Research provided convincing information regarding thesis objectives:

- During literature research, necessary deep learning neural network information was gathered. Popular networks, classifications and working principles explained in the literature research part of the thesis.
- During literature research, vast amount of research articles regarding deep learning opportunities were gathered and later presented in the literature research part of the thesis.
- During literature research a list of news and articles regarding deep learning risks were gathered and later presented in literature research part of the thesis.
- Conclusive qualitative research was conducted to investigate social media and deep learning connection.

- After research a concreate, demographic responded profile was determined (AI, ML or DL specialist, working in mainly information and technology industries, with median work experience in industry - 2 – 6 years).
- After research a concreate list of popular neural networks, opportunities, and risks was determined. It can be stated that mainly used neural networks are: MLP, CNN, RNN, LSTM, GRU, RBM. Neural networks are used by social media networks to provide company itself and users with interesting opportunities. These might include live face de-identification, caption creation, speech recognition, etc. Deep learning implementation also has its risks, and they are: Fake news generation, data poisoning, bias data.

Overall, deep learning seems to constantly grow in popularity. Applications it provides are often new and extremely useful for both businesses and everyday customers. Meaning that technology delivers the necessary components for it to continue growing. If companies keep on providing customers with new and exciting innovations, this growth will not stop.

RECOMMENDATIONS

Main recommendations concerning deep learning implementation, usability and opportunities for social media will be presented:

- As trustworthiness of information, news or data published on social media is declining, social media companies should invest more recourses in countering creation and publication of fake or tampered information. Even though companies like “Facebook” and “Twitter” are investing substantial amount of resources in solving this problem, currently this is not enough, especially considering current geopolitical situation and vulnerability of social data.
- As mentioned in previous recommendation, a tremendously important course of action is needed to solve data poisoning in social media. While social media users are free to share any information and ideas, they see fit, some control would be acceptable. This control by means of deep learning networks, could be used to fight propaganda shared on social platforms with a malicious intent.
- Many social media users are concerned about data privacy. Currently all data captured in EU is transferred to US. Because data privacy regulations differ in these two areas (EU - GDPR regulations), EU users are uncertain about how their data is used by social media companies. It would be recommended to improve communication between social media representatives and platform users. This way contributing more recourses to transparent communication with social media users. Currently EU is fighting in court with “Facebook” over correct data storage location and rules (Bloomberg, 2022).

OPPORTUNITIES AND CHALLENGES OF DEEP LEARNING IMPLEMENTATION IN SOCIAL MEDIA

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Bachelor Thesis

Business Information Systems

Vilnius University, Faculty of Economics and Business Administration

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Vilnius, year 2022

SUMMARY

49 pages, 4 pictures, 13 tables, 37 references.

Almost 70 years ago exceptionally clever people started brainstorming and creating first-ever rudimental models describing how machines could learn (machine learning) and what applications they could serve. A decade later, the first machines capable of mimicking the human brain and learning manner have been created (deep learning). This learning manner was studying by example, from data provided by humans. It so happens that after the creation of the first deep learning model, the world has moved into the information age. This meant that people started generating an immense amount of data from all possible information sources, as well as creating more capable and better computer hardware. Using all possible advantages of this period, the popularity of deep learning networks has increased and is still increasing to this day. By now most technological companies utilize deep learning models to some extent, such companies like Google, Facebook, Twitter, Tesla, Amazon, and Microsoft. Some companies use deep learning for internal company processes management and optimizations, while some provide their users with new functionalities powered by deep learning models.

This paper will mainly focus on presenting most popular social media-oriented or social media developed deep learning opportunities, risks as well as what models enable those functions.

A literature and qualitative research were conducted to identify main applications / opportunities.

GILINIO MOKYMOSI ĮGYVENDINIMO SOCIALINĖJE MEDIJOJE GALIMYBĖS IR IŠŠŪKIAI

NAGLE VAIČIULIS

Bakalauro baigiamasis darbas

Verslo Informacinės Sistemos

Vilniaus Universiteto Ekonomikos ir Verslo Administravimo Fakultetas

Vadovas - Mindaugas Krutinis

Vilnius, 2022 m

SANTRAUKA

49 puslapiai, 4 paveikslai, 13 lentelių, 37 literatūros šaltiniai.

Prieš beveik 70 metų išskirtinai sumanūs žmonės pradėjo kurti pirmuosius pradinius modelius, aprašančius, kaip mašinos gali mokytis (mašininis mokymasis) ir kokioms programoms jos galėtų tarnauti. Po dešimtmečio buvo sukurtos pirmosios mašinos, galinčios imituoti žmogaus smegenis ir mokytis (giluminis mokymasis). Šis mokymosi būdas buvo tiriamas remiantis žmonių pateiktais duomenimis. Taip atsitiko, kad sukūrus pirmąjį giluminio mokymosi modelį pasaulis perėjo į informacijos amžių. Tai reiškia, kad žmonės pradėjo generuoti didžiulius duomenų kiekius iš visų galimų informacijos šaltinių, taip pat kurti galingesnę ir geresnę kompiuterinę įrangą. Išnaudojant visus įmanomus šio laikotarpio privalumus, giluminio mokymosi tinklų populiarumas išaugo ir auga iki šiol. Šiuo metu dauguma technologinių įmonių tam tikru mastu naudoja giluminio mokymosi modelius, pavyzdžiui, „Google“, „Facebook“, „Twitter“, „Tesla“, „Amazon“ ir „Microsoft“. Kai kurios įmonės naudoja gilųjį mokymąsi vidiniams įmonės procesų valdymui ir optimizavimui, o kai kurios teikia savo vartotojams naujas funkcijas, pagrįstas giluminio mokymosi modeliais.

Šiame darbe daugiausia dėmesio bus skiriama populiariausių į socialinę žiniasklaidą orientuotų ar socialinių tinklų plėtojamų gilaus mokymosi galimybių, rizikų ir modelių, leidžiančių šias funkcijas, pristatymui.

Buvo atlikta literatūra ir kokybinis tyrimas, siekiant nustatyti pagrindines taikymo sritis / galimybes.

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ANNEXES

Anne 1

Questionnaire:

DEAR RESPONDENTS,

Naglis Vaičiulis, a 4th year student at the Faculty of Economics and Business Administration of Vilnius University, is conducting research on the topic “OPPORTUNITIES AND CHALLENGES OF DEEP LEARNING IMPLEMENTATION IN SOCIAL MEDIA “. By agreeing to fill in the questionnaire, you will take part in a survey aimed at figuring out deep of learning, applications, opportunities, challenges, and risks. Please answer question without going into too much detail, but provide concreate, simple and straightforward responses.

Thank you for your help.

PART 1:

1. What industry do you work in?
    a. Arts, Entertainment and Recreation.
    b. Educational Services.
    c. Healthcare and Social Assistance.
    d. Finance and Insurance.
    e. Professional, Scientific and Technical Services.
    f. Information.
    g. Online Retail.
    h. Technology.
    i. Advisory and Financial Services.
2. How many years of experience do you have in artificial intelligence field of expertise?
    a. 0 - 2 years.
    b. 2 - 4 years.
    c. 4 - 6 years.
    d. 6 - 8 years.
    e. 8 - 10 years.

f. 10 + years.

3. What continent are you from?
    a. Europe.
    b. Asia.
    c. North America.
    d. South America.
    e. Africa
    f. Australia

PART 2:

1. Please provide few most popular deep learning neural network examples.
2. Please share few examples of what opportunities in business could be provided by deep neural networks
3. Please share few examples of what opportunities in social media could be provided by Multilayer Perceptron Network.
4. Please share few examples of what opportunities in social media could be provided by Convolutional Neural Network.
5. Please share few examples of what opportunities in social media could be provided by Restricted Boltzmann Machines.
6. Please share few examples of what opportunities in social media could be provided by Recurrent Neural Networks.
7. Please share few examples of what opportunities in social media could be provided by Long-Short Term Memory Networks.
8. Please share few examples of what opportunities in social media could be provided by Gated Restricted Unit Networks.
9. Please share few examples of what risks and challenges deep learning might provide in social media.
10. Please share few examples of what risks and challenges deep learning might provide to business overall.