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Machine Learning Based on Cloud Solutions

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Abstract

Cognition is a domain of thinking creatures, isn't it? Based on that computers cannot learn anything more than was in the initial data feed. In this article, I just want to defend that nowadays technical solutions can break this rule. The aim of this article is to provide a short technical overview what Machine Learning (ML), Artificial Intelligence (AI) and Neural Networks (NN) were before in the area of standalone gigantic servers, and how do they look now in Cloud Computing (CC) times. The ML paradigm is not any more reserved for big enterprises only but now is available for single internet user. I just want to present AWS and Azure, as the biggest CC providers, functionalities and potential usage of such Cognitive Services (CS) in current internet services. The great example is for instance bot usage instead of diving deep in the FAQ on the company website or digging into the corporate wiki. Another big area is graphics analysis and sound or text recognition. Those are only examples of predefined CC functions ready for use right now in the public cloud.

Keywords: Machine Learning, Artificial Intelligence, Neural Networks, Cloud Computing, Cognitive Services, AWS, Azure

What is the current course of new technologies development?

The Accenture Company in their Technology Vision 2017 report states that “technology holds the key to shaping the world around us. It’s also giving companies that do it right an opportunity to weave themselves into the new digital society” (Accenture, 2017, p. 6). The technology influence on the nowadays word shape is definitive and it is still emerging. The trends of upcoming time we can predict based on Gartner Hype Cycle for Emerging Technologies (July 2017). According to it on the pick of inflated expectations in a shorter period of time is development of Deep Learning, ML (2-5 years), Virtual Assistants and Connected Home (5-10 years). On the rising site were placed most innovation triggered ideas like: 4D Printing, General AI, Human Augmentation, Quantum Computing, Brain-Computer Interfaces, Volumetric Displays (all of them in the 10+ years period). On the slowly declining site are: Autonomous Vehicles (10+), Nanotube Electronics, Cognitive Computing, Blockchain (5-10), Commercial

UAVs (Drones) and Cognitive Experts Advisors (2-5). Trends predictions shows clearly that next years will spread and emerge of AI in everyday activities. Gartner also mentions two other trends: Transparently Immersive Experiences and Digital Platforms (Gartner, 2017).

AI/ML on standalone machines – a little bit of history

In 1959, the IBM computer scientist Arthur Samuel, defined ML as: "A field of study that gives computers the ability to learn without being explicitly programmed" (Bell, 2015, p. 2). In general understanding ML is a branch of AI. Using computing, we design systems that can learn from data in a manner of being trained. The systems might learn and improve with experience, and with time, refine a model that can be used to predict outcomes of questions based on the previous learning (Bell, p. 2). ML concept can be extended to Reinforcement Learning (RL), in which intelligent programs constantly adapt and learn to the environment based on points earned from taken actions. Feedback might be positive (reward) or negative (punishment). What differs RL and ML is that the researcher does not interfere training data sets, interaction happens with environment and not data itself, so many site factors may come into play. In RL all acts which are focused in and bring closer to the goal are rewarded (Nandy, Biswas, 2018, pp. 1-2). ML can use supervised or unsupervised learning. The first refers to working with a set of labeled training data. Every example in the training data got a pair of an input and an output object. On the opposite end of this continuum is unsupervised learning, where the algorithm can find a "hidden" (not described in initial hypothesis) pattern in the initial data set. In that type of learning there is no right or wrong answer; it's just a case of running the machine learning algorithm and seeing what patterns and outcomes occur (Bell, 2015, p. 3).

First examples of ML were (1) Alan Turing game where judge need to decide that is computer a human or not and (2) Arthur Samuel program to play checkers, where each board position was assigned a score based on its win likelihood. Basically, it worked, but Samuel wanted to improve the performance, so he prepared the program play thousands of games against itself and used the results to refine the positional scoring (Brink, Richards, Fetherolf, 2017, p. 3). This action seriously accelerates the ML development area. That time the server infrastructure was powerful enough to allow the ML development.

The ML development is based on at least two factors. First is data feed and second is computation power to process those data. In the background of those ML examples is the computation power based on IT infrastructure solutions. First of all, Operating System (OS) is needed. On the server infrastructure it can be installed like on common desktop but with some extra features to manage devices (DAS, NAS, SAN), connection interfaces (iSCSI, Fiber-Channel) and management tools (DFS for shared volumes, AD for user accounts and authentication, GPO for central permissions spread, WSUS for managing update policy, DHCP for IP addresses tenancy, DNS for IP translation into human understandable format, etc.). Normally the Bare Metal (BM) approach needs dedicated server components and special server room with air condition to ensure low humidity, isolated power source and infrastructure specialist to manage and maintain those. To use multiple isolated OSes the BM need Hypervisor like Hyper-V or VMware ESXi to allow access to resources (CPU, RAM, HDD) to particular Virtual Machines.

The classical server architecture is complex in configuration and hardly expensive to buy and maintain. Depending on application requirements the infrastructure state need to be expanded and often reconfigured or even rebuilt. This may cause the service downtime and interfere ML run results.

ML in the cloud - the important shift and available functions

Currently the ML development was shifted from standalone dedicated servers to CC lightweight services (PaaS, IaaS) available to use without having and maintaining complex server infrastructure inside the company. Obviously on the background of CC services there need to be hard server infrastructure, but it does not affect the end user to care about it. Data Scientist or Developer who is using those computation power as an end user do not need to take care of installing OS on machine, patching, provisioning and maintaining the whole infrastructure. He is only using set environment to accomplish his own goals. The CS, AI, ML services are offered now at least by two providers: Amazon Web Services (AWS) and Microsoft Azure.

Microsoft Azure provides CS which use AI to solve business problems. Services like Face API is used to detect, identify, analyze, organize and tag faces on photos and videos. Based on Azure Computer Vision API it is possible to recognize face, describe graphical content and insert tags into it and even detect mood of presented people (Emotion API (preview)). We can track reserved for adult or violent content and prevent unauthorized people to have an access to it. Azure provides speech analysis which allows to translate voice in real-time, convert it into text and then if needed prepare a short summary of long texts or search for the main idea. Azure Custom Speech Service allows to create language modes and isolate speaking style and specific vocabulary from background noise. Language Understanding (LUIS) allows user apps to understand specific commands. Bing Spell Check API detects and correct spelling mistakes and Web Language Model API allows to predictive language models trained on web-scale data. Section Knowledge on Azure is only on preview state, but in the future those services will be available as fully released. Services like Recommendations API, QnA Maker are self-explanatory. The same is on Search section, where we can choose Bing Autosuggest API, Bing News Search API, Web, Entity, Image, Video and Bing Custom Search API.

AWS on the ML initial page mention that Amazon has been investigating deeply in AI for over 20 years[1]. They offer at least six services which will be described below. Amazon Comprehend is a natural language processing (NLP) service that uses machine learning to find insights and relationships in text (identify the language of the text; extracts key phrases, places, people, brands, or events; understands how positive or negative the text is) and automatically organizes a collection of text files by topic. Amazon Lex is a service for building conversational interfaces into any application using voice and text. It provides automatic speech recognition (ASR) for converting speech to text, and NLU to recognize the intent of the text. Lex is the basis of Amazon Alexa and can be used to build natural language conversation bots. Amazon Polly allows to turns text into lifelike speech (using male or female speech). Amazon Rekognition is a deep learning-based image and video analysis, which allows to identify objects, people, text, scenes, and activities, as well as detect any inappropriate content[2]. Amazon Transcribe provides an ASR service and Amazon Translate is an NN machine translation that uses ML and deep learning models to deliver more accurate and more natural sounding translation than traditional statistical and rule-based translation algorithms.

One of the key advantages of CC approach in comparison with on-premise solutions is simplicity of usage. End user is only using particular service and do not need to set up and configure it from scratch. Scalability is the next benefit. On both CC platforms most of services can be scaled vertically (Azure) by rising up resources on running virtual machine or horizontally (AWS) by adding more containers and getting bigger performance. The reason for scaling up is mostly large number of instances, complexity of algorithm, high input dimensionality, but obviously the software architecture needs to fit CC expectations and allow to scale up or work multiple threads in parallel (Bekkerman, Bilenko, Langford, 2012, pp. 1-4).

ML functionality potential usage

ML is widely used in software field, where basically, application learns from initial usage based on user choices and after some time application is able to predict what the user wants to do. The most common example is the third-party firewall or some external browser plugin to block unwanted content. More complex is detection of some elements on the pictures or use OCR based on NN to transfer handwriting to computer text. Regardless of which example will be quoted, the fact is that the use of ML is always practical.

[1] https://aws.amazon.com/machine-learning/#
[2] https://aws.amazon.com/rekognition/

To better understand what ML is and how it works we can use a simple example. Let's try to use ML algorithm to distinguish cats from dogs based on their pictures. Firstly, when we got already defined a goal to accomplish, we need to collect data sets for training and testing purposes. In that example we will use supervised learning model and distinguish factors and features specific for two groups in separation. It is important to define what particular factor fits to which group (key-factor(s) and site-factors). The large and more variety data we will provide the better match accuracy we will get. On the next step the model needs to be trained using those data and numeric optimization. The last step will be the evaluation of built recognition model. In that part it is important to use different set of data than during training. In explained example ML algorithm in 83% properly identified which pet is a dog and which is a cat. Only one match doesn't fit, because of dogs' pointed ears (what was identified as a key-factor of a cat) (Watt, Borhani, Katsaggelos, 2016, pp. 1-6).

Very popular example is spam detection on e-mail account. For all the junk mail that gets caught, there's a good chance a Bayesian classification filter is doing the work to catch it. For instance, Google Mail has got implemented SpamAssassin mechanism, which was some form of learning whether a message is good or bad. When some message was classified as junk, it asks user to confirm or decline. If user decided that the message is spam, the system learns from that message and from the experience gathered so far. Future classifications should be more accurate (Bell, 2015, pp. 4-5).

Voice recognition like Apple Siri or Android Alexa services are another example of ML implementation. The service will perform a simple action (like send text message, open calculator, etc.) or Google the phrase in more complex questions (Bell, p. 5).

ML is also used in stock trading and predicting growth or falls based on previous history. Those algorithms can help to make decision whether to buy or sell (Bell, p. 5).

In robotics and general IoT industry the usage of ML now is very promising. Uses include home automation, smart meters for measuring energy consumption, shopping assistants or automotive driving assistants (Vehicle Blind Spot detection, Lane Departure Warning, Pedestrian Detection, Driver Attention Detection, Collision Detection and may others). Those mentioned are only few of many examples (Bell, pp. 6-9).

The wide area of ML usage is in Game Analytics. Jason Bell in his book Machine Learning. Hand-on for Developers and Technical Professionals mentioned Microsoft Forza Motorsport game: "Microsoft also worked on Drivatar, which is incorporated into the driving game Forza Motorsport. When you first play the game, it knows nothing about your driving style. Over a period of practice laps the system learns your style, consistency, exit speeds on corners, and your positioning on the track. The sampling happens over three laps, which is enough time to see how your profile behaves. As time progresses the system continues to learn from your driving patterns. After you've let the game learn your driving style the game opens up new levels and lets you compete with other drivers and even your friends" (Bell, p. 9).

The shift of ML

Currently ML and general working on AI development are more less moved into the CS. The main advantage of such shift is that developers don't have to take care of the infrastructure area and simply can focus on writing a code and testing. The CS also provides the flexible scalability of needed resources if developed application allows it. In that sense company don't need to build and maintain the costly data center filled with professional servers but only configuring CS from Internet browser using user-friendly GUI.

ML gives us only "illusion" of thinking, but it is rather following predefined rules - like OCR text recognition or detection of violent content in images/video based on set criteria. According to the General AI research the "intelligence" is understood as a general-purpose capability, not restricted to any narrow collection of problems or domains, and including the ability to broadly generalize to fundamentally new areas (Goertzel, Pennachin, 2007). Historically speaking in the beginning of AI in the middle of last century, the objective was to build "thinking machines" capable to compare with human minds. Some of them were very sophisticated these times - the General Problem Solver (Newell, Simon, 1963, pp. 279-293) and the Fifth Generation Computer Systems (Feigenbaum, McCorduck, 1983) - but taking into account the general initial goal, they failed (Wang, Goertzel, 2012, pp. 1-2). Popular method among modern cognitive scientists is to generate models or theories that predict and explain empirical data to help develop formal theories predict human grammatically judgments and to associate certain kinds of cognitive processes with brain regions (Cassimatis, 2012, pp. 13-14). These findings can only explain which areas of brain are active, but we cannot strictly connect particular human activity with isolated part of the brain, because lots of factors are connected[3]. In that sense these methods are not adequate to understand human intelligence.

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[3] For instance if researcher want to examine which part of brain is active when human is observing the red color, then he need also include the distance to colorful object, its shape, position, lighting level, etc. There is no possibility to isolate it and check which directly part of the brain is responsible for color recognition (or even red color perception).

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