НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ УКРАЇНИ
"КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ ІМЕНІ ІГОРЯ СІКОРСЬКОГО"

ПОЛІТЕХНІЧНИЙ УНІВЕРСИТЕТ ФІЛІПППІН (ФІЛІПППІНИ)

ЕКОНОМІЧНИЙ УНІВЕРСИТЕТ В БРАТИСЛАВІ (СЛОВАЧЧИНА)

МАТЕРІАЛИ XXII МІЖНАРОДНОЇ НАУКОВО – ПРАКТИЧНОЇ ОНЛАЙН КОНФЕРЕНЦІЇ ЗДОБУВАЧІВ ВИЩОЇ ОСВІТИ ТА МОЛОДИХ УЧЕНИХ

'SCIENCE AND TECHNOLOGY OF THE XXI CENTURY'

"НАУКА ТА ТЕХНІКА XXI СТОЛІТТЯ"

10 листопада 2021 р.

Київ – 2021

Science and Technology of the XXI Century: Proceedings of the XXII International R&D Online Conference for Students and Emerging Researchers, 10 November, 2021. Kyiv, 2021. Part III. 156 p.

The edition is recommended by the organizing committee of the Conference and approved by the Academic Council of the Faculty of Linguistics.

The edition features proceedings delivered at the Twenty Second International R&D Online Conference for Students and Emerging Researchers 'Science and Technology of the XXI Century' held at the National Technical University of Ukraine 'Igor Sikorsky Kyiv Polytechnic Institute' on November 10, 2021.
The Conference attracted over 400 students and postgraduates.
The publication is intended for scholars, undergraduate and postgraduate students from Ukraine, the Philippines, Slovakia involved in research and development work in different fields of science and technology.

The articles compiled in the book are reproduced without editorial interference as they were presented by the authors.

SECTION: MODERN INFORMATION TECHNOLOGIES

THE IMPLEMENTATION OF CUSTOMER RELATIONSHIP MANAGEMENT SYSTEMS
Anna Adamchuk
Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: system, client, company, relationship

Introduction. In the modern world, the competition in the market for goods or services is becoming very acute. Therefore, each company needs to somehow attract and retain customers, build good and long-term relationships with them. Implementation of the system will help to solve these problems. CRM is a tool that implements customer relationship management. In the literal sense, this is software that allows us to collect, store and work with customer information, keep records of communications, plan cases, prepare documents and analyze customer data.

Objectives. The main task is to study the CRM systems, its capabilities and development during the 21st century. Also, divide CRM systems for different purposes and highlight the best ones.

Methods. First of all, note main tools that include customer relationship management technology: collecting a single base with information about customers, statistics of the histories of relationships with customers, partners and suppliers, exchange of information between departments and employees, automation of the implementation of business processes, their integration into the work area, analysis of the effectiveness of marketing research, sales forecast and analysis of customer satisfaction (Morozov, 2015).

However, the CRM did not have so many opportunities all the time. Since 2007, the number of include customer relationship management systems offered for selection has increased tenfold, and companies' costs for their usage have increased from $7 to $69 billion (Gartner_Inc, 2021). CRM systems are gaining popularity because they offer new opportunities that are indispensable for manual labor. Some of them even offer the company to add new functionality, which is very convenient for narrow areas. According to the Scoro rating, «Sugar CRM», «Scoro» and «Salesforce» are in the lead among CRM systems (Leis, 2021).

As we can see, there are different tasks for different areas and companies, so it is important to be able to choose an CPM system. When choosing a system, the main task is to determine what the goals are for this tool, then analyze which employees will work in CRM system and what functionality is needed (Zaittseva, 2016). Also, there are five things to focus on:

1)	Clear interface. It should be clear to employees of different ages and directions.

2)	Wide functionality. The CRM system should cover all goals, objectives and automation needs.

3) Customization of functions. It is a big advantage to be able to adjust CRM system under company, to work as much as possible effectively and to adapt quickly to the new tool.

4) Integrations. It is very convenient when everything can be done in one system, without leaving one window, to configure sending to different services integrated with CRM.

5) Support. It is simply necessary if there are problems or problems with the system.

Results. There are many CRM systems on the market, so each company can pick up the necessary for itself. For example, the following areas can be identified: service sector, retail sales, small business, large business.

Service sector. Company needs to improve the level of service, order management, call recording and increase loyalty, so «EnvyCRM» and «AmoCRM» systems will be suitable for these purposes.

1) Retail sales. The system is required to increase employee productivity, automate work with orders and people, send personalized offers, retain customers, and receive feedback, so «EnvyCRM» and «RetailCR» systems will cope with these tasks.

2) Small business. This type of business needs to increase the speed of processing applications and the efficiency of employees, analyze indicators more deeply, increase sales and the cost of attracting. «Flowlu» and «Bitrix24» will be suitable for solving these problems.

3) Large business. «Salesforce and «KeepinCRM» will cope with automatization of business processes, monitoring employees and management a team.

Conclusion. With the right choice of a CRM system, successful relations with the client will be established and the quality of customer service will be improved, which ultimately should lead to an increase in the company's competitive advantages, an increase in profits and optimization of the company's activities.

References:

Gartner_Inc. (2021, April 29). *Market share: Customer experience and relationship management, Worldwide, 2020*. Gartner. Retrieved September 23, 2021, from https://www.gartner.com/en/documents/4001096-market-share-customer-experience-and-relationship-manage

Leis, M. (2021, March 1). *23 best CRM software and tools in 2021*. Scoro. Retrieved September 23, 2021, from https://www.scoro.com/blog/best-crm-software-tools/

Morozov E.M. (2015) CRM-sistemy kak sredstvo avtomatizacii vzaimodejstvija s klientami [CRM systems as a means of automating customer interactions]. *Sovremennye nauchnye issledovanija i innovacii,* № 3, Part 3. Retrieved September 14, 2021, from https://web.snauka.ru/issues/2015/03/49404

Zaitseva, V. (2016). Rating of CRM systems: TOP 20 best for Your business. *In Scale*. Retrieved September 21, 2021, from https://in-scale.ru/blog/crm-sistemy-rejting/

SATELLITE INTERNET – STARLINK
Kyrylo Andreichenko
Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Internet, satellite Internet, Starlink

Introduction. To begin with, the idea of satellite internet itself is not new. Today, there are several satellite Internet providers operating around the world. To become a subscriber of one of these companies and use their services, you need to purchase a transceiver for converting a satellite signal into a regular network and satellite dish. Modern transceivers with antennas for satellite Internet cost an average of $300 to $800.

Satellites allow you to cover a huge territory and this is their main advantage for providing the Internet. In fact, one apparatus can cover almost an entire hemisphere. But there are also disadvantages – radio waves have to travel a long distance through the atmosphere, which inevitably leads to interference and delays. As a result, the delay can range from hundreds of milliseconds to several seconds, which imposes significant restrictions. SpaceX aims to remove all of these limitations. The Starlink project was created in the United States by SpaceX under the leadership of Elon Musk to develop a high-performance satellite platform for the manufacture of communications satellites and the launch of large numbers of them into space. The new communication system created in this way will be able to provide access to broadband (high-speed) Internet in places far from communications. The first launch of test devices took place in February 2018. And in May 2019, with the help of the Falcon 9 rocket, the first 60 satellites were launched into low Earth orbit (Grush, 2018).

Objectives. The main task of satellite Internet is constant access to the Internet anywhere on Earth. According to current data, four out of ten people on the planet do not use the Internet. Over the past couple of years, network penetration has slowed due to the coronavirus pandemic. The vast majority of the world's population lives in regions where it is not possible to deploy wired Internet or arrange high-speed access. In many cases, building an Internet infrastructure for a specific area is very expensive - for economic reasons or due to poor geographical location. In this case, there is no alternative to communication via satellites.

Corporations need constant access to the Internet. For example, the economic potential of the Arctic is extremely high, but at the North Pole there is no possibility to conduct fiber-optic cable and constantly maintain the line. High-speed Internet is needed by state organizations – police, ambulances, rescue services, military enterprises. Speed is crucial in business. A small signal delay will cost brokers on stock exchanges millions of dollars.

Constant access to the network is necessary for the development of the Internet of Things, smart homes and cities. In the coming decades, with the advent of next-generation cities, the load on the network will be high, and the classic wired Internet may not cope.

Methods. SpaceX originally planned to launch 4425 satellites with Ka- and Ku-band transmitters (12 to 18 gigahertz and 26.5 to 40 gigahertz, respectively) with a service life of 5-7 years into low-earth orbit in 83 orbital planes in an altitude range of 1110 up to 1325 kilometers. According to the scientific publication N + 1, just such a placement, according to the company, should have eliminated the main disadvantage of satellite Internet – long delays in signal transmission. Then, in 2017, it became known that SpaceX's satellite constellation would consist of 11,943 satellites. In addition to the initial 4425 vehicles, it is planned to include 7,518 satellites in lower orbits, from 335 to 346 kilometers, to the constellation. As planned, all devices will be built into a peer-to-peer network (each satellite in the network will be an independent unit, simultaneously performing the functions of both a client, that is, a network participant, and a server that controls its segments). This should expand communication channels and increase access speed in densely populated areas – significantly lower satellite placement will reduce signal latency to 25 milliseconds. For comparison, in 4G cellular networks, the latency averages seven to eight milliseconds, but it can be longer depending on the load on the network and the remoteness of the cell towers (SpaceX, 2021).

In Ukraine, this connection, according to SpaceX, may appear in 2022. When you try to register Starlink from Ukraine, you will see the message "Starlink plans to cover your territory in 2022. Availability is a matter of obtaining permission from the local regulator. Applications will be processed on a first-come, first-served basis."

Results. In Ukraine, the average download speed from satellite Internet – Starlik with fixed broadband access is 40 Mbit per second, the average upload speed is 37 Mbit per second, and the average latency is 3 ms. If we talk about the mobile Internet, the average download speed, depending on the operator, varies from 13.79 Mbps (lifecell) to 19.04 Mbps (Vodafone), uploads – 7.88-8.93 Mbps, and the latency is at the level of 50 ms. In other words, Starlink's performance is very decent, especially considering that the project is now in a closed beta test, and the system will eventually cover the entire world. SpaceX promises that after the official launch, Starlink will provide speeds up to 1 Gbps with delays ranging from 25 to 35 milliseconds (nPerf, 2020).

Conclusion. Starlink is the largest project in the field of satellite communications, and perhaps the entire telecommunications industry in the XXI century, and theoretically gives a chance that satellite communications will return to the "game", because over the past 20 years it has gradually given way to fiber-optical lines in the segment of trunk channels and cellular communications in the market of broadband Internet access for the end user.

The Starlink project should be considered in two aspects: technological and commercial. Despite all the technical complexity of the project, in my opinion, the chances of SpaceX to create a working satellite broadband access system in low orbit are quite high.

But achieving commercial success – making the project profitable, returning money to investors and making a profit today – seems a more difficult task. And a similar story of the Iridium project is a vivid reminder of this.

We have to see in the next 2-3 years what will happen in SpaceX and Elon Musk.

References:

Grush, L. (2018). SpaceX just launched two of its space internet satellites – the first of nearly 12,000. Retrieved from: https://www.theverge.com/2018/2/15/17016208/spacex-falcon-9-launch-starlink-microsat-2a-2b-paz-watch-live

nPerf. (2020). ARM Cortex-A Series Programmer's Guide. Retrieved from: https://media.nperf.com/files/publications/UA/2020-03-30_fixed-connections-survey-nPerf-2019.pdf

SpaceX. (2021). Starlink Mission. Retrieved from: https://www.spacex.com/updates/starlink-mission-05-15-2021/index.html

MODERN PRINCIPLES OF APPLICATION OF INTERNET OF THINGS TECHNOLOGIES IN THE INTRODUCTION OF E-GOVERNMENT AT THE LOCAL LEVEL

Nikita Bakun

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: e-government, Internet of Things technologies, smart city, personal data protection, privacy

Introduction. Modern technologies fully capture all world systems, the public sphere is no exception.

The Internet of Things is a system where all devices communicate with each other through the exchange of data and information, a process often referred to as "communication of things". The biggest advantage of the IoT is that absolutely all devices communicate with each other without human help. Every year, the number of countries focusing on technological development and computerization is growing, primarily due to the simplification and time savings provided by IoT. However, there are also disadvantages, as there are increasing cases of misuse, such as the collection of personal data, intrusion into the privacy of citizens, cyber threats, and so on (Gillis, 2021).

Objectives. Current trends and options for the use of Internet of Things technologies in the implementation of smart cities, especially e-government at the local level. An example of the use of e-government at the local level is the experience of New York.

Methods. The job of the Internet of Things is to coordinate and control smart devices that support sensors and "communicate things" using informational data and analyzing it. IoT devices send a spare part to the cloud storage or exchange them directly. This whole process simplifies certain tasks and makes the process faster and in real time.

Thanks to the analysis of research results and foreign experience, we can say that the term "smart city" is a system that combines modern innovation, public interests, economic, political and business sectors. This can reduce waste or energy consumption, improve road traffic and increase safety (Lee, 2013).

Results. For example, in San Francisco there is a smart parking system SFpark: special devices process information about the number of free spaces to a special case. Experts estimate that thanks to this system, the search time for parking spaces has decreased by 50%, and the amount of harmful emissions into the atmosphere – by 25%. Another example of using data to optimize e-government at the local level is the experience of New York, in particular its municipal emergency management. Its main purpose is to prepare for and respond to major emergencies. Emergencies activate urban resources in new ways, forcing the creation of new data and operational processes that did not exist before (Tapscott,1999).

Conclusion. In order to effectively implement and disseminate the concept of the Internet of Things, it is necessary to actively involve citizens in this process. In the implementation of e-government, the priority should be – quality, efficiency, quantification and ease of use of open data.

References:

Gillis, A. S. (14.04.2021). EVALUATE Ultimate IoT implementation guide for businesses [Web log message] [Web log message]. Retrieved 19.09.2021, from https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT

Lee, J.H., Phaal, R., & Lee, S.-H. (2013). An integrated service-device-technology roadmap for smart city development. *Technological Forecasting & Social Change 80(2),* 286–306.

Tapscott, D., & Agnew, D. (1999). Governance in the digital economy: The importance of human development. *Finance & Development 36(4),* 34–37.

ROLE OF ADDITIVE MANUFACTURING IN CREATION OF SUSTAINABLE CLOTHING

Anna Bilous
Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: additive manufacturing, 3D printing, clothing, sustainability

Introduction. Since ancient times clothing served humans as protection from exposure to heat, cold, precipitation and various hazards. In the course of time, in addition to its original purpose, clothing also became the symbol of status, and during the last few centuries clothing has also become an instrument for self-expression. Unfortunately, nowadays the excessive amount of produced clothing and material wastage during the manufacturing process result in waste of precious natural resources and poisoning of the environment with non-biodegradable materials.

Additive manufacturing is considered a revolutionary process technology (Despeisse, Ford, 2015). It faces constant improvements and possesses high potential, but its impact on the fashion industry is still relatively low. That is why the development of clothing making technologies that involve the usage of additive manufacturing with the aim to create sustainable clothing is one of the most relevant topics.

Objectives. The objective of this work is to explore how additive manufacturing, also known as 3D printing, can be used during the clothing manufacturing process, define the advantages of 3D printing for the fashion industry and identify how 3D printing can produce sustainable clothing. The existing examples of clothing projects, footwear and jewelry, which were created using additive manufacturing technologies, will be reviewed in this work.

Methods. There are three main types of 3D printers: the Fused Deposition Modeling (FDM), the Selective Laser Sintering (SLS), and the Stereolithography (SLA) types (Kim, Seong, Her, Chun, 2019).

The SLS type is mostly used for industrial purposes and is unnecessary for fashion industry: the clothing does not require high durability that this type of 3D printer provides. In addition, the materials for this type require additional equipment for post-treatments, which is expensive, takes up a lot of space and is disadvantageous for fashion industry.

The SLA type produces parts with high level of details, smooth surface and tight tolerance. It seems suitable for clothing manufacturing, but the main disadvantage of this type is the price of equipment (mostly due to the high detailing of the products, which is unnecessary for clothing in most cases and is beneficial for industrial purposes as well).

The FDM type is cost-effective and is currently the most appropriate equipment for mass production clothing manufacturing, even though the products have rougher surface, compared to SLS and SLA type of products. Moreover, the FDM type uses plastic filaments for printing onto the build platform, whilst the SLS and SLA types use lasers to print with polymer powder and resin respectively. This allows the usage of recycable and bio-degradable plastic filaments, such as polylactic acid (PLA) and polyethylene terephthalate (PET).

With the help of 3D printing more complex designs become available without exceeding waste in materials. Even the highly detailed projects only require the materials for the parts themselves, with little to no non-recyclable leftovers as compared to more traditional methods of clothing production. Thus, not only does the process save on resources, but it also reduces the cost of the materials being used.

Results. Here are stated the best implemented 3D printed clothes projects.

‒ In 2015, a Dutch designer Anouk Wipprecht developed the Spider Dress that has extending and retracting mechanical arms, which react in response to external stimuli when people approach. The dress was fully 3D printed with SLS technology.

‒ In 2018, an American designer Julia Daviy presented her sustainable 3D-printed clothing collection that is comfortable to wear on daily basis. The first collection consisted of dresses, skirts and tops. She also designed a jewelry line and bags collection from recycled materials.

‒ Adidas company in partnership with Carbon 3D launched project called Futurecraft 4D. Its goal is the development of sport shoes with 3D-printed midsoles. These shoes are mass-produced and are currently available for purchase around the globe.

– Nervous System company specializes in 3D-printed jewelry that is inspired by natural phenomena and human blood vessel structure.

Conclusion. To sum up, additive manufacturing has already begun its gradual way into fashion industry and has high potential of becoming permanent part of fashion manufacturing in the future. The active development of environmentally-friendly synthetic materials gives chance for sustainable clothing to become 3D-printed and widespread much faster.

<div align="center">**References:**</div>

Despeisse, M., Ford, S. (2015, September). The Role of Additive Manufacturing in Improving Resource Efficiency and Sustainability. *IFIP Advances in Information and Communication Technology, 460(1),* 129–136.

Kim, S., Seong, H., Her, Y., & Chun, J. (2019, December). A study of the development and improvement of fashion products using a FDM type 3D printer. *Fashion and Textiles, 6(1),* 201–225.

Sculpteo (2021). 3D printed clothes in 2021: What are the best projects? Retrieved from https://www.sculpteo.com/en/3d-learning-hub/applications-of-3d-printing/3d-printed-clothes/

<div align="center">

FACIAL RECOGNITION TECHNOLOGY
</div>

<div align="center">*Evgeniy Bondarchuk*
Faculty of Biomedical Engineering, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"</div>

Key words: facial recognition, technology, identification

Introduction. Recently, it has become increasingly interesting to observe the development of newer technologies such as facial recognition. More than 10 years have passed since the first developments in this field were presented, and during this time new and promising possibilities have already emerged. With all that said, the development of the technology has advanced far and wide, never stopping for a second and far from being complete.

Objectives. Features facial recognition technology to improve our lives.

Methods. Facial recognition technology is a biometric software application that can uniquely identify or verify a person by comparing and analysing patterns based on a person's facial contours. Everyone has a unique facial structure. Special software is able to analyse it, matching it against information in a database to further identify who you are. The task of facial identification and recognition is one of the first practical tasks that stimulated the formation and development of the theory of object recognition and identification (Reddy, Kulkarni, & Hariharan, 2009). The interest in the procedures underlying the process of face recognition and facial recognition has always been considerable, especially due to the increasing practical needs: security systems, verification, forensic analysis, teleconferencing, etc. Despite the clarity of the mundane fact that humans are good at identifying people's faces, it is not at all obvious how to teach a computer to carry out this procedure, including how to decode and store digital images of faces.

Results. All modern face recognition technologies use systems that learn from test images. Bases with face-containing and non-face-containing images are used for training. Each fragment of the image under study is characterized as a feature vector, using which classifiers (algorithms to determine the object in the frame) determine whether the given part of the image is a face or not.

Conclusion. Face recognition authentication is about to become one of the most stable. There are methods available to detect and process faces using various levels of sophistication. To summarise, facial recognition for authentication purposes can enhance security. Converged neural networks (CNN) outperform any possible level of human recognition. However, such systems must be continuously improved manually. Another problem associated with such systems is that there has to be accurate data preparation before they can be deployed. It is very important that the system is fast enough to recognise people, and that training is easy as well as quick. (Rasch, 1980).

References:

Rasch, G. (1980). Probabilistic Models for Some Intelligence and Attainment Tests. US: Author.

Reddy, N., Kulkarni, S., & Hariharan, S. (2009). Facial Image Based Mood Recognition Using Committee Neural Networks. US: Author.

PROSPECTS OF 5G TECHNOLOGY DEVELOPMENT IN COMPARISON TO LOWER BAND SYSTEMS

Inna Butko, Kostiantyn Lisovskyi
Educational and Research Institute of Telecommunication Systems, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: 4G, 5G, 6G (4-th, 5-th, 6-th generation broadband connection technology); VoIP; IoT (Internet of things); MIMO (Multiple Input Multiple Output); infocommunication

Introduction. Can you imagine the world where all things and people are connected with each other? 5G enables billions of new safe and instant connections. 5G will influence all industries of our life – automotive industry, health care, emergency care services, production and dissemination of goods, and also will touch space industry, and help to communicate across the Internet in space in the future, also 5G will be used in unmanned control systems which, in their turn, will be used in the agricultural industry. The above-mentioned industries and many others will use advantages of infocommunications and increase production scales due to expansion of 5G network.

Objectives. Changing the mobile generations requires more efforts in industry of research and development, requires resources, so we cannot go over on new generation overnight. For example, 4G development lasted decades, and problems which were announced, were difficult to solve. 5G must change the world deeply, in contrary to 3G and 4G technologies, and bring the benefits for economics, mobile telecommunication providers and society in general (Qualcomm Technologies, Inc, 2019).

Methods. What allows 5G to integrate so quickly into people's lives? The power of 5G network is satisfied by using millimeter waves systems. The range of millimeter waves has been used enough for a long time in radio astronomy, distance sounding, cars radars, checking security and infocommunications. THz range will be used for 6G. Also security approaches, which will be used in 5G, will not be enough for 6G, so developers have to find new security techniques with cryptographic methods, but these methods have to be low cost, low complexity and have a very high level of security. Due to 5G network technology, data can be transmitted with speed of 20 Gbit/s, that significantly exceeds the speed used in cable networks. 5G allows increasing the volume of information/data, which we can transmit, thanks to the increased bandwidth and antenna technology (Rajiv (Ed.), 2021).

5G reduces information transmission delay, costs and energy, moreover, it can connect a lot of devices. 5G networks will provide the safe connections to cloud storage allowing an access to corporative programs, performing tasks with greater power. There will be new VoIP devices in the market, which give us more opportunities for employment. The concept of small cells used in 5G networks has a lot of positive features: 5G has a better cellular communication coverage, provides higher data transfer with minimum duration of delay, allows an access to cloud storage (Sharma, 2020).

5G offers network management features that will enable infocommunication providers to create virtual networks within a single physical 5G network. Here are some examples: a car that uses autonomous driving needs to have a network segment that provides fast, low-latency connections. This will help the car move in real time. Household appliances may be connected more slowly with less power, but high performance is not crucial in this case. For example, the Internet of Things (IoT) uses only secure connections for data transmission (Qualcomm Technologies, Inc, 2021).

Results. As was noted earlier, the rapid use of unmanned aerial vehicles for wireless communication systems will begin. Wireless communication systems promise to make devices connection without a separate infrastructure ensuring efficiency. Unmanned aerial vehicles will be more flexible to reconfigure and have better communication channels due to the presence of short-range lines, but the use of highly mobile and Energy-Limited UAVs can lead to new problems (Suvetha Andal, & Seshapriya, 2019).

5G network offers an extended and affordable connection almost all over the world. Analysts conducted the study in 2019, in which more than 55% of internet traffic was used to download videos around the world. A very clear video is waiting for us soon. Clear quality can also be obtained in the live broadcast via 5G network. The gaming and entertainment industry will benefit greatly from this technology. 5G provides video transmission at about 120 frames per second, it will have a higher resolution and higher dynamic range than 4G and 3G. In recent years, virtual reality games in HD quality have spread. 5G networks offer the best gaming environment using mega-fast internet.

To increase network efficiency, honeycombs are to be divided into microelements and pico cells. In order to increase the number of users in a certain

territory and work more efficiently on the network, we can reuse the spectrum. Using MIMO technology, multiple receiving and transmitting antennas, we can simultaneously transmit data ensuring an efficient data transfer rate. By increasing the number of antennas, we can perform more transmission and reception (Thales, 2021).

Conclusion. Development of 5G technology will have an impact on all areas of our life which depend on the information transmission. The modernization of the network infrastructure will provide fast connections with low delay, especially – it will become a low-cost solution for network deployment. Definitely, 5G is aimed at changing our life for better, but it's only a matter of time before that happens.

References:

Qualcomm Technologies, Inc, (2019, March 26). *3GPP commits to 5G NR in unlicensed spectrum in its next release*. 5G Nr 3GPP: 5G nr qualcomm. Retrieved October 9, 2021, from https://www.qualcomm.com/news/onq/2018/12/13/3gpp-commits-5g-nr-unlicensed-spectrum-its-next-release

Qualcomm Technologies, Inc, (2021, May 13). *What is 5g: Everything you need to know About 5G: 5G FAQ*. Qualcomm. Retrieved October 9, 2021, from https://www.qualcomm.com/5g/what-is-5g

Rajiv (Ed.). (2021, August 24). *Applications of 5G technology*. RF Page. Retrieved October 9, 2021, from https://www.rfpage.com/applications-5g-technology/

Sharma, B. (2020, October 4). *5G technology*. Engineers Garage. Retrieved October 9, 2021, from https://www.engineersgarage.com/5g-technology/

Suvetha Andal, M. S., & Seshapriya, S. (2019). 5th Generation in Hyper-Connected World. *International Journal of Engineering Research & Technology (IJERT)*, *06*(14), 1–2.

Thales, (2021, April 5). *5G technology and networks (speed, use cases, rollout)*. Thales Group. Retrieved October 9, 2021, from https://www.thalesgroup.com/en/markets/digital-identity-and-security/mobile/inspired/5G

TRANSPARENT SMARTPHONES ARE DOOMED

Yaroslav Chekotun, Ihor Lishchuk

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: transparent, smartphone, technology

Introduction. Smartphones have been constantly changing for the past 15 years. Since the very beginning of their development, there have always been plenty of new technologies implemented in smartphones each year. However, this process has dramatically slowed down during recent years. Nowadays, new devices have minor differences compared to their predecessors. This fact greatly affects sales, because people want to upgrade their current devices only if there is a major innovation offered. Consequently, companies are looking for radically new ways to attract clients. Transparent smartphone is one of the attempts to surprise the user, but will it work out?

Objectives. The main goal of this research is to determine whether transparent phones are really the future of the industry. Despite the fact that it seems to be a promising innovation, there are still plenty of questions to be answered.

Methods. Leading companies are developing foldable smartphones as it seems to be a common trend nowadays. There are also some other attempts to create something completely new on the market, and transparent smartphones definitely fall into this category. One way is to compare both technologies and decide whether they will be popular in the nearest future.

Results. Fully transparent smartphones are similar to foldable ones in terms of functionality. A device of this type does not provide any decent leapfrog in productivity, however, the phone is marvelous in terms of looks. Nevertheless, some people believe that transparent phones can improve both the camera and the process of switching applications. Due to the transparent display users may open two different applications, which simplifies multitasking (MakeUseOf, n.d.). The transparent screen will not offer anything revolutionary apart from that though.

The first prototype of a transparent smartphone was made by Polytron Technologies (Techthirsty, n.d.). A special Polyvision Privacy glass and liquid crystal molecules in an OLED display were used for the manufacture of the case. In addition to OLED technology, a transparent screen can be made thanks to the use of transparent electroluminescent displays (TASEL) and a typical HUD display. TASEL is a glass screen covered with a layer of phosphorus and a printed circuit board (The Verge, n.d.). This type of display is able to provide the most transparent touch screens. There is also a HUD, which is the oldest type of transparent screen technology. It requires three key elements: a battery, a projector, and a computer to generate video.

The idea of a transparent smartphone looks promising, but its implementation is accompanied by several problems. First of all, fragility is the case. Modern realities are such that it is too easy to break a phone, even if it has a cover. A transparent smartphone does not have any protection, because it makes actually no sense, as the transparency itself would disappear. Therefore, it is obvious that the number unsatisfied customers will increase. As for the customers themselves, most of them have already got used to high-quality displays. Unfortunately, transparent screens will not be able to provide the same quality of colors and clarity. So, even if a company releases a smartphone with a transparent screen, sales are unlikely to be very impressive. However, the release of the first true transparent smartphone is quite a feasible task. Taking into the consideration that Japanese companies are creating prototypes, and big brands like Samsung and LG are considering working on this technology, there may really be the release of transparent smartphones in the near future.

Conclusions. To sum up, several devices show that a transparent screen does not provide any advantages, but only creates additional difficulties. Many companies have several similar patents, but so far none of them have launched such device into mass production. Manufacturers will not be able to explain why users need a transparent screen, and foldable smartphones seem to be a better option for now.

References:

MakeUseOf (n.d.). Transparent Phones: Sci-Fi or Future Tech? Retrieved October 9, 2021, from https://www.makeuseof.com/transparent-phones-scifi-or-future-tech/

Techthirsty (n.d.). We might have a Samsung Galaxy Transparent Phone. Retrieved October 9, 2021, from https://www.techthirsty.com/we-might-have-a-samsung-galaxy-transparent-phone/

The Verge (n.d.). Has the transparent smartphone finally arrived? Retrieved October 9, 2021, from https://www.theverge.com/2013/2/15/3966950/will-we-see-a-transparent-phone-polytron-prototype-display

UX/UI WEBSITE DESIGN
Anna Chemanova
Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: website design, UX Design, UI Design

Introduction. Steve Jobs said, "Design is not just what it looks like and feels like. Design is how it works." A wonderful design of a website is an important key part of promoting a product and building customers' confidence. A lot of users are searching for good-looking, understandable, user-friendly websites. These types of sites are usually the result of UX (stands for User Experience or User Experience Design) and UI (stands for User Interface or User Interface Design) coordination.

Objectives. When talking about website design, UX and UI are two concepts that are commonly used (The Next Scoop, 2021). They indicate different design areas, but it's hard to imagine them separated (Lungul, 2021). Although UX and UI concepts seem to be quite simple and easy to understand, they both cover very broad ideas that aren't easy to define (The Next Scoop, 2021). The main task of this research is to explore the concepts of UX and UI designs and to define how do UX and UI fit together.

Methods. UX design is a special process which objective is to increase user pleasure of a product at the expense of increased usability, accessibility, navigation, and satisfaction provided along with product exploitation. UI design is a special process with the ultimate goal of making the user's interaction with the product as simple, intuitively and efficient as possible by creating an attractive appearance.

Once again, UX and UI are not the same. For example, let the product be a house. So UX designer is responsible for an architectural plan of the house and abuilding location. And UX designer responsible for the best color of the house, a style of the house, etc.

UX Design is a circular process that has three phases: discovery, ideation, and validation. UX always begins with a discovery phase. This is a phase where UX designers dig deep into research to understand target audience needs and to reveal key information about a product they want to build (Levy, 2015). Ideation is the second phase. It is a stage of generating possible solutions that amazingly solve users' deepest

needs. This phase can be implemented using the following means: brainstorming, mind mapping, sketching, wireframes, interaction design, etc. The UX process ends with validation. This phase relies on a process called usability testing – designers create wireframes or prototypes and test them with users until the interface is intuitive and pleasant. Without validation, UX designers just assume that customers will like the product (Roth, 2015).

UI design focuses on the visual feeling of the product – it establishes the layout, colors, style, etc. UI has two key phases: design and testing. After the second UX phase (ideation) there is the first UI phase - design. During design, UI specialists commit to internally validate ideas and test those ideas with users. After the design phase, UI designers usually get back to the ideation phase and this return can happen multiple times. After the design phase by analogy with the third UX phase, there is the validation phase. UI designers test design ideas with users to validate them. After UI designers complete the validation phase, they usually get back to the design phase, and this return also can happen multiple times. The final outcome of the UI design will be a draft version of the product and a style guide (Tidwell, 2010).

Results. The outcome of the UX design is a set of the product's functions and a structure of the product (Levy, 2015). The outcome of the UI design is a draft version of the product and a style guide (Tidwell, 2010).

Usually, projects need UX design at first and then UI design (The Next Scoop, 2021). But despite the difference between UX and UI concepts and the fact that there is no "right" way to put them together, website designers need to approach them in cohesion because the combination of UX and UI designs makes user's interaction with the product easy, effective, efficient, and pleasant.

Conclusion. Every business tries to increase its sales and its growth. So, for every business UX and UI designs are very important because these two concepts together improve users' satisfaction and provide users with what they are looking for. And as a result, the number of website users and their confidence increases.

References:

Levy, J. (2015). *UX Strategy: How to Devise Innovative Digital Products that People Want (1st ed.).* Retrieved from https://oiipdf.com/ux-strategy

Lungul, K. (2021, June 24). *UI/UX Design: primary goals and approaches*. Retrieved September 20, 2021, from https://www.axon.dev/blog/ui-ux-design-primary-goals-and-approaches-

Roth, B. (2015). *The Achievement Habit: Stop Wishing, Start Doing, and Take Command of Your Life* (1st ed.). Retrieved from https://ebookmore.xyz/0062356100

Schmidt, A., & Etches, A. (2014). *Useful, Usable, Desirable: Applying User Experience Design* (1st ed.). Retrieved from https://www.alastore.ala.org/file/3750/download?token=evNOWSLs

The Next Scoop. (2021, September 13). *UX vs UI Design: The 5 Main Differences*. Retrieved September 20, 2021, from https://thenextscoop.com/ux-vs-ui-design/

Tidwell, J. (2010). *Designing Interfaces* (2nd ed.). Retrieved from https://oiipdf.com/designing-interfaces

MODERN PRINCIPLES OF BLOCKCHAIN OPERATION

Denis Chernousov

Faculty of Heat and Power Engineering, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: blockchain, decentralization, cryptocurrency, blockchain applications

Introduction. In January 2009, a blockchain was developed to create and maintain the first cryptocurrency, bitcoin. The idea was to create a decentralized digital currency. Obviously, any remittances should be recorded somewhere, so one transaction is encrypted in one block. Together, all blocks form a single blockchain.

The consensus algorithm is used to find out a new block in the blockchain. It means that some computer processes the block by decrypting, recognizing and validating the transaction. The block is then added to the blockchain, creating a new copy that is distributed to the computers on that network. This process, called mining, depends on the number of computers and their capacity. The more computers involved, the more complex the encryption, so the data in the blocks is much more secure, and the blockchain can be much longer. Only one computer is rewarded in cryptocurrency for guessing the riddle (Joel, 2021). This consensus algorithm is called Proof-of-Work (PoW).

Objectives. According to data, bitcoin mining consumes a huge amount of energy for the PoW method. Significant electricity generation leads to considerable pollution. Therefore, it is obvious that an environmental-friendly company like Tesla has recently sold its bitcoin assets. Moreover, miners usually sell earned cryptocurrency to pay for electricity, which leads to an outflow of money from the same cryptocurrency, making it cheaper.

Centralized web services, such as Google or Facebook, are vulnerable to hacker attacks and accidents because they have few data centers. Google, for example, has 12 around the world, but what if they held at least 1 million centers?

Methods. Instead of PoW, other modern consensus algorithms are introduced, such as Byzantine fault tolerance, Proof-of-Stake (PoS), Directional Acyclic Graphics, etc. For instance, Proof-of-Stake requires users to stake their cryptocurrency to become a validator in the network. Unlike a Proof-of-Work protocol, the PoS system does not require a lot of equipment and, consequently, energy consumption (Laura, 2021). The new cryptocurrency, with this algorithm, will certainly overtake Bitcoin.

In the blockchain block you can record not only money transfers, but also applications and complex systems. The third-generation blockchain continues to develop this idea, and Proof-of-Authority (PoA) technology based on identity as a stake is expected to be introduced.

Results. Now, Google is creating its own blockchain for decentralization to make the services more secure and stable. Ethereum, the second largest open source blockchain, is switching from PoW to PoS to make the cryptocurrency eco-friendlier and less consumable. There are the applications that applies the technology: Algorand – currency exchange system, Voatz – voting mechanism, WholeCare – secure sharing

of medical data, Madhive – social media, Filament! – real-time IoT operating systems, DHL – supply chain and logistics monitoring, Ligero – personal identity security, Propy Inc – title registry system, and more (Daley, 2021).

Conclusion. To sum up, blockchain technology is elaborated quickly and concurrently by different developers. Sooner or later, it will be used to improve many old centralized institutions, such as the banking or even the military systems, to ensure stability and efficiency.

References:

Daley, S. (August 18, 2021). Blockchain applications and real-world use cases. Retrieved from https://builtin.com/blockchain/blockchain-applications

Joel, S. (2021). Blockchain for Dummies: The Ultimate Guide. Retrieved from https://cryptomaniaks.com/guides/blockchain-for-dummies-ultimate-blockchain-101-guide

Laura, M. (May 19, 2021). Proof of Work VS Proof of Stake: Which One Is Better? Retrieved from https://www.bitdegree.org/crypto/tutorials/proof-of-work-vs-proof-of-stake

CONFLICT RESOLUTION DURING SYNCHRONIZATION IN COLLABORATIVE REAL-TIME TEXT EDITING

Sofiia Chorna
Faculty of Applied Mathematics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: collaborative editing, synchronization, conflict, multi-user application

Introduction. Real-time collaborative editing allows multiple users to edit a shared document at the same time. Recently, online collaborative editing gained much attention as Google Docs support such features. However, online collaborative applications face several theoretical challenges. Typing at the same time, simultaneous change of symbols can produce edit conflicts. There are different methods to resolve the problem: the use of algorithms, making the editor asynchronous, storing backups, file comparisons of each edit before merging the versions.

Objectives. The main task is to consider different algorithms to resolve conflicts during multi-user online text editing.

Methods. There are two most widely used algorithms to handle the conflicts: Operational Transformation (OP) and Conflict-free Replicated Data Type (CRDT).

Operational Transformation (OT) represents the document state as a sequence of operations. When an operation comes from one user to another, it is transformed so that it becomes valid concerning the difference between the documents of these two users. A few commercial document editing systems such as Google Docs adopt centralized OT algorithms (Sun, 2018).

Otherwise, CRDTs require no history of operations, and no detection of concurrency to ensure consistency. Some CRDT algorithms work with peer-to-peer message propagation, others rely on client-server models. All the operations are

broadcasted to all the clients first, when there is a conflict they are resolved using mathematical formulas. This technique is used by Figma, Apple Note.

Results. The problem of concurrency in collaborative editing is well researched. Asynchronous implementation allows only one active participant at a time, lacking in concurrency and locks the document. Other approaches like the operational transformation have been identified as an appropriate approach for maintaining consistency of the copies of the shared document in real-time collaborative editing systems (Ahmed-Nacer, 2014). CRDT approaches were proposed to ensure convergence without blocking user operations and without having to deal with consensus. Both algorithms are used in commercial applications, i.e. Google Docs.

Conclusion. Collaboration is a very important aspect of any team activity and hence of importance to any organisation such as business, science, education, administration, political or social institutes. Central to collaboration is editing of shared documents. Synchronous or real-time collaboration means that modifications by a member are immediately seen by other members of the group. The conflict occurs when an editor gets a copy of a shared document file, changes the copy, and attempts to save the changes to the original file, which has been altered by another editor after the copy was obtained. The most effective way to resolve the challenge are OT and CRDT algorithms. The real-time collaborative text editors relying on these algorithms represent the document as a sequence of operations.

References:
Sun, C. (2018). Operational Transformation in Real-Time Group Editors: Issues, Algorithms, and Achievements. *Association for Computing Machinery.* 1 (1), 59–68.
Ahmed-Nacer, M. (2014). Merging OT and CRDT Algorithms. *1st Workshop on Principles and Practice of Eventual Consistency.* 1 (1), 1–4.

IMPORTANCE OF USING THE BUSINESS PROCESS MODEL AND NOTATION

Valeriia Demenkova
Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: BPMN, diagram, business, process

Introduction. The need for these diagrams is for the system implementation team to take the technology and turn them into a working system. Until the business process model and notations are in place, such a team would create a system and customize it, or they would already buy a ready-made system. With the advent of the business process model and notation, life has become easier – the process has now been brought to automation. This diagram can atomically guide the process into the system, a concept that greatly simplifies and speeds up the process and helps the User get the desired automated result faster.

Objectives. The main task is to conduct a study on the construction of a model and notation of business processes, hereafter BPMN-diagrams, to study their existence and role in the life cycle of systems development. This research will be artificial and

simple, describing the methods in which BPMN can be useful, as well as finding the differences between it and other analogues of diagrams. The main purpose of learning and using BPMN is to get people to spend a lot of time creating diagrams (Dumas, 2013).

Methods. The use of generic diagrams is a problem because the user has to pass them on to other people who are doing the programming and building. The question arises, is it possible to neglect this step and not involve more people and waste their energy and time trying to understand how it should work and what the end result should be? Is it possible to create a process where the diagram can be used without additional costs and with a more streamlined system-building process? The concept behind BPMN is that it is a new modeling notation that will be easy to use for all users, but strong enough semantically to allow information technology devices to take the diagram and use it as the basis for execution. The process begins with building a model, and models are not flowcharts, although they have some similarities to flowcharts and bar charts. The next step is to run the diagram itself through an optimization process that uses a set of algorithms to automate it, making the process more efficient. The user is able to treat the business process execution language as computer code to run the process. This idea is quite interesting, because business analysts can analyze not only the final result, but also effectively design their own system at the beginning, develop their own methodology and their own algorithms. The components of BPMN are simple enough for beginners: there are processes, there are solutions, there is a sequence or a flow. The scheme is easy to read – there is a beginning and an end, there are numbers (Dumas, 2013).

Results. BPMN flowcharts describe business processes in a single standardized language understood by all participants, regardless of their level of technical expertise, i.e. business analysts, process implementers, managers, developers, as well as external employees and consultants. Ideally, these flowcharts should represent the sequence of activities with sufficient detail and clarity to build a convenient bridge from business process design to implementation. There are now several specialized tools available to draw BPMN diagrams and generate BPEL, that is, a language for executing business processes. One of the most popular diagramming tools is a product called Microsoft Visio (Freund, 2017).

Conclution. As a result, concise information presented in a diagram is usually easier to understand than a text description. The use of BPMN makes it easier to share information and work together to create an effective process for producing quality results.

<div align="center">**References:**</div>

Dumas, M. (2013). *Fundamentals of Business Process Management*. Springer.

Freund J., Rücker B. (2017). *Real-Life BPMN: With introductions to CMMN and DMN. Analyze, improve and automate business processes in your company. 3rd Edition*. CreateSpace.

Hoffer, J. A., George, J. F., & Valacich, J. (2013). *Modern Systems Analysis and Design* (7th ed.).

MODERN INFORMATION TECHNOLOGIES IN EDUCATION

Oleksandra Denysenko
Faculty of Applied Mathematics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: educational systems, communication technologies, self studying

Introduction. The sphere of education has changed a lot. Most of the reasons were provoked by the worldwide pandemic and the accelerated growth of information technology for this reason. The online education has become a more popular and easy way to study, due to the appearance of new tools and ability to learn subjects in convenient environment. Wherever the student is, he or she has an access to all the materials and even to a teacher. Companies that picked up a new wave of changes in time were able to introduce new technologies in education and get great benefits from this, as well as give humanity new opportunities.

Objectives. The main task is to conduct research for modern information technologies and tools, that are used in education nowadays. The main focus of the research is the study of the online environment and its development to improve the education system in schools, universities and private companies.

Methods. Information and communication technologies (ICT) are an important part of the education modernization process. ICT is a variety of devices and methods of information processing, first of all – computers with the necessary software and telecommunications equipment which contains information. They allow remote interaction of teachers and students, in other words – to receive education remotely (Mason, 1998).

A wide range of modern information technologies can be classified by the methods that contain: computer tools of self-education, systems of graphic and operational presentation of information, communication systems, information technologies in the system of additional education (Nickerson, 2013).

In order to illustrate materials at the lessons, teachers can use computer projector devices and smart boards. These tools are the examples of graphic and operational presentation of information. Modern smart boards are supplemented with calculating and graphic functions which may improve the educational process.

Self-studying programs are highly demanded, as people are able to learn new material depending on their goals, place of living and time. Students can use electronic textbooks, videos, educational software and systems of virtual reality. For instance, during the global pandemic medical universities started to use a virtual environment for operations and 3D models of organs.

Communication systems that are presented mostly by social media help to receive and transfer information between students and teachers. These tools help to accelerate educational process.

Use of text editors and graphical programs became especially popular during the last decade. Depending on the studied field, calculating-typographical software can be useful in creating presentations and media files, drawing graphics and mind-maps.

Information technologies bring the opportunity and the need to change the model of the educational process: the transition from reproductive learning (the "overflow"

of knowledge from one head to another, from the teacher to the students) to the creative model. Experts believe that the development of traditional and new technologies should proceed according to the principle of complementarity and intercorrelation, which, in turn, allows us to speak of a fundamentally new dimension of the educational environment – a global dimension that exists in real time and associates the entire set of educational technologies (Nickerson, 2013).

According to the experts, the most important feature of this new technology is that it allows you to create "networked communities". Due to this, the concept of community takes on a global scope and some completely new features. According to the author "One of the most important features of such a space is its global nature, which allows for almost instant connection and communication. Already, this environment is indispensable for commercial and financial transactions involving a wide variety of societies and cultures. Thus, the Internet is both the main cause of globalization and its most visible manifestation" (Nickerson, 2013).

Thanks to the Internet, the various facets of globalization (scientific, technological, economic, cultural and educational) have had a very significant impact on both traditional full-time educational institutions and the development of various educational innovations such as distance learning and virtual universities. In all of these organizations, globalization requires profound and radical changes in structure, teaching and research methods, and the training of management and teaching staff (Mason, 1998).

Results. The greatest influence in accelerating educational process has been achieved by social media. Communication systems allow faster data transferring and connection between students and teachers. It has also caused the demand on creating communities and quick search of studying materials.

Conclusion. In summing, the field of education has changed a lot over the last few years, due to the introduction of new information technologies. The appearing of new tools has made it easier and more effective to study at universities, schools, as well as self-studying has become more accessible.

<div align="center">**References:**</div>

Mason, R. (1998) Globalizing Education: Trends and Applications. *Routledge.*

Nickerson, R.S. (2013). Technology in Education: Looking toward 2020. *Routledge Taylor & Francis Group.*

<div align="center">

PROGRAMMING LANGUAGES BASED ON VIRTUAL MACHINE
Mykhailo Didur
Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

</div>

Key words: virtual machine, interpreter, programming language, crossplatform code

Introduction. Virtual machine is modern technology in programming that allows to run any application anywhere. So, what if it would be possible to use virtual machines for programming languages? Nowadays there are a lot of programming

languages based on virtual machine. One of the most popular is Java. It can be compiled for any machine for which JVM (Java Virtual Machine) is written.

Virtual machines work really fast and even crossplatform. It works like a Turing machine. So, there is an array with numbers and instruction pointer that points to current instruction. If it is needed to write a virtual machine, it will be possible to add memory allocation, working with threads and even calling some low level instructions from assembly.

Also there are interpreters, but what is the difference? Interpreter has a similar idea, but it is much harder to implement for other machines to run everywhere. For example, a virtual machine requires implementation of functions that reacts on each value that is in the "array" of instructions.

As for interpreters, it is needed to parse text, build an execution tree and only then run it for each token in the tree.

Objectives. The main task is to implement a simple programming language based on a virtual machine and research how it works inside.

Methods. In this part it is prepared a small example implementation of a virtual machine written in Python.

```python
def run(arr):
    mem = list()
    ip = 0 # instruction pointer
    while(ip < len(arr)):
        print("[CALLED]: " + arr[ip])
        instr = arr[ip]
        if(instr == "push"):
            to_push  = int(arr[ip+1])
            mem.append(to_push)
        elif(instr == "pop"):
            mem.pop()
        elif(instr == "add"):
            mem.append(int(mem.pop())+int(mem.pop()))
        elif(instr == "log"):
            print(mem[len(mem)-1])
        print("[MEMORY]: " + str(mem))
        ip += i_s[arr[ip]]


    # instruction size
    i_s = {
        "push": 2, # pushes num to stack
        "pop": 2, # pop num from stack
        "add": 1, # add two top nums from stack
        "log": 1, # print top value of stack
    }
```

```
code = ["push", "1", "push", "1", "add", "log", "pop"]

run(code)
```

In the code above it is implemented a simple virtual machine with four instructions in the set. These instructions are "push", "pop", "add" and "log". First two instructions pushing and removing to/from stack memory. Stack was chosen because it is the most popular and the fastest structure for allocating memory. "add" instruction takes from stack two top values, adds them and pushes to stack again. "log" instruction is the simplest, it just prints the top value of the stack. As for other code, in the "run" function there is "while" construction that reads each instruction one by one. Inside of the loop there are a lot of if-elif-else statements that are needed for parsing and running instructions in runtime. In the code it is called two "print" functions except of the "log" instruction. They are needed for debugging (Angell, 2015).

Result. Now it is needed to run the code to show that everything works correctly. Console output:

```
[CALLED]: push
[MEMORY]: [1]
[CALLED]: push
[MEMORY]: [1, 1]
[CALLED]: add
[MEMORY]: [2]
[CALLED]: log
2
[MEMORY]: [2]
[CALLED]: pop
[MEMORY]: []
```

In the listing above it is presented console output of the virtual machine. As it can be seen the virtual machine works correctly, in the stack it is pushed two "1", then it is made sum of them, print and remove the last element from stack.

Conclusion. So, during the writing of this article it was written and tested "hello world" virtual machine that has simple memory, one math operator ("+") and print function to show what is the highest value in stack. It is how a basic virtual machine works and if more functionality is needed it is possible to improve or add anything. The app for running our simple syntax can be written with any other language on any other machine with the same behaviour.

References:

Angell, F. (2015). Virtual machine in C. Retrieved September 29, 2021, from https://felix.engineer/blogs/virtual-machine-in-c

VIRTUAL REALITY: ANOTHER WORLD WITHIN SIGHT
Ruslan Drif

Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Virtual reality, technology, medicine

Introduction. Virtual reality is a kind of semblance of the world around us, artificially created with the help of technical means and presented in digital form. The created effects are projected onto the human consciousness and allow us to experience sensations as close as possible to real ones. This technology changed the vision of humanity and made a vital contribution to the development of many fields.

Objectives. The main task is to study the latest trends in the use of virtual reality to improve life and business, as well as predict future changes in various areas of the economy, medicine, technology and entertainment.

Methods. The most common means of immersion in virtual reality are specialized helmets or glasses that are worn on a person's head. The principle of operation of such a helmet is quite simple. The display in front of your eyes displays video in 3D. Attached to the body, a gyroscope and accelerometer track head movements and transmit data to a computing system, which changes the image on the display depending on the readings of the sensors. As a result, the user has the ability to "look around" inside virtual reality and feel in it as in the real world. In order for the image to have high definition and always fall into focus, special plastic lenses are used.

The active use of virtual (VR) and augmented (AR) realities in a variety of areas forms a "merged reality", in which the boundaries between augmented, virtual and physical worlds are blurred. This conclusion was reached in early July 2017 by experts from the Ericsson ConsumerLab research unit, having studied the impact of AR and VR technologies on the habits and preferences of users.

7 out of 10 users expect VR / AR technology to revolutionize 6 areas: media, education, work, social, travel and retail. Users are also confident that virtual space will replace classrooms and offices, and in less than a year, virtual screens will replace television and theaters. According to 25% of respondents, AR technologies will be used to obtain information about travel and in maps as early as next year. 50% of early adopters believe that VR / AR will be integrated into one device combining AR glasses and built-in VR functions (Renub Research, 2021).

In medicine, several important technologies have been introduced. In mid-October 2020, surgical planning software developer ImmersiveTouch unveiled its VR digital surgery platform. It is intended for dentists and maxillofacial surgeons. In mid-August 2020, a new module for training hip and knee operations in virtual reality (VR) was launched on the Osso VR platform (Renub Research, 2021). In the face of the pandemic, developers are prioritizing the expansion of the curriculum across multiple majors to provide ongoing training for medical students and residents.

In mid-September 2019, as part of a study, one of the Oxford nursing homes began to implement virtual reality technologies to help patients with dementia. At the same time, virtual reality pictures are created individually for each patient.

The pilot project team negotiated with nursing home workers and created a panorama of pictures from the past for dementia patients. Several patients were sent back to their youthful memories: to rock and roll dance halls from the 1950s, to the church where they got married, on trips abroad. Patients described the experienced sensations as "amazing" and added that after such a shake-up they feel much more invigorated. Scientists report that the use of VR technology improved communication and cognitive abilities in more than half of the patients with dementia who participated in the study (Thomspon, 2019).

Virtual (VR) reality projects can not only create conceptually new markets, but also expand existing ones. According to Goldman Sachs analysts, VR in the cinema industry is one of three notable growing market segments, along with the gaming industry and online streaming services. According to analysts, the use of virtual reality technologies will bring the film industry $ 750 million by 2020 and will have an audience of at least 24 million users. In 2025, this amount will increase to $ 3.2 billion and 72 million viewers, respectively.

Results. The largest number of changes as a result of the introduction of virtual reality affected the areas of entertainment, medicine, media and economics. This made it possible to improve the indicators of scientific research, to make human life easier and brighter, even in times of crisis and pandemic.

Conclusion. To summarize, the market for virtual reality technologies mainly influences the human vision of the world. According to experts, the main catalysts for the growth of the AR market have become the availability of technology and the simplicity of smart devices. In addition, the COVID-19 coronavirus pandemic is helping, in which people have limited physical contact and are increasingly using technology for distance communication, education and work.

References:

Renub Research (2021). Augmented Reality Market Global Forecast by Segments, Region, End-User, Headset Volume, Company Analysis. Ireland. 133-135.

Thompson, A. (2019). Improved cognition and communication skills in half of the dementia patients. Retrieved from https://www.dailymail.co.uk/health/article-7460227/Virtual-reality-helped-bring-memories-dementia-patients-NHS-trial.html

USE OF PASSWORDLESS TECHNOLOGIES AS THE PRIME WAY TO DATA SECURITY

Olena Fedchuk

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: passwordless, software, cybersecurity

Introduction. A widespread notion declares digitalization to be snowballing in every field of human activity. As an innate claim for privacy, it is even more poignant online, in the whirlpool of disposed personal info. However, the trend is always set to convenience being preferred to safety.

Due to the ephemeral apps supplied with an account system infesting the global market, an average human is forced to inevitably retype the outdated familiar password with the lack of time and inspiration, deteriorating the overall cybersecurity ambience drastically. According to one of Microsoft's recent surveys, 1 in 10 people admitted reusing passwords across sites. Microsoft also found 15 percent of people using their pets' names and important dates for password basis, and 40 percent tending to use a formula, like Fall2021, eventually transforming through time (Microsoft, n.d., para. 11).

There are a whopping 579 password attacks every second – that's 18 billion every year. And the majority of them resulted from the above illustrated human nonchalance. The significant question is up to arise here: does the almighty anti-forgery pill exist to cure and amplify the web habitat of the average internet surfer?

Objectives. According to Bret Arsenault, CISO at Microsoft, "Hackers don't break in, they log in" (Microsoft, n.d., para. 6). Thus the main goal is to conduct profound research aimed at modernized passwordless technologies delivering excessive safety and convenience for users which also will ensure the prevention of the inevitable financial crisis for apps still clinging to time-proven yet graceless text forms instantly drearing the potential customers.

Methods. Despite the imposing amount of the research that excludes passwords as the top of the modern security tools pyramid, they are still not hopeless. Use of transliteration into English from other – preferably Slavic languages can still become a tangible obstacle to personal data in the event of a high-level system disruption. It does prevail to some extent over more predictable and less flexible English vocabulary, due to the sounds transcription and special character replacements.

Regarding the advanced methods facilitating the authorization process, the forecasts are far more assured. Nowadays, the sphere of software cybersecurity overstepped itself endeavouring to minimize the general pipeline of authentication rather than recalling a humongous auto-generated passphrase.

To start with, the well-known email confirmation magic links that seamlessly transfer users to advanced personal functionality, or one-time code sent to the specified phone number (DZone, n.d., para. 7, 8). Being less time – and memory – consuming, they are the most suitable basis for the research.

Next, it's a good practice to take the pitch unique representation of a human species into consideration. Biometric data have always been and will be the most precious resource to intertwine with technology. Currently it has already stemmed into a completely different device-human interaction level.

The relevancy of the research should also be supported by the deliberated integration of the above mentioned approaches to produce the optimised assisting software as a unified gateway to the multiverse of personal accounts.

Results. Accelerated authorization pipeline has already defined the trends modern businesses are tending to stick to. Improved User Experience and security provided by the passwordless connectors raise the influx of customers as much as they curtail the ability to hack the password as the passwords in their familiar form do not exist. One of the leading companies that dipped their toes into the cold water of

passwordless technologies and made that step profitable, was Microsoft. The great success came with the announced Windows Hello authentication app, currently available only to the enterprise organizations.

Recalling the biometrical impact, the technology is experiencing a significant developmental leap. According to the research held by the Russian retail company M. Video-Eldorado Group, the demand for smartphones with biometric authentication technologies soared in the last quarter of 2018, with the part of piece and monetary units accounting for 60% and 80% of its sales volume respectively. Each piece had one or more sensors integrated: a fingerprint scanner, face recognition system, iris scanner. By the end of 2019, the numbers exceeded 90% in both categories (Mobile Review, n.d., para. 3).

Conclusion. To put the above mentioned in a nutshell, the genuine inconvenience of password generation as well as lack of security is still the entry point for the majority of attacks across enterprise and consumer accounts. Due to the exponential increase of digitalization, this topic will lead in information technology applied scientific research with the department of Cybersecurity at the head. Yet, the highlighted parts only force to presume

the subsequent spread of identity thefts aimed at copying the biometrical aspects. Thus the field of data protection is far away from being exhausted for good.

References:

DZone. (n.d). How Passwordless Authentication Works. Retrieved from dzone.com/articles/how-passwordless-authentication-works

Microsoft. (n.d.). The passwordless future is here for your Microsoft account. Retrieved from microsoft.com/security/blog/the-passwordless-future-is-here/

Mobile Review. (n.d). Russians trust biometric authentication in smartphones. Retrieved from https://bit.ly/3lrTyD6

MODERN INFORMATION TECHNOLOGIES

Ivan Fesenko

Educational and Research Institute of Special Communications and Information Security, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Information technology, computers usage, online world

Introduction. Electronics have become very popular in 2021. As we can see, humanity does not stop in its research. Information technology has made people's lives easier and made it possible to get acquainted with the online world where certain combinations, codes, cyphers, and much more prevail. Currently, programming languages are being studied very intensively, and mostly young people are interested in the development of technology, and now the latest technology is widely used in medicine. That is why the development of information technology is one of the most pressing topics (Alec, 2016).

Objectives. The main task is to carefully study the methods, processes and methods of using computer and communication systems to create, collect, transmit,

search, process and disseminate information for the effective organization of human activities. As the famous Bill Gates said: "Software is a great combination of art and engineering. Despite the rigidity of project programming, it needs creativity to be well executed."

Methods. To scientifically substantiate the results of this study, it should be noted that information technology today is: a set of focused and organized information processes that use computer technology to provide high-speed data processing, rapid information retrieval, decentralization of data and access to information sources, regardless of where they are located. IT carries a lot of information, and with the help of a computer it has become easier for us to communicate with relatives who live very far from us, to order movie tickets, to choose things that we like on certain sites. We have discovered a world of technology that has changed our lives. We have many developers and sculptors of modern web design, who have the task of creating a website, as well as writing code for various applications and is almost on the verge of creating a full-fledged artificial intelligence (Klaus, Nicholas, 2018).

Results. Nowadays in the educational environment a well-known representative of such technologies is a training software package based on SMART board technology, which is known as an "interactive whiteboard". The complex includes: SMART Board touch screen, own software, personal computer, multimedia projector and communication equipment. This complex is an information and communication environment and is used for both traditional and innovative pedagogical and technological training. No special skills or abilities are required to work with the screen – it is enough to be an experienced user of a personal computer. In addition to training, as already mentioned, medicine is also interested in the latest technologies that have already succeeded in the medical information system, telemedicine, diagnostics, expert systems, robotics and many related fields of information technology (Klaus, Nicholas, 2018).

Conclusion. So, IT is a large-scale innovation for our world, because the future lies in technology. With each passing day, more and more software improvements and techniques for writing programs, creating effective code, and discovering artificial intelligence, which can be both a friend and an enemy. Of course, this depends on our programmers, but, as already mentioned, one wrong step, and the program will create errors that will be impossible to fix. IT technologies are our future, the main thing is that we take this future seriously and continue to improve our knowledge in the IT space.

References:

Alec, R. (2016). The Industries of the Future, Simon & Schuster, 320.

Klaus, M.S. Nicholas, T. D.(2018). Shaping the Fourth Industrial Revolution, Penguin, 288.

MODERN TOOLS AND METHODS OF PROCESSING AND ANALYSIS BIG AMOUNTS OF DATA

Bohdan Filenko

Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: processing, big data, methods, analysis, tools

Introduction. In parallel with the deployment of technology and with more infusion of social life into the information sphere, IT engineers face a problem of storing and processing big sets of multimedia data that rapidly increases day by day. Every day, 2.5 quintillion bytes of data are created, and it's only in the last two years that 90% of the world`s data has been generated ("Big Data Analysis Techniques", 2019, para. 1). Nowadays, analysis of big data is not a fiction or buzzword, but it'd become a complex and independent area of IT with a wide set of methods and well-paid specialists around the world.

Objectives. The main goal is to get familiar with the main tools and methods of processing big amounts of data nowadays, delve deeper and discover the idea and working principle of these methods.

Methods. Big data processing tools include the following technologies.

Analysis using RAM: processing data in operational memory removes a lot of limitations, such as high delays while executing I/O operations. All related data stores in the operational memory while its processing. Also, RAM memory provides instant analysis thanks to its speed, so a lot of business information is available almost immediately. One of the great solutions for a lot of analytical cases with high computational requirements is enabled by moving entire databases with big amounts of data to RAM. There are some technologies using this idea, such as Hyper, SQL Server Analysis Services, etc.

NoSQL databases: this kind of database allows storing data in four different forms – column, key-value, graph or document sets. It provides good reliability and scalability and high performance. Non-relational databases are very useful for handling diagrams and huge data streams. The most popular NoSQL databases are MongoDB, Azure DocumentDB, Cassandra and HBase.

Columnar databases: instead of rows like in relational databases columnar databases use columns to store information. This technology allows reducing read data items during query processing and provides high performance of concurrent queries. Column-based databases are read-only environments and usually used for enterprise data and applications with a large number of queries. The following databases are column-oriented - Maria DB, Amazon Redshift, Vertica Analytics platform.

Predictive analytics: this technique uses machine learning, which works with algorithms to produce assumptions based on data sets. Thanks to this technology, computers can predict the future that would be impossible for human analysts.

Graph databases: these databases are very useful for related data with a lot of entities and relations within. Making queries, merging and modeling of data are more facilitated because of the flexibility of this kind of database. Graph databases get

popular day by day because many big data sets have a graph nature. In the latter case, the graph databases allow analyzing and predicting relationships to solve many different problems (Lisowski, 2019, para. 10).

All these tools are useless without using methods and practices of data analysis, so let's get closer with some of them.

A/B testing: this method involves comparing a control group with different test groups to determine what changes or treatments will improve a given objective variable. Good results of the technique will be achieved if the control group and test groups are of a big enough size.

Data fusion and data integration: the main idea of this technique is that the insight would be more efficient and more accurate when analyzing and integrating data from multiple sources instead of single resource.

Data mining: the method extracts templates from huge data sets using combined algorithms of statistics and machine learning. For example, this technique is used for determining offers according to customer's search requests in the browser.

Natural Language Processing (NLP): this set of machine learning technologies, algorithms and computer sciences is used for analyzing human language.

Statistics: this technique is for collecting, organizing and interpreting data, within different surveys and experiments.

Genetic algorithms: these algorithms are inspired by the evolution mechanisms such as inheritance, mutation and natural selection. The analogues for these mechanisms are useful to select the best solutions from a big amount of data.

Regression analysis: on a basic level the main idea of this kind of analysis involves manipulating some independent variable to examine how it influences a dependent variable and describes relations between these variables.

Association rule learning: it's a method for discovering correlations between variables in large databases. It was first used by major supermarket chains to discover interesting relations between products, using data from supermarket point-of-sale (POS) systems (Stephenson, n.d., para. 5).

Statistical classification: this method identifies categories that a new observation belongs to. It usually requires a training set of correctly determined observations, such as historical data.

Results. The use of the methods above has brought great success and development in the field of data analysis. Nowadays, all of the mentioned methods and tools are actively used in a lot of social media. Accurate managing and effective use of the techniques can reveal a host of business, product, and market insights.

Conclusion. To sum up, examining data analysis methods and developing new tools and techniques is a very leading theme in the modern IT sphere. Each data analyst has to know about those methods, understand their principles and have to know how to effectively use each of them in business. It's hard to say what is the future of data analysis, but undoubtedly data innovation is changing business and social life right now.

References:

Big Data Analysis Techniques. (2019, February 7). Retrieved from www.getsmarter.com. https://www.getsmarter.com/blog/career-advice/big-data-analysis-techniques/

Lisowski, E. (2019, April 4). *Processing Huge Data sets using Big Data technology*. Retrieved from www.addepto.com. https://addepto.com/process-huge-data-sets-using-big-data-technology/

Stephenson, D. (n.d.). *7 Big Data Techniques That Create Business Value*. Retrieved from www.firmex.com. https://www.firmex.com/resources/blog/7-big-data-techniques-that-create-business-value/

MODERN INFORMATION TECHNOLOGIES: STARLINK SATELLITE INTERNET

Pavlo Galdetsky

Faculty of Electric Power Engineering and Automatics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Satellites, internet, network

Introduction. Starlink is a project by SpaceX with the aim to create a network or "Mega constellations" of orbiting satellites capable of providing high-speed broadband Internet.

Objectives. This project is primarily aimed at improving communication in hard-to-reach places on the Earth such as distant and isolated islands, deserts or forests, as well as remote settlements where high-speed cable Internet is unprofitable, for example, settlements in tundra or desert regions (Crist, 2021).

Methods. The original idea of connecting satellites was that each satellite should have five lasers, four of which work simultaneously. Transmitting information using lasers in a vacuum should speed up the transmission rate compared to fiber optic cables. This possibility is explained by the fact that the refractive index of glass slows the speed of light passing through fiber optics by 47% (Contributor, 2020).

But at this stage, the first batch of satellites was without this technology. As a result, the signal from the satellites first goes to specialized stations of the existing fiber-optic system called "gateways". Thus, the Starlink home antenna connects to the satellite through the service data passing through the gateway, as a result of which it makes you dependent on the gateway, which should be no further than 800 km from you. But this problem is being solved, for the transition to lasers (Betz, 2021).

The wireless Internet itself begins to work only upon reaching the endowment of a sufficient number of satellites in orbit. Initially, the network is limited and works only over North America and partly Europe, more than 1400 satellites were launched for this, although at this stage the Internet cannot boast of stability due to the huge gaps in the satellite network.

To cover the entire globe, SpaceX was negotiating with NASA to provide space around the planet for wider satellite coverage. In general, in order to provide stable high-speed broadband Internet throughout the planet, it is planned to launch up to

42 thousand Starlink satellites into the orbit. The launch of satellites is planned to be carried out in batches of 60 satellites on 1 rocket every 2 weeks.

However, Starlink still has room to improve. For example, the cost of the Internet is very high nowadays. Almost 100 dollars per month, at a speed of 140-200 Mbps at the moment. This speed-price ratio is not optimal against the background of fiber-optic systems, as well as too huge for the Third World countries, which suffer most from the lack of fiber-optic systems (Neel Patelarchive, 2021).

Results. With the proper development of the mega constellations of satellites project on the example of Starlink, it is possible to achieve the presence of excellent communication and a more affordable price/quality ratio on the planets anywhere in the world and not only. Indeed, in the future, such technologies will contribute into faster information transmission with distant satellites and stations on other planets, which will accelerate the other planets colonization.

Conclusion. As a result, we can say that this is one of the most promising technologies associated with the information transfer at the moment. The opportunities that it can provide are incredible and could only be a figment of the imagination several decades ago. But there are also problems that need to be solved, ranging from pricing policy to technologies such as the light speed of lasers and the stability of a huge system.

<div align="center">**References:**</div>

Crist, R. (Sept. 18, 2021 6:15 a.m. PT). Starlink explained: Everything you should know about Elon Musk's satellite internet venture. Retrieved from https://www.cnet.com/home/internet/starlink-satellite-internet-explained/

Betz, E. (Jun 28, 2021 6:00 PM). How Do SpaceX's Starlink Satellites Actually Work? Retrieved from https://www.discovermagazine.com/technology/how-do-spacexs-starlink-satellites-actually-work

Contributor, T. (January, 2020). Starlink. Retrieved from https://whatis.techtarget.com/definition/Starlink

Neel V. Patelarchive (September 6, 2021). Who is Starlink really for? Retrieved from https://www.technologyreview.com/2021/09/06/1034373/starlink-rural-fcc-satellite-internet/

<div align="center">

PROCEDURAL GENERATION IN GAMES DEVELOPMENT
Alona Haiova

</div>

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: procedural generation, algorithm, automatically created, open world

Introduction. These days simple linear games will not keep the player's attention for a long time. Games that use the open-world concept are one of the most successful. However, it`s extremely hard and expensive to create such a huge space by hand. That`s why an automatic generation of surrounding such as forests, cities, fields, etc. is an ingenious way to find a balance between the quality and price of a project.

Objectives. The main task is to study current methods of procedural generation and how it can be applied in game development. Furthermore, it is necessary to study which algorithms are better suited for creating various game objects.

Methods. There are a variety of procedural generation algorithms. All of them are united by the need for a huge amount of information. Natural landscapes generation needs to take into account the type of climate, amount of precipitation, possible plant species, season, proximity to the road, etc. Only with a large number of parameters, written by developers, PSG is capable of creating a realistic image. Examples: "The Witcher III Wild Hunt", "Skyrim". Talking about city pictures, creating realistic traffic is hard but important task. The algorithm must know all the traffic laws, traffic lights and pedestrian's movement to make all the system look realistic. Important thing to do is generating building which should not be the same. Examples: "Marvel`s Spider-Man", "Sinking City". Spider-Man PCG uses different easy shapes as cylinders or parallelepipeds randomly sized to create buildings. Then small details are added. Game "Sinking City" uses existing models of houses which are combined with different details (windows, doors, lights, etc). This strategy helps to create the variety of objects. Although the final result is always checked by designers (MIT, Procedural Generation)

Results. Games that have created a high-quality open world show good results in terms of replayability. Players very often replay their favorite games. Moreover, players spend a huge number of hours in the game deviating from the main storyline. They are fascinated by exploring the world, communicating with NPC characters, side quests, and so on. For example, a Skyrim player can postpone missions and raise sheep. The freedom of action enthralls users and gives a wide range of gameplay possibilities, which makes people choose this game over and over again (Short, Adams, 2020). Linear games are gradually losing their relevance. If we look at the top of the most popular computer games, we will see many open world games among them (Top 100 PC Games, 2021).

Conclusion. To sum up, research shows that procedural generation is an extremely important tool in games development. We studied different algorithms of PCG in open worlds creating and compared them. Then we studied advantages of using PCG in game, which are interest of players, rising game popularity, replayability.

References:

Brummelen, J. V., & Chen, B. (n.d.). *Procedural Generation.* Retrieved from http://www.mit.edu/~jessicav/6.S198/Blog_Post/ProceduralGeneration.html

Short, T., & Adams, T. (2020). 5. *Procedural Storytelling in Game Design* (pp. 37-48). Russia: DMK Press. (Original work published 2019).

Top 100 PC Games (2021). Retrieved from https://www.pcgamer.com/top-100-pc-games-2021

VIRTUAL REALITY – NEXT STEP IN EDUCATION
Maksym Havatiuk
Faculty of Applied Mathematics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: virtual reality, education

Introduction. In today's world, the use of gadgets for the learning process is growing rapidly. And virtual reality technology is no exception. According to research, 90% of the information a person receives is through vision. Virtual reality just provides perception through the display of information.

Objectives. The main task is to show the prospects and benefits of the introduction of virtual reality in the educational process. And how can this be used to interest students in studying.

Methods. Virtual reality technologies provide education with incredible opportunities that facilitate the learning process, for example, their use has greatly facilitated the perception of vector algebra in explaining three-dimensional space. Notwithstanding the increasing likelihood that students have at some point experienced a form of virtual reality potentially reducing the novelty factor, virtual reality in education has consistently been found to be motivating and exciting for students (Ryan Lege & Euan Bonner, 2020).

As the main advantages of using virtual reality, I would like to cite the following points:

– Clearness. All information becomes available for viewing. Now you do not need to imagine everything, because you will see everything with your own eyes at once.

– The effect of presence. Everything that happens a person sees in the first person, which allows him to feel his presence in this situation.

– Safety. Various experiments or reactions that cause element instability or explosions will be possible and safe, because they will not be real.

– Concentration. Everything that happens around completely captures the whole space, which allows you not to be distracted by various insignificant things.

In addition, virtual technology can reduce the cost of purchasing the necessary reagents for chemical experiments or other tools needed for demonstration.

Results. The use of virtual reality technologies opens many new opportunities and prospects, promotes student development, provides research experience, makes learning bright, prevents distractions from learning and increases motivation to learn, helps to better understand complex concepts, definitions, theorems, properties.

Conclusion. VR technologies have many advantages in education, but in the most general form virtual education is a process and result of interaction of subjects and objects of education, accompanied by the creation of a virtual educational space.

References:
Ryan Lege & Euan Bonner (2020) Virtual reality in education: The promise, progress, and challenge, p.169.

SERVERLESS ARCHITECTURE IN ERA OF DIGITALIZATION

Ivan Hedz

Faculty of Biomedical Engineering, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: cloud, server, digitalization, FaaS

Introduction. The rapid business of 21 century cannot compete without data insights that come from extensive digitalization. The important IoT integrated environment is rapidly developing right now. It needs a sophisticated solution to deliver the highest quality data for gathering, computing, and analyzing valuable business-related insights. The needs of businesses for fast, cheap, scalable, and reliable services are also at an all-time high. As we step into a new decade, the new hot FaaS (Function as a Service) rises and getting momentum.

Objectives. The main task is to outline customers' needs and find the intersection with the pros of Serverless magic compared to the dreadful IaaS approaches. Such architectures remove much of the need for a traditional always-on server component (Roberts, 2018, May 22).

Methods. The integration of cloud-native technologies such as cloud serverless is the next step in optimization and innovation in an era of rapid digitalization. At the moment, the use of such cloud-native technologies is at least 1 in 5 organizations in the world. However, serverless still has its flaws, like a slower startup, and lack of wholeness complexity for some sophisticated systems. Also, a deal-breaker for a lot of customers is vendor lock-in. Serverless architectures may benefit from significantly reduced operational cost, complexity, and engineering lead time, at a cost of increased reliance on vendor dependencies and comparatively immature supporting services (Roberts, 2018, May 22).

Results. By using a serverless approach, we benefit highly in terms of maintenance of infrastructure and reduced costs. Making such an adoption puts us ahead of the competition. Serverless is growing fast. And not just with smaller companies — the enterprise is adopting serverless technologies for critical workloads just as rapidly (Sugob, 2019, May 21).

Conclusion. To sum up, the use of serverless isn't all cases solution, but it's sophisticated enough to please most of the current business needs. Serverless is still growing and taking a hugger chunk of the market. However, it doesn't mean that Ops will go away anytime soon.

References:

Roberts, M. (22 May 2018). Serverless Architectures Retrieved from https://martinfowler.com/articles/serverless.html

Sugob, S. (May 21, 2019). Serverless Architecture — Complete Reference Guide [2019]. Retrieved from https://medium.com/swlh/serverless-architecture-complete-reference-guide-2019-55363c08d1be

USING A BLOCKCHAIN FOR ELECTRONIC VOTING SYSTEM
Bohdan Hereha

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Blockchain, voting system, information, voting data

Introduction. The Blockchain contains all possible potentials for improving outdated voting during elections. Most of the time we hear about the Blockchain potential in the context of financial services and banking systems. But the sphere that could have benefited from the technology the most is voting.

During the last election cycle, there was widespread talk of fraud, fake news and "manipulation of the system" in various countries. Our existing mechanisms have been found to be vulnerable to outside interference. It became clear to everyone that something had to change. And this is exactly where the Blockchain comes in.

Objectives. The main task of this paper is to show that the use of Blockchain for voting provides a number of advantages, namely transparency of voting, fast results and the impossibility of vote rigging.

Methods. The main advantage of moving our voting systems to the Blockchain is the increased transparency that it enables. The Blockchain will definitely prevent malicious actors from cheating on the system. It would ensure people don't vote twice. It is expected that everyone would have an immutable record of their voice and identity. And nobody would ever be able to delete votes, because again the Blockchain is immutable. People responsible for the counting of votes will have a final record of each vote counted, which can be verified at any time by regulatory authorities or auditors (Liu & Wang, 2017).

Moreover, the results recorded and stored in the Blockchain are not only immutable and transparent, they are also immediately available. This means that conducting elections on the Blockchain is not only more secure but also more efficient.

Results. It currently takes hours and sometimes days for votes to be counted after the elections – and sometimes the results are mixed up due to human or machine errors, which of course makes the process even longer. Whereas, the Blockchain provides a way for human error to be taken out of the equation and the results to be counted immediately (Shahzad & Crowcroft, 2019).

When regarding elections, everything that happens before election day must be also taken into consideration, such as the dissemination and discussion of information and news. Perhaps that is where existing voting system has proven to be the most vulnerable during last election cycle. To this day, users on social media sites are regularly exposed to pictures and articles that look real to an untrained eye. Readers have to rely on their own devices to determine whether or not something is actually authentic. At the same time, the Blockchain promises a way that allows users to verify which news sources are reputable and verifiable. It can serve as an immutable data source against which news sources can be verified (Taş & Tanrıöver, 2021).

For example, if we had such type of voting data stored on the Blockchain, a user on Facebook could look up an author or page they encountered and see if that author

or page is demonstrably publishing true or blatantly false information. That dataset would be located on the Blockchain for everyone to access. Individual articles could even be upgraded or downgraded depending on whether users can confirm that the content is correct. This would give people more opportunities to practice smart social media consumption habits.

It becomes clear that the more one examines the Blockchain as a potential mechanism for controlling electoral processes, the more one realizes that its application extends beyond municipal or public elections. Individual companies and organizations could enjoy the same benefits by using the Blockchain internally.

For example, companies could use tokens to give voting rights to employees and stakeholders. The allocation of tokens is also a way to encourage good behavior, such as consistent accuracy.

Companies like Ethereum are already experimenting with this type of structure– a structure that, in addition to increasing transparency and efficiency, also diversifies power (Albin, 2020).

Conclusion. The Blockchain technology that will come in handy to improve our voting processes already exists. Many states and countries around the world are experimenting with this technology: voting on the Blockchain, using the Blockchain to store and track voting data, and verifying news sources through a decentralized consensus. There is undoubtedly more to be done before this becomes a reality. But the technology is there. And we know what to expect if we decide to make transparency, efficiency and security a priority: a new future.

<div align="center">

References:

</div>

Benny, A. (July 11, 2020). Blockchain based E-voting System Retrieved from SSRN: https://ssrn.com/abstract=3648870 or http://dx.doi.org/10.2139/ssrn.3648870

Liu, Y., & Wang, Q. (2017). An E-voting Protocol Based on Blockchain. Cryptology EPrint Archive: Report 2017/1043, 1–5. Retrieved from https://eprint.iacr.org/2017/1043.pdf

Ruhi Taş & Ömer Özgür Tanrıöver (2021). A Manipulation Prevention Model for Blockchain-Based E-Voting Systems. *Security and Communication Networks*, vol. 2021, Article ID 6673691. Retrieved from https://doi.org/10.1155/2021/6673691

Shahzad, B. & Crowcroft, J. (2019). Trustworthy Electronic Voting Using Adjusted Blockchain Technology. *IEEE Access, vol. 7, pp. 24477-24488*. doi: 10.1109/ACCESS.2019.2895670

<div align="center">

ONLINE INTERVIEW PLATFORM FOR SOFTWARE ENGINEERS

</div>

<div align="center">

Mykhailo Hnatyshyn, Vladyslava Zhmurkevych
Faculty of Heat and Power Engineering, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

</div>

Key words: interview, vacancy, software engineer, code editor, videoconference

Introduction. We can observe an increased amount of interviews that have been moved to the online format since the first lockdown because of the pandemic. It is very

comfortable for candidates not to waste time on getting to a potential employer office for an interview meeting but just join an online conference (Roberts, Pavlakis & Richards, 2021). But only a video conference is not enough in case of interviewing the candidate for a software engineering role since it usually requires solving some practical coding tasks. Currently, HR staff and technical interviewers must use one program for managing interviews, another one for video conferences and one more for programme code editing. That's why, nowadays, creating an interview platform for software engineers that will include candidates and a meeting management system, video conference, live code editor and feedback management system is very relevant.

Objectives. The main task is to model and implement software that will help in conducting interviews for software engineers and include an interview management system, videoconference and live code editor. The rest of the possible functions should be researched while analysing existing analogues.

Methods. Problem solution has to be easily accessible for all the participants of the interviewing process so it is a good idea to implement it as a web application with no need to install any additional programs on users computers. User experience and user interface belong to the main parts of a software's comfortability. Interview platform should be suitable for being used by human resource personnel that are responsible for managing candidates, scheduling interviews and handling feedback; interviewers that are responsible for the formal part of the interview like asking questions and providing practical coding tasks; candidates that should answer interviewers questions and solving program tasks. Definite separation of the platform part by user's roles can be observed so it is a great place for using a micro-service architecture since it will allow to model and implement all these parts independently and with minimum coupling but maximum cohesion (Richardson, 2018). One of the most difficult technical parts, videoconference, needs to be reliable for a reasonable number of simultaneous participants, which can be determined as 5 for a typical interview in software engineering.

Results. Developed software product showed itself reliable in all aspects. It harmoniously combines systems for management interviews, videoconferences and code editor. The interview platform is looking stable under the performance load expected for the average amount of potential users. The software seems to have a good potential for future functionality enhancing and being presented to potential end-users.

Conclusion. To sum up, the process of candidate selection and interview conduction in software engineering has lots of weak points that can be improved by modern information technologies. This topic has only started to gain attention recently and its relevance will only grow in the future.

References:

Richardson, C. (2018). *Microservices Patterns (1st ed.)*. NY: Manning.

Roberts, J.K., Pavlakis, A.E. & Richards, M.P. (2021, March 25). It's More Complicated Than It Seems: Virtual Qualitative Research in the COVID-19 Era. *Sage Journal*, 1-2, Retrieved from https://journals.sagepub.com/doi/full/10.1177/16094069211002959. doi: 10.1177/16094069211002959

DATABASE MANAGEMENT SYSTEMS MOVE TO CLOUDS. WHAT FUTURE LIES AHEAD FOR THEM?

Ivan Holubov

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: DBMS, IaaS, DBaaS

Introduction. Currently, databases are one of the most widely demanded information technologies. Databases provide structure and methods for organizing data for advanced analytics and manipulation. Without a modern DB, you won't be able to associate a site or application with business logic, rendering your products useless.

Objectives. The main task is to analyse the main approaches to the implementation of cloud DBMS, their pros and cons. This and much more will be described further.

Methods. Cloud-based DBMSs are reliable, affordable, and easily scalable for changing workloads, so they can be the best choice for data storage. Currently, there are two main approaches to cloud DBMS implementation.

First, you can use the Infrastructure as a Service (IaaS), rent the necessary infrastructure resources. The main pros and cons of these are presented in table 1.

The second approach to cloud DBMS is based on the SaaS scheme (Software as a Service), where a DBMS is used as software, therefore it has been given its name DBaaS (Database as a Service). The main pros and cons of these are presented in table 2.

Table 1

pros	cons
economic efficiency	the client has no control over the security of the data
unlimited (at least in theory) scalability	problems in data networks can cause the operation to stop
the absence of any problems with updating the equipment when new requirements arise	placing data and software in the provider's data centre causes attachment to him
flexibility	
reliability	

Table 2

pros	cons
the ability to access the database directly	even less control over data than IaaS
scale the database under load	
the provider is responsible for the reliability of the DBMS	

Results. Fast, scalable and cost-effective DBMS in the cloud takes over. The DBMS in the cloud offers flexible pricing models, no capital costs, lower operating costs through a pay-as-you-go model. But they also have a disadvantage in the form of little control over the data (Li, 2020).

Conclusion. Thus, local database infrastructure and legacy systems are slowly disappearing. All organizations, large and small, will increasingly use the cloud. While it is still possible and likely that larger organizations will support both cloud and on-premises systems.

References:

Li, F. (2020, February 20). Cloud DBaaS is the future of database management for the Enterprise. Retrieved from https://timesofindia.indiatimes.com/business/india-business/cloud-dbaas-is-the-future-of-database-management-for-the-enterprise/articleshow/73803296.cms

EFFECTIVE WAYS TO FIND SPECIALISTS IN IT

Artem Hrechok

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: specialists, job, IT, freelance

Introduction. The development of the technological world has led to a drastic rise in the amount of work performed, plenty of new professions have appeared and the necessity to meet even more people's needs is constantly increasing. In total, there are more than 12,000 jobs where thousands of different tasks are performed (CareerPlanner, n.d.). Since one person cannot have enough skills to be able to perform every existing task, there is a need to find specialists. It is relevant both for individuals and companies. Due to the lack of time or appropriate skills, it is necessary to find a worker who would successfully complete the tasks receiving a certain reward for it. It can be either one-time work or permanent employment. This applies to most companies out there.

Objectives. The hiring process is extremely complex. According to the Glassdoor employment site (n.d.), hiring a new employee takes an average of almost 23 days while filling some other vacancies may take much longer. However, even the fact that the company has hired the desired employee is not a guarantee of success, because, according to Leadership IQ, 46% of all new professionals leave the company during the first 18 months (IndustryWeek, n.d.). The main goal is to determine what the ways to find a solid specialist are.

Methods. It goes without saying that in order to find a valuable worker, you have to place vacancy announcements on the resources where appropriate candidates are located. Incorrect placement of the ad leads to time being wasted on low-quality options. So what are the main places where you can find the right specialist? The method of rolling sample was used to select the main ways of finding candidates for vacancies. Comparative method analysis helped to identify the most popular and effective ones.

Results. Employment sites are the most popular and effective sources of staff search, because they allow you to get the maximum number of responses to the vacancy with minimal time. Social networks are now widely used for establishing business contacts and job search, as employers are desperately turning to social networks in

order to find narrow-profile specialists. Freelance forum is an ideal source for finding staff if the company has many one-off projects that require the help of a specialist. Moreover, it is also the case when a worker for remote work is needed.

The company's website is another effective source of staff search. That is exactly why it is so important for it to have a "Vacancies" section where candidates have an opportunity to learn about current vacancies and send their resumes. It would also be great to add an electronic form to the vacancies section for candidates to leave their contact details or send a question at any time. Despite the fact that the print media is losing its relevance, it is still possible to successfully find employees with the help of ads in newspapers. Furthermore, educational institutions may also help attract young professionals. Successful companies often deliberately select staff from talented students and offer them specialized training in their companies. Thus, such companies receive a highly qualified and loyal specialist at the time of graduation.

Conclusions. All things considered, there are plenty of effective ways to find specialists in IT. Some of them are becoming more and more popular every day, while others are gradually losing their relevance. However, there is an obvious tendency of searches being performed due to digital technologies rather than using traditional methods.

References:

CareerPlanner. (n.d.). List of over 12,000 Careers. Retrieved October 8, 2021, from https://www.careerplanner.com/ListOfCareers.cfm

Glassdoor. (n.d.). How Long Does it Take to Hire? Interview Duration in 25 Countries. Retrieved October 8, 2021, from https://www.glassdoor.com/research/time-to-hire-in-25-countries

IndustryWeek. (n.d.). Study: Nearly Half of New Hires Fail. Retrieved October 8, 2021, from https://www.industryweek.com/the-economy/public-policy/article/21949369/study-nearly-half-of-new-hires-fail

PREVENTING OF DATA LEAKAGE IN BUSINESS
Olena Hryhor, Mariia Korotiuk
Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: information, information leakage, leakage channels, business

Introduction. Nowadays more and more technologies are used in everyday life that is why, the amount of information, which gets into the Internet, is increasing rapidly.

According to Cabric (2015, p. 121), in order to succeed in modern world of business, valuable companies' data must be kept strict secret as it's leakage may lead to terrible consequences. This crucial information includes data about clients important for the business, any particular technologies and so on. All valuable information requires a reliable internal safeguarding system.

Although every company has own confidential information, risks related to confidentiality breach, integrity and data accessibility are usually underestimated. It is

easier for business to estimate direct profit then theoretical losses, as developing and support of effective information security system is highly expensive and complicated process. Hundreds of information leaks are reported each year. Average loss of each of them evaluated in several million dollars. Less scale cases occur hundreds of times daily.

Objectives. Information security is one of the main components of any business and enterprise. Information leakage is one of the key issues of modern world and deficient attention on this is a main reason of leakage of confidential information, both personal clients` data and actually business's.

Methods. Leakage may take place from various accidental reasons, such as emergencies, equipment failures, software engineers' errors, but mainly the hugest damages are evoked because of deliberate intervention.

Hackers are able to get unauthorized access to confidential information by multiple ways. Firstly, when hardware protection of network infrastructure from external threats is weak or absent at all.

Secondly, criminals are able to use an employee of the company for their goals. Such worker can take copies or photos of valuable documents, save any important for the company information onto a flesh drives and remove it from the office after that (Marion & Twede, 2020, p. 120).

Thirdly, hackers can use vulnerabilities, for instance interception of passwords, decryption of encrypted information.

The last but not least, they can use special devices like decoders and scanners of electromagnetic radiation from communication lines.

Results. Leakage of information is a significant threat for an activity of any enterprise all over the world. Either loss of reputation or trust of the customers, large financial losses, bankruptcy of the enterprise until the liquidation of the business entity are possible consequences of information leakage. That is why allocating a big amount of resources for the implementation of measures to prevent information leakage is very important.

There are some principles of providing information security by modern systems and one of them is required antivirus protection.

By the way, it is worth to keep in mind about timely updating of software and using only licensed versions of operating systems. The use of pirated software may lead to a complete work stoppage, which in monetary terms repeatedly exceeds the saved money.

Control of employees' activities in the office is important as well. It includes creating lists of visited websites, monitor the installation of third-party applications, control the copying of data on the flash drives and sending data by messengers.

In the case of devices loss, the data on them should be encrypted or protected with a password at least. Google, for example, allows a domain owner to force smartphone users to use reliable security methods: PINs, passwords, and others.

Conclusion. To sum up, any entrepreneurship is always related to creation, using and storage of significant amounts of information and documents, which represent certain value for the company and therefore they belong to the obligatory

protection against various types of threats. In addition, it is important to take into account all possible consequences before providing any confidential data.

References:

Cabric, M. (2015) Corporate Security Management: Challenges, Risks, and Strategies.

Marion, N. E. & Twede J. (2020) Cybercrime: An Encyclopedia of Digital Crime.

MODERN ART
Maryna Ishchenko

Faculty of Chemical Technology, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: art, museum, modern technologies, digital art, visualization

Introduction. Progress does not stand still. The the world is changing and improving these days, and humanity needs to follow technology and meet modern trends and demands. Today, modern technologies are changing art, as well as artistic professions that will be relevant in the near future.

Objectives. The main task is to tell about the development of modern technologies in art. The main task is to update ordinary art into contemporary art with technological and innovative progress.

Methods. Because of the technical revolution, radical changes have taken place in all spheres of human activity, including culture and art. Thus, under the influence of new technologies on the artistic environment there was a phenomenon called digital art. These are certain types of artistic activity, the productive and conceptual basis of which is closely interconnected with the digital environment. For example, wide creative opportunities have revealed such areas as virtual reality, three-dimensional animation, and interactive systems. If we talk about the fact that modern technologies have brought something new to art, then here, first, it is worth noting new artistic means and interactivity. First, there are new opportunities for creativity. Secondly, it is an opportunity for the viewer to get in touch with the artist and even participate in the creation of works (Bailey Anna, 2021).

Results. Cultural institutions around the world love to use modern technology. The main trend of museum and exhibition spaces is interactive interaction and cognitive tools, which are the point of contact between people and technology companies. Museums can now digitize their exhibits. Now you can sit at home and see the collections of many museums and galleries. This improves people's access to the art world. The British Museum added augmented reality experience to the visitors' impressions. For example, by pointing your smartphone at an ancient statue, you can now see missing items that have been damaged or disappeared over time. Exhibitions of contemporary art are turning into technological happenings with a bias towards science and media. Theatrical performances go beyond one stage. Adopting the mechanics of video games, they turn into quest theaters like those.

The development of modern technologies, of course, contributes to the emergence of new professions. For example, here are just a few of them that will be in demand in the near future. The choreographer of interactive shows is a director who works with interactive and robotic technologies. The artist-programmer is the creator of creative algorithms. Curator of virtual spaces – curator of online and interactive galleries. The architect of adaptive spaces is a specialist in creating landfills and a "smart" environment for mixed reality (Lawrie Eleanor, 2019).

Conclusion. Rethinking art through the Internet of Things can change the way we get to know and interact with art. Modern technologies open wide opportunities for the organization of virtual interactive presentations and exhibitions, in particular in the on-line mode. New technologies make it possible to demonstrate three-dimensional objects from any computer connected to the Internet.

References:
Bailey, A. (2021, February 23). Augmented reality art: Where your home becomes the gallery. Retrieved from https://www.bbc.com/news/entertainment-arts-56123958
Lawrie, E. (2019, April 23). Could a computer ever create better art than a human? Retrieved from https://www.bbc.com/news/business-47700701

NFT TOKENS AND DIGITAL OWNERSHIP
Mykyta Kanyuka, Anastasiia Averkova
Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: NFT, blockchain, cryptocurrency, digital ownership

Introduction. More and more things are moving from the real world to the digital one. Art objects are no exception. But how does it designate the right to own an object on the Internet? How do you know what is the original and what is the copy? This problem can be solved by NFT tokens.

Objectives. NFTs can solve one of the main problems of digital art: how to identify the original if you can find thousands of copies of the same object on the Internet? A new technology proposes to bind non-fungible tokens to digital objects, thus indicating their uniqueness and authenticity.

Methods. NFTs are based on blockchain technology. Simply put, a blockchain is a collection of data that is stored on different computers around the world. In the modern model of the Internet, there are nodes to which user devices are connected, but the blockchain operates on a different technology. There are no central hubs here. In such a system, different devices simultaneously store information about the blockchain. Tokens, in turn, are part of the blockchain chain and store various kinds of information. Before the advent of NFT, all tokens were replaceable. They could be compared to the currency of any country or other cryptocurrency (Sherman, 2021).

NFT stands for non-fungible token. "Non-fungible" means that it is unique and cannot be replaced by anything. This technology was created in 2017 based on Ethereum smart contracts. The difference between Ethereum and other

cryptocurrencies is that its blockchain supports the NFT. Each of such tokens is unique and exists in a single copy, it cannot be divided, and all information about its author, buyer and all transactions with it is securely stored in the blockchain. In other words, an NFT is a digital certificate attached to a unique entity.

Results. Due to its peculiarity of NFT, it began to be used by artists to designate authorship and ownership of digital objects. Of course, you can still copy this object, but you will not have the original ownership of it. This is the same as scanning a painting by Van Gogh. Yes, now you also have it, but it is a copy, and the original is still the only one and is kept by one person.

Many musicians and artists are starting to use non-fungible token technology to sell their work. This is a great opportunity for fans to support their favorite author. In addition, due to its uniqueness, such objects can be collected and resold. The author also receives a percentage of the resale, which is why NFTs have become so popular now.

Conclusion. At the moment, NFT technology is the most common in collecting. People buy collectible objects for a lot of money, and then sell them tens of times more. The most popular platforms for sales are OpenSea, Rarible and Nifty Gateway. The sales record was the painting "Everydays: The First 5000 Days", which was sold for $ 69.3 million.

In addition, this technology has the potential to have a great future. NTF are applicable in many areas, for example, to resolve problems in intellectual property (IP) law – the type that governs such ideas as patents and trademarks.

References:

Kari, P. (2021, April 3). *NFTs are helping artists solve a vital problem: who owns digital artwork?* The Guardian. Retrieved from https://www.theguardian.com/artanddesign/2021/apr/03/non-fungible-tokens-digital-art-artists

Milton Prime Research. (2021, August 10). *What is an NFT?* Milton Prime. Retrieved from: https://miltonprime.com/trading-education/articles/cryptocurrency/what-is-nft/

Sherman, E. (2021, May 30). *After The Hype: The Future for NFTs.* Forbes. Retrieved from: https://www.forbes.com/sites/zengernews/2021/05/30/after-the-hype-the-future-for-nfts/?sh=140b61022146

PROCEDURAL GENERATION WORKFLOW IN 3D INDUSTRY

Ihor Karpiuk

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: procedural mesh generation, procedural workflows, non-destructive methods

Introduction. The 3D industry has grown deep into a whole set of adjacent industries over the past thirty years. Nowadays we cannot imagine high-budget films or games making use of no 3D in production, and the communities of 3D artists are

growing stronger by day, producing spectacular amounts of educational content to accelerate their growth even further. Even 2D artists nowadays are starting to adopt 3D packages in their work and more opportunities are being presented to people for creation, simulation, prediction, and visualization. With the help of open-source, free 3D software, 3D is now being integrated into the smaller businesses and teams as their main or even additional means of getting around.

With all of this expansion of the area of our capabilities, we are also observing saturation of its horizon with newer, more exciting problems coming around that require smart engineering solutions. One of those problems is the machine memory limitation for big open-world games and movies. The innate human desire for exploration needs more space, which is hard to fill up with points of interest if you are memory-limited. But even if you solve this problem, the consequential one is the sheer amount of 3D assets that have to be generated for the big open world projects. That is where procedural workflow comes in.

Objectives. One solution to the memory limitation problem is not to store the memory-heavy 3D assets on the drive at all. They have to be *regenerated* every time they are being fetched in a way that is not going to produce too much of a bottleneck on the CPU/GPU. Real-time and runtime solutions are required for this task. Beautifully, as all simple solutions are, procedural generation itself is the answer to the second problem – to create a wide variety of 3D assets, artists do not have to model or sculpt each one of them individually. They can give the computer a general description of what the asset should look like, and get an almost infinite amount of diverse-looking assets, just from one program/description (Santiago, 2019).

Methods. To achieve the results quickly, new node-based technologies are being invented. Since you cannot make all of the buttons needed and put them into the UI, which is a bad practice in and of itself, you often have to code or "node" the solutions. The artists now have to adopt some programmer thinking to construct complex logical sequences from the building blocks provided by the software. Game engines provide bridges to software devoted to procedural generation (Pablo, 2019).

Results. The biggest advancement in this area of 3D has been made by the people working on Houdini, a SideFX program capable of realizing almost anything one can imagine with the powerful node-based systems for procedural generation, modeling, shading as well as simulation. The biggest films and games in the world are now regularly using the set of tools it provides. It invented the concept of "digital asset", which you can create in Houdini and then reuse in whatever engine supports it. That way, utilizing the compiled instructions, to create diverse procedural assets for the project.

Conclusion. All that stated, the research and technological development over the past thirty years has brought us a unique set of tools and solved the problem by procedural approaches, minimizing the work for artists and dissolving the limits of the current computers.

References:
Pablo, G. S. (June 3, 2019). Procedural Modelling. Development of procedural cities generation in Unity3D using Houdini (pp. 14). Retrieved from

http://repositori.uji.es/xmlui/bitstream/handle/10234/183597/Garc%C3%ADa_Segarra%2C_Pablo.pdf?sequence=1&isAllowed=y

Santiago, D. (2019, July 28). Procedural System Assisted Authoringof Open-World Content for Mar vel's Spider-Man. Retrieved 2021, October 8, from https://dl.acm.org/doi/epdf/10.1145/3306307.3328158

STATE OF THE ART IN DIGITAL AUDIOMETRY

Anastasia Kharchenko

Faculty of Biomedical Engineering, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Hearing test, subjective audiometry, tonal threshold audiometry, audiometer, digital audiometry

Introduction. Often we begin worry about our health when health problems become obvious. A person may not always notice-hearing loss, especially when it is mild. Our brain is able to fill in the gaps that appear, and a person can't find out that there are problems. Therefore, a hearing test is important. It is valuable to prevent illness and serious consequences. To do this, you can use the most accurate hearing test procedure – audiometry (AudioMetr, n.d.).

Audiometry allows you to conduct a comprehensive assessment of hearing acuity and determine the degree and nature of the lesion when diseases are detected. The strength of the sound stimulus is regulated and expressed in decibels. Audiometry is divided into subjective and objective (Auris, n.d.).

Objective. determination of the presence of hearing problems in a person in the early stages with minimal expenditure of resources.

Methods. digital audiometry refers to the subjective methods of audiometry. Subjective audiometry is a comprehensive type of hearing diagnostics, as it covers all levels of the hearing organ, from the outer ear to the cerebral cortex (Aurora, n.d.).

The main method for studying hearing in adults and children over 7 years old is tone threshold audiometry. To carry out tone threshold audiometry, a special device is used - an audiometer (Lor-Practica, n.d.). Hearing is tested at frequencies ranging from 125 to 8000 Hz. At each frequency, the patient is given a sound of different intensity, that is, less loud and louder. In this case, the patient is often located in a separate soundproofed room. If the patient hears a sound, he must press the button. The result of the TTA is a special graph document – an audiogram (Vashkevich, Azarov, & Petrovsky, 2014).

Recently, this process can be replaced by mobile applications. The test principle for such applications is consistent with tone threshold audiometry. This hearing test takes less time and is more affordable for everyone. But in this case, the person relies only on himself and on attentiveness receiving instructions from the developers.

Results. hearing test using mobile apps has a number of positive aspects: price and availability at any time. But it also has a big disadvantage – measurement accuracy. Such applications will never determine the norm for each person, because only a doctor can do this.

Conclusion. subjective audiometry is usually used for evaluation of subject's auditory sensitivity to various sounds – tonal, noise and speech, comparing to the sensitivity of normally hearing people. That is a problem, because each person is individual. What is the norm for one is not a standard for another. It is also need to remember that subjective audiometry methods are limited. It is impossible to diagnose accurately a specific lesion site. These methods are about searching for reasons to use objective diagnostic methods. So the use of hearing test applications based on the method of tone threshold audiometry can only be used to answer if the person needs a doctor.

References:

AudioMetr. (n.d.). *Otoakusticheskaja jemissija* [Otoacoustic emission]. Retrieved from https://audiometr.ru/otoakusticheskaya-emissiya

Auris. (n.d.). *Diagnostika sluha* [Hearing diagnostics]. Retrieved from https://www.auris.com.ua/service/diagnosis-of-hearing/

Aurora. (n.d.). *Diagnostika sluha metodami sub"ektivnoj audiometrii* [Hearing diagnostics using subjective audiometry]. Retrieved from https://aurora.ua/ru/articles/diagnostika-sluha-metodami-subektivnoj-audiometrii/

Lor-Practica. (n.d.). *Diagnostika pri pomoshhi audiogrammy. audiometrija sluha* [Diagnostics using the audiogram. audiometry of hearing]. Retrieved from https://lordoctor.kz/diagnostics/ear/166-diagnostika-pri-pomoschi-audiogrammy-audiometriya-sluha.html

Vashkevich, M. I., Azarov, I. S., & Petrovsky, A. A. (2014). *Kosinusnomodulirovannye banki fil'trov s fazovym preobrazovaniem: realizacija i primenenie v sluhovyh apparatah* [Phase Transform Cosine Modulated Filter Banks: Implementation and Application in Hearing Aids]. Retrieved from https://www.bsuir.by/m/12_100229_1_136930.pdf

HOW WILL THE COVID-19 OUTBREAK IMPACT ON OVERALL ICT MARKET GROWTH

Oleksandr Khomych
Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Information and Communication Technologies, COVID-19, market research

Introduction. The unprecedented COVID-19 crisis has demonstrated the vital role of digital technology. Since the beginning of the pandemic, we have witnessed a truly incredible resilience of networks and people. The world is witnessing accelerated digitalization of many activities and services, including telecommuting and video conferencing systems in and outside the workplace, access to health and education systems, and essential goods and services.

Objectives. The main task of the research is to make an overview of current positive changes that were made by an outbreak of COVID-19 based on China's

experience. The results of this research can be adopted and applied by other countries to support and develop the ICT industry.

Methods. According to IDC analysts, the outbreak of the COVID-19 coronavirus will lead to five major changes in the Chinese economy: smarter government management, decentralization of urban clusters, accelerated digital transformation in the healthcare system, accelerated introduction of contactless services and faster implementation of the strategy to turn China into a global supply leader (IDC FutureScape, 2019).

With an unprecedented global health emergency, networks and platforms are being strained to the limit. Many opportunities lie in online medical services, as the virus is driving the acceleration of the digital transformation of healthcare systems. Another area that has experienced a powerful surge in user activity is online pharmaceuticals. It is no need to go to the pharmacy at the risk of encountering the virus if you can call a doctor and get a prescription using mobile apps.

The pandemic has caused an increased demand for the development of high technology. Opportunities for growth and technology renewal that businesses previously had to prepare for within a few years are available in June 2020 in a matter of weeks. Other types of challenges and challenges require organizations to innovate and rethink how they work quickly (Katz, 2021).

Organizations were forced to move quickly to "digital rails" of business development, placing IT staff in leadership positions to cope with critical changes and minimize the impact of the COVID-19 pandemic on their financial performance. According to the study, this led to a 3-fold acceleration in the implementation of digital transformation projects (GlobalData, 2020).

In addition, according to experts, new opportunities are being created for companies and services that offer employees remote work. Approaches in education are also changing: in case of mass diseases, people will strive for distance education and online courses. Opportunities for business development are given to technology developers for stores that use a minimum of staff or none at all, as well as online food delivery services and telecom operators when building 5G networks and launching services based on them.

In the short term, the pandemic is stressing ecosystems for innovation, opening up opportunities for innovation across ecosystems. It is enough to count how many restaurants are left open in quarantine just because grocery delivery startups connect them with customers. Cities are partnering with hotels to accommodate homeless people and stop the spread of the virus in overcrowded shelters.

Finally, the outbreak of the coronavirus could give a new round of development of robots for their use in supply management systems. The demand for industrial and service robots should grow. Within its framework, authorities and companies seek to contain or reduce labour costs, including through the use of technological solutions (Karen, 2019).

Results. Despite the prospects that the coronavirus outbreak opens up for the ICT market, it has a huge negative impact on the global economy and China in particular. So, according to IDC forecasts, the global difficulties caused by COVID-19

will lead to the fact that the cost of information and communication technologies in the first quarter of 2020 will be reduced by 10%. Sales of computers and smartphones will fall by 30% and by 15% – of servers, network equipment and data storage systems. The impact on the entire Middle Kingdom will be enormous, given that digital technology accounts for 37.8% of the local economy (IDC FutureScape, 2019).

Conclusion. Summing up, the coronavirus pandemic has divided the world into "before" and "after". This affected both global and national economies. The dynamically developing IT sector was not ready for the pandemic and the steps that the leaders of the country, companies and enterprises were forced to take. These steps to a large extent slowed down development and weakened the resilience of the high-tech sector. However, despite this, many companies have found a way to deal with it and even make a profit. The pandemic and crisis have led not only to negative consequences but also to a significant step forward in the use of the latest technologies to preserve health and improve the standard of living of people.

References:

IDC FutureScape. (2019, October). Worldwide IT Industry 2020 Predictions. Retrieved September 15, 2021, from https://bit.ly/3kazQLc

Katz, R. (2021, February 4). Regulating for resilience: Reigniting ICT markets and economies post-COVID-19. Retrieved September 15, 2021, from https://bit.ly/3Eoksmq

GlobalData. (2020, October 5). Government investment to aid post-COVID-19 recovery of ICT market. Retrieved September 15, 2021, from https://bit.ly/2Z1MELV

Karen, S. (2019, December 11). What will be the 10 trends impacting IT infrastructure and operations in 2020? Retrieved September 15, 2021, from https://bit.ly/3tJeI1I

GENERAL TIPS FOR WEB-DESIGN

Tetiana Klimovich, Mila Oreper
Educational and Research Institute of Publishing and Printing, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: web-design, composition, visualization, combination of style, graphic design

Introduction. Today our life can not be imagined without Internet resources and Internet resources can not be imagined without design. Almost any product, publication, the project is not released without prior stylistic processing. For spreading and popularity, a designer should not forget about the aesthetic combination of all elements and the convenience of using, such as navigation. A real designer must combine in his work skills in style of composition, functionality, as well as knowledge of culture and art.

Objectives. The object of this study is the general advice on the combination of all key points when working with one of the main design areas – web design, based on three articles where various components are considered.

Methods. Scrolling any site, each of us wants to see some pleasant pictures, get some aesthetic pleasure and the purpose of most sites is a large audience, what means that every element must be thoughtfully appropriate. Designers always seek harmony when placing items (text, image, video), color gamma and navigation elements (Poydina & Savchenko, 2018, p. 169). Every project should look holistic, as well as all pages and blocks, as well as separate subdivisions. All blocks should always interact with each other and even complement each other. For example, for the decoding of visual information, the figurative forms are used by associativity and artistic thinking. It is worth thinking about visual harmony of the entire composition and for this it is better to use proportionality. This property is still supported by the functionality of the scale. Makhova and Groschkova (2017) noted that "With a large number of information, it is better to allocate specific elements of the text by increasing the keg, colors, drawing changes, emphasizing or even changing the font, but it all needs a competent combination. The style must be the only way to interact with other page elements (photos, frames, blocks, animation)" (p. 692). It is worth saying that the properties of the compositions are relative to each other. Some changes in objects lead to a change other elements that creates static or dynamics of compositions. The creation of projects also requires skills in working with the mechanism of construction and modeling of grids, knowledge of interaction of users with the interface, analysis of competitors and the notion of the style of modern design. A designer must constantly develop in many spheres, because all technologies and trends go ahead with an incredible speed. The main element in communicative design is Infographics. It includes the organization a wealth of information, emphasis on important moments, representing the design of the subject, as well as visual confirmation. It can be a static and dynamic infographic. For now the second option is very popular, but the first one is also not forgotten, because it is basic. Using of animation graphics gives the effect of dynamism and visual accent.

Results. So, the Internet is the biggest value of many people, it is their culture and addiction. Web design has an enormous impact on our lives, because thinking, views, tastes are changing. A good design is like pleasure for our eyes and souls. For the development of visual culture it is necessary to constantly develop, be interested in various images, create something new, you need to generate ideas and embody them. There is even a general fact, that design projects have a positive effect on people, their level of development. Each designer should know the rule of compositions and be able to combine them. A stylistic solution must always combine fonts, forms that were mentioned above and color gamut. Iakutova and Petrova (2013) found that "The font can perform not only an information function as every person may consider. It can be an element of design. In these cases, it should not be forgotten that the text should still be readable and comfortable for the audience" (p. 273). For readability, you need to combine certain parameters: headset, cap, background color and text, size fields, blocks and interlinks. The color is more likely to be selected, depending on the purpose of sites, subjects, as well as the number of text. A great addition will be knowledge of the general color theory. The text as an element of concentration may not meet the basic requirements, more often it is complete opposite, because it has a different goal. It is

worth learning a lot of spheres in order to become a good worker in this direction. Each element has its own purpose – correctly selected font contributes to the improvement of the site, as well as greater interest in this project. Properly selected color will give better psychological perception. A competent location of items will make a great interest for users. Convenient navigation will leave positive emotions and inspire to return again and again to the site and the unity of one style will make the site better. So, a designer must combine a lot of skills in his project for a good result.

References.

Iakutova, O.M., & Petrova, O.A. (2013). Shrift kak element dizayna veb sayta. [Font as an element of web design.] *Komp'yuternye I informacionnye nauki,2*(9), 273-274.

Makhova, A.I., & Groschkova, A.A. (2017). Svoystva kompozitsii v graficheskom dizayne. [Properties of composition in graphic design]. *Reshetnevskiye chteniya, 2*, 692.

Poydina, T.V., & Savchenko, Y.V. (2018). Veb dizayn v professionalnoy culture sovremennogo dizaynera. [Web design in a today's designer's professional culture.] *Uchenye zapiski,3*(17), 169-170.

PERSONALIZED MEDICINE IN HEALTHCARE

Maria Klymchuk

Faculty of Biomedical Engineering, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: personalized medicine, human genome, genetic, cancer, healthcare

Introduction. In recent years, there has been a shift from traditional medicine to personalized medicine. Personalized medicine allows you to draw up a treatment plan based on the individual characteristics of the human body. Unlike traditional medicine, which focuses on treating a disease, personalized medicine focuses on treating a specific patient. The doctor establishes a treatment plan based on symptoms and general information about the patient such as age, weight, gender, and continues to make adjustments to treatment until the most effective plan has been achieved.

This direction is very developing nowadays. It is known that one medicine may be useful for one person, but may not be of any benefit to another. Therefore, personalized medicine studies the genetic and molecular characteristics of the patient's body and instead of the approach: "one medicine for all patients", doctors use information about the human genome, using modern technologies. This is precisely the main problem of introducing such an approach to treatment, because it requires an increase in costs for diagnostics and modern medical equipment.

Objectives. The main goal of personalized medicine is to provide the right medicine, at the right dose, at the right time, to a particular patient (Sadée, Dai, 2005). In addition, personalized medicine is aimed not only at treatment but also prevention. Consequently, its goal is to identify the risks of developing certain diseases at a time when a person is still healthy, and to take preventive actions to avoid the development of a particular disease.

Methods. Personalized medicine is widely used in the treatment of cancer, in help fight our current coronavirus global pandemic and also for prevention. Personalized medicine allows physicians to predict patients' susceptibility to certain diseases, prevent disease progression, improve disease detection, prescribe more effective medications, and reduce treatment time and costs (The Jackson Laboratory, 2021).

Results. Through personalized medicine, for example, a drug such as Herceptin has been found as an extremely useful drug for around 20-30% of breast cancer patients who have elevated expression of HER2. However, some patients with elevated HER2 levels are inherently resistant to Herceptin due to mutations to the HER2 gene (Vu, Claret, 2012). Also, personalized medicine is changing the approach to diagnosis and treatment, enabling the patient to take an active part in treatment. For example, active monitoring of prostate cancer gives patients the choice of either immediate treatment with potential complications and discomfort, or waiting for signs of disease progression (Romero-Otero, García-Gómez, Duarte-Ojeda, 2016). Another example of the research is to determine if drugs developed to treat other diseases can be used to treat coronavirus. Personalization in medicine can also be used for other tasks. For example, the digital operating room can be customized to the surgeon and his preferred workflows, allowing him to create and execute the best surgical plan for the patient (Jocelyn, 2020).

Conclusion. In conclusion, we can say that the direction of personalized medicine is very promising and, accordingly, requires large costs and resources. Personalized medicine can have a positive impact on the healthcare system. Based on the individual characteristics of the body, doctors will be able to select high-quality treatment for patients. In addition, personalized medicine makes it possible to identify in advance whether a person has a predisposition to the development of a particular disease, thereby this will allow early start of treatment and prevent deterioration of the patient's condition. I think, that in the future this direction will develop at an even greater speed and will provide an opportunity to bring positive changes to our health care system.

References:

Jocelyn, M. (2020). How Personalized Medicine is Transforming Patient Care.

Romero-Otero, J., García-Gómez, B., Duarte-Ojeda, J.M., Rodríguez-Antolín, A., Vilaseca, A., Carlsson, S.V., Touijer, K.A. (2016). Active surveillance for prostate cancer. *Int J Urol. 23,* 211–218.

Sadée W, Dai Z. (2005). Pharmacogenetics/genomics and personalized medicine. *Hum Mol Genet, 14*, R207–R214.

The Jackson Laboratory. (2021). What is personalized medicine? Retrieved from: https://www.jax.org/personalized-medicine/precision-medicine-and-you/what-is-precision-medicine#

Vu, T., & Claret, F.X. (2012). Trastuzumab: Updated mechanisms of action and resistance in breast cancer. *Front Oncol. 2,* 62.

STARLINK
Anastasiia Klymenko
Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Satellite Internet, Wired Internet, Coverage problems

Introduction. It is important to understand that there are three global technologies. There is wired Internet, Internet connected with mobile communications, and there is satellite Internet (Benkler, 2017). These technologies have their advantages in different places. The quality of wired Internet in large cities is always better (Benkler, 2017) – it is more reliable, cheaper and has a higher bandwidth. In medium-density areas, mobile internet certainly has economic advantages. A base station is installed and some conditional area is immediately covered. Of course, coverage problems cannot be avoided – mobile Internet is less reliable. Satellite Internet is good for covering very large areas (Maral, 2019). In fact, it provides guaranteed coverage of the entire planet in places where there are no cell towers. Although it also depends on the weather and may not work, for example, during a thunderstorm or heavy rain. Satellite Internet was mostly inaccessible to individuals. Now everything will change.

Objectives. The idea is to wrap the entire planet in a network of small telecom satellites in low Earth orbit – 500-2000 km from the surface. One satellite covers a small area, for example, the size of Alaska (Maral, 2019). Therefore, they are launched in groups to cover a specific area. The success of any LEO project will lead to a complete change in the telecom infrastructure around the world. To launch the work, Starlink intends to deploy 12,000 satellites in near-earth orbit. At the moment, only 1800 satellites have been launched and the system is in test mode. Last year, Elon Musk announced that Starlink testing in Europe will begin in February-March 2021. But as of today, Starlink only operates in 11 countries, including the US, Canada and Australia.

Methods. The financial driver is a potential market – underdeveloped areas with poor Internet coverage, difficult terrain or being in the ocean. For example, the population of Africa alone, according to the UN, is 1.3 billion, or 16.7% of the world's population.

The technology for the production of reusable rockets will drastically change the cost and feasibility of a mesh of thousands of Internet satellites (Maral, 2019).

Results. In the near future, satellite internet will not be able to compete with mobile or wired internet. Satellite internet will always be more expensive due to frequency spectrum restrictions and the complexity of radio transmission. It is economically unprofitable. This is a very complex and expensive technology. Now its price is about $100 per month (Kellmereit, 2013). For example, in Europe, wired Internet costs about $30-50 per month (Benkler, 2017), which is two times cheaper than satellite (Kellmereit, 2013). The difference in price for Ukraine is even greater – we have a good high-quality wired Internet costs up to $10. In addition, now many people use Internet TV – this is a large amount of information with the Time Shift function and it is also expensive to transmit it via satellite.

Conclusion. Satellite Internet is good for places where there is no connection at all. For example, you can climb to Hoverla, where there is no cell tower and send a photo to your mom from there. However, for this you will have to lug a satellite terminal with you. In remote villages where there is no connection, it will work well. Thus, the question lies in the plane of the price: the wire is cheap and a lot, the satellite is 2-5 times more expensive or less, but everywhere and without restrictions.

At the same time, projects like Starlink will appear in the future and in other countries. A number of companies have already announced similar projects. But at the moment, the satellite Internet from Elon Musk is progress, and progress, as you know, cannot be stopped.

References:

Benkler, Y. (2017). *The Wealth of Networks* (3rd ed.). London, United Kingdom: Yale University Press.

Kellmereit, D., & Obodovski, D. (2013). *The Silent Intelligence – The Internet of Things* (1st ed.). Australia: DND Ventures LLC.

Maral, G., Bousquet, M., & Sun, Z. (2019). *Satellite Communications Systems: Systems, Techniques and Technology* (5th ed.). Australia: Wiley.

HOW AMAZON WEB SERVICES CAN MAKE DEVELOPMENT EASIER

Hennadii Kochev

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: AWS, cloud computing, infrastructure, service

Introduction. Amazon Web Services (AWS) is a fast-growing, widely-used computing platform that provides many different products like Platform-as-a-service (PaaS), Infrastructure-as-a-service (IaaS). AWS can offer many products like virtual servers, database and content storage, game-tech solutions (Wittig, 2015).

Objectives. The main task is to find out how Amazon Web Services bring software development process to the new level of abstraction. In particular, we need to look at different products made by AWS like Lightsail, Elastic Cloud Computing, Simple Storage Service, DynamoDB, AWS Lambda and others.

Methods. Amazon Web Services started in 2006 for handling of Amazon-internal operations. Nowadays, AWS offers tools and solutions both for individual software developers and for enterprises. (Raoul, 2019) Their data centres are located in more than 200 countries and it makes distributed cloud computing even more effective. Every AWS service can be easily configured in many ways based on developers' demand, this includes API, Web UI setting and other ways. AWS EC2 provides effective, scalable flexible computing capacity in cloud space. AWS S3 is a storage service designed for performance, data availability and security. AWS Aurora is a relational SQL-compatible database which combines availability and simplicity of traditional databases.

Results. Cloud computing offers more security than local servers so developers never have to worry about losing critical data (Wadia, 2016). Furthermore, the cloud service actually saves money in the long run. At the present time, Amazon Web Services have a big amount of products and that helps to keep it a low-cost platform that scales well and is very available.

Conclusion. To finish up, using cloud computing services, such as AWS, is a very popular practice that we can often see nowadays. When using the cloud, developers make their working process faster and more effective. Cloud computing saves developers' time, money and comfortability.

References:

Raoul, A. (2019). AWS: The Most Complete Guide to Amazon Web Services from Beginner to Advanced Level. *Kindle. 1 (1),* 152–153.

Wadia, Y. (2016). AWS Administration – The Definitive Guide. *Packt Publishing. 2 (1),* 108–109.

Wittig, M. (2015). Amazon Web Services in Action. *Manning Publications, 3 (1),* 20–22.

THE USE OF BLOCKCHAIN NFT TECHNOLOGY IN THE ART FIELD

Anton Kononov

Faculty of Biomedical Engineering, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: blockchain technology, non-fungible token

Introduction. Observing the endless change of styles and techniques, sooner or later we come to realize that one of the driving forces behind the development of art is the desire for novelty. Realizing the full potential of any trend, the creative nature of the artist begins to search for new horizons. This can explain the extravagance of some works of contemporary art, often bordering on lack of taste and senseless epatage. Having tried everything that traditional art could give, masters began bold experiments with form, color, materials, and genres. But along the way, too, a physical limit quickly emerged. Bypassing the material limits, contemporary art attempts to shift the emphasis from forms of expression to meaning. This leads to a blurring of the boundaries between art and non-art. Blockchain technology has opened up new horizons for us. With it, art has overcome the limitations of physical reality and begun to conquer virtual space.

Objectives. The main goals of NFT technology are to solve the problem of ownership of information objects and to make possible the monetization of digital files with cultural and aesthetic value. The technology enforces intellectual property rights when it comes to the public reproduction or commercial use of an object tied to an NFT token. A fairly common practice today is the purchase of graphic content for computer games. To avoid possible lawsuits, developers buy ownership of the digital file. But the most interesting area of application of the technology has become the virtual art market. Despite the ease of copying digital files, for many users, it is important to have

ownership of the original work. The same logic applies here as in the conventional art market: by buying the original, you become the owner of a piece of history.

Methods. Blockchain is software code that contains records of all past transactions. On its basis, cryptocurrencies are created, which are used as a monetary unit. The key advantage of blockchain technology is the high level of protection against counterfeiting, uncontrolled issuance and theft. The software code is arranged in such a way that all other token owners have information about all transactions, so it takes enormous resources to steal cryptocurrency. In 2017, this technology was adapted to produce so-called non-fungible tokens NFT (Non-Fungible Token). They are all unique, indivisible and irreplaceable. These properties make them ideal for confirming ownership of virtual and real objects (Tapscott, 2018).

Results. NFT CryptoPunks are believed to be the first full-fledged, non-interchangeable tokens. Larva Labs studio developers created 10,000 unique 24-by-24 pixel images of punks. All of the images were unique, but some were rarer than others. At first, they were not very popular, but it was estimated that the value of all sales between 2017 and 2021 had already exceeded $100 million. They were not only bought for resale but also use as social media avatars or collections (Dowling, 2021).

Today, artworks tied to NFT tokens continue their active expansion into the art market. Despite their singularity, they have already managed to occupy all market niches, from inexpensive sticker collections to works worth tens of millions of dollars. Perhaps the most famous work to date is Beeple's collage "Everyday's The First 5000 Days," sold in March 2021 The work was a collage made from the artist's 5000 Days works (Nadini, Alessandretti, Giacinto, Martino, & Aiello, 2021).

Conclusion. The success of artworks based on NFT technology can in a sense be considered natural. Since computer technology has penetrated all spheres of our life, modern man is haunted by the feeling that the world has divided into physical and virtual reality. Gradually the Internet space has become a new dimension of our lives, in which we communicate, work, have fun and even own property. Under such conditions, the emergence of a new type of art, existing in virtual space, was a matter of time. NFT technology solves the problem of ownership of information objects and opens up the possibility for their further use as a commodity unit. Thanks to this, millions of designers can now tokenize their creativity and turn the hobby into a profitable activity.

Most likely, real and virtual art will exist in parallel, allowing us to choose for ourselves which world is more important to us. And at some point, visiting a virtual museum with NFT paintings will become as commonplace as walking through the Louvre or the Met.

References:

Dowling, M. (2021). *Is non-fungible token pricing driven by cryptocurrencies?* Boston, United States: Lettio R.

Nadini, M., Alessandretti, L., Giacinto, F. Di, Martino, M., & Aiello, L.M. (2021). *Mapping the NFT revolution: market trends, trade networks and visual features.* United States: A Baronchelli.

Tapscott, D. (2018). *Blockchain Revolution: How the Technology Behind Bitcoin is Changing Money, Business, and the World?* New York, United States: Alex Tapscott.

GROWTH OF WEB DEVELOPMENT CHANGING THE WORLD
Anna Korzh
Faculty of Applied Mathematics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Web, development, Internet, services

Introduction. Some people may haven't noticed how Web development dramatically overcame an evolution. Since the creation of the World Wide Web, a lot of new technologies have cropped up. All the changes have made Web programming much more sophisticated and demanding. Development methods have markedly transformed to keep up with the trends (Kundariya, 2021). The understanding and evaluation of Web development's impact on human lives are fateful because this technology is the one to determine the future of programming. The research is of current interest to the world because some sceptics consider Web development to have a too low barrier to entry, so professionals in this sphere will soon cease to be in demand (Aaron, 2020). Moreover, the investigation is unique as it combines the most significant achievements in the IT field according to the author's opinion.

Objectives. The work aspires to analyze the experience people have gained because of the growth of Web inventions. In addition, there is an attempt to predict the perspectives of the sphere.

Methods. The research has catered for consulting with professionals in the scope. Experts here mean mentors and teachers of Web development. The study of the topic also provided for familiarization with articles and books about it. Top it all, as a junior Web developer author has also used personal acquaintance with the theme.

Results. Online communication has undergone the most noticeable metamorphosis. In the past, it mainly boiled down to four things: email, forums, first messengers, chats. However, the Internet connection was not easy to catch, so it was much easier to give a call or write an SMS. In 2006 first social media were launched. They are multipurpose, and therefore they became trending quickly (OrtizOspina, 2019). In the past couple of years, messengers evolved and rushed forward. The main difference between modern messengers and social media is that the first ones are private. By this example the conclusion, that the whole world tends to introversion suggests itself.

Cloud storage Web services have transformed the way we share and keep information. Talking about the past days, we should consider the necessity of saving files on the computers, additional HDDs or CDs and even bigger problem was exchanging data. Uploading, as well as downloading, on file-sharing sites took much time to be finished. The custody of data on the Internet was inconvenient for a couple of reasons: the network speed was too slow for loading anything directly; there were no suitable encryption algorithms to protect data from stealing; disk space allocation

systems did not exist at that time. In 2007 Dropbox, cloud storage for personal use emerged. It allowed uploading files into a virtual folder and sharing the link to it with others. Gradually other cloud storage services started to appear. Thanks to it, we can: store terabytes of information without clogging up space on the computer; create backups; open files on any device with Internet access; share any data by just sending links; edit files online directly on the cloud without using additional programs (Adams, 2012, p. 85).

Web evolution also affected the entertainment industry. Not so long ago, the monopoly of video content belonged to the TV. People used to watch favourite soap operas and shows at the designated time without an opportunity to do it later. Films were sold on DVDs, and there was no other alternative. The same was with music. The reason for this is evident – the Internet was too slow to load media content. Today such devices as audio and video players are archaic and pointless, being replaced with streaming services, where we can watch and listen to anything (Bozkurt, 2019). Besides, Web developers have made these services intelligent: they remember a moment when you stopped watching/listening, offer you content taking your preferences into account, provide a system of parental control for children.

One more thing that has changed is the sales area. Less than twenty years ago, it was impossible to buy anything on the Web. Stores were only available offline. In contrast, at present, it is hard to imagine a business startup without a site. Programmers elaborated catalogues of products with filters to simplify the searching process, online payment systems, personal accounts, carts to make an order, etc.

During the coronavirus pandemic, an urgent need for distance learning services popped out. And in just a few months, WEB specialists have covered the demand with new applications and services. It seemed impracticable, but now we have a viable alternative to offline full-time education programs.

Web development has transformed the way business perform their work. Industries are now dependent on various web technologies to streamline their workflow, enable their employees to improve their productivity. Whether it is manufacturing, management, e-commerce, etcetera, all industries are affected by the rise of custom Web development (Nagar, 2018).

Conclusion. Then consumers could not imagine having a smartphone in their pocket, a tablet on the desk, or even a browser different from Internet Explorer. Now frontend, backend, and full-stack programmers are working to improve the users' perception of sites, make the interaction with them as efficient as possible, and minimize the time spent on loading pages (Stangarone, 2015). Today's reality is just the beginning. Whatever awaits us on the Internet of the future – WEB developers will create. To conclude, we should admit that the potential of this area of programming is inexhaustible. Professionals in the sphere will be needful on the market for more than a decade. The future of the Web is creating an environment of information that is not only faster but also more effective without costing too much (Nagar, 2018).

References:
Aaron, P. (2020, August 6). Is Web Design A Dying Career? – 2021 [Blog post]. Retrieved from https://www.ramotion.com/blog/web-design-dying-career/

Adams, R. (2012). *The Emergence of Cloud Storage and the Need for a New Digital Forensic Process Model*. In K. Ruan (Ed.), Cybercrime and Cloud Forensics: Applications for Investigation Processes (pp. 79–104). Hershey, PA: IGI Global.

Bozkurt, Ç. (2019). *The rise of online streaming services* [Blog post]. Retrieved from https://www.twentify.com/blog/the-rise-of-online-streaming-services

Kundariya, H. (2021, April 29). *Top 10 Web Development Trends to Expect in 2021* [Blog post]. Retrieved from https://blog.hubspot.com/website/web-development-trends

Nagar, T. (2018, June 13). *How Rise of Web Development Changed the Industry Trends?* Retrieved from https://www.linkedin.com/pulse/how-rise-web-development-changed-industry-trends-tarun-nagar

Ortiz-Ospina, E. (2019, September 18). *The rise of social media.* Retrieved from https://ourworldindata.org/rise-of-social-media

Stangarone, J. (2015, September 1). *Web Development: What's changed and where is it going?* [Blog post]. Retrieved from https://www.mrc-productivity.com/blog/2015/09/web-development-whats-changed-and-where-is-it-going/

IS ARTIFICIAL INTELLIGENCE THE FUTURE OR PRESENT, GOOD OR EVIL?

Dmytro Kotenko

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: AI (artificial intelligence), afraid, search, provide

Introduction. Nowadays you can see on the street what even some ten years ago it was impossible to imagine: electric cars, quadcopters, jack pats, etc. And despite all this, most people do not have the slightest idea about AI. It is believed that AI is an unrealizable future associated with the rise of robots or something similar (Podcast "The Fifth Floor", 2015).

Objectives. The purpose of this article is to tell people who think in this way what AI really is. Although the goal is very simple, it is very important, because due to the ignorance of some people from the news lines, we can see similar headlines: "Residents of village X demolished 5G cell phones", "In the city Y, unknown people burned the office of a company that was engaged in the development of AI" and so on. The main enemy of every human is unknownness and the goal is to overcome it by telling how things really are.

Methods. Descriptive method and method of observation were used to implement our main aims and objectives.

Results. AI is used a lot in everyday life so each industry should be described in details:

– navigation; These days, using Google Maps and other similar software, you can easily get the shortest route to your desired location. These apps take traffic and

roadwork into account to find the fastest route to your destination, all powered by AI (CRITEO, 2019).

– mechanical engineering; Self-driving cars are now able to operate in an infinite number of possible scenarios, which makes the roads safer and the journey much more comfortable. These smart cars reduce the likelihood of accidents usually caused by human factors. Also, by analyzing the actions of the owner, the car can automate the switching on and off of some functions.

– Search engines have made the most of AI technologies. AI learns to respond to a user's request based on their behavior in order to provide the best results for the client. For example, if you type in the search engine "Warriors", then in a few minutes you will be able to find in the song of the group Imagine Dragons, and not a sports American football team. The use of AI allows you to save a lot of time due to the intuitive thinking of the search engine, as well as provide an opportunity for the use of targeted advertising.

– Modern servers allow storing huge amounts of user data. In turn, AI can analyze them and, based on the results, implement the maximum possible targeted advertising. For example, by studying user requests for paint, wallpaper, laminate flooring, AI can create useful advertisements for building materials or the services of professional builders (FutureNow, 2021).

Conclusion. Summarizing all the above, we can say that AI is already an integral part of some branches of our life. And as technology advances, we will see more and more decisions being made for us by AI. I would also like to say about the threat of capture by human beings with artificial intelligence. AI by itself is not capable of this, but someone can help him figure it out. AI is just a tool, and in the hands of a bad person, any tool, even a wand, can become a real weapon.

References:

FutureNow. (2021). *5 examples of using AI in everyday life.* Retrieved September 29, 2021, from https://futurenow.com.ua/ru/5-prymerov-yskusstvennogo-yntellekta-v-povsednevnoj-zhyzny/

Podcast "The Fifth Floor" (September 14, 2015). Is artificial intelligence threatening humans? Retrieved September 29, 2021 from https://www.bbc.com/russian/science/2015/09/150914_5floor_ai

CRITEO. (August 27, 2019). 8 areas of daily life where artificial intelligence has revolutionized. Retrieved September 29, 2021 from https://www.criteo.com/ru/blog/8-областей-повседневной-жизни-в-которы/

MODERN INFORMATION TECHNOLOGIES IN EDUCATION SYSTEM

Natalia Kovalchuk
Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: learning, multimedia, teachers, educational process

Introduction. With each passing day, information technologies (IT) are increasingly evolving in different areas. Since the beginning of the pandemic Covid-

19, the whole world has switched to distance learning. Initially, it was challenging to adjust, and some teachers had no idea what an online conference was, how to broadcast the computer screen, and how to create the learning process more productive and interactive.

Objectives. The main objective is to disseminate information on modern IT in the field of learning, such as online conferences, multimedia training, platforms for learning, interactive assignments. All of this will help students and learners to better capture and assimilate information. In general, introduce new technologies into the educational process to improve the perception of information and help students learn new material faster.

Methods. The Internet offers various information and resources to its users. A basic set of services may include:
– e-mail;
– cloud technologies;
– Usenet;
– videoconference, online meetings in messengers and services, webinars;
– Google Forms, test constructor;
– ability to publish their information, create their homepage and post it on a web server;
– access to information resources;
– practice in modern computer rooms;
– access to personal accounts on special sites, and so on;
– search engines;
– chat room (Almabaeva, 2017).

One method is to train teachers to the skill of computers to instantly react to input information to ordinary training programs in the form of exercises. With this experience, teachers will be able to assist students in better master theoretical and practical knowledge.

Also, as an adjunct, it's multimedia learning, which has grand potential for teaching different subjects and spheres. Thanks to an optimal combination of digital technologies (video, television, radio, newspapers, magazines, books, telephones) and extra features (interactivity, graphics, etc.). Multimedia education provides virtually unlimited learning opportunities. Our motto is "Teach and learn!".

Results. Introducing new technologies into the educational process will create learning much more interesting, more productive and more effective (Aguilar, 2018). Students will view learning as a positive portion of their lives that requires active participation and not as a boring and tiring routine (Bajraktari, 2020).

Conclusion. Technology has a profound impact on nearly every aspect of our lives, and education isn't an exception. So, the Internet is one of the most powerful tools for teachers to assist students collaborate, interact and actively partake in the learning process. With the assistance of modern IT in the education system, students and learners will be more pleased with the educational process and will work much more productively.

References:

Aguilar, J. (2018). Role of Information Technology in the Education Sector. Retrieved from https://medium.com/@iamaguilarjubileen1999/role-of-information-technology-in-education-sector-baef822a001e

Almabaeva G.B., Artykova E.U. (2017). Modern information technologies in the education system. Retrieved from https://articlekz.com/en/article/22309

Bajraktari, D. (2020). Modern Technology in Education. Retrieved from https://itchronicles.com/education/modern-technology-in-education/

INFORMATIONAL TECHNOLOGIES IN THE STATE MANAGEMENT

Vladimir Kozemaslov

Educational and Research Institute of Special Communications and Information Security, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: information technology, public authorities, modern information, administration

Introduction. Increasingly, experts resort to modern information systems and technologies to monitor external and internal flows of information, use them for analysis, forecasting, management decisions. The main purpose of using information technology in public administration is to improve the efficiency of public administration mechanisms, which include public information systems and resources, as well as the means to ensure their functioning, interaction with each other, the population and organizations in the provision of public services. The state policy in the field of use of modern information technologies is called to provide coordination of activity of public authorities for creation of the state information systems and increase of efficiency of budgetary expenses in this sphere. Prioritizing the use of information technology in the activities of public authorities should be based on an assessment of the possibility of obtaining meaningful socio-economic results and the amount of relevant resources. Thus, the priorities in the use of information technology in the field of public administration of modern society are urgent tasks of socio-economic development countries.

Objectives. The aim of the work is to analyze the measures for the introduction of modern information technology in the activities of public authorities, using the available regulatory framework (Abrosimova, 2013).

Methods. The logic of development of modern society and the state requires not only the improvement of public administration through its informatization, but also a new strategy of public administration in the period of formation and development of the information society (Abrosimova, 2013).

Results. In the structure of public authorities, bodies responsible for the formation and implementation of state policy in the field of information technology were formed, the basis of the system of interagency coordination of state programs and projects for the use of information technology, the order of creation of coordinating

and advisory bodies in this sphere is defined. The quality of information technology management processes is improving. A significant number public authorities implement relevant programs, most of which have qualified personnel who are responsible for the creation and implementation of departmental information systems and resources. Projects for the implementation of automated information systems in the field of electronic document management, management of logistical, financial and human resources, as well as projects for the integration of state information resources are being successfully implemented among themselves in the framework of the implementation of electronic administrative regulations for the provision of public services. Applied systems of information and analytical support are created, databases on the basic directions of activity of public authorities are formed. Widespread use of information technology in public administration can increase the efficiency of: interagency cooperation; provision of public services to the population and organizations; personal and collective work of employees of federal public authorities. Determining priorities in the use of information technology in the activities of federal public authorities is based on assessing the possibility of obtaining significant social (economic result and the amount of relevant resources. Priorities in the use of information technology in public administration are specified on a regular basis basis in accordance with the current objectives of socio-economic development. In accordance with the main directions of administrative reform, the priorities for the use of information technology in public administration are as follows: 1) improving the efficiency of the implementation of the functions of the state, establishing the law, and improving the mechanisms of state regulation based on the creation and development; 2) improving the efficiency of law enforcement activities of public authorities on the basis of creation and development; 3) improving the efficiency of control and supervisory functions based on the creation and development of systems; 4) reduction of operating costs for the maintenance of the state apparatus; 5) growth of qualification of civil servants on the basis of creation and development of the information system; 6) improving the interaction of public authorities (Kamolov, Artemova, 2017).

Conclusion. The main directions of increasing the level of protection of general information technology infrastructure of public authorities at the present level are to be: providing a comprehensive approach to solving information security problems to determine technical requirements and criteria, creating a register of critical objects, ensuring effective monitoring of information security; improving the regulatory legal and methodological framework, conducting orderly certification of state information systems and resources by public authorities.

References:

Abrosimova, M. A. (2013). *Information technology in state and municipal administration.* KNORUS, 256.

Kamolov, S. G. & Artemova, P. V. (2017). *Information technologies for government officers*. MGIMO, 215.

WAR OF GAME ENGINES. UNREAL ENGINE VS UNITY

Nazarii Kozynets
Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: unreal engine, unity, effects, developers

Introduction. Unreal Engine vs Unity – this dispute between game developers has been going on for a very long time. Two popular game engines, Unity and Unreal Engine, are used by both large companies and ordinary developers.

Objectives. Objectively compare the two game engines: list the disadvantages and advantages of each. And also understand where to start and for what purposes it is best.

Methods. One of the main differences in Unity vs. Unreal Engine is the quality of the visual effects. Unreal offers clear visual effects, while Unity- needs a lot more work to look almost like Unreal. Because of this, Unreal is more used for big games (Ferrone, 2020). So, if you want to have photorealistic resources, use Unreal. If you want to create a project to work on mobile phones, Unity is best, because it does not require such power as Unreal. If, on the contrary, you are creating a project for a PC, then Unreal really looks like the best option. But it also depends on the number in the team (Cookson, 2019).

Results. Going to the code level, Unity wins because it's C#, which is easier to write. Unity has a huge community, and you can find many tutorials on YouTube, so even without programming skills, you can implement something simple with this engine. UE4 is great for rapid prototyping, big games, open source, but requires C++ knowledge. The big advantage is the ability to create a full-fledged game with little or no code. Unity has slightly lower system requirements, the engine itself and the projects on it take up less disk space. Two engines are capable of reproducing approximately the same graphics. Initially better in UE4, but it all depends on the experience of developers.

Conclusion. In conclusion, I now use Unity because I'm just starting to learn how to develop games and don't need better visualization. However, in the future I hope to switch to Unreal Engine 5 as soon as it comes out. I was convinced that Unity was suitable for simple, low-level development, and for quality games it was better to use Unreal Engine. Each developer chooses his engine, which he likes, and develops in this direction.

References:

Cookson, A. (2019). Unreal Engine 4 Game Development in 24 Hours, Sams Teach Yourself. Retrieved from https://t.me/bookfordev/42

Ferrone, H. (2020). Learning C# by Developing Games with Unity 2020 Fifth Edition: An enjoyable and intuitive approach to getting started with C# programming and Unity. Retrieved from https://t.me/archivedevelop/194

USE OF SOCIAL ROBOTS IN THE THERAPY OF CHILDREN WITH AUTISM

Olexandra Kravchenko

Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: social robots, autism, therapy, robotic pets

Introduction. Social robots are autonomous robots that interact and communicate with humans, fulfilling a specific social role. Such robots are necessarily physically embodied, and are usually humanoid. It rarely happens that a social robot simply follows a set of given instructions. These are very simple robots. Many of the newer options adapt to people, their behaviors, schedules, and habits, with little to no additional customization.

Objectives. The main task is to study different types of social robots, figure out how they participate in therapy and consider possible ways to improve this direction.

Methods. For children with various autism spectrum disorders, communicating with others is challenging and at times impossible. It is difficult for such children to maintain eye contact and concentrate on the conversation, which brings discomfort to them and those around them. The answer to their needs was the idea of creating an intermediary robot, following which, special children would learn social interaction. These robots also help adults to communicate with children without discomfort for the latter (Casas, 2020).

Robots arouse interest in children, help improve mood, concentrate on studies, reduce feelings of anger, and help in psychotherapy. According to some studies, children who used robots for therapy spent more time with them than talking with a human specialist. Moreover, after several sessions of such communication, children without anxiety began to use simple patterns of behavior and expression of emotions, read directly from the "face" and "body" of a specialized robot (Kim, 2012).

For children, interaction with robots is a priority than with adult specialists: robots are usually much more attractive in appearance, they (and with them!) Are always fun, they will not be angry, irritated, they cannot be hurt, they will not hit or shout. Robots often give children a sense of security, and they are more willing to study with them, carry out assignments. This is very important when working with special children and those who have experienced trauma or abuse, when help is needed now, and it will take some time to establish contact with an adult specialist (Dawe, 2019).

Another helping type of social robots are pobopets. (Sefidgar, 2016) Pet therapy is already in use, but there are several reasons why robotic animals are better than living animals.

First of all, it saves time. The development of a robot takes a long time, but after its completion, we can replicate this technology as many times as we want, and we do not need to spend resources on training each individual Labrador: it is already sewn into their brains.

Second, there are biological limitations. The robotic pet adjusts itself to your daily routine, it does not need to be fed, bathed, it does not take up much space and

does not require special care. This is an advanced toy that gives you the feeling of a real pet. Even a baby can cope with leaving – just do not drop it and charge it regularly. In addition, such a pet will never die, which will have a positive effect on the psychological well-being of a person.

Thirdly, such pets are safe: they will never be allergic, they will never bark suddenly and will not frighten a person. He can't be hurt, so he won't bite or scratch. He is never in a bad mood and he cannot get sick.

Robotic pets are not yet perfect enough to completely replace real pet therapy, but I'm sure this is heading towards that.

Results: As a result of the need to use social robots in therapy, we have many solutions. Among the robots created especially for special children, we can distinguish the robot teacher QTrobot and the robot with a human face Bandit, which teaches social behavior. You can also remember the little funny robot Keepon, which helps to recognize children's emotions.

If we talk about robopets, there are Paro, the robot seal, Pleo, the robot dinosaur, and other robot pets.

Conclusion. Thus, we see that the use of social robots in working with special children has many advantages. This area is worth developing to make it easier for them to adapt and work with them.

<div align="center">**References:**</div>

Casas, J., Cespedes, N., Múnera, M., Cifuentes, C.A. (2020). Human-robot interaction for rehabilitation scenarios. In: Control Syst. Bio-Robotics Bio-mechatronics with Adv.

Dawe, J., Sutherland, C., Barco, A., Broadbent, E. (2019). *Can social robots help children in healthcare contexts?* Retrieved from https://doi.org/10.1136/bmjpo-2018-000371

Kim, E. S., Berkovits, L. D., Bernier, E. P., Leyzberg, D., Shic, F., Paul, R., et al. (2012). *Social robots as embedded reinforcers of social behavior in children with autism.* J Autism Dev Disord.

Sefidgar, Y.S., MacLean, K.E., Yohanan, S., Van der Loos, H.M., Croft, E.A., Garland, E.J. (2016). *Design and evaluation of a touch-centered calming interaction with a social robot.* IEEE Trans Affective Comput.

<div align="center">

SOLID-STATE DRIVE (SSD)
</div>

<div align="center">

Oleksandr Kryzhanovskyi

Faculty of Biomedical Engineering, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"
</div>

Key words: Solid-state drive, hard disk drive, storage technology

Introduction. As you all know, the computer's hard disk drive (HDD) has always been subject to considerable requirements. Capacity (amount of data that can be stored by the drive), performance (access time and average data rate), the amount of buffer (memory for smoothing read/write differences), interface, physical size, power consumption, and many others. Whenever a new standard in this field is

released, they are of great interest. And so it happened, a new word in storage systems – it is a solid-state drive (SDD).

Objectives. The purpose of this work is to determine the advantages and disadvantages of a solid-state drive (SSD). For whom, when, and whether you need to use the solid-state drive, or should you continue to use the regular HDD.

Methods. Consider SSD technology, its pros, and cons regarding HDD technology. A solid-state drive is a computer storage device based on memory chips, without moving mechanical parts. It is incorrect to call it a "disk" because the SSD does not have a disk: the drive consists of memory chips and a controller, like flash memory (Palagin & Yakovlev, 2005). In essence, a solid-state drive is a flash drive that is used almost by everyone. Flash memory-based solid-state drives (SSDs) were in existence a few years before they hit the mass market. The fact is that SSDs are much more expensive per gigabyte than conventional hard disk drives. SSDs were originally designed for high-speed servers or military computing systems. Consider the advantages of solid-state drives (SSDs) over hard disk drives (HDDs):

– low energy consumption;
– complete absence of noise due to the absence of moving parts and cooling fans;
– wide range of working temperatures;
– stability of time of reading of files irrespective of their placement or fragmentation;
– great modernization potential, both in the drives themselves and in the technologies of their production;
– much less sensitivity to external electromagnetic fields.

Results. The main disadvantage of SSD is the limited number of overwrite cycles (Tatarnikov, 2007). And the price of a gigabyte of SSDs is significantly higher than the price of a gigabyte of HDD. In addition, the cost of SSDs is directly proportional to their capacity, while the cost of traditional hard drives depends on the number of plates and grows more slowly with increasing storage capacity.

Conclusion. Therefore, considering the advantages and disadvantages of solid-state drives, you can choose the best option for the end-user. Install the SSD drive for the system (Windows, macOS, Linux) and an HDD for storing all other information. This method of use will lead to faster computer operations, and relatively cheap space to store large amounts of data.

<div align="center">**References:**</div>

Palagin, A. & Yakovlev, Y. (2005). *System integration of computer equipment*. Universum-Vinnytsya.

Tatarnikov, O. (2007). *Solid-state drives. compress.ru*. Retrieved October 10, 2021, from https://compress.ru/article.aspx?id=17939

PERCEPTION-BASED IMAGE AND VIDEO COMPRESSIONS ALGORITHMS

Illia Kvashuk

Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Perception, Compressions, Algorithm, Human Perception System

Introduction. With constant improving in capacity and resolutions of modern digital cameras and other different state-of-art equipment dedicated for capturing visual signal, the ability to transmit, store and change requires high-effective algorithms for compression. They must be almost lossless, fast and performed on most electronic devises like smartphones, smart-glasses and laptops thus possessing from moderate to low computations powers (Pandey, 2015).

Various ways of such process have been set out during previous century and during the beginning of current one. They exploit sophisticated math theories among those are matrix decompositions (NASA lunar and Mars probes photos) and frequency decomposition (JPEG format) (Chang, 2007).

Meanwhile showing great result in reducing file size in the magnitude of 2-10 ratio, questions about human perception of changed images and videos arise. In most cases it's semi-impossible for humans to tell apart compressed files and original ones hence implying, as well as robustness of accepted in industry algorithms, the further ways for development brand new perception-based algorithms that will make use of this feature in human visual processing and fill theoretical gap of acceptable loses indistinguishable from users.

Objectives. Main task is to provide information about current and upcoming compression algorithms and describe different approaches devoted to them (Yadav, 2012). Additional task is to give brief observation on the Human Perception System and show its interactions with key aspects of the mentioned algorithms.

Methods. All algorithm that are represented in the modern visual field of compression can be separated in two distinct groups – loos and lossless. This division has both solid math and information theory background, that can be used to analyze them. Main focus will be on loos algorithms. Measuring effectiveness of operation by ratio between files size before and after (compression ratio), collecting information among user about quality of image via survey and tests of their perception abilities, introducing special image space and using other tools from math field we can get certain results on various implementation of compression algorithm.

Results. Different approaches from math, optic, physics and math field have shown that human vision is much more complex than was previously thought. Basic approach with Mean Sum Error from picture to picture doesn't have correspondence in Human Vision System (Wu, 2013). This results in fewer possible way for implementation of simple algorithms (like averaging neighboring pixels or SVD) to fulfill both compression required ratio and lossless for viewer perception.

Much more effective way was based on variation of famous Fast Fourier Transformation (Yadav, 2012; Chang, 2007). Such technique uses set of filters that

react on diverse part of picture which then give as output certain value for the specific part of picture's color-saturation-brightness space. Main result is that meanwhile people percept whole picture and all its aspects simultaneously, some of the aspects are not so crucial and can be truncated. Filters combine all of the image dimensions in simple way and choosing right technique for defining filters we can compress image and video even in HDR quality without any notice from audience.

Conclusion. Modern information and high-tech world require vast information transfer almost instantly. This pushes scientists and researchers all over the world to develop and experiment with new ways for files compressions. Technique applicable for images and videos are most interesting because of their size. Existing methods are effective in reducing them – Singular Value Decomposition SVD and Fast Fourie Transformation both have found implementation in different fields of science, engineering and entertained. Deep dive in human perception can give us even more tools to compress files in human-friendly way. Exploring different ways to filter images scientists can get access to both coding and compression mechanisms of digital machines and human perception system (Zhang, 2011).

<h2 style="text-align:center">References:</h2>

Chang, C. L., & Girod, B. (2007). Direction-adaptive discrete wavelet transform for image compression. *IEEE Transactions on Image Processing, 16(5),* 1289–1302.

Cochran, W. T., Cooley, J. W., Favin, D. L., Helms, H. D., Kaenel, R. A., Lang, W. W., ... & Welch, P. D. (1967). What is the fast Fourier transform? *Proceedings of the IEEE, 55(10),* 1664–1674.

Pandey, S. S., Singh, M. P., & Pandey, V. (2015). Image Transformation and Compression using Fourier Transformation. *International Journal of Current Engineering and Technology, 5(2),* 1178–1182.Sims, C. R. (2018). Efficient coding explains the universal law of generalization in human perception. Science, 360(6389), 652-656.

Wu, H. R., Reibman, A. R., Lin, W., Pereira, F., & Hemami, S. S. (2013). *Perceptual visual signal compression and transmission. Proceedings of the IEEE, 101(9),* 2025–2043.

Yadav, R. K., Gangwar, S. P., & Singh, H. V. (2012). Study and analysis of wavelet based image compression techniques. *International Journal of Engineering, Science and Technology, 4(1),* 1–7.

Zhang, Y., Reinhard, E., & Bull, D. (2011, September). Perception-based high dynamic range video compression with optimal bit-depth transformation. *In 2011 18th IEEE international conference on image processing* (pp. 1321–1324). IEEE.

THE DIAGNOSTIC VALUE OF THE PULSE WAVE AND ITS MEASUREMENT METHODS BASED ON THE USE OF INFORMATION TECHNOLOGIES

Myroslava Liubchenko

Faculty of Biomedical Engineering, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: cardiovascular system, digital medicine, information technology, pulse wave

Introduction. Cardiovascular disease is one of the leading causes of death worldwide. Therefore, it is important to find ways to timely diagnosis of diseases of the cardiovascular system. This is one of the reasons for the continued growth in the importance of information technology in medicine. New and safer diagnostic methods appear with their help. The most commonly used technologies to measure the state of the cardiovascular system are digital medicine, photoplethysmography, and electrocardiography.

It is undoubtedly, that one of the important indicators of the health of the cardiovascular system is the elasticity of blood vessels. It can be estimated using the pulse wave velocity.

A pulse wave is a wave that travels through the aorta and arteries. Moreover, this wave is caused by the ejection of blood from the left ventricle during systole. As we know, the right and left ventricles of the heart contract simultaneously, but the left ventricle contracts more strongly, because it needs to push blood to a greater distance – into the systemic circulation. Accordingly, this release of blood during systole into the aorta accompanies the formation of a pulse wave.

With an increase in vascular stiffness, the speed of propagation of the pulse wave increases. Because of this, we can have the strain on the heart. With age, this problem can become fatal at some point. That is why we need to research the pulse wave and the parameters of its shape. After all, they can give a lot of information about the state of health, especially the state of the cardiovascular system.

Objectives. The main task of this work is to study the diagnostic value of the pulse wave and other parameters of vascular stiffness, and to investigate methods for their measurement using information technologies.

Methods. After analyzing the sources, we can say that the shape of the pulse wave carries information not only about the rigidity of blood vessels, but also about other characteristics of the body. The pulse wave velocity can be found by knowing the distance that the pressure spike travels from one point of the vessel to another, and the time of its movement.

A method, based on the measurement of pulse waves, using sensors installed on the carotid and femoral arteries, is used to determine the stiffness of the vessels. In this case, the pulse wave velocity is estimated from the signal delay recorded by these sensors (Fainzilberg, 2020, p. 48). But, in addition, this measurement method requires some medical training and medical equipment.

Nowadays, the help of highly qualified specialists is needed to make the interpretation of the pulse waveform. Therefore, today the main task of medicine is to optimize and make it convenient to measure various health indicators and to automate the processing of the pulse wave signal, among them. And also we need to draw conclusions on the results obtained, which will be understandable to an ordinary person who does not have a specialized education (Tarakanov et al., 2013). Digital medicine solves this problem. Since the pulse wave velocity is an extremely important indicator for determining the risk of developing cardiovascular diseases, it should be measured using digital medicine. In this case, each person will be able to measure the elasticity of blood vessels even at home. This is what can help diagnose diseases in the early stages, because a person does not have to waste time in order to have a doctor's appointment. A patient of any age will be able to do a mini-examination on their own or with a little help from their relatives.

Results. The greatest success in pulse wave research has been achieved in the AI RHYTHMOGRAPH mobile smartphone app. To receive a signal with information about the pulse wave, the user covers the smartphone camera with the phalanx of his finger, which is illuminated by a built-in flashlight. Due to the blood flow in the capillaries of the phalanx of the finger, the brightness of the frames of the image sequence changes. As a result of processing the received signal, a pulse wave is recorded (Fainzilberg, 2020, p. 48). The experience of developing AI-RITMOGRAPH can be used when creating other smartphone applications that will allow everyone to assess the elasticity of blood vessels.

Conclusion. So, many studies have already been carried out aimed at assessing the elasticity of blood vessels. Further research will be aimed at constructing mathematical models for assessing the characteristics of the body by the parameters of the pulse waveform.

<div style="text-align:center">References:</div>

Fainzilberg, L. S. (2020). Intelligent digital medicine for home using. *Klinical Informatics and Telemedicine*, 15(16), 45–56. https://doi.org/10.31071/kit2020.16.03.

Tarakanov, S. A., Kuznetsov, V. I., Ryzhakov, N. I., Rassadina, A. A., & Gaidukov, V. S. (2013). Pulse wave sensors for cardiovascular diagnostics. *Bulletin of New Medical Technologies.*

<div style="text-align:center">

MAIN PRINCIPLES AND MOST EFFICIENT METHODS OF GRAPHIC DATA COMPRESSION
Maxim Liubimov
Faculty of Applied Mathematics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

</div>

Key words: visual data, compression, algorithms

Introduction. Over the past decades the quality of visual information that we operate with has been improving rapidly whether we talk about digital photography, video or computer graphics of any kind. Increasing resolutions and the amount of frames lead to increasing file sizes. At the same time heavy files require a lot of

computing power and memory to work with, store, transfer and share. The fact is we not always need the whole amount of information in an image, that it gives. While analysing the image, human vision operates with contours, general transition of colors and is relatively insensitive to small changes. This is where compression appears. Image compression is the process of encoding visual information with or without losses in order to reduce file size. Compressed image is different from the original one, but in the way that it does not affect the perception to a significant level.

Objectives. This paper is aimed at describing most efficient and popular image compression methods and determining which one is the best option.

Methods. Raster graphics that consists of small rectangular pixels, arranged to represent an image, is the most common to be compressed nowadays. It is easy to notice that in every raster image pixels, located close to each other are usually colored mostly the same. So the general principle of compression is removing or grouping together certain parts of an image to lover it's size. The basic steps of image compression are applying the image transform, quantization of the levels and encoding the sequences.

Most common compression methods include:

1) Reducing color palette, so that only most common colors are used.

2) Chroma subsampling, which is focused on brightness level changes. That is because the human eye is better at perceiving differences in brightness than differences in color (Fox, 2019).

3) RLE. In run-length encoding, the computer replaces each row with numbers that say how many consecutive pixels are the same color, always starting with the number of white pixels (Fox, 2019).

4) LZW, LZ77, LZ78. These are types of Lempel – Ziv – Welch algorithm for lossless data compression. The principle is following: algorithm creates a table of rows transformations and groups of bits of fixed length (usually 12) are used instead of chosen symbols sequences, so the table is used as a dictionary.

5) Huffman coding is all about knowing the probability of symbols appearance in a message, which makes it possible to describe the procedure of making codes of different lengths.

6) Deflate, which is the hybrid, made of LZ77 and Huffman coding.

7) DCT, which stands for Discrete Cosine Transform is the most popular method of compression. It uses Fourier-related transform and among all of the compression algorithms is claimed to be the most efficient one. JPEG is based on this method. It operates with 8x8 areas, on which luminescence and color changes are not that abrupt. JPEG algorithm was invented in 1992 originally to work with 24-bit photos. Soon, from 1997 to 2000, the more improved standard called JPEG 2000 or JP2 appeared. It used wavelet-based method instead of DCT, but did not get such widespread acclaim.

Results. The more we compress an image, the bigger amount of artifacts we will see and the less the final image size will be. Lossless image compression means that no quality will be lost. This can be done by removing metadata and nothing more. Rabbani and Jones (1991, p. 7) stated that "lossless compression is ideally desired since no information is compromised. However, only a modest amount of compression is possible". Nowadays lossless types of images are what we call RAW, often used in

DSLR cameras, because it saves all the data that was captured by camera sensor while keeping file size big, PNG, BMP, etc. Most popular lossy image types are JPEG and GIF. They require a lot less memory while keeping the quality at a decent level. The new flagship format is HEIF, which is also based on DCP like JPEG. Its main feature is the ability to store images encoded using different formats, which allows it to reduce file size even more.

Conclusion. To sum things up, graphic data compression has never been as demanded as it is nowadays. JPEG and GIF remain to be the most widely used formats. While new, improved solutions like HEIF arrive, they still are not able to replace them and become the new standard. Surely in the near future humanity will be constantly facing even greater needs in graphic data compression for as long as information technologies and computer sciences will progress.

References:
Fox, P. (2019). *Lossless image compression.* Khan Academy. Retrieved October 9, 2021, from https://www.khanacademy.org/computing/computers-and-internet/xcae6f4a7ff015e7d:digital-information/xcae6f4a7ff015e7d:data-compression/a/simple-image-compression

Fox, P. (2019). *Lossy compression.* Khan Academy. Retrieved October 9, 2021, from https://www.khanacademy.org/computing/computers-and-internet/xcae6f4a7ff015e7d:digital-information/xcae6f4a7ff015e7d:data-compression/a/lossy-compression

Rabbani, M., & Jones, P. W. (1991). *Digital image compression techniques (Vol. 7).* SPIE press. P.

AT A SAFE DISTANCE. HOW THE PANDEMIC AFFECTED THE VIRTUAL TECHNOLOGY MARKET

Tatiana Lugovets
Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: AR, XR, VR, medicine**,** pandemic

Introduction. Industry experts predict, that virtual and augmented reality technologies will be used more and more, as a lot of people use them for communication with colleagues and for entertainment. This trend has intensified with the COVID-19 pandemic. Interest in virtual reality continues to grow as more companies use these technologies to implement a wide range of learning scenarios.

Objectives. The main task is to allow people to gradually use real interaction in virtual space for immersive communication and get rid of temporal and spatial constraints. With XR technology, our lives, work, studies and social contacts will become more open, simple and effective.

Methods. Developers of VR and AR technologies worked in the medical field even before the pandemic, but now, according to the president of the Augmented and Virtual Reality Association, projects have become more interesting. There is a project of consultation with a doctor who is in the "dirty zone" with a dangerous patient. The doctor puts on augmented reality glasses, his hands are free, and everything is

controlled by voice. In this case, everything around the doctor is filmed and the doctor can also see the image on a small screen on the side. And it turns out that another specialist who is in the "clean zone", in the office, in another hospital and even in another country, can advise here and now. A specialist in the "dirty zone" talks about what is happening with him and immediately receives recommendations on what to do. Stanford University made a project for training medical specialists, and now it is used by more than 50 world clinics in order to train, remind doctors of some actions. For example, it is necessary for doctors who have retired or changed their profession, but are ready to help in connection with the pandemic. A virtual simulator is a rendered office with a patient who needs to be examined and conclusions drawn. There are many scenarios, they may not even be repeated (Communications, 2016).

Results. It is clear that it is impossible to teach how to operate from scratch, but it is quite possible to recall the treatment protocols, some nuances due to such working off. A person remembers not just some theoretical part, but in fact works through it. This direction has already existed, but has shown its timely necessity.

Conclusion. To sum up, the pandemic has spurred people to accelerate their journey towards a digital future. This new video-centric norm we live in will quickly transition to the XR-centric norm - that's what awaits us. In addition to typical examples where VR technologies are used to train people to work with expensive equipment or dangerous situations, we see a noticeable surge in interest in using virtual reality technologies to develop skills from representatives of various industries.

References:

Communications, I. (2016). How a video-gaming programmer created a popular VR surgical simulator. Retrieved from https://www.computerworld.com/article/3144527/how-a-video-gaming-programmer-created-a-popular-vr-surgical-simulator.html

BENEFITS OF COMPUTATIONAL PHOTOGRAPHY
Dmytro Maksymenko
Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: algorithms, image stacking, stabilization, smartphone cameras

Introduction. Back in the day, just about ten years ago, people were using mostly standalone cameras for capturing images, point-and-shoot cameras were prevalent for taking pictures on the go, let alone professional photography, where only professional cameras were used. In recent years, however, the situation has changed dramatically; nowadays people prefer to simply use their smartphones for the same purpose point-and-shoot cameras were used; moreover, although still not as popular, such thing as "professional mobile photography" does indeed exist now. All of this is undoubtedly due to the fact that smartphone camera quality has improved by a huge margin compared to, for example, 2015. It made proper cameras obsolete in some usage scenarios and, therefore, not being worth the hassle of carrying an additional device around. Of course, this happened partially thanks to the progress in mobile

cameras hardware, but that is definitely not the main reason, it being, in fact, computational photography algorithms advancements, which has been quite a hot topic ever since the release of the early Google Pixel models.

Objectives. The main purpose is to analyze the positive effects of using computational photography algorithms.

Methods. The whole concept of computational photography is built around machine learning and artificial intelligence capabilities. There is a number of software techniques which are used for image enhancement, most of them are based on image stacking. A bunch of photos get taken using different settings, after that they get combined for better output. Here are some examples of stacking-based algorithms.

To begin with, there is exposure stacking. Perhaps everybody knows the situation when you get one part of the photo bright enough, but the other is way too dark, or the opposite, one is way too bright while the other one is normal. Exposure stacking sole purpose is to deal with that kind of problem. It combines the properly lit parts from differently exposed photos and in the result the output is a balanced picture.

However, the main disadvantage of HDR with exposure bracketing is its incredible uselessness in poor lighting (Zubarev, 2020). That is why developers came up with time-stacking. Instead of combining differently exposed photos, it just combines a number of photos taken in RAW format. This allows to collect much more information, therefore giving much better results in the dark. Interestingly enough this method turned out to be useful for daylight pictures as well, as it allows better detail in shadows.

Another interesting method is pixel shifting. The idea is as follows: normally each subpixel only captures either green, blue or red; this technique captures a few pictures so that each pixel captures each of the three base colors at one point. This results into better detail, especially if photographer's hands are particularly shaky.

Next one is focus stacking. To do it camera captures a few shots with different focus, thus solving the issue of way too shallow depth of field.

Panorama photos are the result of stacking as well. It allows you to composite images next to each other, and it then combines them into one large, high-resolution image (Vicente, 2021).

Such popularity of stacking resulted in some interesting solutions along the lines the one used in Nokia 9 PureView. The idea is that multiple cameras with the same or similar field of view are placed, then they capture photos simultaneously, and then the phone merges the results into one better image.

One of the most popular non-stacking based features is portrait mode, which creates digital bokeh effect where it is optically impossible due to smartphones using small sensors. It is usually done by creating a depth map of a photo with the assistance of a secondary camera, and then different levels of blur are applied at different depth of the photo. Digital bokeh also allows to readjust the blur later on, thus providing more flexibility.

EIS (electronic image stabilization) is also worth mentioning. While OIS (optical image stabilization) relies purely on physics, EIS depends solely on processing power. Main usage of EIS is video stabilization. Each picture gets a little bit cropped with a bit

of diagonal adjustment, which allows to exceed the usual limitations OIS has while not requiring any additional hardware expenses.

Last but not least, in most modern smartphones the camera app has an "AI" toggle, which turns on scene identification, thus allowing the phone to adjust colors depending on the scene for it to look better (not necessarily realistic though).

Results. There are a lot of well-developed and polished techniques and algorithms used in smartphone cameras these days in order to improve the quality of photos. Most of them use image stacking, while others are more specific and unique, and every smartphone uses at least a handful of the aforementioned methods. Besides, new algorithms are constantly created by the companies leading in the industry.

Conclusion. Thanks to the processing power phones have these days they are capable of capturing well-processed photos and outputting not just viable, but quite competitive results, beating point-and shoot cameras and even some of the professional cameras in terms of quality. With a lot of progress going on in the area of machine learning, smartphone camera performance is only bound to improve. Perhaps one day professional cameras will finally adopt the advancements in this field.

References:

Vicente, V. (2021, January 19). What Is Computational Photography? Retrieved from https://www.howtogeek.com/659806/what-is-computational-photography/

Zubarev, V. (2020, June 3). Computational photography part I: What is computational photography? Retrieved from https://www.dpreview.com/articles/9828658229/computational-photography-part-i-what-is-computational-photography

PROGRAM SOURCE GENERATION FOR UML DIAGRAMS

Serhii Matsei

Educational and Research Institute of Special Communications and Information Security, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: activity diagram, class diagram, visual programming, class, object, UML diagrams

Introduction. A promising area for improving the efficiency of software development is visual programming. For modern programs, including object-oriented, the development of visual programming tools based on graphical schemes remains a topical issue. The paper presents the results of designing a visual programming system that uses a graphical form of program representation in the form of a minimum set of UML diagrams for the automatic generation of the program text.

Objectives. The aim of the work is to create a visual programming system for generating program source code based on UML diagrams, which will include the following modules:

– module for loading and saving projects;

– module for adjusting system parameters;

–   module for checking the correctness of downloaded charts;

–   module for building connections between the necessary diagrams;

–   module for generating the source skin of the program from the selected UML diagrams (Ciccozzi, 2019).

Methods. To solve this problem, the minimum required set of UML diagrams for the correct operation of the system was determined, namely: the general algorithm of the program (activity diagram), class diagram, as well as the diagram of function activities for each of the classes. The main idea of the method is to describe fully the UML diagrams of the program's functionality and link the diagrams into a single model. The main diagram of the model is the activity diagram of the top-level program, which uses objects created on the basis of the class diagram, in which each method is also described by the activity diagram. Due to this, the ability to generate the complete source code of the program becomes a reality (Maryam, 2018).

Results. As a result, a software project was created that allows us to generate program code based on a minimum set of UML diagrams. The practical application of the developed system consists in the project creation, loading graphic materials in the form of UML diagrams in it, and execution of the program with the subsequent generation and preservation of the program source code.

Conclusion. The developed software allows increasing both productivity of the developer, and efficiency of the qualitative software creation.

<div align="center">

References:

</div>

Ciccozzi, F., Malavolta, I. and B. Selic. (2019). Execution of UML models: a systematic review of research and practice, *Software & Systems Modeling*, vol. 18, no. 18, 2313-2360. doi: 10.1007/s10270-018-0675-4.

Maryam I. Mukhtar and Bashir S. Galadanci. (2018). Automatic code generation from UML diagrams: the state-of-the-art, *Science World Journal*, vol. 13. no. 4, 47-60.

<div align="center">

REMOTE UNMODERATED USABILITY TESTING

</div>

<div align="center">

Alina Matvieieva

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

</div>

Key words: usability, testing, research, user experience

Introduction. Usability testing is an important part of the product development lifecycle. It is always carried out to improve the user experience of the interface or service by testing it with users from the target audience. Commonly, participants of usability tests are asked to accomplish some tasks within the interface, while the moderator watches, listens, and makes notes. But there are also types of testing that don't require the researchers and testers to be in one physical place. These are called remote usability testing, and they are often less expensive than in-person testing. Also, they are a lot safer in the context of pandemics.

One of the types of remote testing is regular usability testing when participants get tasks to accomplish within the product. It can be moderated, which means a moderator gives participants tasks to complete and remotely observes the way users

do it, what difficulties and bugs are occurring through the way. Or it can be unmoderated testing when participants are completely on their own with given tasks.

Objectives. The goal of remote unmoderated usability testing, like any other user testing, is to reveal hidden problems in the user experience, collect qualitative and quantitative data and discover how much participants are satisfied with the application. It is also a great way to reproduce some mistakes in program code that didn't show up during in-team testing.

The main benefit of unmoderated remote usability testing is that it does not include any direct interaction between the researcher and the study participants. Therefore, this type of testing is easier to arrange and less expensive than the moderated type. It allows gathering feedback extremely fast, collecting results from numerous users, and launching worldwide testing. Unmoderated remote usability testing is suitable for testing both highly functional prototypes and already working early-stage products. However, testing a prototype can save much more money, because it can uncover imperfections in user experience (UX) before any code was written. And the earlier problems are distinguished and adjusted, the fewer costs will be spent on its solving.

Methods. Running efficient and representative unmoderated usability testing requires some obligatory steps. It includes developing a dependable test plan, finding participants, managing the testing process, and analysing all received feedback.

During the preparation phase, researchers should define the goals of the usability test — what specifically they want to test. Also, it is important to decide via which tool or service users will send their feedback, so it is easy and comfortable for both participants and researchers.

The next step is recruiting the right participants. Researchers should consider that test users must be able to use the product and be part of the product's target audience. The number of participants depends on project complexity and can vary from 3 to 500.

After testing is launched, it can very fast generate an enormous amount of data. Researchers have to be organized and have a well-adjusted process to analyse all the feedback they get. The type of data depends on the study goals, but most often it will be qualitative data, such as participant's notes, screenshots, and screen recordings.

To run successful testing it's also important to be a good manager. Getting needed information takes a lot of involvement with users during the testing. Researchers have to keep them engaged by reminding periodically, admitting their efforts, asking them to continue the good work, and answering all questions they may have. Also, it will be appropriate to provide some kind of compensation or gift to ensure that people are dedicated through the study (Moran, 2021).

Results. At the end of usability testing, UX specialists should provide a list of suggestions and instructions on how the interface can be improved. To do so, they need to thoroughly analyse founded issues and suggestions. The main task here is to understand which problem is more important and has a bigger priority. Next, to solve the founded issues and decrease the chance of wrong decisions, researchers have to create multiple alternative solutions and prioritize them according to some parameters.

These parameters can include the impact of the problem, it's frequency, criticality, and severity. The effectiveness and complexity of the solution should also be taken into account. And when all calculations are done and decisions are made, the product team starts to work on implementing selected solutions and bringing them to end-users.

Conclusion. Remote unmoderated usability testing is a qualitative study that is considered to be one of the most popular testing methods for gathering lots of feedback in a short amount of time, with a big number of users, and for the lowest costs. This activity allows seeing how people interact with the product and which problems they face. In most cases, it is enough to reveal very interesting and sometimes completely unexpected insights about the user experience of an application or a service. Though the goals of testing can vary, the main purpose is always the same – to build a product that will be functional, useful, and easy to use.

References:

Farkas, D., & Nunnally, B. (2016). *UX Research: Practical Techniques for Designing Better Products*. O'Reilly Media, Incorporated.

Moran, K. (2021, August 8). *Qualitative Usability Testing: Study Guide*. Nielsen Norman Group. Retrieved October 11, 2021, from https://www.nngroup.com/ articles/qual-usability-testing-study-guide/

THE DEVELOPMENT OF PYTHON

Mykola Melnyk
Faculty of Applied Mathematics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: programming language, object-oriented approach, data structure

Introduction. Python is a high-level, scripting, subject-oriented programming language that is used in various areas of IT, such as machine learning, application development, web, parsing and others. In 2019 Python became the most popular programming language, overtaking Java by 10%. This is due to many reasons, one of which is the high salary of qualified specialists (about 100 thousand dollars per year) (Reed, 2020, p. 4).

Objectives. The main task is to find out the beginnings of creating Python, and to get to know how it became the most popular programming language.

Methods. The creation of the Python language started out rather slowly and hesitantly. Guido Van Rossum was the first enthusiast who took it up in 1990 on his Macintosh home computer for several weeks. Python was a kind of hobby project, written in the ABC programming language, which he author helped to develop at the Center for Mathematics and Computer Science in the Netherlands meanwhile (Zelle, 2016, p. 6).

Python was first published 1991 to a wider audience at alt.sources. Even then, the language adhered to an object-oriented approach, it could work with classes, inheritance, functions, exception handling and all basic data structures. Having excellent potential, the code was freely distributed on the Internet, finding new and new supporters.

In February 1991, the language's source code was published at alt.sources. In 1996, when this project was gaining critical mass, Steve Mayevsky joined the development, who was quite famous on the network, as he wrote his blog "Comparative criticism of programming languages".

In 2000, the second version of Python was released. Many important tools have been added to it, including Unicode support and a garbage collector.

Results. The third version of Python became outstanding because of fully removing significant errors. The developers managed to simplify the programming procedure, reorganize the structure and avoid unnecessary duplication. The 13 years have passed since the third version release, but the official community has provided support only recently, since the end of 2020 ensuring the secure compatibility.

Conclusion. The use of Python as a basic programming language has a history of at least 30 years. Its application is extensive and consists in the creation of graphic editors, apps, games, web, ultimately, development and analysis of large databases. The ubiquity of the programming language proves its usage in almost every medium and large project. Almost 39% of the favourable votes have been received on Stack Overflow survey, which allows to be on the honourable 7th place.

<div align="center">**References:**</div>

Reed, M. (2020). *Python Programming: The Ultimate Beginners Guide to Master Python Programming Step-By-Step with Practical Exercises* (pp. 4–12). PUBLISHING FACTORY LLC.

Zelle, J. (2016). *Python Programming: An Introduction to Computer Science* (pp.5–7). Franklin: Beedle & Associates Inc.

<div align="center">

APPLICATION OF ARTIFICIAL INTELLIGENCE IN THE CONTROL SYSTEM ENTERPRISE: PROBLEMS AND BENEFITS
Daryna Mishchenko
</div>

<div align="center">
Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"
</div>

Key words: Keywords: artificial intelligence, computer control, enterprise, automation

Introduction. The strategy of any enterprise should be formed on the basis of effective management production process for maximum profit. The use of artificial intelligence in this area allows the most efficient, fast, high quality management of all processes enterprises. The introduction of computer technology reduces the risk of erroneous actions organization of the production process. However, this implementation requires significant investment, which is not c in all cases it may be economically justified. Although nowadays all enterprises try transfer responsible operations to computers (Tikhomirov, Romanov, 2003).

Objectives. Identify the features and problems of artificial intelligence in the system enterprise management (Sajmon, 2004).

Methods: theoretical analysis (study of basic theoretical concepts); critical analysis (study of the problem in determining artificial intelligence); theoretical

synthesis (generalization of theoretical information about comic intelligence in the enterprise); system analysis (selection of actual material and its grouping); descriptive method (description of the features of the disclosure of the creation of artificial intelligence).

Results. In our country, most companies are engaged in this type of work highly qualified specialists who, based on their own experience, knowledge and abilities, can predict development activities of the enterprise. But, since this task is solved by a person, there is a certain level of risk that the specialist may be wrong. Therefore, we can identify the main shortcomings of human intelligence comparable to high-speed artificial (computer) are:

– inability to perform a large amount of calculations. If a person analyzes a large amount of information, then the probability of missing an important detail increases. After processing a large amount of data, the person systematizes the information and receives the general result;

– the possibility of disorientation of the specialist when processing large amounts of data, which can lead to making not the most effective, but possibly wrong decisions;

– lack of vision of development prospects, as they are not obvious in conditions of high competition;

Artificial intelligence – a science and technology that can reproduce the thought processes of the human brain and direct them to the creation and processing of various computer programs and intelligent machines, capable of completely replacing and simplifying human work (Sajmon, 2004).

There are a number of reasons for the rapid development of modern computer technology in the field enterprise management:

– rapid level of development of the external environment, which causes the need for rapid making optimal, effective decisions that a person cannot perform in the required short time interval. Consequences of erroneous ineffective decisions made in management organization, can cause significant losses or even threaten the very existence enterprises;

– automation of the enterprise management system and all technological processes contributes rapid development of the enterprise and all its divisions, cost savings and reliability of production process;

– introduction of artificial intelligence ensures the competitiveness of the enterprise in the conditions modern development of computer technology, which is directly related to the needs of people (Kyzym, Matiushenko, Shostak, 2012).

The main task for man is to develop and improve intelligent systems that would performed the functions assigned to it as clearly as possible and would fully meet its purpose. The main requirements for modern intelligent systems are:

– high level of flexibility and simplicity of interaction of the system with the user, which provides for expansion system functionality to cover more and increase the level the complexity of the tasks that the user assigns to the system, which is implemented through the use of more powerful, innovative data handling devices, the logic of which is best adapted to individual features of the user;

– increasing the level of autonomy of operations, namely the independent solution of problems with given areas with the possibility of further clarification of the calculation and assumptions made in the process.

Conclusion. For proper effective management of production processes, business leaders must remove barriers to computerization and the introduction of innovative technologies. But in further it is necessary to control the level of intelligent systems used on enterprises. Further research is needed to assess the feasibility of implementing such systems, opportunities to increase the reliability of their work, analysis of their impact on the economic situation of the country and on unemployment rate (Novakivskyi, Rachynska, 2011).

References:

Kyzym, M.O., Matiushenko, I.Yu., & Shostak I.V. (2012) *Prospects for the development of information and communication technologies and artificial intelligence in the economies of the countries of the world and Ukraine*. KHARKIV: Inzhek [in Ukrainian].

Novakivskyi, I. I., & Rachynska H. V. (2011) *Application of artificial intelligence to manage innovation processes in value chains.* Lviv: Natsionalnyi universytet «Lvivska politekhnika», 720, 303-309 [in Ukrainian].

Sajmon, G. (2004) *The science of the artificial.* MOSCOW: URSS [in Russian]. ISSN:2521-6384 (Online), ISSN: 2521-103X (Print) №2(8), 2019 Economic journal Odessa polytechnic university 99

Tikhomirov, N. P. & Romanov V. P. (2003) *Intelligent Information Systems in Economics.* MOSCOW: Ekzamen [in Russian].

IMAGE RECOGNITION. APPROACH AND APPLICATION

Kateryna Nekhomiazh
Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: image recognition, artificial intelligence, detection, classification

Introduction. Image recognition-related tasks are part of the problems, the solution of which, scientists have been looking for almost from the very beginning of the development of computer vision technologies. And as the methods and approaches rapidly change, the main idea is to "teach" the algorithms to detect objects and classify them into categories. Such an easy task for the human brain seems to be a significant problem for a machine world.

Objectives. The main task is to conduct research on the use of image recognition technologies and the problems they solve.

Methods. There are several most used approaches to handle image classification problems: traditional computer vision and machine learning. The first one needs outstanding competence, a lot of time, and has plenty of parameters and specifications that need to be manually defined. The second one, on the contrary, uses algorithms to discover hidden data from a dataset.

Results. Image recognition consists of a few smaller tasks: object localization, object detection, and finally image classification. The purpose of object detection is to detect the presence of an object. Object localization algorithms take a picture as an input, and the output is a bounding box. And the purpose image classification part is to predict the category or type of detected object (Canty, 2019).

Object recognition is used or can potentially be useful in absolutely any field. Here are some examples:

– Agriculture. Thanks to the analysis of images from satellites, aircraft, or drones, decisions can be made about when, how, and what crops should be grown, whether it is necessary to use fertilizers, additional watering, whether the plantings are threatened by diseases, animals, and insects, or any anomalies.

– Security. Similar to plantings and their maintenance, modern technologies for recognizing objects can ensure the safety of strategically important locations, as well as people. Algorithms can take on a large share of the work that people are used to doing, this, firstly, will eliminate the human factor and the likelihood of unnoticed threats, and, secondly, will significantly reduce the cost of employees.

– Retail. Checkout-free shops are becoming more popular and widespread every year. Image detection technologies help to determine which products the customer has put in his basket, which ones he returned to the shelf, and calculates the number of purchases, and issues an invoice. Nowadays it is a unique experience for visitors, but in the long run, it is a way to save on employee salaries, to speed up the shopping process as much as possible. In particular, it contributes to the automation of inventory management and the reduction of shortages of goods.

As it is a long-term problem, a lot of deep learning models exist. They differ in the execution time, the complexity of the algorithm itself, the amount of knowledge and competencies required to use them, the amount of memory that must be allocated, and the quality of the work performed. The most popular currently are:

R-CNN Model Family (Region-Based Convolutional Neural Networks). To avoid the need to select a large number of regions, the following method was proposed: extract only 2000 regions from the image (region proposals) and work with them. The search algorithm consists of three steps: the creation of candidate regions; combining similar regions into larger ones; using new regions as candidates. Next, CNN extracts features from these images, on the basis of which it classifies the images. The problems of this method are the need for a large amount of time to execute and the lack of the possibility of implementation in real-time, as well as the high probability of generating bad regions (Shanmugamani, 2018).

YOLO Model Family (You Only Look Once). The principle of operation of YOLO is that the image is divided into an SxS grid, inside each such grid we take m bounding rectangles. For such rectangles, the algorithm outputs the classification probability and offset values for the bounding rectangle. If the class likelihood for the bounding box exceeds the threshold, then they are used to locate the object in the image. The advantage of the model is that it is much faster than analogs. But the serious drawback of the algorithm is the spatial limitation (Yang & Deng, 2020).

Conclusion. To sum up, image classification algorithms can be applied in absolutely any area, such widespread use stimulates their continuous evolution. This, in turn, leads to a decrease in the speed of their execution, a higher quality of classification, and, as a result, an improvement in business performance and an increase in the quality of life of ordinary people.

References:

Canty, M. J. (2019). Neural networks. *Image analysis, classification and change detection in remote sensing: with algorithms for Python* (4th ed., pp. 248). Boca Raton, USA: Taylor & Francis Group, LLC.

Shanmugamani, R. (2018). Regions of the convolutional neural network (R-CNN). In A. Varangaonkar (Ed.), *Deep Learning for Computer Vision: Expert techniques to train advanced neural networks using TensorFlow and Keras* (pp. 335). Birmingham, UK: Packt Publishing.

Yang, Y. & Deng, H. (2020, July 31). GC-YOLOv3: You Only Look Once with Global Context Block. *Electronics*, Retrieved from https://doi.org/10.3390/electronics9081235.

INFLUENCE OF INFORMATION TECHNOLOGIES IN THE MODERN WORLD

Viacheslav Okonechnikov, Igor Riy, Vitally Golub
Faculty of Electric Power Engineering and Automatics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: information age, algorithm, social media, technological solutions

Introduction. Since the beginning of the world people have been exchanging information with each other. Be it the theaters and messengers of Antiquity, itinerant minstrels and heralds of the Middle Ages, or newspapers and radio of the new era, a person has always found an opportunity to receive news of politics, economics or fresh rumors. However, in our time, the scale of information exchange has reached unprecedented proportions. Social networks such as Facebook, WhatsApp, Telegram, and Viber unite more than 5.5 billion users in total on the current day. In practice, despite the positive aspects of such a scale of globalization that allows us to receive fresh news from every corner of the world, to be able to communicate and share the range of interest with people from other countries, the bad aspects also exist.

Objective. This paper deals with the impact of modern digital communication on social media users and the technological side of propaganda techniques.

Methods. One of the negative effects of modern information society is that the users can be forced to take certain actions because of their recommendations, which have been intestinally altered. YouTube's algorithm is a combination of programmed engineer instructions and learned behavior that has evolved into an opaque machine learning process, making it difficult to understand the algorithm and programming guidelines. Independent tests to replicate the algorithm have shown that the algorithm has a strong bias towards right-wing political ads, including racist views expressed by the far-right community. While the algorithm appears to be pushing users toward

alternative video content only in an effort to keep users in the video loop, the end result makes YouTube a powerful recruiting tool for neo-Nazis and alternative rightists. The filter bubble effect that this creates pushes users into a loop that reinforces radicalism rather than balancing actual resources. This is also true for ad integrations and recommendations (Bryant, 2020).

Another bad aspect is fake news creation. A striking example of the negative consequences of fake news is the events that took place in India. In July 2018, residents of the small Indian village of Rainpad beat five innocent travelers to the fair to death, and this happened because of false rumors about the kidnapping of children and the sale of their organs, which were spread through the WhatsApp messenger (Vasudeva & Barkdull, 2020).

Most importantly, there is a big difference between the adverse effects of fake news created by ordinary people, sometimes even for fun, and that of the fake news created by large media companies controlled by governments, for the sake of extra impact in hybrid warfare. Social networking sites like Twitter and Facebook also use an algorithm to analyze word expressions or hashtags to create a list of topics in the order of their popularity. According to a 2015 social media study, this "trending list" frequently draws attention of a large number of readers and thus can be considered as a tool to determine what users will read. By using this feature along with automated "bot" accounts, foreign agents can embed propaganda on social media networks and send out their messages more quickly and efficiently than by doing anything else.

Results. Social media can easily share a message from a particular social group of so-called true believers by dominating the trend. It works due to four main components involved: a message that supports some "dark" narrative; a group of "true believers" who are likely to trust that message; a relatively small team of cyber agents; and a large network of automated bot accounts. Any kind of propaganda must adapt to the narrative to spread among the true believers. Typically, the cyber team will develop a specific message to be distributed as well as will generate associated fake videos, memes, etc. To achieve the aim of spreading propaganda most effectively, all the players have to cooperate to take control of the trend they have created. Therefore, in the modern high-tech society one can influence the users of information sources by applying various propaganda techniques, which involve social media contexts, internet news feeds, and traditional types of media (Prier, 2021).

For example, TV channel RT, part of Russia Today agency, edited photos of refugees from Afghanistan, adding weapons to them. The original photo by Reuters shows a man and woman with children as they arrive at a military base in Melsbrook, Belgium after the Taliban entered the Afghan capital, Kabul. The edited image appeared on RT's official English-language Twitter with 2.9 million subscribers. Kalashnikov assault rifles, a grenade launcher and a rocket launcher were attached to the backpacks of the people in the photo in the RT tweet. The tweet read, "Are some terrorists getting a free ticket from Afghanistan?" Further, without reference to the original source, the Defense News, the anonymous "representative of the American government" was quoted. "Up to 100 evacuated Afghans are on the surveillance lists

of the special services," the quote said. That was obviously done to raise a xenophobic attitude in European and American society (New Arab Staff, 2021).

Conclusion. To live together in harmony in the digital age, we need to develop our media literacy. For example, you should not constantly receive information of the same kind or from the same sources, so as not to get into the information bubble. It is also worthwhile to regularly engage in polemics with your fellows and friends, as this will help to better understand different points of view. Finally, the last but most important thing is to check the information received for bias, and of course to develop critical thinking skills that will allow you to comprehend the information adequately.

References:

Bryant, L. V. (2020). The YouTube algorithm and the Alt-Right filter bubble. *Open Information Science*, *4(1),* 85–90.

Prier, J. (2017). Commanding the trend: Social media as information warfare. *Strategic Studies Quarterly*, *11(4),* 50–85.

The New Arab Staff (2021, August 27). Russia Today faces backlash after tweeting 'hateful' photoshopped image of Afghan refugees carrying weapons. Retrieved from: https://english.alaraby.co.uk/news/rt-slammed-after-tweeting-hateful-image-afghan-refugees

Vasudeva, F., & Barkdull, N. (2020). WhatsApp in India? A case study of social media related lynchings. *Social Identities*, *26(5),* 574–589.

THE ORIGINS OF MACINTOSH OPERATING SYSTEM

Olena Pastushok

Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: iPod, Mac OS, iPhone, operating system

Introduction. Have you ever thought about what this has been for centuries? How is it different from others? This century is the age of high technology, the technology that is changing the world upside down. But have you ever thought that someone made these discoveries? This person will forever be included in the history of the world, and now I want to tell about one such person and his work, a person I admire and who will forever remain in the history of modern technology.

Objectives. Discover the facts about the creator of Apple Computers Mr. Jobs and how has gained a good reputation for being a demanding perfectionist, obsessed with details, who could make a niche product popular with a computer-savvy public. He introduced the colored iMac computer to the world, followed by the iPod and iPhone.

Methods. To investigate the facts and data we have used statistics and computing techniques.

Result. In early 2003, Jobs found pancreatic cancer. In April 2009, he underwent surgery for a liver transplant, and doctors called the patient's prospects excellent. However, in January 2011, Apple's management announced that Jobs was going indefinitely for health reasons. Returning to the management of the company, Jobs

resigned from the post of CEO of the corporation in August, having stepped down as chairman of the board of directors. The first version of Mac OS was released in 1984 with the first Macintosh computer (Warren, 2020). Mac OS version 6.0.3 (1989) was the first graphical operating system to be translated into Ukrainian. As early as 1990, the developers of this system created the Pink and Blue Mannies groups under the Taligent project. The developers at Blue wrote System 7, and the developers at Pink wrote a completely different system, which after its release would replace System 7. But the Pink team realized that their project is difficult to implement, and they are backed by the support of the old software. Subsequently, in 1995, Apple completely outsourced the IBM Taligent project, and it, together with Motorola, created the CommonPoint project, which wrote software for IBM AIX and OS / 2 systems. The Pink project was buried. At that time, the stability of System Software was at its lowest level compared to MS-DOS. Apple left Taligent in 1994 to create a Copland project for CommonPoint compatibility (Denisko, 2021). There was no new system yet, and System 7 was very old. Copland was renamed System 8 in 1995 and, a little later, in Mac OS 8. But there were no updates, there was only a new name. In 2001, a conceptually new version of Mac OS was released – the so-called Mac OS X, the tenth version based on the Darwin kernel (BSD). All previous versions of Mac OS were called "classic". In the wake of Apple's move to X86 processors, the network has been rumored to release Mac OS X for regular PCs. Although the company later denied it, a group of enthusiasts from the OSx86 Project managed to launch OS X on a non-Apple PC.

Mac OS X Snow Leopard supports Microsoft Exchange and OpenCL (use of graphical accelerator capabilities for normal computing), better performance on multi-core systems (improved scheduler), support for only 64-bit Intel processors, and significantly reduced application sizes included in the standard bundle, and most of the OS code rewritten from scratch (Engst, 2020).

Conclusion. To conclude, I should notice that fact that technologies will never disappear from our lives thank to such greatest inventors as Steve Jobs.

<div align="center">

References:

</div>

Engst, A. (January 10, 2020). The Few Remaining Uses of the Word "Macintosh*". TidBITS.*

Denisco, A. (June 19, 2021). MacOS Monterey: What you should know about Apple's latest Mac software update. *CNET. CNET.*

Warren, T. (June 22, 2020). Apple is switching Macs to its own processors starting later this year. *The Verge*.

WHY AUTOMATED TESTING CAN'T REPLACE MANUAL

Nikita Petrenko

Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: quality, software, automation, manual, tests

Introduction. The history of software testing begins in the '50-'60s last century. The process of testing was strictly formalized. In fact, testing was more like debugging programs. Through more than 40 years, there has been a transition from testing as such to a more comprehensive process called "Quality assurance" which covers the entire software development cycle and affects the planning, design, creation and execution of test cases, support of existing test cases and test environments. Testing has reached a qualitatively new level, which naturally led to the further development of methodologies, the emergence of quite powerful tools for managing testing processes and test automation tools.

Objectives. Nowadays, the position of AQA (Automated Quality Assurance) is more and more in demand perhaps due to a lot of software development companies that have a QA department are implementing automated testing as well as due to companies that completely switched to automated testing. Therefore, appeared such vacancies as SDET (Software Development Engineer in Test), TestOps Engineer (a person who manages test environments).

But automated and manual testing are not parts of different methodologies, they are still part of common quality assurance approaches.

Methods. Implementing automated tests have to be under strict management due to the development of tests takes more time than a manual tester can complete the test case steps.

So there is a common list of tasks that automation helps to solve: (Kulikov, 2021, p. 259)

- execution of test cases beyond human ability;
- solving routine tasks;
- acceleration of test execution;
- freeing up human resources for intelligent work;
- increased test coverage;
- improving code by increasing test coverage and using special automation techniques.

These tasks are most often encountered and are easiest to solve in the following cases:

- Regression testing;
- Installation testing;
- Configuration testing and compatibility;
- Module testing;
- Integration testing;
- Security testing;
- Performance testing;

- Smoke testing;
- E2E testing.

Results. Automated testing has its advantages and disadvantages. Currently, automated testing can even speed up the delivery of software to production. On the other hand, without advanced managing QA processes, implementing automated testing may even worsen the situation on the project. The best practice is combining automation and manual testing. They have to complement each other because in a modern SDLC (software development life cycle) implementing automated tests without running before manual tests is expensive and very often not necessary.

Conclusion. To sum up, implementing automated tests is a great approach if they save time and do not hinder the quality assurance process. But to completely abandon manual testing, as it seems, of the lack of a human factor and, as it seems, savings, is, as it is said in IT: anti-pattern.

<div align="center">**References**:</div>

Kulikov, S. (2021). *Software Testing – Base Course 3-rd edition.*

<div align="center">

SIMULATOR OF NONBINARY STATE MACHINES
Oleksii Poliakov

</div>

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: FSM, simulator, nonbinary automaton

Introduction. Finite state machines are used as models for the behavior of technical systems. In the course of experiments on these models, the external environment of the machine and its behavior are simulated. Well-known simulators, such as JFLAP (JFLAP, 2021.), simulate the behavior of finite state machines, which are described by a tuple $<X, Y, S, s_0, \lambda, \mu>$, where X is a set of inputs, Y is a set of outputs, S is a set of states, s_0 is an initial state, λ is an output function, and μ is a transition function.

Objectives. At the same time, there are known (Poliakov& Andrias, 2019) finite automata with a different tuple – nonbinary automata, as well as problems of simulating the interaction of two automata. There are no simulators for non-binary automata and problems of interaction of such automata.

Purpose of the work: automation of experiments with non-binary automata by developing a simulator of non-binary automata, the properties and external environment of which are specified in the form of user text files.

Methods. The simulator is designed for a hierarchical complex of two automata, one of which is controlled (CA1) and the second is a control (CA2). The lower-level automatic machine CA1 is controlled by the CA2 and itself controls the system object through its outputs. There is a two-way exchange of information and commands between the machines. CA2 sends commands to control the configuration of CA1 from its outputs. Each such command defines a subset of CA1 inputs, which are allowed (or prohibited for transitions from the current to other states of this machine. In turn, information about the current state of CA1 comes from the CA1 outputs to the CA2

inputs. As a rule, control machines in control systems operate cyclically. Therefore, the management of the CA1 structure is reduced to the choice of its next cycle at the end of the previous one.

Automata CA1 and CA2 can be either binary or non-binary. In the developed simulator, the following properties of a non-binary automaton are modeled:

1. The ability to control the behavior of the automaton during the experiment by setting permissions for the inputs of the automaton.

2. Possibility of non-binary gradation of inputs, outputs and activity of states, which makes it possible to simulate the behavior of an automaton with "aftereffect of activity" and "preparatory activity".

The simulator program is developed in the Visual Studio Code environment Type Script language. The program code is available at the link (Poliakov, 2021). The program screen contains a project manager with the structure of files of machines CA1 and CA2. Each machine is described by 5 files with the *.txt* extension. The *States* file contains the designations of the states of the machine. The *Transitions* file describes the transitions between states when input signals are received. The *Controls* file describes the currently enabled inputs for each state. File *Inputs* – describes the input signal (designations and values) in each cycle in the mode of reading inputs from a file. *Outputs* file – shows the cycle number, designations and values of the input signal, the value of the states of the machine, as well as the list of inputs allowed for transition to the next cycle. The simulator is designed with the following constraint: all cycles of the automatic machine CA1 must pass through the initial state S0. If the automatic machine CA1 is in s_0, then it, through its outputs, informs the control machine CA2 about it. The latter at this moment adjusts the control of the CA1 machine. The simulator program is adjusted to a new type of machine by replacing text files.

Results. The experimental results confirmed the possibility of simulating the non-binary behavior of an automaton and controlling the structure of a controlled automaton using the developed program.

Conclusion. The simulator is planned to be used in the process of studying the interaction of subsystems of a hierarchical system, as well as in the process of teaching non-binary automata.

References:

JFLAP (2021). A cross-platform program Java Formal Languages and Automata Package for experiments with various objects found in the theory of formal languages: the site of the organization. Retrieved from http://www.jflap.org/

Poliakov, M. & Andrias, I. (2019.). Finite state machines with nonbinary elements of sets. *System technologies. Regional interuniversity collection of scientific works. Dnipro, 2(121),* 85–94.

Poliakov, O. (2021). FSM Simulator Code. Retrieved from https://gitlab.com/Eonus/fsm-simulator

SDN ENABLED BROADBAND ACCESS (SEBA)

Victoria Polyvana
Educational and Research Institute of Telecommunication Systems, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: SDN (Software defined network), SEBA, network, ONF (Open Network Foundation), reference design (RD), software

Introduction. In today's world, networks need higher data speeds and improved tools used for network management and monitoring. Therefore, these circumstances lead to the emergence of new functional and technological networks, with complicated infrastructure. Old methods of monitoring and management do not meet the new requirements.

Monitoring and management of the network steel a bottleneck in the traditional network approach, with the development of the Internet. This led to the emergence of a new concept of network building based on the SDN (Software defined network) architecture. Modern development trends information technologies clearly change corporate networks. There is an increase in the volume of network traffic, in this regard, there is a need for the configuration of the constant addition of complex network structure. The popularity of software-configuration SDN networks are increasing.

Objectives. SDN Enabled Broadband Access (SEBA) is a large open source development and integration project organized by the Open Network Foundation (ONF). SEBA is designed to support the network and functional needs of several operators with a general architecture. SEBA's reference design (RD) provides a high-level template or architecture to support broadband with minimal purpose technological choice. (From CORD to SDN Enabled Broadband Access (SEBA), 2020).

The approach allows many implementation streams to meet SEBA requirements in general or in parts as a set of modules and compositions that allow the combination of SDN, NFV as well as outdated PNF components to be used as compositional elements in deployment. In addition to SEBA RD, ONF will potentially develop exemplary implementations and implementation streams that emerge from the exemplary platform (ONF, 2019, p. 1).

Methods. SEBA is designed to provide an architecture template for solution development for broadband access of the carrier. The goal is to determine the common infrastructure component, which will not be considered differentiation of both for operators and suppliers. Community helps to create efficiency in the development of open and white-boxes, and then commercial products and support for these entities. The scope of SEBA RD is designed to cover a wide range of wireless lines and fixed wireless access technologies and related features of Service Edge. SEBA is designed as a set of container elements that work in Kubernetes environment. The system is modulated on one typical microservice system architecture, and there is a modularity hierarchy used to allow flexibility compositions at different scales (ONF, 2019, p. 1).

Results. SEBA can be implemented in different ways, depending on the operator and/or situation. Most important in this regard is a clear decoupage and separation of

"service" from "infrastructure". This also involves the implementation of SEBA on different various infrastructure platforms, including but is not limited to those based on CORD. Modularity due to good functional decomposition should provide widespread reuse in ONF solutions providing high volume, serial, SW possible assemblies from the ecosystem. SEBA will provide an opportunity to improve access networks around the world to provide open, software-driven systems in new critical areas, such as multi-gigabit fiber access networks. (ONF, 2019).

Conclusion. To sum up, the concept of software-defined networks (SDN) thoroughly changes principles of network functioning and their management. Software and configuration network use the mode of operation, sometimes called adaptive or dynamic. SDN technology can significantly improve efficiency telecommunication networks, bandwidth and quality of service. SDN networks are the future of telecommunications.

References:

Das, S. (2020, December 4*). From CORD to SDN Enabled Broadband Access (SEBA) [invited tutorial].* Journal of Optical Communications and Networking. Retrieved October 9, 2021, from https://www.osapublishing.org/jocn/abstract.cfm?uri=jocn-13-1-A88

ONF. (2019, March 18). *SDN Enabled Broadband Access (SEBA) [reference design].* Retrieved October 9, 2021, from https://opennetworking.org/wp-content/uploads/2019/04/ONF-Reference-Design-SEBA-032919.pdf

ANALYSIS OF REINFORCEMENT LEARNING ALGORITHMS FOR MODELING THE BEHAVIOR OF SELF -DRIVING CARS

Yaroslav Popryho
Educational and Research Institute of Physics and Technology, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Key words: reinforcement learning, machine learning, algorithms, self- driving cars

Introduction. Nowadays, the issue of autonomous driving is becoming more acute. Every day, many companies are working on improving many factors closely related to the behavior of self-driving cars. Increasing the level of passenger safety and other traffic participants, elimination of congestion, reduction travel time, increase in capacity, increasing fuel economy – are one of the most important tasks in self – driving cars. Consideration and analysis of efficiency learning algorithms that predict this behavior, have the most direct influence on the choice effective learning algorithm, which is one of the most urgent tasks in this field.

Objectives. The task of the research is to train a car model behavior in the environment by spending on training as few episodes as possible.

Methods. In the work was considered method of reinforcement learning. What is reinforcement learning? Almost the same as supervised learning, but the "teacher" is a real or virtual environment. Let's be on our toes: remember the popular way to teach swimming? Take it in a boat to the middle of the lake and throw it into the depths

with the instruction: "If you want to live, you will swim out." The same principle works in reinforcement learning: a robot is thrown into a maze, from which it must find its way out. In the process of searching, the robot receives information from the external environment about where there is no exit, thus studying the world around it and learning to find a way to the exit (Shweta Bhatt, 2019).

Although the purpose of the uncontrolled learning is the search for similarities and differences between data points, in the process of reinforcement the goal is to search for an appropriate model of action that would maximize the total aggregate remuneration of the agent. In the work was built a simple environment, in which were realized reinforcement learning algorithms for a specific use case.

Results. Finally, let's get down to modeling. In this paper was compared the accuracy of 3 algorithms: Q – learning, SARSA, Expected – SARSA.

As a result of work of algorithms Q – learning and SARSA, it was possible to understand basic forms of car model behavior for 3,500 and 3,700 episodes respectively. In case with Expected – SARSA algorithm, this was done in 4,000 episodes.

Conclusion. In this work was built a model environment and using 3 algorithms were considered the main approaches to self – driving car behavior modeling. The most effective of them is the Q-learning algorithm.

References:

Shweta Bhatt. (2019). Things you need to know about reinforcement learning. Retrieved from July, 7:2019, 5.

USE OF TRANSFORMER NEURAL NETWORKS IN NATURAL LANGUAGE PROCESSING TASKS

Dmytro Pryshchepa
Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: natural language processing, neural networks, transformers

Introduction. In the modern information-driven world natural language processing (NLP) becomes a very important and prominent field of research in mathematical linguistics and artificial intelligence. Tasks like context-aware translation, topic summarization, sentiment analysis and intelligible text generation are extremely hard for a simple human-written computer algorithm. Any natural human language is, generally speaking, too complicated for simple programs to understand. There are common cases where to properly understand a sentence computer needs to not only know simple grammar and have a dictionary, but also have experience and vast knowledge about the subjects of that sentence.

Objectives. The primary objective is to design a new neural network architecture that is specifically optimized to work with sequences of data and can be easily parallelized. The second objective is to utilize this new architecture and design a neural network that will be trained on large corpus of human-written texts and not only learn

the grammar and punctuation, but also will be context-aware and get the basic knowledge needed to properly understand complicated sentences.

Methods. Originally the main architecture for these types of tasks was recurrent neural network that uses long short-term memory (LSTM) neurons (Hochreiter, 1997) or gated recurrent units (Cho, 2014). They perform decently but one of the main problems (and one of the reasons for developing gated recurrent units and then transformer models) was that recurrent models are very slow in training and require the data to be fed sequentially, which prevents them from being trained in parallel, greatly reducing the speed and, as a consequence, the size of the training dataset. That makes the second objective nearly impossible to achieve using those. In 2017 a new type of neural network architectures was introduced by researchers from Google Brain – a transformer (Polosukhin, 2017). It doesn't require the data to be processed sequentially and can be trained in parallel on different parts of the originally sequential data. That finally allows the training to be done using a very large corpus of texts, which was first done by Google with their Bidirectional Encoder Representations from Transformers (BERT) network (Devlin, Jacob et al. 2018). It was pre-trained on unlabeled data from English Wikipedia and BooksCorpus sites with total of 3.3 billion words. The current biggest transformer model is the third generation of Generative Pre-trained Transformer model (GPT-3) by OpenAI which was trained on a much larger corpus of 570 gigabytes of English text (Brown, 2020).

Results. The new transformer-based approach shows great success in natural language processing. Before the release of GPT-2 and GPT-3, BERT was achieving the highest results in all common NLP metrics, such as General Language Understanding Evaluation (GLUE), Stanford Question Answering Dataset and Situations with Adversarial Generations metrics (Devlin, Jacob et al. 2018). But with the release of bigger models by OpenAI GPT-2 and GPT-3 quickly took over the first place. It is important to mention that those tasks don't measure performance in terms of time the model needs to solve the task, which grows quickly with the size of the model.

Conclusion. In summary, new transformer models show great results in natural language processing and while OpenAI's nearly brute-force approach with direct model scaling is questionable, it nevertheless shows great results. With rapid development in both neural network and computational technology fields we can expect even better results in near future. Though Yann LeCun (2020) argues that while such approaches work when it comes to beating records, but they cannot provide a way of creating a truly language-understanding AI. The latter is a much more complicated task that requires a drastically different approach.

References:

Brown, T. B., Mann, B., Ryder, N., Subbiah, M., Kaplan, J., Dhariwal, P., Shyam, P., Sastry, G., Askell, A., Agarwal, S. et al. (2020). *Language Models are Few-Shot Learners.*

Cho, K., van Merrienboer, B., Gulcehre, C., Bahdanau, D., Bougares, F., Schwenk, H., Bengio, Y. (2014). *Learning Phrase Representations using RNN Encoder-Decoder for Statistical Machine Translation*

Devlin, J., Chang, M.-W., Lee, K., & Toutanova, K. (11 October 2018). *BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding*.

Hochreiter, J., & Schmidhuber, J. (1997). Long short-term memory. *Neural Computation*. 9 (8): 1735–1780.

Polosukhin, I., Kaiser, L., Gomez, A., Jones, L., Uszkoreit, J., Parmar, N., Shazeer, N., & Vaswani, A. (2017-06-12). *Attention Is All You Need*.

CLOUD COMPUTING IMPACT ON BUSINESS
Vira Pyrih

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: cloud computing, service models, business, IT infrastructure

Introduction. Cloud technologies are rapidly evolving to contribute to the development of businesses across the globe. IT infrastructure costs are being minimized through the use of hardware and software suits managed by 3rd party providers. Such suits provide on-demand services meaning that none of resources are left idle. This is basically the purpose and main idea of what is called cloud computing. Several cloud solutions are provided and business can benefit from them only in case clear requirements are set and right choice is made.

Objectives. The main task is to evaluate the impact that cloud computing has on business as well as explore the difference between several cloud solutions. Study of advantages and limitations of the selected set of technologies will come in handy for the research.

Methods. Various service models are present and should be incorporated into organizations based on business needs. The National Institute of Standards and Technology differentiates between three standard models, which are: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) (Mell, Grance, 2011). IaaS model is a perfect solution for companies that require large storage and server capabilities along with maintenance and support. It covers the network resources needs including virtual machines, load balancers, firewalls and software bundles (Amies, Sluiman, Tong, Liu, 2012). Therefore, companies can focus on other areas of their business by delegating network maintenance tasks to service providers. Next model – Platform as a Service – could be a choice of software development companies. It provides a suitable environment for application development, testing and organization. Examples of the resources used in PaaS would be execution environments, databases, web servers, development tools. Finally, SaaS model is designed to provide cloud access to web applications. Any kind of organization can benefit from such model as long as web version of application is needed instead of one installed in the on-premise infrastructure. It is worth noting that such models are often combined with each other and can be structured as layers from low-level IaaS to high-level SaaS.

Results. Proper application of cloud computing technologies can help companies gain advantages in several fields. With business growth comes need in

storage capacity and infrastructure expansion. Cloud service providers allow companies to save money that would be spent on hardware and software installation. Customer experience benefits as well. Quick access to specific information and 24-hour support help to improve customer care processes. Moreover, the vast majority of cloud solutions offer self-service portals that make customer requests even easier to be created. One more important advantage of cloud services is the flexibility of employees work. Remote job offers for various positions appear more often in the wake of global events. It's reported that world pandemic of 2020 lead to over 160% Zoom growth (Wilhelm, 2021). Nevertheless, cloud solutions have the downside related to specific limitation issues. One concern is the lack of customization. Organizations should have clear vision of what services they need considering that no extra resources or functionality will be provided. Privacy and control are also sources of the limitation problems because access to back end infrastructure is available to cloud vendors only making it hard for companies to monitor which of their data is being accessed.

Conclusion. To sum up, cloud computing in the context of business growth is the leading theme. Three standard service models provide specific solutions based on business needs giving benefits to companies in one set of fields but also limiting them in the other. Consequently, cloud services improvement with customer individualised approach is a perspective topic for the further research.

References:

Amies, A., Sluiman, H., Tong, Q. G., & Liu, G. N. (2012). Infrastructure as a Service Cloud Concepts. Developing and Hosting Applications on the Cloud. *IBM Press*.

Mell, P. & Grance, T. (2011). The NIST Definition of Cloud Computing (Technical report). National Institute of Standards and Technology: U.S. Department of Commerce.

Wilhelm, A. (2021). Remote work helps Zoom grow 169% in one year, posting $328.2M in Q1 revenue. *TechCrunch*.

HOW FUTURE OF INFORMATION TECHNOLOGY IS BEING SHAPED BY CONCEPTS OF CLOUD COMPUTING

Vitalii Radchuk

Faculty of Electric Power Engineering and Automatics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: cloud computing, resource allocation, balance the load

Introduction. In recent years, cloud computing has found its use in many trends of our life such as business, markets, enterprise and government. The paper aims to explore the role and the opportunities given by cloud computing technology. The concept itself firstly appeared in the 1960's as a time-sharing model which includes sharing computing resources with other users at the same time combining multiprogramming and multitasking. As telecommunication networks became more developed and access to the internet become wide-spread, new ways to make large-scale computing power available to more users by using time-sharing were found.
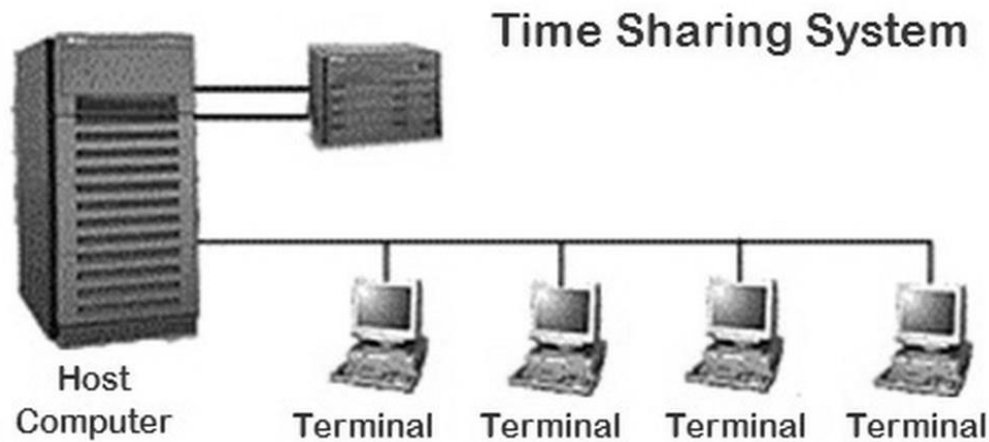
Fig.1. Example of the time-sharing system.

Objectives. The main goal of cloud computing is to give users easy access for all of the   without having lesser options and paying more when it comes to the scalability, power and upkeep rate, which can often lead to heavy losses in terms of infrastructure and maintenance costs. Whereas cloud computing allows for users to use as much as they would need, balancing the load and allocating resources substantially (Kollolu, 2020, p. 1).
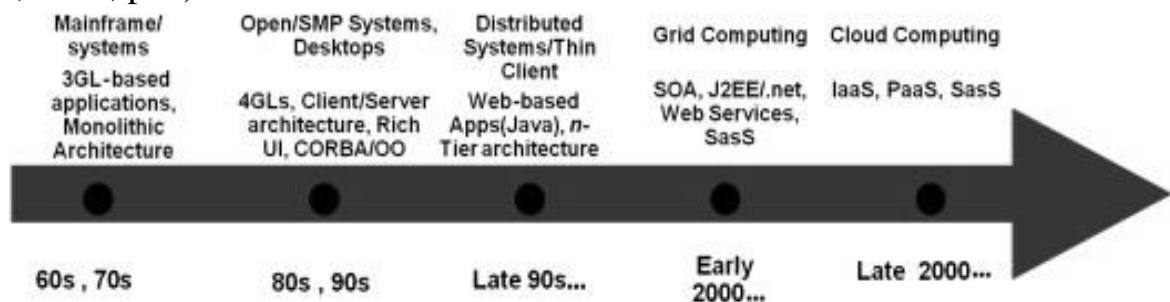
Fig.2. Evolution of the computing capabilities.

Methods. Different types of cloud computing can be categorized based on two wide categories, one being deployment model and the other being service model (Alam, 2020, p. 111).

There are four deployment cloud services models available for the user:

– Public cloud is a type of cloud which is available to every user who want to use its hardware or software computing resource, allowing customers to pay only per usage the CPU cycles, storage, or bandwidth they consume.

– Private cloud infrastructure is exclusively operated by a single organization.

It could be managed by the organization or a third party and may exist on-premise or off-premise. Despite being more expensive than public clouds because of the expenses that include acquiring and maintaining them, it is better in terms of privacy.

– Hybrid cloud is a cloud that combines both public and private cloud infrastructure. It is used to rapidly scale up users computing capacity for a defined period of time to meet an increased demand.

– Community cloud can support numerous users sharing computing resources and make up a group which creates a community. Such model is used in the universities or government institutions.
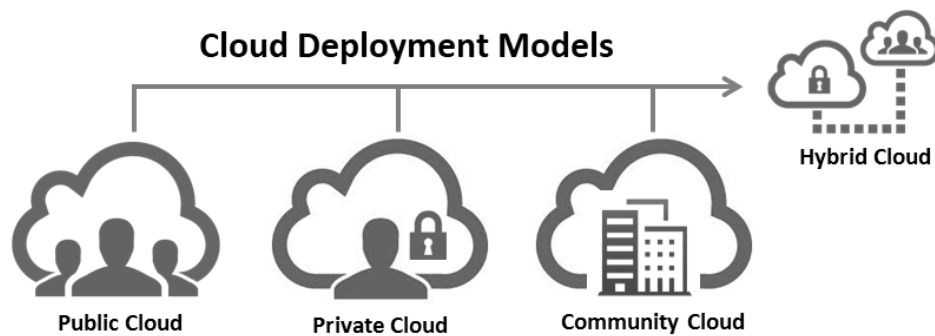
Fig.3. Cloud deployment model.

The basic areas for applications for cloud computing (Kollolu, 2020, p. 3):

– IaaS (Infrastructure as a Service) – is a cloud platform which allows to rent a "bare" Windows/Linux server with adjustable computing capacity (Shukur, et al., 2020, p. 98).

1. IaaS provides a basic computing infrastructure.

2. Its services are available on pay-for-what-you-use model.

3. Providers of such service are Amazon Web Services, Microsoft Azure and Google Engine.

– PaaS (Platform as a Service) – is a cloud platform with all of the necessity and supporting software such as database and frameworks (Shukur, et al., 2020, p. 98).

1. PaaS provides cloud platforms and runtime environments for developing, testing and managing applications.

2. Such cloud platform allows software developers to deploy applications without infrastructure needed.

3. Providers of such service are Windows Azure, Force.com.

– SaaS (Software as a Service) – is a business application which offers an internet service to a final user, it does not require to maintain any IT equipment (Shukur, et al., 2020, p. 98).

1. Software application on pay-as-you-go pricing model is hoted and managed by the cloud providers.

2. No need to maintain anything as both provided software and hardware is managed by vendor.

3. Such service is provided by Google Apps, Salesforce CRM.
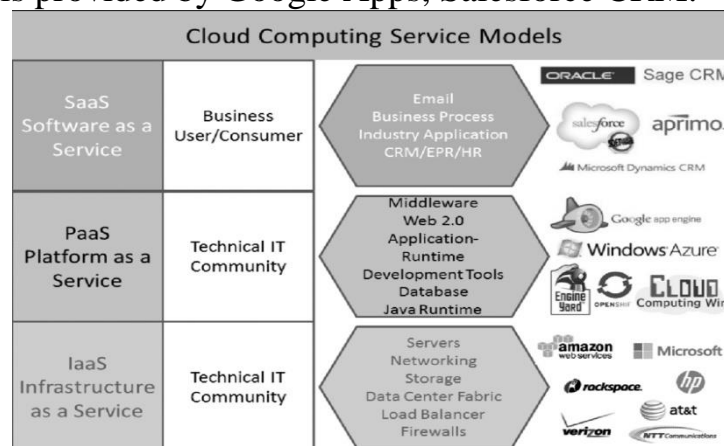
Fig.4: Cloud service model.

Results. Benefits of Cloud Computing model (Alam, 2020, p. 112):

–	Flexibility and Mobility.

Cloud computing gives users plenty of convenience when it comes to the scalability that allows them scale or descale their infrastructure. Not only it allows users get as much resources as they would need but also gives access their data wherever they are at any time through laptops, tablets and more.

–	Security.

In digital age security and privacy are essential when it comes to the business on the internet. Any online company can be vulnerable to the security breaches and attacks. In cloud computing security algorithms are more complex, including multiple security levels and constant maintenance of the system by the provider.

–	Business assurance.

Any business can be affected by some unforeseen circumstances such as company's bankruptcy, equipment failure or natural disasters. Cloud computing makes the occurrence of such problems dramatically low. Otherwise, cloud offers a data recovery.

Conclusion. To summarize, Cloud computing is a unique technology that evolves with each year and is going to be commonly used in IT. Its main goal is to provide users with computing power and various resources, allowing them you use as much as they would need which helps to balance the load and allocate the resources. However, the final result depends on how much of the on-premises technology the want to be involved, which aspects in terms of software need to be managed and what deployment and service model would be more efficient for their application.

<div align="center">

References:

</div>

Alam, T. (2020). Cloud Computing and its role in the Information Technology. *IAIC Transactions on Sustainable Digital Innovation (ITSDI), 1(2),* 108–115.

Kollolu, R. (2020). Infrastructural Constraints of Cloud Computing. *SSRN Electronic Journal.* Published.

Shukur, H., Zeebaree, S., Zebari, R., Zeebaree, D., Ahmed, O., & Salih, A. (2020). Cloud Computing Virtualization of Resources Allocation for Distributed Systems. *Journal of Applied Science and Technology Trends, 1(3),* 98–105.

<div align="center">

USE OF ELECTRONIC DOCUMENTS IN DAILY LIFE

</div>

<div align="center">

Maksym Rusakov

Faculty of Applied Mathematics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

</div>

Key words: Diia application, possibility, document control

Introduction. Our documents play an important role in our lives. After reaching the age of 14, everyone is required to obtain their first passport. It also provides new opportunities. Anyone with an ID card as a passport may now download the Diia app and have all of their documents stored on their phone. Diia (Action), to refresh your memory, is smartphone software that allows Ukrainians to access digital documents. Diia has a user base of over 2 million people in Ukraine. They can now use their

smartphone to access a driver's license and vehicle registration certificate, as well as a digital student ID and the option to test a biometric passport and ID card (2020).

Objectives. The main task is to make it possible for people to use electronic documents in any situation. The major goal is to make it as simple as possible to use. The Diia app's programmers worked hard to ensure that their work could be used to a variety of fields. It is now necessary to enable the use of this app.

Methods. There are a lot of places where you need to pass document control. For example supermarkets. Every time when a person needs to buy alcohol or cigarettes he should show his document to cashier. And cashier should recognize whether this document is real and the age of the owner is bigger than 18. The best solution for easy recognition is a special app on cash register that will be connected with Diia servers and will show the age of the app owner. This will relieve the cashier of all responsibilities for verifying the age and validity of the passport, and will make the verification safer. Such apps should be in every document control point as post offices, train stations, airports, police controls. This applies not only to passport control, but in general to all the documents that a person has. You can often get a discount for students at the cinema, zoo, when buying train or bus tickets. For such purposes, it is also necessary to verify the reality of data and documents.

Results. Now we also have part of the opportunity. For example, the government has launched a pilot program to use the Diia application and website to complete car customs. During a regular meeting of the Cabinet of Ministers, Prime Minister Denys Shmyhal remarked that importing cars had frequently been inconvenient for tens of thousands of Ukrainians. "As a result, we enacted a resolution allowing anyone to submit appropriate papers by smartphone, pay customs duty, and complete the vehicle's customs clearance in real time. Everything is as simple, straightforward, and free of corruption as possible" said the Prime Minister (2021). The Diia system makes a significant contribution to the objective of "a country in smartphones." The Diia portal, in particular, enables Ukrainians to access numerous official services online, such as registering a child's birth and registering and closing self-employment status. Ukrainians can also use Diia to sign digital papers, manage their taxes, and register and update their address. The Ministry of Digital Transformation aspires to have all public services available online by 2024.

Conclusion. To summarize, one of the most prominent themes is the use of electronic documents in everyday life. This inquiry is directed at all places where document control is used. I believe that in the not-too-distant future, we will be able to use our phones to verify our documents anywhere.

References:

Communications Department of the Secretariat of the CMU. (2021, September 15). Denys Shmyhal: Diia will provide an opportunity to get customs, clearance of vehicles. Retrieved from https://www.kmu.gov.ua/en/news/rozmitniti-avto-mozhna-bude-cherez-diyu-denis-shmigal

Ministry of Digital Transformation of Ukraine. (2020, April 07). *Ministry of Digital Transformation launches push notifications in the Diia app*. Retrieved from https://www.kmu.gov.ua/en/news/mincifri-zapuskaye-push-povidomlennya-u-zastosunku-diya

CREDIT SCORING BASED ON SOCIAL NETWORK DATA
Andrii Samoshyn

Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: credit scoring, machine learning, social media

Introduction. Social networks accumulate a huge amount of information that can provide valuable information about user behavior. Using the social data of popular social networks, you can try to distinguish between solvent and insolvent users of banks or credit institutions. Social data can be used to enrich the organization's classic scoring cards. When a traditional credit history is not informative enough for new customers, social data can increase the efficiency of the rating system.

Objectives. The main task is to conduct research on how open data about a user from his profile affects his assessment of creditworthiness.

Methods. All data was encrypted to protect privacy. This data includes variables of the borrower's personal information. Personal information is the borrower's demographic information from the social network profile, including the borrower's age, gender, marital status, number of children, education status, job title. In-depth study of the borrower's profile, you can find out his interests, political views and estimated level of income, such as a photo from vacation, in the car, and so on. User comments help to compile his characteristics (level of intelligence, aggression). Also to determine the level of creditworthiness seeks a circle of close friends. We can identify friends who are already regular users of the bank and get aggregate information about the new borrower (Dumitrescu, 2020).

Many statistical models are used to estimate credit, such as linear or logistic regression or naive Bayes. However, these methods are often inefficient when working with nonlinear relationships. Therefore, many methods of machine learning and artificial intelligence have been used to estimate credit, and these algorithms worked better than statistical analysis. In recent years, ensemble techniques such as random forest and GBDT have paid close attention to credit score. Compared to various credit scoring algorithms, ensemble methods tend to be more stable and demonstrate better forecasting results (Provenzano, 2020).

Results. The research results show that information from social networks about the borrower can be used to stabilize credit scoring, and the model's ability to predict correct results has improved. Social data should improve the set of traditional lending variables and help improve the effectiveness of borrower appraisal. Thus, organizations receive a set of variables that covers the maximum number of aspects about the user and obtain a credible characterization of the borrower. An analysis of the classification metrics shows that the model has good predictive power and high stability in relation to abnormally non-standard cases relative to traditional credit scoring features. For the scoring system, the Gini coefficients are improved by 7–10 % (Guo, 2016).

Conclusion. To sum up, predicting loan repayment is important for financial institutions, which can use predictive models to rank clients for good and bad borrowers. In many countries, new borrowers do not have credit history data, making

it difficult to predict borrower default. In such cases, financial institutions need an alternative method for assessing creditworthiness. Since modern users are quite closely connected with social networks, it seems possible to use information about the user from his profile. The results show that social media variables can be used to improve the accuracy of predictions. However, there are some limitations to keep in mind. Traditional banks must inform the client about the reason for the denial of credit, while the reason for the denial is based on information from social networks, which cannot be used as the main reason. Therefore, this approach using social media to improve creditworthiness can only be used by microcredit organizations (De Cnudde, 2018).

References:

De Cnudde, S., Moeyersoms, J., Stankova, M., Tobback, E., Javaly, V., & Martens, D. (2018). What does your Facebook profile reveal about your creditworthiness? Using alternative data for microfinance. Retrieved from https://www.tandfonline.com/

Dumitrescu, E., Hué, S., Hurlin, C., & Tokpavi, S. (2020). Machine Learning or Econometrics for Credit Scoring: Let's Get the Best of Both Worlds. Retrieved from https://hal.archives-ouvertes.fr/

Guo, G., Zhu, F., Chen, E., Liu, Q., Wu, L., & Guan, C. (2016). An Exploratory Study of Mining Social Data for Credit Scoring. Retrieved from https://dl.acm.org/

Provenzano, A.R., Trifir`o, D.A., Datteo, L. Giada, Jean, N., Riciputi, A., Pera, G.Le, Spadaccino, M., Massaron, L., & Nordio, C. (2020). Machine Learning approach for Credit Scoring. Retrieved from https://arxiv.org/

BLOCKCHAIN TECHNOLOGIES IS THE FUTURE OF XXI CENTURY

Vladyslav Seletkov
Faculty of Applied Mathematics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: blockchain, cryptocurrency, algorithm, decentralization, bitcoin, transaction, project

Introduction. At least once, everyone has heard of such a coin as bitcoin. If you already look deeper, then at the heart of bitcoin is the blockchain. Unfortunately, not everyone knows about this, although it has very promising chances for development and implementation in everyday life. The innovation of this technology is that information about the transaction is no longer stored in a centralized database, but is transmitted to computers of all network members that save data local, this is a decentralized digital register of transactions (Antonopoulos, 2014).

Objectives. The main task of this research is to discover the disadvantages and advantages of blockchain technology, to find out how this system is used and where it is applied.

Methods. To begin with, it is necessary to define these terms. According to Antonopoulos (2014), blockchain is a continuous sequential chain of blocks (linked

list), built according to certain rules, containing information. Most often, you can hear the term "blockchain" when it comes to transactions in various cryptocurrencies, but blocks can contain any information.

Furthermore, we will analyze every detail. Blocks are information, transaction data, agreements and contacts within the system, which are presented in cryptographic form. All these blocks are built in a chain and, as a result, have a connection with each other. To write a new block, you need to sequentially read data from all previous ones. All collected information cannot be deleted, replaced or altered. The main feature of blockchain is decentralization. There is no the main server that holds all the information. All participants of the blockchain network possess the data at the same time.

Results. There are a number of extensions for the development of business applications on the blockchain, providing: secure network administration, storage of digital certificates, secure two-way transactions, confirmation of rights to any property, DNS system invulnerable to DDOS attacks, proof of product authenticity using a securely secured certificate and other (Conoscenti, et al., 2016).

The use of this technology will give confidence that it is theoretically possible to hack such a system, but in practice it is completely pointless. Blockchain security is ensured by such features as: complex mathematical algorithms, special encryption programs, thousands of powerful computers included in the mining system, between which the entire set of data is distributed (Conoscenti, et al., 2016).

It is possible to note such advantages: the blockchain is based on transparency and security, using this system you can eradicate corruption forever, and this technology also allows you to engage in trade, change the work of the banking sector, and even introduce various services in life. For example, there are many different crypto projects based on blockchain technology, these projects have a variety of products that can be studied and invested in it. As a result, you can develop these projects, support and popularize and even make money on it. Moreover, as proof of the development of blockchain and cryptocurrencies, in Salvador, for example, recently passed a law recognizing bitcoin as a means of payment.

On the other hand, the blockchain has several disadvantages, such as: the performance of the blockchain is inferior to high-loaded systems, besides, it is still difficult to find developers who are good specialists in this area and can work with this, and large investments are required in infrastructure, security, private key storage system and more.

Conclusion. Blockchain is a storage room in which you can put something and any visitor will be able to notice an attempt to substitute content.

References:

Antonopoulos, A. M. (2014). *Mastering Bitcoin: unlocking digital cryptocurrencies*. O'Reilly Media.

Conoscenti, M., Vetro, A., & De Martin, J. C. (2016). Blockchain for the Internet of Things: a systematic literature review. *2016 IEEE/ACS 13th international conference of computer systems and applications (AICCSA)*, Agadir, Morocco.

NATURAL LANGUAGE GENERATION USING GENERATIVE PRE-TRAINED TRANSFORMER 3

Polina Semonova, Anastasiia Odyntsova

Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: automation, artificial intelligence, GPT-3, semantics

Introduction. Language and linguistics is a complex and vast field that human beings learn throughout their lives in order to communicate with society, understand the meaning of words, form sentences and give answers that have contextual meaning, as well as to use slang. Can artificial intelligence even partially learn this skill? To answer this question, let's turn to the GPT-3 and understand how it works and how it learns.

GPT-3 (Generative Pre-Trained Transformer) – a language model that uses deep learning to produce human-like text. Or to put it more simply, it is a computing system designed to generate word sequences, code or other data, starting with initial input, called the prompt.

Objectives. The main task is to understand whether GPT-3 can understand the language and linguistics that will reach the level of human speech and be on an equal footing with it. Also what progress the GPT-3 has made compared to the GPT-2.

Methods. GPT-3 achieves strong performance on many NLP datasets, including translation, question-answering, and cloze tasks, as well as several tasks that require on-the-fly reasoning or domain adaptation, such as unscrambling words, using a novel word in a sentence, or performing 3-digit arithmetic. At the same time, it was identified some datasets where GPT-3's few-shot learning still struggles, as well as some datasets where GPT-3 faces methodological issues related to training on large web corpora. Finally, it was found that GPT-3 can generate samples of news articles which human evaluators have difficulty distinguishing from articles written by humans (Brown, Mann, & Ryder, 2020).

To find out about all the features of GPT-3 and numerous, three tests were conducted to check how well it handles logical-mathematical, semantic and ethical queries.

GPT-3 works in terms of statistical patterns. So, when prompted with a request such as "solve for x: x + 4 = 10" GPT-3 produces the correct output "6", but if one adds a few zeros, e.g., "solve for x: x + 40000 = 100000", the outcome is a disappointing "50000".

GPT-3 does not perform any better with the Turing Test. Having no understanding of the semantics and contexts of the request, but only a syntactic (statistical) capacity to associate words, when asked reversible questions like "tell me how many feet fit in a shoe?" GPT-3 starts outputting irrelevant bits of language.

The third test, on ethics, went exactly as we expected, based on previous experiences. GPT-3 "learns" from (is trained on) human texts, and when asked by us what it thinks about black people, for example, reflects some of humanity's worst tendencies. Some stereotype tests have been done and GPT-3 seems to endorse them regularly (Luciano & Chiriatti, 2020).

Results. Although it has failed mathematical, semantic, and ethical tests, GPT-3 writes better than many people. Its availability marks the dawn of a new era in which mass production of good and cheap semantic artifacts has become possible. Writers will have less work, at least in the sense that writing has functioned since its invention. Template test writing will now use software for such things as – translations, summaries, minutes, commentaries, web pages, catalogs, newspaper articles, manuals, directories, fill-in forms, reports, recipes. This is the biggest transformation of the writing process since the word processor. Already this future has come as Microsoft announced in May 2020 that it would lay off a dozen journalists and replace them with automated news production systems.

But people should not worry too much about being completely replaced, since the GPT-3 will be their helper, human brain activity is still needed. GPT-3 will highlight a few important texts, and a person will already need to link them logically and grammatically. The GPT-3 will also make it possible to recover missing parts of a text or to complete them, this can be used to complete many novels.

Conclusion. It is to be expected that, thanks to applications like GPT-3, intelligent and analytical systems will become more sophisticated and will be able to identify patterns that are not immediately discernible in huge volumes of data. Automated personal assistants, chat-bots of online stores will be able to better understand customer requests and give the most relevant answer based on the context, thus improving the relationship between consumers and companies.

References:

Brown, T., Mann, B., & Ryder, N. (2020). Computation and Language. *Language Models are Few-Shot Learners.*

Floridi, L., & Chiriatti, M. (01 November 2020). Computation and Language. *GPT-3: Its Nature, Scope, Limits, and Consequences.*

DISEASE DIAGNOSTIC BY MACHINE LEARNING ALGORITHMS

Diana Shevaha, Vlad Yurochkin

Faculty of Biomedical Engineering, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: machine learning, deep learning, artificial intelligence, machine learning algorithms, Naive Bayes

Introduction. Machine learning (ML) is the subfield of artificial intelligence learning. Many researchers think that without intelligence analysis ML cannot be generated. There are many types of ML techniques, which are used to classify the dataset: supervised, unsupervised, semi-supervised, evolutionary learning, reinforcement and deep learning.

The pattern recognition and data classification process are significant for ages. Today, in medicine, diagnosing diseases is a liable task. It is vital to understand the exact diagnosis of patients through examination and clinical assessment. For effective analysis and management, computer-based decisions can play a critical role. Now, for efficient data analysis, ML recommends many tools. Machine learning technologies

are very effective for analyzing medical data and a great job has been done regarding diagnostic issues. Machine learning techniques (MLT) have discovered electronic medical records that typically contain high-dimensional patterns and multiple sets of data. Pattern recognition is the subject of MLT, which supports prediction and decision-making for diagnosis and treatment planning. ML algorithms are capable of managing a large amount of data, aggregating data from different sources and integrating basic information into the study (Fatima, Pasha, 2017).

Objectives. The objective is to determine the best algorithm of different machine learning algorithms for diagnosing various diseases such as heart disease, diabetes mellitus, liver disease, coronary heart disease, dengue and hepatitis.

Methods. The Naive Bayes algorithm and Support Vector Machine (SVM) method are worldwide used algorithms for disease detection. Both algorithms have better accuracy compared to other algorithms. The artificial neural network is also effective for prediction. The other algorithms, that are used for disease detection: FT Tree Algorithm, Rough Set Theory (RS), Random Forest, Multi-layer Perceptron.

Results. In medical imaging, computer-aided diagnosis is a dynamic and rapidly growing area of research. In the last few years, significant attempts have been made to improve computer-assisted diagnostic applications because mistakes in medical diagnostic systems can result in seriously misleading treatments. ML is crucial in computer-aided diagnosis. After using a simple equation, things like organs may not be accurately indicated. Thus, pattern recognition fundamentally involves learning examples. In the biomedical field, pattern recognition and machine learning promise greater precision in disease perception and diagnosis. They also promoted objectivity in the decision-making process. For the analysis of high-dimensional, multimodal biomedical data, machine learning offers an important approach to creating elegant, automated algorithms. Many researchers have worked on different machine learning algorithms to diagnose illnesses. The researchers accepted that machine learning algorithms work well in diagnosing a variety of diseases (Tan, Teoh & Goh, 2009). The figurative approach of the diseases analyzed using machine learning techniques is shown in Figure 1. The best accuracy for heart disease shows SVM, for diabetes disease – Naive Bayes, for liver disease – FT, for dengue disease – RS, for hepatitis disease – NN (Fatima, Pasha, 2017).
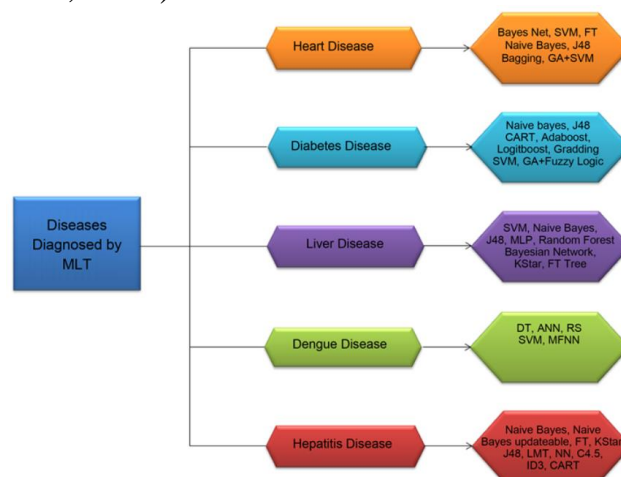
Fig.1 Diseases diagnosed by MLT

Conclusion. Statistical estimation models that are unable to produce high-performance results have flooded the evaluation area. Statistical models do not successfully deal with missing values and large data points. All of these factors stem from the importance of MLT. ML plays an important role in many applications, for example, image detection, data mining, natural language processing and disease diagnosis. We examined different machine learning techniques for diagnosing various diseases such as heart disease, diabetes, liver disease, dengue and hepatitis. Many algorithms have shown good results because they recognize the attribute accurately. The set of tools developed in the AI community are very useful for analyzing problems and also provide an opportunity to improve the decision-making process.

References:

Fatima, M. & Pasha, M. (2017). Survey of Machine Learning Algorithms for Disease Diagnostic. *Journal of Intelligent Learning Systems and Applications*, 9, 1–16. Retrieved from https://doi.org/10.4236/jilsa.2017.91001

Tan, K.C., Teoh, E.J., Yu, Q. and Goh, K.C. (2009). A Hybrid Evolutionary Algorithm for Attribute Selection in Data Mining. *Journal of Expert System with Applications*, 36, 8616-8630. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S095741740800729X?via%3Dihub

VIDEO GAMES. THE HISTORY OF THE GAMING INDUSTRY

Danylo Shyshko

Faculty of Applied Mathematics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: games, video games, computer

Introduction. Nowadays, a huge number of different people often play computer games – and not only bored school children or truant students. Among the players there are businessmen, politicians, housewives, engineers, and artists – in general, completely different people. All of them are united by one thing – the desire to experience something new in the virtual worlds, to try their luck and enjoy both the gameplay and the results achieved in the game.

Objectives. The main task is to try to tell the story of the formation of games one of the popular areas of entertainment

Methods. Attempts to create simple games on digital devices were made even before the outbreak of World War II: in 1947 the first electronic game was programmed, the monitor for which was the military radar screen – it was a simulator of enemy missiles. However, it is believed that the first computer game was OXO "("Tic Tac Toe ") made by A.S. Douglas back in 1952. Then was invented "Tennis for two", and implemented by William Higingbotham in 1958 in New York. Visitors of his laboratory could play tennis with a joystick, controlling their "rackets" (Donovan, 2010, p. 55).

The first computer games began to be massively created by computer operators IBM in various semi-closed scientific institutions that had computers at their disposal.

For example, in 1962, a group of students at the Massachusetts Technical Institute created the Spacewar game for the new DEC PDP – 1 computer. In Spacewar, players were given the opportunity to control with the help of controller's spaceships firing at each other with exploding rockets. It became very popular all over the world because DEC built it into its computers as a program with the help of which their performance was checked.

In 1971, the Spacewar game was greatly simplified by removing physics and inertia from it, which made it possible to simplify it and place it on compact electronic boards, connecting them to the TV and getting ... the first gaming machine (World Video Game Hall of Fame, 2018, p. 19).

In 1972, Debney and Bushnell created the Atari video game company, which soon created the highly popular "Pong" game, borrowed a lot from Tennis for Two. Over 1900 machines with the "Pong" game flashed into them were sold. So "Pong" was the very first ever pay-off computer game in history. In 1978, another game development company Taito also released the extremely popular Space Invaders game. Atari saw how much people want pixels and show – and that very year launched the very financially successful "Asteroids" (Harris, 2015, p. 21).

In the late nineties, 2D games were gradually fading into the past – they were gradually replaced by games with more realistic 3D graphics. 32 bit processors were made.

At the beginning of the 2000th, PC games developed intensively and appeared many configurations of computers capable of displaying graphics that no one could have dreamed of. An increasing number of people began to gain access to the Internet, which contributed to the development of low-budget indie game development studios that were able to sell their games over the Internet without the cost of reselling physical media.

Results. And the last stage of development of video games is still ongoing, games are becoming more demanding on hardware: new consoles, multi-core processors appeared. Almost all gamers have the Internet, sales of games are rapidly switching to digital format. The largest developers began releasing cross-platform projects immediately on various gaming platforms for a better payback, more and more indie studios began to draw on funds from crowdfunding (collecting donations from potential players on specially created platforms for this). The number of new games released every year is growing rapidly.

Conclusion. Today there are more and more games, and they become diverse and exciting, which lead to the fact that more and more people begin to play video games. And the gaming industry brings big revenues, because of which there are more companies that develop games, therefore it is possible to say that in the near future, games will become a usual entertainment for everyone, as was the case with books, radio and films.

References:

Donovan, T. (2010). Replay: the history of video games (pp. 50-98). East Sussex, England: Yellow Ant.

Harris, B. (2015). Console wars: Sega, Nintendo, and the battle that defined a generation (pp. 20-33). New York, NY: Dey St., an imprint of William Morrow Publishers.

World Video Game Hall of Fame (2018). A History of Video Games in 64 Objects (pp. 15-60). New York: Dey Street Books.

CASE-TECHNOLOGIES
Maryna Sivachenko
Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: case-technologies, case-facilities, toolkit, tool, scheme

Introduction. Computer-Aided Software / System Engineering (CASE) as a new direction in programming has formed over the past 10-15 years. CASE-technologies are used to create complex information systems, which usually require the collective implementation of a project involving a number of experts: system analysts, designers and developers (Krishnamurthy, n.d.). The main advantage of CASE-technology is to support collaborative project work due to the ability to work in a local developer network, export / import any project fragments, and organize project management.

Objectives. The main objective of the article is to determine the potential of case technology, review and analyze the types of case tools in order to reveal the advantages and disadvantages of case technologies.

Methods. CASE tools are used to support the various stages and phases of the software development life-cycle. Most CASE-technologies are based on the paradigm methodology / method / notation / tool. A methodology defines the steps of the task, their sequence, and the rules for the distribution and purpose of the methods. The method determines how a particular goal is to be achieved.

Notation system used to describe system structure, data items, processing stage and other components. Tools – toolkit for supporting methods. These tools provide the work of user-developers when creating and editing a project in an interactive mode, perform component compliance checks and encode software modules in some programming languages. Most often, the following tools are used in the structural analysis methodology: STD (State Transition Diagrams), DFD (Data Flow Diagrams), ERD (Entity-Relationship Diagrams) (Systems Engineering Thinking Wiki, 2019).

Results. The main purpose of CASE-technologies is to separate software design from the coding and development stages. The more activities that will be taken into design from coding, the better.

As any technology existing nowadays, CASE-technologies have their pros and cons. Regarding the advantages, it is necessary to emphasize that with the help of technology under study it is possible to improve the quality of the software being executed due to the means of automatic control (first of all, the control of the project). Moreover, it allows to create a prototype of a future system in a short time as well as speed up the design and development process and free the developer from routine work,

allowing him to concentrate entirely on the creative part of the development. Finally, development support and the possibility to reuse a development components using the technology add to its benefits (Systems Engineering Thinking Wiki, 2019).

Among CASE-technologies disadvantages there should be considered cost, learning curve and tool mix. When talking about the cost one should bear in mind that using the case is very expensive. In particular, large software companies do not invest in CASE tools because they believe that the benefits of CASE are justified only when developing large systems. Learning curve covers the situations when developer productivity can drop early in the development of an application because it takes time for the user to use the technology. Many consultants provide training and on-site services that can be important to accelerate the learning process and to develop and use CASE tools. With tool mix in consideration, it is important to create an appropriate set of tools to provide economic benefits. CASE integration and data integration across all platforms is very important (Patel, n.d.).

Conclusion. CASE technology allows you to distinguish information system design from actual programming and debugging: the system developer engages in higher level design without breaking the details. This allows you to avoid mistakes already at the design stage and to have more advanced software products.

<div align="center">

References:

</div>

Krishnamurthy, G. (n.d.). CASE Tools. Retrieved from http://www.umsl.edu/~sauterv/analysis/F08papers/View.html

Patel, P. (n.d.). Computer Aided Software Engineering. Retrieved from https://www.geeksforgeeks.org/computer-aided-software-engineering-case/

Systems Engineering Thinking Wiki (2019, August 18). CASE. Retrieved from http://sewiki.ru/CASE

<div align="center">

ROBOT SURGEONS

Anastasia Skachkova

</div>

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: surgery, robot surgeons, operations, laparoscopic

Introduction. In the sphere of surgery on average operations, the last 4-24 hours is something quite hard for a surgical team. The human resource isn't unlimited so today medical errors aren't a rarity. That's why, nowadays, the use of robot surgeons in surgery is relevant and in demand.

Objectives. The main task is to research robot surgeons that are used in medicine.

Methods. The pioneer among robotic surgeons is Da Vinci. The Da Vinci Surgical System is a robotic surgical system, that was made by the American company Intuitive Surgical. It is designed to facilitate surgery using a minimally invasive approach and is controlled by a surgeon from a console. Surgeries are performed on the stomach, esophagus, pancreas, liver, intestines with the help of it (Hussan, 2014). Its peculiarity and the reason for its popularity is a three-dimensional image of the

operating field. It is clear that this is typical of other robotic surgeons, but their usage in the world became available much later. For the first time in Ukraine, the Da Vinci System was used in Vinnytsia. Nowadays, operations with it help make out in many cities of Ukraine: Kyiv, Lviv, Dnipro, etc.

Another widely known system is VIKY, which is used in gynecology, general surgery, urology, thoracic surgery and is used on more than 150 devices around the world (Binder, & Kramer, 2001). Using it, the surgeon controls the operation with help of verbal instructions.

One more gaining popularity in recent years is the laparoscopic robotic surgeon Versius. Gynecological, gastric, and intestinal operations are performed with help of it. It stands out for its adaptability, versatility, and positioning versatility (Medeiros, 2020).

As far as I know from the perspectives, in January 2021, the robot surgeon Dexter should be released. It will be possible to use the robot for its incompatibility with any laparoscopic instruments, in theory.

In addition to robotic surgeons, there are robotic assistants in medicine (from which robotic surgery began to develop), therapeutic, diagnostic robots, and bioprinters. However, it is precisely robotic surgeons that are the most interesting and significant topic during operation.

Results. Robotic operations significantly reduce blood loss and simplify the work of the medical team. Unfortunately, the promotion of robotics in Ukraine isn't sufficiently developed due to a lack of funds. But we see from the analysis of the efficiency of operations the need to expand the usage of robotic surgeons and the need for their development in Ukraine. In turn, the number of robots is growing in the world and every year it becomes more universal and adaptive.

Conclusion. To sum up, research and the discovery of new robot surgeons are the leading topics for simplifying the work of the surgical team. These machines allow the surgeon not to use a scalpel, only to control the robot. Also, surgeons don't have to spend hours in uncomfortable positions. They will only apply their knowledge and control the process, which reduces the risk of medical errors.

References:

Binder, J, & Kramer, W. (2001). Robotically-assisted laparoscopic radical prostatectomy. Retrieved from https://www.kup.at

Haig, F., Medeiros, A., & Chitty, K. (2020). Evaluating the usability of Versius, a new robotic surgical device for use in minimally accessible surgery. Retrieved from https://sit.bmj.com/content/2/1/e000028

Hussain, A., Malik, A., Halim, & M.U. (2014). The use of robotics in surgery: a review. Retrieved from https://www.researchgate.net/publication/266564241_The_use_of_robotics_in_surgery_A_review

Mosoyan, M.S., & Fedorov, D.A. (2020). Modern robotics in medicine. Retrieved from https://transmed.almazovcentre.ru

ARCHITECTURE OF THE CONVOLUTIONAL NEURAL NETWORKS
Vsevolod Slavinskyi

Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Machine learning, Convolutional neural networks, neural networks architecture

Introduction. One of the most popular uses of this architecture is image classification. For example, Facebook uses CNN for automatic labeling algorithms, Amazon for generating product recommendations, and Google for searching among users' photos (Sorokina, 2017).

Objectives. The main goal of the study was to understand what complex and large-scale convolutional neural networks are made of, which solve many problems today. The result of the research can be applied to further study of neural networks and deepen the topic of their study..

Methods. The convolution operation is usually indicated by an asterisk ($*$) (Sorokina, 2017):

$$s(t) = (x * w)(t)$$

If we consider this operation in terms of neural networks, x is the input value and w is the kernel. The result of the operation is sometimes called a feature map.

CNN architectures consist of individual layers. In all cases, the layers take as input a 3D volume, transform that volume using differential equations, and output a 3D volume. Some layers require hyperparameter settings, while others do not.

The Input layer represents the input pixel values of the image as a 3D W x H x D matrix, where D depth corresponds to the number of color channels in the image.

The Convolution layer computes the output data of the nodes connected to the local regions of the input matrix. This layer calculates point products between a set of weighting coefficients, usually called a filter, and values from the local input domain (McDermott).

Results. The result of the convolution layer is fed to the element-by-element activation function, usually ReLU. The Activation layer determines whether the input node will "work" given the input data. So, if a node "doesn't work," this means that the convolution layer filters have detected a visual feature. The ReLU function is defined as max (0, x) with a threshold value of 0. To reduce the width and height of the original image, pixel combining and the corresponding Pooling or subsampling layer (Pooling layer) are applied.

The last layer in the CNN network is the Fully connected layer. The class probabilities are calculated using, for example, the SoftMax function and are output in a 3D array with dimensions: [1x1xK], where K is the number of classes.

Also, CNN often uses a form of regularization called Dropout: randomly selecting neurons that are ignored during learning. Dropout temporarily eliminates contributions to neuronal activation, and updating the weights improves the models and prevents certain sets of weights from specializing in specific features, which can lead to overlearning.

The architecture of the CNN is similar to the structure of neuronal communication in the human brain and inspired by the organization of the visual cortex. Individual neurons respond to stimuli only in a limited area of the visual field known as the receptive field. A collection of such fields is superimposed over the entire visual zone (Saha, 2018).

References:

McDermott, J. (n.d.). *Convolutional Neural Networks – Image Classification w. Keras.* Retrieved from https://www.learndatasci.com/tutorials/convolutional-neural-networks-image-classification/

Saha, S. (2018). A Comprehensive Guide to Convolutional Neural Networks – the ELI5 way. Retrieved from https://towardsdatascience.com/a-comprehensive-guide-to-convolutional-neural-networks-the-eli5-way-3bd2b1164a53

Sorokina, K. (2017). Image Classification with Convolutional Neural Networks. Retrieved from https://medium.com/@ksusorokina/image-classification-with-convolutional-neural-networks-496815db12a8

CELLULAR AUTOMATONS: SIMPLE SIMULATION TOOLS AND LANGUAGE FOR BEHAVIOR DESCRIPTION

Natan Smolij

Faculty of Informatics and Computer Science, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: cellular automaton, simulation, instruction language

Introduction. Cellular automaton by itself is a discrete model of computation studied in automata theory. As a simplified description of cellular automaton 2- dimentional array filled with different integer numbers can be given. As cells in real life, it evolves with time. Next state of every cell depends on its neighborhood and set of rules that connects variety of cell states with a variety of possible neighbors' placements. As an example John`s Conway`s "Life Game" can be given. It`s outer-totalistic, irreversible cell automaton. Irreversible means that previous state of array can`t be re-built using current state because different states can evolve into same state. Outer-totalistic means that the state of the cell in the next generation depends on both its own state and states of its neighbors (Shkilnyak, 2009).

Objectives. The main tasks are 1) to describe variety of possible events that cell can experience in cellular automaton; 2) to define possible attributes that can cause these events (over/under population leads to death, neighboring cell has state that affects next state of current cell, etc.); 3) to describe language that describes connections between states and events.

Methods. Program environment for cell automaton and conduct research on existing rules for cellular automatons are created (Wolfram, S.) in order to learn about events that can occur with cell and attributes of cell that can lead to these events. In this way information that is required to build terminal vocabulary of language can be found. Then main non-terminal symbol of the language must be discovered and grammar terms it consists of. Thus, grammar structure of formal language will be

defined and it becomes possible to build grammar-recognizing automaton. It will provide possibility of recognizing sentences written in our informal language and interpretation of written information will become possible (Martynenko, 2013).

Results. 1) List of discovered events occurred with cell: birth**;** **s**urvival (cell didn`t die during evolving of cell automaton)**;** change (cell changed its type)**;** death.

2) List of possible attributes that can cause events are distinguished: number of neighbors; type of cell and place of cell relative to another cells

3) Main non-terminal symbol is code like B3/S2,3. It consists of smaller parts: pairs of event-condition separated with '/' sign. All this information can be used for build informal language. The proper form of sentence in this language is:

N:<name of cell type>

<event>:<condition>/<event>:<condition>/<event>:<condition>/<event>:<con ditio>

Where <event> may be the one event from the list above and <condition> may relate to one or many of the attributes. It may be a case when we need to make references to many attributes. In this case <condition> non-terminal will be divided into parts:

<amount reference><placement reference><type reference>

As an example, there is a code that describes pyramid building in cell automaton: N:block/B:3|down|block

In this case the following changes will happen:
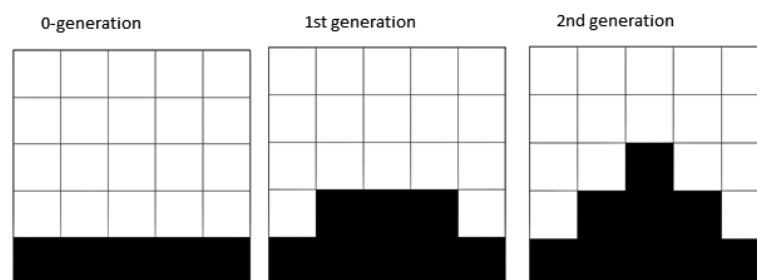
Possible amount references:

1,4,6,7 – enumeration

[2;8]-non-strict array

(2;8)-strict array

<array1>U<array2> - logical "or"-array1 with array2

<array1>!<array2> - logical "not"-array1 without array2

Possible placement references:

None-8 cells around current

Up/Left/Right/Down-to "look" at 3 cells in according direction

By pointing at exact cell using coordinate system connected with current:

<-1;0>

By two cells using coordinate system connected with current:

<-1;0><1;3>c- rectangular from 11 cells("c" includes current cell in array)

By concatenation or cutting of rectangles or points using ligic operators:

<-1;0><1;3>^/U/!<-1;-1><1;3>^/U/!<p1;p2>^/U/!...

Possible type references can be made with pointing on exact type, enumeration of types and using logic operators "!",""^","U"(not,or,and).

Also logical operators ^,U and ! can be placed between conditions in event groups in order to make proper logic formulas.

Type references can`t be used without amount or placement reference.

Conclusion. To sum up, problems of creation of artificial languages and integration of these languages into software such as cell automatons are difficult and require further researches. But result of such researches may lead to unpredictable results from discovering of new simulation tools to creation of new algorithms that can be used in programming. As a result of this research creation of one artificial language for describing cell behavior in cell automatons can be presented.

References:

Martynenko, B. K. (2013). *Formal grammar definitions.* In E. A. Hirsch (Ed.), Languages and broadcasts (2nd ed., pp.14). St. Petersburg, Russia: St. Petersburg University Publishinh House. (Original work published 2003).

Shkilnyak, S. (2009). *Expressiveness in algebraic systems. Arithmetic predicates, sets, functions. In Academic Council of the Interregional Academy of Management staff* (Ed.), Formal Models of Algorithms and Algorithmically Calculated Functions (4th ed., pp.63). Kiev., Ukraine: Publishing house "Personnel".

Wolfram, S. (n.d.). Wolfram Atlas: Cellilar Automata. Retrieved from http://atlas.wolfram.com/01/01/

NEURAL NETWORKS HAVE BECOME AN IMPORTANT PART OF LIFE

Vladyslava Sobkovych

Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: neural networks, technological progress, artificial intelligence, development, technologies

Introduction. In recent decades, scientific and technological progress has developed rather quickly. It is especially worth mentioning the invention of modern complex computers and the Internet. They have enabled the further development of various programming languages and the invention of neural networks. These are the achievements we can see in various areas of modern life. Tablets, mobile phones, smart watches or data readers, as well as appliances used in smart homes, such as lighting, protection, automatic watering, without which it is difficult to imagine our life.

Objectives. The main task is to define all benefits and disadvantages of using neural networks and to notice the most usefull sphere, where it can be used.

Methods. Neural networks can be classified into many groups. However, I would like to say some of the most important. In particular, the division of neural networks into widely used and used in narrow industries. The first one includes those that can replace a person in everyday work. At the same time the second designed to perform one specific task.

Results. In my opinion, one of the greatest achievements is the invention and development of neural networks. They have filled all parts of our world. First, it is worth mentioning the use of artificial intelligence in medicine. Of course, it is difficult to replace the work of experienced workers, but it is AI that can reduce the number of errors, as well as improve the accuracy of research. In general, there are four main functions of neural networks. In particular, it is the development of drugs, diagnosis, gene editing and prescribing treatment (Dragutsan, 2020).

Another field that cannot be imagined without the use of artificial intelligence is astronomy. Quite unexpectedly, but AI allows us to calculate the time and trajectory of spacecraft, find new stars, and sometimes entire galaxies. Development in recent years has been particularly rapid. Here we can cite the example of the development of various international private companies.

I also want to talk about the use of neural networks in the automotive industry. For example, everyone knows Tesla electric cars with the ability to automatically control the car. Quite often it is the autopilot that controls much better than a human. It can anticipate events in a much shorter period of time and this greatly improves the quality of management (Protsenko, 2018).

Neural networks are used in economics. For example, thanks to AI, banks assess credit risks and possible losses for each option. In solving such problems, they use various characteristics, including: borrower's credit history, business stability, terms of use, loan amount, and sometimes the age of the user. Such technologies significantly increase the accuracy of the forecast and allow you to effectively perform all important calculations. An example is the operation of neural networks and artificial intelligence in stock markets, which is one of the fastest growing, especially in the last few decades (Burns, 2018).

Another example is the use of neural networks in a huge number of programs. In particular, these are programs for text recognition, data reading, information processing. This is quite a difficult task, because there are not only a large number of languages, but the text itself can be not only printed but also written by hand. Many parameters are important here, in particular, the size or shape of the symbol, the number of strokes or dots, the order of placement. Another problem may be the handwriting of the person. All this leads to incorrect or slow operation (Robertson, 2012, p. 84).

Conclusion. We can conclude that neural networks have become an important part of our lives. They are used in many areas and have significantly improved the accuracy and quality of work. Among the main advantages are the ability to learn independently, independence from external factors, the ability to work where there is a threat to people. However, artificial intelligence requires a lot of time and efforts. And it is important not only to be able to rapidly develop modern technologies, but also to be able to control all actions that affect the future.

<div align="center">**References:**</div>

Dragutsan, A. (n.d.). How neural networks work. Retrieved from http://apeps.kpi.ua/neural-networks/en

Ed Burns, Executive Editor (n.d.). What is a neural network? Explanation and examples. Retrieved from https://searchenterpriseai.techtarget.com/definition/neural-network

Protsenko, A. (n.d.). Application of neural networks in manuscript text recognition. Retrieved from https://conf.ztu.edu.ua/wp-content/uploads/2018/05/37.pdf

Robertson, G. (2012). Mullahs Without Mercy: Human Rights and Nuclear Weapons. Retrieved from https://www.amazon.com/Mullahs-Without-Mercy-Nuclear-Weapons/dp/1742758215

BLOCKCHAIN TECHNOLOGY
Valeriia Stopen

Faculty of Applied Mathematics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: financial transaction, security, block of chains, privacy

Introduction. Nowadays almost everyone has a bank account and likely faces a problem of a huge number of restrictions that each bank has. For example, the bank has a right to deny any transaction, the government can easily track all bank transactions and to get any client`s private information, bank account privacy is limited to how secure the bank's servers are and how well the individual user secures their own information. Therefore, an independent and secure system for financial transactions was needed.

Objectives. The main task is to create a technology to simplify the way of money transactions, that will not need the third parties or middlemen to make guarantee. The first place is to remain independent from any organizations or governments and to provide client`s full security and privacy.

Methods. In 1991 a young cryptographer Stuart Haber for the first time describes the cryptographically secured chain of blocks. His idea remains impracticable until 2008 when a programmer or a group of programmers working under the pseudonym Satoshi Nakamoto created the model for a blockchain and a year later Nakamoto brings out the first blockchain as the public register for transactions made using bitcoin. In 2013 a nineteen-year-old student Vitalii Buterin found out that it is possible to store any type of data in chain of blocks. Finally, in 2014 blockchain technology is detached from the currency and its potential is discovered (Conway, 2021).

Blockchain is a structure similar to the database. A blockchain collects data together in blocks that hold sets of data. These groups have determined storage capacities and, when they are full, they are chained onto the previous block, forming a chain of information known as the blockchain. All new data is collected to a freshly formed block and the filled new block is attached to the last block in a chain again. This process repeats on and on, creating new blocks and making the chain longer.

The important feature of a blockchain is decentralization and independence. It means that nobody owns or controls the blockchain. Nodes are presented like any electronic device and each of them contains a copy of the full chain, that is the way the network functions.

Comparing to banks, blockchain security is much more complex and modernized. To compare, if the bank's servers were hacked then the client`s account

would be as well, however, the level of blockchain security is up to the participant. Each user has its own unique key, generated using cryptography, which allows the access to transactions. Moreover, the bigger the chain, the more nodes are created and the more secure they are (IBM, 2020).

Blockchain privacy is also vital. Though it is hard to get bank client`s personal information, it is still possible, because it is stored in a server, while in the blockchain you can be as private as you wish and it will be impossible to establish who owns virtual currency at all, because blockchain will not ask you for any personal information. Furthermore, anyone can make financial transactions with blockchain, no boundaries exist.

However, some problems connected with the ethical side of the invention occurred. Blockchain lets anyone buy anything and remain totally anonymous, this means that no illegal financial operations can be tracked. This issue caused a lot of arguments, eventually, most influencers reached an agreement that criminal use of blockchain is a problem of society rather than a disadvantage of technology.

Nowadays blockchain is planned to be used in new ways. First of all, it is planned to be applied in tracking the anti-COVID vaccination, to make it clearer, and to monitor the side effects and the rise of efficiency of the vaccines. Moreover, the blockchain technologies will help distributors to monitor and fix mistakes in deliveries or pharmacologists to optimize stock management.

Results. Blockchain and cryptocurrency are the alternatives for the banks. Using blockchain finances can be sent anywhere without the need for currency exchanging and without the interference of any third parties. The security of the blockchain is the strongest and it allows private transactions with no personal information involved. Nowadays blockchain is planned to be used in other directions.

Conclusion. The demand for an anonymous banking system was huge, so blockchain technologies arrived. Cryptocurrency erases the boundary between counties and lets anyone perform financial operations without currency exchange and almost with no delay. In the blockchain the finances are totally safe from any cyberattacks and even from any civil services. Though the technology can be used for illegal operations, it is still very helpful for any stratum of the population. In the future blockchain will be used in numerous systems.

References:

Conway, L. (2021). Blockchain explained. Investopedia. Retrieved October 9, 2021, from https://www.investopedia.com/terms/b/blockchain.asp.

What is Blockchain Security? IBM. (2020). Retrieved October 9, 2021, from https://www.ibm.com/topics/blockchain-security.

ARTIFICIAL INTELLIGENCE IN 2022

Kostiantyn Storozhuk

Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: AI, trend, data, machine learning

Introduction. Artificial Intelligence and Machine Learning has recently reached the highest point of its development in the fields of technologies, business, administrative tasks, creation innovations in various spheres. According to forecasts, next year, the majority of companies around the globe will implement up to AI tools in their business processes.

Objectives. The main goal is to study the potential directions for the development of artificial intelligence in 2022, its main trends and ways to control the market using new technologies.

Methods. Nowadays companies work with large amounts of data and their extraction requires automation. Data science and analysis can be found everywhere. We have entered a new era in the generation of data science because data analysis tools have become more accessible these days (Galeon, 2017).

Data Scientist, Enterprise Architect, Machine Learning Specialist, Application Architect, and Data Engineer are some of the professions that are in high demand. Data science is used in various industries such as financial companies, manufacturing firms, insurance agencies, marketing firms, and others. Intelligent automation is used by organizations to conduct research to increase their bottom line.

The following cutting-edge technologies are commonly used in hyper-automation: Robotic Process Automation (RPA), Artificial Intelligence (AI), Machine Learning (ML), Automation of cognitive processes, Intelligent Business Process Management Software (iBPMS).

Results. The idea is to combine the right technologies to simplify, design, automate, and manage processes in an organization, instead of using script-driven tools designed for narrow use cases (Galeon, 2017). Hyper-automation allows any organization to improve the indicators of communication with customers, increase the productivity of employees (automate labor-intensive processes), and systematically integrate all processes.

Artificial intelligence and machine learning technologies are becoming an important part of information security. With the help of AI and ML, organizations are developing new methodologies to make cybersecurity more automated and risk-free. AI helps organizations strengthen their cloud migration strategy and improve the performance of big data technologies. Cybersecurity involves many data points. Thus, AI can be used in cybersecurity to cluster, classify, process and filter data.

On the other hand, ML can analyze past data and propose optimal solutions for the present and the future. Based on past data, the system will provide instructions on various patterns for detecting threats and malware. Thus, AI and ML will violate the essence of any party trying to infiltrate the system.

Augmented intelligence is about bringing machines and people together to improve cognitive performance. According to Gartner, by 2023, 40% of infrastructure and operations teams will use AI-augmented automation to improve IT productivity. In fact, digital workers' contribution will grow 50% by 2022.

Augmented intelligence helps platforms to collect all types of data, including structured and unstructured, from various sources and present it for a complete 360-degree view of customers. Financial services, healthcare, retail, and travel are good examples of sectors where the use of augmented intelligence is growing.

Traders and companies can predict stress and make quick decisions with advanced AI and ML solutions. Managing complex tasks and maintaining correctness is critical to business success, and AI and L are flawless at this. The dynamic scale of ever-growing industries further enhances the relevance of trends in artificial intelligence and machine learning (Smith, McGuire & Yang, 2006).

Artificial intelligence will have the biggest impact on business, manufacturing, user support and cybersecurity in 2022. The introduction of automation and machine learning can reduce the cost of human resources.

Conclusion. To sum up, by 2022, the volume of the artificial intelligence market may reach $ 52.5 billion. The introduction of artificial intelligence technologies will increase the global market for goods and services by $ 15.7 trillion over the next 10 years. These technologies will have a significant impact on the development of retail, energy and defense industries. Smart technologies are driving the development of robotics, cognitive, neuromorphic, quantum and large-scale computing.

References:

Galeon, D. (2017). *State Minister for Artificial Intelligence*. Retrieved from https://futurism.com/dubai-just-appointed-a-state-minister-for-artificial-intelligence

Smith, C., McGuire, B., & Yang, G. (2006). *The History of Artificial Intelligence*. Retrieved from https://courses.cs.washington.edu/courses/csep590/06au/projects/history-ai.pdf

HOW DOES CONTAINERIZATION WORK

Eugene Sukhodolsky

Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: containerization, Linux kernel, virtual machine, hypervisor, Docker

Introduction. In ever-growing projects and systems: manufacturing changes, scaling functions, adding new features is challenging, as is finding and fixing bugs. Fortunately, a container technology has developed over time to help relieve many of these problems, as well as avoid unstructured growth.

Objectives. The aim of this work is to describe what is containerization in a nutshell and how does it work (Shaan, 2019).

Methods. The primary item of the container architecture is what is titled Docker. Docker is an open source Linux core that is constrained to create containers on the operating system. On the master branch, we propose virtual regulable servers with

Kernel-based Virtual machine virtualization that cooperate with docker containerization. By accessing a one operating system core Docker can operate aggregate apportioned applications that run in their own container. In additional, containerization is supported on a container enforced in a unity essential workload. Containers are tempered from Docker images. Although images are read-only, docker combines a read-write filesystem with an image-only filesystem to construct a container. When the container is created, Docker starts a web interface that transmits between the package and the localhost. It so joins an IP address to the created container and runs the fixed treat to accomplish the application allotted to it. When containerization is implemented, each container has each the requirement sections to run the program. As stated earlier, packages shouldn't have an OS over-the-counter than a virtual machine. This characteristic builds them quicker and easier as they exhaust less server or cloud resources (Cormack, 2021).

Results. Containerization has allowed virtualization for optimization above VM by reduction the quantity of exchequer and implementation time. In addition, partnerships save capital considering they do not call for aggregate types of OS with duplicate licenses. The identical as with virtual machines. The containers are lightweight and not overloaded. With this capability, containers are used to exfoliation programs transversely groups of systems that scale up or down services in response to peaks in demand. One of the finest tools for scaling in containers is Google's Kubernetes. Kubernetes admit you to automatically control the loading of containers, their interplay and implementation (Poulton, 2020).

Conclusion. Containerization is an extensive tendency in software development and its spread out diffuse is probably to burst in both size and speed. Colossal participants like Google and IBM are gambling intemperately on containerization. In addition, an immense startup ecosystem is being shaped that allows containerization to be implemented. Proponents of containerization believe that it allows developers to build and deploy applications quicker and more securely than traditional methods. Although containerization is high-priced, it is expected to decrease significantly as containerization environments evolve and evolve. Thus, containerization will definitely become the new standard in software development.

References:

Cormack, J. (2021). Use containers to build, share and run your applications. Retrieved from https://www.docker.com/resources/what-container

Poulton, N. (2020). Docker deep dive: zero to docker in a single book. Retrieved from https://dokumen.pub/docker-deep-dive-zero-to-docker-in-a-single-book-may-2020nbsped.html

Shaan, R. (2019). What is containerization? Retrieved from https://hackernoon.com/what-is-containerization-83ae53a709a6

COMPARING DOM MANIPULATION TECHNIQUES
IN THE LEADING JAVASCRIPT FRONT-END FRAMEWORKS

Kateryna Tarelkina
Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: JavaScript, DOM, Angular, Vue, React

Introduction. In early years, websites were usually just static HTML pages and provided almost no interaction with the user. JavaScript, the most popular programming language for front-end, has allowed adding some dynamicity to the page.

Websites have become increasingly popular. Nowadays, they can be huge applications with complex logic and many dynamic components, and JavaScript alone does not satisfy developers' needs anymore. This is why the web frameworks were created. They are built on top of JavaScript and provide powerful instruments to create complex yet maintainable and scalable web applications (Levlin, 2020).

One of the main issues when building front-end applications is interacting with Document Object Model. Developers are very interested in making this communication as efficient as possible, as it can hugely impact a website performance (Grov, 2015, p.15). As a result, there is a strong need for an efficient algorithm. And this is one of the most important problems frameworks take responsibility for.

Objectives. The main task is to compare different techniques, which leading JavaScript frontend frameworks use to make interacting with DOM as efficient as possible. The purpose of such algorithms is to create a web application, which works fast on any device, from a highly efficient desktop computer to a simple smartphone, optimizes memory usage and therefore provides a solid user experience. The first place is user satisfaction from interacting with an application.

Methods. Both React and Vue use a so-called virtual DOM. The virtual DOM is a lightweight abstraction of the real DOM (Tung, 2018, p. 21). This JavaScript DOM representation proves to be very efficient (Grov, 2015, p.28). When updates should be made, two virtual DOM representations are compared: before-tree and after-tree. After that, a special algorithm calculates the minimal difference between them. Initially, such an algorithm has complexity of $O(n\^3)$ (where n is a number of nodes in a tree), which is rather slow and therefore needs improvement. For this, React uses a heuristic algorithm. To make it work, two main points are taken into consideration. The first one is the assumption that tree nodes of different types produce different subtrees. The second is about the *key* property of components. By giving an element a unique key, a developer can help React to determine whether the element needs to be updated (Facebook Inc., n.d.).

Vue implements virtual DOM, too. The difference is that Vue creates a so-called virtual Node (VNode) for every component, and the virtual DOM consists of these VNodes (Levlin, 2020).

Angular uses a completely different approach, called Incremental DOM. It does not build the whole representation of a real DOM and compute differences using a real DOM directly. In Angular, each component is compiled into a set of instructions, which

are then used to create a DOM tree and make updates to it. So, Angular does not need to create a DOM representation on each rerender. Moreover, since components are compiled into instructions, this approach allows Angular to do tree-shaking, which is the process of removing unnecessary code (Dulanga, 2020; Savkin, 2020).

Results. DOM, or Document Object Model, is a tree representation of an HTML document, in which each element is a tree node connected with others. DOM provides an API to create, modify and delete elements.

It is a very important task to keep a UI and data in synchronisation and to quickly and properly react to user's actions. When an application grows, DOM can contain hundreds of elements, and interacting with it becomes more and more costly in terms of speed.

Frameworks solve this problem by changing only parts of DOM and doing it in a sensible manner.

React and Vue use virtual DOM, which is a representation of a real DOM tree, and then apply a special algorithm to calculate the minimum number of changes needed to update the real DOM. Angular, on the other hand, uses Incremental DOM, which communicates with a real DOM directly. Since Angular does not need to keep a DOM representation in memory, it has more optimized memory usage. This fact is especially important for devices with lower capacity, such as phones. However, Angular's approach is more time-consuming, while a virtual DOM is considered to be faster.

Conclusion. To sum up, JavaScript frontend frameworks significantly simplify creating, teasing and maintaining web applications. Nowadays, the most popular are React, Vue and Angular. One of the most important tasks they solve is taking care of communication with the DOM, which is needed to keep a UI and data in synchronization. The virtual DOM approach is adopted by React and Vue, while Angular uses Incremental DOM. Virtual DOM proves to be faster than Incremental DOM, while Incremental DOM optimizes memory usage.

References:

Dulanga, C. (2020). *Incremental vs Virtual DOM*. Retrieved from https://blog.bitsrc.io/incremental-vs-virtual-dom-eb7157e43dca

Facebook Inc. (n.d.). *Reconciliation.* Retrieved from https://reactjs.org/docs/reconciliation.html

Grov, M. (2015). *Building User Interfaces Using Virtual DOM*. Oslo, Norway: University of Oslo. Retrieved from https://www.duo.uio.no/bitstream/handle/10852/45209/mymaster.pdf?sequence=7&isAllowed=y

Levlin, M. (2020). *DOM benchmark comparison of the front-end JavaScript frameworks React, Angular, Vue, and Svelte*. Turku, Finland: Åbo Akademi University. Retrieved from https://www.doria.fi/bitstream/handle/10024/177433/levlin_mattias.pdf?sequence=2&isAllowed=y

Savkin, V. (2020). *Understanding Angular Ivy: Incremental DOM and Virtual DOM*. Retrieved from https://blog.nrwl.io/understanding-angular-ivy-incremental-dom-and-virtual-dom-243be844bf36

Tung, K. (2018). *Developing a frontend application using ReactJS and Redux*. Espoo, Finland: Laurea University of Applied Sciences. Retrieved from https://www.theseus.fi/bitstream/handle/10024/150837/Tung_Khuat_1301747_Thesis.pdf;jsessionid=01F77375184536D38FB7DD4FC16AFD8B?sequence=1

HETEROGENEOUS GRAPHS FOR PRODUCT EMBEDDINGS

Oleksii Tsepa
Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: heterogeneous graphs, machine learning, retail

Introduction. Nowadays, retail is growing rapidly, and especially with the onset of covid, it is moving online and being digitalized. Retailers are increasingly using technologies such as price optimization – a method that automatically finds the optimal price for your product based on historical data, external factors, competitors' prices, etc., product basket analysis – analysis of the position of products in the market over time. And all because at some point machine learning algorithms work much faster, and sometimes more accurately than people because there is always a human factor, which machines are deprived of. In this article, we will talk about product basket analysis.

Objectives. The main task is to understand the position of the product on the market and its competitors.

Methods. Our main source of data is checks and transactions. From them, we can get the following information: when a person made a purchase, what product he bought, at what prices, and in what quantity. We can represent this data in the form of a knowledge graph, where the vertices will be our products, and the edges show that a person bought two products together in one check (Fanglin, 2020).

As characteristics to the vertices of the graph, you can add: the number of products sold over the last month, the average price of the product, the average discount, it is also practiced to use the representation of the name of the product as a vector of numbers through modern language models (Hamilton, 2017).

For the edges between the vertices, we can also add characteristics: the ratio of prices between two products, vector proximity between their names, consistency in receipts (Biswas, 2017).

We also know a brand for all products, which will be convenient for us to use in the form of another type of node, which we will connect with the products of this brand. Having more than one type of node and edges will give us the concept of graph heterogeneity (Kumar, 2020).

Having the above dataset, we can use modern graph neural networks and predict the presence of different pairs of products in one check. And from one of the last layers of the neural network, get the vector representation of the product.

Results. Our research has shown that the above method of obtaining vector representations of products works for the following reasons: visual analysis – you can see that products from the same categories often lie close to each other, which indicates

that they are competitors to each other, although they do not buy together; using our embeddings, we predicted the product category that the seller gave in advance, and came to a fairly high accuracy, which means that our final vectors are quite meaningful and can divide products into categories, although they did not have such information in the training data.

Conclusion. As a result, we understand that in such an area as retail, advanced methods in the form of heterogeneous graphs, which were previously used in biology / social networks, can be used and benefit the business in the form of insights that are directly converted into money.

References:

Biswas, A., Bhutani, M., Sanyal, S. (2017). MRNet-Product2Vec: A Multi-task Recurrent Neural Network for Product Embeddings. Retrieved from https://www.amazon.science/

Chen, F., Proserpio, D., & Troncoso, I. (2020). Product2Vec: Understanding Product-Level Competition Using Representation Learning. Retrieved from https://papers.ssrn.com/

Hamilton, W.L., Ying, R., & Leskovec, J. (2017). Inductive Representation Learning on Large Graphs. Retrieved from https://arxiv.org/

Kumar, M., Eckles, D., & Aral, S. (2020). Scalable bundling via dense product embeddings. Retrieved from https://www.researchgate.net/

MACHINE LEARNING ALGORITHMS FOR NATURAL LANGUAGE PROCESSING

Julia Tsymbal

Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Natural language processing, computer science, artificial intelligence, and linguistics

Introduction. Natural language processing is an area at the intersection of computer science, artificial intelligence, and linguistics. The goal is to process and "understand" natural language to translate text and answer questions. With the development of voice interfaces and chatbots, NLP has become one of the most important artificial intelligence technologies. However, fully understanding and reproducing the meaning of language is an extremely difficult task, since human language has its characteristics. Human language is a specially designed system for conveying the meaning of what is said or written. This is not just an exogenous signal, but also a deliberate transmission of information. In addition, the language is coded so that even young children can learn it quickly. Human language is a discrete, symbolic, or categorical signaling system with reliability. The categorical symbols of the language are encoded as signals for communication over several channels: sound, gestures, writing, images, and so on. At the same time, the language can express itself in any way (Lane, Howard, Hapke, 2019).

Objectives. The main goal of the research is to make an overview issue to find out what the problems of natural language processing are and what machine learning methods are used nowadays.

Methods. Natural language processing technologies have made great strides forward today, and much of the credit for this belongs to machine learning, which is used, in particular, to understand texts. Natural language processing includes speech recognition and generation, classification, knowledge extraction from texts, and other actions aimed at understanding texts in order to fill knowledge bases, form answers to questions and conduct a dialogue. Previously, the problem of parsing accuracy, which is the percentage of correctly formed grammatical links, and the likelihood that a long sentence will be parsed correctly was very acute. At the same time, thanks to new algorithms and approaches, including deep learning, the speed of parsing have increased. In addition, almost all leading algorithms and models have become available to a wide range of researchers, and perhaps the most famous work in the field of deep learning for NLP (Natural Language Processing) is Thomas Mikolov's algorithm (Mikolov, 2013). Today, researchers working with natural language have many tools for creating intelligent systems, which can be roughly divided into three classes: methods for working with individual words, methods for working with sentences, and methods for processing arbitrary texts from several sentences (Velikhov, 2016). A significant part of NLP technology is powered by deep learning. A field of machine learning that only began to gain traction at the beginning of this decade for the following reasons. Firstly, large amounts of training data have been accumulated. Secondly, computing capacities developed: multi-core CPU and GPU; new models and algorithms have been created with enhanced capabilities and improved performance, with flexible training on intermediate representations; learning methods using context, new methods of regularization and optimization have appeared. Most machine learning methods work well because of human-developed representations of data and input features, and optimization of weights to make the final prediction better. In deep learning, an algorithm tries to automatically extract the best features or representations from raw inputs. Handcrafted features are often overly specialized, incomplete, and time-consuming to create and validate. In contrast, the features identified by deep learning are easily adaptable. Deep Learning offers a flexible, versatile, and learnable framework for representing the world in both visual and linguistic terms. Initially, this led to breakthroughs in the areas of speech recognition and computer vision. These models are often trained using one common algorithm and do not require the traditional construction of features for a specific task (Vajjala, Majumder, Gupta, Surana, 2020).

Conclusion. Thanks to new methods of deep learning, today it is possible to obtain high-quality semantic representations for words, phrases, and sentences, even without training samples. Less and less effort is now required to create your own semantic dictionaries and knowledge bases, so it has become easier to develop automatic word processing systems. However, we are still very far from an adequate solution to the problem of understanding interrelated events presented in the form of a sequence of sentences or images, as well as dialogues. All methods are known today

work successfully either in solving problems of "superficial" understanding of the language or with a significant limitation of the subject area.

References:

Lane, H., Howard, C., Hapke, H. Foreword by Dr. Arwen Griffioen (2019). *Natural Language Processing in Action* (1st ed.), 544.

Mikolov, T. et. al. (n.d.). Efficient Estimation of Word Representations in Vector Space. Retrieved September 24, 2021, from http://arxiv.org/pdf/1301.3781.pdf

Vajjala, S., Majumder, B., Gupta, A., Harshit S. (2020). *Practical Natural Language Processing, 456*. Retrieved September 24, 2021, from https://pdf2read.com/?book=1492054054

Velikhov, P. (2016). Machine learning for natural language understanding. Retrieved September 24, 2021, from https://www.osp.ru/os/2016/01/13048649

MODERN INFORMATION TECHNOLOGIES IN EDUCATION SYSTEM

Kateryna Vandysh
Faculty of Biomedical Engineering, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: education, modern technologies, Information and communications technology

Objective. To cover the use of modern information technologies as widely as possible, in particular in the educational process.

Methods. Used in the work theoretical methods: analysis, generalization of scientific and scientific-methodical sources on the problem research, analysis of existing concepts, works of domestic and foreign researchers, experts in the field of open science, knowledge society. The analysis of use of information technologies in education is carried out. It is shown that modern information technologies open students access to non-traditional sources of information, increase work efficiency.

Results. In general, the rapid development of science and technology puts the education system in need of new teaching aids, modern IT technologies. Computer today – the most powerful tool for obtaining information, the capabilities of computer technology, their speed is very surprising in a positive sense. Therefore, it will be quite natural to introduce modern technologies into the educational process (Training, 2021).

The transformation of science, in turn, is aimed at its development on the principles of openness, combination with European and world standards of scientific activity, integration into the European innovation space. It is clear that with the rapid development of information technology role and use in education. Of course, the introduction of new learning technologies and their perfect mastery require a certain readiness of both teachers and students of the educational process (Spivakovsky, 2016).

The use of modern information technologies makes it possible to reveal the great potential of natural and historical sciences associated with the formation of worldview, consciousness in particular. One of the modern ways to optimize the improvement of the educational process is the use of modern information technology and the use of computer technology, because the world is developing rapidly, and we need to develop

in this direction, because we still strive for European educational standards. That is with the introduction of modern information technology (Buleyko, 2021).

The use of information technology related to the Internet in education allows to implement the principle of lifelong learning, you can have access to any resources, at any age, get an education regardless of age, go from the usual and well-known memorization of material, which over time is completely forgotten to the activity and competent approach — training professionals capable in today's world to solve existing problems in certain conditions, for example, the current situation with Covid-19 (Training, 2021).

Information and communication technologies have great opportunities for personal development, the disclosure of its potential, so at the present stage a significant role is played by distance learning forms and technologies. Today, without the widespread use of distance learning, educational institutions cannot compete in the market of educational services and provide training at the current level, as in the European Union, and so far there is such an unpredictable situation with Covid-19 that education is gradually moving to distance learning, so knowledge of information and communication technologies is currently very important and necessary. In a number of years, our education will have a better, higher level, through distance learning. Now the stage is such that teachers have to adapt to the use of information technology, and probably in a few years, there will be very interesting platforms, sites, innovations, where distance learning will not be a problem for everyone (Yesina, 2015).

Conclusions. For the development of the modern world, introduce, so that our education is constantly developing and kept at a high level among European countries. Our education is becoming one of the main sources – the most important resources of human knowledge, and the main accelerator of its development is informatization. Therefore, the application of modern information technologies of education, as an integral part of the general informatization of society, should solve the problem of preparing the modern generation for its productive activities in the information society (Spivakovsky, 2016).

References:

Buleyko O. I., & Karlova O.M. (n.d.). Modern information technologies in the organization of educational process in colleges and technical schools. Retrieved from https://journals.indexcopernicus.com/api/file/viewByFileId/907444.pdf

Spivakovsky, A., Vinnyk, M., Tarasich, Yu., Poltoratskiy, M. (2016). Design and Development of Information System of Scientific Activity Indicators. Retrieved from https://fmo-journal.fizmatsspu.sumy.ua/journals/2020-v4-26/2020_4-26-Nosenko-Sukhikh_FMO.pdf

Training fund. Informatization of the education system. Informatization of the education system. Introduction to information technology. Introduction to information technology. Retrieved from https://slonimsmc.grodno.by/infotex/p8aa1.html

Yesina OG, Lyubovich AA, (n.d.). Odessa National Economic University. Modern information technologies in education. Retrieved from https://core.ac.uk/download/pdf/147039123.pdf

DISPLAY OF TRACKS IN GPX FORMAT ON MAPS OF OPEN SERVISES

Serhii Vlasiuk

Faculty of Applied Mathematics, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: GPX, Yandex.Maps, Bresenham Algorithm

Introduction. An important place in science is occupied by the processing of video footage obtained from unmanned aerial vehicles. A wide range of tasks related to automatic image processing and linking them to maps in different projections. It is of interest to display on the map the trajectory of the vehicle as intermediate results. Both a UAV and a car can act as it. Similar results were reported in Yurchuk, Piskunov, & Prystavka (2018).

The earth and any other celestial body has an extremely complex surface shape. It is almost impossible to determine the position of objects, distances between them or directions, if these objects are located at considerable distances. Therefore, in geodesy and cartography to solve practical problems, the Earth is described using simplified mathematical models. The real surface of the Earth is replaced by the mathematical surface of the Earth, any point of which has a clear definition through a set of equations (Mukola, 1998).

Objectives. Develop software in the C # programming language to display tracks in GPX format on search and information serviceYandex.Maps by Yandex resources. Consider ways and methods of displaying coordinates on a plane. Submit route data in the form of a table.

Methods. Yandex.Maps allows you to draw a polyline from vertices that do not exceed 100, which means that if there are more vertices, we need to select 100 significant ones (Yurchuk, Piskunov, & Prystavka, 2018).

To increase the speed, it is desirable to reduce the number of displayed points while maintaining the overall appearance of the track depending on the scale. Bresenham's algorithm was chosen for such optimization.

Brezenham's algorithm is an algorithm that determines which points of a two-dimensional raster need to be shortened to get a close approximation of straight lines between two given points. General equation of the line:

NaviTel 7.5.0.1342 navigator was used to obtain test data of GPS tracks in .gpx format (Yurchuk, Piskunov, & Prystavka, 2018).

GPX (GPS eXchange Format) is a text format for storing and exchanging GPS data based on XML (Mukola, 1998).

Results. In today's world there is a significant advantage of automation, and this is noticeable in all areas of human activity. In this regardis the need to create new or upgraded software systems that provide computer processing and analysis of cartographic information. Visualization of data, models and processes with the help of developed computer tools, specialized tools for processing and analysis of geographical data.

Conclusion. Software was developed to display tracks in GPX format on open service maps. Testing of the developed software on the real GPS data representing a track received from the GPS device is carried out and described. Implemented data output table that provides information about longitude, latitude, altitude, time, horizontal geometric factor and the number of satellites.

The prospect of further development is the development of technical requirements for information systems for modeling the behavior of moving objects and changes in the environment taking into account the weather, generating a photo plan, the user can download and demonstrate for him a description of objects in given coordinates and process video -materials from the registrar.

References:
Mukola, B. L. (1998). *Mathematical cartography*. Moscow, Russian: Zlatoust.

Yurchuk, I., Piskunov, O., & Prystavka, P. (2018). *Information Technology of the Aerial Photo Materials Spatial Overlay on the Raster Maps*. Kiev, Ukraine: Author.

DIGITALIZATION IN UKRAINE: EXPECTATIONS AND REALITY
Olena Vytoshko
Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: digitalization, Diia, e-passport, Paperless regime

Introduction. From August 23 the e-passports of Diia are equated to plastic and paper. "We are the first country with such experience and have made a real breakthrough at the world level" said Minister of Digital Transformation Mikhail Fedorov. The e-passport Act was the first step towards the Paperless regime. Work has been going on since last year to equate Diya digital passports with physical ones (Dev.ua, 2021). The Ukrainian delegation led by President Volodymyr Zelensky, including representatives of the Ministry of Digital Transformation met with the CEO of Apple Inc. Tim Cook in early September. When the Deputy Minister of Digital Transformation Oleksandr Bornyakov was addressing representatives of the Ukrainian IT industry at Peremoga.Space, he literally conveyed Cook's remarks on Ukraine's digital progress. "This is impressive," said Tim Cook (Dev.ua, 2021).

So, why have I written such the long first paragraph about this very difficult path of implementation e-passports in Ukraine? Because, I would like to show you, that such changes are super complicated to implement, but they are worth it.

Objectives. To justify the urgency of the need to take a course on digitalization in whole world. To tell about the changes that are planned in the near future in Ukraine and what to expect from them as well.

Methods. Once I have read an article were there were approximate statistics about an amount of time people spend on sleeping, eating, working, waiting in traffic jams, etc. There was also a point about standing in queues. How much time do we spend in queues to get a document to get another document which helps us to get another document? Rhetorical question. This way with many intermediaries of getting any documents is a very fertile ground for corruption.

There is population happiness rating where corruption is one of criteria. Corruption is a large problem not only for Ukraine. It's global. That's why there are anti-corruption laws around the world. Digitalization and Paperless regime solve this problem. So, digital progress can literally make people happier.

The next step that is planned in Ukraine is identification of consumers of mobile connection. It will be possible to purchase SIM cards only with a passport. This law will be in force on January 1, 2022. It is proposed to give the transition period to subscribers for identification until January 1, 2025, until then they can use the connection. Prerequisites for this are more and more cases of refilling – transferring calls through telecommunications gateways and SIM cards to minimize communication costs. And it is almost impossible to find out the identity of the owner of the SIM card without identification, because 85% of mobile connection users in Ukraine use it anonymously (Official website of Ukraine, administered by the Ministry of Foreign Affairs of Ukraine and Ukrainian Institute, n.d.). So, this step helps doing businesses in sphere of communications. These companies are large taxpayers in our country.

Results. Nowadays in Ukraine we have really great results: except e-passport, there is also an opportunity to use e-student ID, e-taxpayer card, e-driver's license (you can even refresh it in application Diia when expiry date comes) and another documents less commonly used. And it is just the beginning.

Conclusion. In this short article I have justified our need of digitalization, showed results of Ukraine and on its example main benefits of this process were noted.

<div align="center">**References:**</div>

Dev.ua (2021, August 23). *E-passport Diia is equated to plastic and paper.* Retrieved from https://dev.ua/news/tsyfrovi-pasporty-diia-pryrivnialy-do-paperovykh?utm_source=Tg&utm_medium=msg&utm_campaign=News_dev_ua_channel&utm_content=diia

Dev.ua (2021, September 13). *«This is impressive». How did CEO of Apple Inc. Tim Cook react on digital achievements of Ukraine.* Retrieved from https://dev.ua/news/tim-apple

Official website of Ukraine, administered by the Ministry of Foreign Affairs of Ukraine and Ukrainian Institute (n.d.) *Digital country.* Retrieved from https://ukraine.ua/invest-trade/digitalization/

<div align="center">

ARTIFICIAL INTELLIGENCE TO FORESEE SELF-HARMING
Andrii Yakovyna

</div>

<div align="center">
Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"
</div>

Key words: artificial intelligence, machine learning, health

Introduction. Teenagers have always been inclined to live a destructive way of life, and in most cases the damage is being caused to themselves (Castellví, 2017). Scientists state that a tendency to many mental problems, e.g., self-harming, can be spotted in early childhood by using an artificial intelligence (AI).

Objectives. The main task is to conduct a research for using AI for detecting mental problems at early ages. The article will go about feature engineering techniques in algorithms which presumes basic knowledge of machine learning methodologies.

Methods. Firstly, let's refresh in memory how does the AI can decide whether adolescents have higher risk of self-harming or not. Basically, it is a clustering algorithm trained on big amount data to make predictions with some certainty. In this particular case the data included different whole life emotional and behavioural characteristics of almost 11000 individuals. Feature selection analyses let the scientists notice concurrent correlates of self-harming behaviour.

Results. The method helped to identify 2 distinct groups of young people having significant risk factors of self-harming. Notably, both groups could be predicted by the method almost 10 years before the first case of self-harming happened. One of the groups reported a long history of mental health, sleep problems and low self-esteem. As for the other group, it was much harder to predict self-harming in their childhood. The key points were showing less consistency in their life choices (more impulsiveness) and poor relationships with their friends and family (Lockwood, 2017). The difference in accuracy (and hardness) of predicting risk of self-harming in both groups can be explained by different value of data the group obtained. Thus, such parameters as "mental health problems" are much more "significant" in making positive predictions than "impulsiveness" (Stanford, 2017). Nevertheless, even less significant parameters showed that some "adolescent risky behaviour" may lead to surprising consequences.

Conclusion. The research showed that AI does have the ability to identify people's mental problems at early age, thus machine learning techniques may significantly influence our lives in better way and health area is only one of the hundreds of places to apply the AI. I believe that humanity follows the right path in artificial intelligence development and it will become better and better.

References:

Patel, H. (2021). *What is Feature Engineering for Machine Learning.* Retrieved from https://towardsdatascience.com/what-is-feature-engineering-importance-tools-and-techniques-for-machine-learning-2080b0269f10

Stepheni, Uh, Mphil, Edwin, S. Dalmaijer, DPhil, Roma Siugzdaite, Tamsin J. Ford, Duncan E. AStle (2021). *Two Pathways to Self-Harm in Adolescence.* Retrieved from https://www.sciencedirect.com/science/article/pii/S0890856721002197?via%3Dihub

USE OF INFORMATION TECHNOLOGIES IN ARMED STRAGGLE

Vadym Yaroshchuk

Educational and Research Institute of Special Communications and Information Security, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: informatization, information technology, automated control systems

Introduction. The revolution in communications and informatization has prepared a change in the human worldview. Thanks to this, there is a rapid development

of military affairs. New types appear weapons based on the use of Information Technologies that allow you to conduct non-contact combat operations actions. Intelligence tools, automated control systems for troops and weapons are being developed (Abdeev, 1992).

Objectives. The main task is to study the growing dynamism of military operations, the formation of new concepts for introducing operations and new concepts for conducting operations using information technologies.

Methods. Progress in the means of conducting armed struggle and management systems of all levels, causes a high level of dynamism, intensity and destructive force of military operations. At the same time, the combat situation will be characterized by transience and sudden changes. As a result, intelligent decision support systems become an integral part of the special mathematical and software support of military systems. The widespread introduction of it in armed struggle has an impact on military affairs in the following directions:

1. *The emergence of promising types of weapons.* We are talking about the principles of creating new types of weapons. The principles are implemented through the functional integration of intelligence, control and strike components into a single complex

2. *New concepts for conducting operations with the use of Information Technologies.* Military specialists in the developed countries of the world are working hard to develop and implement new concepts of conducting operations. The introduction of it allows you to significantly expand the possibilities for developing such concepts.

3. *Formation of new concepts of conducting operations.* The introduction of it allows to implement new concepts for conducting operations. From the point of view in terms of the use of force they can be classified as concepts with the use of "hard Force" and concepts with the use of "soft force". Concepts with the use of "hard Force" provide for the use of it as a means of justifying and ensuring the actions of troops in the performance of certain tasks. Concepts with the use of "soft power", in contrast to preliminary, provide for the use of it as a weapon.

Results. An example of creating a new type of weapon of a temporary specific type of guided weapon is the integration into one system of satellite reconnaissance components, information processing and control components, the striking component – the Patriot air defense system to combat the Scud OTR in the coalition operation in the Persian Gulf in 1991 (Azov, 2003).

Among the concepts based on the use of "hard force", the most revealing are the so-called "network-centric concept of conducting combat operations", developed by American specialists and the concept of "Integrated Combat space", proposed by military specialists of Great Britain. The "network-centric concept of combat operations" combined with the use of high-precision weapons, first used by the Americans and their allies in the last operation in Iraq, actually made a real revolution in military affairs, absorbing all the achievements of military art and combat experience of past wars. Another feature of this concept is that American officers no longer draw maps or transmit combat messages on the radio. In the last Iraq war, they first used the

new distributed Combat Control Information System FBCB (Force XXI Battle Command Brigade or Below), covering the Brigade, battalion, and company level.

Conclusion. Thus, the latest information technologies today are turning from a factor of ensuring managerial efficiency into a system-forming factor of modern armed struggle. Thanks to their use, the number of initiatives for resolving and conducting armed conflicts with detailed planning and forecasting of their consequences in all sectors (political, economic, military, etc.) is significantly distributed. They allow us to achieve a qualitatively new stage in the development of the art of war – the transition from managing troops during armed conflict to managing the conflict as a whole.

References:

Abdeev, R. F. (1994.) Philosophy of information civilization. VLADOS.

Azov, V. (2003). The concept of creating a unified information management structure of the US Armed Forces. ZVO, 3–10.

USAGE OF TERNARY NUMERAL SYSTEM IN COMPUTER SCIENCE

Serhii Yarovyi

Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: Ternary, numeral systems, alternative computer architecture

Introduction. Ternary numeral system, colloquially known as base 3, is one of several less-used bases nowadays, completely outshined in popularity by binary system and its offshoots, while also not being as theoretically useful as heximal (base 6) or duodecimal (base 12) numeral systems. However, despite its flaws, ternary was actively discussed and even used during the juvenile years of computer science.

Objectives. To investigate notable stages of development of ternary computational systems

Methods. I used a combination of both printed and virtual sources to receive a fuller picture on the history of the ternary computation. By using a multitude of sources of different origins we can examine them independently and avoid copying any inlayed bias, whether ideological, geographical or chronological.

Results. In literature word "ternary" might mean two separate entities: ternary positional system, where every digit can contain only non-negative numbers and balanced ternary system, which is a deviation from the standard positional numerals, as it's digits can contain negative numbers. Thus, balanced ternary is the smallest positional numeral system for integers. First mention of the balanced ternary is Michael Stifel's tractate *Arithmetica Integra*, which was published in 1544 (Stifel, 1544, p. 38).

Yet another form of practical application of the ternary system is BCT (binary-coded ternary) which is mostly analogous to BCD (binary-coded decimal), and is used as a bridge between ternary and binary systems, utilizing two bits per trite conversion as follows:

BCT	00	01	10
Balanced	-1	0	1
Unbalanced	0	1	2

Propositions on usage of ternary in computer science were often based on two ideas – knowledge, that ternary is the counting system with the best radix economy (amount of digits needed to express a number in it, multiplied by the base). Radix economy can be approximated as $\frac{b}{\ln(b)}$ which is the best for b=3. Second benefit is an ability to more effectively map analog input into digital output. In computer science, a ternary digit is called trit(trinary digit), which holds $\log_2 3 \approx 1.58496$ bits of information. In practical usage, such as Setun and QTC-1 computers, on which I will elaborate later, trits were grouped into groups of six, called trytes (singular is tryte), which held roughly 9.5 bytes each.

Usage of ternary systems in computation tech started before the invention of the modern computer, as first machine using balanced ternary was built by Thomas Fowler in 1840 (Glusker, Hogan & Vass, 2005, p. 27).

Unfortunately, following century had a lull in usage of ternary machines, as the next instance appeared only in 1958, with the creation of Setun, the first electronic ternary machine at the Moscow State University, USSR, by Sergei Sobolev and Nikolay Brusentsov. It featured operating memory of 81 words, each word composed of 3 trytes (18 trits), with additional 1844 3-tryte words on a magnetic drum (which roughly equates 7 KB). Serial production began in 1959, and 50 machines were completed before production was ceased in 1965, in favor of new, binary models. Despite its limited use, Setun performed on par with its binary contemporaries, while being over two times as cheap and using less electricity overall (Brusentsov & Jose, 2007).

After five years of research, newer model, called Setun-70 came into production, with a new architecture principle, similar to RISC philosophy. It was using unique DSSP (Dialogue System of Structured Programming) programming language, similar in its ideas and syntax to the Forth programming language, designed by Charles H. "Chuck" Moore in 1970. Unfortunately, only one experimental prototype was built, and as machine was deemed impractical for mass production, it was converted to binary architecture, which marked the end of soviet ternary computing branch.

On the opposite side of the Iron Curtain, TERNAC – an emulator of ternary computer for the binary Burroughs B1700 machine was created in 1973. It used FORTRAN, allowed for both fixed-point and floating-point operations, and used 24-trit fixed-point words and 48-trit floating-point words, with a 42-trit mantissa. This was mostly an experiment in feasibility of emulating a nonbinary structure on a binary computer, which was largely successful but, unfortunately, never led to any continuation (Epstein, Frieder & Rine, 1974).

Similarly, experimental QTC-1 ternary CMOS, developed in Canada in 1988, never went any further than obscure scientific papers and a couple of early prototypes (Cho & Mouftah, 1988).

Conclusion. While present of ternary computation seems pretty grim, future may hold a turn for better, as potential of ternary computation in optical and especially

in quantum computers. Qutrits (quantum trits, analogous to qubits – quantum bits) can be in superposition in three mutually orthogonal states, which meants that logic gates, which operate on n qutrits are $3^n * 3^n$ unitary matrices, as opposed to $2^n * 2^n$ unitary matrices of qubit logic gates.

Reference:

Brusentsov, N. P., & Alvarez J. R. (2007). Troichnye JeVM "Setun" i "Setun' 70" [Ternary computers "Setun" and "Setun' 70"]. *Russian Virtual Computer Museum.* Google translation. Retrieved September 18, 2021 from https://www.computer-museum.ru/histussr/setun_b.htm

Cho, Y. H., & Mouftah, H. T. (1988). A CMOS ternary ROM chip (PDF). Proceedings. The Eighteenth International Symposium on Multiple-Valued Logic. IEEE. doi:10.1109/ISMVL.1988.5195.

Epstein, G., Frieder, G., & Rine, D. C. (1974). The development of multiple-valued logic as related to computer science. Computer. IEEE. 7 (9): 20–32. doi:10.1109/MC.1974.6323304. eISSN 1558-0814. ISSN 0018-9162.

Glusker, M., Hogan, D. M., & Vass, P. (July–September 2005). The Ternary Calculating Machine of Thomas Fowler. IEEE Annals of the History of Computing. 27 (3): 4–22. doi:10.1109/mahc.2005.49.

Stifel, M. (1544). Arithmetica integra [Integral Arithmetic], p. 38.

THE ERA OF BIG DATA

Yana Yatsko

Educational and Research Institute for Applied System Analysis, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Key words: big data, machine learning, artificial intelligence, data mining, technologies, data usage

Introduction. To start with, I would like to notice that everyone has heard concerning "Big data", however a lot of people can`t determine this concept properly. So "Big data" is a set of instruments for processing structured or formless data in aim to implement it for certain tasks and aids. Speaking about the creator of the definition "Big data", Clifford Lynch, he was a great Nature's editor. He noticed a graduate growth of data in his work in 2008. Another "plain" definition of "Big data" defined by Uchetechs (2018): "social-economic occurrence, that is associated with the state telling about new technological capabilities have appeared to analyze a impressive stores of data".

Objectives. In order to cooperate with "Big data" personage should deal with math, physics and numerous IT-disciplines. Professor McKinsey defines "Big data" by such analysis techniques as data mining, machine learning, artificial neural networks, predictive analytics, statistical analysis and so on… By the way, HIBS (2019) argued that "Meta Group offered their own characteristics of "Big Data" – "Three V": Volume, Velocity, Variety". These are the main characteristics of data.

Methods. So, where did all this data come from? Let's consider all our transactions which we make during a typical day on our smartphones or PCs – we use

a small bit of data in comparison with the whole volume of it, that it can be compared with sand in the sea. When you buy ticket at the railway station, food at the shop or visit a nearby cafe, your purchases are recorded. All that recorded information is written in companies` databases. Manufacturers want to find out what you like to buy and how to sell you more. They are looking through big tables of data and look for the most frequently used ones. Then they give these details to specialists, called data analytics or data scientists, to process the data and extract useful trends and strategies from all this infinite mass.

Results. Why this concept is very important in our modern society? The answer is very simple. According to statistics, data usage from 2003 to 2015 increased from 5 exabytes of data (1 DL = 1 billion gigabytes) to 6.5 zettabytes (1 ZB = 1024 exabytes). Relating to the information presented by mass media services, humans will make 40-44 zettabytes of resources in 2020. SAS institute notices that it should also grow up 10 times to the 2025 year. So people who can help companies to work with a huge stores of statistics will be in a great demand soon.

According to Hult International Business, there are basic data usage principles:
– 	Lower prices (f.e. techniques like Hadoop or cloud-based coherent lead relevant value benefits of holding enormous quantity of statistics).
– 	Rapid processing schedule (Hadoop and memory-inside statistics have an ability to examine storage instantly – draw conclusions related to the analyzed.
information).
– 	New goods and services (With the ability to evaluate customer`s needs through analytics comes the ability to give them what they want).

Which industries need data scientist to work with? As SAS Institute writes: these are government (to analyze strategies of management), retail (to understand which sort of goods are most frequently used by customers), health care (to learn how to use previous experiments for future tasks without fails), traveling (to make the shortest way to get needed place), etc. In general, the smallest field of activity needs to collect data, analyze it and use in future plans and goals.

Conclusion. To sum it up, I would like to say that progress is not reversible. "Big data" is already changed the world, so we must take it for granted. It is difficult to say how quickly technology will take over our mind, but we are ready to direct large data streams to the right paths.

References:

Hult International Business School (2019). The Big Phenomenon of Big Data: It's More Personal Than You Think. Retrieved from http://www.hult.edu/blog/the-big-phenomenon-of-big-data-its-more-personal-than-you-think/

SAS Institute. (2017). Big data analytics. What it is and why it. Retrieved from https://www.sas.com/en_us/insights/analytics/big-data-analytics.html

Uchetechs. (2018). What is big data – the most important information about data. Retrieved from https://www.uchetechs.com/2018/04/what-is-big-data.html

CARS WITH ARTIFICIAL INTELLIGENCE. AUTOPILOT TECHNOLOGIES

Kostiantyn Zvieriev, Ivan Fedorchuk
Faculty of Applied Mathematics, National Technical University of Ukraine
"Igor Sikorsky Kyiv Polytechnic Institute"

Key words: artificial intelligence, level of autonomy, self-driving system, automation.

Introduction. In the modern world the question of application of artificial intelligence for optimization of work processes of human activity more and more often arises. One of the progressive industries is the automation of driving, because programmed drivers would have incredible efficiency and lightning reflexes. Which would significantly improve global economic performance, as most of the used goods are delivered by suburban highways, which do not require complex solutions when driving a vehicle.

Objectives. The main task is to determine the current level of developed technologies for the use of artificial intelligence for autonomous or semi-autonomous driving, to consider the main problems hindering the widespread introduction of these technologies and the development of new ones.

Methods. Modern cars use a combination of various advanced hardware and software technologies for auto-control. A typical self-management system consists of 3 stages (*sounding, understanding and control*).

At the first stage (*sounding)* objects surrounding the car are detected by cameras and various sensors.

At the stage of *understanding*, the system has certain data sets that fully characterize the location of the car. This data needs to be processed using various artificial intelligence algorithms, including computer vision. This technology is designed to analyze the entire environment of the car. All prepared information is passed to the next stage, namely to the control stage of self-government.

At the *control* stage, the system analyzes all information received from the computer vision system. After that, artificial intelligence will drive the car using this information. However, different things can happen on the car way – coating defects, various debris on the road or incorrect road signs – something unexpected and inevitable that artificial intelligence has never seen before.

Therefore, currently certain delimited levels of car autonomy have been formed (Shane, 2019), namely:
– zero level – no automation, the car can maintain a fixed speed;
– first level – assistance to the driver, the car has the technology of holding the lane;
– second level – partial automation, the car can maintain the distance and follow the road, but the driver must be ready to take control of the vehicle if it is necessary;
– third level – conditional automation, the car can go independently in some conditions. A driver is rarely needed, but must always be prepared to respond;

–   fourth level – high automation, the car does not need a driver, when he is on a controlled route on other routes, the car still needs a driver;

–   fifth level – full automation, the car never needs a driver.

Currently, conditional automation is the highest level of car autonomy available commercially today.

Talking about further increasing autonomy, we can say that the situation is becoming much more complicated. This is due to the fact that the next level of automation is high, which will allow transportation on a controlled route without the intervention of the driver.

However, at the moment this level of automation has not been achieved. The reason for this is the emergence of road situations to which artificial intelligence has not been trained and its behavior in such situations is unpredictable and often dangerous for both the driver and others.

Thus, in 2018, cases were recorded in which autonomous cars:

–   recognized as an obstacle overhanging branches;

–   did not recognize the cars leaving in front of them;

–   could not determine the lane on which there was another car.

One such situation caused a fatal accident in March 2018. The artificial intelligence vehicle recognized the pedestrian first as an unknown object, then as a bicycle, and then, when there were 1.3 seconds left to brake, as a pedestrian.

It is also worth noting that in order to help solve the existing problems with the orientation of autonomous vehicles, it is necessary to create a favorable infrastructure that could transmit information about existing facilities on the roads of the city. In addition, it is necessary to develop systems such as Car-to-Car, through which autonomous vehicles could transmit information to each other.

However, all these dangerous situations on the roads involving self-driving cars are insignificant compared to the number of car accidents caused by humans. Therefore, the main question today is whether we are ready to entrust our road safety to computer algorithms in the future.

Results. As a result, we can say that today autopilot technology plays a supporting role for the driver and cannot completely replace it. The main reason for this is the unpreparedness of artificial intelligence for various unforeseen situations that may occur on the roads.

Conclusion. Therefore, we note that in today's world for most industrial companies the idea of creating self-driving cars is a very cost-effective technology, but there is an extremely difficult task of adapting artificial intelligence to the environment. Undoubtedly, in order for cars driven by artificial intelligence to become widely available to users, we will have to make certain compromises, such as the creation of new controlled transport networks and the introduction of the fourth level of automation.

References:

Lv, Ch. (January 2018). Analysis of Autopilot Disengagements Occurring during Autonomous Vehicle Testing. Retrieved from https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=8232590

Shane, J. (6 November 2019). Many of us thought we'd be riding around in AI-driven cars by now — so what happened?. Retrieved from https://ideas.ted.com/many-of-us-thought-wed-be-riding-in-ai-driven-cars-by-now-what-happened/

MODERN INFORMATION TECHNOLOGIES

		Research adviser	Foreign language teacher	
Anna Adamchuk	The Implementation of Customer Relationship Management Systems		*Nataliia Chizhova*	3
Kyrylo Andreichenko	Satellite Internet – Starlink	*Oleh Lisovychenko*	*Oksana Serheieva*	5
Nikita Bakun	Modern Principles of Application of Internet of Things Technologies in the Introduction of E-Government at the Local Level	*Oleh Lisovychenko*	*Oksana Serheieva*	7
Anna Bilous	Role of Additive Manufacturing in Creation of Sustainable Clothing		*Nataliia Chizhova*	8
Evgeniy Bondarchuk	Facial Recognition System		*Nataliia Kompanets*	10
Inna Butko, Kostiantyn Lisovskyi	Prospects of 5G Technology Development in Comparison to Lower Band Systems	*Oleksandr Zhyvkov*	*Olha Nazarenko*	11
Yaroslav Chekotun, Ihor Lishchuk	Transparent Smartphones are Doomed		*Maryna Kolisnyk*	13
Anna Chemanova	UX/UI website design	*Vira Huskova*	*Mykola Tyshchenko*	15
Denis Chernousov	Modern Principles of Blockchain Operation		*Iryna Nazarenko*	17
Sofiia Chorna	Conflict Resolution during Synchronization in Collaborative Real-Time Text Editing		*Natalia Chizhova*	18
Valeriia Demenkova	Importance of Using the Business Process Model and Notation	*Natalia Kuznetsova*	*Mykola Tyshchenko*	19
Oleksandra Denysenko	Modern Information Technologies in Education		*Nataliia Chizhova*	21

СУЧАСНІ ІНФОРМАЦІЙНІ ТЕХНОЛОГІЇ

		Науковий керівник	**Викладач іноземної мови**	
Анна Адамчук	Внедрение систем управления отношениями с клиентами		*Наталія Чіжова*	3
Кирило Андрейченко	Супутниковий інтернет – старлінк	*Олег Лісовиченко*	*Оксана Сергеєва*	5
Нікіта Бакун	Сучасні принципи застосування технологій Інтернету речей у впровадженні електронного уряду на місцевому рівні	*Олег Лісовиченко*	*Оксана Сергеєва*	7
Анна Білоус	Роль адитивних технологій у створенні екологічного одягу		*Наталія Чіжова*	8
Євгеній Бондарчук	Система розпізнавання облич		*Наталія Компанець*	10
Інна Бутько, Костянтин Лісовський	Перспективи розвитку технології 5G у порівнянні з іншими низькочастотними системами	*Олександр Живков*	*Ольга Назаренко*	11
Ярослав Чекотун, Ігор Ліщук	Прозорі смартфони приречені		*Марина Колісник*	13
Анна Чеманова	UX/UI дизайн сайтів	*Віра Гуськова*	*Микола Тищенко*	15
Денис Черноусов	Сучасні принципи роботи блокчейна		*Ірина Назаренко*	17
Софія Чорна	Розв'язання конфліктів під час синхронізації при спільному редагуванні текстів у реальному часі		*Чіжова Наталія*	18
Валерія Деменкова	Важливість використання моделі та бізнес -процесу	*Наталія Кузнєцова*	*Микола Тищенко*	19