The Youth in Science: Challenges and Prospects

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Atlas of Modern Managerial Professions

ABSTRACT.
Our study addresses the issue of the unequal distribution of workforce in the Russian market. Given an officially confirmed excess of qualified personnel in Russia, the following question arises: what should one do in order not to become superfluous in the labour market? Statistically, about a third of university graduates end up being employed in professional fields that differ markedly from what they were initially trained for. One in four graduates takes up a position which does not require a university degree. The oversupply of certain professions also leads to the risk of tax revenue being reduced. In 2020, this situation was complicated by the global COVID-19 pandemic, when 45% of Russian employers were forced to lay off their staff and about 7 million people were made redundant. In view of the above, our research goal was to analyse the current situation on the domestic labour market and create an "Atlas of Modern Managerial Professions" as a guide to employment opportunities. The results of the study should enable young people to become the most in-demand specialists in the third decade of the 21st century and are potentially of use to local authorities as a tool for dealing with unemployment.

Keywords: *management; professions; labor market; graduates; unemployment.*

The modern world dictates new business rules. Every year, employers and specialists in all spheres have to adapt to new market conditions. How many times have you heard: "Your profession is no longer in demand!"? Annual statistics show that one in three graduates may choose not to pursue a career based on their university degree and initial qualifications. The number of vacancies and the number of candidates ready to fill them are growing at about the same rate, but the actual standard of education does not meet the requirements of most companies, which provokes contradictions between companies and

potential employees [8, p. 15]. Competent specialists who carefully select their future career and regularly improve their skills are real heroes. Unfortunately, 2020 was the worst year for the global economy comparable only to the Great Depression of the 1930s. The COVID-19 pandemic has transformed business and society. Many people have lost their jobs and their previous standard of living. The "COVID-19 effect", also referred to as coronacrisis, has become an unprecedented challenge [ibid., p. 27]. But we sincerely believe that a pandemic is a time of opportunity, a time of action. Our present is not our future. The only fundamental law of nature is change. Even if things do not look good right now, do not worry! It will change. Our team conducted a study that allowed us to put all the information together. We are delighted to present our "Atlas of modern Managerial professions", which is a guide to Russia's labour market. Thanks to our research, you will be able to choose a direction forecast to become more popular in the third decade. We will be happy if our work helps you define your future or change the present, find your favorite business, and be in demand as a highly qualified specialist.

Our team used the field research method, i.e., searching, collecting and processing the data required for our analysis. Our field research is based on primary information, in other words, on the data obtained specifically to solve the problem under study. The data was collected in strict accordance with the exact research aims and objectives; the methodology of data collection was strictly controlled. The study required a complex approach, therefore both qualitative and quantitative tools for data collection and analysis were applied. The quantitative methods of collecting sociological data included the analysis of documents, as well as content analysis (the analysis of the content of various sources). The qualitative method we used was the audit and monitoring of the situation on the Russian labor market. More than fifty authoritative sources were analyzed, including both business and glossy magazines, scientific journals and open-access resources.

1) HR | Profile: Facilitator

General info: A facilitator is a specialist who provides successful and effective group communication through a variety of discussion tools. This profession already exists, however, it will become increasingly relevant as more cross-industry and cross-cultural teams appear, whose members find it difficult to understand each other. The facilitator works directly with the collective mind, guiding the team to make the right decisions [2, p. 38]. The facilitation process involves the whole team where each member is heard. "The facilitator believes in the team's capabilities: he knows that the team can find all the solutions independently". The facilitator only accompanies assess anyone's performance; he is not responsible for the team's results. He is a neutral person who is responsible only for the process of interaction of participants, without controlling its content [ibid., p. 40]. His task is not to come up with a ready-made answer to the question of how to continue being a team, but to help the team find its way.

What you will do: The activity of the facilitator includes drawing up a plan for the progress of the group process, selecting the necessary techniques that will bring the group closer to achieving the desired result. You will set the basic rules of the meeting, set the background, establish contact, listen to all participants and involve them in the discussion, control group dynamics, mediate and prevent conflicts, carry out surveillance, record the actions of the team, observe the process and summarize the results; you will also watch the timing of the meeting.

Hard skills: Client orientation; multilingualism and multiculturalism; the skills of a psychologist; experience in project management; good knowledge of facilitation methods and tools; the ability to handle customer requests, time management.

Soft skills: Cross-sectoral communication; quick and flexible response; sociability; understanding of group dynamics; strong internal motivation; the ability to maintain a healthy environment in a team and to stay calm.

2) Projects | Profile: Auditor of the project and project management processes

General info: A project auditor is a specialist who provides an independent assessment of the state of a project, its parameters, and the entire team. Project audit often takes place at critical moments, when a customer does not have any ideas as to how to carry on with an important project and the team finds it difficult to take further action [ibid., p. 22]. It is then that the project auditor comes in, who analyzes the activities of a company or group of individuals for compliance with the project management standard. If inconsistencies are identified, the auditor makes recommendations or develops a plan for further project management. This specialist differs from an ordinary auditor in that the scope of his activity is limited only to projects where a certain amount of knowledge and experience is needed.

What you will do: The activity of the project auditor includes evaluating the effectiveness of a team or company. The auditor makes recommendations for correcting the errors identified during the audit. This specialist conducts independent research, advises clients and minimizes risks and losses. He also develops a plan that will help automate and improve a vast number of project management processes. You will consult your client on issues relating to compliance with various parameters.

Hard skills: Practical experience in conducting a risk-based audit; knowledge in the sphere of automation, tokenization, encryption, PCI, fraud; knowledge of current industry trends/problems; knowledge of industry-specific accounting; the ability to apply an extensive range of risk analysis methods; budgeting; understanding of business processes in project activities; expert assessments and opinions.

Soft skills: The ability to identify customer needs; the ability to formalize tasks; relationship management; change management.

3) Products and marketing | Profile: Corporate anthropologist

General info: A corporate anthropologist is a specialist who studies the future market. This method improves the quality of a company's dialogue with its target audience. The demand for specialists of this kind will grow rapidly as a large number of organizations need to better understand themselves and more productively manage their resources. While the anthropologist specializes in the study of social factors, the corporate anthropologist still manages the process of change [5, p. 17]. The corporate anthropologist anticipates demand, future customer preferences, and the requirements of potential buyers. This allows you to come up with the best offer on the market before a global trend begins.

What you will do: The activity of the corporate anthropologist includes the study of the markets for a company's innovative products using various methods. This specialist analyzes the corporate culture of a company and evaluates all the nuances of the relationship between its different departments. You will implement effective management of the company, identify the true motivation of employees and remove barriers to the introduction of revolutionary management solutions. Your authority will include drawing up a portrait of a new customer in order to accurately identify their future needs.

Hard skills: Multilingualism and multiculturalism; project management; quality control analysis; knowledge and understanding of the management model; implementation and maintenance of changes; diagnostics and evaluation; understanding of business processes in the market.

Soft skills: Analytical thinking; being customer-orientated; expertise; intuition.

4) IT & RnD | Profile: UX- analyst

General info: A UX analyst ("user experience") is a specialist who analyzes user activity on a website or in an application, which gives an idea of how its design can be adapted to the current or changing needs of end users. UX analysis measures what users do and why they do it [6, p. 390]. This data set allows you to draw conclusions about: why users leave and where they go; why users are so keen on using a particular product, what attracts them to this product, what preferences are formed in the market.

What you will do: The UX analyst's job is to study numbers in an effort to improve consumer acceptance and engagement for a particular website, application, ecosystem, or software. These experts investigate categories such as customer retention and revenue trends to determine the best way to create realistic customer goals and then achieve them. If you are a UX analyst, then your goal is to increase the coverage of the project by improving the interactivity and enjoyment of the final product. You will have to create a user interface environment and layouts that will simulate the actual user interaction with a digital product to better understand consumer behavior and experience.

Hard skills: Being customer-oriented; the ability to build hypotheses and test them; knowledge of business analysis, web analytics, test design; the ability to handle customer requests; the ability to identify customer needs.

Soft skills: Creative and analytical thinking; being result-oriented; expertise; advanced skills of a team player.

5) Finance | Profile: Crowdfunding specialist

General info: A crowdfunding specialist is a specialist who advises a company or individuals on issues related to attracting third-party capital to invest in potentially successful ideas. Such specialists are able to organize and conduct the crowdfunding of a company, evaluate the prospects and objectivity of a project, and attract big and reliable investors. Crowdfunding makes it possible to combine the resources of a large number of people in order to implement a project [8, p. 48]. This approach to fundraising differs from other approaches in that it is based on a voluntary system and does not imply any legal obligations to compensate for investments or fully implement an idea.

What you will do: The activities of a crowdfunding specialist include consulting on attracting private investment. You will have to pre-check and evaluate the prospects of projects; identify and analyze the target audience of the project, as well as the best communication methods; prepare an information campaign before the project is released on crowdfunding platforms; analyze conflicts between investors and project holders; organize the activities of crowdfunding platforms.

Hard skills: Knowledge of the features of the crowdfunding market in Russia and in the world; the ability to analyze market conditions; knowledge of current industry trends/problems; experience in project management; understanding of the principles of crowdfunding, crowdinvesting, crowdlending.

Soft skills: The ability to work in a team; strong internal motivation; flexibility and resourcefulness; sociability.

6) Change Management |Profile: Sustainability manager

General info: A sustainability specialist is a specialist who serves as a liaison to local sustainability project teams, promoting communication and best practices throughout the organization. He is active in areas such as corporate branding, marketing, public relations, project implementation, procurement, business ethics and policy on the corporate side [7, p. 7]. Usually, "sustainability" is understood as an organization of the system that causes minimal damage to the environment and takes into account long-term programs, prospects for the conservation of limited resources. Sustainability implies the creation of an environmentally friendly product, without the use of harmful and toxic materials, where there is versatility and durability.

What you will do: The activities of a sustainable development specialist include cooperation with corporate communications to develop and implement communication plans and social media campaigns; collecting data on sustainable development and creating individual reports based on internal and external customer needs; coordinating and managing special public projects, partnerships and opportunities for education/community involvement; minimizing the reputational losses of a company, reinforcing its the brand image in the eyes of consumers.

Hard skills: Knowledge of concepts, practices, policies and procedures related to sustainable development; cross-industry communication; project management experience; the ability to distill complex and ambiguous subjects into clear action plans; knowledge of business analysis; the ability to identify customer needs.

Soft skills: Strong internal motivation; focus on results; quick and flexible response; expertise.

7) Operational unit | Profile: Mind-fitness trainer

General info: A mind fitness trainer is a specialist who creates special programs and techniques for developing certain important skills. One of the basics of mind fitness is a fluent reading program. Usually, a person is able to read a text in sixty seconds, the length of which will not exceed 250-300 words [ibid., p. 13]. It is believed that if you double your reading speed, you can more successfully move up the career ladder. Mind fitness trainers also guarantee to teach clients to read up to 1,500 words in a minute. This specialist will open up new opportunities in you, make you more confident and convincing in the eyes of the world around you. People who have improved brain function and performance are better able to follow directions, implement plans and build successful careers.

What you will do: The activity of a mind fitness trainer includes the ability to understand people, feel their needs, be resistant to stressful situations and perfectly understand the programs that he sells to clients. Absolutely every technique, including those that are developed independently, is tested by the mind coach personally. You will determine the psychotype of a person, evaluate the strengths and weaknesses of his brain, and based on all this you will build a training program. The activity of this specialist includes training the memory of the human brain, training the speed of reaction to certain stimuli and other cognitive skills of the client.

Hard skills: Multilingualism and multiculturalism; cross-industry communication; the ability to handle customer requests; the ability to identify customer needs.

Soft skills: Focus on results; expertise; creative and analytical thinking; cross-industry communication; quick and flexible response.

8) Procurement & logistics | Profile: Foreign trade manager

General info: A foreign trade manager ("Import, export and planning"; foreign economic activity) is a specialist who manages material and information flows, organizes events, improves the delivery system, and develops the methodology. The foreign trade manager oversees a range of processes, from the delivery of a small product or the organization of an event to being in charge of rail, road and air transport [5, p. 13].

What you will do: The activities of the foreign trade manager include finding foreign partners and establishing communication with them; discussing the terms of a transaction; signing contracts; controlling payments; processing documents; organizing cargo delivery; declaring goods at customs.

Hard skills: Knowledge of economic geography; knowledge of big data management systems; a good command of foreign languages; knowledge of the political situation in the world; knowledge of the domestic and global markets; the ability to analyze market conditions.

Soft skills: Initiative; stress resistance; flexibility and resourcefulness; good communication skills.

9) Entrepreneurship | Profile: Digital specialist

General info: A digital specialist is a specialist who increases brand awareness, promotes a company's products or services, and attracts potential customers. Unlike using more traditional marketing channels, digital specialists (digital marketers) communicate effectively through appropriate technology platforms. These specialists also work to initiate effective online marketing campaigns and translate business goals into successful marketing

campaigns [3, p. 65]. They are adept at assessing the needs of the consumer market and can understand how and where to acquire knowledge about consumer trends and needs.

What you will do: The activity of a digital specialist includes the development of a strategy for marketing a product on the Internet. You will be responsible for transferring the product to an online environment, as well as developing digital media campaigns in accordance with the client's business goals. You will also coordinate the creation of digital content (such as a website, blogs, press releases, and podcasts), establish a company's online presence to increase brand awareness, maintain a strong online company voice through social media, monitor ROI (return on investment) and key performance indicators.

Hard skills: Experience of visual communication; knowledge of current industry trends/issues; project management experience; the ability to assess the needs of the target audience.

Soft skills: Excellent analytical and project skills; creative and analytical thinking; result-oriented approach.

10) Government relations & promotion | Profile: Lobbyist

General info: A lobbyist is a specialist who is engaged in professional promotion of the interests of individuals, society, business or the entire state. Lobbyists are a group of highly qualified specialists who are able to gather the necessary information and persuade the authorities to make decisions in favor of the group whose interests they represent. Lobbyists often act as intermediaries in various types of transactions between interest groups and politicians, including legislators and members of the government, thereby influencing the formation of the country's political course [4, p. 7]. The profession of a lobbyist is truly unique and very prestigious. There are very few specialists in the field of international GR in Russia: this activity requires a fairly large and specific set of skills, which cannot be obtained within the framework of one degree.

What you will do: Lobbyist activities include lobbying politicians to vote for or against the current legislation by sending appeals in support of certain individuals or groups. You will also legitimately promote your client's interests in various spaces, whether it is a private business or a global political arena. The lobbyist needs to establish contacts with influential or well-known people regularly in order to succeed in decision-making with their help.

Hard skills: Project management; multilingualism and multiculturalism; cross-industry communication; the ability to identify customer needs; psychological skills; knowledge of the lobbying sphere; the ability to identify customer needs.

Soft skills: Sociability; stress resistance; flexibility and resourcefulness; oratory skills and charisma; creativity; strong internal motivation; focus on results; expertise.

To summarize our research findings, we would like to highlight the following key points:

1. Most of the professions in the sphere of management have not disappeared without a trace, but have only been transformed to meet the standards of modern society;

2. In the Russian labor market, you can be a sought-after specialist if you choose your specialty correctly and get a good university degree;

3. It is necessary to constantly improve your professional competencies because modern employers are interested in versatile specialists;

4. In the future managers are forecast to have a wide range of options to choose from, which should allow them to focus on those aspects which are as close as possible to their personal interests;

5. Managers should think outside the box. The key quality of a successful manager is the ability to facilitate interpersonal communication and teamwork, solve problems, and show ingenuity. A synthesis of thinking outside the box and a strategic approach to every project could be regarded as a critical success factor.

We sincerely hope that the Atlas of Future Managerial Professions has helped, or will help you to better understand yourselves. Do not hesitate to refer to it whenever you begin to have doubts about your career. Look into the future and find a job tailored to your needs and personal preferences, a job that will contribute to improving our country's economy.

References

1. Bedworth D. D. & Bailey J. E. Engineering Management International. Amsterdam: Elsevier Science Publishers B.V., Volume 2, Issue 4., 279–286.

2. Braun D. & Kramer J. (2018). The Corporate Tribe: Organizational lessons from anthropology. Britain: Routledge & CRC., 1–50.

3. Braungar M. (2018). Cradle to Cradle: Remaking the Way We Make Things. United States: North Point Press, 1–80.

4. Gallant K. (2019). Forbes Article, Six Things Every Great Facilitator Should Know. Unites States: Forbes Media.

5. Guang R. T., Panneer S. & Malhotra S. (2018). Business Anthropology. New York City: John Wiley & Sons, Inc.

6. Jesmond A. & Chudley J. (2012). Smashing UX Design: Foundations for Designing Online User Experiences. Volume 1. New York City: Goodwill of Silicon Valley, 378–392.

7. Sam C. J. Huibers (2018). The Roles of the Auditor in Projects: Proactive Project Auditing. Issue 1. EDPACS: The EDP Audit, Control, and Security Newsletter, 1–14.

8. Varlamova D. & Sudakovo D. (2020). Atlas of New Professions 3.0. Moscow: Alpina publisher.

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The Impact of Covid-19 Pandemic on the Global Unemployment Rate in Economically Developed Countries

ABSTRACT.
This work provides the insights into the impact of Covid-19 pandemic on the global economic factors especially related to the unemployment rate in the economically developed countries. Through the study, the necessary data containing information on changes of the unemployment rate and the number of new coronavirus cases for several years for 36 countries was collected from the web pages, analyzed and presented in a structured form. A large number of methods is employed in the project proposal, including the descriptive data

analysis, the frequency data analysis, the data grouping and aggregation and the data correlation analysis. The results of the study show the general patterns and causes of the increase in the unemployment rate in the considered countries, the impact of the coronavirus pandemic on the economies of the world. The prediction of the future growth of new cases and the growth of the unemployment rate in Russia in 2021 is made using the linear regression method.

Keywords: *data analysis; Covid-19 pandemic; the unemployment rate; the prediction.*

Background of the Study

Today, humanity is experiencing the largest pandemic in more than a hundred years. The deadly virus took the whole world by surprise. The world was not ready for the global pandemic. Rapidly spreading, coronavirus has completely changed the lives of people in more than 200 countries [7].

The vaccine took about six months to develop [8]. This could have been done much earlier and millions of people would have survived if the reaction of the countries where this pandemic began had been timely, quick and open. This can be called a global failure.

A resurgence in infectious cases in the world calls for lockdowns in many countries [11]. The economic fallout from the pandemic could risk continued labor dislocations as a result of lingering high levels of unemployment. Since the beginning of Covid-19 pandemic the number of unemployed people all over the world have increased causing many problems. The world economy was paralyzed.

The analysis of the actions of the state governments allows to identify the existing problems in the social, economic and managerial spheres. Given the importance of the existing problems in the labor market related to the world crisis caused by the global pandemic, the scientific analysis of these problems and their causes and the identification of weak and vulnerable points in the economy is an urgent and important task.

Problem statement

The object of the research is the global unemployment rate in the economically developed countries.

The subject of the study is the change of the global unemployment rate in economically developed countries since the beginning of Covid-19 pandemic.

The purpose of this work is to analyze the impact of Covid-19 pandemic on the unemployment rate in the economically developed countries using big data analysis in Python.

In order to achieve this purpose these primary goals are reached:

●   The necessary basis of the balanced panel data containing the information on changes of the unemployment rate and the number of new coronavirus cases for several years for 36 countries is collected from the web pages;

●   The modifications to the data necessary for the research are made;

●   The appropriate analysis methods depending on the data type are selected;

●   The analysis of the received data is carried out;

●   The prediction of the future growth of new cases and the growth of unemployment rate in Russia in 2021 is made;

●   The results are presented in the form of summary tables and graphs of various types.

The following hypotheses are advanced in the study:

●   The increase in the unemployment rate during the Covid-19 pandemic is correlated with the increase in the number of cases and deaths from coronavirus;

●   The increase in the unemployment rate during the Covid-19 pandemic is correlated with the value of the country's human development index;

● The largest increase in the unemployment rate in the United States was due to a large number of Covid-19 cases and was registered during the first wave of the Covid-19 pandemic;

● The increase in the value of the government response Stringency index on average is accompanied by an increase in the unemployment rate at the beginning of the Covid-19 pandemic;

● In the countries with a large share of the services sector in GDP a strong increase in the unemployment rate among women during the Covid-19 pandemic was recorded;

● The third wave of the growth in new cases of the coronavirus in Russia is expected in the spring of 2021 and is not characterized by the increase in the unemployment rate.

Professional Significance of the Study

The practical and theoretical significance of the research is determined by the identification of problems in the social, economic and managerial spheres in the context of the global pandemic.

Literature Review

Of course, by the end of 2020, a sufficient number of scientific publications about the impact of Covid-19 on the global economy were published [2-5]. The authors of these studies tried to find out whether the new coronavirus infection affected the increase in mortality in the world, what effect the global spread of the pandemic had on the world energy and stock markets, what problems oil-dependent countries faced, what difficulties the world trade is experiencing.

Research Objects and Methods of Study

The analysis was carried out on the basis of the Balanced panel data collected from the website of The Organization for Economic Co-operation and Development [12]. Balanced panel data contains statistical information about the same set of objects for a number of consecutive periods of time. The resulting dataframe contains information about 36 countries.

The main method of my research are contemporary methods of data analysis in Python (such libraries as Pandas, NumPy and Matplotlib) including the following:

A.   Graphical data analysis

The first step in data analysis, after data collection and perhaps some data cleaning, is exploring the data using graphs, diagrams and summary statistics. The kind of graph that is applicable depends on the data type of the variables to be plotted. If the analysis concerns one single variable, it is a univariate analysis. If the relationship between two variables is involved, it is a bivariate analysis. With more than two variables, it is a multivariate analysis. For a univariate categorical analysis, the most common plots are bar plots (figure 1 is an example of a bar plot showing the maximum increase in the unemployment rate in the countries during the beginning of the Covid-19 pandemic). To visualize the relationship between two numerical variables the most appropriate graph is a scatter plot (figure 2 is an example of a scatter plot showing the relationship between the value of the Government Response Stringency Index and the value of the increase in the unemployment rate in Russia during the beginning of the Covid-19 pandemic).
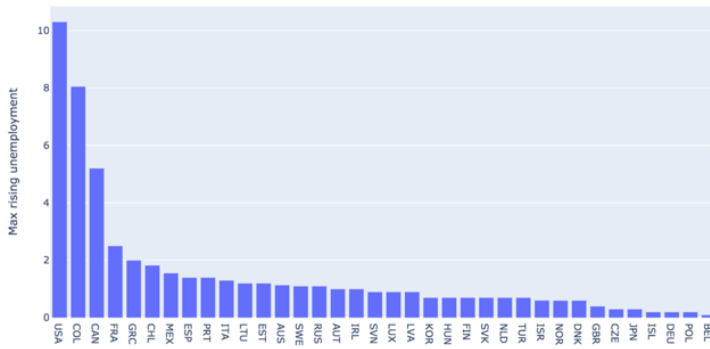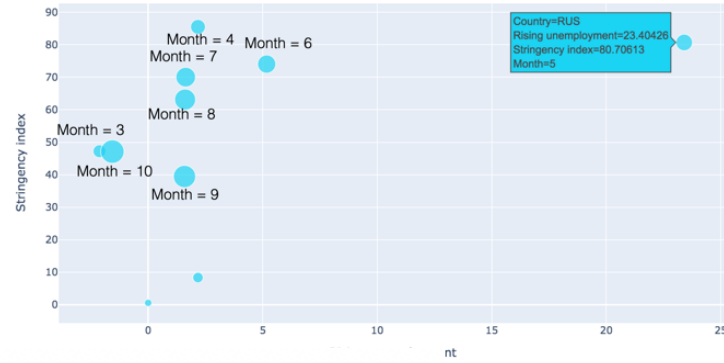
Figure 1

Figure 2

B.   Correlation analysis

Correlation (to be exact Correlation in Statistic) is a measure of a mutual relationship between two variables whether they are causal or not. Correlation is useful because it can indicate a predictive relationship that could be exploited in the practice. If there is a connection available, whether the increment of one the increased parameter (positive correlation) or the decreasing (negative) of the other one. The correlation analysis helps to determine whether it is possible for the value of one indicator to predict the potential value of the other one. The correlation coefficient ranges from -1 to +1. If the value of the coefficient is 0 linear dependence between samples does not exist. For example, figure 3 shows a good positive correlation between the value of the Government Response Stringency Index and the value of the increase in the unemployment rate.

	Unemployment rate
Stringency index	0.442628

Figure 3

C.   Descriptive statistics

A large number of methods collectively compute descriptive statistics on the given data set. Descriptive statistics calculates the central metrics that give the information about data centers of concentration, such as mean, median, and mode of values, metrics for estimating data variability that indicate the spread of values, such as variance and standard deviation of the values. Also, it calculates the number of non-null observations, the sum of values, the minimum and maximum values. Table 1 shows the example of descriptive statistics of the data for the beginning of the Covid-19 pandemic.

	Value	Total cases	Total deaths	Stringency index	Rising unemployment	Max rising unemployment
count	35.000000	33.000000	15.000000	35.000000	35.000000	35.000000
mean	6.307997	3247.959986	192.209425	27.155286	0.333283	1.504785
std	4.058234	11854.238332	408.231747	31.162635	1.408337	2.133350
min	2.000000	0.068966	0.000000	0.000000	-0.700000	0.100000
25%	3.583334	1.500000	0.996552	2.539310	-0.100000	0.602515
50%	5.000000	9.241379	9.666667	13.027931	0.000000	0.900000
75%	7.000000	379.448276	140.466667	37.621296	0.200000	1.350000
max	20.236260	66384.466667	1554.400000	88.083000	8.046120	10.300000

Table 1

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D. Linear predictor function

The linear prediction function in Excel allows to predict future values with some degree of accuracy based on existing numeric values and returns the corresponding values. For example, some object is characterized by a property whose value changes over time. Such changes can be recorded experimentally, as a result of which a table of known values of X and their corresponding values of Y will be compiled, where X is a unit of measurement of time, and Y is a quantitative characteristic of the property. Using the linear regression method, you can assume subsequent Y values for new X values.

The paragraphs above contain the review of the main methods connected with data analysis in order to highlight key points and describe the scope of my research.

Achieved Results

I. The increase in the unemployment rate during the COVID-19 pandemic is not correlated with the increase in the number of cases and deaths from coronavirus.

The first graph (figure 4) shows the total growth of the unemployment rate in the countries considered by month. And next two graphs (figure 5 and figure 6) show the total number of new cases and deaths in the reviewed countries by month. A strong and maximum increase in the unemployment rate and a strong increase in the number of cases and deaths are recorded in March-April 2020 – the period of the "first wave" of the coronavirus. However, with the further increase in new cases and deaths, there is a slowdown in the growth of the unemployment rate. And already in August – the month with the highest number of new cases of infection – in most countries, there is a decrease in the unemployment rate. There is a poor correlation 0.1 between the value of the unemployment rate and new cases and deaths.
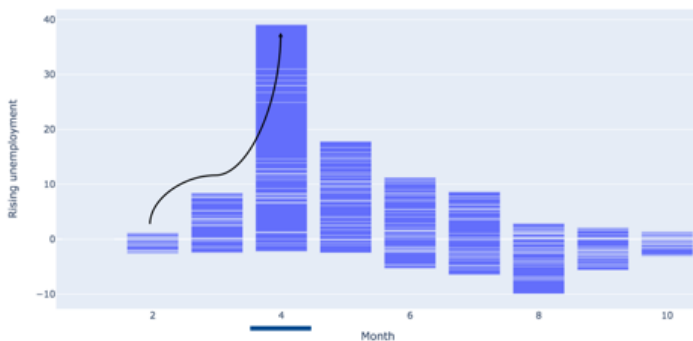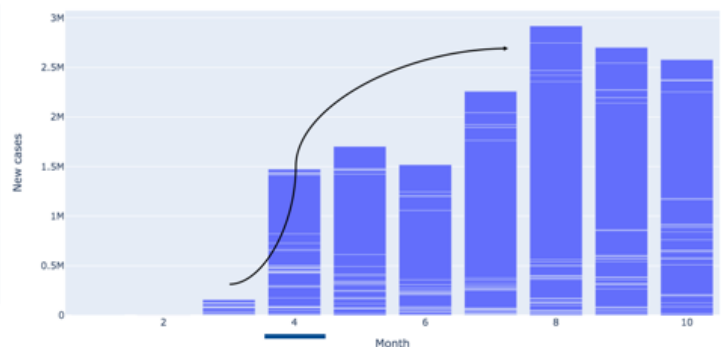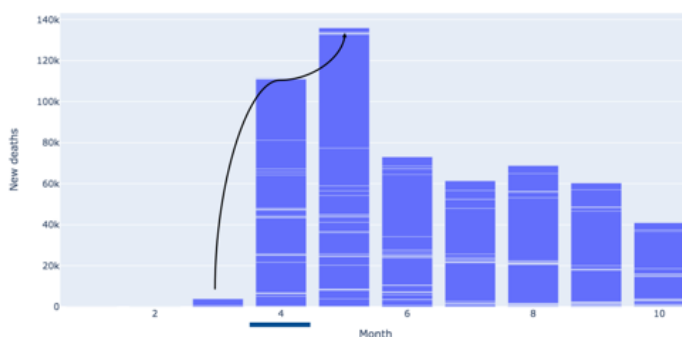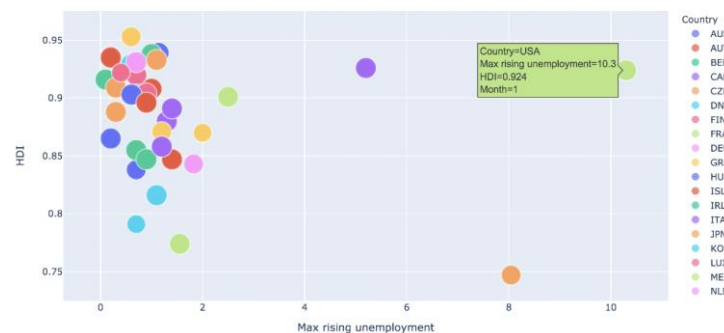

Figure 4

Figure 5

Figure 6

Figure 7

Thus, from the analysis, the strong increase in the unemployment rate falls in March-May (the period of the first wave of coronavirus) and is due to the countries' unavailability to strongly worsen the epidemiological situation.

II. The increase in the unemployment rate during the Covid-19 pandemic is correlated with the value of the country's human development index.

The countries have a high human development index value of 0.75-1. In countries with a human development index > 0.75 (figure 7), the maximum increase in the unemployment rate ranges from 0.1% to 2.5%. The exceptions are Canada (5.2%) and the United States (10.3%). There is a strong negative correlation -0.42 between the value of the unemployment rate and the value of the country's human development index.

III. The largest increase in the unemployment rate in the United States was due to a large number of Covid-19 cases and was registered during the first wave of the Covid-19 pandemic.

The U.S. unemployment rate jumped to 14.7% in April 2020, the highest U.S. unemployment rate since the Great Depression [9]. It's 5 or even 10 times higher than the increase in the unemployment rate in countries with an equal value of the human development index.

The first graph (figure 8) shows the growth of the unemployment rate in the United States by month. The second graph (figure 9) shows the number of new infections in countries in April. In the following months, the graphs will be similar. The maximum increase in the unemployment rate in the United States was observed in April, and since this month, the United States has been the leader in the number of cases of coronavirus infection. The number of new cases in the United States exceeds the number of new cases in other countries by several hundred times.

The third graph (figure 10) shows the number of new cases of infection in the country by month. We see that with a decrease in the unemployment rate, the number of new cases of infection is quickly increasing every month.
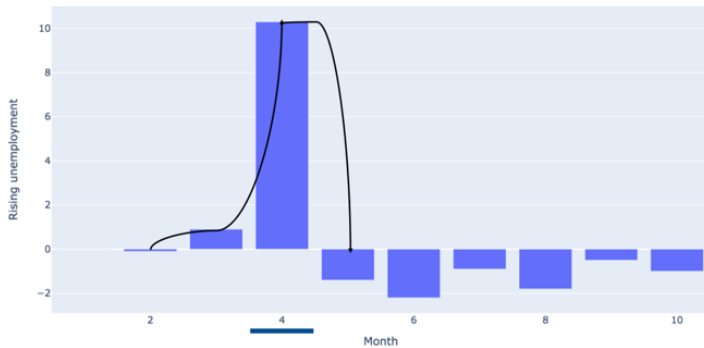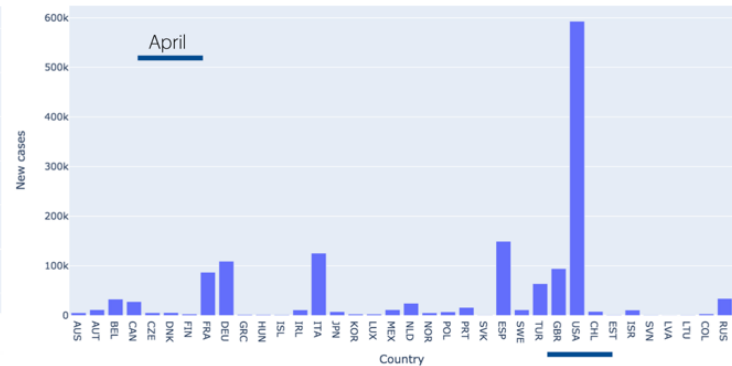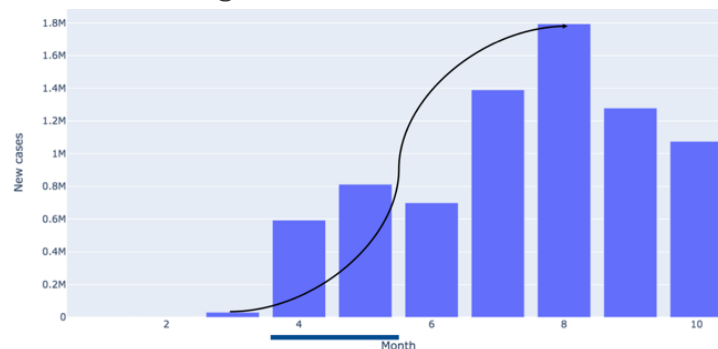

Figure 8
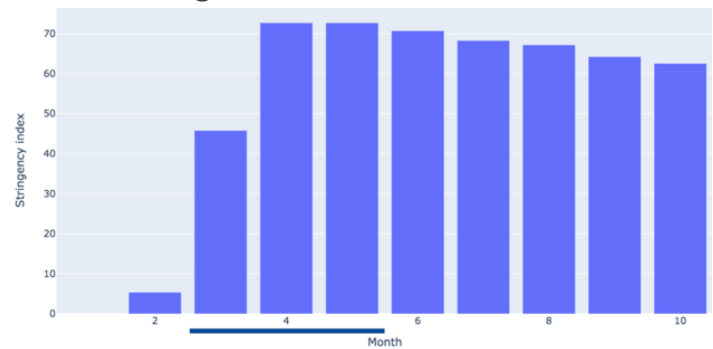

Figure 9

Figure 10

Figure 11

At the same time, in March-April, the maximum value of the Stringency Index was noted (figure 11), which indicates that these measures were mainly focused on limiting contacts

between people, suspending the work of companies. In the following months, the index is at a very high level (60-70), there is a negative increase in the unemployment rate and a strong increase in sick people, therefore, further government measures were more focused on supporting the economy.

IV. The increase in the value of the government response Stringency index on average is accompanied by an increase in the unemployment rate at the beginning of the Covid-19 pandemic.

There is one detected pattern in most countries: Hungary, Italy, Norway, Sweden, the Netherlands, Japan, England, Russia etc. With an increase in the value of the Stringency Index during the first wave (March – May), there is the increase in the unemployment rate (figure 2). This is due to the fact that state measures are primarily focused on limiting contacts between people, which caused an increase in unemployment. There is a strong positive correlation 0.44 between the value of the Stringency Index in the country and the value of the unemployment rate.

V. In the countries with a large share of the services sector in GDP a strong increase in the unemployment rate among women during the Covid-19 pandemic was recorded.

As a result of comparing the maximum increase in the unemployment rate among men and women, the following results were revealed: in 18 countries out of 32 reviewed (57%), the maximum increase in the unemployment rate among women is higher than the maximum increase in the unemployment rate among men. And in 5 countries (15%), the increase in the unemployment rate among men and women is equal.

It should be noted that in 9 countries (28%) (including Russia figure 12) at the end of October 2020, the unemployment rate among women for the first time in several years exceeded the unemployment rate among men. Experts explain a strong increase in the unemployment rate among women by the fact that since the beginning of the Covid-19 pandemic, the service sector and retail trade have suffered primarily.
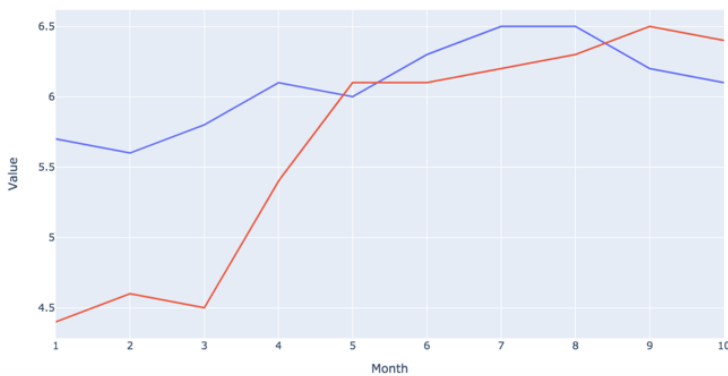
Figure 12
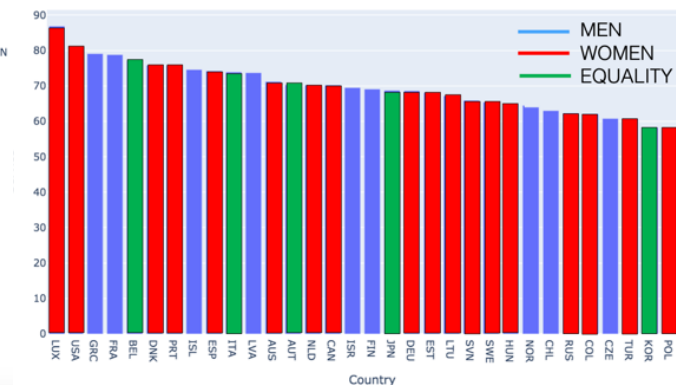
Figure 13

Data on the shares of the service sector in the GDP of countries was downloaded and selected [12]. The resulting graph (figure 13) shows that the share of services in GDP of all the countries is high (>60%), which exceeds the average part of services in GDP in the world (62%). It is revealed that in countries with a high share of services sphere in the GDP, the increase in the unemployment rate for women is greater than the increase in the unemployment rate for men during the COVID-19 pandemic.

VI. The third wave of the growth in new cases of the coronavirus in Russia is expected in the spring of 2021 and is not characterized by the increase in the unemployment rate.

The prediction function and the linear regression method were used to predict the future growth of new Covid-19 cases (figure 14) and the growth of the unemployment rate (figure 15) in Russia based on the available data. The third wave of coronavirus in Russia

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should be expected in May, which will not be as powerful as the second, and the beginning of the fourth wave in October.
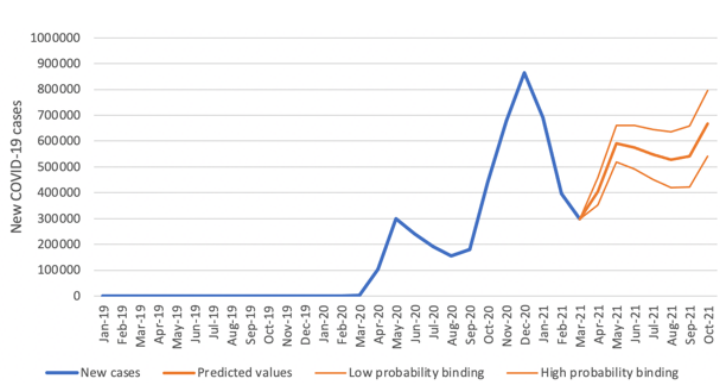
Figure 14
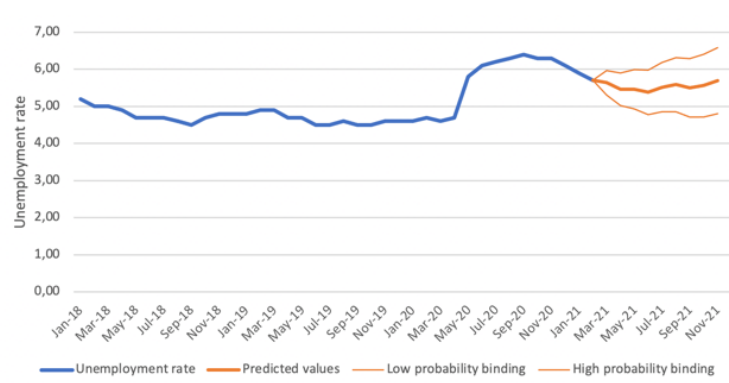
Figure 15

The power of the new wave depends on several indicators:
1)   The spread of a new British type of coronavirus. Which has already caused a strong increase in cases and a new lockdown in Britain [1];
2)   Repeated disease of people in a favorable period for this;
3)   And slow vaccination because of the refusal of people to be vaccinated.
According to the prediction, the average unemployment rate in 2021 will be 5.6%.

Descriptive statistics (table 1) says that by October 2020, the country's unemployment rate had increased by an average of 1%, compared with the average unemployment rate at the beginning of 2020 (6.3%). It says about the recovery of the labor market! This is also indicated by the stop of unemployment growth in October 2020 (the average value of unemployment growth is 0.09% with a standard deviation of 0.26%, compared to 0.33% at the beginning of the year with a standard deviation of 1.4%).

By the end of 2020, the average value of the government response Stringency index almost doubled to 48.9%, which indicates that a large number of measures to limit the spread of coronavirus have been strengthened and preserved.

At the beginning of the pandemic, the government response Stringency index exceeded the value of 37% in only 25% of the countries reviewed. By October 2020, the index exceeded the value of 39% in 75% of countries.

As a result of the research of all hypotheses, it can be argued that the Covid-19 world pandemic caused the increase in the unemployment rate in countries all around the world to the fact that countries were not prepared for a strong increase in new dangerous disease cases and they made too strong restrictions because of the unknown disease.

Countries with a high level of human development index mobilized all their forces, especially medical ones, and introduced hard lockdowns. The medical system is not adapted to the instantaneous mass influx of patients in acute clinical form causing the collapse of health care. Most companies were unprepared for this and faced serious difficulties including financial ones. This helped to slow the spread of the virus and get time for research of the virus and the development of the vaccine. As a result of the lockdowns, 34 of the 36 countries reviewed experienced a high increase in the unemployment rate in 1-2.5% in May-July.

Since the beginning of the Covid-19 pandemic, the service sector and retail trade were the hardest hit. That's why in 27 countries out of 36 reviewed (75%), the maximum increase in the unemployment rate among women is higher or equal than among men.

According to the prediction, the third wave of coronavirus in Russia should be expected in May, which will not be as powerful as the second, and the beginning of the fourth wave in October; the average unemployment rate in Russia in 2021 will be 5.6%.

The high level of the government response Stringency index in most countries was preserved until the end of 2020. But government measures have largely been weakened and focused on medical care and supporting the economy. The stop of unemployment growth in October 2020 says about the recovery of the world labor market.

The proposal for further research is to continue to research the impact of new coronavirus infection on the economies of countries around the world to identify new patterns and the most effective government responses to the coronavirus outbreak.

References

1. A timeline of UK lockdown measures [Electronic resource]. URL: https://www.expressandstar.com/news/uk-news/2021/01/04/a-timeline-of-uk-lockdown-measures-since-the-pandemic-began/

2. Ashraf B. N. (2020). Economic impact of government interventions during the COVID-19 pandemic: International evidence from financial markets. Journal of Behavioral and Experimental Finance.

3. Baker S. R. (2020). The unprecedented stock market reaction to COVID-19. The Review of Asset Pricing Studies.

4. Baldwin R., Weder di Mauro B. (2020). Economics in the Time of COVID-19. London: CEPR Press.

5. Bello Abba Ahmed (2020). Impact of COVID-19 Pandemic on Global Economy. MPRA Paper No. 103753.

6. Cathy O'Neil, Rachel Schutt (2013). Doing Data Science: Straight Talk from the Frontline. California: O'Reilly Media.

7. Covid-19 Live Information [Electronic resource]. URL: https://www.worldometers.info/coronavirus/

8. First registered covid-19 vaccine // TASS. URL: https://tass.com/society/1188135

9. Heather Long, Andrew Van Dam. (2020). Unemployment in the USA. Washington: The Washington Post.

10. Jeroen Janssens (2014). Data Science at the Command Line: Facing the Future with Time-Tested Tools. California: O'Reilly Media.

11. Lockdowns in the world // BBC NEWS. URL: https://www.bbc.com/news/world-52103747

12. Organization for Economic Co-operation and Development website [Electronic resource]. URL: https://www.oecd.org/

13. Wes McKinney (2017). Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython. California: O'Reilly Media.

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Real-Time Multi-Agent Pathfinding for Video Games

ABSTRACT.
Character navigation and pathfinding are some of the fundamental components of modern video games. One of the challenges of implementing a path planning system is to give artificial intelligence agents the opportunity to act cooperatively, i. e., to take into account each other's movement. For example, one agent may need to give way to another agent or avoid a crowded area to get to the goal faster. The solution could be to use a multi-agent pathfinding system designed for effective real-time computing so that it would be able to build incomplete suboptimal paths and interleave planning and plan execution. This paper presents a software project that aims to implement such a system as a plugin for the Unreal Engine 4 game engine. In the course of the work, an asynchronous system of cooperative navigation on a two-dimensional grid with performance and movement settings was created.
Keywords: *multiagent path planning; video games.*

Modern video games offer an endless source of practical tasks in the field of artificial intelligence (AI). They are often connected with the control of interactable in-game agents. Their actions should be elaborated in such a way that the player can see the agents as characters with logical behavior. Among many technologies that are used to create interactive worlds, the most common application of AI is path planning [1]. Without an effective system for passing obstacles, the agents cannot respond quickly to the players' actions, which leads to unresponsive gameplay.

One of the most popular requirements for path planning is the support of a large number of agents. The challenge here is to manage with the increased computational costs and collisions between agents. There are several areas of AI research that can be applied in these circumstances, and one of them is solving the Multi-agent Pathfinding problem (MAPF) [6]. The standard MAPF solution involves finding a path for each agent to its target, provided that certain types of collisions between agents are prohibited. However, in the context of video games, MAPF may have additional features. Although the performance requirements are high, the plans do not need to be optimal, however they should be adaptive to environmental modifications. The project presented in this paper aims to create a tool in the form of Unreal Engine 4 [7] plugin to use multi-agent pathfinding that is potentially suitable for these specifications.

A* is a standard algorithm for single-agent pathfinding. The core principle of A* is to maintain a closed list of nodes that store information about optimal paths and add nodes from an open list to it. The order in which the nodes are processed and moved from one list

to another depends on the value of the path length and the heuristic. This algorithm is widely used because of its straightforward structure and flexible customization capabilities.

Windowed Hierarchical Cooperative A* (WHCA*) [5] inherits the advantages of A* and offers a way to sequentially find single-agent paths in such a way that they do not invalidate each other. The core principle is to consider time and space as discrete values and maintain a space-time reservation table. This table stores space-time cells occupied by agents. So, when a new plan is requested, the algorithm can use A* which considers the cells of static obstacles and the cells of this table as non-traversable. While planning, we also need to analyze the adjacent space-time cells to check if the move between cells is valid.

The heuristic value of space-time A* is the distance between a cell and the goal in the environment without other agents (the real distance). To find this value the algorithm executes another A* (spatial A*) but this time in a two-dimensional space. To find the heuristic value of the cell which was not closed by the spatial A* we do not need to restart it from a new cell, because we can continue the execution of the A* main loop until the needed cell is closed. The only difference in terms of A* structure is that it is executed backward: from the goal to the start cell, expanding different cells on its way.

The next key feature is the windowed approach of WHCA*. To limit the search depth, we stop space-time A* when the first node with the desired depth is closed. The reason to choose the cell of this node is that it has the minimum value of heuristic which equals the real distance.

The original paper [5] also gives several techniques for using this algorithm in real-time computations and we are going to use them to describe a possible workflow of interaction with the navigation system in the next sections. Although space and time are considered discrete and the algorithm cannot guarantee to find a cooperative plan in some situations, WHCA* gives us a flexible scalable architecture suitable for practical implementation.

Implementation

A.   Algortihm realisation

The main challenge during the first steps of the development was to create a convenient class structure. As we mentioned, WHCA uses two types of A* for different graph structures. Since we tested our version of spatial A* using the format of data that was different from the data we used to work with MAPF problems, we needed a way to reuse a well-tested codebase to implement space-time A*. Moreover, spatial A* needed an upgrade to support search continuation. The solution is to create an abstraction of an A* class with separated virtual functions.

At first, we need a function to describe the main A* loop, which moves the nodes from the open list to close, gathers statistics such as time of execution and returns the found results.

We also need to separate the function which checks if a given node reaches a cell. This cell can describe not an exact location in space and time but some special rule. In terms of spatial A*, we just need to open a node, which holds a target cell with a precise location. However, in terms of space-time A*, we do not need to reach some precise cell in the reservation table; we need to check if it is as far from the start cell as we want our depth to be. We can mark the time variable of the target cell with a special value (-1, for example) to handle such behavior.

Then we need to implement a node expansion. The functionality of expanding some node in one direction to find or create another node does not change from one search to another. So, we can override the way we choose these directions and validate them based on the permitted moves, however, we do not need to override the expansion process.

The next part is to estimate the path length using heuristics. There is a problem that any legal move has the same cost because the time is discrete. It means that for an AI agent

a zig-zag trajectory is as efficient as a straight trajectory. To prevent this effect, we have a check inside the node expansion process which chooses between two nodes that are equally far away from the examined node in terms of the time spent.

Two types of A* are used by a WHCA class that executes them, stores accumulated results, plans, the list of agents, and a reservation table. It also adds functionality for moving the time of the internal clock and get the move that must be chosen by an agent. This clock should be looped to prevent errors during long algorithm execution. This functionality is combined with the technique described in the original paper [5] that separates agents into groups to reduce computation time. As our agents plan separately and consider the plans of other agents, we need to order them in some way. This order is just an array of identifiers. It can be separated into equal sections (the last section can be smaller than the others). The algorithm rebuilds the paths of the agents from the current section and moves to the next one. Then we move the internal clock and get new moves for all the agents. Then we can execute replanning again and continue infinitely. It is important to maintain the equation that connects the section size with the search depth:

$$\frac{agents}{section\ size} \leq \frac{depth}{2} \frac{agents}{section\ size} \leq d/2 \qquad \square\square\square$$

This equation can guarantee that every section will have a plan if we move time between other sections replanning. Also, every decision will be based on the information of at least half of the cooperation depth.

Sometimes agents can get stuck in crowded areas because of their fixed order, so we also swap agents randomly before section planning so that these agents still have enough planned steps.

The original work suggests keeping the result of the A* work at a low level so that if one needs to find heuristics, they do not need to start the process from scratch. We use this method while searching for the value of the heuristic, however, after planning for one agent, we do not save the state of A* for the next planning stages of this agent. Practical implementation and testing have shown that the running time of A* is small enough to run it from scratch for every agent. However, memory consumption while maintaining states for all the agents is not efficient enough.

B.   Testing platform

To develop a plugin, we initially created a command-line platform-independent application where a raw version of the algorithm can be executed and tested. This debugging environment helped us to monitor performance and validate the quality of the paths. This platform can collect performance statistics in tabular format, log results in different formats, read files from a Moving AI [6] task base. It also includes a visualization script on Python.

C.   Plugin implementation

Although the chosen algorithm spends relatively little time on replanning, it is still too much for synchronous operations. To use our algorithmic core outside the game loop thread Unreal Engine 4 thread pool can be used. It allows us to create the tasks to lock resources and execute pathfinding. An additional difficulty is to be able to quickly cancel planning, if necessary, although, this aspect of realization will be considered later.

Fig. 1. An example of a map with a length and width of 50 agents moving to their destinations in real-time with a consistently high frame rate.

To display the solutions of the algorithm we used the Visual Logger which is an Unreal Engine 4 subsystem to create and record visual representations of the gameplay state. As we have mentioned above, WHCA* uses a space-time reservation table. So, we decided to draw space-time cells to show what happens in the algorithmic core. The challenge here is to call the Visual Logger functionality in the main thread while plans are built outside it.
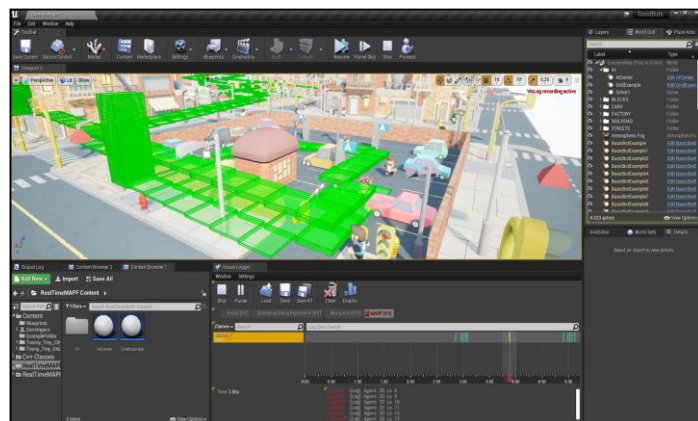
Fig. 2. The Visual Logger timeline can be used to check the history of algorithm decisions (green cuboids show the found paths).

Plugin structure

The first thing to do using our plugin is to create a grid map. Since the solver class communicates with an interface, the developer can choose either to implement grid functionality or to use classes from the plugin. The plugin grid class comes with an editor widget which makes it easier to configure the map. It can be used to change a cell size and choose traversable cells to better correspond with the objects on the scene.

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Fig. 3. An overview of the *GridEditor* widget usage in the editor.

The developer also has access to the example agent system class and the agent class. With their help, the developer can learn the basics of section-based planning and build visualizations of the algorithm functionality. To do this, it is enough to configure several details such as the size of the section and the tasks of the agents. In all the figures in this paper, these classes are used together with a set of animations and models. It is impor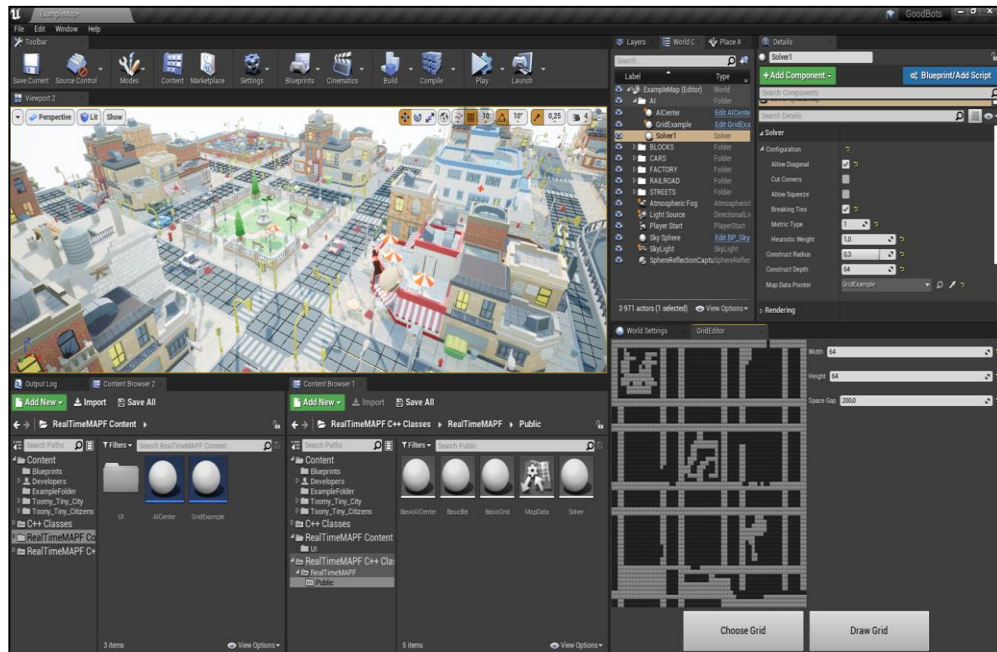tant to notice that the project objective is not to create a system to control character movement, their tasks, or other aspects of gameplay but to implement a pathfinding solver which decisions can be used to guide agents in the environment.

The resulting plugin is ready to provide basic functionality for real-time cooperative pathfinding. However, the current state of the plugin is just the beginning of a potentially major expansion of the existing Unreal Engine 4 systems. We are now going to describe a list of potential features that can expand the capabilities of the plugin and bring it to a high level of quality.

● Improved multithreading to plan several paths in parallel.

● Advanced planning cancellation which increases the responsiveness of the system.

● The support of different agent sizes and speed values.

- Rebuilding paths in case of environmental changes.
- Automatic grid construction.

To implement the listed features different techniques can be used including ideas from algorithms like SIPP [4], LPA* [3], M* [8], FAR [9].

Source code
https://github.com/MShepelin/RealTimeMAPF

References
1.   Botea A., Bouzy B., Botea A., Buro M. Bauckhage C., & Nau D. (2013). Pathfinding in games. Artificial and Computational Intelligence in Games. Dagstuhl Follow-Ups, 21-31.
2.   Holte R. C. (1996). Hierarchical A*: Searching abstraction hierarchies efficiently / R. C. Holte, Robert C., Maria B. Perez, Robert M. Zimmer and Alan J. MacDonald. AAAI/IAAI, Vol. 1, 530-535.
3.   Koenig S., Likhachev M., & Furcy D. Lifelong planning A*. Artificial Intelligence, 155, no. 1-2, 93-146.
4.   Phillips M., & Likhachev M. (2011). Sipp: Safe interval path planning for dynamic environments. IEEE International Conference on Robotics and Automation, 5628-5635.
5.   Silver. D. (2006). Cooperative pathfinding. AI Programming Wisdom, 3, 99–111.
6.   Stern. R. (2019). Multi-Agent Pathfinding: Definitions, Variants, and Benchmarks / R. Stern, N. Sturtevant, A. Felner, S. Koenig, H. Ma, T. Walker, J. Li, D. Atzmon, L. Cohen, T. K. Satish Kumar, E. Boyarski and Roman Bartak. arXiv: 1906.08291 [cs.AI].
7.   Unreal Engine 4 Documentation [Electronic resource]. URL: https://docs.unrealengine.com (Accessed 28.05.2021).
8.   Wagner G., & Choset H. (2011). M*: A complete multirobot path planning algorithm with performance bounds. 2011 IEEE/RSJ international conference on intelligent robots and systems, 3260-3267.
9.   Wang K. H. C., & Botea A. (2008). Fast and Memory-Efficient Multi-Agent Pathfinding. ICAPS, 380-387.

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An application for converting the equation of a second-order curve into canonical form

ABSTRACT.

Curves of the second order are one of the most interesting and difficult topics to study, the variety of problems directly related to curves and a sufficiently large number of inaccuracies in their solution, forces users to look for solutions to similar problems on the Internet. This project is aimed at developing an application that will help users cope with most of the arising problems.

The purpose of the work: a function that reduces a curve given in a general form to a canonical one and displays additional features for some straight lines (parabolas, hyperbolas and ellipses).

As a result of work on the project, the functions necessary to achieve the set goal were created: a function that returns the type of an equation, a function that returns a canonical equation. For hyperbola, the functions that return asymptotes, eccentricity, directrix, foci, and the tangent equation are additionally implemented. For the ellipse, the functions of finding foci, area, eccentricity, directrix and tangent equation are implemented. For a parabola - functions that return focus, directrix and tangent equation. In addition, the theoretical part of the project was presented at the conference "The youth in science: challenges and prospects".

Keywords: *second-order curve; general view; canonical form; parabola; ellipse; imaginary ellipse; pair of imaginary intersecting lines; hyperbola; pair of intersecting lines; pair of parallel lines; pair of imaginary parallel lines; pair of coinciding lines.*

Every year the number of applications that solve both everyday tasks and tasks related to non-trivial mathematical calculations is growing. The emergence of various mathematical applications helps students learn the material and avoid many mistakes.

One of the key topics in the study of analytical geometry is the topic "Curves" including curves of the second order and their classification. There are many tasks related to second-order curves: determining the type of a curve, reducing the equation of a curve to a canonical form, plotting a curve in a coordinate system and so on. Such a number of exercises on this topic generates a demand for an application that receives the equation of a second-order curve as input in a general form and helps to check the result obtained in the process of solving the problem, as well as, if necessary, displays some features of a given curve (type, parameters, location in relation to the original coordinate system).

The research tasks of the present work are the following: to study the research area, to analyze the existing solutions, to define functional requirements for the application, to write the documentation. The main task is to implement functions that allow us to perform necessary calculations and transformations. Namely, these functions can be as follows:
• a function that returns the type of the curve;
• a function that returns the canonical equation of the curve;

The project goal is to create a working application for converting the second-order curve to the canonical form.

To reach the goal it is necessary to analyze the existing solutions in terms of positive and negative aspects of some site designs. These observations can be crucial in the course of creating an application within our project.

The existing solutions to this problem are various sites in which it is necessary to enter the coefficients into the equation of the curve in general form and obtain the result.
1)   math.semestr.ru (Math.semestr.ru, 2021):

The following advantages of the site can be distinguished:
• detailed description of all transformations;
• definition of the type of curve;

• finding the corresponding transformations of coordinates.

Among the disadvantages of the site, we can mention the following points:
• when determining the type of a curve, coinciding straight lines, imaginary intersecting straight lines, imaginary ellipse are not taken into account;
• The specified curve (rotation by a specified angle, translation parallel to the coordinate axes) can not be transformed.

2)   kontrolnaya-rabota.ru (Kontrolnaya-rabota.ru, 2021):

The following advantages of the site can be named:
• two methods of solution with a detailed description of all transformations;
• the type of the curve is determined;

Among the disadvantages of the site, we can find the following points:
• unnecessary information accompanying the transformation;
• there is no graph of the given curve.

3)   mathhelpplanet.com (Mathhelpplanet.com, 2021):

The following advantages of the site can be described:
• concise description of all transformations;
• precise definition of the type of curve;
• availability of theoretical information to support the conclusions drawn about the type of curve.

Among the disadvantages of the site, we can observe the following:
• The specified curve (rotation by a specified angle, translation parallel to the coordinate axes) can not be transformed.

Thus, the main disadvantages that should be taken into account when creating the application can be identified:

1)   it is required to implement the functionality that competitors lack (that is both the main curves of the second order: hyperbola, parabola, ellipse, and coinciding straight lines, imaginary intersecting straight lines, etc.);
2)   the description of the curve transformations should not be overloaded with unnecessary information;
3)   transformations of a given curve must be available (rotation by a given angle, translation parallel to the coordinate axes).

It should be mentioned that functional and non-functional requirements for the program is another essential factor to be considered at the preparatory stage of our project design.
1)   Functional requirements for the program:

In addition to the basic functions described in the "Introduction" section, a function that makes up the equation of the tangent of the curve should be additionally implemented:
• a function that performs curve compression;
• a function that defines the tangent to the curve;
• a function that returns the vertices of the curve;

It is also necessary to implement a number of functions that determine the features of specific curves:
1.   Parabola:
• a function that returns the focus of a parabola;
• a function that returns the directrix of a parabola.
2.   Hyperbola:
• a function that returns the asymptotes of the hyperbola;
• a function that returns the eccentricity of the hyperbola;
• a function that returns the directrix of the hyperbola.
3.   Ellipse:
• a function that returns the area of an ellipse;
• a function that returns the eccentricity of the ellipse;
• a function that returns the ellipse directrix;

2)   Non-functional requirements for the program:

• Reliability of the program: regardless of the input, the program should work correctly and should not terminate abnormally;
• Requirements for technical equipment: installed Python interpreter version 3.6 or higher.

You can find the sources of this project by following link: *https://github.com/lavender-eclair/Project_hse*

Description of the implemented functions:
1) Function What_curve returns the type of the curve: the method is used to determine the second-order curve by invariants. The function accepts the input data in the array format, then it checks that the curve with the given values is a curve of the second order. To do this, it is checked that the coefficient for at least one leading coefficient is not equal to 0. If the check is not performed, the function returns: "The equation does not define a curve of the second order." If the check is passed, then the necessary determinants are calculated and in accordance with the table (Mathhelpplanet.com, 2021) given below, the type of the curve is returned in the format of a string.

Classification of second-order lines

Species feature	Line name
$\delta > 0, \Delta \neq 0, \tau \cdot \Delta < 0$	ellipse
$\delta > 0, \Delta \neq 0, \tau \cdot \Delta > 0$	imaginary ellipse
$\delta > 0, \Delta = 0$	pair of imaginary intersecting lines
$\delta < 0, \Delta \neq 0$	hyperbola
$\delta < 0, \Delta = 0$	pair of intersecting lines
$\delta = 0, \Delta \neq 0$	parabola
$\delta = 0, \Delta = 0, k < 0$	pair of parallel lines
$\delta = 0, \Delta = 0, k > 0$	pair of imaginary parallel lines
$\delta = 0, \Delta = 0, k = 0$	pair of coinciding lines

2) Function Roots_of_characteristic_polynomial calculates the roots of the characteristic polynomial of a matrix composed of the quadratic part of the equation. The function takes the input data in the array format and returns its roots.

3) Function Canonical_form returns the canonical equation of a straight line: a function that takes the values of function 2, composes an equation and displays it on the screen.

4) Function Asymptotes_hyperbola returns the asymptotes of the hyperbola: the function takes the result of function 2 as the input and performs substitution into the formula for the asymptotes of the hyperbola. The resulting equations in string format are the return values of the function.

5) Function Eccentricity_hyperbola returns the eccentricity of the hyperbola: the function takes the result of function 2 as the input and performs substitution into the formula for the eccentricity of the hyperbola. The calculated value is the return value.

6) Function Directris_hyperbola returns the hyperbola directrix: the function takes the result of function 2 as the input and performs substitution into the formula for the hyperbola directrix. The calculated values are the returned result.

7) Function Tangent_hyperbola returns the tangent to the hyperbola at a given point: the function takes the result of function 2 as the input and the point where the tangent function must be found. First, the belonging of the given point to the hyperbola is checked, if the check is not performed, then the function returns: "The point (x_0, y_0) does not belong to the hyperbola". If the point satisfies the equation of the hyperbola, then the tangent equation is returned in string format. The formula for the tangent is given below (Publish.sutd.ru, 2021).

$$\frac{xx_0}{a^2} - \frac{yy_0}{b^2} = 1$$

8) Function Square_ellipse returns the area of an ellipse: the function takes as input the result of function 2 and calculates the area of an ellipse using the formula (Microexcel.ru, 2021):

$$S = \pi ab$$

9) Function Eccentricity_ellipse returns the eccentricity of the ellipse: the function takes the result of function 2 as the input and performs substitution in the formula for the eccentricity of the ellipse. The calculated value is the return value.

10) Function Dirictris_ellipse returns the ellipse directrix: the function takes the result of function 2 as the input and performs substitution into the formula for the ellipse directrix. The calculated values are the returned result.

11) Function Tangent_ellipse returns the tangent to the ellipse at a given point: the function takes the result of function 2 as the input and the point where the tangent function must be found. First, the belonging of the given point to the ellipse is checked, if the check is not performed, the function returns: "The point (x_0, y_0) does not belong to the ellipse". If the point satisfies the equation of the ellipse, then the equation of the tangent line is returned. The formula for the tangent is given below (Publish.sutd.ru, 2021).

$$\frac{xx_0}{a^2} + \frac{yy_0}{b^2} = 1$$

12) Function Focus_parabola returns the focus of the parabola: the function takes the value of function 2 and returns the point with coordinates (p / 2, 0).

13) Function Directris_parabola returns the directrix of the parabola: the function takes the value of function 2 and substitutes the directrix of the parabola into the equation. The function returns the resulting equation in the format of a string.

14) Function Tangent_parabola returns the tangent to a parabola at a given point: the function takes the result of function 2 as the input and the point where the tangent function must be found. First, the belonging of the given point to the parabola is checked, if the check is not performed, then the function returns: "Point (x_0, y_0) does not belong to the parabola". If the point satisfies the equation of the parabola, then the tangent equation is

returned in the string format. The formula for the tangent is given below (Publish.sutd.ru, 2021).

$$yy_0 = p(x + x_0)$$

The main result of the work is the implementation of the declared function. What concerns the anticipated results of the project further development of the project is possible in the following directions:

1) improvement of the application for the convenience of the consumer;

2) implementation of functions that display the graphs of curves on the screen and change the graph (rotation of the curve by a given angle, transfer of the graph relative to the coordinate axes);

3) implementation of the rotation functions of a second order curve at any given angle with the following integration into SymPy.

References

1. Docs.sympy.org. [Electronic resource]. – Access mode: https://docs.sympy.org/latest/modules/geometry/ellipses.html#sympy.geometry.ellipse.Ellipse (Date of application: 07.02.2021)

2. Ilyin V.A., Kim G.D. (2007). Linear Algebra and Analytic Geometry: textbook. 3rd ed., rev. and add. M.: TK Welby, Prospect Publishing House, 400.

3. Kontrolnaya-rabota.ru. [Electronic resource]. – Access mode: https://www.kontrolnaya-rabota.ru/s/analiticheskaia-geometria/canon/ (Date of application: 07.02.2021)

4. Mathhelpplanet.com. [Electronic resource]. – Access mode: http://mathhelpplanet.com/static.php?p=onlain-opredelit-vid-krivoy-poverkhnosti (Date of application: 07.02.2021)

5. Math.semestr.ru. [Electronic resource]. – Access mode: https://math.semestr.ru/line/curve.php (Date of application: 07.02.2021)

6. Microexcel.ru. [Electronic resource]. – Access mode: https://microexcel.ru/ploshhad-ellipsa/ (Date of application: 05.04.2021)

7. Publish.sutd.ru. [Electronic resource]. – Access mode: http://publish.sutd.ru/e_books/analit_geometr_2014/glava/analiticheskaya_geometria_na_ploskosti/kasatelnie.html (Date of application: 05.04.2021)

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The Age of Artificial Intelligence or How Far Has Humanity Gone in Search of Answers to its Questions

ABSTRACT.

This study provides fundamental information about AI in plain language to people professionally uninvolved with this technology. I collected the data for the study through the analysis of articles from various specialized sources, as well as video lectures directly related to the study of artificial intelligence. This comprehensive study will properly implement a simplified approach to complex information. All the information that is going to be delivered will become attainable for everyone to assimilate, which will make it easier for even a small child to understand. For a more effective assimilation of specific information, this study will use video and audio tracks, as well as memes. However, this research includes some limitations. There is a likelihood that the topic will be incomprehensible to someone since each person possesses a different speed of receiving and processing information. By learning something new about technologies like artificial intelligence, the human brain can only remember more factual information through direct interaction with this technology. Despite all the difficulties faced, I chose this topic, since the main reason is my personal interest. For me, this is a rewarding experience with complex material and an unprepared audience. My involvement in the process and a sincere desire to share this information were the key points that led to this research.

Keywords: *artificial intelligence; technology; development; future; algorithm; innovation.*

Over the years, humanity has developed in many directions. The further we move in time, the brighter and more incredible discoveries, inventions, and improvements appear in what was created relatively recently, in what has survived for many years of evolution and continues to exist to this day. If we look back, we will be surprised at how quickly the world of technology has been evolving. It has been growing at a faster rate than any other science and taking less time to spread wider than ever before, for example, it took about 10,000 years from writing to the printing press, and only about 500 years to email. In the present circumstances, it seems that we are on the verge of a new age that will change the comprehension of everything we know about the modern world. And its name is the age of A.I. Let us take a look at the definition.

«Artificial intelligence (AI) refers to the computer simulation of human intelligence in machines programmed to think like humans and mimic their actions. The term can equally be applied to any computing machine that exhibits traits associated with the human mind, like learning and problem-solving» [2].

What does it imply? You and I have a lot in common in that we completely, or in principle, do not understand all the intricacies of this technology. Although there is a pool of engineers working on AI development all over the world, their number is only growing. Most ordinary people know little about this and cannot come up with a few words to describe it somehow, although the Internet is full of data and opinions on this matter. I strongly believe in the saying that the best way to learn about a subject is to teach it to others. As a result, I think now is the time to open this Pandora's Box and debunk some of the common misconceptions about supposedly complex things we thought we did not understand, but probably will soon get the hang of. The terms like «machine learning», «algorithms», «computer vision», and «big data» will be conveniently unpacked to help each of us feel like we fully understand what we are talking about.

Motivation

The ideal description of the true capabilities of Artificial Intelligence is its ability to rationalize situations and tasks and instantly take actions that have the greatest chance of achieving the result of a specific goal.

As a result of continual use and gradual improvement of this development, it turned out that two dominant categories of AI can be tracked:

• Narrow AI: This type of artificial intelligence, sometimes referred to as "weak AI", works in a limited context and is only an imitation of human intelligence. Narrow AI is often focused on performing tasks in one category efficiently, and while these machines may seem smart, they operate with far more constraints than even a small child [5].

• Artificial General Intelligence (AGI): AGI, sometimes referred to as "strong AI", is a type of artificial intelligence that we see in movies, like robots from the Western world or data from Star Trek: The Next Generation or the main robot from The Terminator. AGI is a versatile intelligent machine that, like humans, can use this intelligence to solve any problem [ibid.].

However, an intriguing question arises. After all, everything that happens to a person and inside a person, except for the most ordinary human behavior, is referred to as intelligent actions, and even the most complex behavior of insects is never considered an indicator of intelligence. Then how can you track the presence of this intelligence in a programmed machine?

The pioneer in the study of this issue was the mathematician Alan Turing. Less than ten years after the Nazi encryption machine Enigma was hacked, and the Allied forces got help for to win World War II, he changed history for the second time by asking the simple question: "Can machines think?"

Turing's paper «Computing Machines and Intelligence» (1950) and the subsequent Turing test established the fundamental goal and vision of artificial intelligence.

By that time, AI's only goal was to answer yes to Turing's question. It was then that the first attempt was made to reproduce or simulate human intelligence in machines.

The broad purpose of artificial intelligence has generated many questions and controversies. So much so that the only definition of this field available became unacceptable.

The major limitation in defining AI as "creating intelligent machines" is that it does not explain what artificial intelligence is. In their groundbreaking textbook «Artificial Intelligence: A Modern Approach» authors Stuart Russell and Peter Norvig tackle this problem by integrating their work around intelligent agents in machines. This means AI is "the study of agents who perceive the environment and perform actions." [1, p. 26]. In other words, it is the ability of a machine to perform its actions with the help of special software assistants (agents) that receive and analyze signals transmitted from the external environment.

Norvig and Russell continue exploring four different approaches that have historically defined the realm of AI:

• Thinking humanly
• Thinking rationally
• Acting humanly
• Acting rationally

The first two ideas are about thought processes and reasoning, while the others are about behavior. Norvig and Russell emphasize the rational components that act to achieve the best result, noting that "All the skills needed for the Turing Test also allow an agent to act rationally." (Russell & Norvig, 2016).

While these definitions may seem abstract to an average person, they help focus the field of computer science and provide a blueprint for implementing machines and programs with machine learning and other subsets of artificial intelligence.

Addressing the crowd at the Japan AI Experience 2017, DataRobot CEO Jeremy Achin kicked off his talk with the following definition of how AI is being used today: «AI is a computer system able to perform tasks that ordinarily require human intelligence... Many of these artificial intelligence systems are powered by machine learning, some of them are powered by deep learning and some of them are powered by very boring things like rules» [5].

Next, we will focus on the first two categories of artificial systems, since their development possesses enormous potential and already in our time one can observe examples of breakthrough technological projects that are ready to solve seven fundamental problems identified in artificial intelligence. This list includes:

1.   **Computing Power.** The amount of power consumed by power-hungry algorithms represents the limiting factor for most developers. Machine learning and deep learning remain the cornerstones of this AI, and it requires more cores and GPUs to run efficiently. Various fields are available for deep learning, from automatic driving to medical devices [4].

2.   **Trust Deficit.** One of the most critical reasons for concern about AI is the unknown nature of how deep learning models predict an outcome. It is challenging for an average person to comprehend how a certain set of inputs can achieve solutions to various problems [ibid.].

3.   **Limited Knowledge.** Although the share of the labor market focused on AI is constantly increasing, the real problem — the number of people who understand AI — still lags other high-tech developments. Beyond technology enthusiasts, college students, and researchers, there are only a few people who realize the potential of AI [ibid.].

4.   **Human-level.** This is one of the most significant challenges in artificial intelligence, because of which researchers are constantly pursuing opportunities to use artificial intelligence services in companies and startups. These companies boast over 90% accuracy, but people can do better in these scenarios. For example, a model predicts whether an image is a dog or a cat. A person can predict the proper result almost every time, achieving a staggering accuracy of over 99% [ibid.].

5.   **Data Privacy and Security.** The leading factor on which all deep and machine learning models are based remains the free availability of resources to train them. Absolutely, we do possess data, but since this data comes from millions of users around the world, there is a possibility that this data could be used for personal gain [ibid.].

6.   **The Bias Problem.** The good or bad nature of an artificial intelligence system depends on the amount of data from which it gains knowledge. Hence, being able to get good data offers a solution for good AI systems in the future. But in reality, the day-to-day data that organizations collect is scarce and irrelevant [ibid.].

7.   **Data Scarcity.** As large companies such as Google, Facebook, and Apple face accusations of unethical use of generated user data, various countries, such as India, have adopted strict IT regulations to restrict the flow. As follows, these companies are currently experiencing the challenge of using local data to develop applications for the world, which can lead to bias. Some companies are trying to implement new methodologies and are focusing on creating AI models that can produce accurate results, despite a lack of data. Because of biased information, the entire system can become incorrect [ibid.].

Solution

There are many revolutionary discoveries and incredible inventions taking place in the world. Every year, we can observe the gradual development of various technologies from the field of informatics. Next, you will learn about some of the most interesting and innovative developments that have radically influenced human life.

A.I. and Speech Recognition

Let us get down to something more mundane and more real to implement.

Speech recognition, the ability of devices to respond to voice commands. Speech recognition simplifies the management of various devices and provides input for automatic translation and printing of texts. The first applications for speech recognition were automated telephone systems and specialized software.

In the beginning, the sound of the voice is converted into a waveform, which is in fact just a picture of the sound. The waveforms are then matched with the transcriptions or "labels" for each word. These marker cards exist for most words in the English language. This is where machine learning takes over. Using millions of voice samples, a deep learning model is trained to map input sounds to output words. The algorithm then uses rules like grammar and syntax to predict each word in the sentence. Thus, the AI can distinguish between "there", "their" and "they're" [3].

Can A.I. Make Real Art?

It's difficult to recall the last time Hollywood produced something truly unique. With this, there is a possibility that AI will figure it out. People repeatedly say creativity is the only thing that machines will never have. Amazingly, in fact, the opposite is true. Art and creativity are actually easier than problem-solving. We already have computers that create brilliant images, that generate indistinguishable music from music composed by humans, so machines are incredibly creative [ibid.].

The World's First A.I. Chef

NotCo - A.I. a startup with a humble mission... to save the planet by cutting back on meat. Their job is not to develop a plant-based alternative to popular animal proteins. Many companies are already achieving this. NotCo is trying to come up with something more elusive... taste and perception. Using A.I. an algorithm they call Giuseppe, they try to make people think they are eating steak, eggs, or milk when in reality they are... not [ibid.].

Building Synthetic Humans

The sanctuary of A.I. is a tech startup constructing what they call "synths," or synthetic people. Artificial intelligence in the body. Their mission is to develop machines that are physically, cognitively, and emotionally indistinguishable from humans. Doing so involves solving problems of engineering, computer science, neuroscience, even art, and design. But for Sanctuary, the problem of artificial human reproduction boils down to a deeper question about what it means to be a human. [ibid.].

We have no way of knowing if there are any other intelligent species in the universe. There is also no guarantee that a person will create a humanoid robot. But there are other pressing issues as well, like mind and body, adaptation, work and creativity, survival, preservation. Everything from the realm of fantasy and magic, and now only science. The challenges are still complex, but they are currently possible thanks to innovation, computing power, will, and enthusiasm. And yet, despite all this, a trace of the unknown remains. Technology is definitely changing us. The very idea of what it means to be human is changing. A.I. may represent the most valuable tool of humanity, but it is also just that. A tool. What we decide to do about it is up to people.

References

1.   Artificial Intelligence: Definition, Examples, and Applications. Available at: https://www.britannica.com/technology/artificial-intelligence (accessed Feb 19, 2021)

2.   How Artificial Intelligence Works (2021) Available at: https://www.investopedia.com/terms/a/artificial-intelligence-ai.asp#:~:text=Artificial%20intelligence%20(AI)%20refers%20to,as%20learning%20and%20problem%2Dsolving (accessed Feb 19, 2021)

3. The Age of A.I. (2020) Available at: https://www.youtube.com/playlist?list=PLjq6DwYksrzz_fsWIpPcf6V7p2RNAneKc (accessed Feb 20, 2021)

4. What is Artificial Intelligence? How Does AI Work? Available at: https://builtin.com/artificial-intelligence (accessed Feb 19, 2021)

5. These five AI developments will shape 2021 and beyond. Available at: https://www.technologyreview.com/2021/01/14/1016122/these-five-ai-developments-will-shape-2021-and-beyond/ (accessed Feb 19, 2021)

6. Education, I. (2020). What is Artificial Intelligence (AI)? Available at: https://www.ibm.com/cloud/learn/what-is-artificial-intelligence (accessed Feb 19, 2021)

7. What is Artificial Intelligence (AI)? Definition, Benefits and Use Cases. Available at: https://www.techtarget.com/searchenterpriseai/definition/AI-Artificial-Intelligence (accessed Feb 20, 2021)

8. Russell, S. J., & Norvig, P. (2016). Artificial intelligence: a modern approach. Pearson.