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DATA SCIENTIST: A GLANCE INTO THE FUTURE

A comprehensive system approach to determine the qualification characteristics of a data scientist, the newest profession in the field of data analysis, is presented. The inconsistency of traditional methods to overcome the problems of big data processing and the advantages of Data Mining technology in solving these problems has been proved. The examples of practical activity of data scientists were considered. The analysis of the training of analysts in the higher education system of Ukraine was conducted.

Keywords: Data Scientist, Data Mining, Big Data, System Analysis, Artificial Intelligence, Business Intelligence, Intellectual Data Analysis.

Роскладка А., Иванова Е., Кулаженко В. Data scientist: взгляд в будущее. *Представлен комплексный системный подход к определению квалификационных характеристик Data Scientist – новейшей профессии в области анализа данных. Доказана несостоятельность традиционных методов преодоления проблем обработки больших данных и преимущества технологии Data Mining в решении этих проблем. Рассмотрены примеры практической деятельности Data Scientists. Проведен анализ подготовки специалистов-аналитиков в системе высшего образования Украины.*

Ключевые слова:Data Scientist, Data Mining, Big Data, системный анализ, искусственный интеллект, бизнес-аналитика, интеллектуальный анализ данных.

Background. The world information amount has reached a gigantic scale. It eloquently indicates that 90 % of the data acquired by humanity during its existence has been received over the past two years. In the next two years, by 2020, the amount of data will double to 40 000 exabytes (1 exabyte = 2^{60} bytes) (*figure 1*).

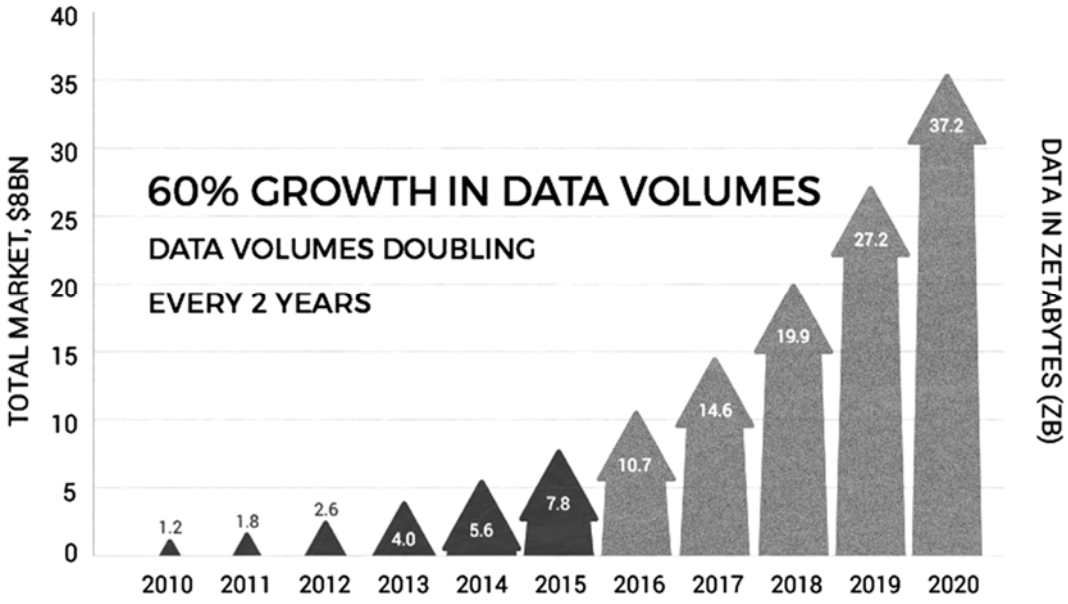

Figure 1. Growth in data volumes, 2010–2020[1]

When analyzing big data by «traditional» methods, a number of problems arises that lead to a significant elimination of the obtained results. The main problem is the use of huge arrays of disordered uncorrelated information, which greatly complicates the analysis without prior processing by a data scientist. In addition, it leads to inefficient use of hardware to operate and store these data. Solving such problems is a priority task of a data scientist, which may complete this task within a few months.

Analysis of recent research and publications. J. Manyika [2] disclosed the importance and prospects of dynamic growth of data volumes and appropriate techniques dealing with digital data, but the research has a rather extended (macro and micro) focus on big data without specifying the professional competencies of a specialist who directly works with big data to deliver value to managerial decisions. R. Gehl [3] contributed to the historical background of a data scientist in the context of big data and the knowledge economy and summarized appropriate genealogic changes in this profession. R. Mitchell [4] outlined the trends in the cutting-edged technologies of big data analytics that should fill up the toolset of a modern

data scientist. Ain.ua [5] provides the simplified and short explanation of modern technologies of data science, cognitive science, machine learning, neural networks and data scientist work in the IT industry; however, the presented logic of the provided IT trends missed the detailed specificity and relevance of a data scientist training. Along with application in a business sector, big data usage in training practice of data mining and data analytics is clarified by K. Sin and L. Muthu [6]. It expands the scope of recruitment and involvement of a data specialist into modern business practice.

Education in data science becomes the prerogative of modern competitive universities and scientific schools that are able to build a bridge between the business and educational service sectors. This is the work of I. Song and Y. Zhu [7] who successfully specified the data science education and a data scientist training in U.S. as the practice to follow to. Nevertheless, Datascientist.com [8] revealed the advanced portfolio of a data scientist from the position of labor market entry, personal traits, and professional skills. Moreover, the analyzed curriculums of foreign universities [9; 10] and job overviews in data science [11–13] confirmed the necessity to train this specialist in the fastest growing sector of the world economy and his competitiveness in the global labor market.

Currently the data science research in Ukraine is at the lowest level, namely, the number of Ukrainian-language publications is low. Thus, one of the most popular U.S. retail services amazon.com gives the following results for search queries in the category «Books» over the past 90 days: «Big data» – 417 results, «Data Science» – over 2000, «Data Mining» – 582, «Data Analysis» – 525. Instead, the Ukrainian service Yakaboo.ua gives the following results for the same search queries but without time constraints: «Big data» – 1 Ukrainian-language output, «Data Science» – 2, «Data Mining» – 2, «Data Analysis» – no specialized editions in the Ukrainian language. The scientific periodicals demonstrate the same pattern. As a rule, individual domestic scientists use English literature as the sources of information. The achievements of foreign authors are also recommended when studying at workshops and training courses.

Data scientist is a new profession in Ukraine, which only begins to appear on the Ukrainian labor market. It is absent in the classifier of professions, but it gains popularity rapidly among domestic employers. All these facts require careful analysis of the qualitative characteristics of a data analysis specialist.

The **aim** of paperis to analyze the competences of a specialist in the field of data science and determine the prospects for the data science development and key aspects of the data analysts' training in the higher education institutions (HEIs) of Ukraine.

Materials and methods. Information sources for the article are open statistics from Gartner, IBM, Glassdoor, the World Economic Forum

reports held in Davos, the data of the Ministry of Education and Science of Ukraine on the results of the admission campaign of HEIs in 2018.

General research methods used in the article are the following: the methods of theoretical generalization and historical analogies, the classification method, the analytical and comparative methods to research the prospects of data science development and to form the comprehensive approach to the qualification characteristics of a data scientist.

Results. In a broad sense, data are facts, text, graphics, pictures and sounds, analog or digital video segments. Data resulted from measurements, experiments, arithmetic and logical operations. They should be presented in a suitable form for storage, transmission and processing. In other words, data are a raw material provided by data providers and used by consumers to generate information.

Data science technology makes it possible to turn data into information, and then information into knowledge. It is necessary to clearly separate the concepts of «data», «information» and «knowledge».

Traditional data analysis methods (statistical methods) are mainly focused on verification-driven data mining and raw intelligence analysis, which forms the basis of operational analytical processing (OLAP), while one of the main provisions of data mining is the search for non-obvious regularities. Data mining tools find these patterns independently and build the hypotheses about interconnections.

The main feature of data mining is the combination of broad mathematical toolkits (from classical statistical analysis to new cybernetic methods) and the latest advances in information technology. In data mining technology, strictly formalized methods and methods of informal analysis, i.e. quantitative and qualitative data analysis, are harmoniously combined. Most data mining methods have been developed within the framework of the artificial intelligence theory.

Data mining methods and algorithms include the following: artificial neural networks, decision trees, character rules, methods of the nearest neighbor and k-nearest neighbor, method of reference vectors, Bayesian networks, linear regression, correlation-regression analysis; hierarchical methods of cluster analysis; non-hierarchical methods of cluster analysis, including k-means and k-median algorithms; the methods for finding associative rules, including the Apriori algorithm; depth-limited search, evolutionary programming and genetic algorithms, various data visualization methods and many other methods.

Most of analytical methods used in data mining technology are well-known mathematical algorithms and methods. New aspect of their application is inclusion in solving specific problems due to the opportunities of new technical and software tools. Comparative analysis of the data mining method sincludes their characteristics of accuracy, speed, complexity, etc. (*table 1*).

Table 1

Comparative analysis of various methods of data mining [14]

Algorithm	Correctness	Scalability	Interpretation	Suitability for use	Complexity	Versatility	Speed	Popularity
Classical methods (linear regression)	Middle	High	Middle	High	Middle	Middle	High	Low
Neural Networks	High	Low	Low	Low	Middle	Low	Very low	Low
Visualization methods	High	Very low	High	High	Very high	Low	Extremely low	High
Decision Trees	Low	High	High	Middle	High	High	Middle	High
Polynomial neural networks	High	Middle	Low	Middle	Middle	Middle	Middle	Middle

The modern use of data science for big data processing is diverse [15]. Some of the practical examples of such use are given in *table 2*.

Table 2

Examples of practical use of data science and big data in different fields of human activity [16]

Field of use	Content
Business and Economy	Customer behavior analysis to maximize the likelihood of a purchase and a positive attitude towards a brand, the development of personal product offerings based on personal preferences; forecast of change in customer loyalty or refusal.
Retail	Forecast of consumer demand for certain goods; transport and warehouse capacity optimization based on the needs of sales points
Financial Analytics	Forecast of financial instrument prices, estimation of likelihood of a favorable transaction conclusion; modeling of signal generators for successful loan returns or attraction of investments
Social communication	Search for hidden links between social network users; study of public discussions of various social, economic and political issues; analysis of a user voice tone, thematic modeling, selection of central users of discussion and opinion leaders
Medicine	Analysis of the experience of real patients for the deeper understanding of drug action mechanisms; clustering of diseases, treatment types or their symptoms, taxonomy of patients and drugs
Police and security service	Development of a patrol schedule based on the facts of crimes committed; forecast of the number and locations of patrol vehicles based on data on the number of crimes, their location, time, type and number of victims; optimization of a patrol route
Banking	Behavioral customer segmentation, fraud prevention system with the ability to explore atypically expensive purchases of popular products or multiple accounts opened in a short period with similar data.
Fire Security	Optimal allocation of resources for fire elimination; modelling of the dependence between the geographic distance of a fire station and the time that the brigade needs to get to a place, based on traffic information and accessibility of highways
Marketing	Segmentation of competitors and consumers
Management	Staff distribution into different groups, classification of consumers and suppliers, identification of similar production situations
Sociology	Distribution of respondents into homogeneous groups
Archeology	Taxonomy of stone structures and ancient objects

The necessary skills for a data scientist are divided into two types: business and technical (soft and hard skills). It is these skills and abilities that need to be addressed to become a data analyst [17; 18].

Technical (hard) skills:

- ability to acquire data from different sources;
- ability to perform pre-processing of data (cleaning, quantization, transformation, etc.);
- ability to work with data algorithms (classification, clustering, regression, etc.);
- use of programming languages for data analytics (Python, R, C++);
- ability to analyze and build reports in analytical platforms (Power BI, Deductor, etc.);
- ability to work with SQL databases;
- ability to work with big data technologies;
- ability to work with enterprise data analytics packets (SAS, SPS).
- *Business (soft) skills:*
- ability to validate the data analysis results;
- ability to make practical outcomes from data analytics results and apply in business;
- ability to interest decision makers;
- ability to search and find creative solutions in a specific subject area.

A more detailed and systematic list of hard and soft skills are presented in *figure 2.*

Figure 2. Hard skills and soft skills for a data scientist [19]

According to IBM [20], the demand for specialists in data science with advanced data analysis technologies will grow to 2,7 million by 2020. Harvard Business Review has identified a data analysis professional as «the sexiest job of the 21st century» [19].

The demand for data science specialists is growing rapidly every year (*figure 3*).

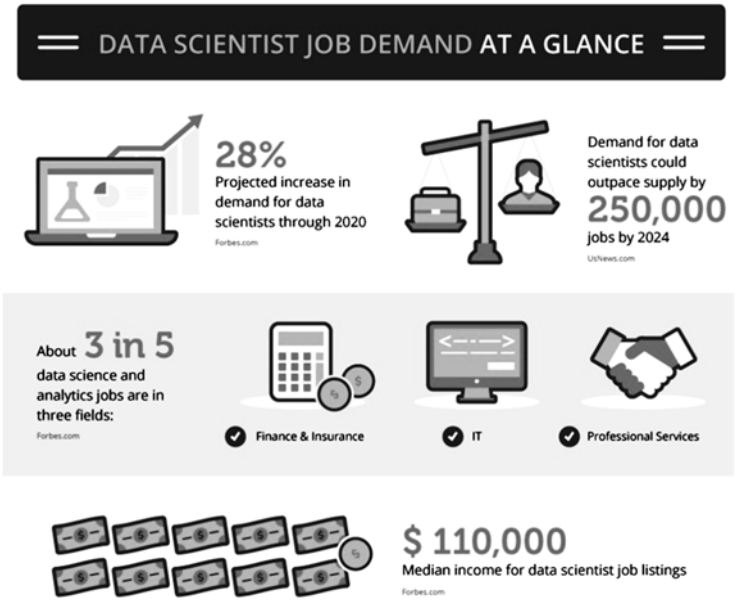

Figure 3. Data Scientist Job Demand [11]

The most authoritative job search website *Glassdoor*, which annually publishes the 50 most relevant professions, prefers data analysis specialists for three consecutive years (*figure 4*).

50 Best Jobs in America for 2019

Best Jobs | 2019 | United States

	Job Title	Median Base Salary	Job Satisfaction	Job Openings	
#1	Data Scientist	$108,000	4.3/5	6,510	View Jobs
#2	Nursing Manager	$83,000	4/5	13,931	View Jobs
#3	Marketing Manager	$82,000	4.2/5	7,395	View Jobs
#4	Occupational Therapist	$74,000	4/5	17,701	View Jobs
#5	Product Manager	$115,000	3.8/5	11,884	View Jobs
#6	Devops Engineer	$106,000	4.1/5	4,657	View Jobs
#7	Program Manager	$87,000	3.9/5	14,753	View Jobs
#8	Data Engineer	$100,000	3.9/5	4,739	View Jobs
#9	HR Manager	$85,000	4.2/5	3,908	View Jobs

Figure 4. Most relevant professions in USA [12]

Figure 5 shows the vacancies and wages of data analysis experts from the affiliates of the world's largest companies in San Francisco (USA).

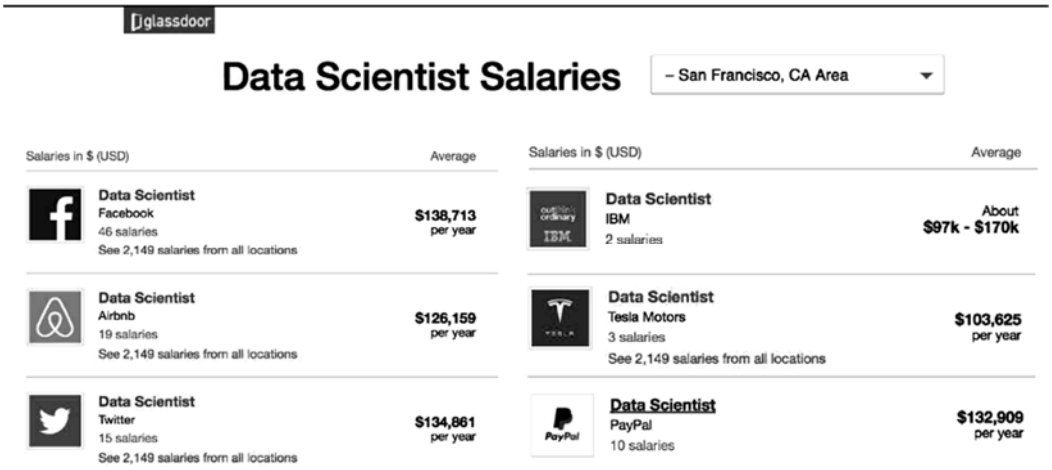

Figure 5. Requests for data scientists in San Francisco (USA) [12]

According to the World Economic Forum report [13], 85 % of companies in the world will need, first of all, data analysis specialists by 2022 (*figure 6*).

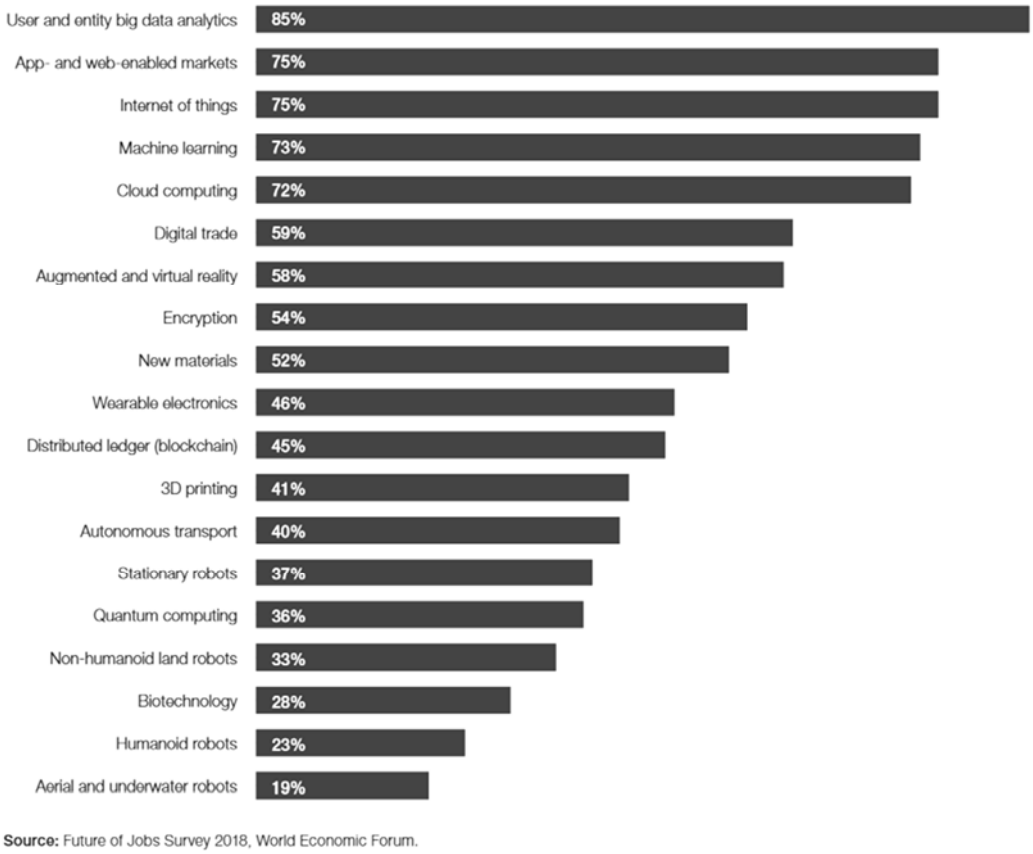

Figure 6. Technologies by proportion of companies likely to adopt them by 2022 [13]

In the World Economic Forum report, the analysis of both promising and redundant occupations is interesting (*figure 7*).

Stable Roles	New Roles	Redundant Roles
Managing Directors and Chief Executives	Data Analysts and Scientists*	Data Entry Clerks
General and Operations Managers*	AI and Machine Learning Specialists	Accounting, Bookkeeping and Payroll Clerks
Software and Applications Developers and Analysts*	General and Operations Managers*	Administrative and Executive Secretaries
	Big Data Specialists	Assembly and Factory Workers
Data Analysts and Scientists*	Digital Transformation Specialists	Client Information and Customer Service Workers*
Sales and Marketing Professionals*	Sales and Marketing Professionals*	Business Services and Administration Managers
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	New Technology Specialists	Accountants and Auditors
	Organizational Development Specialists*	Material-Recording and Stock-Keeping Clerks
	Software and Applications Developers and Analysts*	General and Operations Managers*
Human Resources Specialists		Postal Service Clerks
Financial and Investment Advisers	Information Technology Services	Financial Analysts
Database and Network Professionals	Process Automation Specialists	Cashiers and Ticket Clerks
Supply Chain and Logistics Specialists	Innovation Professionals	Mechanics and Machinery Repairers
Risk Management Specialists	Information Security Analysts*	Telemarketers
Information Security Analysts*	Ecommerce and Social Media Specialists	Electronics and Telecommunications Installers and Repairers
Management and Organization Analysts	User Experience and Human-Machine Interaction Designers	
Electrotechnology Engineers		Bank Tellers and Related Clerks
Organizational Development Specialists*	Training and Development Specialists	Car, Van and Motorcycle Drivers
Chemical Processing Plant Operators	Robotics Specialists and Engineers	Sales and Purchasing Agents and Brokers
University and Higher Education Teachers	People and Culture Specialists	Door-To-Door Sales Workers, News and Street Vendors, and Related Workers
Compliance Officers	Client Information and Customer Service Workers*	
Energy and Petroleum Engineers		Statistical, Finance and Insurance Clerks
Robotics Specialists and Engineers	Service and Solutions Designers	Lawyers
Petroleum and Natural Gas Refining Plant Operators	Digital Marketing and Strategy Specialists	

Source: Future of Jobs Survey 2018, World Economic Forum.

Figure 7. Examples of stable, new and redundant roles, all industries [13]

In Ukrainian HEIs unlike foreign universities (for example, [9; 10]), the data science training is just starting to develop. As aforementioned, the data scientist profession has not yet been reflected in the Ukrainian classifier of occupations, but local employers persistently impose appropriate require mentson the educational service market. Given the complexity and systematic nature of the data scientist training, we believe that the professional competencies identified in the higher education standard of the specialty 124 «System Analysis» most closely corresponds to employers' requests among the available specialties.

Currently 30 HEIs in Ukraine train students by the specialty «System Analysis», but only three universities position this specialty as the education in the field of data analysis – namely, Ivan Franko Lviv National University (specialization «Intellectual Data Analysis (Data Science)»), Ukrainian Catholic University (specialization «Information technologies and business analytics»), and Kyiv National University of Trade and Economics (specialization «Information technologies and business analytics (Data Science)». *Figure 8* presents the distribution of licensed volumes of training in the framework of the specialty 124 «System Analysis» by various regions of Ukraine.

Figure 8. Number of licensed volumes by regions in Ukraine

In 2016 the Kyiv National University of Trade and Economics [21] has obtained a license of the Ministry of Education and Science of Ukraine for the training by the specialty «System Analysis». The new study program «Information Technologies and Business Analytics (Data Science)» has opened in 2019 on the basis of this specialty.

This study program is developed for training of highly qualified specialists in the fields of the Data Science, Big Data, Data Analytics, Data Mining, Business Intelligence, Artificial Intelligence, and Machine Learning.

Kyiv National University of Trade and Economics meets all modern requirements for the training of highly skilled specialists in the field of Data Science. Currently a new business analytics lab is setting up at the Department of Cybernetics and Systems Analysis [22], which provides the training by this specialty. The lab will be equipped with powerful computers and special software for analysis, modeling, and visualization of data.

The training of analysts at the Department is carried out by experienced teachers, including doctors and PhD in economic, technical and physical-mathematical sciences. They are professionally involved in data modeling and analysis. Four teachers of the Department have «Data Science Instructor Bootcamp» certificates of international level, issued by IBM with the provided right to teach and certify data analysis specialists.

Conclusion. Data analysis allows solving problems in all areas, from business and government planning to personal life. Data science is not just a new fashion word in information technologies. It will change the approaches to programming, business, and even consumers no less than the invention of a steam engine or personal computer in their time. The work with information becomes a priority worldwide for any business with a professional scientific approach. Ukraine already needs talented data scientists, who are capable enough to process big data to support artificial intelligence platforms.

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Роскладка А., Іванова О., Кулаженко В. Data scientist: погляд у майбутнє.

Постановка проблеми. *Data Scientist є новою професією в Україні, яка тільки з'являється на українському ринку праці. Вона відсутня у класифікаторі професій, проте великими темпами завойовує популярність серед вітчизняних роботодавців. Усе це потребує ретельного аналізу якісних характеристик фахівця в галузі аналізу даних.*

Аналіз останніх досліджень і публікацій *показав, що попри наявність окремих наукових доробок, залишається невирішеною важлива науково-практична проблема щодо впливу глобальних дисбалансів на кредитний ризик банків.*

Мета *статті – аналіз компетентностей фахівця в галузі Data Science, визначення перспектив розвитку науки про дані та ключові аспекти підготовки фахівців з аналізу даних у закладах вищої освіти України.*

Матеріали та методи. *Інформаційними джерелами для написання статті слугували відкриті статистичні дані компаній Gartner, IBM, Glassdoor, звіти Всесвітнього економічного форуму, дані Міністерства освіти і науки України. У статті використано загальнонаукові методи дослідження: теоретичного узагальнення та історичних аналогій, класифікації, аналітичного та порівняльного аналізу.*

Результати дослідження. *Проведено порівняльний аналіз традиційних та новітніх методів аналізу даних, який дав змогу довести неспроможність традиційних методів подолати проблеми обробки великих даних та переваги технології Data Mining у вирішенні цих проблем. Розглянуто приклади практичної діяльності Data Scientists у різноманітних сферах.*

Представлено комплексний системний підхід до визначення кваліфікаційних характеристик Data Scientist, наведено технічні навички («жорсткі») та бізнес-навички («м'які»), якими повинен володіти професіонал у галузі бізнес-аналітики.

Проаналізовано процес підготовки фахівців-аналітиків у системі вищої освіти України та перспективи фахівців Data Scientists на українському ринку праці.

Висновки. *Аналітика даних надає можливість вирішувати проблеми у всіх галузях – від бізнесу та урядового планування до особистого життя. Data Science – це не просто нове модне слово у світі інформаційних технологій. Це те, що змінить світ програмування, бізнесу і навіть споживачів не менше, ніж свого часу його змінили винахід парового двигуна або персонального комп'ютера.*

Таким чином, робота з інформацією набуває в усьому світі пріоритетного значення для будь-якого бізнесу із професійним науковим підходом. І в Україні неминуче виникне потреба в талановитих Data Scientists, здатних обробляти великі масиви даних для підтримки платформ штучного інтелекту.

Ключові слова: Data Scientist, Data Mining, Big Data, системний аналіз, штучний інтелект, бізнес-аналітика, інтелектуальний аналіз даних.