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The world of data
A few words about the visualization of information

ABSTRACT

In the world of digital technologies, the creation and reception of information are based on data processing, which is an ordered structure of data stored as a sequence of zeros and ones. This representation has significant consequences on how to collect, process, visualize and analyze data. Currently, they are based mainly on algorithmic methods available from the application level, often generally open and free of charge. Data digitalizing is a challenge for researchers who, to practice digital humanities, should incorporate modern tools to improve their work with the massive amount of data available today. The aim of this article is describing the fundamental issues related to the exploration and visualization of data in the humanities. It is a contribution to the broader considerations.

KEYWORDS: Digital Humanities, digitalization, data, information, visualization

STRESZCZENIE

Świat danych. Kilka słów o wizualizacji informacji

W świecie cyfrowych technologii tworzenie informacji opiera się na przetwarzaniu danych, będących uporządkowanymi strukturami zapisanymi w postaci sekwencji zer i jedynek. Taka reprezentacja niesie ze sobą istotne konsekwencje dotyczące sposobów gromadzenia i przetwarzania danych, a w konsekwencji ich wizualizację i analizę. Procesy te opierają się głównie na algorytmicznych metodach, dostępnych

z poziomu aplikacji, często ogólnie dostępnych i nieodpłatnych. Narzędzia te dostępne są również dla humanistów. Aby uprawiać cyfrową humanistykę powinni oni włączyć je do swojego warsztatu badawczego. Celem artykułu jest przedstawienie podstawowej problematyki związanej z zagadnieniem eksploracji i wizualizacji danych w naukach humanistycznych. Stanowi on przyczynek do dalszych rozważań.

SŁOWA KLUCZOWE: humanistyka cyfrowa, digitalizacja, dane, informacja, wizualizacja

Data is Money, Data is Power,
Data is Everything and Everything is Data
Lev Manovich

Since the dawn of man, we have dealt with data. We measured and counted and collected results. We transformed data into information to build knowledge about the surrounding reality. The invention of printing has opened the possibility to multiply data and computerization has created the tools for their advanced analysis.[1]

The concept of data is ubiquitous in the modern world, describing something obvious, it would seem, requiring no explanation.[2] However, in order to establish a framework on which the data theory is based, one can make definitional arrangements recognizing that a datum is a basic, smallest unit of information, a term referring to its interrelated elements. In the world of digital humanities, this term already seems to be too simplistic. The concept of data in the humanities is a complex issue. Data analysis is first of all strictly dependent on the context in which it is being made. So, for example, in studies related to the analysis of literary works, it would be difficult to recognize words directly as data fragments and texts as their collections.[3]

1 See more K. Krzysztofek, *Big Data Society. Technologie samozapisu i samopokazu: ku humanistyce cyfrowej,* „Kultura i Historia", 21, 2012, http://www.kulturaihistoria.umcs.lublin.pl/archives/3626 [access 2.03.2018].

2 J. Drucker, *Introduction To Digital Humanities. Course Book. Concepts, Methods, and Tutorials for Students and Instructors*, 2014, p. 28, https://ia801202.us.archive.org/4/items/IntroductionToDigitalHumanities/Introduction%20to%20Digital%20Humanities.%20Concepts,%20Methods,%20and%20Tutorial%20for%20Students%20and%20Instructors.pdf [access 7.03.2018].

3 C. Battershill, H. Southworth, A. Staveley, M. Widner, E. Willson Gordon, N. Wilson, *Scholarly Adventures in Digital Humanities. Making The Modernist Archives Publishing Project*, Pallgrave MacMillan, Cham 2017, p. 133.

In the humanities, also the amount of digital data is increasing, the analysis of which and their huge size (Big Data) requires the use of specialized methods. Therefore, the need for tools for efficient and effective presentation of data in the humanities and their efficient presentation is growing, too. For this purpose, Big Data visualization tools are designed, along with methods of code-based visualization methods in programming languages.[4]

Humanists in cyberspace

In recent years, interest in digital humanities, a branch of science at the crossroads of humanities and computer science, has been growing. Its rising popularity is a consequence of the digitization of almost every area of our life, which also includes the world of science. Digital humanities cover a number of technologies such as the Internet, social media, databases, geographic and social mapping tools, linguistic analysis solutions, data analysis tools and more. The area of digital humanities is closely associated with hard science. "Humanistic" refers to the subject of research using these technologies: history, philosophy, art, religious studies, literary studies, modern and ancient languages, cultural studies and other disciplines of humanities.[5]

Digital humanities is a discipline which is not easily subjected to complex analysis due to the fact that along with progressive technological development, the research area connected with it is expanding as well. Therefore, further attempts to define and research related to the area of its application are constantly made. What is certain is that technology changes the way the people research in the humanities. Representatives of the humanities commonly use by digital materials while conducting research. This includes a wide variety of digital sources such Google Books, university repositories and others. Due to this, institutions and agencies (including government ones) worldwide are increasingly sharing resources in their databases that used to be available only to select employees.

The scientific workshop of the modern humanist has exceeded the space of manuscripts and printed sources. It has become clear that the now humanist must have powers that will allow him or her to analysis of massive amounts of data that are currently available only in digital form.

4 One of the newest book about data visualization: J.D. Miller., *Big Data Visualization*, Packt Publishing Ltd., Birmingham, 2017. *Big data* definition see: pp. 11-14.

5 S. Hai-Jew, *Data Analytics in Digital Humanities*, Springer, Cham 2017, p. VIII.

The contact with a huge number of data affects the research process. Researchers may avoid the selection of a sample and examine the entire set of data. In the case of the humanities, it is important, because it dramatically expands the research area. And so, for example, literary scientists can cover all the texts of the period they are interested in instead of basing their studies on a partial representation thereof.

Advances in computer science, including advanced algorithms, have opened up the possibility of quick and accurate analysis of digital data. There is no need to read many thousands of publications (which would be time consuming and impossible to achieve) in order to formulate conclusions on the relationship between the published works, such as the frequency of taking up similar themes or individual concepts (so-called distant reading).[6]

Digital humanities use the whole range of possibilities offered by encoding, algorithms and support for large amounts of data. The data on which it is based emerged as a result of digitization of texts of culture or are associated with cultural heritage which was already created in the digital environment. Therefore, as it were by their very nature, they belong to the virtual world of digital electronics (more and more scientific journals are sharing their resources solely in electronic form). Nowadays, most – if not all – digital humanities projects are based on digitized data.[7]

Research methods previously used in the humanities are no longer sufficient. This applies e.g. cultural scientists and sociologists, who acquire the research material in the fast-changing digital environment (e.g. social networks or open databases). In turn, religious scientists or historians have gained access to a huge amount of historical data from open databases (e.g. open source data from GitHub).

Using new analytical tools the humanist can answer many questions, find many dependencies between objects, texts, events, etc.[8] An example of a project using text analysis tools is Open Source Shakespeare: An Experiment in Literary Technology. An exploration of words used in all of Shakespeare's works, indicates that the word *happy* shows up in 238 entries, whereas the word *unhappy* appears in 41 instances. The project

6 S. Sinclair, G. Rockwell, *Text Analysis and Visualization*, [in:] *A New Companion to Digital Humanities*, S. Schreibman, R. Siemens, J. Unsworth (eds.), Wiley Blackwel, Malden 2016, p. 282.

7 T. Koltay, *Information Overload in a Data-Intensive World*, [in:] A.J. Schuster (ed.), *Understanding Information. From the Big Bang to Big Data*, Springer: Cham 2017, pp. 202-203.

8 See more: G. van Schie, I. Westra, M. Tobias Schäfer, *Get Your Hands Dirty. Emerging Data Practices as Challenge for Research Integrity* [in:] *The Datafied Society Studying Culture through Data*, M. Tobias Schäfer, K. van Es (eds.), Amsterdam University Press, Amsterdam 2017, pp. 184-186.

allows one to not only find the number of occurrences of the words, but also to analyze the contexts in which they occur.[9]

In Poland, the popularity of the digital humanities dates back to 2012, when a conference in Lublin dedicated to digital humanities, entitled "Digital turn in the humanities" took place. A few years have passed since then, however, advanced research in the digital humanities are taken up in few national science centers. This is mainly due to the lack of appropriate competence and knowledge needed for programming and operating complex digital tools. Therefore, it is so important to develop a research methodology that would employ digital tools in the humanities. However, it is worth mentioning that the Polish universities that do become involved in digital humanities, do it in a thoughtful manner and the results of their activities are studies that include this broad discipline.[10]

Treatment of sources as data means that at some point the analysis process they must be treated as numbers. Geographic spaces are represented by latitudes and longitudes and texts are reduced to tokens. Many of the methods of the digital humanities are based on mathematics, and consequently the understanding of the basic principles of mathematics is necessary for their use. Calculation methods allow the humanists to explore a lot more sources than before and discover phenomena that the traditional research methods would not be able to see.

At the basis of modern methods there is a set of more basic skills for working with data that allow an efficient and correct research work. Some of these skills include understanding the structure of data structure, the ability to read them in programs and the ability transform them into a new quality. Humanists must therefore work with structures such as arrays, matrices, records, CSV files and many other representations of data.

The development and improvement of digital tools have marked the beginning of the process of digitization of centuries-old cultural heritage which was preserved in the traditional form (manuscripts, printed texts, images). In large part it is available today in a digital form, which brings with it new editing capabilities, analysis, formulation of conclusions, scientific hypotheses and their verification.[11] In this way, the humanities

9 S. Henderson, E.H. Segal, *Visualizing Qualitative Data in Evaluation Research*, "Data Visualization, Part 1", 139, 2013. p. 57; website of the project: www.opensourceshakespeare.org [access 2.03.2018].

10 According to the subjective opinion of the author of this text, one of the most interesting analyzes of issues related to digital humanities in: Radosław Bomba, Andrzej Radomski, Ewa Solska (eds.), *Humanistyka Cyfrowa. Badanie tekstów, obrazów i dźwięku*, E-naukowiec: Lublin, 2016.

11 See more: D. Cook, L. Eun-Kyung, M. Majumder, *Data Visualization and Statistical Graphics in Big Data Analysis*, "Annual Review of Statistics and Its Application", 3/2016, pp. 133-139.

have begun to apply computational technologies, supporting the responses to new research questions.

Issues of scientific data visualization

Data visualisation is a great and powerful tool of communicating a message and the strongest tool of exploratory data analysis. It is, therefore, not surprising that in the last quarter of a century, research on visualization has become an important part of science. Initiated in the 1990s, it seemed to be a branch of science that would be easy to define. It was also born primarily out of interest in the media such as television or advertising, they relied on the methodology of the other areas of science, especially cultural studies. Visual studies analyses mainly referred to the work of such theoreticians as Michel Foucault, Walter Benjamin, Roland Barthes or Jacques Lacan[12]. Soon, however, in the face of a dynamic development of digital media, their theories began to be insufficient. They did not fit into the issues and subject area of the digital nature of information. Ubiquitous digitalization began a new phase of research, in which digital nature of data has been taken into account, and hence the possibility of exploration.

The concept of visualization is not easily put into a framework of the definition. Stating that it is a representation of data, a concept of phenomenon using an image would be an oversimplification. It refers to the building, modeling and simulation of processes and also to certain didactic methods based on the absorption of the image.[13]

Data are the building blocks of statistical information and a basis for visualization. In the hands of a humanist, they can gain an additional role and become a raw material to present stories in an attractive package that speaks to the imagination and emotions. Dry facts and statistics become interesting images and animations.

Publishing data and network access to specialized databases indicates the need for continuous development of the methods of acquiring knowledge: based on analysis, processing and visualization of diverse,

12 J. Elkins, *An Introduction to the Visual Studies That is Not in This Book*, [in:] *Theorizing Visual Studies Writing Through the Discipline*, red. J. Elkins, K. McGuire, M. Burns, A. Chester, J. Kuennen, Routledge, New York 2017, p. 3.

13 A. Radomski, *Wizualne analizy, wizualne narracje*, https://www.academia.edu/25916127/Wizualne_analizy_wizualne_narracje [access 2.03.2018].

unstructured network data. This is reflected in the rapid development of interdisciplinary research on the visualization of information.[14]

In the humanities many phenomena or cause and effect relationships between events, objects or texts can be explained in a friendly, intuitive way with the aid of effective and intuitive visualization of data describing the research problem.

One of the most important aspects of the digital humanities is visualization understood as, on the one hand, the presentation of results (e.g. statistical and stylometric analyses) and on the other – as a tool for analysis and data mining. In this sense, the traditional research model is being dropped in favor of "exploratory visualization", on the basis of qualitative research in a large amount of material.

Visualization requires a practical knowledge on how to present data sets presented in a condensed form comprehensible to the recipient. The modern humanists, whose workshop is based on large amounts of data, needs to build many skills, from mathematics and statistics to computing and design. Moreover, they should be able to efficiently evaluate data characteristics and formulate correct conclusions. Additionally, they should have basic IT skills, if the undergoing project requires extraction, filtering and collecting data. These same skills are essential in the development of the visual presentation of the results.

Currently, there are huge possibilities of transparent and effective presentation of information. The use of digital tools for visualizing the results has both scientific and artistic potential. It is also a huge opportunity for communicating science, as aesthetic, clear visualization is often placed on public websites. Multimedia and interactive visualizations are particularly successful in the Internet.

Visualization is a medium for storytelling. Numbers are the source material and charts describe the source. It responds to a series of questions, implies further ones, leading to the formulation of proposals not previously assumed.[15]

The introduction of hypertext narrative marked the division of the narrative about the way of absorbing content in a linear and non-linear manner. Visualization is such a non-linear representation of information. The simultaneity that characterizes it greatly facilitates observation of phenomena and trends which may remain unnoticed between the lines of

14 V. Osińska, P. Malak, B. Bednarek-Michalska, *Rozwój badań nad wizualizacją informacji*, „Annales Universitatis Cracoviensis. Studia ad Bibliothecarum Scientiam Pertinentia", 14, 2016, pp.72-73.

15 N. Yau, *Data Points. Visualization That Means Something*, John Wiley&Sons, Indianapolis 2013, p. 261.

text. As Lev Manovich says, modern man thinks mostly in images, colors and numbers.[16]

Modern applications allow one to perform analysis of large, diverse sets of data, to organize them and identify the most relevant ones. They give one the opportunity to show data and information with images. For the modern man it is the most readable way of data presentation. Appropriate knowledge and application of simple tools allows for the presentation of research results in an attractive way, in a clear and understandable form that translates to popularizing science and its internationalization.

Visualization is also a good practice in communicating complex concepts that are easier to understand when expressed using charts, diagrams, maps, and other graphic elements. Many issues in the digital humanities still remain in the early stages of defining (such as digital mapping) and therefore a coherent methodology of research is yet no be developed.

Mathematics is increasingly associated with the humanities, if only because work based on digital sources and materials means working with numbers (all digital sources and materials in their base form are numbers). Every humanist whose research is based on the analysis of large data resources (such as those derived from open digital databases) should be able to use the laws of statistics and logic. This is extremely important, because wrong interpretation of data distribution or adoption of wrong criteria for the evaluation of data will result in inference errors that lead to the formulation of erroneous theses.

In turn the role of information technology in modern humanities studies is expressed in a collection of tools that the humanist uses to filter and sort data using multiple keys, analyze their characteristics, visualize and present them. The role of mathematics and computer science in the digital humanities is easily noticed, for example, by tracking the process transforming raw data into an image that is their interpretation.

From data to picture information

Visualization of information requires high, interdisciplinary competence from its creator. The process of converting the raw data into an image as their representation is a multi-step one, and even minor mistakes committed during any stage may result in an erroneous interpretation of the results.

16 L. Manovich, *Język nowych mediów*, from: A. Radomski, *Wizualne analizy, wizualne narracje*, https://www.academia.edu/25916127/Wizualne_analizy_wizualne_narracje [access 2.03.2018].

The first stage of visualization is validating digital data**.** A large number of variables and data records to be processed should be included in validation analysis, which requires developing and testing different methods. The subject of many studies requires a detailed statistical analysis of data. It is about issues of data normalization, data aggregation, the appropriate selection data properties for scientific reasoning. A valid assessment of the statistical properties of data is determined by the validity of inference.

The next stage is the analysis of data for the purposes of scientific visualization. It includes finding relationship networks between data, which should be particularly exposed in the visualization. This is the stage in which decisions on data selection to visualize will affect whether it will be effective and scientifically suitable.

The final stage of the data visualization process is related to the choice of the type of visualization, depending on the type of data and purpose. The question of the selection of techniques and methods is the most important step in visualization and it decides on its efficiency and scientific value[17]. Bad decisions related to the selection of the wrong type of visualization can result in the fact that it will be difficult to understand what exactly and to what purpose it was presented in the visualization or, what is worse, the visualization can result in wrong conclusions.[18]

However, even a properly conducted process of data visualization is sensitive to manipulation at the final stage. Images have a huge potential for distorting reality. They affect emotions, which make them a great tool for shaping the views of the recipient without their will and knowledge. Much has been written about the manipulation of photography. The way of cropping or changing the lighting in a conscious way can affect the pronunciation of the photo. The intended effect of blurring reinforces the viewer's belief in the authenticity of the situation portrayed in the picture.[19] The awareness of manipulating on a diagram, graph or chart is smaller at the same time.

Information can easily be distorted for example through the selection of units in a chart or the range of a number line, the presentation of bars in a graph in different scales or by the use of purposefully selected colors. By manipulating the parameters of a number line one can achieve the desired effect to present a trend depicted, or to hide the fact of its existence, depending on the intention of the designer. The number of factors, which

17 T. Koltay*, Information Overload in a Data-Intensive World*, [in:] A.J. Schuster (ed.), *Understanding Information. From the Big Bang to Big Data*, Springer: Cham 2017, p. 209-210.

18 T. Azzam, S. Evergreen, A.A. Germuth, S.J. Kistler, *Data Visualization and Evaluation*, "Data Visualization, Part 1", 139, 2013, p. 13 and next.

19 A. Kampka, *Retoryka wizualna, Perspektywy i pytania*, „Forum Artis Rhetoricae", 1, 2011, p. 11.

can easily influence the final reception and interpretation of data is almost unlimited.[20]

Erroneous conclusions can lead to the kind of complicated graphical representation of data find in a popular column chart. Depending on the adopted scale of the unit and the starting point of the value axis, the charts presenting the same set of data can lead to entirely different conclusions. The graphs in Figure 7 show the number of graduates of a certain university in the subsequent years 2007-2017. On chart 7a, it is difficult to see a significant increase in the number of graduates over the years. The chart 7b leads to completely different conclusions, on which the number of graduates growing year by year is visible.[21] This example presents how easy is to manipulate by very simple techniques such as y-axis trimming.

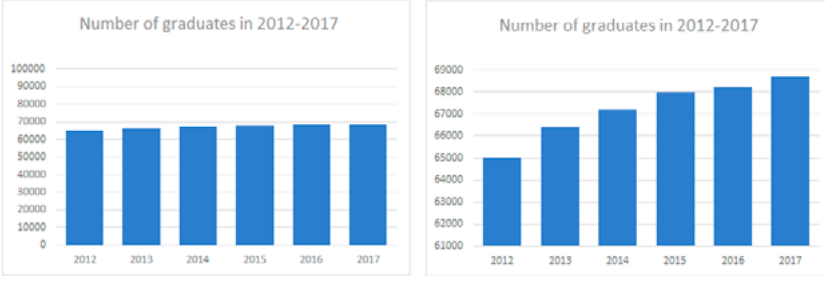


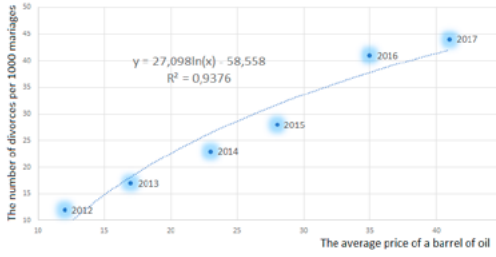
Fig. 1. Number of university graduates in 2012-2017. Source: author's own elaboration.

In the second example we find that we have access to a set of statistical data of a specific state gathered in 2012-2017. This gives us, among other things, information on the price of the oil barrel as well as the number of divorces per 1000 married couples in sequence of years. If these data were presented in a common chart, it would suggest that the rising price of oil is linked to an increase in divorce rates. This conclusion is, of course, nonsense, and comes from some errors that are associated with both the choice of data and the type of chart used. Additional factors strengthening the impression of dependence are the presentation of the trend line, the pattern of relationship between data and the high value of the correlation

20 P. Biecek, *Odkrywać! Ujawniać! Objaśniać! Zbiór esejów o sztuce prezentowania danych*, Warszawa 2014, p. 137 and next.

21 Space prevents further discussion on which of the two graphs reflects the reality of the situation at the university. It depends on many additional factors, such as the number of graduates in previous years.

coefficient R^2 (in this example, invalid use of these parameters due to the small size of the dataset).[22]



Year	The average price of a barrel of oil	The number of divorces
2012	12	12
2013	17	17
2014	23	23
2015	28	28
2016	35	41
2017	41	44

Fig. 2. The average price of a barrel of oil and the number of divorces over several fixed years. Source: author's own elaboration.

It is worth adopting the principle according to which, if the visualization does not help the reader to understand, and even leads to wrong conclusions, it is better to leave the data in the table, or even in the text description, and opt out of its visualization.

Many years ago, Neil Postman warned: *We must keep in mind the story of the statistician who drowned while trying to wade across a river with an average depth of four feet. That is to say, in a culture that reveres statistics, we can never be sure what sort of nonsense will lodge in people's heads*.[23]

Data visualization which does not convey information in a manner intended by the designer or, worse, suggests the wrong conclusions remains mostly a pretty picture.

Conclusion

Digital humanists are entering new research areas which are defined by concepts of hard science. However, with the benefit of digital tools to make innovative studies, they accept the obligation to understand their logic resulting from their digital nature.

Digital humanities is nothing short of a living tissue: it grows dynamically, just as does digital technology. Adapting them for humanities research requires our thinking about the world of science to be turned around. It is reasonable to say that the humanist seeking her or his place in

22 The correlation coefficient R^2 can assume a value from 0 to 1. The higher its value, the stronger the dependence between categories, here: between the price of oil and the number of divorces.

23 N. Postman, *Technopoly. The Surrender of Culture to Technology*, Vintage Books, New York 1992, p. 132.

the digital world should also be a bit of a mathematician and a computer scientist.

Bibliography

AZZAM Tarek, EVERGREEN Stephanie, GERMUTH Amy A., KISTLER Susan. 2013. J.,*Data Visualization and Evaluation*, "Data Visualization, Part 1", No 139.

BATTERSHILL Claire, SOUTHWORTH Helen, STAVELEY Alice, WIDNER Michael, WILLSON GORDON Nicola, WILSON Elizabeth. 2017. *Scholarly Adventures in Digital Humanities. Making The Modernist Archives Publishing Project*, Cham: Pallgrave MacMillan.

BIECEK Przemysław. 2014. *Odkrywać! Ujawniać! Objaśniać! Zbiór esejów o sztuce prezentowania danych*, Warszawa: Wydawnictwo Uniwersytetu Warszawskiego.

BOMBA Radosław, RADOMSKI Andrzej, SOLSKA Ewa (eds.). 2016. *Humanistyka Cyfrowa. Badanie tekstów, obrazów i dźwięku*, Lublin: E-naukowiec.

HAI-JEW Shalin. 2017. *Data Analytics in Digital Humanities*, Cham: Springer.

HENDERSON Stuard, SEGAL Eden H. 2013. *Visualizing Qualitative Data in Evaluation Research*, "Data Visualization, Part 1", No 139.

COOK Dianne, EUN-KYUNG Lee, MAJUMDER Mahbubul. 2016. *Data Visualization and Statistical Graphics in Big Data Analysis*, "Annual Review of Statistics and Its Application" No 3, http://www.annualreviews.org/keyword/Information+Visualization

DRUCKER Johanna. 2014. *Introduction To Digital Humanities. Course Book. Concepts, Methods, and Tutorials for Students and Instructors*, https://ia801202.us.archive.org/4/items/IntroductionToDigitalHumanities/Introduction%20to%20Digital%20Humanities.%20Concepts,%20Methods,%20and%20Tutorial%20for%20Students%20and%20Instructors.pdf

ELKINS James. 2017. *An Introduction to the Visual Studies That is Not in This Book*, [in:] *Theorizing Visual Studies Writing Through the Discipline*, J. Elkins, K. McGuire, M. Burns, A. Chester, J. Kuennen (ed.), New York: Routledge.

KAMPKA Agnieszka. 2011. *Retoryka wizualna. Perspektywy i pytania*, „Forum Artis Rhetoricae", No 1.

KOLTAY Tibor. 2017. *Information Overload in a Data-Intensive World*, [in:] A.J. Schuster (ed.), *Understanding Information. From the Big Bang to Big Data*, Springer: Cham 2017.

KRZYSZTOFEK Kazimierz. 2012. *Big Data Society. Technologie samozapisu i samopokazu: ku humanistyce cyfrowej*, „Kultura i Historia", No 21, http://www.kulturaihistoria.umcs.lublin.pl/archives/3626

MILLER James D.2017. *Big Data Visualization*, Birmingham: Packt Publishing Ltd.

OSIŃSKA Veslava, MALAK Piotr, BEDNAREK-MICHALSKA Bożena. 2016. *Rozwój badań nad wizualizacją informacji,* "Annales Universitatis Paedagogicae Cracoviensis. Studia ad Bibliothecarum Scientiam Pertinentia", No 14.

POSTMAN Neil. 1992. *Technopoly. The Surrender of Culture to Technology*, New York: Vintage Books.

RADOMSKI Andrzej, *Wizualne analizy, wizualne narracje*, https://www.academia.edu/25915335/Wizualne_analizy_Interaktywne_narracje

SINCLAIR Stéfan, ROCKWELL Geoffrey. 2016. *Text Analysis and Visualization*, [in:] *A New Companion to Digital Humanities*, S. Schreibman, R. Siemens, J. Unsworth (eds.), Malden: Wiley Blackwel.

YAU Nathan. 2013. *Data Points. Visualization That Means Something*, Indianapolis: John Wiley&Sons.

VAN SCHIE Gerwin, WESTRA Irene, TOBIAS SCHÄFER Mirko. 2017. *Get Your Hands Dirty. Emerging Data Practices as Challenge for Research Integrity* in: *The Datafied Society Studying Culture through Data*, M. Tobias Schäfer K. van Es (eds.), Amsterdam: Amsterdam University Press.

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