



DATA PRESENTATION ON THE MAP IN GOOGLE CHARTS AND JQUERY JAVASCRIPT TECHNOLOGIES

Karol Król

Summary

The article presents selected software development tools and technologies that enable the presentation of statistical data on digital maps in the browser. The aim of the study was to describe them, and to conduct their comparative evaluation. In our studies, we have used ad-hoc tests, performed on the basis of usability and functionality, using the technique of self-evaluation.

Based on the criteria of global popularity and availability, the following were subjected to ad-hoc tests: Google Visualization – Geomap and Geo Chart, as well as selected solutions developed on the basis of the jQuery JavaScript.

In conclusion, it has been demonstrated that the tested design and development technologies are complementary, while the selection of tools to carry out the design principles assumed remains at the discretion of the user.

Keywords

data visualisation • mashup • web cartography

1. Introduction

In recent years, we can observe rapid development of Internet-based technologies. It is accompanied with the increasing availability and variety of design techniques and tools [Gotlib 2008, Halik 2011, Kukulka 2011, Król 2015a]. Creating visually attractive data visualizations in the browser window, with the use of digital maps, is no longer reserved exclusively for advanced computer users. Developers put increasing emphasis on the software's versatility, universal accessibility, and availability. Therefore, increasingly, the software is developed in two parallel ways. On the one hand, advanced and specialized solutions are created, and on the other hand, simpler ones, intended for users without an IT background, and serving, among other things, to popularize the technology. In addition, software is issued in versions for web-based or mobile devices.

This trend can also be observed in the use of geodata. The suppliers thereof, in the light of increasing competition, seek to attract the users – and the majority of the latter still have rather little knowledge of geo-data. With those users in mind, sets of accessible design tools and techniques are developed, which enable the use of geo-data, often

in an automated manner [Bitner et al. 2014, Król 2015c, Król 2015d]. All this means that more and more sites of “mashup” type appear on the Internet, which combine selected thematic content with the map background [Benslimane et al. 2008, Yu et al. 2008]. Many techniques and tools are conceived in such a way, that the application thereof requires only entering the source data and selected configuration parameters of the map. Others, in turn, are made available in the form of “wizards”, or map generators, which produce maps of spatial phenomena in an automated way to.

Interactive cartographic tools made available on the Internet have many advantages. Spatial (geographical) perspective on information management, which uses digital surveying and mapping, supports the interpretation of data, and the maps are clear and intuitive way of presenting that data. Compilation of thematic maps makes it easy to see and demonstrate the relationships hidden in the numbers. Furthermore, the information provided in the form of interactive maps is attractive for the customer, and more easily remembered.

The aim of this study is to review, describe, and conduct a comparative evaluation of selected techniques for data presentation on general world maps and administrative maps.

2. Materials, methods and data sources

The aforementioned techniques and design tools, and the maps created by means thereof, were tested using exploratory “ad-hoc” testing, also referred to as “Expert Testing or Monkey Testing” [Chhabra 2012, Kölling and Patterson 2004]. It is one of the least formal methods of software testing. Exploratory studies are performed without pre-planned user cases (test cases); however, the aim of testing is specified. Ad-hoc tests are preliminary in character. Often they precede tests proper, they may support the planning of the test proper, or, because of limited resources or time constraints, may replace them completely. They allow you to predict critical points, to which you should devote more attention when conducting further, more formal testing. In the case described herein, ad-hoc tests were carried out on the basis of usability, from the point of view of an average user, while self-assessment technique was applied, which is based on self-registration of experiences and observations made.

The advantage of ad-hoc testing is their cognitive function. They allow you to become familiar with the application being tested, which may not be accurately reflected in the design documentation. The scenario of testing carried out in this manner provides for observing and recording the behaviour of the program in typical conditions in which it operates, i.e. during the implementation of project objectives or activities performed by the user.

The main goal of the design was to create an online map illustrating the numeric or text data, including statistics related to a specific administrative area, or a point phenomenon. Ad-hoc tests (of usability and functionality) were administered to test techniques and design tools, which were selected on the basis of global popularity and availability. Some of the selected techniques and tools are based on geo-data, which is provided by Google (Visualization: Geomap and Geo Chart). In others (jQuery

JavaScript), map primer must be created from scratch (e.g. vector map drawing), or a ready-made map must be obtained from external sources.

The project of the Web application included the creation of a model presentation of statistical data, including the number of inhabitants and the area of the largest cities in Małopolska (Poland), as well as data related to the characteristics of individual provinces. The project assumes that the presentation must take on a multimedia, interactive character, and that it is intended as a component of a website. In addition, the main carriers of information must take the form of either POIs (points of interest), lines or polygons, whose graphic form and principle of operation may vary, depending on the development techniques applied. Further, attempts were made to create a presentation (as described), using various technologies, and their respective design potentials were subsequently rated.

3. Characteristics of design and development techniques applied

The study was preceded by a review of the network services provided free of charge, enabling the presentation of data on the map primer. Analysis of various tools showed that, in general, these services apply out in the four technologies (the classification of which was made according to the type of map primer and the manner of programming interactivity):

1. Static – presentation of statistical data on the raster map (no interactivity). The map is generated in the browser window as a graphic file;
2. Interactive, raster map-based – presentation is a component of a website, based on raster foundation. Interactivity is achieved with selected programming techniques and tools;
3. Interactive, based on vector graphics. Interactivity is achieved with selected programming techniques and tools;
4. Other (mixed), e.g. in presentations using Adobe Flash technology, applying selected programming techniques and development tools (Table 1).

Table 1. Selected formats of map presentation as a component of a website

Format of map presentation	Features of presentation and technical remarks
Raster	Presentation of statistical data as a raster (static computer graphics). The map is not interactive.
Raster, extended	Based on raster (graphic) files, such as PNG, JPG and others, which are the foundation for the data embedded dynamically, using programming scripts.
Vector	Cartograms and map diagrams are rendered in the web browser, in vector format – SVG or VML (line drawing).
Other	Combinations of various designing techniques, for instance Adobe Flash and script-based languages.

Source: author's study

Based on a review of available design tools, Google Chart API and jQuery JavaScript, among others (Table 2) were selected for exploratory ad-hoc testing. These technologies provide tools and techniques for creating interactive presentations, which can be a component of your web site, and they are among the most popular throughout the world.

Table 2. Selected methods and techniques of interactive data presentations

Development technology	Designing techniques and tools	Data source	Licence
Google Charts API (Image Charts)	Parametrization of the address of the URL web resource	Basic text format	Completely free*
Visualization API: Geomap • regions display style • markers display style	DHTML: HTML, CSS, Adobe Flash, JavaScript, Google Visualization API	Google Chart libraries (jsapi and loader) DataTable	Completely free*
Visualization API: Geo Chart • Region GeoCharts • Marker GeoCharts • Text GeoCharts	DHTML: HTML, CSS, SVG, VML, JavaScript, Google Visualization API	Google Chart libraries (jsapi and loader) DataTable	Completely free*
jQuery JavaScript SVG • jVectorMap	DHTML: HTML, CSS, SVG, VML, jQuery JavaScript	SVG foundation. Free vector and raster map data*	Dual-licenses – GNU GPL and Commercial License
jQuery JavaScript • CSSMap • CraftMap • MouseWheel • MapBox • ZoomBox	DHTML: HTML, CSS, jQuery JavaScript	Raster foundation. Requires acquisition of data	Open Source, Royalty free
GIS and JavaScript • ImageMapster • Maplight	QGIS, HTML Image Map Plugin – Map Area DHTML: HTML, CSS, jQuery JavaScript	Raster foundation. Requires acquisition of data	Open Source

* Completely free for all uses: commercial, governmental, personal or educational

Source: author's study

3.1. Static charts – “Google Image Charts”

Google Image Charts service can generate static charts in the browser. These charts can take the form of bar graphs, pie charts, but also the character cartograms [Ratajski and Lipinski 1973]. Presentation of data is elicited from the server of the service provider on the basis of a URL address (Uniform Resource Locator), in which the parameters of the map are stored, in addition to other elements. Access to the service is free and unlimited.

3.2. Interactive charts – “Visualization API: Geomap, Geo Chart”

Google Charts is an extended service available within the Google Developers, which allows you to create varied graphical, interactive charts, diagrams and other formats of data presentation [Gesmann and Castillo 2011]. Using the service, you can create both traditional pie charts, bar (column) charts, or line charts, as well as charts with a spatial reference (Geomap, Geo Chart). Charts are generated as part of a hypertext document in Adobe Flash technology and SVG or VML format.¹

The SVG format (Scalable Vector Graphics) allows you to combine vector graphics, raster graphics and text. It is characterized by a high degree of integration with hypertext documents. It allows you to handle events (using scripting languages), which in turn facilitates the programming of smooth scaling and moving image functionality, as well as changing the presentation of layers or access to the data assigned to graphic objects [Madej 2003]. The testing focused on the possibility of applying numerical data to the digital map (Visualization API: Geo Chart and Geomap).

3.3. Vector maps in SVG format

The technique of creating interactive maps using jVectorMap [Lebedev 2016] does not provide for the use of raster graphics. The whole image is generated based on HTML, CSS and jQuery JavaScript using SVG or VML. This solution facilitates presentation of statistical data for different administrative units (states, regions, etc.). In order to present data on the map other than the one provided by jVectorMap, you must first create a vector (e.g. GIS formats – Shapefile SHP, Inkscape – SVG formats), and then convert it using a converter prepared in Python programming language. It is available on the jVectorMap website (<http://jvectormap.com>). JVectorMap constitutes the basis for vector maps downloaded from Natural Earth [2016], available under the “*public domain*” license.²

3.4. Maps created using “jQuery JavaScript”

JQuery is a comprehensive library of JavaScript programming, first published on 26 August 2006 (the first stable release), which provides a relatively simple way of creating dynamic components of websites and web applications [jQuery 2015].

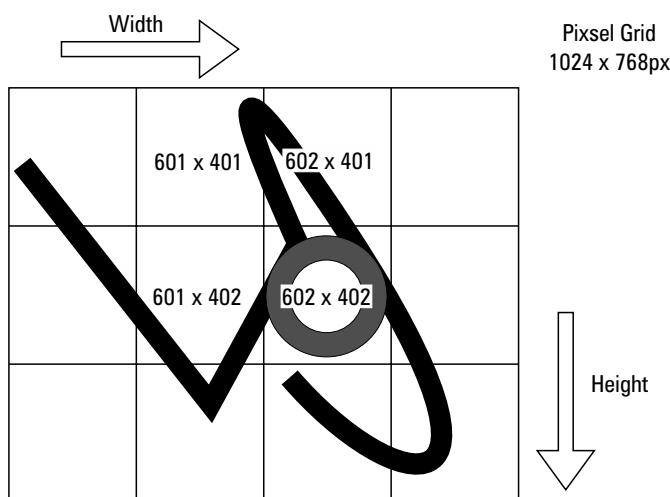
Among the many solutions based on jQuery, those selected for testing include CraftMap jQuery Plugin [Dziewulski 2013, Król and Bedla 2013, Król 2015b]. This

¹ Vector Markup Language – language of the XML family, serving to generate vector graphics, created by Microsoft company. Standard VML is used for the presentation of charts in older versions of the Internet Explorer browser (adopting VML for old IE versions), which ensures compatibility with various browsers and devices such as iPhone, iPad and Android-type software.

² To simplify, “*public domain*” signifies creations, which can be used without limitations. This unlimited use may result from the expiry of copyright, or from the fact that the given work has never been or is not subject to copyright.

component is available for free under the Creative Commons NonCommercial Use license (NC), which means that it can be used free of charge only in non-commercial projects.³

The component facilitates viewing static raster graphics, which – via the script – take over the function of a map of coordinates, so to speak. Each pixel here is localized, based on the attributes of length and width of the image (Figure 1). Based on that, an interactive marker is positioned on the map so, which can be a carrier of textual or pictorial information, or the two simultaneously. The information accompanying the points is revoked at the user's request in the form of a pop-up window.



Source: author's study

Fig. 1. Indication of marker location in point 602 x 402 px of the raster image

The second version, based on jQuery script, provides for the execution of the base of map using software such as “desktop GIS” which applies QGIS (open source GIS software license). Map source is stored in a vector format, and then transformed, using QGIS, into a raster file. Its interactive presentation in a browser window is made possible via the following scripts: mouseWheel Extension jQuery Plugin [Aaron 2012] and MapBox Zoomable Maps jQuery Plugin [Abel 2012].

Another jQuery script that allows you to display data on the map base is jQuery ZoomBox [Sutherland 2009]. The script performs mainly the function of navigation, i.e. it facilitates data viewing. In addition to the map, interactive markers are also the

³ The CC NC license allows for copying, distribution, displaying and using the work and all its derivatives, but only for non-commercial purpose.

carriers of information. The script also makes it possible to zoom in the map view. The effects of the zoom-in and the drag are simulated; they are based on a raster maps, superimposed layer upon layer onto one other. At the user's request, individual layers are displayed, and the others are hidden, which resembles the effect of zooming in the map image.

Also analysed was the possibility of presenting data using the CSSMap script [Popardowski 2016]. Interactivity of the map thus created is executed almost entirely by using cascading sheets of CSS styles, with a minor contribution of jQuery scripts. The whole presentation is based on a raster basis. The solution is available with *royalty free* licence.⁴

3.5. Maps created using "JavaScript – map area"

Another analysed technology involves the use of "desktop GIS" type software to create the base of the map (vector layer), which is then converted to raster using HTML Image Maps Plugin [Salata and Król 2012]. The map thus created is accompanied by a hypertext document containing, among others, the coordinates of the vertices of objects previously plotted on the vector layer. Interactivity of the applications can be programmed using jQuery ImageMapster script [Treworgy 2013], which allows graded (stepped) zooming in of the map view. After selecting the zoom, polygons depicted on the map are scaled (reduced or enlarged).

The basis of an applications thus created is provided by raster maps. For practical reasons and for reasons of the application's utility, large image files can be divided into sectors. Each raster map is covered with an interactive layer, generated by the jQuery Maplight script [Lynch 2013]. Mapped graphics is displayed in the IFRAME, commonly called a "floating frame". The frame allows mutual inclusion of the hypertext documents.

4. Test results

Solutions based on Google Chart are relatively simple to implement and they require no additional extensions, however, they have a closed form, i.e. the user has access to the defined scope of the presentations and to selected graphic attributes; also, he must agree to such terms of use (Table 3). They lack the possibility of extending the functionality of e.g. the option to capture and drag the map area, for example by implementing an appropriate script, or adding module. Attempts to modify or interfere with the format of charts' presentation can also be inconsistent with the stated terms of use. However, this is compensated by high quality of visuals and seamless service.

⁴ The licensing model is based on a one-off fee, paid by the license buyer, upon which he gains the right to repeated, free use of the intellectual property, with no need to make repeated payments.

Table 3. Summary of observations made during exploratory testing⁵

Development technology	Google Charts (Visualization API: Geomap, Geo Charts)	jQuery JavaScript, SVG	GIS and JavaScript
Time of development	+	++	+++
Complication level of the implementation of a functionality	+	++	+++
Possibility to personalize the map	++	+++	+++
Format of the map base	Adobe Flash, SVG/VML	Raster PNG, JPG, or another, SVG	Raster PNG, JPG, or another
Format of presentation of numerical data	Fixed, defined	Free, possible to program	Free, possible to program
Amount of data presented	Limited by the form of presentation	Depending on the script solution	Depending on the script solution
Form of implementation	Direct implementation in the HTML code (embed a map) or implementation using iframe	Direct implementation in the HTML code (embed a map) or implementation using iframe	Direct implementation in the HTML code (embed a map) or implementation using iframe
Modification of map base	No access, based on Google Maps	Full access, if based on custom map	Full access, if based on custom map

+ the least time consuming (least complication)

+++ the most time consuming (highest complication)

Source: author's study

⁵ In Table 2, no assessment of the technique for generating static charts was presented, as it has been replaced with solutions facilitating the creation of dynamic and interactive presentations.

In contrast, in the case of solutions based on jQuery JavaScript, the basis for the presentation is provided by the raster, which can be created from scratch using programs such as desktop GIS or other vector graphics applications. The source file, resulting from the conversion, provides foundation of a kind for further work. Implementation of external scripts can give it an interactive character (of a dynamic presentation). In this case, statistical data can be presented in a any form and quantity, without limitations. However, for the user, the lack of expertise may be an obstacle, as some expert knowledge is necessary to be able to program or implement the functionality of the map. Maps prepared in a variety of technologies, presenting one and the same phenomenon, may share a similar or even identical form of presentation. The technology, in which they have been developed, can be identified based on the analysis of the source code, subtle differences in graphic design, or functionality testing.

Ad-hoc tests have demonstrated that subsequently, it is advisable to conduct testing of interactions of the solutions described herein with other components of the site, for example, other jQuery scripts (interaction of selected scripts within a hypertext document), as well as performance testing, in order to assess the impact of the presentation on overall comfort of using the service, in which they are included as components.

4.1. Google Image Charts

The advantage of maps and charts generated using Google Image Charts is the simplicity and lack of limitations to use. Parameterization of the address of network resources does not cause many problems, however, this technique allows you to generate presentations of data on a limited basis. The disadvantage of the maps thus prepared is the lack of possibility to plot numerical data or text onto them. In the web browser window, they assume a chorochromatic format.

The service allows you to generate maps only in a defined spatial range (records of map parameters: *africa*, *asia*, *europe*, *middle_east*, *south_america*, *usa*, *world*). The form of encoding of the map's parameters is not very intuitive, nor is the range of their values (Table 4). A certain advantage comes from the option to save them in any order relative to each other. Another limitation is the relatively small size of the generated map (440 × 220 px).

Numerous restrictions as to the form and scope of the generated maps and charts, coupled with the development of dynamic presentation technologies, led to the closing of the Google Image Charts project in 2012. The official announcement by Google pertaining to this case is that the service may be turned off completely, without prior notice, although the service provider is not currently planning to do so [Google 2016]. The question of the cessation of work on the project may be debatable, because the maps thus generated could find their place in the projects of websites and web applications for mobile devices.

Table 4. Example of parametrization of URL address of a static map of Europe

URL address	Significance of parameters
http://chart.apis.google.com/chart?	Basic address of the service
cht=t	Defines the type of chart
chs=440x220	Chart size in pixels
chd=t:0,60,100	Defines the data of the chart
chco= FFFFFF,B3FFB3,008000	Parameter which decides on the colour of the states plotted on the map
chl=FRDEPL	Codes of the states, which shall be marked with a colour on the map, Poland (PL), Germany (DE), France (FR)
cht=europ	Base area of presentation (Europe)
chf=bg,s,EAF7FE	Colour of water basins
&	Character dividing individual parameters
The record of URL address in whole, to be entered in the browser window	
http://chart.apis.google.com/chart?cht=t&chs=440x220&chd=t:0,60,100&chco=FFFFF,B3FFB3,008000&chl=FRDEPL&cht=europ&chf=bg,s,EAF7FE	

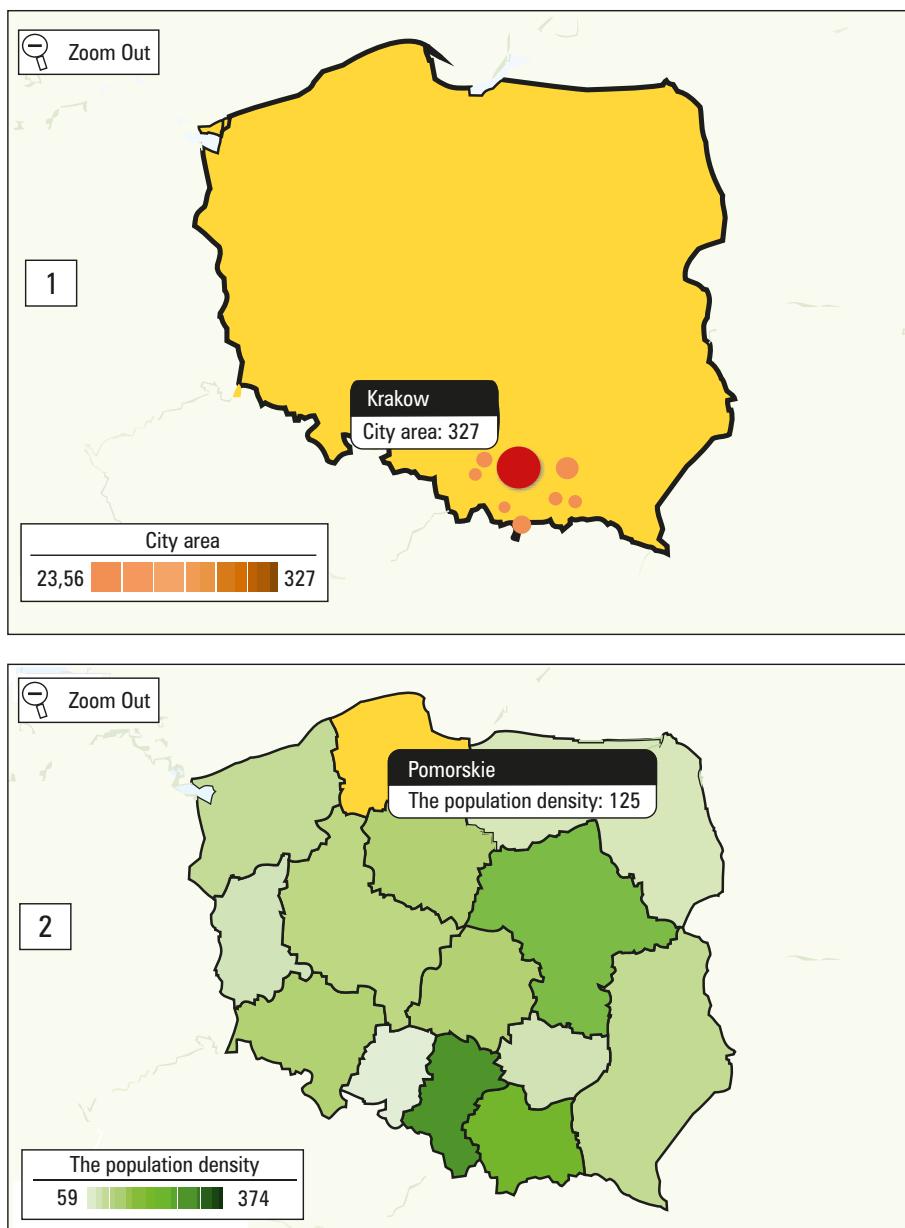
Source: author's study

4.2. Google Visualization API

Of all the analysed technologies, Google Visualization API is relatively the easiest to use, the most effective and impressive. It does not require the user to install any additional software. The basic configuration and implementation of maps require only a minimum of expertise.

The advantages of Google Visualization: Geomap include the availability of two design options: the presentation of data based on interactive polygons (a map made using surface method, and quality background, it shows geographical range – i.e. *regions display style*) and points (*markers display styles*, a map made using map diagram method – simple, graded point map diagram). A map thus prepared is automatically equipped with a legend, and the user is pre-equipped with a ready map and mapping software. Moreover, this technique is versatile, it is recommended by Google (locations are geocoded by Google Maps), and it is accompanied by an extensive system of training and technical support. Visualization: Geomap facilitates publication of visually appealing presentations of data on a map, divided into continents, countries or regions. Figure 2 shows an example of an interactive map prepared on the basis of Visualisation: Geomap, in the *markers display style* version (Małopolska region: the area of the largest cities) and in the *regions display style* version (Poland: population by province).

The service can be used free of charge, in both personal and educational projects, as well as commercial. Terms of use do not allow you to download and store on your computer the base server code: *google.load* or *google.visualization*. It follows that the assembly of all the components of the presentation in any medium of digital data, and



Source: author's study using the data of Polish Statistical Authority (Główny Urząd Statystyczny) [GUS 2014]

Fig. 2. Screenshot of interactive maps – presentation of statistical data using Visualization: Geomap. 1. Presentation with spatial reference, of the areas of selected cities of the Małopolska region; upon marking a selected point, previously defined information is presented. 2. Presentation of population density; the region selected by the user with a mouse cursor is marked (highlighted) in orange.

using them without access to the Internet, is incompatible with the terms of use. At the same time, it is permissible to generate a screenshot and insert it as a component of a website.

The disadvantages of presentations prepared using the “Visualization: Geomap” include the limited area of the map, i.e. inability to capture and drag with the mouse cursor, and look at the map of the entire globe. Furthermore, Visualization: Geomap utilizes Adobe Flash – Flash-based visualizations (also known as Macromedia Flash). The map is displayed in a browser window using the Flash player (Adobe Flash Player).⁶

4.3. SVG vector maps

The main advantage of maps developed in SVG format is their flexibility. Thus created maps are generated in the browser in real time (e.g. on the basis of coordinates stored in JavaScript files), which does not require the use of raster graphics. This reduces the time associated with loading the map in the browser window and the amount of data transmitted by the network. Interference with the application code allows you to modify forms of presentation and the scope of the presented data. The effect of drag and zoom of the map view is usually performed using the jQuery JavaScript scripts.

4.4. Components of jQuery JavaScript

Overview of the jQuery Java scripts for presenting data on maps in the browser window, and testing of the selected scripts demonstrate that, in general they are based on raster. Opportunity to explore the map, and its very presentation can be similar to the functionality specific to geoportals, however, the effects achieved using jQuery are usually the simulation of the latter, hence the limited possibilities for their application.

Simulation of the map zoom-in view is the result of the “vertical” overlapping of the previously developed raster maps, one upon the other. The effect can be described as “passive zoom”. Each layer has a different raster size in pixels. Varying sizes of raster grids are levelled by the window of map presentation, where only a fragment is displayed, e.g. the size of 600×500 px. Using navigation elements, successive layers are selected and presented in a vertical hierarchy, which the user perceives as zooming in or zooming out of the map. In this case, the degree of mapping the terrain is always the same. The number of objects depicted on the map is fixed. The only thing that changes is the magnification (visibility). The effect of changing the map scale would be possible to achieve only through adequate preparation of raster bases, i.e. every one of them should be prepared so that it would depict the given area or phenomenon in a different scale.

⁶ Simply speaking, Adobe Flash is a technology of creating animations using vector graphics. At this point we should note that the presentation of a map using Flash technology may depend on individual settings. If the browser extension (that is, Adobe Flash Player) is switched off, damaged or not installed, the map will not be displayed. Furthermore, there is a group of users who deliberately refrain from using Flash technology, because it is often described as “consuming too many resources”, that is, overloading and slowing down the browser.

Limitations to mapping applications created using jQuery are mainly due to the restrictions of the raster base, whose size should be relatively small (it can be assumed that it should be no larger than 1 MB, as otherwise it might result in a lack of usability of the presentation thus developed). Geocoding is lacking, i.e. the points are plotted on the map not based on geographical coordinates, but based on the pixel location on the raster base. All components of the presentation can be gathered in one place (saving the files from the website to be used off-line), and so they can be used without Internet access.

CSSMap tests show that this is a flexible tool, which is largely due to the fact that it has been developed, practically in its entirety, based on CSS styles (this provides a lot of flexibility in modifying the presentation of content). Maps have been developed carefully and they are visually appealing. However, the CSSMap solution is not free. The availability of numerous, alternative free scripts does not encourage its use.

4.5. Testing the map created using “JavaScript – map area”

Presentation of statistical data on the administrative map requires the preparation of the map and the database in full (vectorization of raster bases), or downloading data from unlimited use sources. Vectorization of the map is associated with the installation of GIS desktop software and its additional extensions, enabling the transformation of a vector map into a raster map, covered with a mosaic of active objects in a hypertext document using the <map> marker. They are formed during the conversion, based on the vertices constituting the vector map.

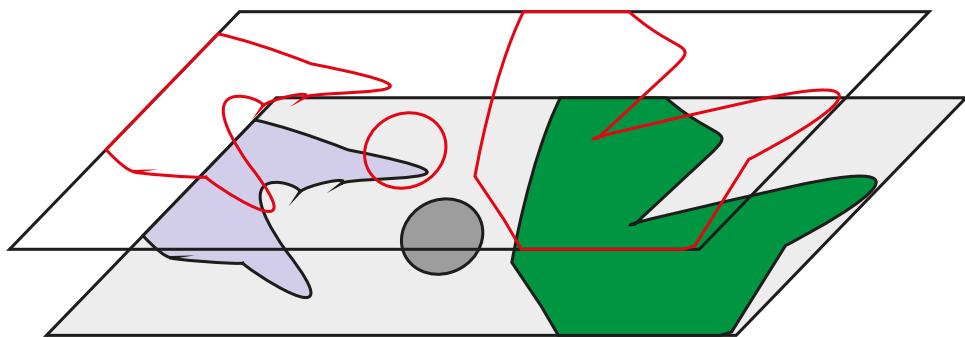
The base in the form of a set of coordinates stored in the hypertext document can serve as a foundation for providing interactivity scripts, e.g. JQuery Map Hilight [Lynch 2013] or ImageMapster [Treworgy 2013]. The latter work on the basis of the <map> marker, which defines the map's address for a given element, telling the Web browser that the graphics (raster) is covered with a grid of active links, which in turn form the map of links (Figure 3). The map of links is an accurate representation of all the objects shown in the grid. Each reference (link) may be a carrier of information, text, graphics, or both simultaneously.

What is typical for the application thus created is the limited area of the map and limited functionality range, i.e. inability to capture and drag with the mouse cursor, and look at the map of the entire globe. In addition, the map's form is static⁷. A greater range of interactivity, similar to the opportunities offered by Visualization: Geomap, can only be achieved through the implementation of additional scripts.

The advantages of the applications developed in this way include the ability to operate offline, i.e. without access to the Internet. This method involves the preparation of the map from scratch in vector format, hence the lack of restrictions in terms of

⁷ In the jargon of coders (programmers), the static character of a website is described as “dry format of application.” This means, among other things, for “floating” frames, no smooth transitions or animations, no curves and no shadowing of objects whatsoever. The effect is that of certain coarseness, in the sense of no smooth cooperation between various functionalities.

the form of the presented objects. Selected jQuery scripts, which create the effect of interactivity (including ImageMapster) do not work if the raster base consists of one hundred or more objects (polygons), especially on computers with a slower Internet connection. Scaling of these objects in the browser window takes too long, which may discourage the user from using the application.



Source: author's study

Fig. 3. Active map of links generated in the form of a layer, over the raster base

5. Conclusions

Presentations of statistical data in the form of interactive digital maps, which take the form of cartograms and map diagrams, created by people without basic knowledge of the field, may be incompatible with the principles of cartography. Therefore, it is advisable that presentations thus created be consulted with cartographers or experts in the field of geo-informatics.

Generally available designing techniques enable the users (who lack foundations in the field of geo-informatics) to present statistical data in the browser window, in the form of various diagrams, cartograms and map diagrams. The techniques and tools we have analysed are well-developed and relatively simple to use. Their use usually requires only a basic knowledge of embedding the objects in the structure of a hypertext document. The configuration of map parameters, the choice of the presentation format, and the database input depend on the user.

The technologies and techniques and design tools, which were described in the present study, and which enable the presentation of data in the form of an interactive map, are only a selection from the wide range available on the market. It is difficult to determine, which of the tested sets of tools and techniques is the best. Practice shows indeed that they are complementary. Complementarity is reflected in the selection of an appropriate set of tools for the implementation of a given project assumptions. A specific task will determine the selection of a suitable tool. The differences between the tools are mainly due to programming techniques and data sources used. All this

gives each of them a unique character. The properties resulting therefrom translate into the possibility of design and application in a given project.

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Dr inż. Karol Król
Uniwersytet Rolniczy w Krakowie
Katedra Gospodarki Przestrzennej i Architektury Krajobrazu
30-198 Kraków, ul. Balicka 253a
e-mail: k.krol@ur.krakow.pl