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Development of an interactive map within the implementation of actual state and public directions

Maksym Lupei
Department of Intellectual Information technologies
Institute of Cybernetics of National Academy of Sciences of Ukraine
Kyiv, Ukraine
ORCID: 0000-0003-3440-3919

Myroslav Shlahta
Department of Ukrainian Geographics
Lviv National University
Lviv, Ukraine
ORCID: 0000-0003-3476-2129

Oleksandr Mitsa
Department of Informative and Operating Systems and Technologies
Uzhhorod National University
Uzhhorod, Ukraine
ORCID: 0000-0002-6958-0870

Yurii Horoshko
Department of Computer Science and Computer Engineering
Taras Shevchenko National University "Chernihiv Colehium"
Chernihiv, Ukraine
ORCID: 0000-0001-9290-7563

Hanna Tsybko
Department of Computer Science and Computer Engineering
Taras Shevchenko National University "Chernihiv Colehium"
Chernihiv, Ukraine
ORCID: 0000-0002-1861-3003

Vasyl Gorbachuk
Department of Intellectual Information technologies
Institute of Cybernetics of National Academy of Sciences of Ukraine
Kyiv, Ukraine
ORCID 0000-0001-5619-6979

***Abstract* — The problem of developing an effective way to display selected dynamic information of geographical content on an interactive map is being investigated. Various approaches to solving this problem are analyzed, including the use of Python programming language. Pointing out their advantages and disadvantages, the paper proposes an approach that allows one to complete the task in full with high efficiency and low cost of time and human resources. It is based on a model that uses a Data Science methodology of five stages: obtaining primary data, data processing, necessary calculations, visualization creating and visualization disseminating. As a source of data there were used open data from the web portal "Diia", developed by the Ministry of Digital Transformation of Ukraine, and data from the Institute of National Memory. The processing of the data was as follows: each toponym was assigned a localization binding and it was determined whether it falls under the law on decommunization or not. The processed data were visualized using the Google Maps web mapping service. Each non-decommunized object was marked on the map. The interactive map is integrated into the Analitycs-UA web portal.**

Keywords — geographic information system, map model, interactive map, Python programming language, decommunization

I. INTRODUCTION

Information technologies facilitate solving many problems in different directions. One of such important problems is the implementation of current state and social trends, one of which is related to decommunization. Ukraine, as a post-Soviet country, has been terribly influenced by totalitarian communist ideology and needs to be deprived of its cultural, political and economic consequences. Therefore, the development of an interactive map with the display of non-decommunized toponyms and convenient tools for analysis is on time.

To solve this problem, it is possible to use already developed geographic information systems, but, in our opinion, they have certain disadvantages compared with creating a specialized software product, for the latter gives an opportunity to work easily in real time, cover more data, provides better scalability, accuracy, as well as the ability to immediately use the results of research.

Currently there have been created various tools for the development of interactive maps. In particular, [1] describes an easy-to-use Python ST_VISIONS library for interactive visualization of spatial and spatiotemporal datasets. Using this library, users can create interactive maps by writing Python code at a higher level of abstraction, thus making it easier to create geovisuals based on data from different data sources.

Another approach to interactive maps creation is to implement a connection between programming languages and geographic information systems. Thus, [2] describes the implementation of connection between the Python language and the ArcGIS geographic information system. It also provides some practical examples of such association. Essentially, the paper is the result of experience of creating Python scripts for the ArcGIS geoprocessor. Note that the ArcGIS program is a proprietary one.

In [3] it is pointed to existence of a significant amount of large sets of demographic data, many of which are publicly available, but they are in basic repositories,

where the user has to create his own visualizations and analyze to get an idea. Therefore, the paper describes a developed web mapping platform called DataShine, and its use to link the census data of England and Wales 2011 with open geographic data, and further analyze them to demonstrate the power and usefulness of creating an interactive map with a simple but flexible interface and a very detailed set of demographic data. This development concerns the visualization of geodata for a specific geographical region and was used by us only as an example for our work.

The research [4] also examines the use of Python in the application of geographic information systems (GIS), thatv helps developers to create multi-purpose Internet maps. Some ideas of this work were a catalyst for ideas in creating our own development. Also, a lot of results was taken from the work [5], which concerned the search for employees for vacant positions and used data processing from various sources.

To search for information resources that contain data promoting communist themes, one can use the tools described in [6]. For the analysis of large data sets of different nature there are usually used methods of data mining, which allow to identify hidden patterns and draw sound conclusions. Such methods include clustering [7], classification [8], combined identification method [9] and probabilistic latent semantic analysis [10]. Another approach to data mining is to use connectionist methods in combination with specialized models of neurons [11] or neural networks with generalized activation functions [12].

Thus, scientists have created a significant amount of specialized software for various tasks, including the use of Python, but the approach proposed below allows us to perform the task in full with high efficiency and low cost of time and human resources. It allows local governments and activists to see the situation in their own and other regions of Ukraine and monitor the pace of change in the country.

II. FORMULATION OF THE PROBLEM

The object of our research is IT tools for geospatial analysis and their application. The subject of the research is development of effective software product for ivestigation of the state of decommunization in Ukraine.

The purpose of the research is: to create an interactive map of non-decommunized street names of settlements.

The purpose is specified in the following tasks:

1) analysis of existing approaches in working with geospatial data;

2) choice of stack of technologies to create an interactive map and development of a common model of their construction;

3) development of an interactive map.

III. RESEARCH METHODS

A. Stack of technologies

Choosing a programming language for research, we focused on the Python, because it implements a large number of convenient libraries for data calculation and rapid visualization, as well as the ability to use modules of communication with many existing geographic information systems and machine learning libraries (Table 1). Thus, the Python language was used for working with data and for data convertation by administrative territorial units.

The React.js framework was used to develop the interface of the website http://analytics-ua.com/#/decommunization.

AWS-hosting with AWS S3 and domain work with AWS Route63 was used to host the developed site.

Table 1 List of selected Python libraries and specifics of their use

Types	Libraries
Basic	NumPy, Pandas
Geographical	shapely, geopandas
Special	networkx, geovoronoi
Visualization	matplotlib, seaborn, folium

B. Description of the general model of creating an interactive map

We consider that any modern geospatial study will use the Data Science methodology and should have a clear structure, namely consisting of 5 stages:

1) obtaining primary data;

2) data processing;

3) necessary calculations;

4) creating of visualization;

5) disseminating of visualization.

Consider in more detail the above points:

1) Sources and means of obtaining primary data are analyzed in Table 2.

Table 2 Sources and means of obtaining primary data

Тип	Джерела	Засоби
Parsing	News, real estate cards	BeautifulSoap
Georesources	Google Maps, Open Street Maps	osmnx
Collected data of companies, statistical offices	Diia, Lviv Open Data	
Satellite images	Google Earth Engine	Google Earth Engine

2) Data processing also involves a number of possible types of actions, in particular localization binding - providing coordinates to obtained data; cleaning of poor quality data; aggregation of new data from existing ones; emission filtering (removal of irrelevant, distorted data), scaling.

3) The result of data processing can be presented in the following types: Line, Polyline, Polygon, Multipolygon, Point, which besides localization bindings in the form of coordinates will have certain sets of values. However, in this research we came to the conclusion that if we abstract from the type of geometric representation, and take as a basis for classification the genesis of data - their origin, method of processing, we can be satisfied with the following three formats:

- points obtained from a set of individual geo-objects;
- pixels obtained from satellite images or bitmaps;
- areas, that is, polygons obtained by a certain processing.

4) The next stage is creating of visualizations. At this stage, one can create a series of basic maps based on previously obtained data. In particular, these can be maps of saturation of some values in space: Heatmaps, or, for example, maps obtained by clustering. In addition, these can be maps that display values by previously obtained areas, such as Choropleth Maps, which are well suited for analyzing information by administrative area, Cartogram Maps, which allow to distort areas to gain an understanding of the weight of a particular area, Hexbin Maps, suitable when it is necessary to abstract from administrative units. These can also be maps of displaying values for point data, such as Bubble Maps, or maps of displaying interconnections - Connection Maps.

5) Finally, the visualization can be disseminated with the use of the Folium library, for it allows to show the map in Jupyter Notebook, as well as to save it as png or html. At that it is possible to create both a regular map and a time series map, which will allow displaying changes in time as well.

IV. RESULTS OF THE RESEARCH

Let us apply the above 5 stages of geospatial research to create an interactive map of placement of non-decommunized street names in Ukraine.

1) So, first we conduct the stage of data collection. As a source of data, we use open data from Diia and other official sources. From there we download the register of administrative-territorial organization in xml-format.

2) The data themselves are not self-sufficient and need further processing. In particular, it is necessary to give each toponym a localization binding, as well as define whether it falls under the decommunization law or not. To do this, we use the classic approach in Data Science approach to data reprocessing, in particular we use the Pandas library and the method of checking each name for coincidence with one of the names prohibited by Ukrainian law. Data on these forbidden names were taken from the website of the Institute of National Remembrance and also processed, namely the endings were removed from them. We add localization using the Google Maps service. Thus we pass the second stage. In addition, we use bar charts and pie charts to visualize the distribution by region, and we group them by city, using their pre-filtering to find the number of non-decommunized objects larger than one value or another.

3) Futher, we use the methods of cartography and apply the third stage of research. In particular, we use heatmaps to reflect the saturation of the territory of Ukraine with toponyms to be decommunized. This is an important step, because it is required for further matching with the maps of the settlement of national minorities and the spread of the russian language. In addition, we use Bubble Maps to display the number of non-decommunized toponymes by cities, displaying them with icons of different sizes.

4) To create these maps, we use the folium library, which allows one to display high-quality maps in the stage 4, as well as to save the result immediately as an html page and png image. For better visualization, the areas of the map are outlined in different colors.

5) After the map is displayed on the Google Maps platform, we integrate it into the website [13].

As a result we gain an interactive map with the following interface (Fig. 1):

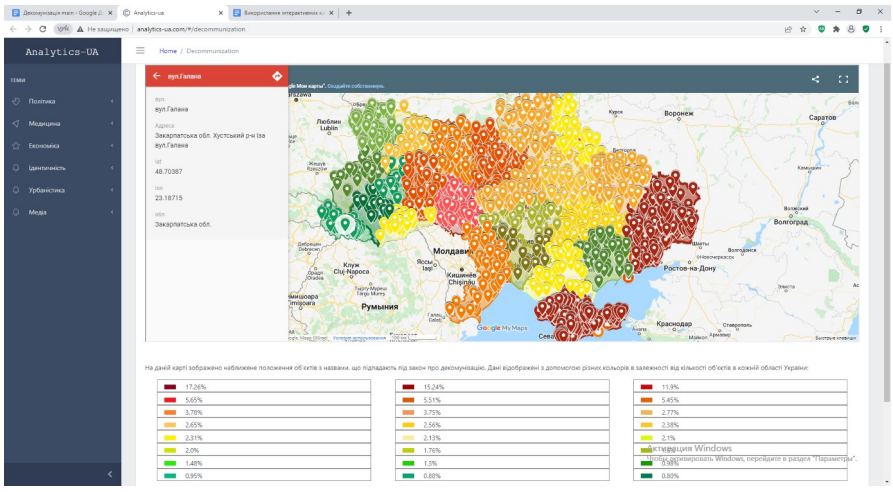

Fig. 1. The interface of the developed software product

The whole map of Ukraine is divided into regions, and for each region there chosen the color of painting. Each color is related to the percentage of non-decommunized streets in the corresponding region. Specific values related to colors are given in the legend below the map.

Each area containes markers of the appropriate color, geographically related to non-decommunized street names. By clicking on such a marker one can get additional information, namely the name of the street, its administrative address, geographical coordinates and the name of the region.

Map scaling is standard with Google Maps.

The developed software product also displays the percentage of toponymic objects of each region of Ukraine that are to be renamed. Currently, in Lvivska, Volynska, Ternopilska, Zakarpatska, Zaporizka, Mykolaivska and Kirovohradska regions rests up to 2% of toponymic objects that fall under the law of decommunization. In Donetska and Luhanska regions and in the Avtonomna Respublika Krym there are from 11% to 17% such objects. In the rest of Ukraine, from 2% to 5.5% of toponymic objects are subject to decommunization. According to the interactive map in the western and central regions of Ukraine, such streets as, for instance, Kolhospna, Pravdy, Zhovtneva, Internatsionalnaya, etc. are subject to renaming. This also concerns with the streets that still are named after such persons as Galan, Artem, Ostrovsky, Tereshkova. In the northern regions, the names in honor of Gorky, Dzerzhinsky, Ostrovsky, Shchors, and Semashko predominate. The situation is similar in the south-eastern part of Ukraine. Many streets and lanes named after Gorky, Dzerzhinsky, Voroshilov. Most of them, of course, are locted in Donetska and Luhanska regions and Avtonomna Respublika Krym.

V. CONCLUSION

Thus, the developed interactive map is one of the tools for implementing state and public policy.

The paper describes the model of conducting any geospatial research created by us, which will use IT technologies, with highlighting of 5 basic stages and possible options for action on each of them. The approach described in this publication allows one to make similar maps quite easily and quickly. The Google Maps service allows one to display and work with a large number of points for free, export files of special format for geodata, klm files, etc. At the output an interactive map should be obtained, which is very convenient to use for determination the state of decommunization. This has been done. The created map has a user-friendly interface with displaying not only the map itself, but also statistics on the decommunization process, is available through a browser on the well-known Ukrainian resource analytics-UA.

Using the information provided on the interactive map, civil activists or political forces can know where to direct their educational activities, lobbying or direct actions.

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