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AN OVERVIEW OF THE POSSIBILITIES OF SOLVING GEODETIC PROBLEMS USING MODERN SPATIAL ANALYSIS SOFTWARE TOOLS

ОГЛЯД МОЖЛИВОСТЕЙ ВИРІШЕННЯ ГЕОДЕЗИЧНИХ ЗАДАЧ ЗА ДОПОМОГОЮ СУЧАСНИХ ПРОГРАМНИХ ЗАСОБІВ ПРОСТОРОВОГО АНАЛІЗУ

Kukhar M.A. / Кухар М.А.
c.t.s., s.r.o. / к.т.н., с.н.с.
ORCID: 0000-0001-8305-6269
Myronenko M.L. / Мироненко М.Л.
ORCID: 0000-0002-0266-4463
Kobzan S.M. / Кобзан С.М.
c.t.s., as.prof. / к.т.н., доц.
ORCID: 0000-0002-5257-8117
Maslii L.O. / Маслій Л.О.
ORCID: 0000-0003-3844-462X
O.M. Beketov National University of Urban Economy,
Kharkiv, Marshal Bazhanov 17, 61002
Харківський національний університет міського господарства імені О.М. Бекетова,
Харків, Маршала Бажанова 17, 61002

Анотація. *Зараз геодезичні прилади забезпечують достатню точність при виконанні більшості геодезичних робіт. Але все ж велика частина геодезистів ще користуються відносно застарілим обладнанням. Тому зростає потреба в сучасних геодезичних інструментах, які використовують сучасні технології та сучасне програмне забезпечення.*

Водночас сучасне програмне забезпечення надає більше можливостей для реалізації сучасних завдань геодезії по збору більшої кількості достовірних даних. Це, в свою чергу, надає більше можливостей для аналізу цих даних за допомогою використання ГІС. Але є нестандартні геодезичні завдання. Ці завдання можна вирішити вручну або за допомогою програми, написаної геодезистом для своїх потреб в конкретній ситуації, на базі вже існуючих допоміжних засобів, наприклад нейронних мереж. У статті концептуально розглянуто можливість створення таких програм в ArcGIS.

ArcGIS використовує спеціальні модулі для обробки геоданих. Одним із таких модулів є інтерпретатор Python. Цей модуль представляє пакет даних ArcPy – він дозволяє конвертувати геопросторові дані, керувати геопросторовими даними та створювати основу для аналізу та обробки геодезичних даних.

Використовуючи мову програмування Python, пакет ArcPy та ряд допоміжних інструментів геопросторового аналізу, можна виконувати додаткові операції з просторовими даними. Це дає більше можливостей для ГІС-фахівців та геодезистів.

Ключові слова: *ГІС, програмування, геодезія, просторові дані, геодезичне обладнання.*

Abstract. *Currently, geodetic instruments provide sufficient accuracy when performing most geodetic works. However, a large part of surveyors still use relatively outdated equipment. Therefore, there is a growing need for modern surveying tools that use modern technologies and modern software.*

At the same time, modern software provides more opportunities for the implementation of modern tasks of geodesy to collect more reliable data. This, in turn, provides more opportunities to analyze this data through the use of GIS. But there are non-standard geodetic tasks. These tasks can be solved manually or with the help of a program written by a surveyor for his needs in a specific situation, based on existing aids, such as neural networks. The article conceptually considers the possibility of creating such programs in ArcGIS.

ArcGIS uses special modules for geodata processing. One such module is the Python

interpreter. This module introduces the ArcPy data package - it allows you to convert geospatial data, manage geospatial data, and provide a framework for analyzing and processing geodetic data.

Using the Python programming language, the ArcPy package, and a number of supporting geospatial analysis tools, it is possible to perform additional operations on spatial data. This provides more opportunities for GIS professionals and surveyors.

Key words : *GIS, programming, geodesy, spatial data, geodetic equipment.*

Introduction.

In the modern world, there is a need to optimize the methods of performing geodetic works: increasing the efficiency of information collection, the volume of information, increasing the efficiency of typical tasks in geodesy. This need characterizes a new stage in the development of geodetic instruments. It is based on the creation of modern software, which is the optimization of technological processes under new conditions. For example, the use of geoinformation systems, the use of modern equipment, the creation of new geodetic programs.

The new level of development consists in the plan of mechanical improvement of geodetic devices, software of the equipment itself, software for interpreting data downloaded from the device, which leads to the search for new ways of optimizing geodetic works and processing geospatial data. And the most economical and well-founded choice is to increase attention to the development of specialized software.

The purpose and tasks of the work

The purpose of the article is to study the capabilities of modern software tools for solving geodetic problems.

To achieve the goal, the following tasks are set:

1. Conceptual analysis of the use of programming to solve problems with spatial data.

2. Determination of prospects for using programming to solve non-typical problems in geodesy.

Conceptual analysis of the use of programming to solve problems with spatial data

Spatial binding is used in various spheres of human activity. First, get spatial information. Then you need to display the information to use it in this area. Information can be displayed similarly: on paper, but now modern technologies are used for this. Specialized software tools such as ArcGis are being developed.

ArcGIS uses special modules for geodata processing. One such module is the Python interpreter. This module represents the ArcPy data package. Data Pact is used for geographic data analysis, data transformation, data management, and map automation in Python.

Python and the ArcPy package allow you to perform additional operations with spatial data, create spatial autonomous maps. To do this, use existing geodetic data. This expands the capabilities of GIS specialists and programmers in working with data [1].

Programming in Python in ArcGIS allows efficient processing of spatial data. This is a convenient auxiliary tool for working with geodatabases.

ESRI 's ArcGIS software uses the Python programming language. This is a data interpreter in ArcMap. It looks like a dialog box. In this window, manipulate geodata

using Python scripts.

This dialog box specifies the script code. A tooltip is displayed on the right side of the window. For example, the Describe function [2] and its prompt (figure 1).

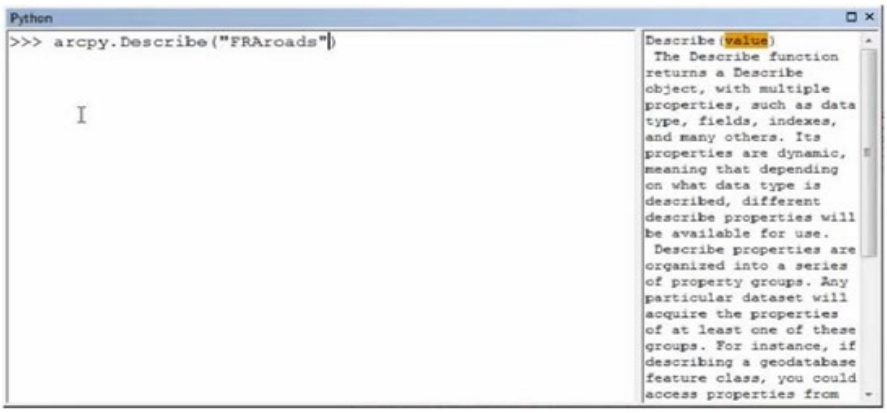

Figure 1 – Illustration of the Describe function

Origin: [2]

Python in ArcMap allows you to work with shapefiles. This is attributive information. It can be displayed in the interpreter and modified. It is possible to display the information of the attribute table of the shape file. It is possible to work with the elements of the attribute table, for example, the for loop. Python in ArcMap allows you to perform operations with electronic maps. For example, by referring to the ListLayrs function and the transparency property, you can change the transparency of the map layer [3-5].

Thus, Python is the programming language that should be used to support geospatial data processing. There is practical value to Python for processing spatial data. Therefore, ArcPy has tools for working with spatial data.

Determining prospects for using programming to solve atypical problems with spatial data

Over the last decade, problems that are solved using 3D models built on the basis of spatial information obtained with the help of geodetic scanners and similar equipment for collecting a large volume of spatial information have become widespread [6–7]. Now this trend has remained unchanged, but additional software capabilities have appeared.

One of the tools for solving non-typical problems in geodesy is the processing of point clouds. For example, the construction of point clouds is presented in ArcGIS PRO. This is many points of space. They have coordinates X, Y, H. These data are obtained by modern geodetic instruments. Many geodetic tasks can be solved at these points. Their solution is carried out within the framework of the set conditions and volume of initial data. Thus, a point cloud of the facades of multi-story residential buildings is presented (figure 2).

The work [8] was taken as the basis of the study. In this work, neural networks determine the position and length of power lines using the functions of the ArcGIS PRO software complex, using «Pre-Trained Models in ArcGIS». Also, neural networks can be programmed to identify corner elements of buildings in a point cloud. This will make it possible to display the set of points of urban architecture

elements in the usual way. Also, it will allow to separate certain information from the cloud of points for solving geodetic problems.

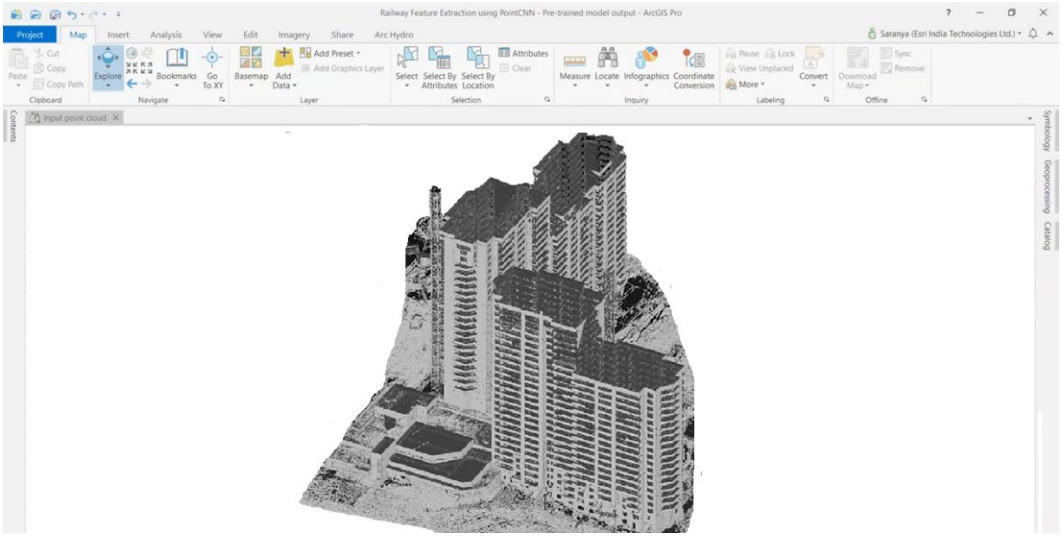

Figure 2 – Illustration of cloud point buildings in ArcGIS PRO

Author's development

The analysis is performed, the sequence of actions from work [8] is used (figure 3), some corner elements of the houses are obtained (figure 4).

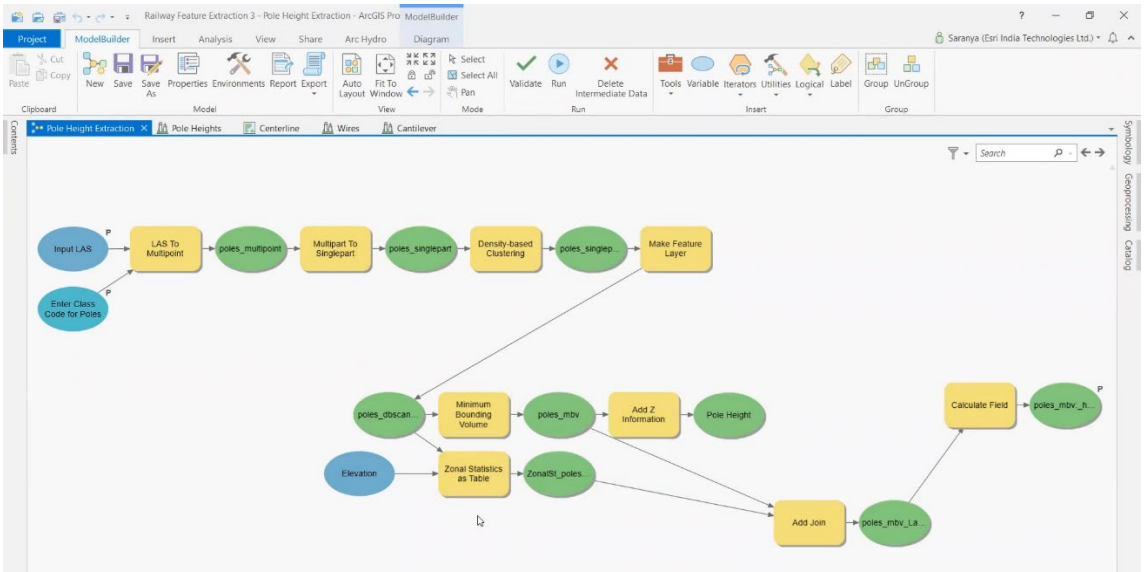

Figure 3 – Illustration of a model builder framework that automate dimension extraction

Origin: [9]

But there are peculiarities of point cloud analysis. Therefore, the Python module can be used. The module has the possibility to improve the ToolBox tools for this analysis or to create new tools for a specific task (figure 5).

Here, for example, is a simple task: determining the height of a building. With the help of these tools, you can solve complex problems. This problem has its own characteristics: initial data, volume of data, complexity of the task, initial data. Python allows you to make changes to the tool code from the model builder infrastructure. These changes are necessary to describe the specifics of our problem.

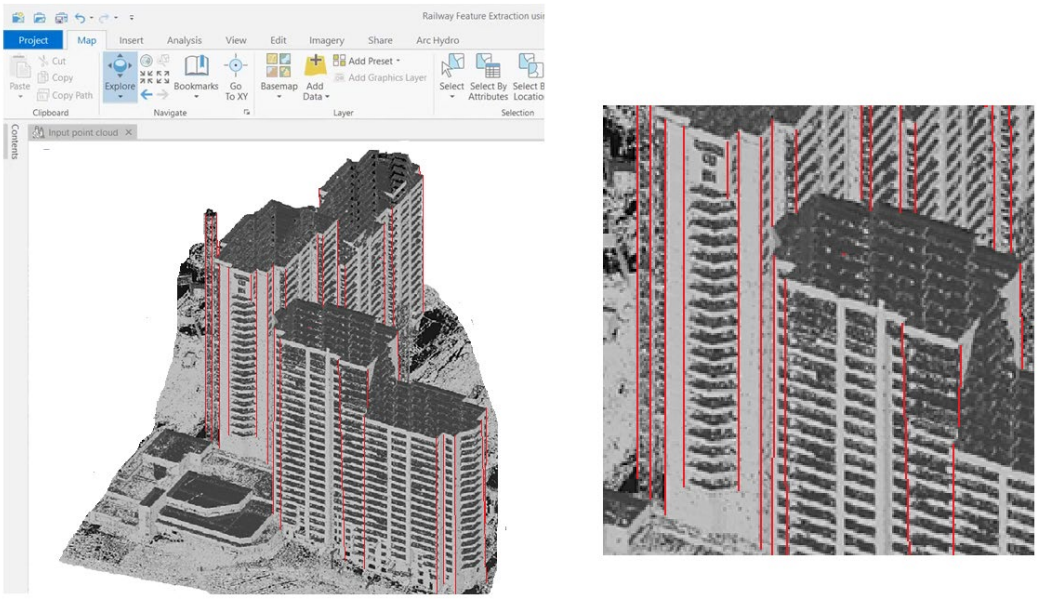

Figure 4 – Illustration of certain corners of buildings in a cloud of points
Author's development

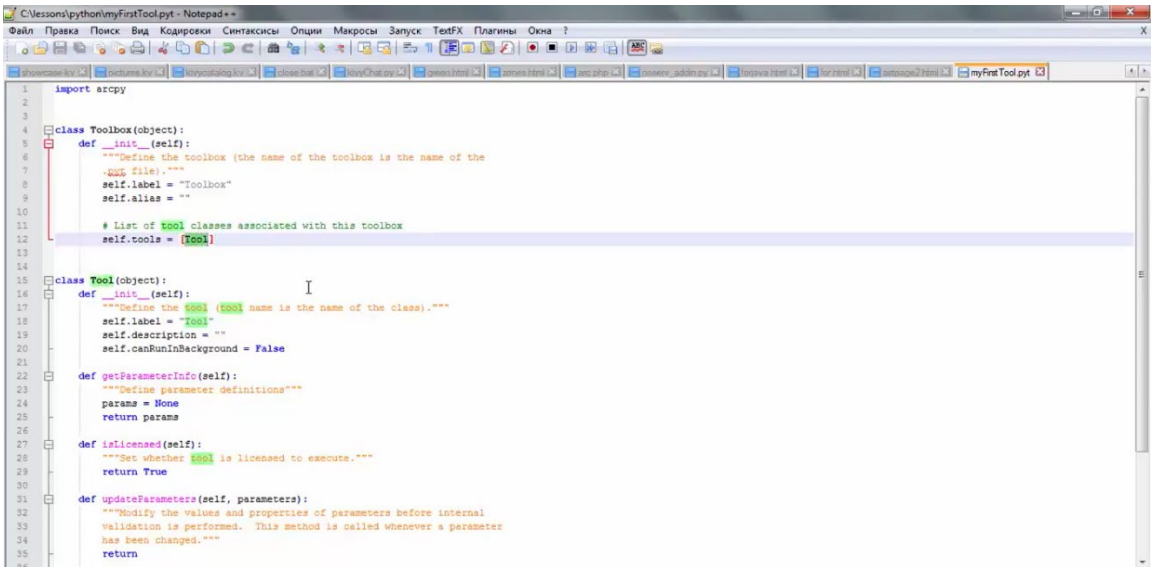

Figure 5 – Illustration of editing tools ToolBox
Author's development

Conclusions.

1. Analyzed modern software. A conceptual analysis of the use of the Python programming language in ArcGIS to optimize the solution of non-standard geodetic problems was carried out.

2. The prospects of using programming to solve problems with spatial data are described. To do this, use: point clouds, the capabilities of neural networks in ArcGIS PRO and the capabilities of the Python module.

In general, a study of modern specialized software was conducted. These software tools will allow solving non-standard geodetic problems using large volumes of spatial data. It should be noted that this is possible when creating additional functions using tools such as ToolBox and Python programming.

References:

1. Pimpler E. (2013) *Programming ArcGIS 10.1 with Python Cookbook.* Birmingham: Packt Publishing. Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwi4xczwmv_8AhXP_aQKHQdXAW4QFnoECAwQAQ&url=https%3A%2F%2Fsc802d58b85de2333.jimcontent.com%2Fdownload%2Fversion%2F1514985073%2Fmodule%2F11874608399%2Fname%2FProgramming.ArcGIS.10.1.with.Python.Cookbook.Feb.2013.pdf&usg=AOvVaw3Jg_H_jm5HnoqWjNG982r_

2. Kukhar M. A. (2019)Analysis of the capabilities of the Python programming language for working with spatial data. *Scientific Journal «ScienceRise»*, 4(57), 40–45. Retrieved from: http://www.irbis-nbuv.gov.ua/cgi-bin/irbis_nbuv/cgiirbis_64.exe?I21DBN=LINK&P21DBN=UJRN&Z21ID=&S21REF=10&S21CNR=20&S21STN=1&S21FMT=ASP_meta&C21COM=S&2_S21P03=FILA=&2_S21STR=texc_2019_4_11

3. ArcGis Pro Describing data (2023). Retrieved from: https://pro.arcgis.com/en/pro-app/arcpy/get-started/describing-data.htm

4. ArcGis Pro UpdateCursor (2023). Retrieved from: https://pro.arcgis.com/en/pro-app/arcpy/data-access/updatecursor-class.htm

5. ArcGis Pro ListLayrs (2023). Retrieved from: http://desktop.arcgis.com/en/arcmap/10.3/analyze/arcpy-mapping/listlayers.htm.

6. Lutso V. V. Qualification work on the topic: Application of 3D scanning in urban planning (2021). *Sensors International*, 2, 100–114. Retrieved from: https://www.sciencedirect.com/science/article/pii/S2666351121000358.

7. William E. Carter, Ramesh L. Shrestha, & Clint K. (2007) Geodetic laser scanning. *Physics Today*, 60(12), 41–47. Retrieved from: https://www.researchgate.net/publication/243391810_Geodetic_Laser_Scanning

8. Manushi Majumdar Dev Summit (2021) Pre-Trained Models in ArcGIS. Retrieved from: https://www.esri.com/arcgis-blog/products/arcgis-pro/analytics/devsummit-2021-pre-trained-models-in-arcgis/.

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