Man perceives the surrounding reality as a set of objects located in three-dimensional space. In order to characterize the geometrical properties of these objects and locate them in space, it is essential to determine their dimensions and coordinates. Measuring the shape of complex objects requires determination of the coordinates of many points on their surface. This can be achieved using remote sensing methods and devices that allow the measurement of an object and determination of its location without direct contact with the characterized object. Measurement results can be presented in various ways, but the so-called point cloud is the product that is the closest to the human perception of the three-dimensional world. Point cloud can be defined as a disordered collection of points representing the surface of measured objects. Each point has three coordinates describing its location in 3D space.

Point clouds can be obtained in several ways, i.e., using laser scanners. The principle of laser scanner operation is based on measuring the time it takes for a laser pulse to reach an object, reflect and then return to the device. The knowledge about the speed of the light and the angle at which the laser beam was sent, enables us to calculate the coordinates of the measured point. Laser scanners can be used stationary or can be placed on a moving object, e.g., a drone or an airplane. Measurement of large entities, e.g., whole cities, is commonly performed using airborne laser scanning (ALS). In this case, the obtained point cloud represents a very large number of objects of various types (buildings, trees, etc.). Therefore, to further process and use the collected data, it is necessary to assign each point with a label indicating its belonging to a certain group of objects (classes), e.g., trees, land surface, etc. This procedure is called classification.

Due to the high density of data, its manual analysis is time-consuming and prone to interpretation errors. Therefore, currently the automatic algorithms are utilized for this purpose. These algorithms mostly employ machine learning approaches that require the training samples that show the correct assignment of labels to points. Based on this sample, the algorithm learns how to assign labels to the rest of points. Usually, the classification is performed using shallow learning approaches that statistically distinguish the objects using a set of point cloud related features that are designed by a human. However, the values of these features are highly dependent on point cloud characteristics and the equipment used. Therefore, recently, the deep learning methods are gaining the attention of the community. These methods employ artificial neural networks that are based on attempts to recreate the way the human brain works. Thus, the deep learning networks consist of many layers of individual neurons. Utilizing deep learning methods for point cloud classification enables us to avoid defining the features, because they are learned during the training process. However, due to their complex character, training of deep learning networks is time-consuming and requires a large amount of training data that is hardly available. **These drawbacks can be overcome by developing a deep learning classification methodology that allows the network to be trained once and then to be used for subsequent classifications without the need for further training. The proposed methodology should enable us to classify the data of different characteristics, such as point cloud density, or equipment used**. However, because of the poor availability of training data, the reproducibility of classification using trained neural networks on data of different characteristics remains unexplored.

Recently, more and more countries have decided to publish their spatial data, including ALS point clouds. In most of the cases the data is classified using automatic methods. However, some of the countries (e.g., Poland, Austria, Netherlands) decided to outsource the manual correction of the automatic classification results to increase its accuracy. This initiative opens very promising possibilities for deep learning classification of ALS data as it enables comprehensive training of the deep nets. Therefore, the aim of this project is to develop a methodology to classify ALS point clouds of various characteristics using a neural network that was trained on different data. The methodology development will be based on publicly available ALS data.

Point cloud classification is the first step of most ALS data processing algorithms. **The development of this methodology will therefore improve the speed and accuracy of the algorithms used to analyze point clouds in a variety of applications such as precise forestry, spatial planning, 3D building modeling, deformation studies, monitoring of geomorphological structures and many others.** On the other hand, in the future, it will allow to reduce the costs of performing an accurate classification of ALS data obtained and published by different countries.