Income inequality remains one of the most interesting social and economic issues of our time. Studying it helps us understand how total income is distributed within populations and how it impacts their quality of life. Many different methods of measuring income inequality have been proposed and described in the literature. The Gini index, which is the most popular, has been criticised for various reasons. From an economic perspective, it gives little information about the details of the inequality in a certain population, focussing only on measuring the sparsity of the income distribution. From a mathematical perspective, estimator of the Gini index is sensitive to outliers, which means that an extreme observation in the data may radically change the value of the index. In addition, the Gini index is well-defined only if the distribution has finite mean value, which may not be the case if we consider data with extremely high incomes. For these reasons, it is necessary to study alternative ways of describing the nature of income inequality. In recent years, some curves and indices expressed with the quantiles have been proposed in the literature to address the aforementioned issues. We call them quantile inequality curves and indices. However, there is still a gap in the literature on these methods. The main goal of this project is to fill this gap.

High levels of income inequality can lead to political instability and may reduce social cohesion. In addition, it can have a negative impact on economic growth. By identifying the causes and consequences of income disparities, policymakers can design more effective taxation, education system, healthcare policy, or welfare programmes. Extended studies of income inequality can also help to evaluate whether current policies truly promote equal opportunity. This topic remains a subject of interest for researchers, as it directly affects the everyday life of citizens and has a potential impact on public policy and the results of elections. A proper understanding of income inequality can contribute to the design of more stable and resilient societies. Research on income inequality can help discover and understand the reasons for social unrest, poverty, and economic inefficiency.

The plan of the project is to expand the knowledge about robust methods of statistical inference regarding income inequalities by developing statistical methods for testing hypotheses concerning the equality of income inequality levels between two (or more) populations and by determining confidence regions for quantile inequality curves and confidence intervals for quantile inequality indices. One of the goals of the project is to state and prove several theoretical results regarding quantile inequality curves and indices. These results will contribute to the discipline of mathematics. The study will consider also a class of zero-inflated distributions, which may more accurately describe the distribution of salaries. This type of distribution includes the case when a certain value appears multiple times in the data, for example, in the case where people without income are considered in a study or if significant number of individuals earn minimum wage. In some countries, the minimum wage is earned by more than 20% of the employees. Hence, such factors may have a huge impact on the distribution of income in society and, therefore, considering them can improve the study of income inequality. Another important part of this project is developing a Python library with implementations of the methods studied in this project. This library will be useful for practitioners, analysts, and researchers in various fields. The accuracy of the inference methods developed in the project will be challenged in a detailed simulation study

The inference methods described throughout this project extend the theory of methods used in the analysis of income distribution and income inequality, which contributes to the discipline of economics. Since the Gini index has applications in many disciplines beyond economics, its alternatives studied in this project may also catch the attention of researchers or policymakers in different fields. The methods developed in this project may find many applications in describing certain phenomena. For example, they can be used to gain more understanding of inequality between different regions of Poland, not only in terms of income inequality, but also in terms of inequalities in access to healthcare or other social services. It is expected that the novel approach to measuring inequality can reveal new possibilities of analysing the distribution of certain resources in populations.