Eye tracking is commonly used in many scientific fields (experimental psychology, neuroscience, behavioral economics, etc.) and can provide us with rigorous data about current allocation of attention. Due to the complexity of data processing and missing methodology, experimental designs are often limited to static stimuli; eye tracking data is analyzed only with respect to basic types of eye movements – fixation and saccades. In dynamic tasks (e.g. with dynamic stimuli, such as showing movies or Multiple Object Tracking task), another type of eye movement is commonly present: smooth pursuit. Importantly, eye tracking data from dynamic tasks is often represented as raw data samples. It requires a different approach to analyze the data, and there are a lot of methodological gaps in analytical tools.

This thesis is divided into three parts. In the first part, we gave an overview of current methods for analyzing scan patterns, followed by four simulations, in which we systematically distort scan patterns and measure the similarity using several commonly used metrics. In the second part, we presented the current approaches to statistical testing of differences between groups of scan patterns. We present two novel strategies for analyzing statistically significant differences between groups of scan patterns and show their application in two behavioral experiments. In addition, we also showed an example of a classical approach to testing differences between groups of scan patterns to answer the question about eye data quality. In the final part of the dissertation, we predicted scan patterns in Multiple Object Tracking task using neural networks. Our results outperformed current, state-of-the-art methods.