A point process as the special type of a random stochastic process is a theoretical model for occurrence of random events in time and space. In this thesis, we examine pairs of point processes in time and their mutual relations. The thesis acquaints the reader with the theoretical background of point processes, two-dimensional point processes and their properties based on measure theory. The purpose of this paper is to present and demonstrate methods of analyzing realizations of two point processes. Our attention is beaing focused mainly on problem of dependency of two point processes. We describe data analyses based on cross-correlation histogram, synchronization indices, and on spectral analysis using coherence. In the last chapter, we conducted these methods on nerve cell spike train data.