Human societies are inherently complex and highly dynamic, resulting in rapidly changing social networks, containing multiple types of dyadic interactions. Analyzing these time-varying multiplex networks with approaches developed for static, single layer networks often produces poor results. To address this problem, our approach is to explicitly learn the dynamics of these complex networks. This dissertation focuses on four problems: 1) learning link formation rates; 2) predicting changes in community membership; 3) using time series to predict changes in network structure; 4) modeling coevolution patterns across network layers.

To study these problems, we created a rich dataset extracted from observing social interactions in the massively multiplayer online game Travian. Most online social media platforms are optimized to support a limited range of social interactions, primarily focusing on communication and information sharing. In contrast, relations in massively-multiplayer online games (MMOGs) are often formed during the course of gameplay and evolve as the game progresses. To analyze the players' behavior, we constructed multiplex networks with link types for attack, communication, and trading.

The contributions of this dissertation include 1) extensive experiments on the dynamics of networks formed from diverse social processes; 2) new game theoretic models for community detection in dynamic networks; 3) supervised and unsupervised methods for link prediction in multiplex coevolving networks for both positive and negative links. We demonstrate that our holistic approach for modeling network dynamics in coevolving, multiplex networks outperforms factored methods that separately consider temporal and cross-layer patterns.