Abstract: Recommender systems (RSs) has been playing a non-negligible role recently in surprisingly many fields, for example, e-commerce platform, social media and search engine. RSs mainly studies how to connect entities within the system effectively and efficiently. Nowadays, RSs serve as a decisive solution to the "information overload" problem by providing users with personalized content suggestions to maintain users participation and satisfaction.

However, to find perfect matches of users and items from millions of contents within the system is apparently challenging. Not only does the giant amount of data demands advanced and sophisticated data mining techniques, but the extreme sparsity that commonly exists in RSs further constrains the user modeling to learn only from noisy and subtle signals. Moreover, in real applications, the overwhelmingly growing amount of data also requires a reliable RS to be light in weight and simple in construction, such that fast inference can be achieved and building and updating can be done on a more frequent basis.

Traditional RSs techniques mostly rely on expressive human-level heuristic modeling and numerous handcrafted features carefully designed by domain experts. Also, restricted by the limited amount of data and computational power, traditional methods are generally linear models that are intrinsically impossible to capture complex user-item relations. Since deep learning and graph-based learning have revealed remarkable breakthroughs in various domains, where learning complicated and nonlinear signals automatically is imperative, they certainly get modified and adopted in RSs as well.

In this thesis, we investigate several effective user modeling methods for practical rcommendations based on deep learning and graph-based techniques to address personalized recommender system. Firstly, we propose "Personalized Pairwise Novelty Weighting (PPNW)" approach for 1-stage novelty-promoting RSs, in order to effectively promote novelty as well as to dealwith the problems of loss functions.
Secondly, we propose a light-weight graph embedding model for recommendation, HANABI (HNB) along with a concept "conditional proximity", in order to imitate the natural way that nodes propagate information to each other on the graph. HNB not only gets rid of any additional parameters both in training and inference phase, but also treats proximity of different orders distinctly by employing an attentive

mechanism on feature level. Finally, as an attempt of integrate knowledge graph as a auxiliary information into RSs, we propose X-2ch framework, which is a quad-channel CF graph model propagating information over knowledge-embedded edges. The two most significant ideas behind X-2ch are: the knowledge-embedded edges and a quad-channel aggregation mechanism. Specifically, rather than lodging KG entities on graph as nodes, X-2ch distills KG information and embeds them as edge attributes to model the natural user-item interaction process. Comprehensive experiments are conducted on various public benchmark datasets to conclusively evaluate and evidence the effectiveness and efficiency of the proposed models in this thesis.