Z-REx: Human Interpretable GNN Explanations for Real Estate Recommendations

Machine Learning on Graphs in the Era of Generative Artificial Intelligence, *KDD 2025*

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ZILLOW | TRULIA | STREETEASY | HOTPADS | OUT EAST

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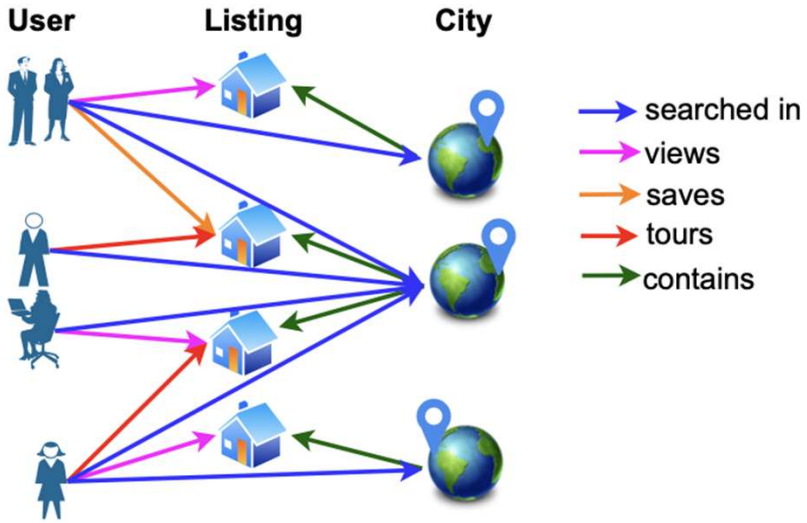
Motivation: Why Explain GNN-based Recommendations?

- Real estate recommendations are high-stakes decisions and gaining user's confidences is paramount: **transparency is crucial**
- GNNs offer strong recommendation performance…. But lack interpretability, specifically for the link prediction (LP) task
  - Existing explainers focus on node or graph classification tasks
- Need **human-interpretable**, **context aware** explanations

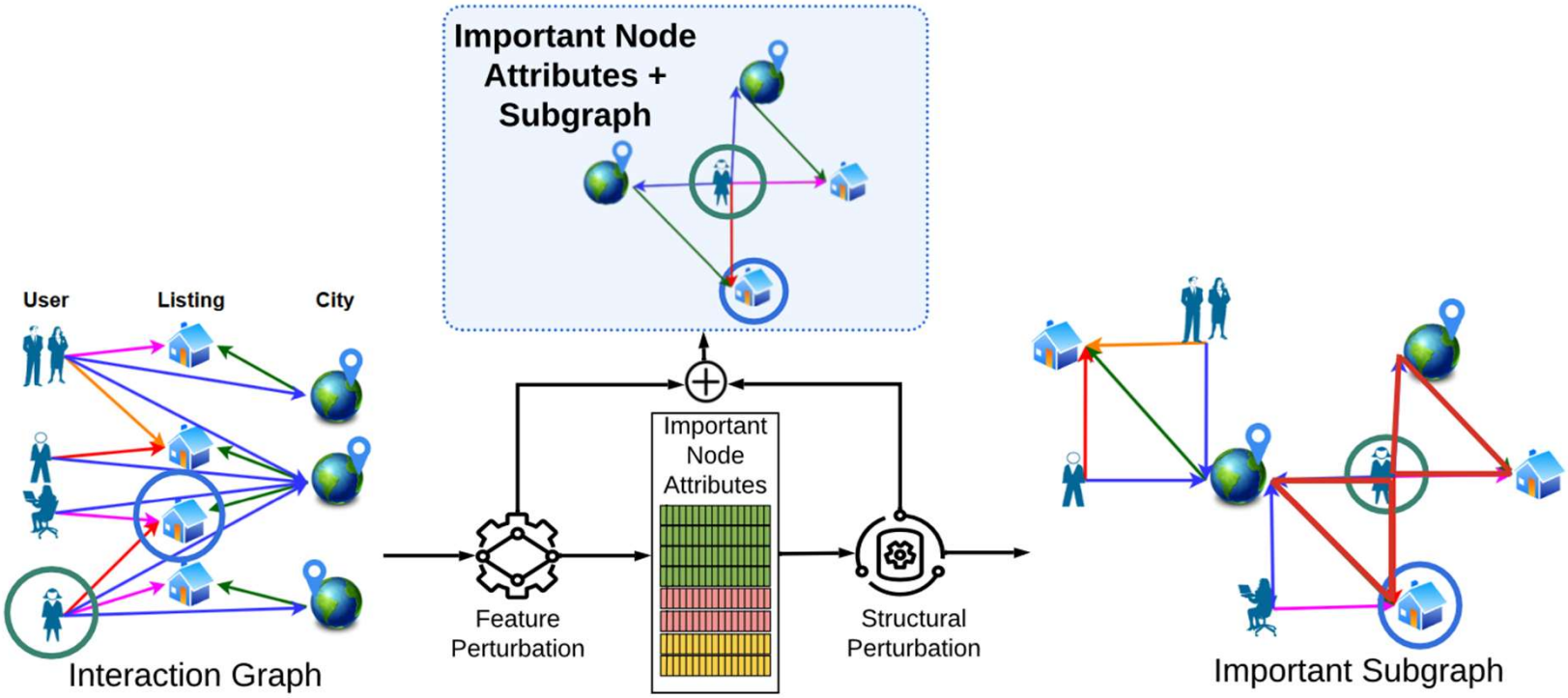
Our main contribution includes a **GNN explanation framework** designed for **heterogeneous LP tasks**

Recommendation Task and Interaction Graph

- Zillow user activity is inherently a graph of interactions between users and listings
  - As wells as cities (or other features)
- The primary task of the recommendation system is to predict the likelihood of a link between a user and a city, where links represent different interactions on Zillow
- ZiGNN: GNN trained on user-city interactions to produce recommendations



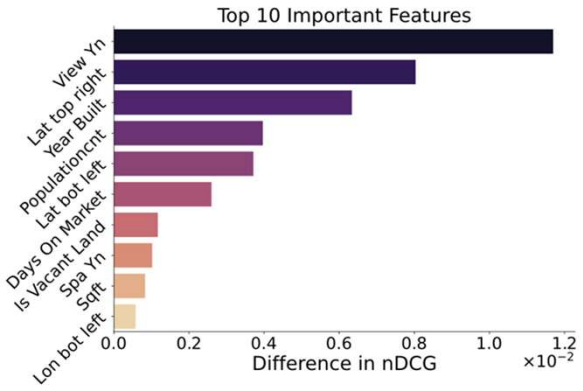
Z-REx Framework

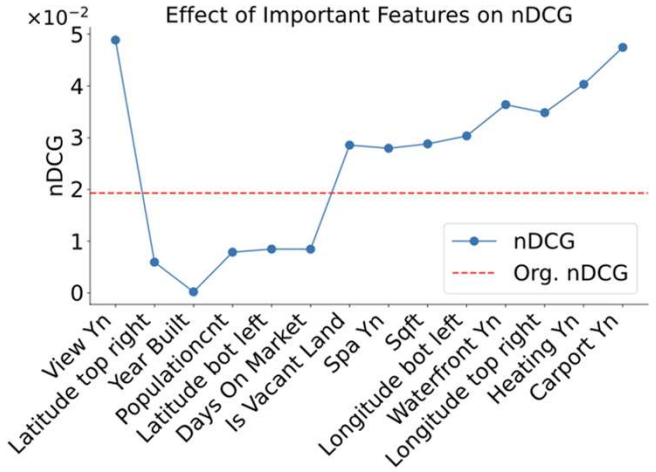


1. Feature Perturbation: Zero out features ➔ measure drop in NDCG@K
2. Structural Perturbation: Remove edges in a k-hop subgraph ➔ observe cosine similarity shift
3. Produces: Key features + critical subgraph

Feature Perturbation: Important Features Align with Real Estate Intuition

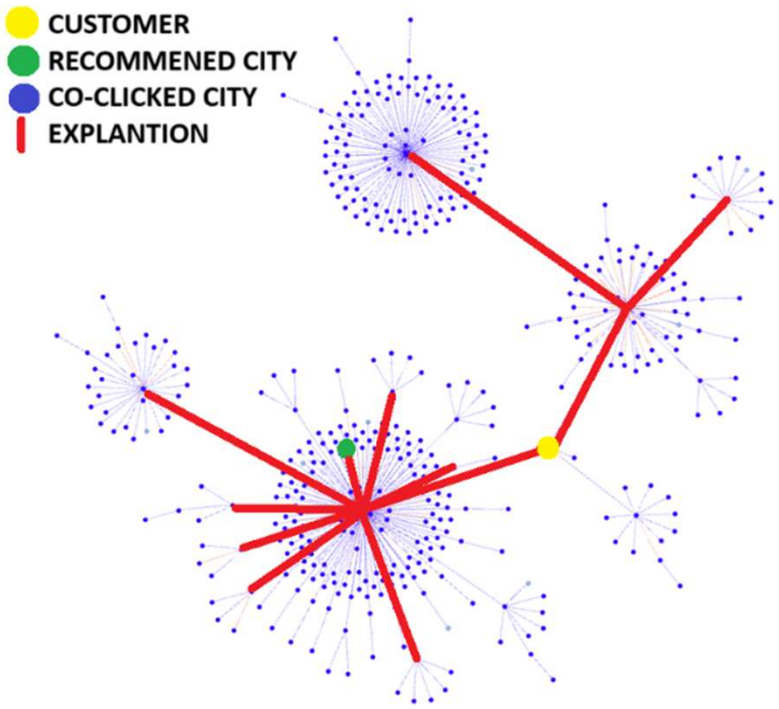
- Geographic Features (view, latitude/longitude, isVacant Land)
  - Not surprisingly location features dominant the top 10 most important
- City size: Population Count
- Freshness: Year Built, Days on Market
- Using only the most important features also yields a higher nDCG than the original model
  - Only these features will be used in structural perturbation





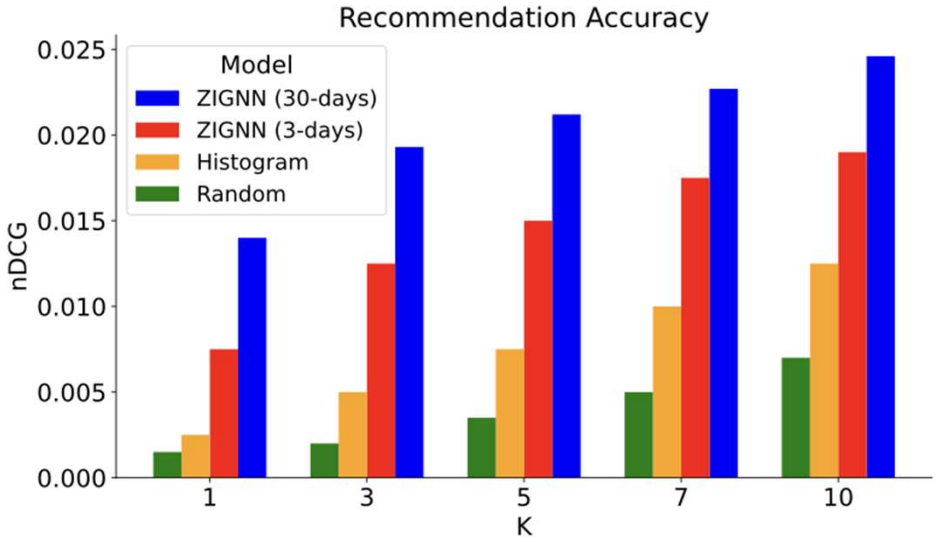
Explaining Graph Structure: Co-clicked Cities Matter

- **Structural Perturbation**
  1. Graph Transformation
     a. Remove all nodes but users and cities, centel on target user
  2. Identify Co-clicked Cities
     a. Add back edges between cities where clicke by a common user
  3. Edge Removal and Similarity Change
     a. Iteratively remove edges and recompute embedding similarity between users and city nodes
- Z-REx highlights hub cities in user interactio
- Hub cities act as bridges, explaining why a specific city was recommended based on shared user behavior and co-click patterns



Z-REx Outperforms SOTA Explainability Models

- Our ZiGNN model outperforms random and histogram baselines for city recommendations
  - Longer interaction period provides better results
- Explainability framework outperforms existing explainers (GNNExplainer, SubgraphX, PaGE-Link) in fidelity metrics



Change in	**Z-REx**	PaGE-Link [4]	GNNExplainer [1]	SubgraphX [3]
		3-days (Training)		
nDCG (% decr.)	**94%**	81% (*-13%*)	21% (*-73%*)	47% (*-47%*)
cosine similarity	**-0.10**	-0.07 (*-0.03*)	-0.02 (*-0.08*)	-0.04 (*-0.06*)
		30-days (Training)		
nDCG (% decr.)	**92%**	63% (*-29%*)	9% (*-85%*)	22% (*-70%*)
cosine similarity	**-0.09**	-0.05 (*-0.04*)	-0.01 (*-0.08*)	-0.02 (*-0.07*)

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Questions?

Thank you!