

HyperCARS: Using Hyperbolic Embeddings for Generating Hierarchical Contextual Situations in Context-Aware Recommender Systems

How can hierarchical contextual information be effectively modeled with hyperbolic embeddings and incorporated loosely into recommender systems for improved performance?

Konstantin Bauman and his colleagues present a new method, HyperCARS, which uses hyperbolic embeddings to model hierarchical contextual information for context-aware recommender systems (CARS). Their study, published in Information Systems Research, addresses the limitations of traditional Euclidean embeddings in capturing complex hierarchies and providing interpretable context representations. Hyperbolic space, with its unique geometric properties, naturally suits hierarchical data, enabling better preservation of contextual relationships.

HyperCARS constructs latent embeddings of contextual variables using variational autoencoders embedded in hyperbolic space. It then applies hierarchical clustering to organize these embeddings into multi-level contextual situations that represent context at different granularities. This hierarchical modeling captures the rich, layered nature of real-world context, such as time, location, and user intent.

Importantly, HyperCARS uses a loosely coupled approach to integrate these hierarchical contextual situations with existing recommendation algorithms. This modular design allows flexible use with a wide range of recommendation models in both hyperbolic and Euclidean spaces. Empirical tests on multiple real-world datasets demonstrate that HyperCARS produces more distinct and interpretable contextual groups than Euclidean methods. It consistently improves recommendation accuracy, ranking, and interpretability metrics.

The authors also propose a latent embedding representation framework that classifies prior embedding work by geometric space and organization method. This framework highlights the novel contribution of hierarchical hyperbolic embeddings in information systems and opens new research avenues beyond recommender systems.

MAJOR TAKEAWAYS:

- Hyperbolic embeddings better capture hierarchical context structures than Euclidean embeddings, improving recommendation quality.
- Loosely coupling hyperbolic contextual situations with recommendation algorithms enables flexible and modular system design.
- HyperCARS provides more interpretable and distinct contextual situations, aiding managerial understanding and practical deployment.

WHO NEEDS TO KNOW:

- Recommender Systems Researchers
- Data Scientists
- Business Managers

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