**Project Title: Recommender System using Vector Projections**



**Project Description:** In this project, you'll explore how vector projections can be used to build a recommender system that suggests items to users based on their preferences. You'll represent users and items as vectors in a high-dimensional vector space and use vector projections to infer users' preferences and make personalized recommendations.

**Key Steps:**

1. **Data Collection:** Obtain a dataset containing user-item interactions, such as ratings or purchases. This could be a dataset from an e-commerce platform, movie ratings dataset, or any other domain where users interact with items.
2. **Matrix Factorization:** Represent the user-item interactions as a sparse matrix, where rows represent users, columns represent items, and each entry represents the interaction (e.g., rating). Use matrix factorization techniques such as Singular Value Decomposition (SVD) or Alternating Least Squares (ALS) to decompose the matrix into user and item latent factor matrices.



1. **Vector Representation:** Represent users and items as vectors in a high-dimensional latent factor space. Each user and item is represented by a vector of latent factors learned during matrix factorization.
2. **Vector Projections for Recommendations:**
   * Given a user's vector representation, compute the vector projection of the user onto the vector representations of all items in the latent factor space.
   * Rank the items based on the cosine similarity or Euclidean distance between the user's vector projection and the vector representations of items. Higher similarity or closer distance indicates higher preference or relevance to the user.
3. **Recommendation Generation:** Generate personalized recommendations for each user by selecting the top-ranked items based on their vector projections.
4. **Evaluation:** Evaluate the performance of the recommender system using appropriate evaluation metrics such as precision, recall, or Mean Average Precision (MAP) on a held-out test dataset.

**Expected Outcome:** By the end of the project, you'll have developed a recommender system that uses vector projections in a latent factor space to make personalized recommendations to users based on their preferences.

**Skills Required:**

* Matrix factorization techniques
* Vector representations and vector projections
* Recommender system algorithms
* Evaluation metrics for recommender systems
* Programming skills in Python or any preferred language for data analysis

**Potential Extensions:**

* Experiment with different matrix factorization algorithms and hyperparameters to improve the accuracy and relevance of recommendations.
* Incorporate additional user and item features (e.g., demographic information, item metadata) into the vector representations to enhance the recommendation quality.
* Implement advanced recommendation techniques such as content-based filtering or hybrid recommendation systems that combine multiple recommendation approaches.
* Deploy the recommender system as a web application or API for real-time recommendation generation in a production environment.