Cross-Domain and Cross-System Recommendations

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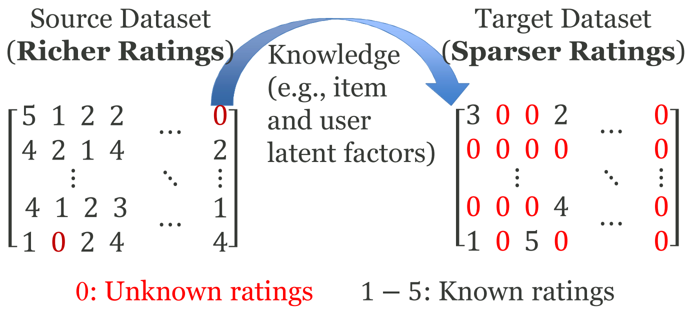
BACKGROUND

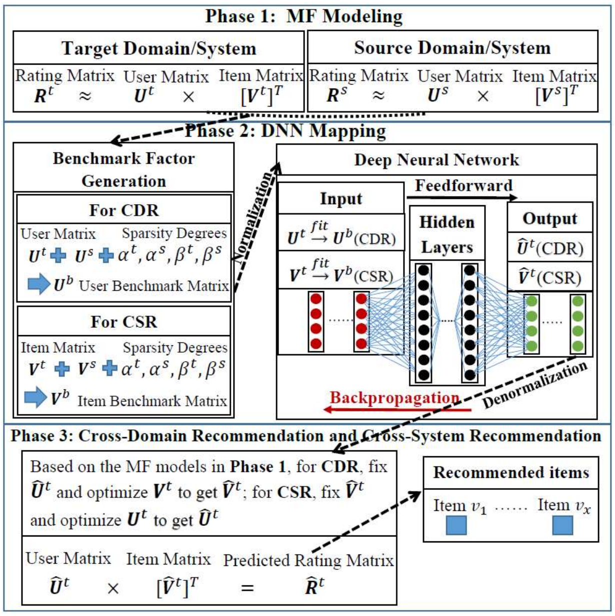
- **Cross-Domain Recommendation (CDR)** and **Cross-System Recommendations (CSR)** are two of the promising solutions to address the long-standing data sparsity problem in recommender systems.
- **CDR:** Different domains + Same system
- **CSR:** Different systems + Same domain
- **Core Idea:** Leverage the relatively richer information, e.g., ratings, from the source dataset (domain or system) to improve the recommendation accuracy in the target dataset.



TARGET PROBLEM

- **Common Idea:** Map the latent factors or rating patterns across domains or systems.
- **Target Problem:** The existing transfer-based approaches cannot effectively obtain an accurate mapping between the latent factors in the two datasets.
- **Our Solution:**
  - (1) MF models (latent factors generation) + A fully connected deep neural network (DNN mapping)
  - (2) Consider the fine-grained sparsity degrees of individual entities (users or items) to generate more reasonable benchmark factors.
  - (3) Apply the DNN to map latent factors in the target dataset to fit the benchmark factors.

METHODOLOGY



EXPERIMENTS

- **Datasets:**

Tasks	Cross-Domain			Cross-System		
Datasets	Douban			Netflix	MovieLens	Douban*
Domains	Movie	Book	Music	Movie	Movie	Movie
#Users	3,982	3,032	1,983	59,688	138,493	500
#Items	90,553	87,848	88,986	17,434	27,278	90,553
#Ratings	2,326,913	239,330	242,013	2,000,000	20,000,263	48,619

- **Experimental Tasks and Results**

	Tasks	Improvements
Cross-Domain Recommendation	**Task 1:** DoubanMovie → DoubanBook	[0.94%, 3.57%]
	Task 2: DoubanMovie → DoubanMusic	[1.66%, 5.41%]
Cross-System Recommendation	**Task 3:** Netflix → Douban*Movie	[3.00%, 9.00%]
	Task 4: MovieLens → Douban*Movie	[3.43%, 9.08%]

		Cross-Domain Recommendation (CDR)				Cross-System Recommendation (CSR)			
		Task 1		Task 2		Task 3		Task 4	
		MAE	RMSE	MAE	RMSE	MAE	RMSE	MAE	RMSE
K=10	BPR	0.7187 (± 0.0011)	0.9386 (± 0.0014)	0.7231 (± 0.0012)	0.9416 (± 0.0017)	0.7524 (± 0.0014)	0.9628 (± 0.0016)	0.7524 (± 0.0014)	0.9628 (± 0.0016)
	MMMF_TL	0.7001 (± 0.0009)	0.9128 (± 0.0007)	0.6978 (± 0.0006)	0.9093 (± 0.0005)	0.7162 (± 0.0012)	0.8951 (± 0.0003)	0.7090 (± 0.0007)	0.8997 (± 0.0003)
	PMF_TL	0.7022 (± 0.0016)	0.9187 (± 0.0006)	0.7077 (± 0.0008)	0.9097 (± 0.0005)	0.7031 (± 0.0008)	0.8913 (± 0.0012)	0.7120 (± 0.0003)	0.9030 (± 0.0007)
	MF_EMCDR_LIN	0.7065 (± 0.0003)	0.9103 (± 0.0006)	0.7024 (± 0.0012)	0.9163 (± 0.0004)	0.7096 (± 0.0008)	0.9113 (± 0.0007)	0.7340 (± 0.0009)	0.9326 (± 0.0007)
	MF_EMCDR_MLP	0.7011 (± 0.0015)	0.9071 (± 0.0009)	0.7022 (± 0.0008)	0.9045 (± 0.0012)	0.7087 (± 0.0008)	0.9049 (± 0.0005)	0.7045 (± 0.0004)	0.9062 (± 0.0005)
	BPR_EMCDR_LIN	0.7084 (± 0.0012)	0.9111 (± 0.0006)	0.7065 (± 0.0005)	0.9105 (± 0.0013)	0.7038 (± 0.0004)	0.9035 (± 0.0003)	0.7080 (± 0.0005)	0.9043 (± 0.0006)
	BPR_EMCDR_MLP	0.7061 (± 0.0005)	0.9054 (± 0.0005)	0.6987 (± 0.0003)	0.9055 (± 0.0008)	0.6995 (± 0.0005)	0.8994 (± 0.0003)	0.6991 (± 0.0002)	0.8994 (± 0.0005)
	MMMF_DCDCSR	0.7041 (± 0.0005)	0.8971 (± 0.0004)	0.6992 (± 0.0003)	0.8875 (± 0.0002)	0.6998 (± 0.0003)	0.8865 (± 0.0002)	0.6994 (± 0.0005)	0.8836 (± 0.0004)
	PMF_DCDCSR	0.7037 (± 0.0005)	0.8965 (± 0.0003)	0.6996 (± 0.0004)	**0.8866 (± 0.0002)**	0.6838 (± 0.0012)	0.8681 (± 0.0011)	**0.6753 (± 0.0006)**	**0.8659 (± 0.0007)**
	BPR_DCDCSR	**0.6943 (± 0.0003)**	**0.8881 (± 0.0006)**	**0.6971 (± 0.0008)**	0.8872 (± 0.0004)	**0.6786 (± 0.0007)**	**0.8651 (± 0.0008)**	0.6854 (± 0.0014)	0.8712 (± 0.0009)
K=20	BPR	0.7146 (± 0.0014)	0.9292 (± 0.0007)	0.7234 (± 0.0011)	0.9352 (± 0.0006)	0.7432 (± 0.0012)	0.9532 (± 0.0014)	0.7432 (± 0.0012)	0.9532 (± 0.0014)
	MMMF_TL	0.7068 (± 0.0004)	0.9146 (± 0.0008)	0.7109 (± 0.0003)	0.9104 (± 0.0002)	0.6915 (± 0.0002)	0.8922 (± 0.0003)	0.7026 (± 0.0003)	0.8986 (± 0.0002)
	PMF_TL	0.7017 (± 0.0003)	0.9188 (± 0.0008)	0.7176 (± 0.0004)	0.9244 (± 0.0006)	0.7024 (± 0.0003)	0.8969 (± 0.0002)	0.7057 (± 0.0003)	0.9012 (± 0.0003)
	MF_EMCDR_LIN	0.7015 (± 0.0008)	0.9070 (± 0.0006)	0.7021 (± 0.0006)	0.9076 (± 0.0019)	0.7027 (± 0.0005)	0.9074 (± 0.0013)	0.6977 (± 0.0015)	0.9032 (± 0.0002)
	MF_EMCDR_MLP	0.7021 (± 0.0003)	0.9095 (± 0.0005)	0.7001 (± 0.0003)	0.9095 (± 0.0005)	0.6995 (± 0.0003)	0.8995 (± 0.0003)	0.6993 (± 0.0005)	0.8995 (± 0.0005)
	BPR_EMCDR_LIN	0.7041 (± 0.0009)	0.9174 (± 0.0005)	0.7021 (± 0.0008)	0.9147 (± 0.0012)	0.7060 (± 0.0007)	0.9024 (± 0.0005)	0.6949 (± 0.0006)	0.9012 (± 0.0008)
	BPR_EMCDR_MLP	0.7023 (± 0.0006)	0.9074 (± 0.0006)	0.7021 (± 0.0008)	0.9047 (± 0.0012)	0.6991 (± 0.0005)	0.8993 (± 0.0003)	0.6995 (± 0.0002)	0.8999 (± 0.0002)
	MMMF_DCDCSR	0.7001 (± 0.0002)	0.8876 (± 0.0004)	0.6987 (± 0.0003)	0.8866 (± 0.0003)	0.7004 (± 0.0003)	0.8875 (± 0.0004)	0.7012 (± 0.0001)	0.8816 (± 0.0004)
	PMF_DCDCSR	0.7003 (± 0.0004)	0.8872 (± 0.0005)	0.6985 (± 0.0003)	0.8879 (± 0.0004)	0.6880 (± 0.0001)	0.8609 (± 0.0006)	0.6805 (± 0.0004)	0.8654 (± 0.0001)
	BPR_DCDCSR	**0.6941 (± 0.0002)**	**0.8845 (± 0.0001)**	**0.6949 (± 0.0004)**	**0.8867 (± 0.0003)**	**0.6723 (± 0.0002)**	**0.8556 (± 0.0008)**	**0.6780 (± 0.0003)**	**0.8601 (± 0.0002)**

CONCLUSIONS

- In this work, we propose a Deep framework for both Cross-Domain and Cross-System Recommendations, called DCDCSR, which employs MF models and a fully connected Deep Neural Network (DNN).
- We consider the fine-grained sparsity degrees of individual entities (users or items) to generate benchmark factors.
- We apply the DNN to accurately map the latent factors in the target dataset to fit the benchmark factors.
- The extensive experiments demonstrate that our framework outperforms the state-of-the-art approaches.