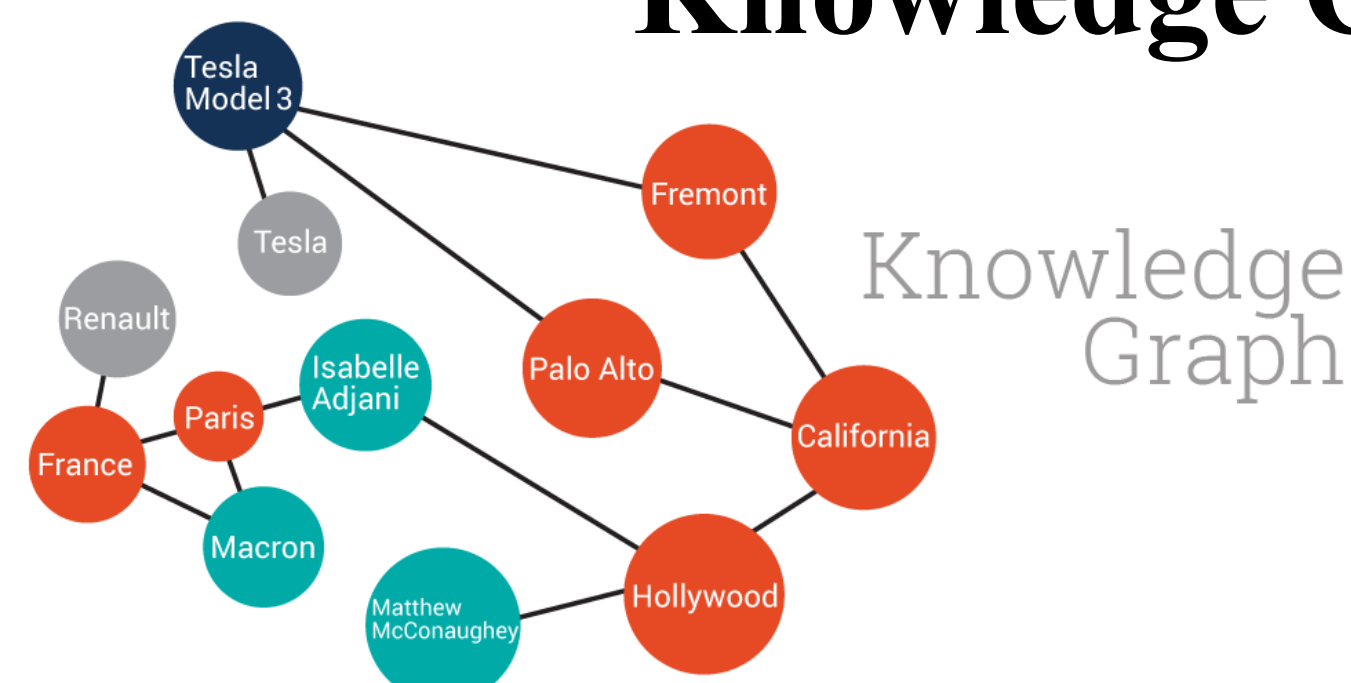


Expanding Holographic Embeddings for Knowledge Completion

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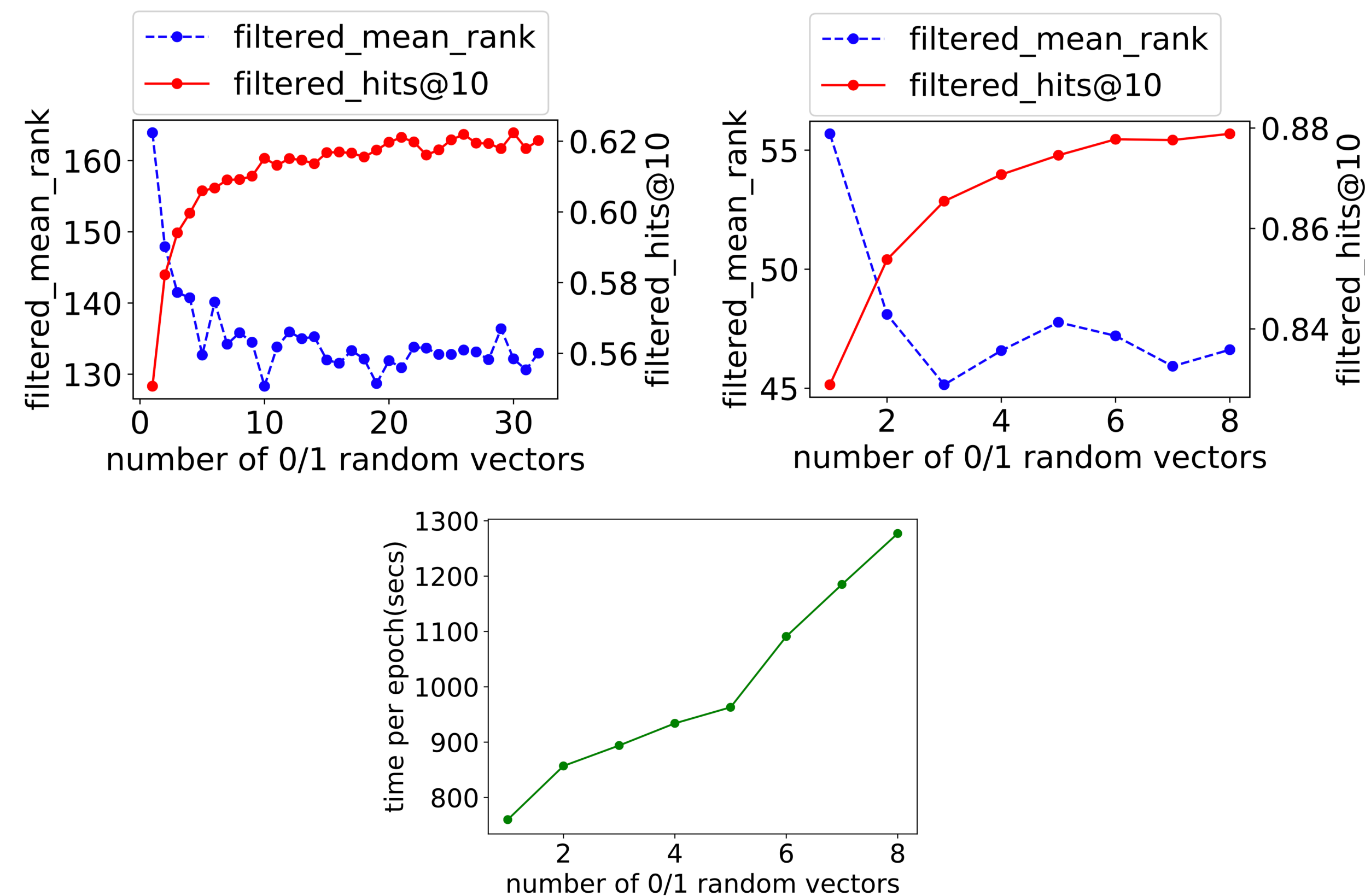
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Knowledge Completion



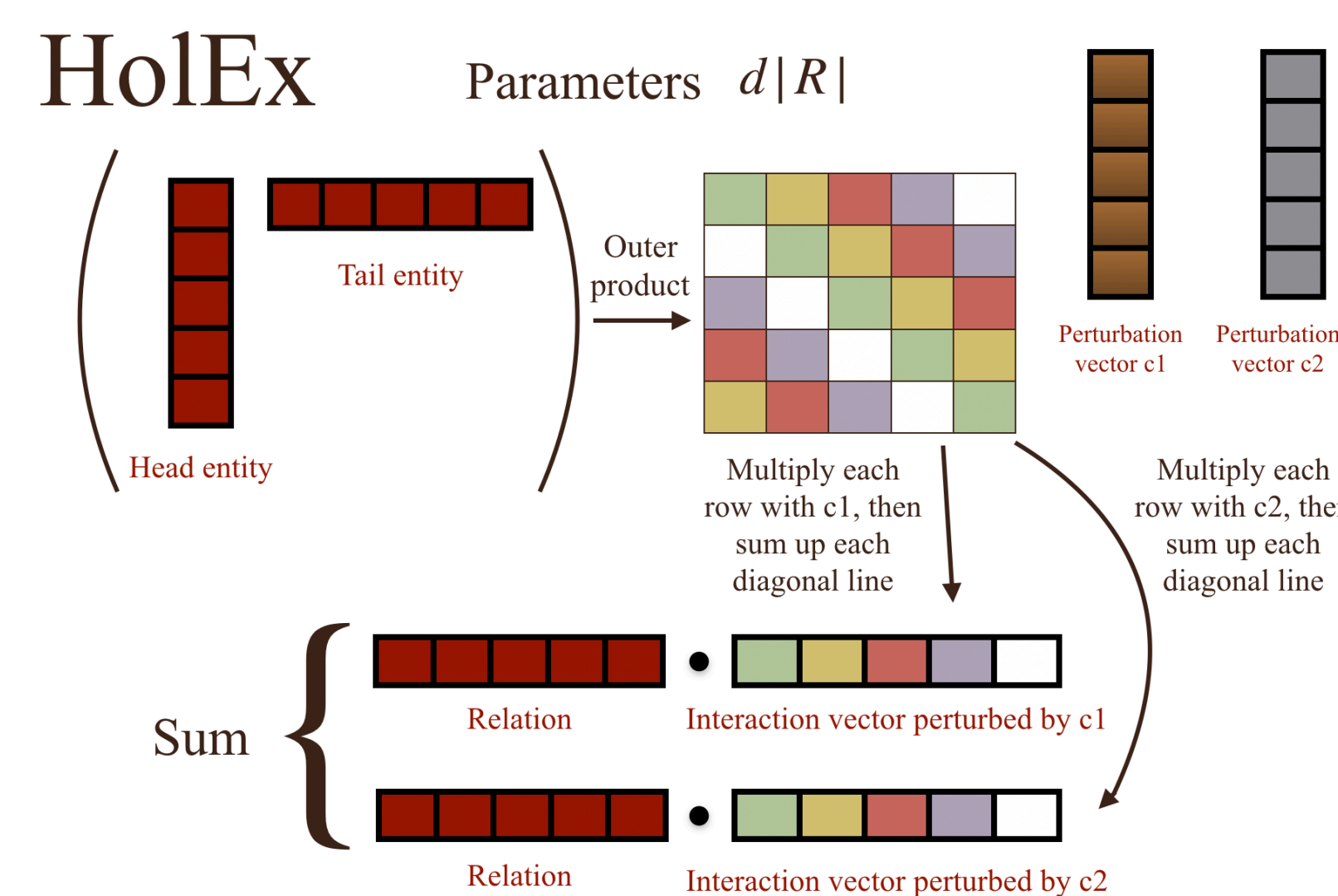
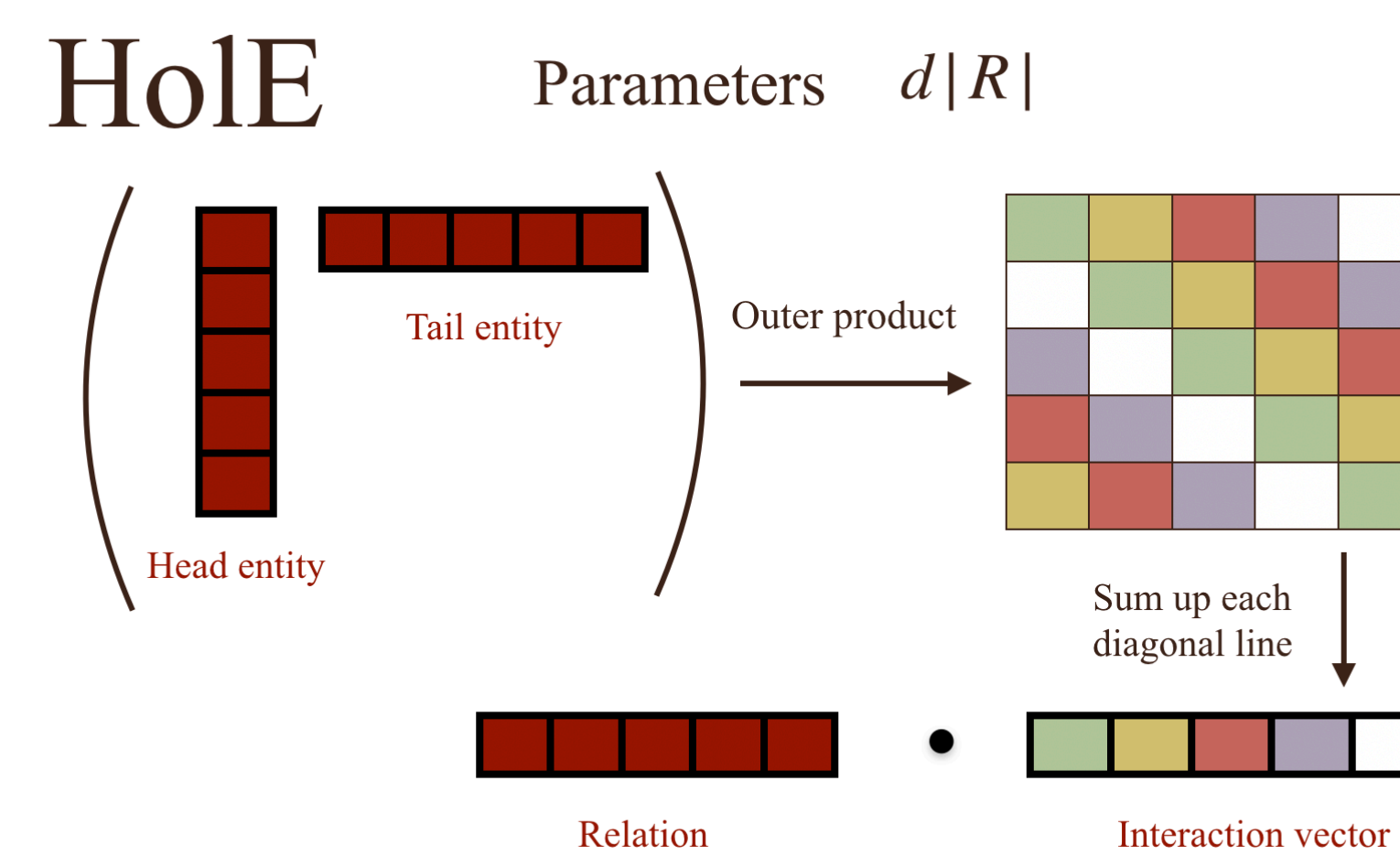
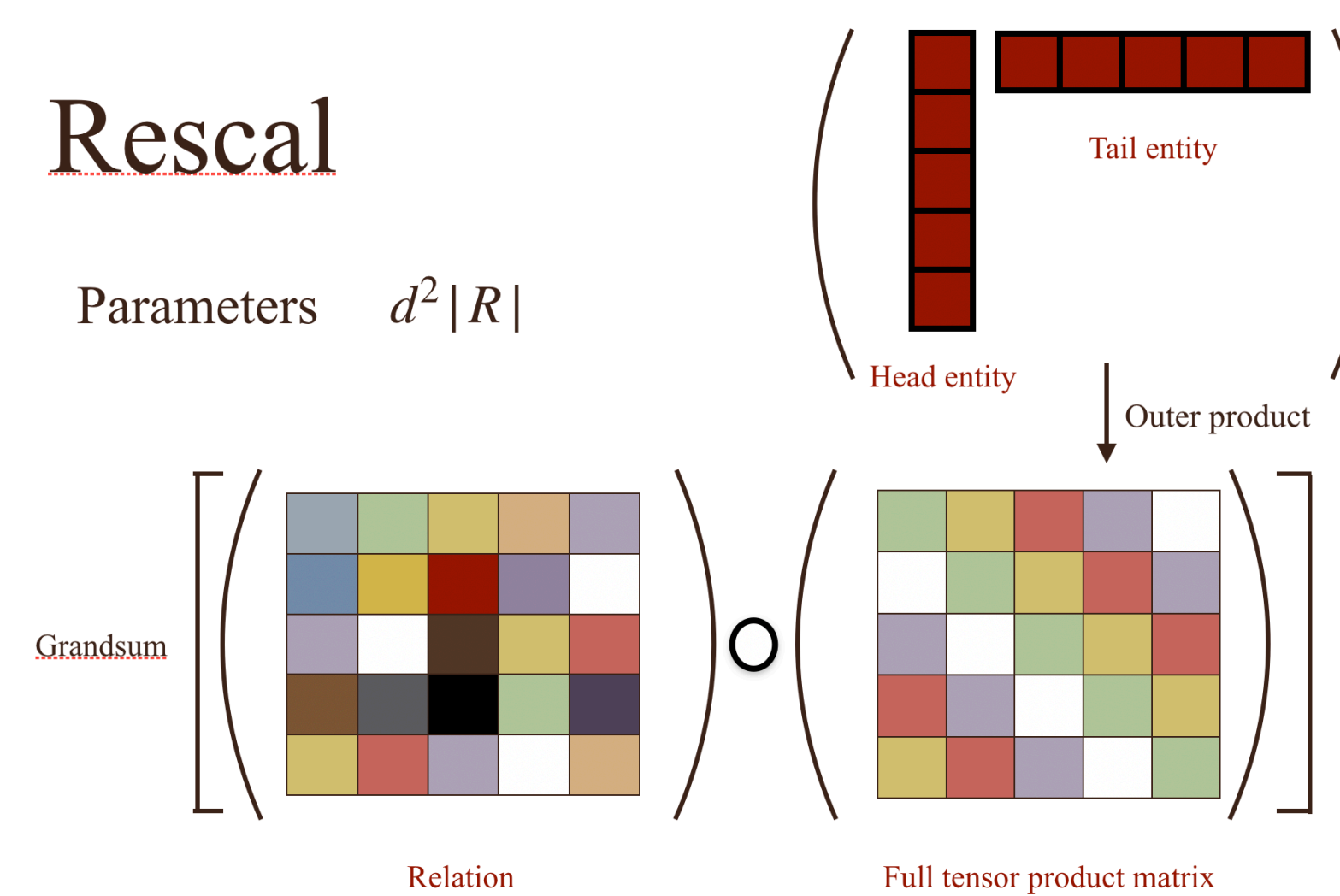
- **Nodes-entities, Edge types-relations**
- **Knowledge in the form of binary relations like (head entity, relation, tail entity)**
- **Given one entity and one relation, try to predict another entity.**

Varying the number of perturbation vectors



- **(Top left) Full interpolation for embedding dimension 32; (Top right) Similar trend for embedding dimension 256; (Bot) Training time per epoch for embedding dimension 256**

Interpolation Description



- **Interpolate between HolE (low dimensionality) and Rescal (high dimensionality)**

Setup of Experiments

- **Framework: ProjE**
- **Dataset: FB15k**
- **Evaluation: For each query, rank all entities based on the score function and filter out other valid answers to get an ordered list. Then calculate metrics on this list.**
- **Metrics:**
 - **Mean Rank**
 - **HITS@k, k = 1, 5, 10**
 - **Mean Reciprocal Rank**

Comparison with Existing methods

- **The best baseline numbers and the best numbers using HolEx are highlighted in bold.**

Knowledge Completion Method	Mean Rank	HITS@10 (%)	MRR	HITS@5 (%)	HITS@1 (%)
EXISTING METHODS					
RESCAL [18]	683	44.1	-	-	-
TransE [5]	125	47.1	-	-	-
TransR [16]	77	68.7	-	-	-
TransE + Rev [15]	63	70.2	-	-	-
HOLE (original, dim=150) [19]	-	73.9	0.524	-	40.2
HOLE (reimplementation, dim=150)	70	78.4	0.588	72.0	47.7
ProjE_pointwise* (dim=256) [22]	71	80.2	0.650	74.8	56.7
ProjE_wlistwise* (dim=256) [22]	64	82.1	0.666	76.8	57.9
ProjE_listwise* (dim=256) [22]	53	82.9	0.665	78.1	56.8
Hole (reimplementation, dim=256)	51	83.0	0.665	77.9	56.9
ComplEx [26]	-	84.0	0.692	-	59.9
PTransE (ADD, len-2 path) [15]	54	83.4	-	-	-
PTransE (ADD, len-3 path) [15]	58	84.6	-	-	-
DistMult [28], re-tuned by Kadlec et al. [13]	42	89.3	0.798	-	-
PROPOSED METHOD (dim=256)					
HolE (reimplemented baseline from above)	51	83.0	0.665	77.9	56.9
HOLEx, 8 Haar vectors	51	86.7	-	-	-
HOLEx, 2 random 0/1 vectors	48	85.4	0.720	81.4	64.0
HOLEx, 4 random 0/1 vectors	47	87.1	0.763	83.9	69.8
HOLEx, 8 random 0/1 vectors	47	87.9	0.786	85.0	73.1
HOLEx, 16 random 0/1 vectors	49	88.6	0.800	86.0	75.0