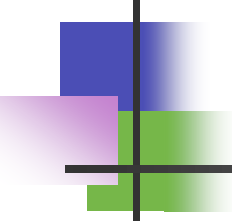




基于路径的知识表示与推理

林衍凯



概览

- 背景
- 模型
- 实验
- 结论

知识库

■ 知识库

- 图（知识图谱）

- 点：实体

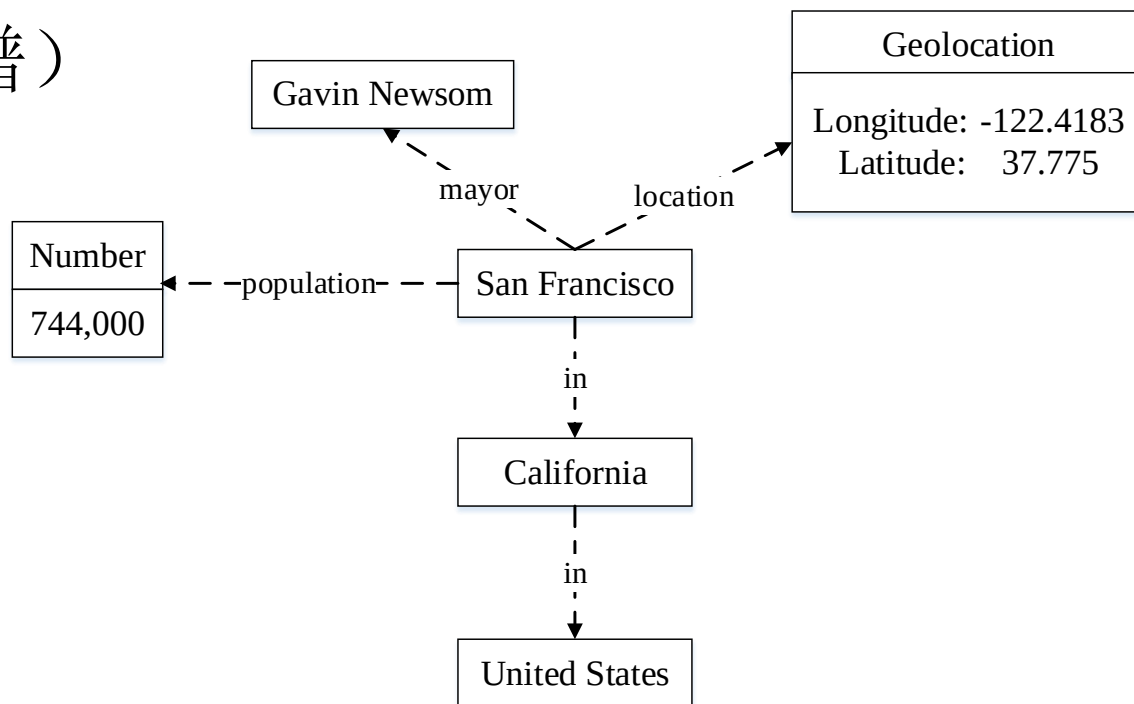
- 边：关系

- 事实

- 头实体

- 关系

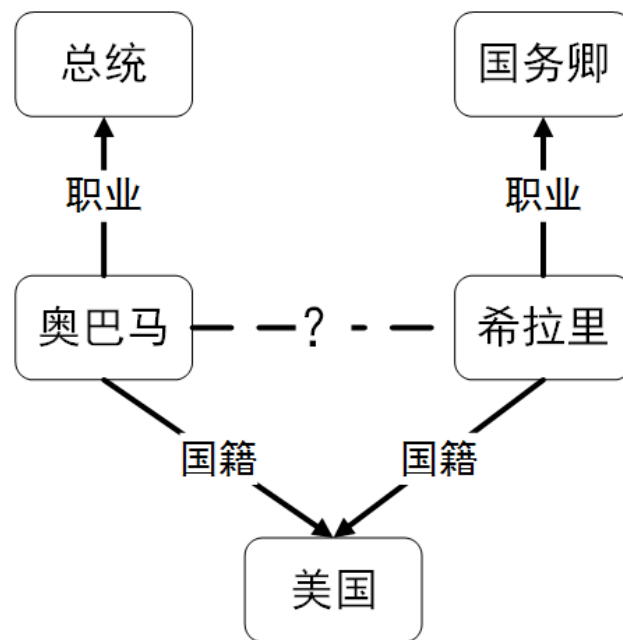
- 尾实体

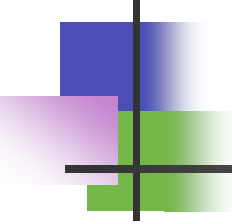


知识推理

■ 目的

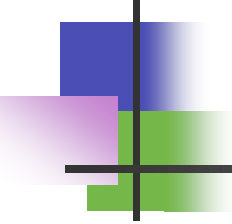
- 推理出知识库中
缺失的事实
- 奥巴马与希拉里的关系





知识推理

- 基于路径（图）特征
- 基于表示学习
 - 张量分解
 - 隐式空间
 - 几何空间



基于路径（图）特征

- Path Ranking Algorithm

- 路径特征
- 分类器

- 例子

- 学校

Relation Path

(draftedBy, school)

(sibling(s), sibling, education, institution)

(spouse(s), spouse, education, institution)

(parents, education, institution)

(children, education, institution)

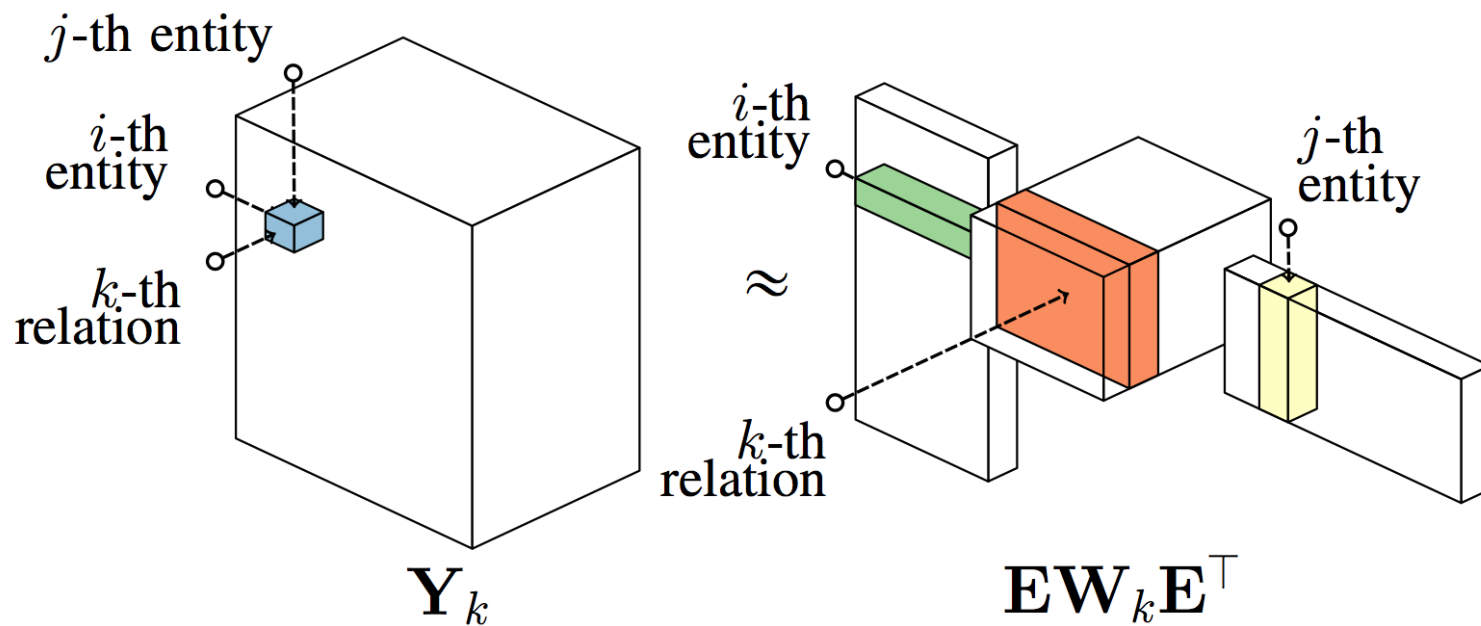
(placeOfBirth, peopleBornHere, education)

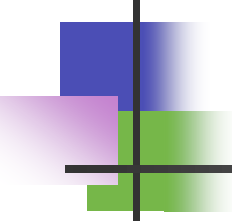
(type, instance, education, institution)

(profession, peopleWithProf., edu., inst.)

张量分解

■ RESCAL





隐式空间

- Structure Embedding (SE)
- Semantic Matching Energy (SME)
- Neural Tensor Network (NTN)
- ...

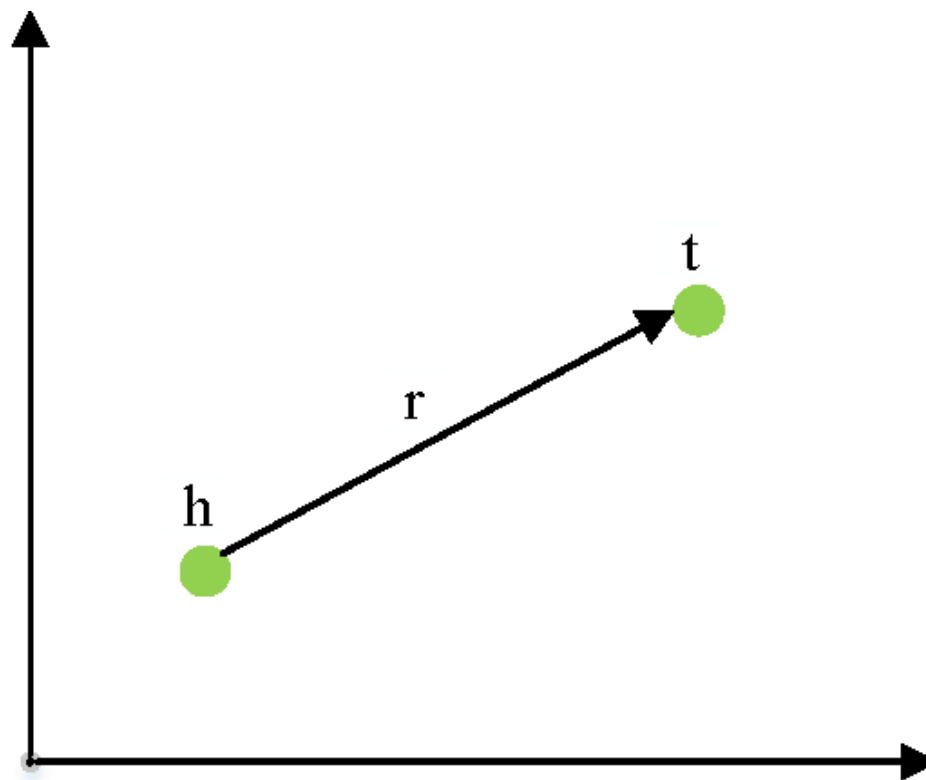
几何空间

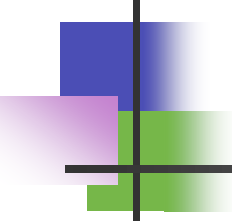
- TransE

- 表示: 向量

- 目标:

$$\mathbf{h} + \mathbf{r} = \mathbf{t}$$



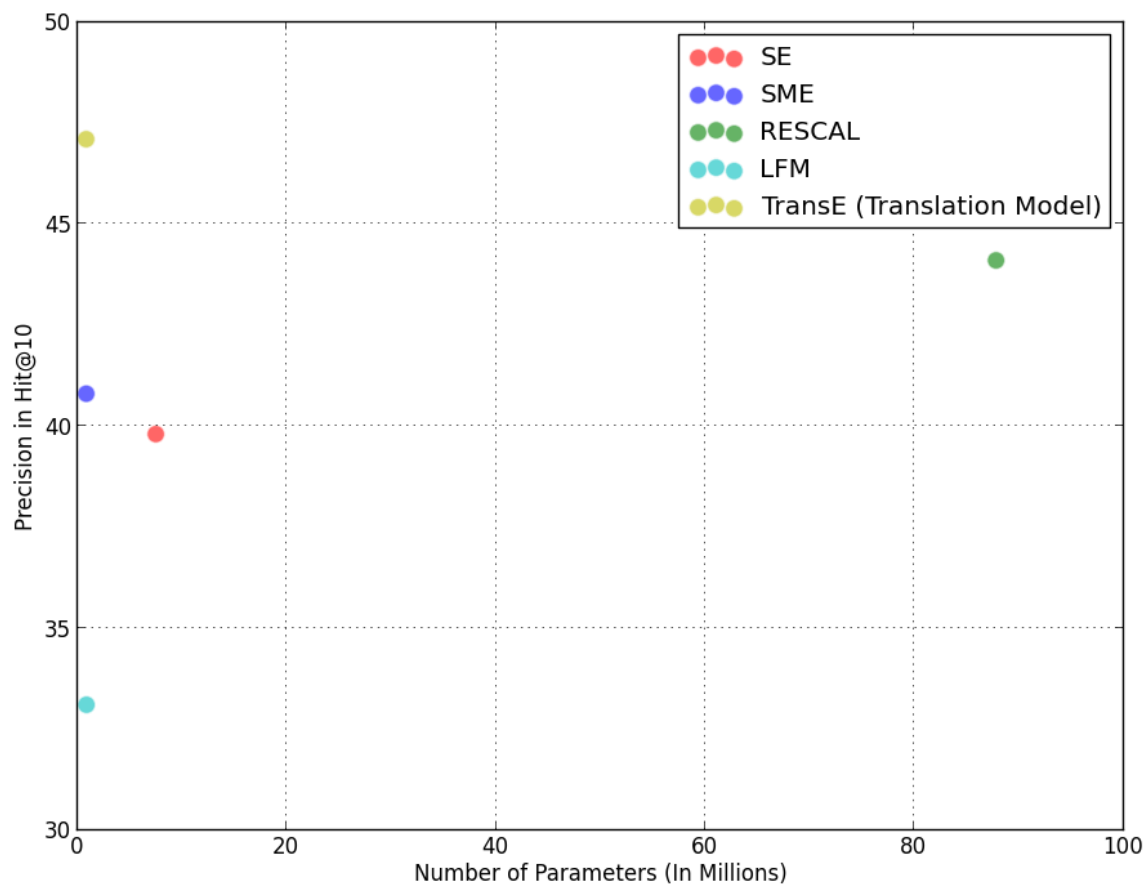


几何空间

- TransH
- TransR
- TransD
- TranSparse
- ...

几何空间

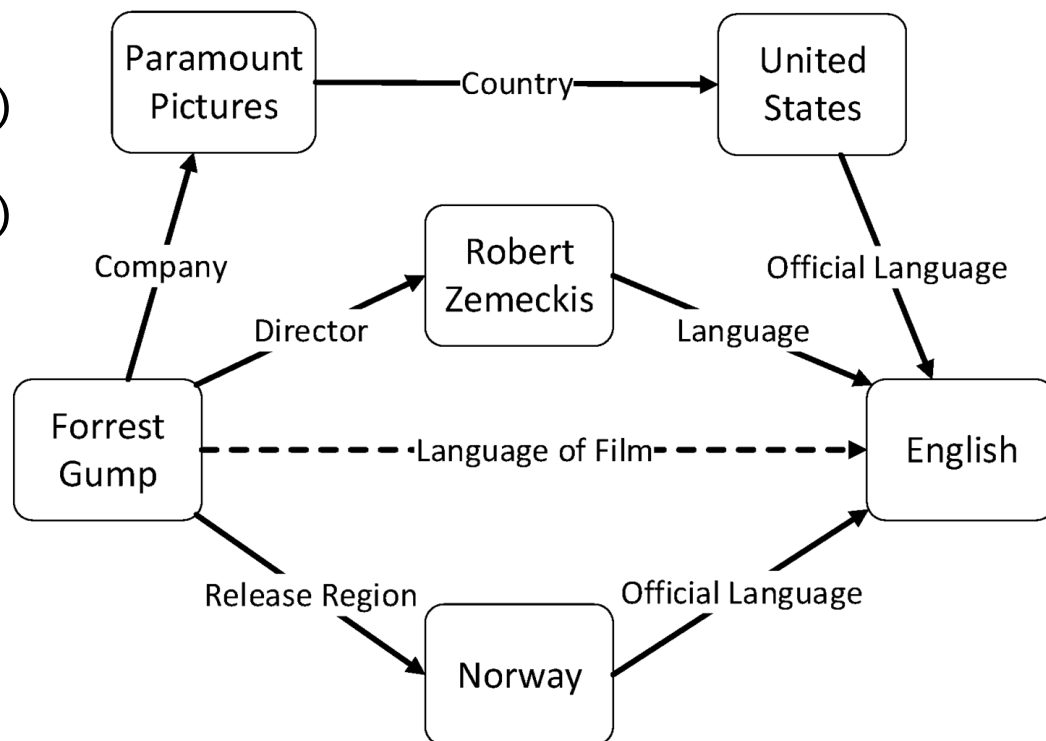
- 简单
- 有效

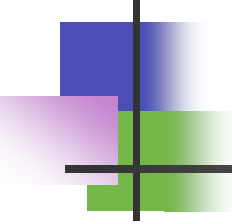


基于表示学习

■ 问题

- 单步信息 (✓)
- 路径信息 (✗)



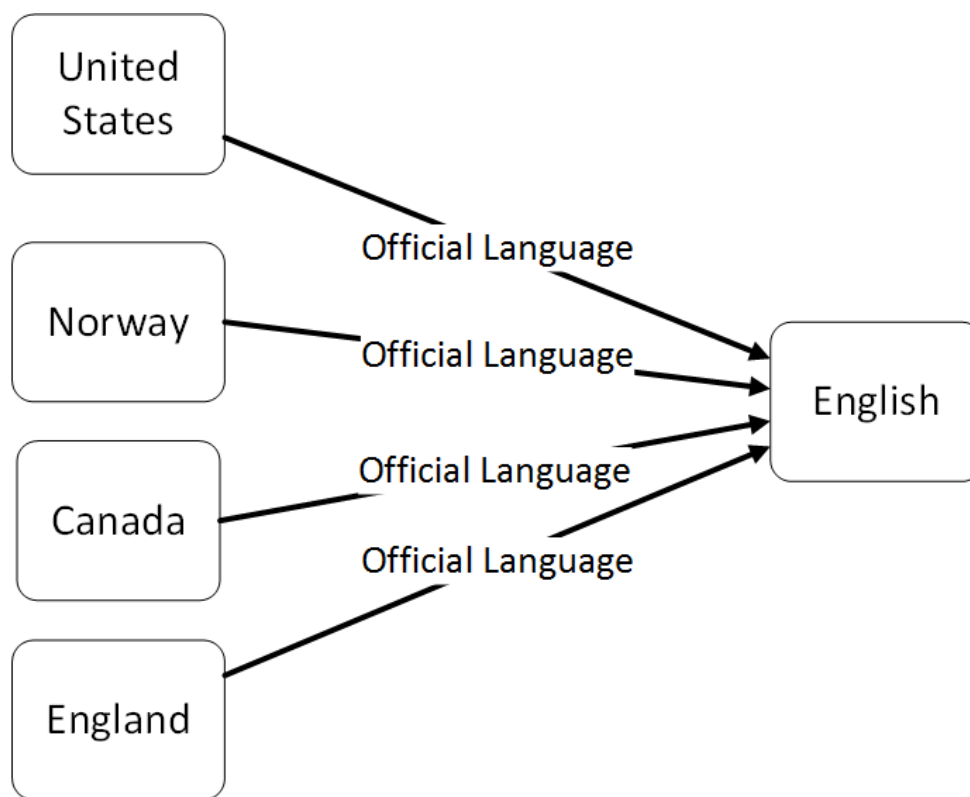


Path-based TransE

- 路径（图）特征+表示学习
 - 单步信息（✓）
 - 路径信息（✓）
- 挑战
 - 路径选择
 - 路径表示

路径选择

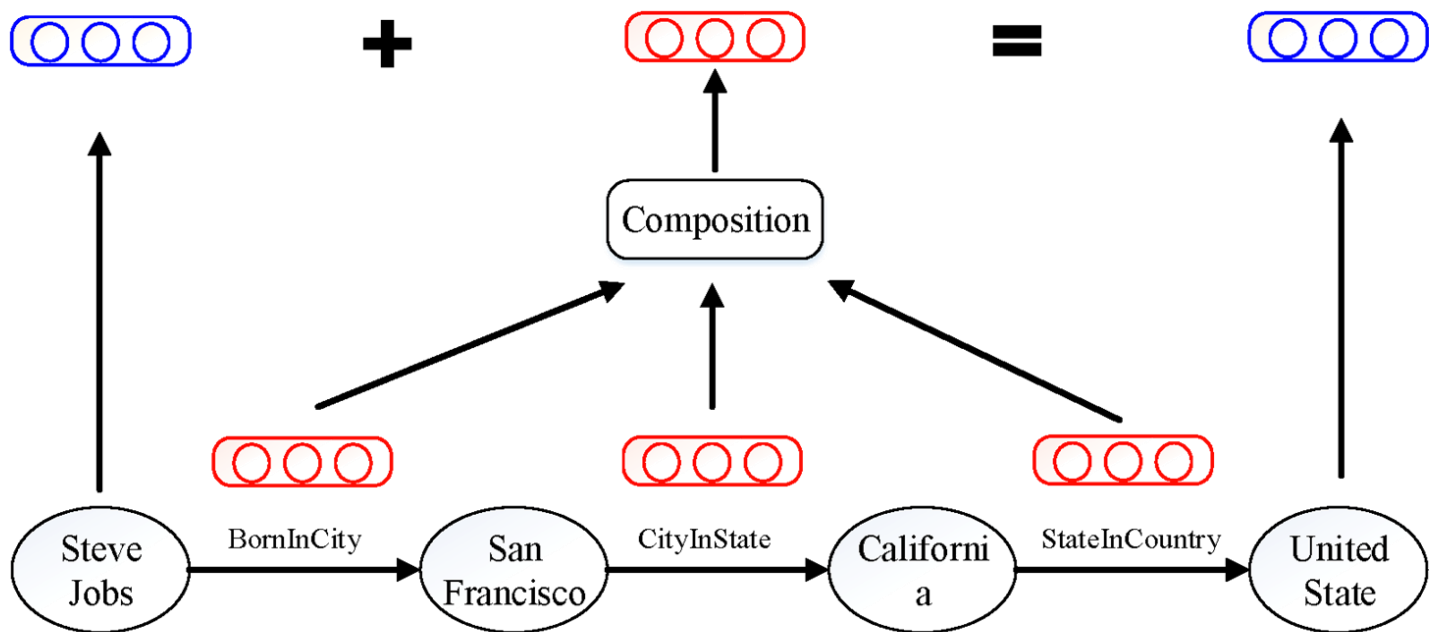
- 路径数量
 - 几何上升
 - 路径意义
 - 路径限制
- 资源分配算法
(PCRA)

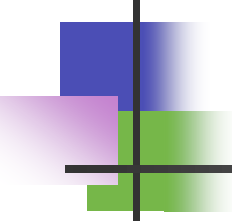


路径表示

■ 常用组合表示

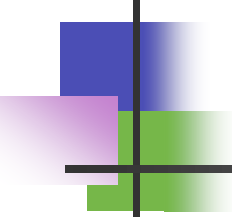
- Add, Multiply, RNN





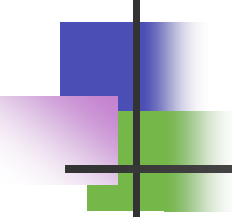
实验

- FB15k
 - 实体: 15k
 - 关系: 1,345
 - 事实: 600k
- 评价指标
 - Hits@10
 - Mean Rank



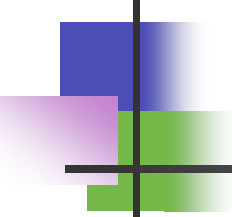
关系预测

Metric	Mean Rank		Hits@1 (%)	
	Raw	Filter	Raw	Filter
TransE (Our)	2.8	2.5	65.1	84.3
+Rev	2.6	2.3	67.1	86.7
+Rev+Path	2.4	1.9	65.2	89.0
PTransE (ADD, 2-step)	1.7	1.2	69.5	93.6
-TransE	135.8	135.3	51.4	78.0
-Path	2.0	1.6	69.7	89.0
PTransE (MUL, 2-step)	2.5	2.0	66.3	89.0
PTransE (RNN, 2-step)	1.9	1.4	68.3	93.2
PTransE (ADD, 3-step)	1.8	1.4	68.5	94.0



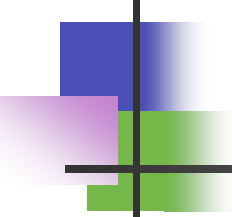
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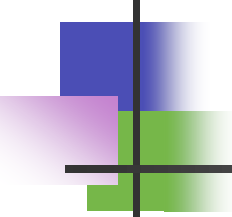
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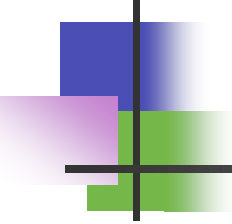
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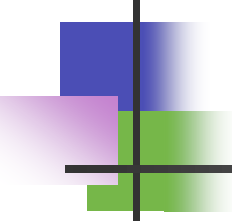
实体预测

Metric	Mean Rank		Hits@ 10 (%)	
	Raw	Filter	Raw	Filter
RESCAL	828	683	28.4	44.1
SE	273	162	28.8	39.8
SME (linear)	274	154	30.7	40.8
SME (bilinear)	284	158	31.3	41.3
LFM	283	164	26.0	33.1
TransE	243	125	34.9	47.1
TransH	212	87	45.7	64.4
TransR	198	77	48.2	68.7
TransE (Our)	205	63	47.9	70.2
PTransE (ADD, 2-step)	200	54	51.8	83.4
PTransE (MUL, 2-step)	216	67	47.4	77.7
PTransE (RNN, 2-step)	242	92	50.6	82.2
PTransE (ADD, 3-step)	207	58	51.4	84.6



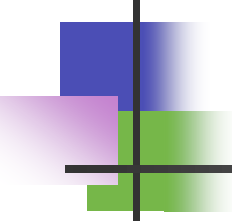
实际样例

Head Entity	Barack_Obama	
Relation	/education/education/institution	
Model	TransE	PTransE
1	Harvard_College	Columbia_University
2	Massachusetts_Institute_of_Technology	Occidental_College
3	American_University	Punahou_School
4	University_of_Michigan	University_of_Chicago
5	Columbia_University	Stanford_University
6	Princeton_University	Princeton_University
7	Emory_University	University_of_Pennsylvania
8	Vanderbilt_University	University_of_Virginia
9	University_of_Notre_Dame	University_of_Michigan
10	Texas_A&M_University	Yale_University



结论与展望

- 知识表示推理引入路径信息
 - 路径选择
 - 路径表示
- 逻辑推理结合的尝试



问答环节

■ 谢谢！