SSP: Semantic Space Projection Knowledge Graph Embedding with Text Descriptions

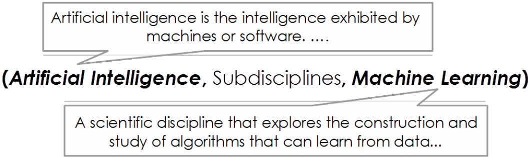
Han Xiao, Minlie Huang, Lian Meng, Xiaoyan Zhu

State Key Lab. of Intelligent Technology and Systems,
National Lab. for Information Science and Technology,
Dept. of Computer Science and Technology, Tsinghua University, Beijing 100084,
PR China

November 30, 2016

SSP: Semantic Space Projection

- **Problem Definition** To incorporate the textual descriptions with the fact triples.

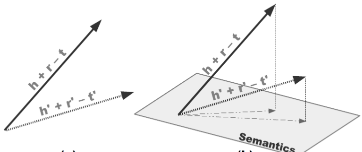


- **Motivations**
  - Discovering semantic relevance between entities.
  - Offering precise semantic expression.
- **Related Work** could not characterize the correlations.
  - Jointly: $\mathbf{w} = \mathbf{e}$.
  - DKRL: $[\mathbf{e}_\mathbf{h}, \mathbf{w}_\mathbf{h}] \xrightarrow{\mathbf{r}} [\mathbf{e}_\mathbf{t}, \mathbf{w}_\mathbf{t}]$.

SSP: Semantic Space Projection

- **Methodology**: Projecting the embedding procedure onto a semantic hyperplane.

$$f_r(h, t) = -\lambda||\mathbf{e} - \mathbf{s}^\top \mathbf{e}\mathbf{s}||_2^2 + ||\mathbf{e}||_2^2$$



(a) (b)

- **Semantic Vector Generation**: Topic Model.
- **Objectives.**

$$\mathcal{L} = \mathcal{L}_{embed} + \mu\mathcal{L}_{topic}$$

$$\mathcal{L}_{embed} = \sum_{\substack{(h,r,t)\in\Delta \\ (h',r',t')\in\Delta'}} [f_{r'}(h', t') - f_r(h, t) + \gamma]_+$$

$$\mathcal{L}_{topic} = \sum_{e\in E,\ w\in D_e} (C_{e,w} - \mathbf{s}_\mathbf{e}^\top \mathbf{w})^2 \qquad (1)$$

SSP: Semantic Space Projection

- **Methodology**: Projecting the embedding procedure onto a semantic hyperplane.

$$f_r(h, t) = -\lambda||\mathbf{e} - \mathbf{s}^\top \mathbf{e}\mathbf{s}||_2^2 + ||\mathbf{e}||_2^2$$

- **Correlation Perspective**: There exists the important restriction, that the entities co-occur in a triple should be embedded in the semantic space composed by the associated textual semantics.
- **Semantic Perspective**: Our model characterizes the strong correlations with a semantic hyperplane, which is capable of taking the advantages of both two semantic effects.
  - Semantic Relevance.
  - Precise Semantic Expression.

SSP: Semantic Space Projection

- **Experiments**: Knowledge Graph Completion.

FB15K	Mean Rank		HITS@10	
TransE	210	119	48.5	66.1
TransH	212	87	45.7	64.4
Jointly	167 [1]	39 [1]	51.7 [1]	77.3 [1]
DKRL(BOW)	200	113	44.3	57.6
DKRL(ALL)	181	91	49.6	67.4
SSP (Std.)	**154**	**77**	57.1	78.6
SSP (Joint)	163	82	**57.2**	**79.0**
WN18	**Mean Rank**		**HITS@10**	
TransE	263	251	75.4	89.2
TransH	401	338	73.0	82.3
SSP (Std.)	204	193	81.3	91.4
SSP (Joint)	**168**	**156**	**81.2**	**93.2**

SSP: Semantic Space Projection

- **Experiments**: Entity Classification.

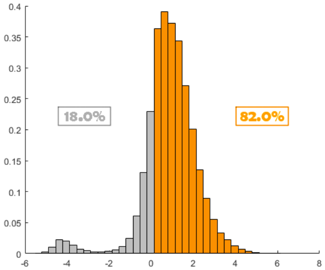
Metrics	FB15K	FB20K
TransE	87.8	-
BOW	86.3	57.5
DKRL(BOW)	89.3	52.0
DKRL(ALL)	90.1	61.9
NMF	86.1	59.6
SSP (Std.)	93.2	-
SSP (Joint)	**94.4**	**67.4**

SSP: Semantic Space Projection

- Semantic Relevance Analysis

	$\mathbf{SSP(S.)}_{\#\leq 100}$	$\mathbf{SSP(J.)}_{\#\leq 100}$
$\mathbf{E}_{\#\geq 500}$	601	672
$\mathbf{E}_{\#\geq 1000}$	275	298
$\mathbf{E}_{\#\geq 2000}$	80	89
$\mathbf{E}_{\#\geq 3000}$	32	39
$\mathbf{E}_{\#\geq 5000}$	3	3

- Precise Semantic Expression Analysis



- **Conclusion.**
  - In this paper, we propose the knowledge graph embedding model SSP, which jointly learns from the symbolic triples and textual descriptions.
  - SSP could interact the triples and texts by characterizing the strong correlations, by which means, the textual descriptions could make more effects to discover semantic relevance and offer precise semantic expression.
  - Extensive experiments show our method achieves the substantial improvements against the state-of-the-art baselines.

Thanks.

Summaries

1. From the geometric perspective of **DATA**, we propose *TransG* to model multiple relation semantics.
2. From the geometric perspective of **MODEL**, we propose *ManifoldE* to achieve an algebraic well-posed system and a flexible geometric form.
3. From the geometric perspective of **INTERACTION** between texts and triples, we propose *SSP* to utilize textual descriptions.

Resources and Handsome Author

XiaoHan 肖寒

Home Page: `http://www.ibookman.net`

Thanks for your attention.