

# 報告書

## 1 今週の進捗

- KG-BERT の理解
- KG-BERT のテスト時の入力を変更 (説明文あり → なし)

## 2 KG-BERT [1]

### 2.1 モデルの説明

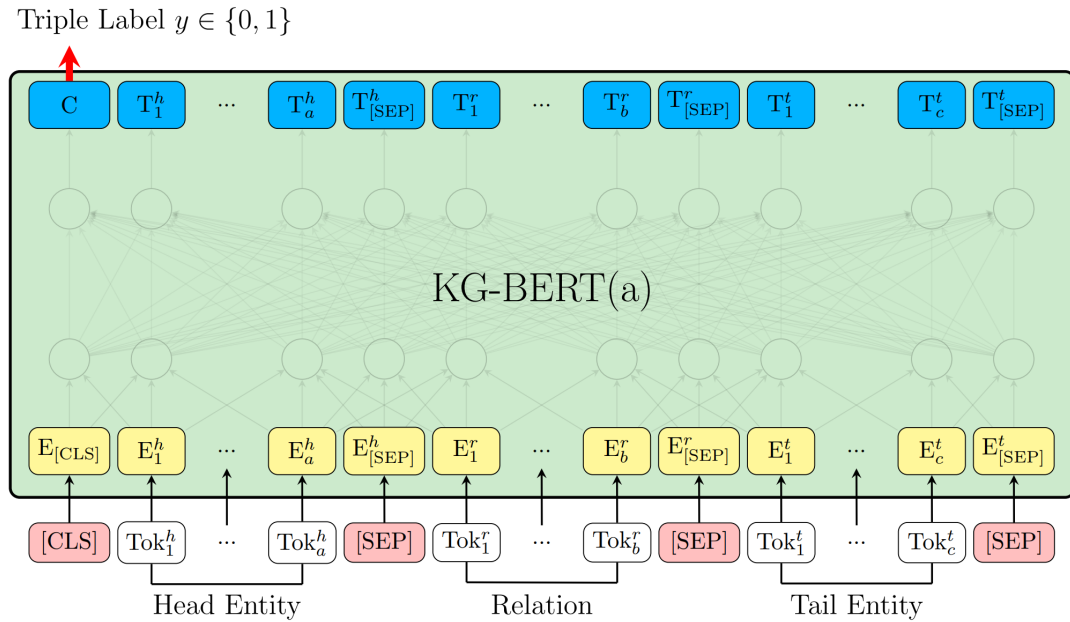


図 1: KG-BERT model [1]

### 2.2 再現実験

今回は「特定の Entity と Relation が与えられたときの triple を予測できるか (Link Prediction)」の再現実験をしています。

ここでは, ある triple (head, relation, tail) に対して, (?, relation, tail) としたときの head の予測, (head, relation, ?) としたときの tail の予測をしています。

表 1: データセット

Dataset	Entity	Relation	Train	Validation	Test
WN18RR	40,943	11	86,835	3,034	3,134

表 2: パラメータ (WN18RR)

パラメータ	値 (default)
学習率	5e-5
epoch	5
dropout rate	0.1
batch size	32
eval batch size	128 (5000)
max seq length	32 (50)

表 3 に文献値と再現実験の結果, テスト時の予測する入力を説明文なしに変換して得られた結果を示す. ここで, 「説明文なしに変換」とは, 例えば, 「duellist, a person who fights duels」という予測する head もしくは tail を「duellist」とすることを指す. なお, 表 3 は head 予測と tail 予測を合わせた結果である.

表 4 に再現実験の結果と説明文なしに変換した結果において, head を予測した結果と tail を予測した結果を示す.

評価指標として Mean Rank (MR), Mean Reciprocal Rank (MRR), Hits@ $k$  を使用する. MR とは, 予測したエンティティのランクの平均を指す. MRR とは, 予測したエンティティのランクの逆数をスコアとしており, こうして得たスコアの平均をとったものを指す. Hits@ $k$  とは, 予測したエンティティを順位付けしたときに, 上位  $k$  個以内に正解が含まれている割合のことを指す.

$$\text{MR} = \frac{1}{|E|} \sum_{i=1}^{|E|} \text{rank}_i \quad (1)$$

$$\text{MRR} = \frac{1}{|E|} \sum_{i=1}^{|E|} \frac{1}{\text{rank}_i} \quad (2)$$

$|E|$  はエンティティ数,  $\text{rank}_i$  は予測したエンティティのランクを表している.

MR は値が小さいとき, MRR, H@ $k$  はともに値が大きいとき推定精度が良いと判断される.

表 3: 再現実験の結果

Method	WN18RR				
	MR	MRR	Hits@1	Hits@3	Hits@10
KG-BERT (文献値)	97	-	-	-	52.4
KG-BERT (再現)	117.77	0.25	12.41	29.44	51.85
KG-BERT (テスト時の入力変更)	2267.75	0.075	3.22	7.00	15.62

表 4: head 予測と tail 予測の結果の比較

Method	WN18RR									
	MR		MRR		Hits@1		Hits@3		Hits@10	
	head	tail	head	tail	head	tail	head	tail	head	tail
KG-BERT (再現)	128.87	106.66	0.25	0.26	13.08	11.74	28.27	30.60	48.40	55.30
KG-BERT (入力変更)	2765.58	1769.92	0.055	0.094	2.39	4.05	5.01	9.00	11.10	20.13

表 5: 正例 (rank = 1) と負例 (rank  $\geq$  200)

	head	relation	tail
正例 (head, tail 予測)	01121948	derivationally related form	10038929
	05921868	derivationally related form	00692718
	00234423	derivationally related form	02535896
	03065516	derivationally related form	05971394
正例 (head 予測)	12039743	member meronym	12073410
	02151700	hypernym	02150948
	04913839	derivationally related form	02457233
正例 (tail 予測)	00103875	derivationally related form	14290534
	10401639	derivationally related form	02294179
	10648237	derivationally related form	02394662
負例 (head, tail 予測)	02713218	derivationally related form	05578442
	02647503	member meronym	02647660
負例 (head 予測)	05018103	hypernym	05009170
	03692379	hypernym	03051540
	12508077	hypernym	11585340
	00057486	hypernym	00053913
負例 (tail 予測)	02001428	member meronym	02007721
	08766988	has part	08769329

## 参考文献

- [1] Liang Yao, Chengsheng Mao, and Yuan Luo. KG-BERT: BERT for knowledge graph completion. *CoRR*, Vol. abs/1909.03193, , 2019.

表 6: Entity to text (正例)

正例 (head, tail 予測)	
01121948	duel, fight a duel, as over one's honor or a woman; "In the 19th century, men often dueled over small matters"
10038929	duellist, a person who fights duels
05921868	hypostasis, (metaphysics) essential nature or underlying reality
00692718	hypostatize, construe as a real existence, of a conceptual entity
00234423	neutralization, action intended to keep a country politically neutral or exclude it from a possible war; "the neutralization of Belgium"
02535896	neutralize, make politically neutral and thus inoffensive; "The treaty neutralized the small republic"
03065516	fatalistic, of or relating to fatalism; "a fatalist person"
05971394	fatalism, a philosophical doctrine holding that all events are predetermined in advance for all time and human beings are powerless to change them
正例 (head 予測)	
12039743	orchidaceae, enormous cosmopolitan family of perennial terrestrial or epiphytic plants with fleshy tubers or rootstocks and unusual flowers
12073410	miltonia, genus of tropical American orchids
02151700	spectate, be a spectator in a sports event
02150948	watch, see or watch; "view a show on television"; "This program will be seen all over the world"; "view an exhibition"; "Catch a show on Broadway"; "see a movie"
04913839	respectfulness, courteous regard for people's feelings; "in deference to your wishes"; "out of respect for his privacy"
02457233	respect, show respect towards; "honor your parents!"
正例 (tail 予測)	
00103875	tan, get a tan, from wind or sun
14290534	tan, a browning of the skin resulting from exposure to the rays of the sun
10401639	sharer, someone who has or gives or receives a part or a share
02294179	share, give out as one's portion or share
10648237	substitute, someone who takes the place of another (as when things get dangerous or difficult); "the star had a stand-in for dangerous scenes"; "we need extra employees for summer fill-ins"
02394662	substitute, act as a substitute; "She stood in for the soprano who suffered from a cold"

表 7: Entity to text (負例)

負例 (head, tail 予測)	
02713218	bobbysocks, a sock that reaches just above the ankle
05578442	mortise joint, a gliding joint between the distal ends of the tibia and fibula and the proximal end of the talus
02647503	family agonidae, poachers
02647660	sea poker, small slender fish (to 8 inches) with body covered by bony plates; chiefly of deeper northern Pacific waters
負例 (head 予測)	
05018103	luminousness, the quality of being luminous; emitting or reflecting light; "its luminosity is measured relative to that of our sun"
05009170	physical property, any property used to characterize matter and energy and their interactions
03692379	loungewear, clothing suitable for relaxation
03051540	wearable, a covering designed to be worn on a person's body
12508077	genus astragalus, large genus of annual or perennial herbs or shrubs of north temperate regions; largest genus in the family Leguminosae
11585340	rosid dicot genus, a genus of dicotyledonous plants
00057486	recession, the act of becoming more distant
00053913	withdrawal, the act of withdrawing; "the withdrawal of French troops from Vietnam"
負例 (tail 予測)	
02001428	order ciconiiformes, order of chiefly tropical marsh-dwelling fish-eating wading birds with long legs and bills and (except for flamingos) unwebbed feet: herons; storks; spoonbills; flamingos; ibises
02007721	family ardeidae, herons; egrets; night herons; bitterns
08766988	germany, a republic in central Europe; split into East Germany and West Germany after World War II and reunited in 1990
08769329	lower saxony, a state in northwestern Germany