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A Bidirectional Multi-paragraph Reading Model for Zero-shot Entity Linking

Hongyin Tang, Xingwu Sun, Beihong Jin, Fuzheng Zhang Meituan Group Institute of Software, Chinese Academy of Sciences



Background

- Zero-Shot Entity Linking (Logeswaran et al. 2019)
 - No mentions have been observed for any of the test world entities during training.
 - **Only textual (non-structured)** information is available.
 - No statistics
 - No meta-data

Task	In-Domain	Seen Entity Set	Small Candidate Set	Statistics	Structured Data	Entity dictionary
Standard EL Cross-Domain EL Linking to Any DB (Silet al. 2012)	1	5		\$ \$	\$ \$	\$ \$
Zero-Shot EL			•			· ·

For the Nords' homeland, see Skyrim.

The Elder Scrolls V: Skyrim is a single-player role-playing video game developed by Bethesda Game Studios and published by Bethesda Softworks.

It is the firth installment in *The Elder Scalls* action/adventure RPG fantasy video game series, and follows *The Elder Scalls IV. Oblivion* by approximately 200 years, during the Fourth Era. The game was announced on November 11, 2010 at the Spike Video Game Awards in Los Angeles, with a release date of November 11, 2011. It features Radiant A.I., along with Radiant Storytelling or Radiant Story, to help enhance quests, and a new and Improved graphics engine.^[11,2]

On June 12th, 2016, Bethesda announced that a remastered version of the game would be released for the PC, Xbox One, and PS4 on October 28th, 2016. The remastered version will include improved graphics, such as snow shaders and volumetric God rays, and will also include the ability to download mods on the main menu.^[3] Paople who own the game on Steam and have either the Legendary Edition on all three add-ons will be able to download the remastered version for free.^[4] Versions for the PlayStation VR and Nintando Switch were released in April 2018.



contents [hide]

Training domain: Elder Scrolls

╈ Former FA

LEGO[®] is a line of toys featuring plastic bricks, gears, minifigures (also called minifigs and figs) in a variety of colors, and other pieces which can be assembled to create models of almost anything imaginable. Cars, planes, trains, buildings, castles, sculptures, ships, spaceships, and even working robots are just part of a extremely short list of the many things that can be built with LEGO bricks. High production quality and careful attention to detail ensures that LEGO pieces can fit together in myriad ways, which is one of the main reasons for the toy brand's success. Coincidentally, "LEGO" translates into various Latin meanings such as "Assemble" and "Connect".



The LEGO logo (1998-Present)

The sets are produced by the LEGO Group, a privately-held company based in Denmark.

Test domain: LEGO



Background

- Bert Baseline (Logeswaran et al. 2019)
 - Domain adaptive pre-training
 - $U_{WB} \rightarrow U_{sc + tg} \rightarrow U_{tg}$
 - U_{NB}: pre-train on Wikipedia and BookCorpus
 - U_{sc} : pre-train on source domain (text segments in train data)
 - U_{ty} : pre-train on target domain (text segments in test data)
 - Pre-train by MLM task
 - Fine-tune by Bert
 - Input: [CLS]*C*[SEP]*D*^t [SEP]
 - C: Mention context (fixed length around mention)
 - *D^t*: Description of t-th entity (first paragraph of the description)
 - Output: relevant score of t-th entity
 - [CLS] embedding \rightarrow FFNN





Motivation

• Input Length Limitation

Caitlin apologises for standing Craig up and says she was in A&E with her dad after the TV take Caitlin back to their house. Johnny lays claim to Aidan's 40% share of the factory. Carla cartner and is surprised when he says otherwise. Tim does his back in and drops Sally when he threshold but they laugh about it.

Dougie Ryan was a fellow-camper at the site chosen by the residents of No's 5 and 9 Coronation Street when they went for a week's break in Wales in August 2015. A braggart and a know-all who often spoke in clichéd expressions, his initial offers of help were but a cover to begin boasting of his knowledge of the "greatoutdoors" and how to cope with nature, dragooning his hapless victims into a "Bear Grylls"-type foraging expedition.

He first made his presence known when he stepped in to assist Tyrone Dobbs in putting up his tent, a complicated affair made worse by the instructions being mislaid. He lost no time at all telling the group that his mother had given birth to him half-way up Snowdon and immediately diagnosed the nature of the materials used to make the tent, telling Tyrone that his methods of erecting it were entirely wrong. After telling the women in the group an emotionally-wrought story about the killing of a deer that he witnessed, he eagerly stepped in when the luckless Tyrone had further problems getting the barbecue to ignite, his efforts gaining the admiration of Kirk Sutherland and Chesney Brown. He also gave the latter two lessons in "whittling", explaining to them that his wife was an out-and-out "towny"



Dougie Rya

Spouse(s)	1 wife
Children	Caitlin Ryan
First appearance	17th August 2015
Last appearance	21st August 2015
Number of	6
appearances	
Played by	Paddy McGuinness

who three times a year allowed him to spend time with his mistress i.e. "the great outdoors", with their daughter Catilin for company, the latter having separately met Craig Tinker and formed a friendly attachment to him as she, unknown to Dougie, was starting to tire of their thrice-yearly expeditions.

Kyle's Dad was the father of Simon Barlow's former footballing team-mate Kyle and a typical "touchline parent", getting himself more excited than the players on the pitch, yelling encouragement at his team's best player (his own son, naturally) and accusing the referee of both not doing his job and of being biased for the opposing team.

His son showed equal charm, making lewd comments about Simon's mother and doing his best to rile him. Simon tackled Kyle, breaking his leg and his dad accused him of being deliberate in his actions. Kyle was stretchered off and as his chances with Manchester City's Youth Academy were now in doubt, he threatened



Kyle's Dad

Evidence exists in other paragraphs of entity document

Motivation

Input Length Limitation •



bolt instead of a bone. She has a facial scar from the Witch Nail.

Background

Ann Lee is a Monster Fighter, proficient in the ancient art of broomstickajitzu. Her monster arch-enemy are the Ghosts, even though she is shown in videos with the Mummy. She met Dr. Rodney when Dr. Rodney was looking for a suitable pilot brave enough to fly into the Monster Realms, and was described as waiting in the air hangar for him.

Evidence exists in other paragraphs of mention document

[show]



Description

5 Gallery

Most of the Mummy's printing is taken directly from the Mummy Warrior minifigure. His bandages are white with grev spots of dirt and a few are loose. The bandages on his face are parted to reveal vellow eves, sand green skin, and a crooked smile with only the tongue visible. He wears a pharaoh's headdress in gold with red stripes on it. On the other side of his head, the unmasked Dr. Najib's face can be seen.

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ieme:	Monster Fighters			
cessories:	Mummy Moonstone Scythe blade			
ars:	2012			
pearances		[show]		
rts		[show]		





Motivation

- Evidence scatter in different paragraphs
 - Directly expand input text (unfeasible due to $O(n^2)$ complexity of cross-attention)
 - Process multiple paragraphs separately
 - Existing in Machine Reading Comprehension(MRC) area (Clark and Gardner 2018)
 - Feeds query and each paragraph into a reading comprehension module
 - Select the final answer from multiple paragraphs
 - How to apply in Entity Linking task
 - Unlike MRC task, there are no explicit query and answer
 - Our model
 - Multiple paragraphs + bidirectional reading



Our Models

- Pre-training
 - Domain-Adaptive Pre-training
 - $U_{WB} \rightarrow U_{sc + tg} \rightarrow U_{tg}$
 - Whole Entity Masking
 - Mask whole entity alias in the dictionary
 - Replace 15% tokens and 50% entities of the input text

Batman (alias <u>Bruce Wayne</u>) is a <u>Batman</u> and <u>Super Heroes minifigure</u> based on the superhero from the <u>DC Comic Universe</u>. (a) Original Input Text

Batman (alias Bruce Wayne) is a Batman and Super [Mask] minifigure based on the superhero [Mask] the [Mask] Comic [Mask].

(b) Vanilla Random Masking

Batman (alias Bruce Wayne) is a Batman and [Mask] [Mask] [Mask] based on the superhero [Mask] the [Mask] [Mask] [Mask].

(c) Whole Entity Masking



Our Models

- Unidirectional Multi-Paragraph Reading Model(Uni-MPR)
 - When evidence exists in different paragraphs of the entity document



- Split entity document to multiple paragraphs D_1, \ldots, D_{l_p}
- Concatenate mention context *C* with multiple entity paragraphs, generate mention-entity representation P_1, \ldots, P_{l_p}
- Gather semantic dependence information among paragraphs through a inter-paragraph attention (Multi-head attention) V_1, \ldots, V_{l_p}



Our Models

- Bidirectional Multi-Paragraph Reading Model(Bi-MPR)
 - When evidence exists in different paragraphs of mention & entity document



- Bottom: generate mention-aware entity representation Uas Uni-MPR
- Top: gather semantic dependence information among multiple paragraphs of the mention document, generate V_1, \ldots, V_{l_a}
- Use *U*as a "query vector" to backward match multiple paragraphs of the mention document.



Experiments

- Zero-Shot EL Dataset (Logeswaran et al. 2019)
 - Collect from wikia.com
 - 16 domains, 8 training domains, 8 validation domains, 49275 labeled mentions in training set, 10000 mentions in dev and test set
- Model Settings
 - Bert Base
 - Pre-training: 256-token paragraphs
 - Fine-tuning:
 - Baseline: mention paragraph length m=128, entity paragraph length n=128
 - Bi-MPR: m=n=128, paragraph number: $I_p = I_q = 2$

Domain	Length	Ent. Spans	Ent. Tokens		
Training					
American Football	665.06	47.83	85.86		
Doctor Who	264.14	33.54	49.30		
Fallout	229.68	20.28	35.03		
Final Fantasy	497.35	35.77	59.70		
Military	870.55	32.93	59.67		
Pro Wrestling	639.53	50.11	88.71		
Star Wars	379.76	53.60	79.43		
World of Warcraft	242.16	28.23	40.69		
Validation					
Coronation Street	264.55	6.15	14.51		
Muppets	161.50	18.71	32.98		
Ice Hockey	282.62	23.48	45.05		
Elder Scrolls	269.03	18.40	30.18		
Forgotten Realms	257.29	20.97	30.81		
Lego	223.86	17.47	24.87		
Star Trek	393.21	47.82	69.86		
YuGiOh	643.68	62.15	96.42		



Experiments

• Performance Comparison

Model	Coronation Street	Muppets	Ice Hockey	Elder Scrolls	Macro Acc.	Micro Acc.
deep-ed	-	-	-	-	- 1	26.96
CDTE	62	-	_	-	_	27.03
Baseline	82.82	81.59	75.34	72.52	78.07	76.5
Baseline+WEM	84.21	81.55	74.29	72.66	78.18	76.52
Uni-MPR(w/o WEM)	85.31	80.78	78.07	73.74	79.48	77.83
Uni-MPR	88.27	82.83	78.12	74.00	80.81	78.8
Bi-MPR(w/o WEM)	86.47	82.47	78.07	74.87	80.41	78.78
Bi-MPR	90.12	82.50	79.37	75.92	81.98	80.1
Model	Forgotten Realms	Lego	Star Trek	YuGiOh	Macro Acc.	Micro Acc.
Baseline	85.60	76.90	75.80	67.22	76.38	74.21
Baseline(WEM)	86.21	78.23	77.66	66.47	77.14	74.98
Uni-MPR(w/o WEM)	85.55	77.42	78.23	68.29	77.62	75.78
Uni-MPR	87.25	78.57	80.56	67.31	78.42	76.65
Bi-MPR(w/o WEM)	89.09	77.18	79.20	69.98	78.61	76.70
Bi-MPR	89.60	80.50	81.04	68.74	79.97	77.85

Experiments

- Impact of Input Length
 - Assume $m = n, I_p = I_q$
 - Entity side input length: $m \times I_p$
 - Mention side input length: $n \times I_q$
 - In Uni-MPR, $I_q = 1$

No.	Model	Length Setting
1	Uni-MPR	$m = n = 64, l_p = 2, l_q = 1$
2	Uni-MPR	$m = n = 64, l_p = 4, l_q = 1$
3	Uni-MPR	$m = n = 128, l_p = 2, l_q = 1$
4	Bi-MPR	$m = n = 64, l_p = l_q = 2$
5	Bi-MPR	$m = n = 64, l_p = l_q = 4$
6	Bi-MPR	$m = n = 128, l_p = l_q = 2$





Cases

Title	Joanne Hamlin			
Mention Document	<i>C</i> : Joanne Hamlin (1921-2009) was an actress, teacher, and writer who appeared in The Muppets Take Manhattan as the woman who identifies Murray Plotsky , the man who defrauded her			
Paragraphs	C'_1 : as well as acting in commercials. As a writer, she contributed to Yankee magazine and wrote the 2006 novel Josie Brewster's Year			
Model	Prediction	√ or ×	Predicted Entity Document Paragraphs	
Baseline	Murray (Anything Muppet)	×	<i>D</i> :Murray is a member of the All Monster and a Guy Named Murray Chorus as seen in Sesame Street Season 37	
Baseline+WEM	Murray the Mediocre	×	<i>D</i> :Murray the Mediocre is a lackluster orange Anything Muppet magician with a prejudice against monsters	
Uni-MPR/Bi-MPR N	Martin Price ✓		D_1 :Jeff Brown (born April 24, 1978) is a Canadian professional defenceman. He was drafted in the first round	
		D_2 :She is accompanied by a policeman who serves Price a warrant for the arrest of Murray Plotsky, a man wanted for fraud, which is the true name of Martin Price		

Both Uni-MPR and Bi-MPR can predict correctly



Cases

Title	1994 Stanley Cup Finals					
	<i>C</i> : The Canucks from the point.	<i>C</i> : The Canucks fired 14 shots at Mike Richter in the first period of Game 6 and led 1-0 on a Jeff Brown bullet from the point				
Mention Document Paragraphs	C'_1 : The <u>1994 St</u> New York Rang	C'_1 : The 1994 Stanley Cup Finals were held from May 31 to June 14 between the Vancouver Canucks and the New York Rangers. The Rangers ended their 54-year drought with a seven-game series win				
	C_2' : Rangers swept the New York Islanders and beat the Washington Capitals in five games					
Model	Prediction \checkmark or \times Entity Document Paragraphs		Entity Document Paragraphs			
Baseline/Baseline+WEM	Jeff Brown (b. 1978)	×	D:Jeff Brown (born April 24, 1978) is a Canadian professional defenceman. He was drafted in the first round			
Uni-MPR	Jeff Brown (b. 1978)	×	D_1 :Jeff Brown (born April 24, 1978) is a Canadian professional defenceman. He was drafted in the first round			
Bi-MPR	Jeff Brown (b. 1966)	\checkmark	$D_1:$ "Downtown" Jeff Brown (born April 30, 1966 in Ottawa, Ontario) is a Canadian former			
			<i>D</i> ₂ : <u>Vancouver Canucks' 1994 playoff run</u> , where they came within one game of winning the <u>Stanley Cup</u> they eventually lost to the <u>New York Rangers</u>			

Only Bi-MPR can predict correctly

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THANKS

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