TableNet: An Approach for Determining Fine-grained Relations for Wikipedia Tables

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https://github.com/bfetahu/wiki_tables

The complete code to be published soon!!

Why tables?

Rich Factual Information in Tables

100 meters — Running Race

Continental records [edit]

Updated 29 November 2018.[25]

Area	Men				Women			
	Time (s)	Wind (m/s)	Athlete	Nation	Time (s)	Wind (m/s)	Athlete	Nation
Africa (records)	9.85	+1.7	Olusoji Fasuba	Nigeria	10.78	+1.6	Murielle Ahouré	Ivory Coast
Asia (records)	9.91	+1.8	Femi Ogunode	Qatar	10.79	0.0	Li Xuemei	China
		+0.6						
		+0.2	Su Bingtian	China				
		+0.8						
Europe (records)	9.86	+0.6	Francis Obikwelu	Portugal	10.73	+2.0	Christine Arron	France
		+1.3	Jimmy Vicaut	France				
		+1.8						
North, Central America and Caribbean (records)	9.58 WR	+0.9	Usain Bolt	Jamaica	10.49 WR	0.0	Florence Griffith-Joyner	United States
Oceania (records)	9.93	+1.8	Patrick Johnson	Australia	11.11	+1.9	Melissa Breen	Australia
South America (records)	10.00[A]	+1.6	Robson da Silva	Brazil	10.91	−0.2	Rosângela Santos	Brazil

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Season's bests

Women [edit]

Year	Time	Athlete	Place
1972	11.07	Renate Stecher (GDR)	Munich
1973	11.07	Renate Stecher (GDR)	Dresden
1974	11.13	Irena Szewinska (POL)	Rome
1975	11.13	Renate Stecher (GDR)	Dresden
1976	11.01	Annegret Richter (FRG)	Montreal
1977	10.88	Marlies Göhr (GDR)	Dresden
1978	10.94	Marlies Göhr (GDR)	Dresden
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		Evelyn Ashford (USA)	Walnut
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1981	10.90[A]	Evelyn Ashford (USA)	Colorado Springs
1982	10.88	Marlies Göhr (GDR)	Karl-Marx-Stadt
1983	10.79[A]	Evelyn Ashford (USA)	Colorado Springs
1984	10.76	Evelyn Ashford (USA)	Zürich
1985	10.86	Marlies Göhr (GDR)	Berlin
1986	10.88	Evelyn Ashford (USA)	Rieti

Rich Factual Information in Tables

> What is the time difference for the best time in Women's **100 Meter Race** in **1974** and **2018**?

- No single source can answer such a complex question.

- Factual information in tables is scattered in isolated tables across different articles.

Rich Factual Information in Tables

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Continental records [edit]

Updated 29 November 2018.[25]

Area	Women			
	Time (s)	**Wind (m/s)**	**Athlete**	**Nation**
Africa (*records*)	**10.78**	+1.6	Murielle Ahouré	Ivory Coast
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Rich Factual Information in Tables

> What is the time difference for the best time in Women's **100 Meter Race** in **1974** and **2018**?

Answer: 0.64s

Continental records [edit]

Updated 29 November 2018.[25]

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Tables in Wikipedia

Tables in Wikipedia

- Tables are one of the richest sources of factual information in Wikipedia and the Web:

  - ~530k Wikipedia article contain tables

  - ~3M extracted tables

  - Results in > 32M rows

- Tables have the potential to cover hundreds of millions of facts and can be used to assess fact consistency and validity if tables can be interlinked.

Tables in Wikipedia

Year	Comedy	Drama	Variety
1949	*Pantomime Quiz* (Most Popular Television Program) (KTLA) *The Necklace* (Best Film Made for Television) (*Your Show Time* series)		
1950	*Texaco Star Theatre* (KNBH)		*The Ed Wynn Show* (KTTV)
1951	*Pulitzer Prize Playhouse* (ABC)		*The Alan Young Show* (CBS)

Tables in Wikipedia

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Season	Episode number						
	1	**2**	**3**	**4**	**5**	**6**	**7**
1	2.22	2.20	2.44	2.45	2.58	2.44	2.40
2	3.86	3.76	3.77	3.65	3.90	3.88	3.69
3	4.37	4.27	4.72	4.87	5.35	5.50	4.84
4	6.64	6.31	6.59	6.95	7.16	6.40	7.20
5	8.00	6.81	6.71	6.82	6.56	6.24	5.40

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3	4.37	4.27	4.72	4.87	5.35	5.50	4.84
4	6.64	6.31	6.59	6.95	7.16	6.40	7.20
					6.56	6.24	5.40

Season	Episodes	Originally released	
		First released	**Last released**
1	10	April 26, 2017	June 14, 2017
2	13	April 25, 2018	July 11, 2018

Tables in Wikipedia

```
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    "structured_values":[{"structured":"VAL", "anchor":"ANCHOR_VAL"}]
    }]
  }]
}
```

Challenges and Potential of Tables

Challenges

- **Extraction and Canonicalization problems:**

  - Lack of explicit schemas (what do the columns mean?!)

  - Non-standard authoring practices

  - Optimized for human readability and display

- **Isolated factual information in Tables:**

  - Tables do not contain any ***explicit relations*** to other related tables

  - Tables often ***subsume*** or are ***equivalent*** to other tables

  - Joining the different tables can provide a richer picture of the factual information present in tables

- **Alignment challenges:**

  - Table columns are ***ambiguous*** out of their ***context*** in which they appear (e.g. "**Name**" for actors, scientists, animals, race type etc.)

  - Subject (or key) columns or a combination of columns is necessary for any two tables to be considered for alignment

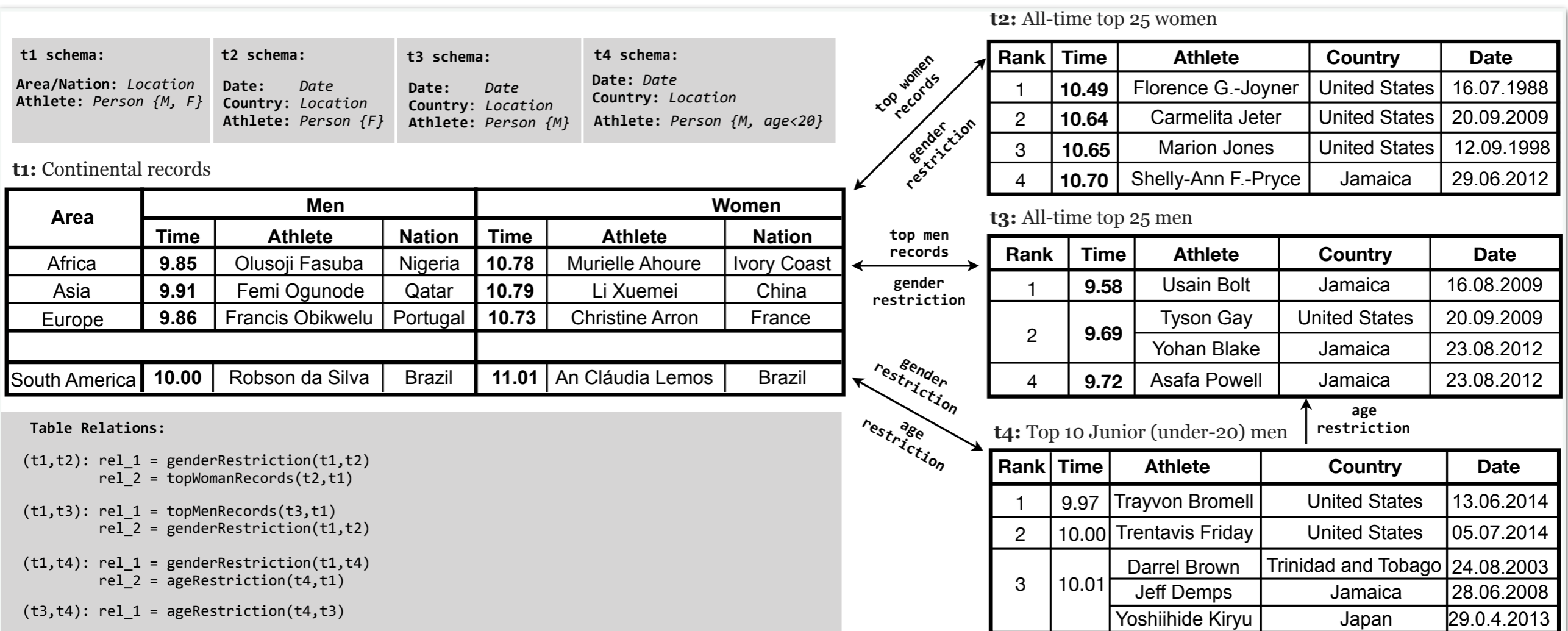 - Large number of tables as candidates for alignment

TableNet Approach

TableNet: Objectives

Automatically extract tables from Wikipedia and **efficiently** *align* tables with high **accuracy** and **coverage** with *fine-grained* relation types.

TableNet: Objectives

Automatically extract tables from Wikipedia and **efficiently** *align* tables with high **accuracy** and **coverage** with *fine-grained* relation types.

t1 schema:

Area/Nation: *Location*
Athlete: *Person {M, F}*

t2 schema:

Date: *Date*
Country: *Location*
Athlete: *Person {F}*

t3 schema:

Date: *Date*
Country: *Location*
Athlete: *Person {M}*

t4 schema:

Date: *Date*
Country: *Location*
Athlete: *Person {M, age<20}*

t1: Continental records

Area	Men			Women		
	Time	Athlete	Nation	Time	Athlete	Nation
Africa	9.85	Olusoji Fasuba	Nigeria	10.78	Murielle Ahoure	Ivory Coast
Asia	9.91	Femi Ogunode	Qatar	10.79	Li Xuemei	China
Europe	9.86	Francis Obikwelu	Portugal	10.73	Christine Arron	France
South America	10.00	Robson da Silva	Brazil	11.01	An Cláudia Lemos	Brazil

```
Table Relations:

(t1,t2): rel_1 = genderRestriction(t1,t2)
         rel_2 = topWomanRecords(t2,t1)

(t1,t3): rel_1 = topMenRecords(t3,t1)
         rel_2 = genderRestriction(t1,t2)

(t1,t4): rel_1 = genderRestriction(t1,t4)
         rel_2 = ageRestriction(t4,t1)

(t3,t4): rel_1 = ageRestriction(t4,t3)
```

top women records
gender restriction

top men records
gender restriction

gender restriction
age restriction

age restriction

t2: All-time top 25 women

Rank	Time	Athlete	Country	Date
1	10.49	Florence G.-Joyner	United States	16.07.1988
2	10.64	Carmelita Jeter	United States	20.09.2009
3	10.65	Marion Jones	United States	12.09.1998
4	10.70	Shelly-Ann F.-Pryce	Jamaica	29.06.2012

t3: All-time top 25 men

Rank	Time	Athlete	Country	Date
1	9.58	Usain Bolt	Jamaica	16.08.2009
2	9.69	Tyson Gay	United States	20.09.2009
		Yohan Blake	Jamaica	23.08.2012
4	9.72	Asafa Powell	Jamaica	23.08.2012

t4: Top 10 Junior (under-20) men

Rank	Time	Athlete	Country	Date
1	9.97	Trayvon Bromell	United States	13.06.2014
2	10.00	Trentavis Friday	United States	05.07.2014
3	10.01	Darrel Brown	Trinidad and Tobago	24.08.2003
		Jeff Demps	Jamaica	28.06.2008
		Yoshiihide Kiryu	Japan	29.0.4.2013

TableNet Overview

TableNet

Table Extraction and Schema Description Generation

Candidate Pair Generation

Table Alignment
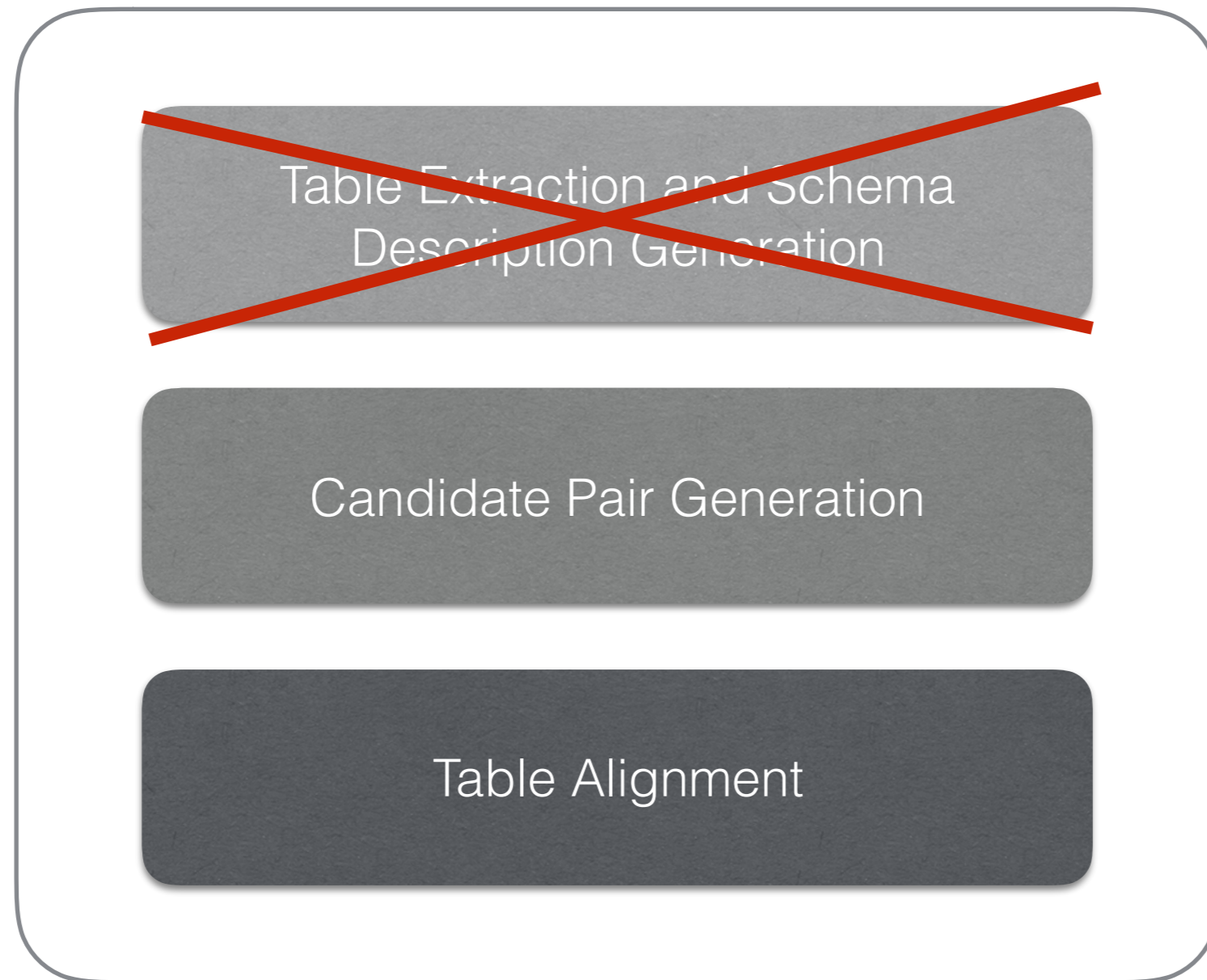
Candidate Pair Generation

TableNet: Candidate Generation

- More than 530k Wikipedia articles contain tables

- Consider all pairs as relevant ?!→ 530K**!** (factorial)

- Efficient algorithm are needed to filter out irrelevant article pairs.

- We propose an efficient approach to reduce the amount of irrelevant pairs and at the same time maintain a high coverage of relevant article pairs, whose tables can be aligned.

TableNet: Candidate Generation

Game of Thrones

From Wikipedia, the free encyclopedia

This article is about the television series. For the novel in the series A Song of Ice and Fire, see A G(disambiguation).

Game of Thrones is an American fantasy drama television series created by David Benioff and D. B. W adaptation of *A Song of Ice and Fire*, George R. R. Martin's series of fantasy novels, the first of which is is filmed in Belfast and elsewhere in Northern Ireland, Canada, Croatia, Iceland, Malta, Morocco, Spain, The series premiered on HBO in the United States on April 17, 2011, and its seventh season ended on series will conclude with its eighth season premiering in 2019.[1][2]

The Handmaid's Tale (TV series)

From Wikipedia, the free encyclopedia

The Handmaid's Tale is an American dystopian drama web television series created by Bruce Miller, ba of the same name by Margaret Atwood. It was ordered by the streaming service Hulu as a straight-to-se episodes, for which production began in late 2016. The plot features a dystopian future following a Seco wherein a totalitarian society subjects fertile women, called "Handmaids", into child-bearing servitude.[1]

The first three episodes of the series premiered on April 26, 2017; the subsequent seven episodes aired every Wednesday. In May 2017, the series was renewed for a second season which premiered on April

TableNet: Candidate Generation

Article Abstract Features

Game of Thrones

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every Wednesday. In May 2017, the series was renewed for a second season which premiered on April :

- doc2Vec similarity between abstracts

- Avg. word2Vec abstract vector similarity

- tf-idf similarity between abstracts

TableNet: Candidate Generation

Categories and KBs Features

Awards for *Game of Thrones* [show]

Authority control ✎ WorldCat Identities⊞ · GND: 1024427587⊞ · LCCN: no2011110818⊞ · VIAF: 256050409⊞

Categories: 2010s American drama television series | 2010s American television series | 2011 American television series debuts | American adventure television series | American drama television series | American fantasy television series | Dark fantasy television series | Dragons in popular culture | English-language television programs | Family saga | Game of Thrones | Giants in fiction | HBO network shows | High fantasy television series | Incest in television | Magic in television | Peabody Award-winning television programs | Primetime Emmy Award for Outstanding Drama Series winners | Serial drama television series | Television programs based on novels | Television programs adapted into video games | Television series about dysfunctional families | Television shows filmed in Los Angeles | Television shows filmed in Northern Ireland | Witchcraft in television | Wizards in television | Zombies in television

Awards for *The Handmaid's Tale* [show]

Categories: 2010s American drama television series | 2017 American television series debuts | American LGBT-related television shows | Dystopian television series | English-language television programs | Feminist television | Hulu original programming | Lesbian-related television programs | Margaret Atwood | Nonlinear narrative television series | Post-apocalyptic television series | Television programs based on Canadian novels | Television series produced in Toronto | Works about totalitarianism | Primetime Emmy Award for Outstanding Drama Series winners | Best Drama Series Golden Globe winners

TableNet: Candidate Generation

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Categories: 2010s American
| English-language television
| Nonlinear narrative televisio
| Works about totalitarianism

Wikipedia categories might lack in quality → Computing embeddings of categories using graph embeddings approaches:

- Similarity in embedding space between categories

- Direct and parent categories overlap

- DBpedia type overlap
….

TableNet: Candidate Generation

Table Features

Season	Episodes	Originally released	
		First released	**Last released**
1	10	April 26, 2017	June 14, 2017
2	13	April 25, 2018	July 11, 2018

- Column title similarity

- Column title distance

Season	Episode number						
	1	**2**	**3**	**4**	**5**	**6**	**7**
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3	4.37	4.27	4.72	4.87	5.35	5.50	4.84
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Table Alignment

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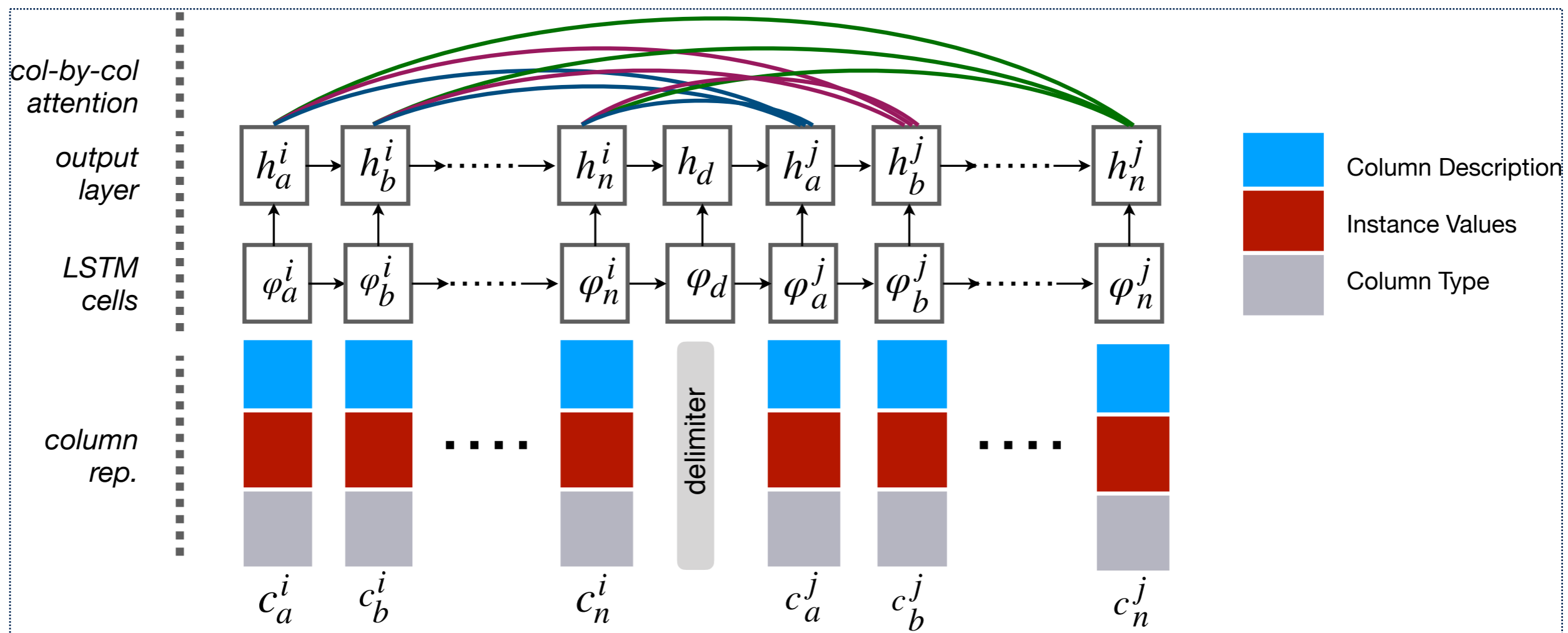
For a table pair predict their relation type

$$r(t_i, t_j) \longrightarrow \{\text{subPartOf, equivalent, none}\}$$

TableNet: Table Alignment

- Column Description
  - Represent the column description tokens based on their world embeddings (Glove)
  - Disadvantage: Column descriptions can be ambiguous (e.g. Title column for Books or Movies)

- Instance Values
  - Avg. embedding of the cell values based on graph embeddings (node2Vec trained on Wikipedia anchor graph)

- Column Type
  - Represent LCA category through graph embeddings

Evaluation Setup

Ground-truth Data

- Random sample of 50 Wikipedia (***source***) articles, respectively their tables

- Ground-truth considerations:

    - **Coverage:** ensure that for each of the tables source articles, we have all relevant tables for alignment

    - **Efficiency:** iteratively manually construct filters to remove articles whose tables cannot yield any relation for the tables of interest

    - **Labelling:** crowdsource the remaining pairs for labelling (3 annotators per table)

    - **Labelling Quality:** comprehensive worker training through detailed instructions and examples before joining the task.

- Ground-truth stats for the **17k** crowdsourced table pairs:

    - 52% pairs with **noalignment**

    - 24% pairs with **equivalent**

    - 23% pairs with **subPartOf**.

Candidate Generation

Use the computed features for pre-filtering, then apply a RF (tweaked to increase recall) for classifying candidates as relevant/irrelevant.
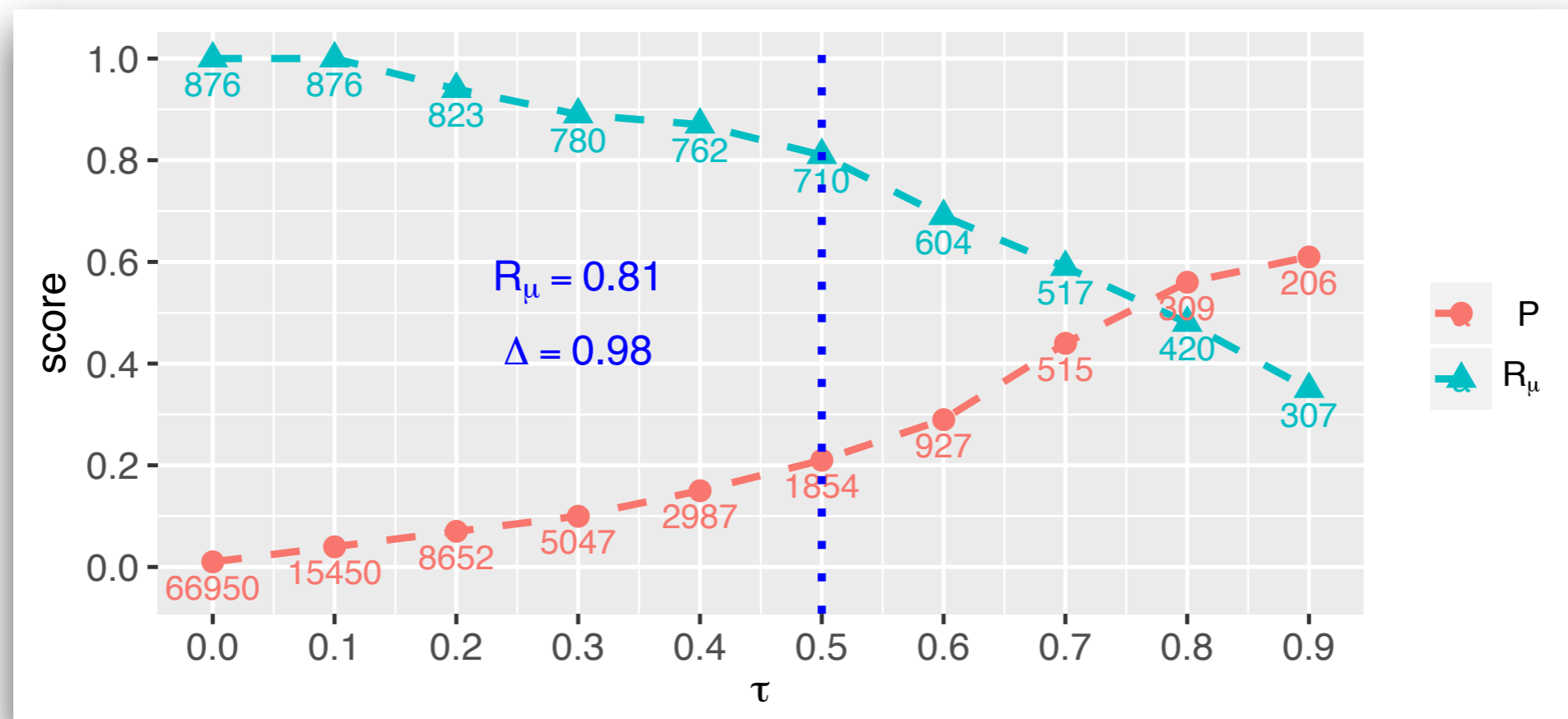
Table Alignment

Table Alignment Results

TableNet based on a BiLSTM with column-by-column attention can determine fine-grained relation types with an accuracy of 83%.

	equivalent			subPartOf			noalignment					
	P	**R**	**F1**	**P**	**R**	**F1**	**P**	**R**	**F1**	**Acc**	**R**	**F1**
Google Fusion	0.809	0.405	0.540	-	-	-	-	-	-			
TableNet$_{LR}$	0.824	0.790	0.804	0.612	0.688	0.648	0.754	0.730	0.742	0.730	0.723	0.731
LSTM^{desc}	0.851	**0.926**	0.887	**0.696**	0.816	0.751	0.870	**0.770**	0.817	0.806	0.837	0.818
LSTM^{+val}	0.865	0.913	0.888	0.668	0.977	0.794	0.936	0.722	0.815	0.823	0.871	0.832
LSTM^{+type}	0.839	0.935	0.884	0.547	0.976	0.701	0.933	0.564	0.703	0.773	0.825	0.763
BiLSTM^{desc}	0.883	0.891	0.887	0.684	0.960	0.799	0.918	0.752	0.827	0.828	0.868	0.838
BiLSTM^{+val}	0.877	0.871	0.874	0.684	0.975	0.804	0.915	0.747	0.823	0.826	0.864	0.834
BiLSTM^{+type}	0.854	0.908	0.880	0.690	0.957	0.802	0.925	0.741	0.823	0.823	0.869	0.835
TableNet^{desc}	**0.888**	0.884	0.886	0.686	0.947	0.796	0.909	0.759	0.827	0.828	0.863	0.836
TableNet^{+val}	0.856	**0.926**	**0.890**	0.675	**0.993**	0.804	**0.952**	0.719	0.819	0.828	**0.880**	0.838
TableNet^{+type}	0.872	0.903	0.887	0.692	0.961	**0.805**	0.925	0.752	**0.829**	**0.830**	0.872	**0.840**

Conclusions

- **Contributions:**

  - TableNet - a knowledge graph of aligned tables

  - Fine grained relation types between tables: equivalent, subPartOf

  - Improvement over existing works, with fine grained table relations

  - Exhaustive ground truth from 50 Wikipedia articles resulting 17K table pairs

- **Resources for TableNet**

  - **Data & Code: https://github.com/bfetahu/wiki_tables**

  - **Note:** The candidate feature generation code and the table alignment code will be published before the TheWebCon 2019.

Thank you! Questions?