UNIVERSITY OF MANNHEIM

DATA AND WEB SCIENCE GROUP

MASTER THESIS

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May 19, 2018

Abstract

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KB Knowledge Base

KG Knowledge Graph

MR Mean Rank

MRR Mean Reciprocal Rank

SGD Stochastic Gradient Descent

Chapter 1

How To

1.1 Setup

This LaTeX template uses `BibLaTeX` and `Biber`. This StackExchange post[1] explains how to setup your IDE accordingly. Additionally, this post[2] justifies why this setup is superior to `BibTeX` and `natbib`.

1.2 Citations

Let's see citations in action. The template uses *authoryear* citation style, you can change it if you want.
A helpful `BibLaTeX` cheat sheet can be found here[3].
I prefer to explicitly denote which kind of citations I use. So, the most important commands are *textcite* that is used for text cites, e.g., Bordes et al. (2013), *parencite* is used to cite with parentheses (Bordes et al. 2013). Multiple citations can be obtained with the plural form *parencites* or *textcites*, e.g. (e.g. Cauchy 1847; Bordes et al. 2013; Nickel et al. 2016).
For direct citations, you can use the `csquotes` package. E.g., "Lorem ipsum [...] dolor sit amet".

[1] `https://tex.stackexchange.com/questions/154751/biblatex-with-biber-configuring-my-editor-to-avoid-undefined-citations`

[2] `https://tex.stackexchange.com/questions/25701/bibtex-vs-biber-and-biblatex-vs-natbib`

[3] `http://tug.ctan.org/info/biblatex-cheatsheet/biblatex-cheatsheet.pdf`

1.3 Acronyms

Acronyms are handled easily. Short – KG, long – Knowledge Graph, full – Knowledge Graph (KG), same for plural – KGs, Knowledge Graphs, Knowledge Graphs (KGs) — or simply KG. Here, I also prefer to be explicit.

1.4 Floats

At this point, just some general advice:

1. You can have separate captions for a single float: A full caption directly at the float and a shorter version for the table of contents, e.g., in Table 1.1 the formatting of the table is only explained below the table, not in the table list at the beginning of the document.

2. *FloatBarrier* from the `placeins` package is awesome to place your floats. It literally is a barrier for your floats.

1.5 Tables

The template uses `booktabs` for beautiful tables. Table 1.1 is an example for a table that contains multiple tabulars. Table 1.2 is a side-by-side table. Note the use of *toprule*, *midrule*, and *bottomrule*. Table 1.3 shows another example that makes use of fancy superscript symbols.

Models	MR	MRR	hits@10	hits@1
R+D	276	0.258	0.420	0.179
R+C	378	0.246	0.405	0.167
R+T	253	0.264	0.423	0.185
D+C	200	0.293	0.481	0.200
D+T	204	0.317	0.484	**0.233**
C+T	281	0.305	0.478	0.218
R+D+C	265	0.269	0.437	0.186
R+D+T	212	0.284	0.450	0.202
R+C+T	238	0.277	0.441	0.195
D+C+T	**191**	**0.321**	**0.494**	**0.233**
R+D+C+T	205	0.292	0.461	0.207

(a) Pre-training and no fine-tuning.

Models	MR	MRR	hits@10	hits@1
D+C+T-MB	329	**0.312**	**0.501**	**0.217**
D+C-L	**178**	0.306	0.494	0.213

(b) Pre-training and fine-tuning.

Models	MR	MRR	hits@10	hits@1
D+C-MB	310	**0.288**	**0.480**	**0.193**
D+C-L	**259**	0.275	0.457	0.185

(c) No pre-training and fine-tuning.

Table 1.1: Link prediction results for the AVERAGE ensemble. Best-performing entries marked **bold**. Model names are abbreviated by their first character.

Model	h	α	η	γ	λ
RESCAL	100	0.5	1	8	0.1
DISTMULT	200	0.1	5	4	-
COMPLEX	150	0.01	5	2	-
TRANSE-L_1	150	0.05	10	2	-

(a) Margin-based loss function.

Model	h	α	η
DISTMULT	150	0.05	5
COMPLEX	150	0.05	5
TRANSE-L_2^2	150	0.05	10

(b) Logistic loss function.

Table 1.2: Best-performing hyperparameter settings for individual models.

Approach	Accuracy	Scalability	Schema	Example
Curated	Very high	Very low	Yes	WordNet[*]
Collaborative	High	Low	Yes	Freebase[†]
Semistructured	High	High	Yes	DBPedia[‡]
Unstructured	Low	Very high	Yes	Knowledge Vault[§]
Unstructured	Low	Very high	No	CORE[¶]

Table 1.3: Comparison of KB construction approaches. Citations: (*) Miller (1995), (†) Bollacker et al. (2008), (‡) Auer et al. (2007), (§) Dong et al. (2014), (¶) Petroni, Del Corro, and Gemulla (2015).

1.6 Algorithms

Algorithms in pseudocode can be realized with the `algorithm` and `algpseudocode` packages as in the example of Algorithm 1.

Algorithm 1 Minibatch Stochastic Gradient Descent

Require: Training data K^{train}
Require: Initial parameters Θ
Require: Minibatch size b
Require: Number of negatives η
while stopping criterion not met **do**
  for $i = 1..|K^{train}|/b$ **do**
    // Sample a minibatch of positive triples without replacement
    $K_i^{train} \leftarrow$ SAMPLE(K^{train}, b)
    // Sample η negative triples for each $x \in K_i^{train}$
    $K_b \leftarrow$ SAMPLE(K_i^{train}, η)
    Update Θ w.r.t. $L(K_b; \Theta)$
  end for
end while

1.7 Listings or Code

A listings example of the `listings` package is depicted in Listing 1.1 that shows C++ code. Can be made more colorful, but I prefer to stay clean and simple.

```
1  virtual double score(Triple &t) {
2    return (E->col(t.subject).array()*R->col(t.relation).array()*
         E->col(t.object).array()).sum();
3  }
4  virtual void gradient(Triple& t, double scale) {
5    sub = R->col(t.relation).array()*E->col(t.object).array();
6    rel = E->col(t.subject).array()*E->col(t.object).array();
7    obj = R->col(t.relation).array()*E->col(t.subject).array();
8    dE->add(t.subject, sub*scale);
9    dR->add(t.relation, rel*scale);
10   add(t.object, obj*scale);
11 }
```

Listing 1.1: Example implementation of DISTMULT.

1.8 Figures

Figure 1.1 shows an example of a figure. It uses **.eps* figures to achieve a high resolution.

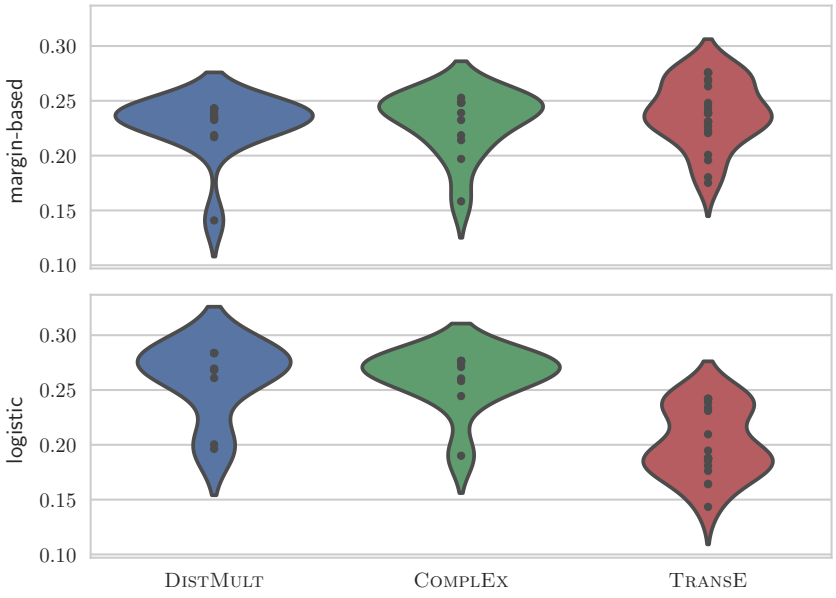

Figure 1.1: Kernel density estimation plot of the MRR metric for different hyper-parameter settings.

1.9 Graphs and Drawings

Figure 1.2 shows an example that uses the `tikz` package to render a sophisticated graph.

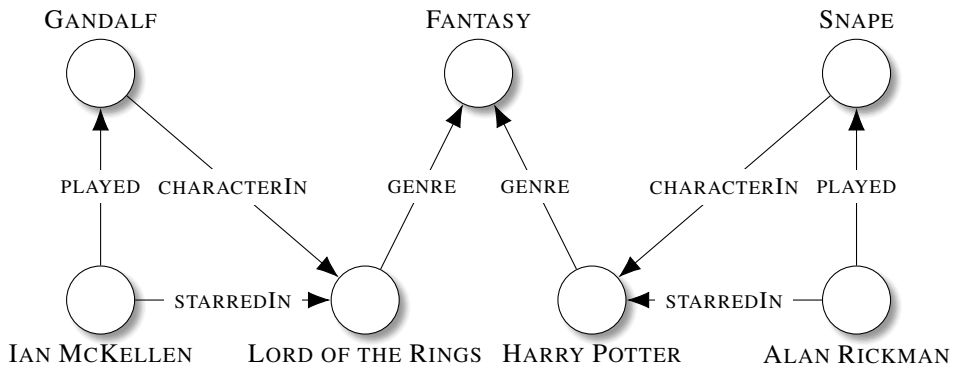

Figure 1.2: Sample knowledge graph. Nodes represent entities, edges represent existing relations between entities. Adapted from Nickel et al. (2016).

1.10 Equations

Equations can be aligned:

$$\begin{aligned} 1 + 1 &= 2 \\ 3 &= 1 + 2 \end{aligned}$$

Different cases:

$$y = \begin{cases} 0 & \text{if } x < 0 \\ x & \text{otherwise} \end{cases}$$

1.11 Todo Notes

Sometimes it is useful to take down some notes of what you plan to do. Especially, if you let someone proof read your thesis. The `todonotes` package is helpful for that purpose. It has side notes as well as inline notes.

This is a side note.

This is an inline note.

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Ehrenwörtliche Erklärung

Ich versichere, dass ich die beiliegende Masterarbeit ohne Hilfe Dritter und ohne Benutzung anderer als der angegebenen Quellen und Hilfsmittel angefertigt und die den benutzten Quellen wörtlich oder inhaltlich entnommenen Stellen als solche kenntlich gemacht habe. Diese Arbeit hat in gleicher oder ähnlicher Form noch keiner Prüfungsbehörde vorgelegen. Ich bin mir bewusst, dass eine falsche Erklärung rechtliche Folgen haben wird.

Mannheim, den 07.05.2018 Unterschrift