NL2SPARQL

by Nico Lutz

A journey

X

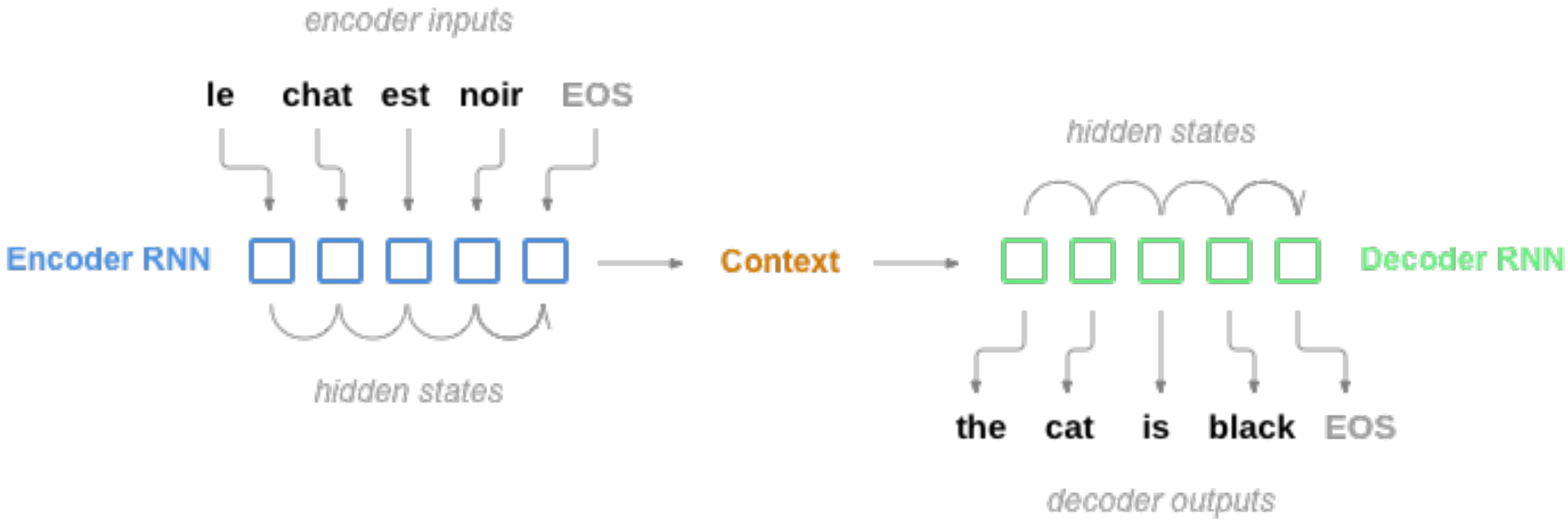
Semantic Parsing via Staged Query Graph Generation: Question Answering with Knowledge Base

Natural Language :
Which comic characters are painted by Bill Finger ?

```
SELECT DISTINCT ?uri
WHERE {
?uri <http://dbpedia.org/ontology/creator> <http://
dbpedia.org/resource/Bill_Finger>  .
?uri <http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
<http://dbpedia.org/ontology/ComicsCharacter>
}
```

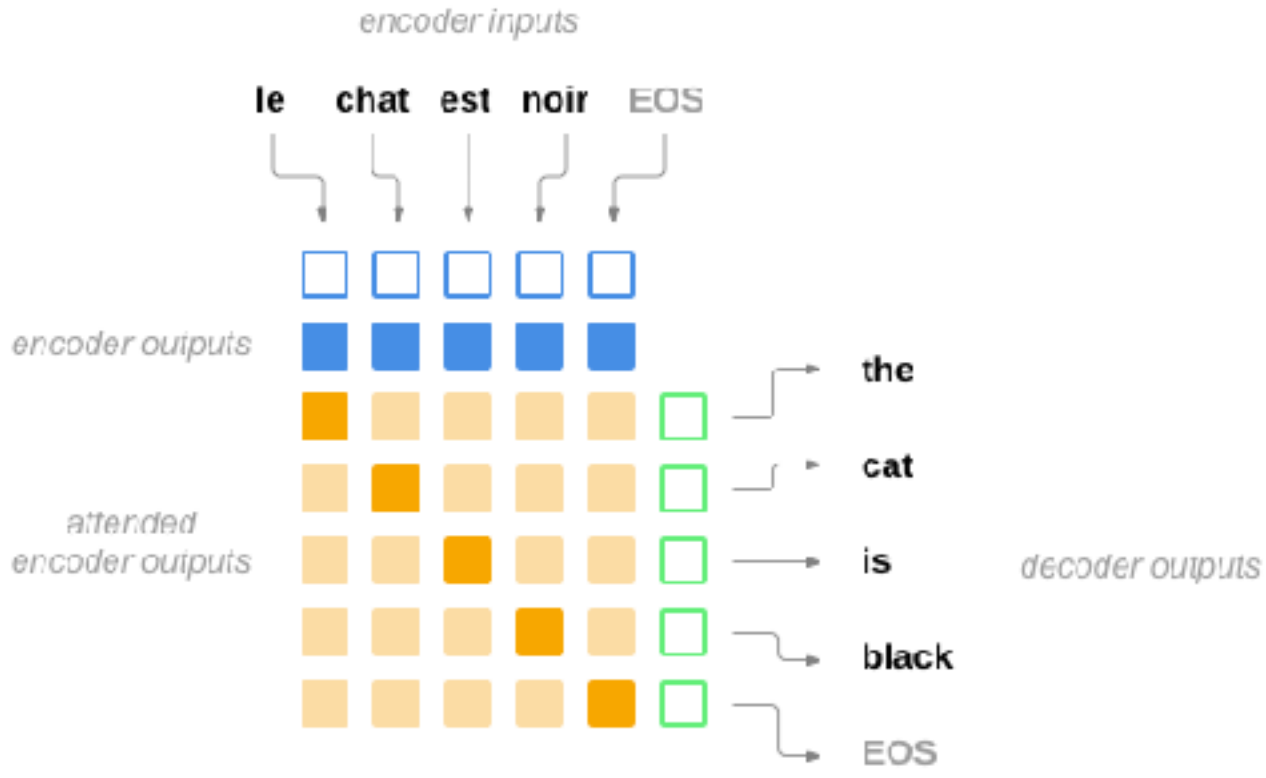
Approach: NMT

Encoder Decoder


encoder inputs
le
chat
est
noir
EOS
Encoder RNN
hidden states
Context
hidden states
Decoder RNN
the
cat
is
black
EOS
decoder outputs

+

Attention



encoder inputs

le chat est noir EOS

encoder outputs

attended encoder outputs

the

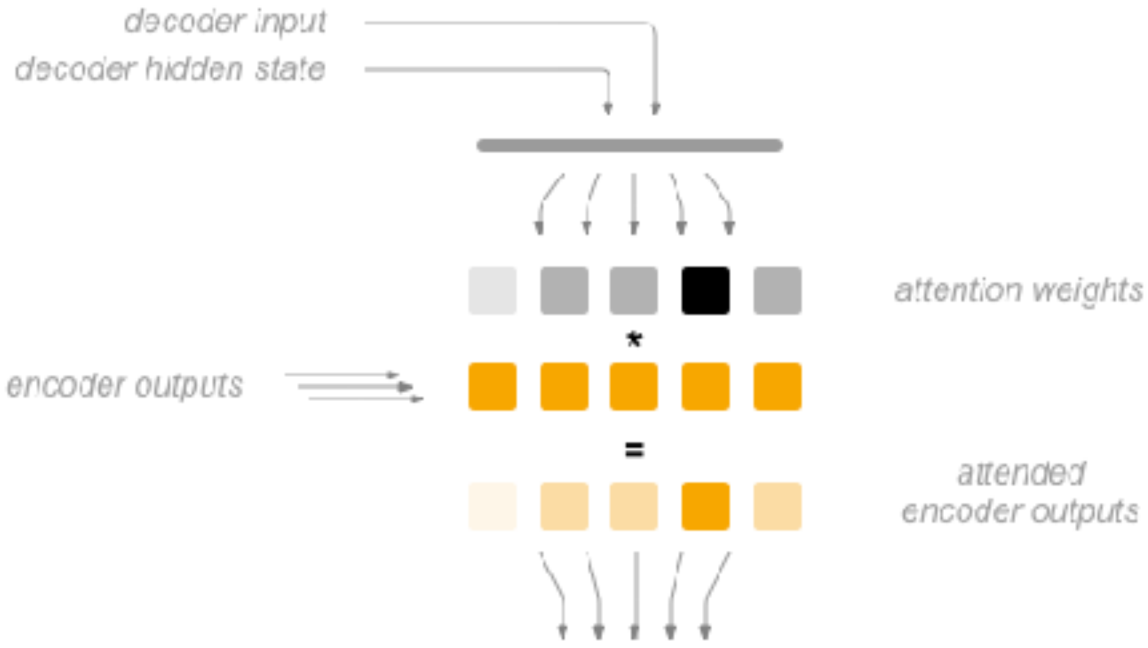
cat

is

black

EOS

decoder outputs



decoder input

decoder hidden state

attention weights

encoder outputs

*

=

attended encoder outputs

Preprocessing

- Lower case
- Adding special tokens:
    - '<curly_open> ': '{'
    - ' <curly_close>': '}'
    - '<croc_open> ':'<'
    - ' <croc_close>’:'>'
    - ' <punc>': '.'
    - ' <ques>':' ?’
    - EOS
    - SOS
    - PAD
- Padding
- Eval / Train split

which comic characters are painted by bill finger <ques>

```
SELECT DISTINCT  <ques>uri
WHERE <curly_open>
<ques>uri <croc_open> http://dbpedia.org/ontology/creator <croc_close>
<croc_open> http://dbpedia.org/resource/bill_finger <croc_close>  <punc>

<ques>uri <croc_open> http://www.w3.org/1999/02/22-rdf-syntax-ns#type
<croc_close> <croc_open> http://dbpedia.org/ontology/comicscharacter <croc_close>

<curly_close>
```

English - German

- Why? -> Dummy testing the implemented networks. See if everything works as it should

Examples

```
tom did what I expected him to do <punc> EOS PAD PAD PAD PAD PAD PAD PAD
```

```
=target-sentence= tom tat, was ich von ihm erwartete <punc> EOS PAD PAD PAD PAD PAD
```

```
< output-sentence < aufschlagen, aufschlagen, aufschlagen, japanischer japanischer
japanischer japanischer japanischer japanischer japanischer japanischer japanischer
japanischer japanischer japanischer japanischer japanischer japanischer japanischer
japanischer japanischer japanischer japanischer japanischer japanischer japanischer
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japanischer japanischer japanischer japanischer japanischer japanischer japanischer
japanischer japanischer japanischer japanischer japanischer japanischer japanischer
```
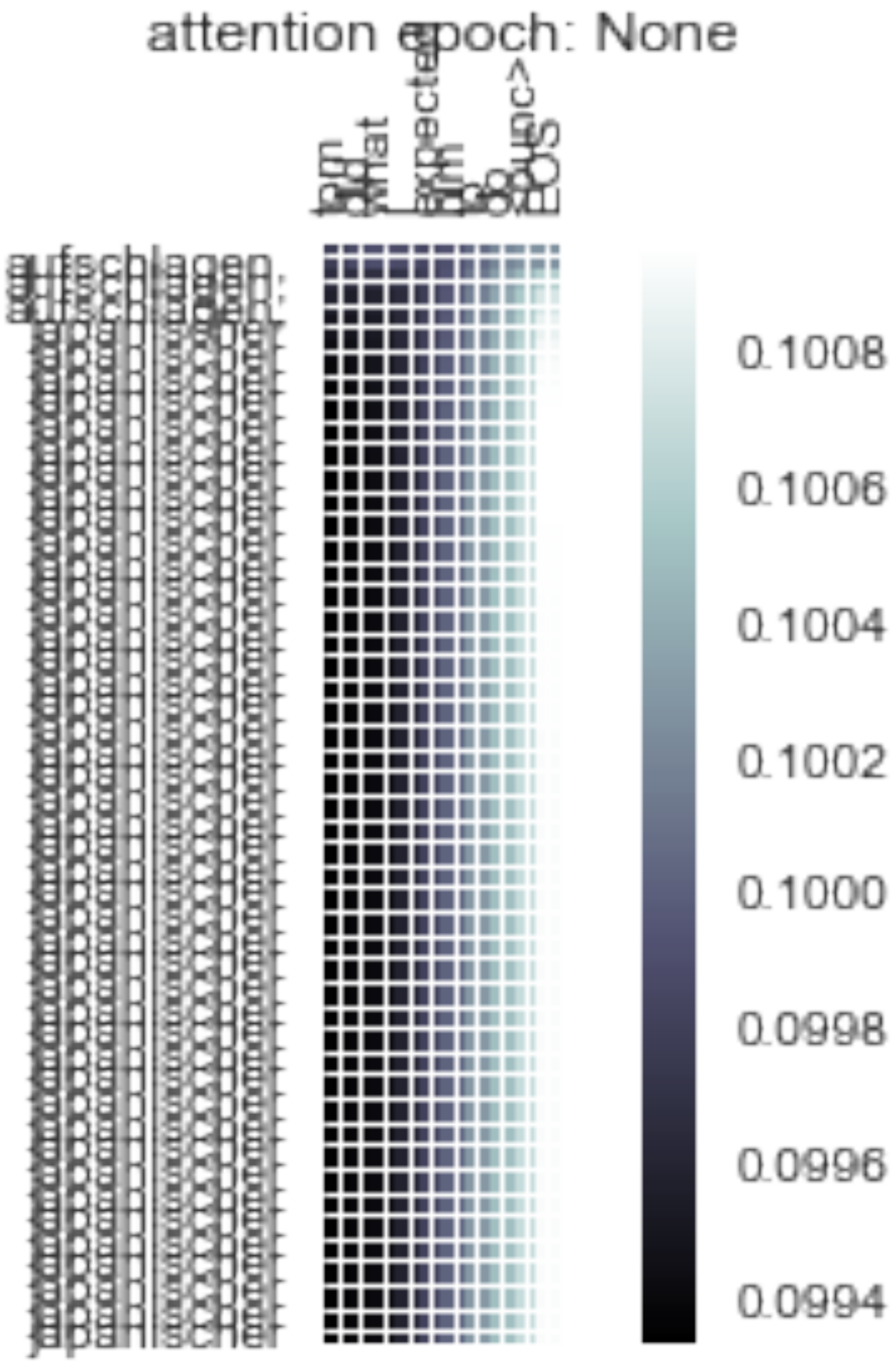
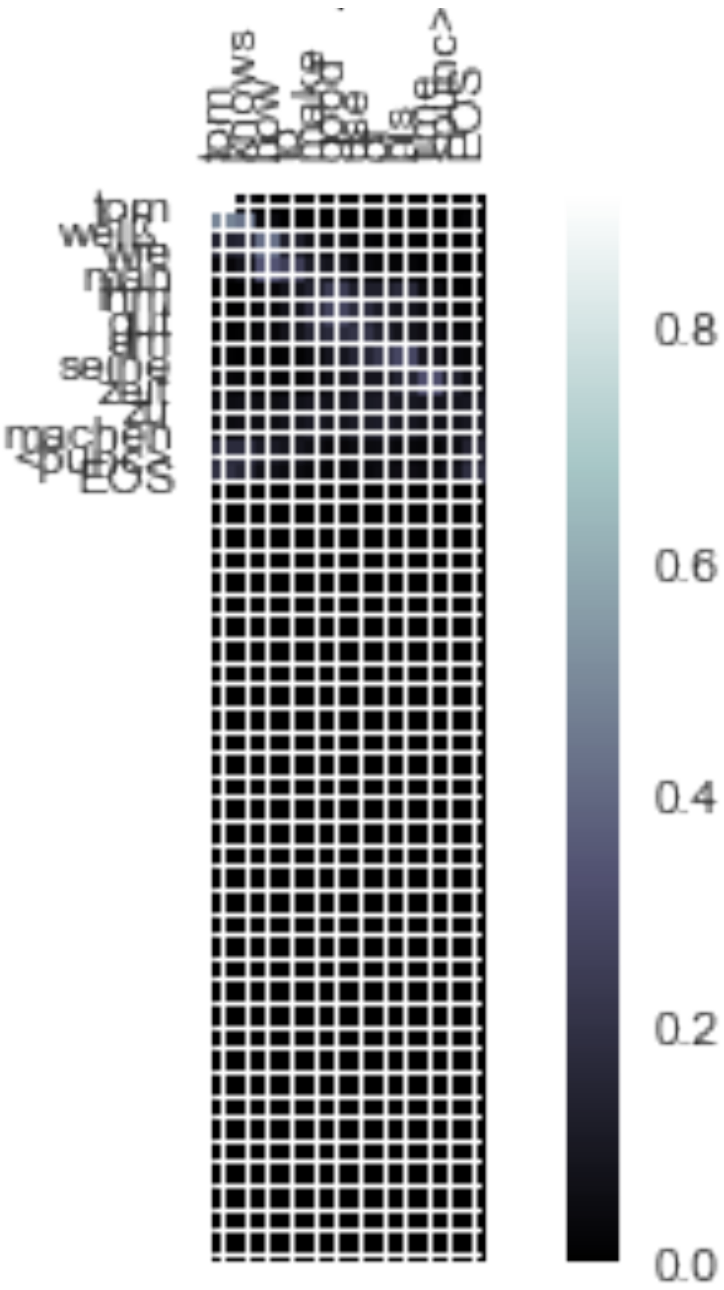
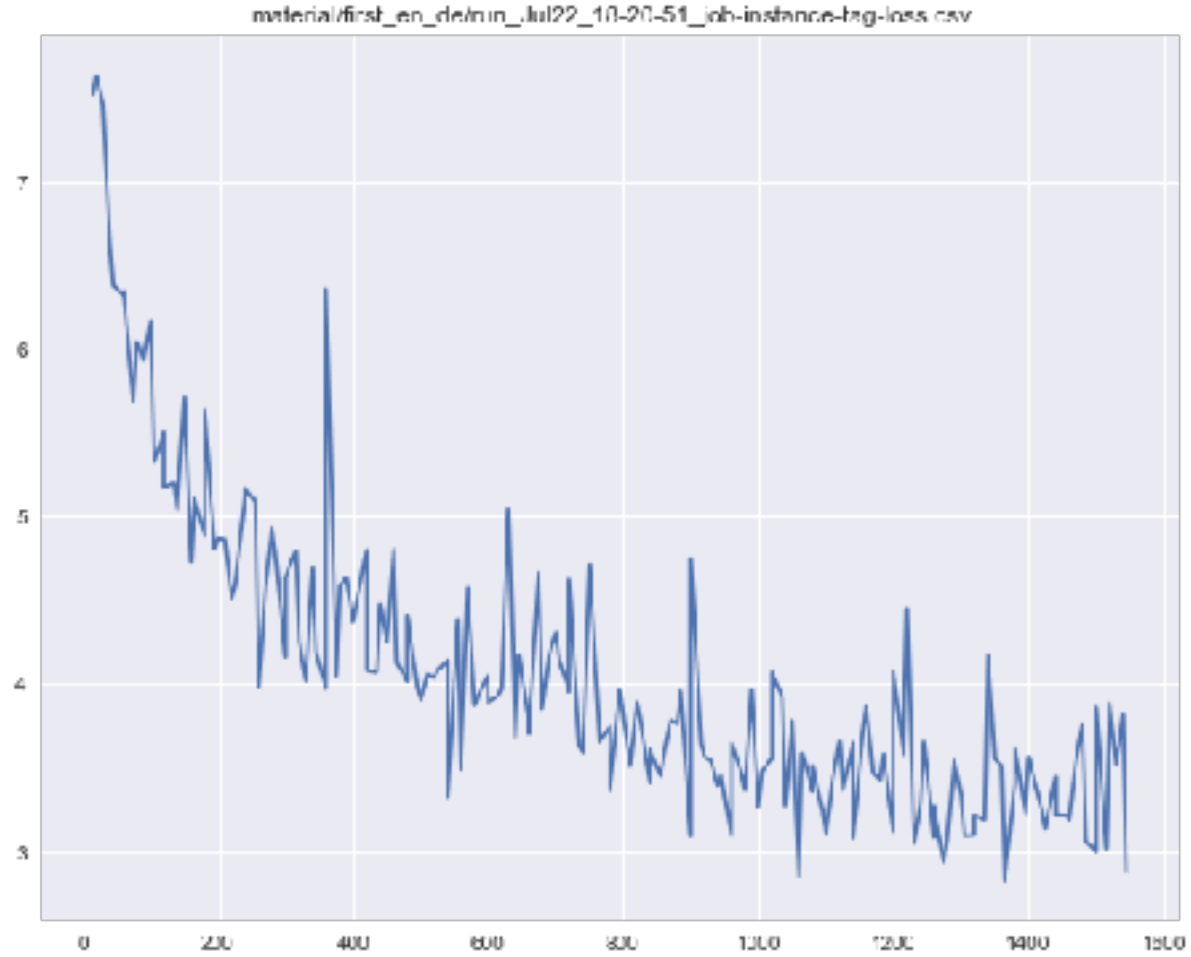



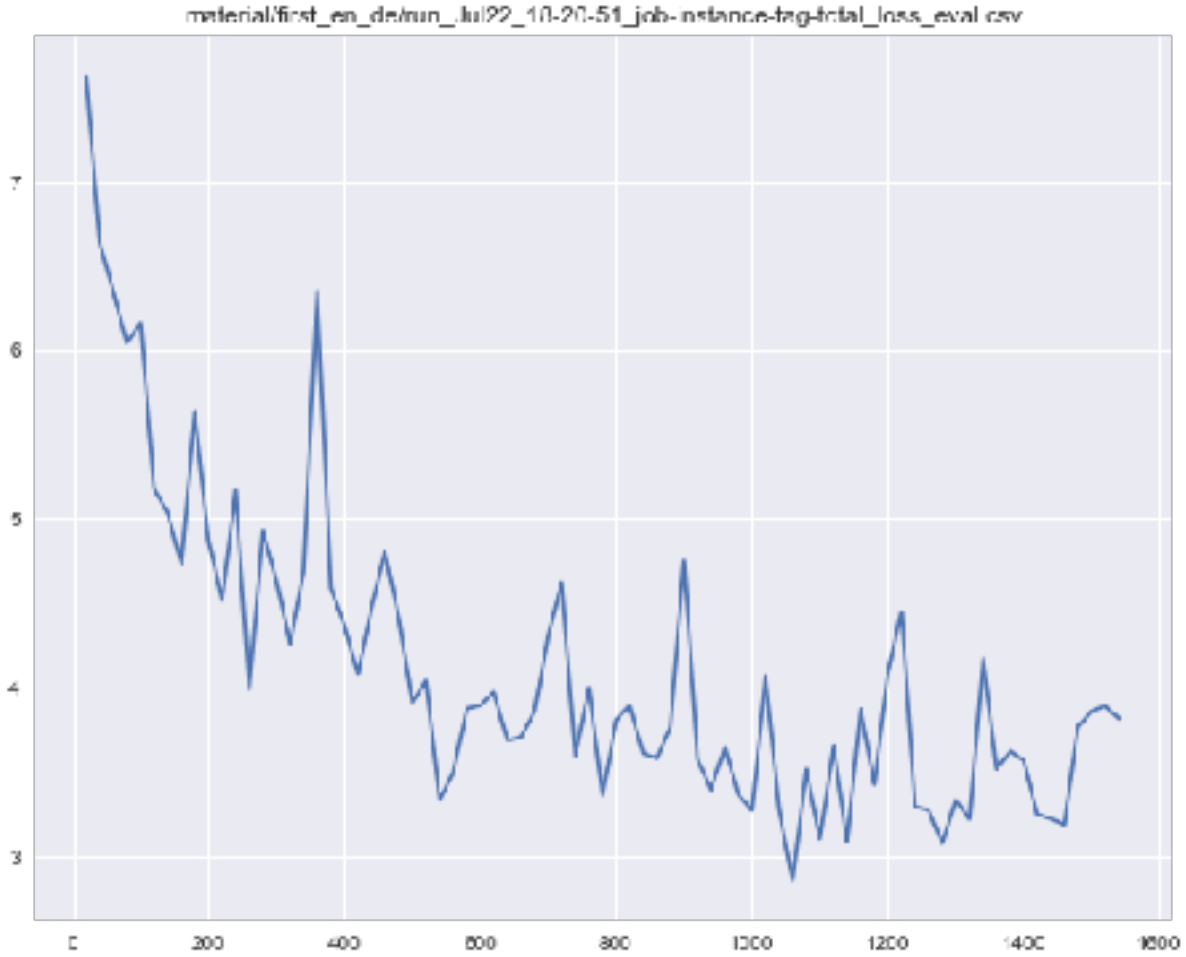
Examples

```
> input-sentence: > tom knows how to make good use of his time <punc>
EOS PAD PAD PAD PAD PAD PAD PAD


=target-sentence= tom versteht es, seine zeit gut einzuteilen <punc> EOS
PAD PAD PAD PAD PAD PAD PAD PAD PAD PAD


< output-sentence < tom weiß, wie man ihm gut um seine zeit zu machen
<punc> EOS
```

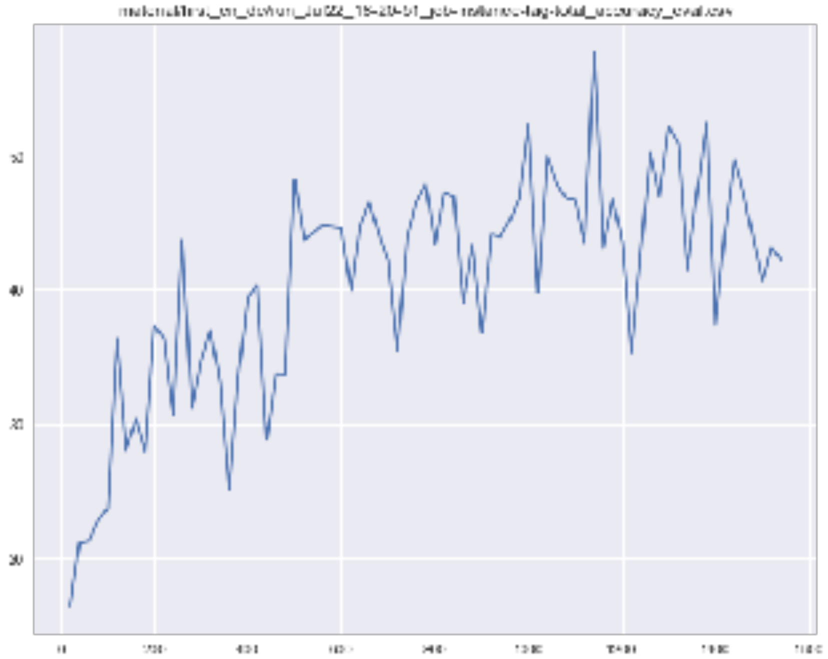


Loss


material/first_en_de/run_Jul22_10-20-51_job-instance-tag-loss.csv


material/first_en_de/run_Jul22_10-20-51_job-instance-tag-total_loss_eval.csv

Accuracy


material/first_en_de/run_Jul22_10-20-51_job-instance-tag-total_accuracy_eval.csv

English - Sparql

Examples

```
> input-sentence: > who is the owner of ford motor credit comapny which is also the builder of FORD SHO V8 engine <ques>
EOS
```

```
=target-sentence= SELECT DISTINCT <ques>uri WHERE <curly_open> <croc_open> http://dbpedia.org/resource/
ford_motor_credit_company <croc_close> <croc_open> http://dbpedia.org/property/owner <croc_close> <ques>uri. <croc_open>
http://dbpedia.org/resource/ford_SHO_V8_engine <croc_close> <croc_open> http://dbpedia.org/ontology/manufacturer
<croc_close> <ques>uri <curly_close> EOS PAD PAD PAD PAD PAD PAD PAD PAD PAD
```

```
< output-sentence < http://dbpedia.org/ontology/racehorse http://dbpedia.org/resource/
philosophiæ_naturalis_principia_mathematica http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica http://
dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica http://dbpedia.org/resource/
philosophiæ_naturalis_principia_mathematica http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica http://
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philosophiæ_naturalis_principia_mathematica http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica http://
dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica http://dbpedia.org/ontology/horserace http://dbpedia.org/
resource/philosophiæ_naturalis_principia_mathematica http://dbpedia.org/resource/
philosophiæ_naturalis_principia_mathematica http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica http://
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ontology/horserace http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica http://dbpedia.org/resource/
philosophiæ_naturalis_principia_mathematica http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica http://
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philosophiæ_naturalis_principia_mathematica http://dbpedia.org/ontology/horserace http://dbpedia.org/resource/
philosophiæ_naturalis_principia_mathematica http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica http://
dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica http://dbpedia.org/ontology/horserace http://dbpedia.org/
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dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica http://dbpedia.org/ontology/horserace http://dbpedia.org/
resource/philosophiæ_naturalis_principia_mathematica http://dbpedia.org/resource/
philosophiæ_naturalis_principia_mathematica http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
```
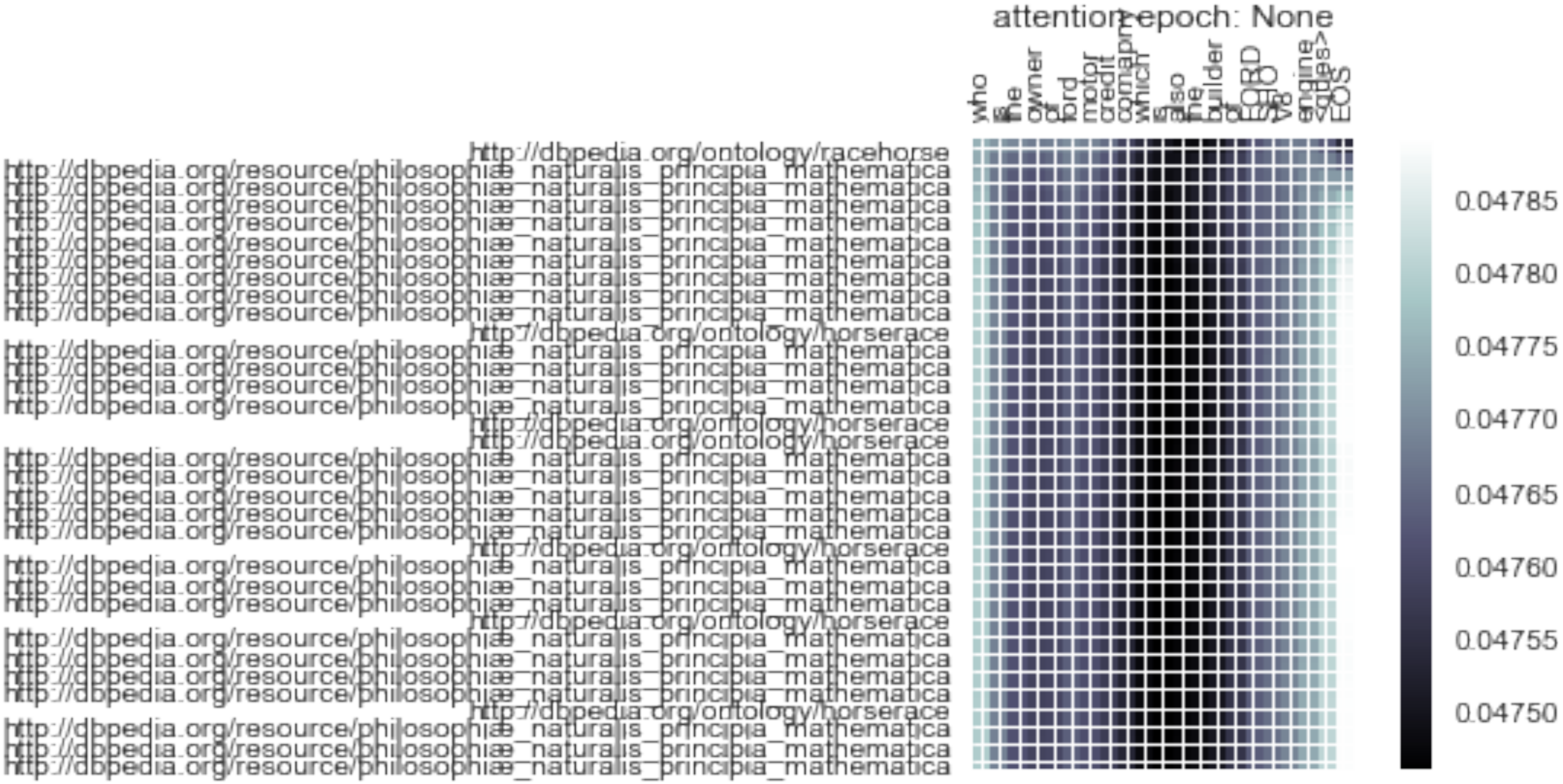

Examples


attention-epoch: None
who
is
the
owner
of
ford
motor
credit
company
which
is
also
the
builder
of
FORD
SOHC
V8
engine
<ales>
EOS
http://dbpedia.org/ontology/racehorse
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
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http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/ontology/horserace
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/ontology/horserace
http://dbpedia.org/ontology/horserace
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/ontology/horserace
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
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http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/ontology/horserace
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
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http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/ontology/horserace
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
http://dbpedia.org/resource/philosophiæ_naturalis_principia_mathematica
0.04785
0.04780
0.04775
0.04770
0.04765
0.04760
0.04755
0.04750

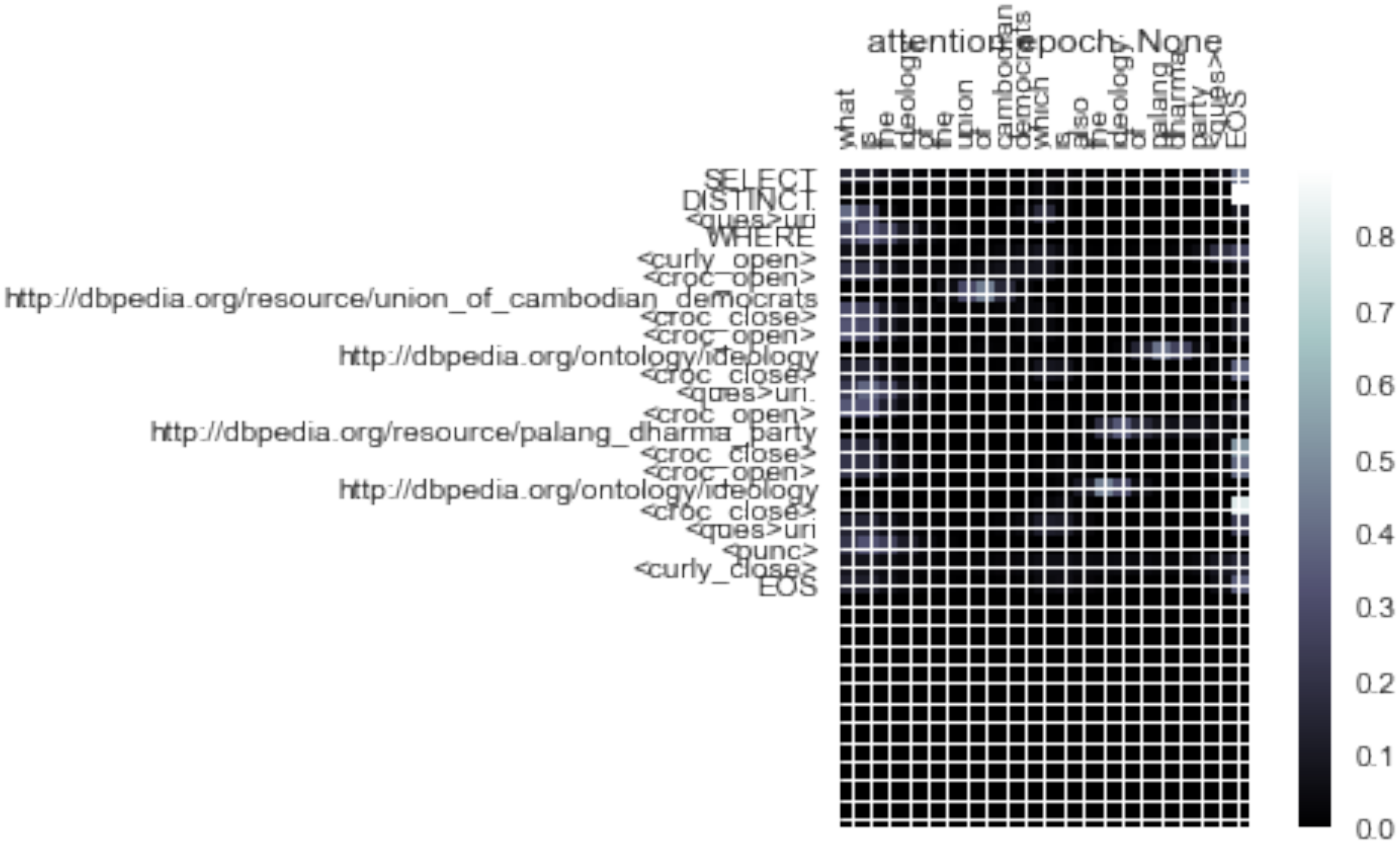
Examples (on train set after 2100 epochs)

```
what is the ideology of the union of cambodian democrats which is also the
ideology of palang dharma party <ques> EOS PAD
```

```
=target-sentence= SELECT DISTINCT <ques>uri WHERE <curly_open> <croc_open>
http://dbpedia.org/resource/union_of_cambodian_democrats <croc_close>
<croc_open> http://dbpedia.org/ontology/ideology <croc_close> <ques>uri.
<croc_open> http://dbpedia.org/resource/palang_dharma_party <croc_close>
<croc_open> http://dbpedia.org/ontology/ideology <croc_close> <ques>uri <punc>
<curly_close> EOS PAD PAD PAD PAD PAD PAD PAD PAD
```

```
< output-sentence < SELECT DISTINCT <ques>uri WHERE <curly_open> <croc_open>
http://dbpedia.org/resource/union_of_cambodian_democrats <croc_close>
<croc_open> http://dbpedia.org/ontology/ideology <croc_close> <ques>uri.
<croc_open> http://dbpedia.org/resource/palang_dharma_party <croc_close>
<croc_open> http://dbpedia.org/ontology/ideology <croc_close> <ques>uri <punc>
<curly_close> EOS
```

Examples (on train set after 2100 epochs)



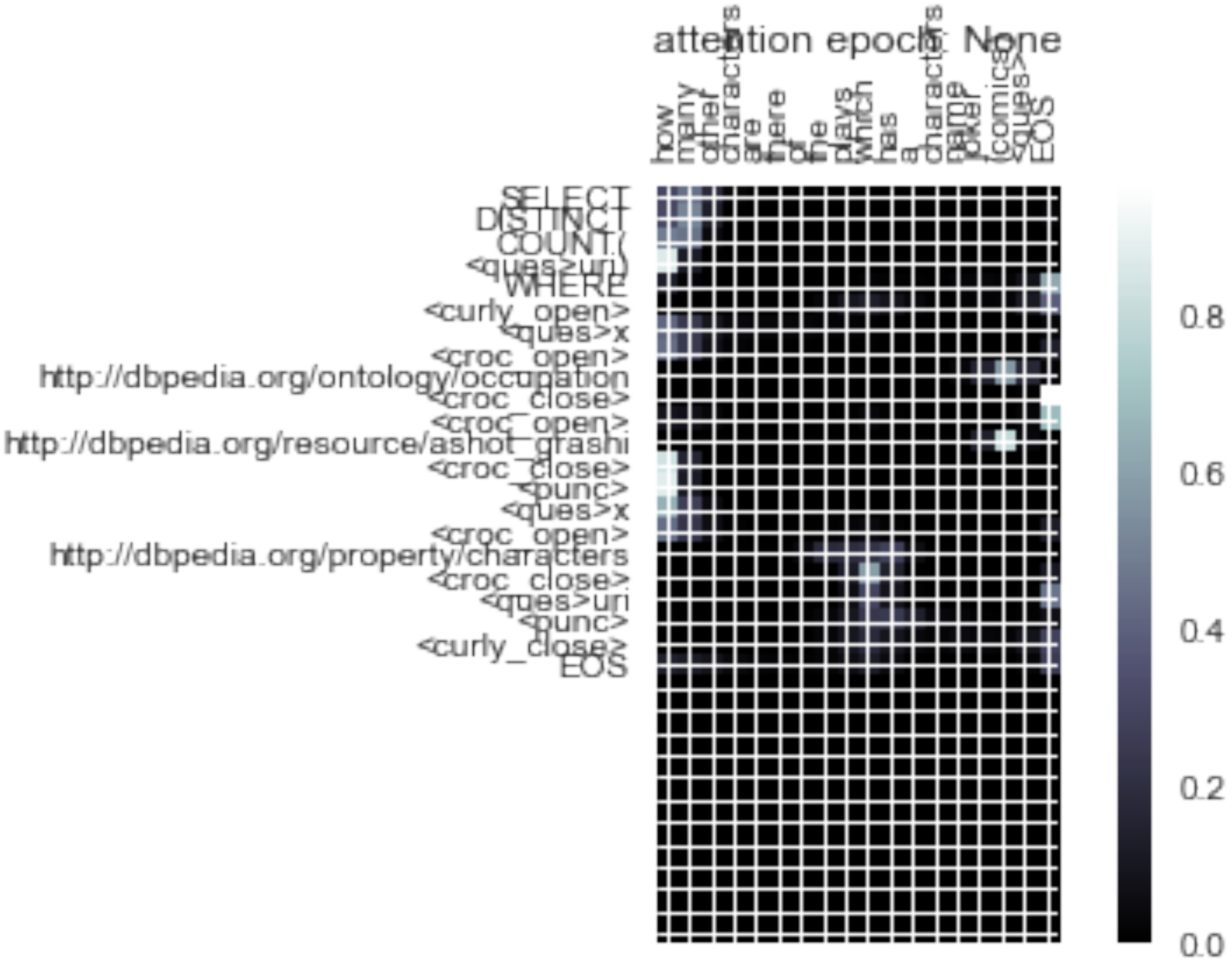
Examples (on validation set after 2100 epochs)

```
> input-sentence: > how many other characters are there of the plays which has
a characters name joker (comics) <ques> EOS PAD PAD PAD
```

```
=target-sentence= SELECT DISTINCT COUNT( <ques>uri) WHERE <curly_open> <ques>x
<croc_open> http://dbpedia.org/property/characters <croc_close> <croc_open>
http://dbpedia.org/resource/joker_(comics) <croc_close> <punc> <ques>x
<croc_open> http://dbpedia.org/property/characters <croc_close> <ques>uri
<curly_close> EOS PAD PAD PAD PAD PAD PAD PAD PAD PAD
```

```
< output-sentence < SELECT DISTINCT COUNT( <ques>uri) WHERE <curly_open>
<ques>x <croc_open> http://dbpedia.org/ontology/occupation <croc_close>
<croc_open> http://dbpedia.org/resource/ashot_grashi <croc_close> <punc>
<ques>x <croc_open> http://dbpedia.org/property/characters <croc_close>
<ques>uri <punc> <curly_close> EOS
```

Examples (on validation set after 2100 epochs)



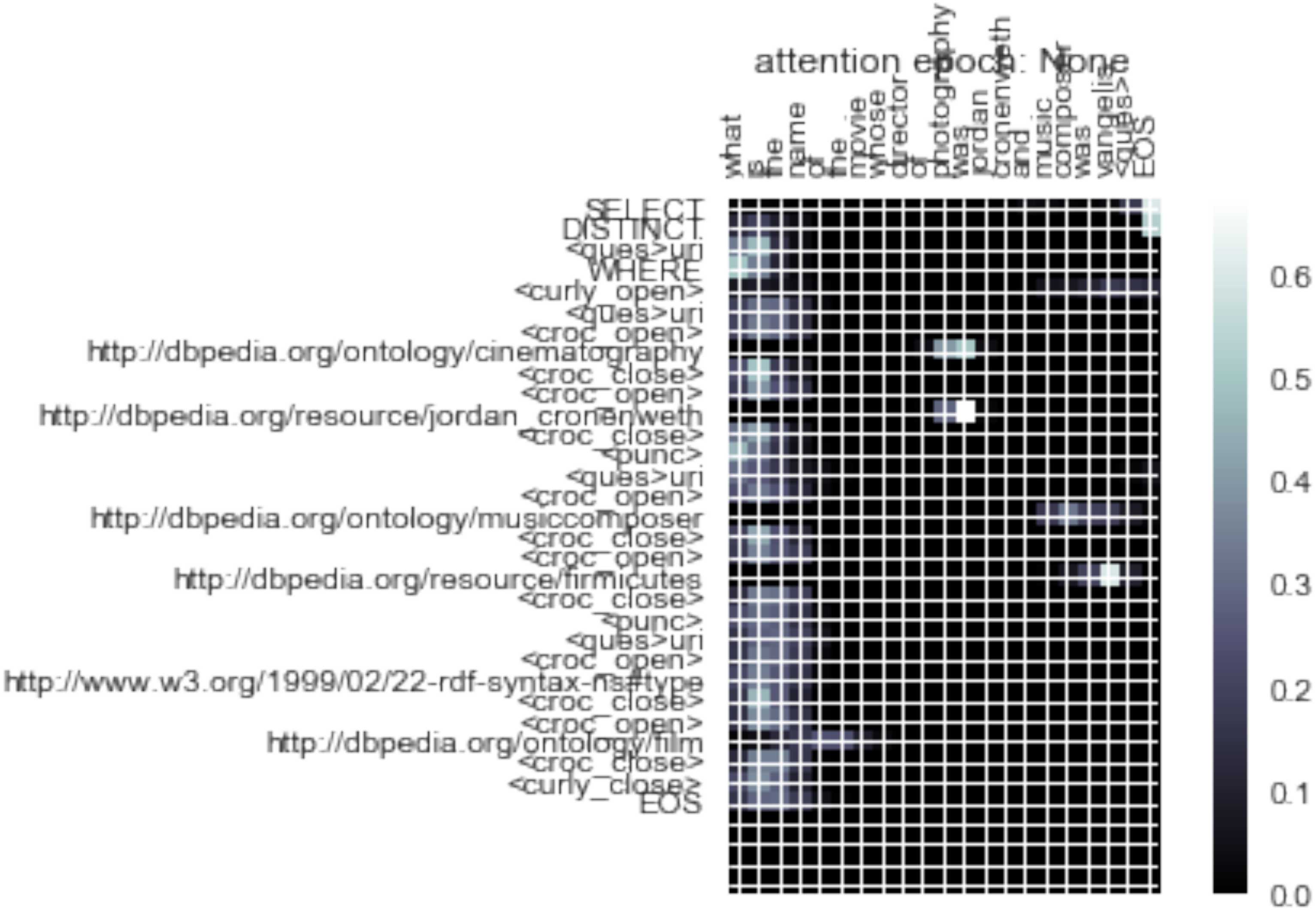
Examples (on validation set after 2100 epochs)

```
> input-sentence: > what is the name of the movie whose director of photography
was jordan cronenweth and music composer was vangelis <ques> EOS
```

```
=target-sentence= SELECT DISTINCT <ques>uri WHERE <curly_open> <ques>uri
<croc_open> http://dbpedia.org/property/cinematography <croc_close> <croc_open>
http://dbpedia.org/resource/jordan_cronenweth <croc_close> <punc> <ques>uri
<croc_open> http://dbpedia.org/ontology/musiccomposer <croc_close> <croc_open>
http://dbpedia.org/resource/vangelis <croc_close> <punc> <ques>uri <croc_open>
http://www.w3.org/1999/02/22-rdf-syntax-ns#type <croc_close> <croc_open>
http://dbpedia.org/ontology/film <croc_close> <curly_close> EOS
```

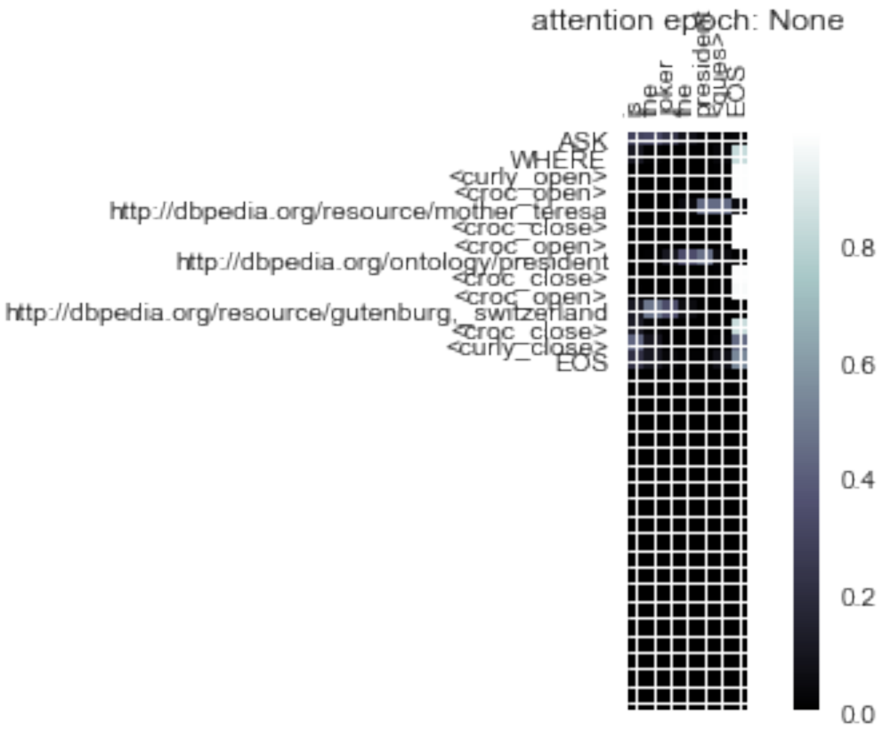
```
< output-sentence < SELECT DISTINCT <ques>uri WHERE <curly_open> <ques>uri
<croc_open> http://dbpedia.org/ontology/cinematography <croc_close> <croc_open>
http://dbpedia.org/resource/jordan_cronenweth <croc_close> <punc> <ques>uri
<croc_open> http://dbpedia.org/ontology/musiccomposer <croc_close> <croc_open>
http://dbpedia.org/resource/firmicutes <croc_close> <punc> <ques>uri
<croc_open> http://www.w3.org/1999/02/22-rdf-syntax-ns#type <croc_close>
<croc_open> http://dbpedia.org/ontology/film <croc_close> <curly_close> EOS
```

Examples (on validation set after 2100 epochs)

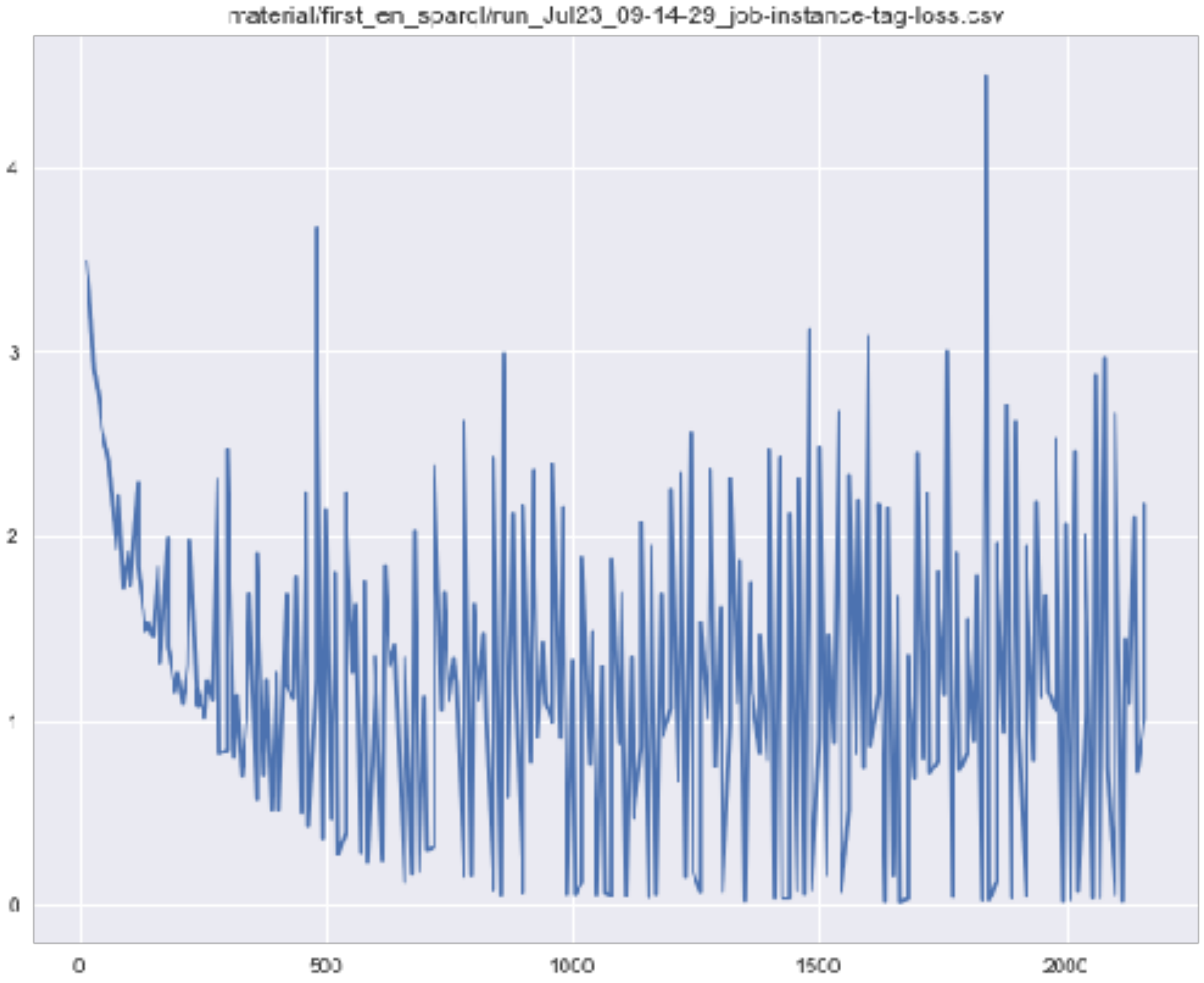


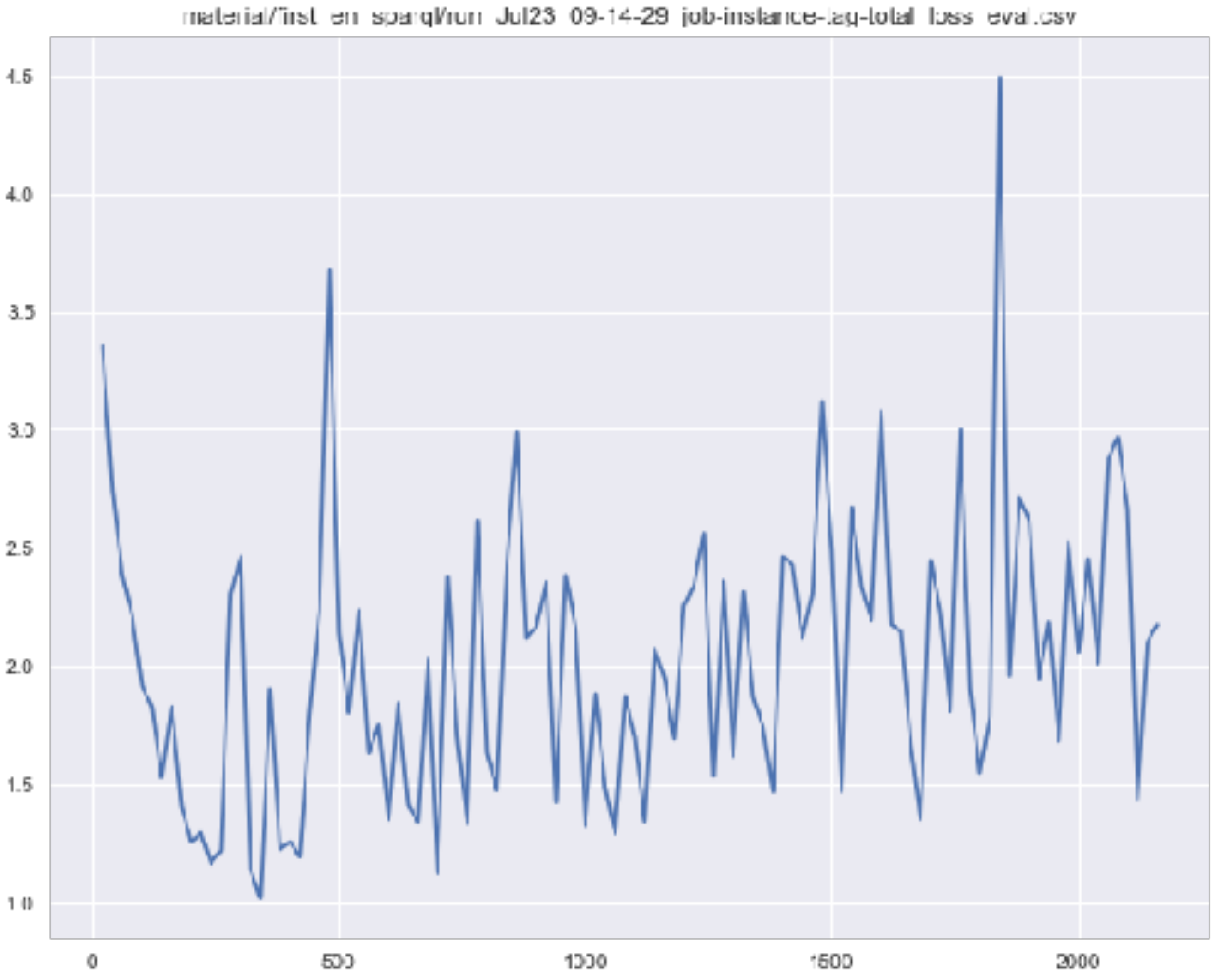
Examples (random question)

```
> input-sentence: > is the joker the president <ques> EOS



< output-sentence < ASK WHERE <curly_open> <croc_open> http://dbpedia.org/
resource/mother_teresa <croc_close> <croc_open> http://dbpedia.org/ontology/
president <croc_close> <croc_open> http://dbpedia.org/resource/
gutenburg,_switzerland <croc_close> <curly_close> EOS



FORMATED:

ASK WHERE {<http://dbpedia.org/resource/mother_teresa> <http://dbpedia.org/
ontology/president> <http://dbpedia.org/resource/gutenburg,_switzerland>} EOS
```

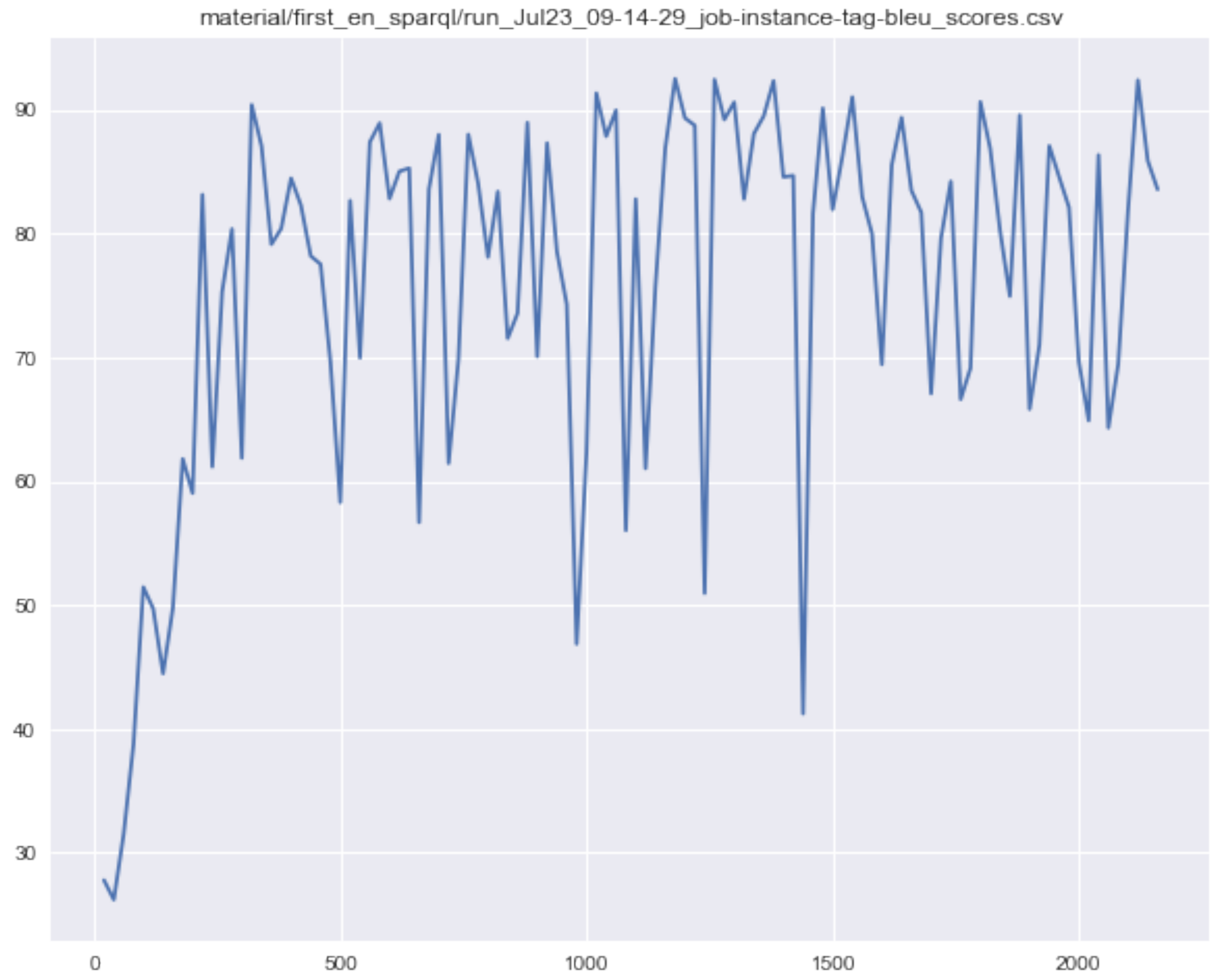


Loss


material/first_en_sparql/run_Jul23_09-14-29_job-instance-tag-loss.csv
4
3
2
1
0
0
500
1000
1500
2000


material/first_en_sparql/run_Jul23_09-14-29_job-instance-tag-total_loss_eval.csv
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0
500
1000
1500
2000

Accuracy


material/first_en_sparql/run_Jul23_09-14-29_job-instance-tag-bleu_scores.csv
90
80
70
60
50
40
30
0
500
1000
1500
2000

Lessons learned

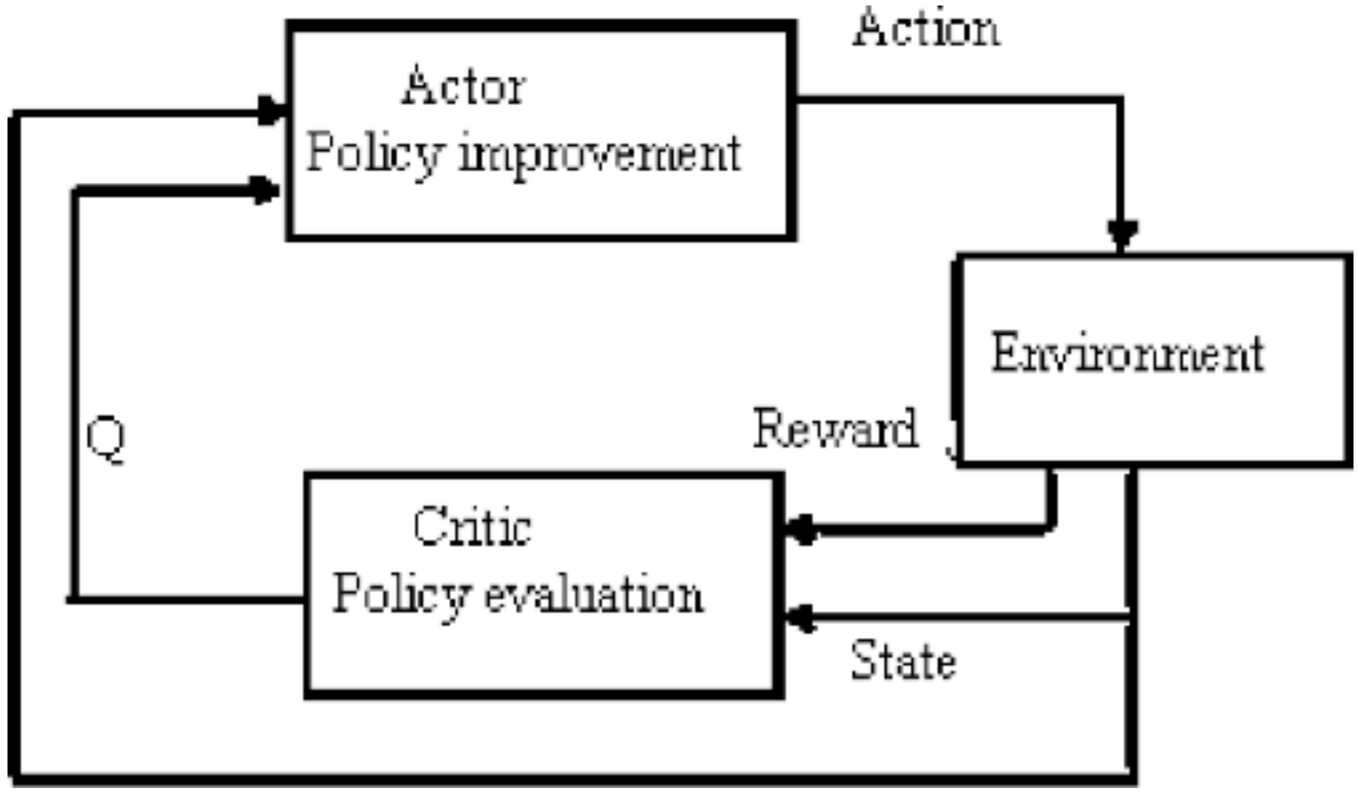
- Lower case seems not to be an improvement
- From very early on the network captures the “grammar” (SELECT COUNT WHERE ASK <> {})
- The mapping from word to its entity … is the hardest part for the network
- Take time for hyper parameter search

Flaws & Improvements

- Works only for words in the embeddings: use a shared embedding or a pretained (fasttext, glove,…)
- Mapping still hard -> maybe other embeddings help
- Training with larger embedding
- Without / degraded teacher forcing ?
- Beam search

Reinforced Training

- Next steps use the spraql query results to update (based on bandit-nmt)


Action
Actor
Policy improvement
Environment
Q
Reward
Critic
Policy evaluation
State

References

- https://github.com/spro/practical-pytorch/blob/master/seq2seq-translation/seq2seq-translation.ipynb
- https://github.com/spro/practical-pytorch/blob/master/seq2seq-translation/seq2seq-translation-batched.ipynb
- https://arxiv.org/pdf/1707.07402.pdf
- https://github.com/khanhptnk/bandit-nmt
- http://opennmt.net/