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Memory Networks for QA on Tabular Data

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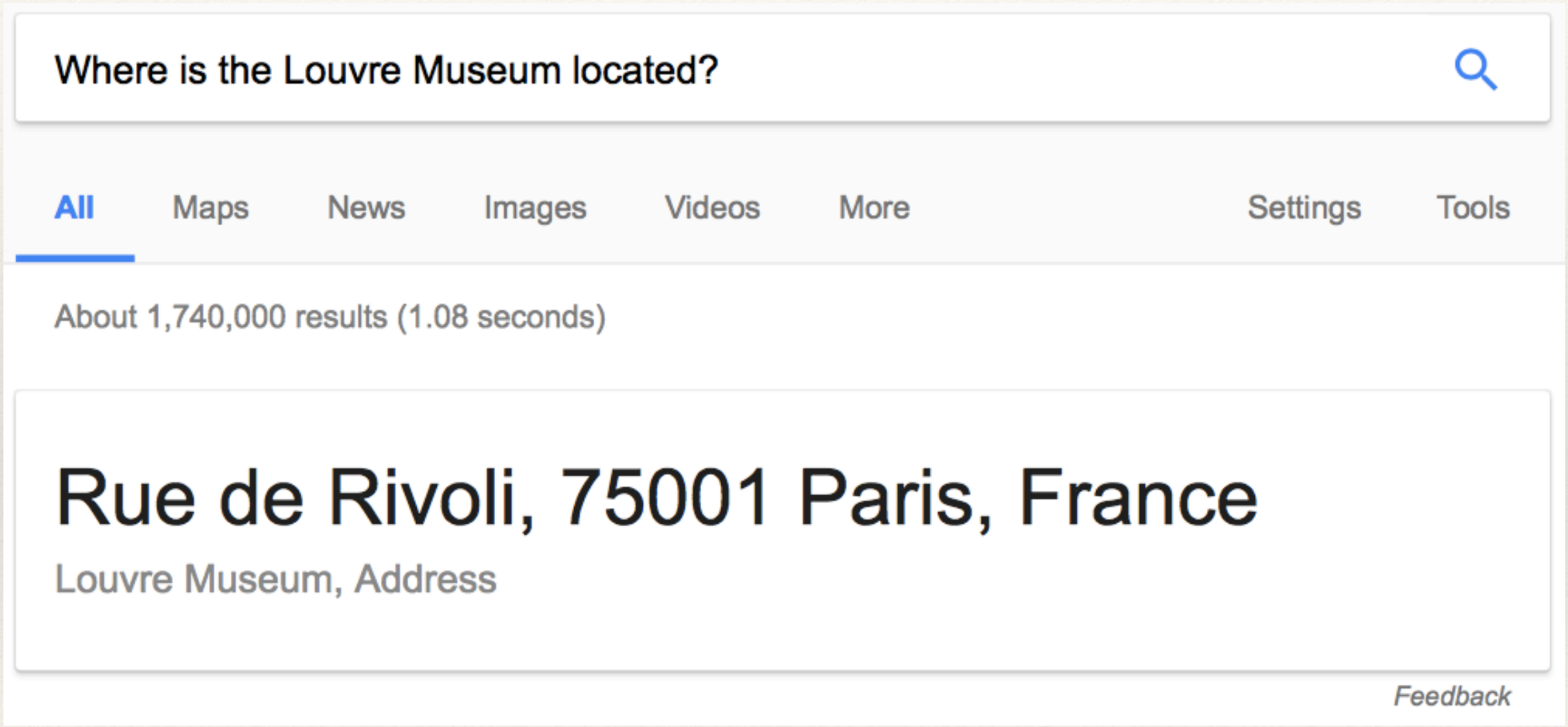
Outline

1. **Task**: Question Answering (QA)
2. **Method**: Memory Networks
3. **Application**: Open Data Tables
4. Memory Networks for QA on Tabular data

QA Task



Daniel Jurafsky & James H. Martin. Speech and Language Processing (Chapter 28). 2016

QA Task

When was the Louvre Museum built?

All News Images Maps More Settings Tools

About 933,000 results (1.09 seconds)

The Louvre was originally built as a fortress in **1190**, but was reconstructed in the 16th century to serve as a royal palace. It continued to be expanded over the years. It currently covers a total area of 652,300 square feet (60,600 square meters). May 10, 2013

The Louvre Museum: Facts, Paintings & Tickets - Live Science

www.livescience.com/31935-louvre-museum.html

About this result Feedback

bAbI Benchmark

- 20 QA tasks: train/test 1K samples

  Factoid QA
  Yes/no questions
  Counting
  Coreference
  Time manipulation
  Basic deduction/induction
  Positional reasoning
  Reasoning about size
  Path finding …

- 6 dialog tasks

Jason Weston, Antoine Bordes, Sumit Chopra, Alexander M. Rush, Bart van Merriënboer, Armand Joulin and Tomas Mikolov. Towards AI Complete Question Answering: A Set of Prerequisite Toy Tasks, arXiv:1502.05698.

2. Factoid QA with two supporting facts

1 Mary got the milk.

2 John moved to the bedroom.

3 Sandra went back to the kitchen.

4 Mary travelled to the hallway.

5 Where is the milk? hallway 1 4

https://github.com/facebook/bAbI-tasks

15. Basic deduction

1 Wolves are afraid of mice.

2 Sheep are afraid of mice.

3 Winona is a sheep.

4 Mice are afraid of cats.

5 Cats are afraid of wolves.

6 Jessica is a mouse.

10 What is winona afraid of? mouse 3 2

12 What is jessica afraid of? cat 6 4

https://github.com/facebook/bAbI-tasks

19. Path finding

1 The garden is west of the bathroom.

2 The bedroom is north of the hallway.

3 The office is south of the hallway.

4 The bathroom is north of the bedroom.

5 The kitchen is east of the bedroom.

6 How do you go from the bathroom to the hallway? s,s 4 2

https://github.com/facebook/bAbI-tasks

Memory Network (MemNN)

- Deep neural network architecture proposed by Facebook AI Research group

Memory: indexed array of objects (e.g. vectors)

- Components:

I: (input) convert incoming data to the internal representation.

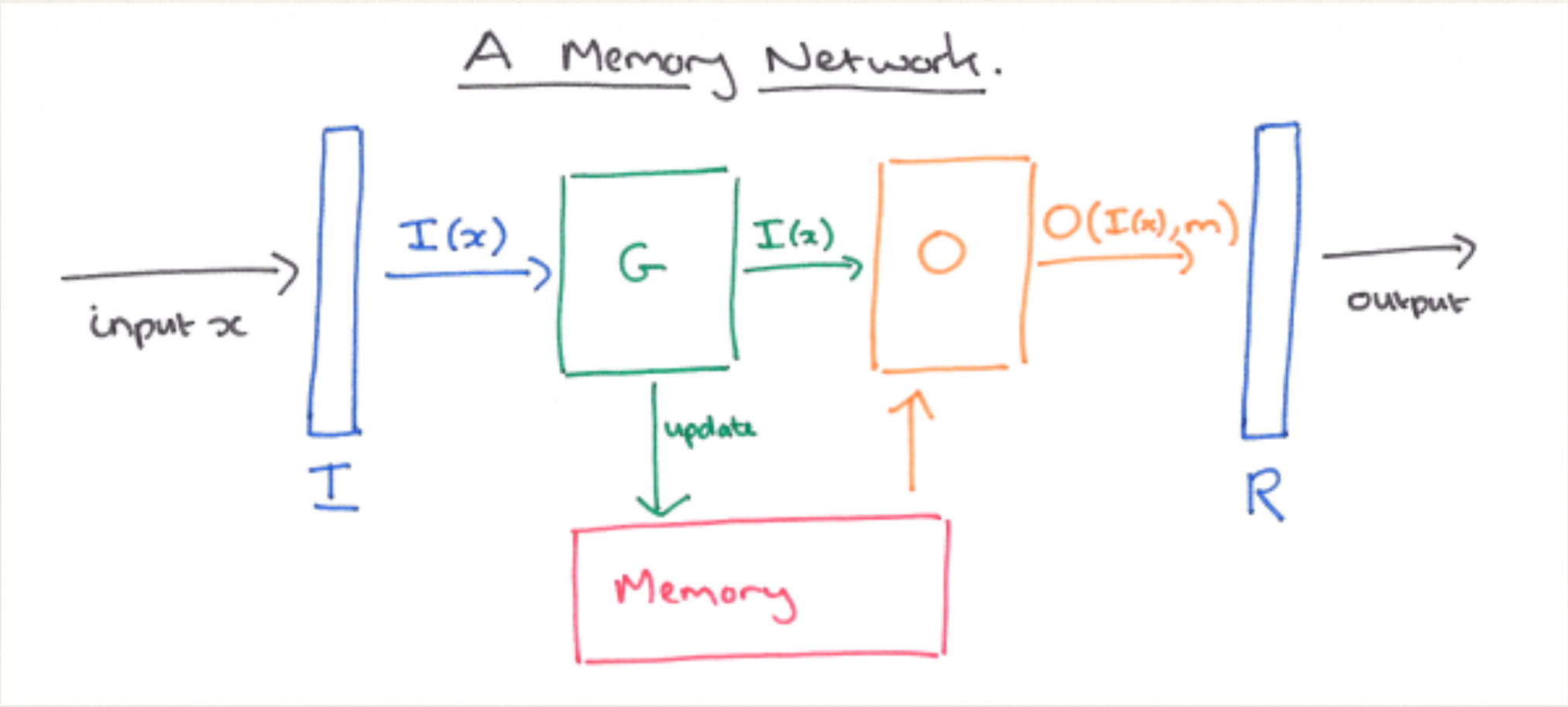
G: (generalisation) update memories given input.

O: (output) produce output given the memories.

R: (response) convert output representation into a response.

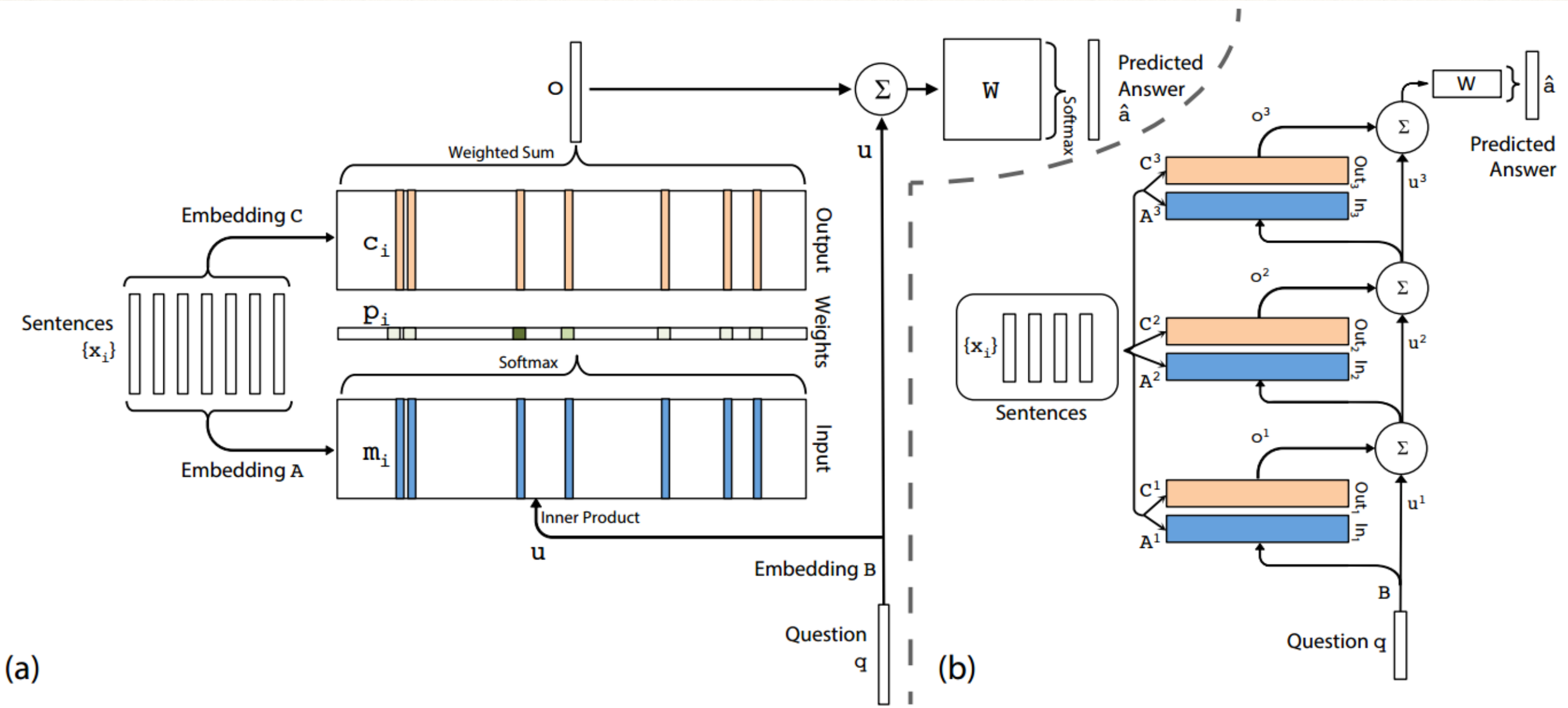
J. Weston, S. Chopra, A. Bordes. Memory Networks. ICLR 2015
https://blog.acolyer.org/2016/03/10/memory-networks/

Memory Network (MemNN)



https://blog.acolyer.org/2016/03/10/memory-networks/

End-to-end Memory Network (MemN2N)



Sukhbaatar, Sainbayar, Jason Weston, and Rob Fergus. "End-to-end memory networks." Advances in neural information processing systems (NIPS). 2015.

Variations

- Ankit Kumar, Ozan Irsoy, Peter Ondruska, Mohit Iyyer, James Bradbury, Ishaan Gulrajani, Victor Zhong, Romain Paulus, Richard Socher: Ask Me Anything: **Dynamic Memory Networks** for Natural Language Processing. ICML 2016.
- Alexander H. Miller, Adam Fisch, Jesse Dodge, Amir-Hossein Karimi, Antoine Bordes, Jason Weston: **Key-Value Memory Networks** for Directly Reading Documents. EMNLP 2016.
- Julien Perez, Fei Liu: **Gated End-to-End Memory Networks**. EACL 2017.

http://yerevann.com/dmn-ui

Application: Open Data

- Open Data -> Open Government
- Increasing transparency
- Empowering citizens and local communities

Global Open Data Index

Rank	Place	Government Budget	National Statistics	Procurement	National Laws	Administrative Boundaries	Draft Legislation	Air Quality	National Maps	Weather Forecast	Company Register	Government Spending	Election Results	Locations	Water Quality	Land Ownership	Score
20	Sweden																53%
22	Germany																51%
23	Hong Kong																50%
24	Belgium																49%
24	Ukraine																49%
24	Slovenia																49%
24	Austria																49%
28	Poland																47%
28	Slovakia																47%
28	Italy																47%
31	Greece																46%
32	India																45%
33	Czech Republic																44%

Company Register in Ukraine

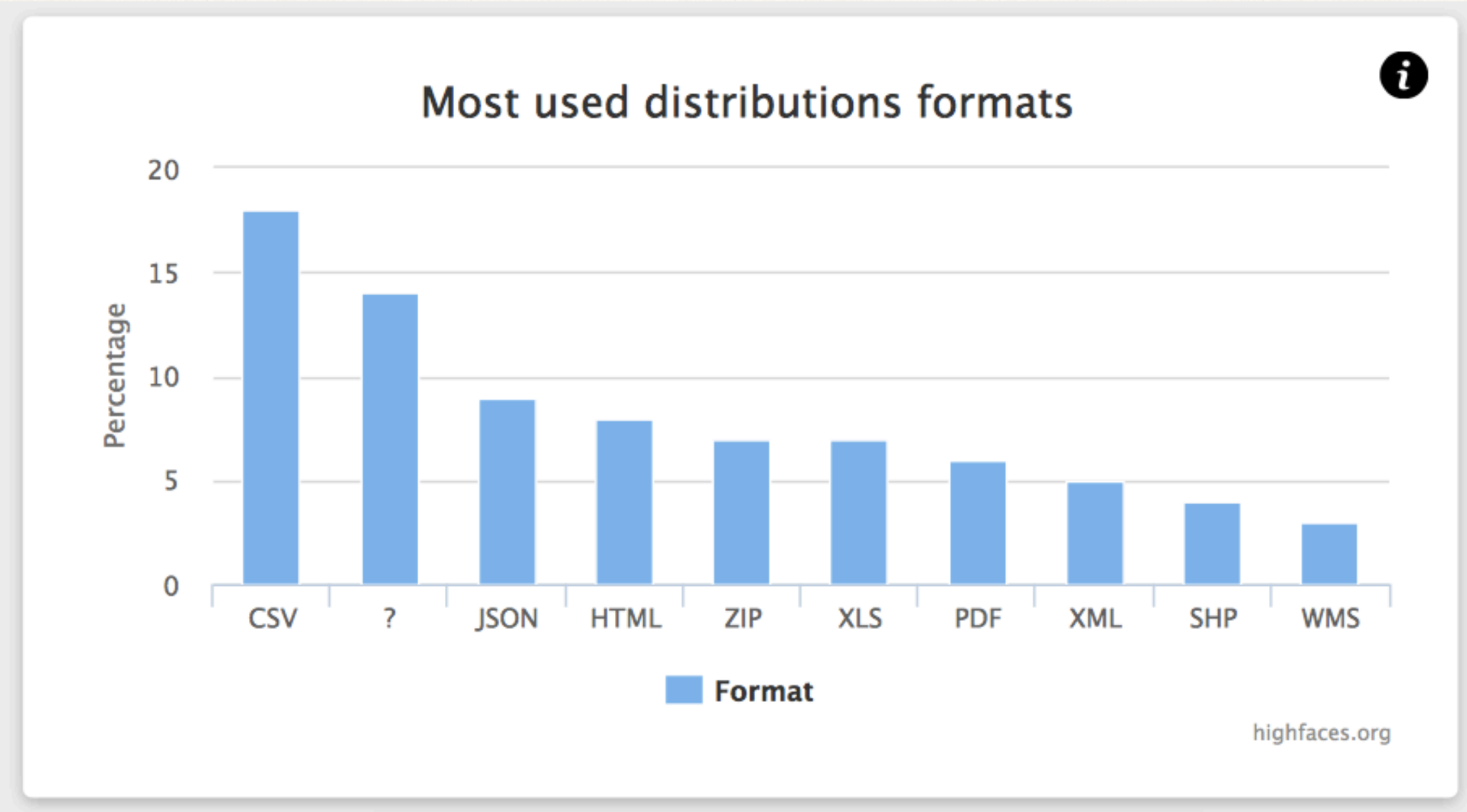
- It's openly licenced
- It's in an open and machine-readable format
- It's downloadable at once
- It's up-to-date
- It's publicly available
- It's available free of charge

Ukraine's company data was opened in April 2016.

Read more »

https://index.okfn.org/place/

Why Tabular Data?



https://www.europeandataportal.eu/mqa-service/en

Memory Networks for QA on Tabular data

Table

nuts2	lau2_code	lau2_name	year	internal_mig_immigration	international_mig_immigration	immigration_total	internal_mig_emigration	international_mig_emigration	emigration_total
at31	41001	desselbrunn	2008	10	5	1	3	1	8
at31	41009	traun	2008	1	8	4	6	2	5
at31	41008	desselbrunn	2010	7	0	8	4	3	4
at31	41001	desselbrunn	2006	6	8	1	10	5	7

Question

what was the immigration in desselbrun in 2008?

was is not recognized and ignored
immigration recognized as immigration_total 0.96
desselbrun recognized as desselbrunn 0.98

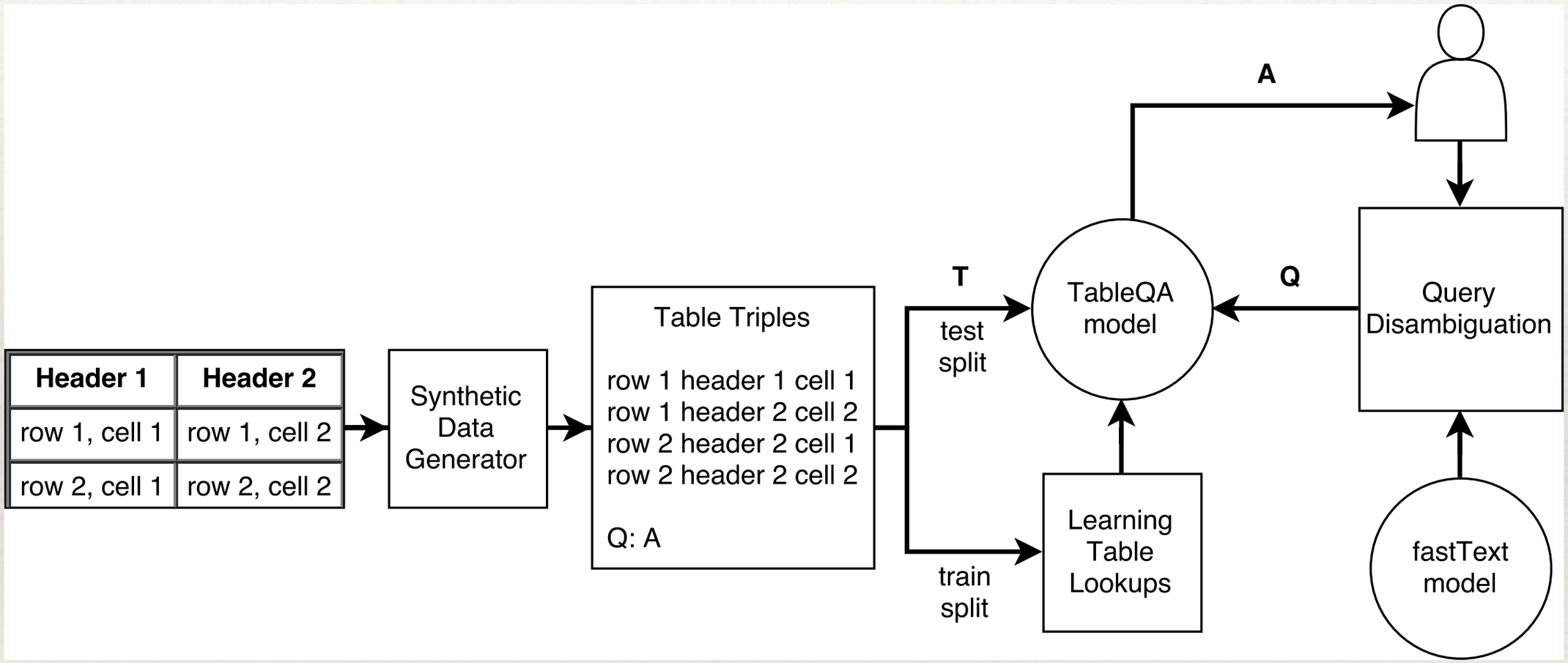
Answer

1
Confidence 99.99%

Predict answer | Get new table

https://svakulenko.ai.wu.ac.at/tableqa

Architecture



System architecture: T - input table; Q - question; A - answer

Table Representation

1 Row1 NUTS2 AT31
2 Row1 LAU2_CODE 40404
3 Row1 LAU2_NAME Braunau_am_Inn
4 Row1 YEAR 2015
5 Row1 INTERNAL_MIG_IMMIGRATION 808
6 Row1 INTERNATIONAL_MIG_IMMIGRATION 357
7 Row1 IMMIGRATION_TOTAL 1165
8 Row1 INTERNAL_MIG_EMIGRATION 607
9 Row1 INTERNATIONAL_MIG_EMIGRATION 186
10 Row1 EMIGRATION_TOTAL 793
11 Row2 NUTS2 AT31
12 Row2 LAU2_CODE 40405
13 Row2 LAU2_NAME Burgkirchen
14 Row2 YEAR 2015
15 Row2 INTERNAL_MIG_IMMIGRATION 138
16 Row2 INTERNATIONAL_MIG_IMMIGRATION 91
17 Row2 IMMIGRATION_TOTAL 229
18 Row2 INTERNAL_MIG_EMIGRATION 195
19 Row2 INTERNATIONAL_MIG_EMIGRATION 12
20 Row2 EMIGRATION_TOTAL 207

21 What is the INTERNATIONAL_MIG_EMIGRATION for Burgkirchen? 12 13 19

Query Disambiguation

- fastText model trained on Wikipedia
- handles OOV words

immigration recognised as **immigration_total** 0.96

code recognized as **lau2_code** 0.86

Piotr Bojanowski, Edouard Grave, Armand Joulin, and Tomas Mikolov. Enriching word vectors with subword information. arXiv:1607.04606. 2016.

Evaluation

The template-based questions are modified by

- **omitting words**: one or more words are removed from the original user query;
- **changing the position of words** in the query;
- **querying a different column** that did not appear in the questions from the training data set;
- **inadequate questions**, for which data required to answer this question are not present in the input table.

Results

The template-based questions are modified by

- ✓ **omitting words**: one or more words are removed from the original user query;
- ✓ **changing the position of words** in the query;
- – **querying a different column** that did not appear in the questions from the training data set;
- – **inadequate questions**, for which data required to answer this question are not present in the input table.

Results

- Test set:

8 samples x 4 corruption types = 32 samples

Task	Test Error	Training Set	Epochs
Simple key	0.5	5,949	29
Composite key	0.59	18,953	88

Conclusions

- Fancy, but tricky!
- Know on what you train?

  data sampling & variance to ensure generalisability
- Know what you trained?

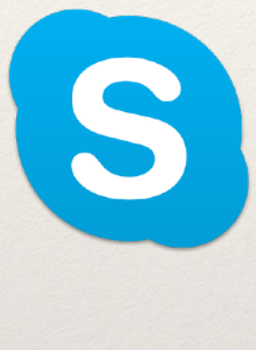
  interaction & visualisation of **learned patterns**

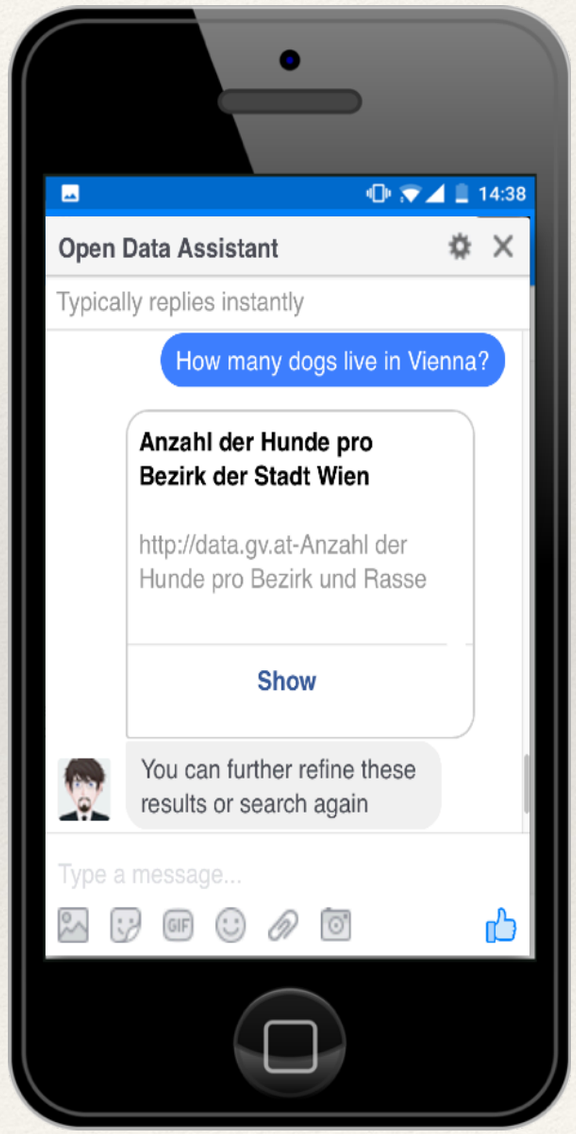
Future Work

- **Scaling up** experiments to real world tables (variance & OOV words)
- **New dataset** for QA from open data tables
- Answering questions **across tables**
- **Semantic integration** of open data tables
- **Joint training** with other bAbI tasks for text understanding

Future Work

Open Data Assistant: chatbot - dialogue interface





Make data your friend!

https://m.me/OpenDataAssistant

Sebastian Neumaier, Vadim Savenkov, and Svitlana Vakulenko. "Talking Open Data." *ESWC* (demo). 2017

References I

- Svitlana Vakulenko and Vadim Savenkov. TableQA: Question Answering on Tabular Data. 2017. https://arxiv.org/abs/1705.06504

- Jason Weston, Sumit Chopra, Antoine Bordes. Memory Networks. ICLR 2015 .
- Sukhbaatar, Sainbayar, Jason Weston, and Rob Fergus. "End-to-end memory networks." Advances in neural information processing systems (NIPS). 2015.

- Ankit Kumar, Ozan Irsoy, Peter Ondruska, Mohit Iyyer, James Bradbury, Ishaan Gulrajani, Victor Zhong, Romain Paulus, Richard Socher: Ask Me Anything: Dynamic Memory Networks for Natural Language Processing. ICML 2016.
- Alexander H. Miller, Adam Fisch, Jesse Dodge, Amir-Hossein Karimi, Antoine Bordes, Jason Weston: Key-Value Memory Networks for Directly Reading Documents. EMNLP 2016.
- Julien Perez, Fei Liu: Gated End-to-End Memory Networks. EACL 2017.

- Antoine Bordes, Nicolas Usunier, Sumit Chopra, Jason Weston: Large-scale Simple Question Answering with Memory Networks. CoRR abs/1506.02075. 2015.

References II

Datasets

- Jason Weston, Antoine Bordes, Sumit Chopra, Alexander M. Rush, Bart van Merriënboer, Armand Joulin and Tomas Mikolov. Towards AI Complete Question Answering: A Set of Prerequisite Toy Tasks, arXiv: 1502.05698.
- SimpleQuestions
- WebQuestions
- CNN QA

Videos

- CS224D Guest Lecture - Jason Weston - 2015 https://www.youtube.com/watch?v=6NHeIEaSie8&t=1435s
- Jason Weston. Memory Networks for Language Understanding, ICML Tutorial 2016

http://www.thespermwhale.com/jaseweston/icml2016/
http://techtalks.tv/talks/memory-networks-for-language-understanding/62356/

Blogs

- https://blog.init.ai/icml-2016-memory-networks-for-language-understanding-f2ed4c8819c4
- https://blog.acolyer.org/2016/03/10/memory-networks/
- https://yerevann.github.io/2016/02/05/implementing-dynamic-memory-networks/

AI Summit Vienna 2017

mostly.ai/summit