Hands-On with **Deep Learning** for Question Answering

Jens Lehmann, Andreas Both, Ioanna Lytra, Mohnish Dubey, Denis Lukovnikov,
Kuldeep Singh, Gaurav Maheshwari, Priyansh Trivedi

Outline

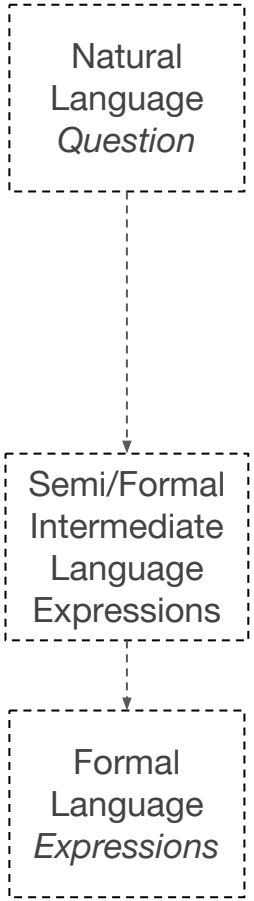
The QA system

Environment Set-up

Programming

Questions

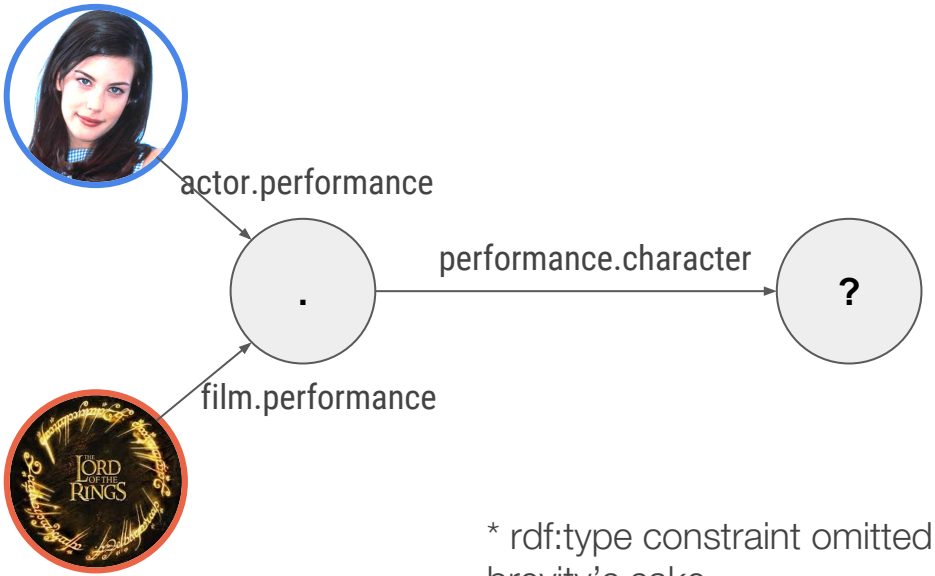
The System



Eg. Query Graphs

"What character did **Liv Tyler** play in **Lord of the Rings**?"

(a question in WebQuestions (Freebase))



* rdf:type constraint omitted for brevity's sake

Core Chains

Linear chain denoting a path in the Knowledge Graph, leading to the intended answer.

Natural Language *Question*

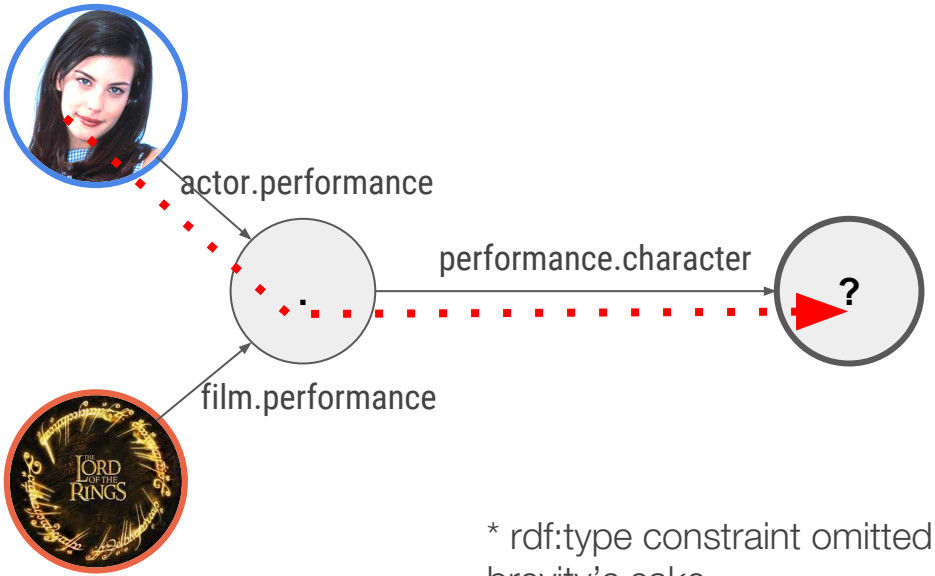
Semi/Formal Intermediate Language Expressions

Formal Language *Expressions*

Eg. Query Graphs

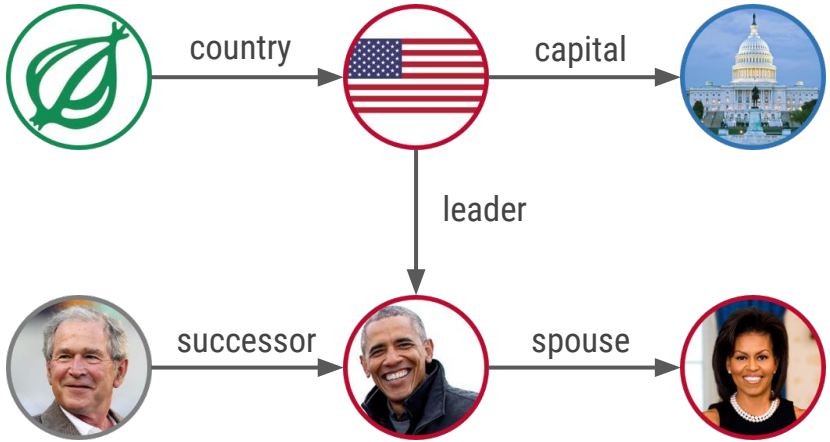
"What character did **Liv Tyler** play in **Lord of the Rings**?"

(a question in WebQuestions (Freebase))

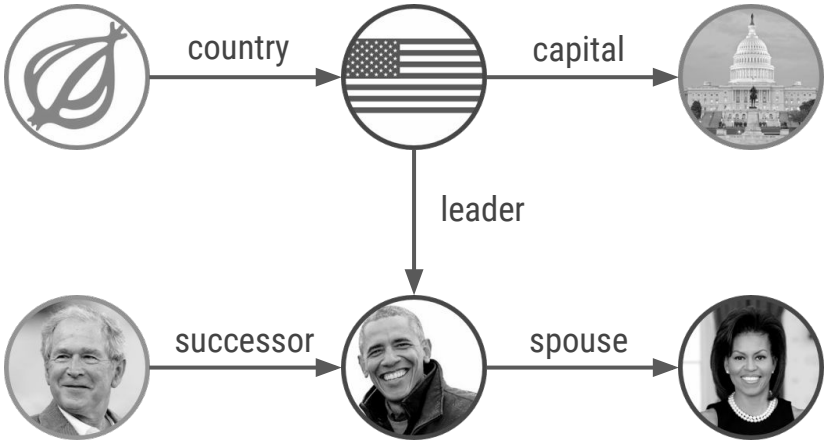


* rdf:type constraint omitted for brevity's sake

Core Chains Example



Core Chains Example

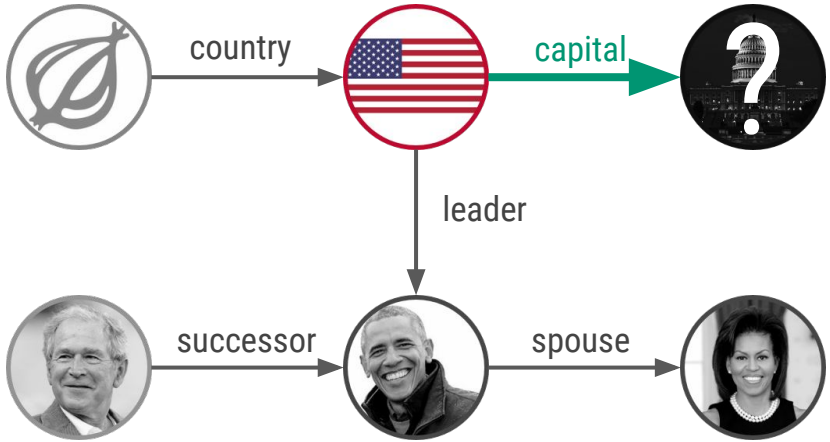


Core Chains Example

Directions depict
- **incoming**
- **outgoing**

relations in the graph

```
dbo:United_States + dbo:capital
```



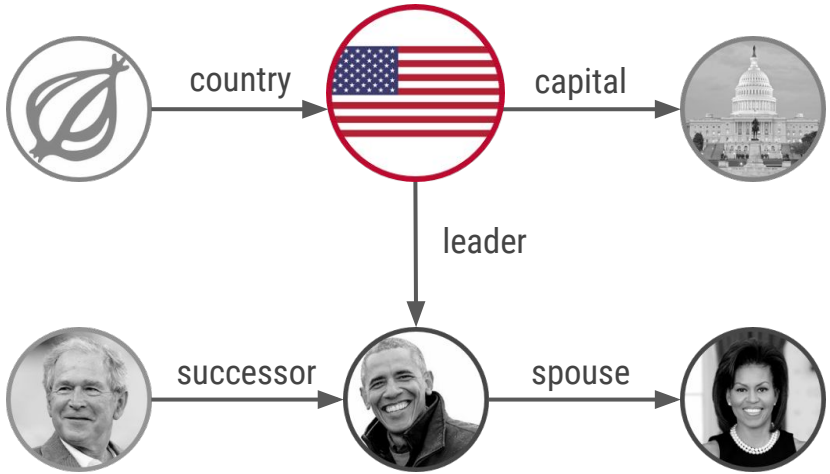
Core Chains Example

Directions depict
- incoming
- outgoing

relations in the graph

Start from a **topic entity**

`dbo:United_States - dbo:country`



Core Chains Example

Directions depict
- incoming
- outgoing

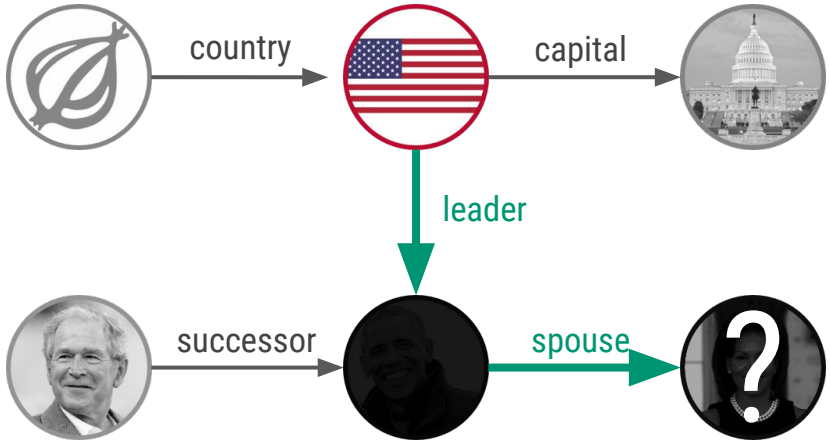
relations in the graph

Start from a topic entity

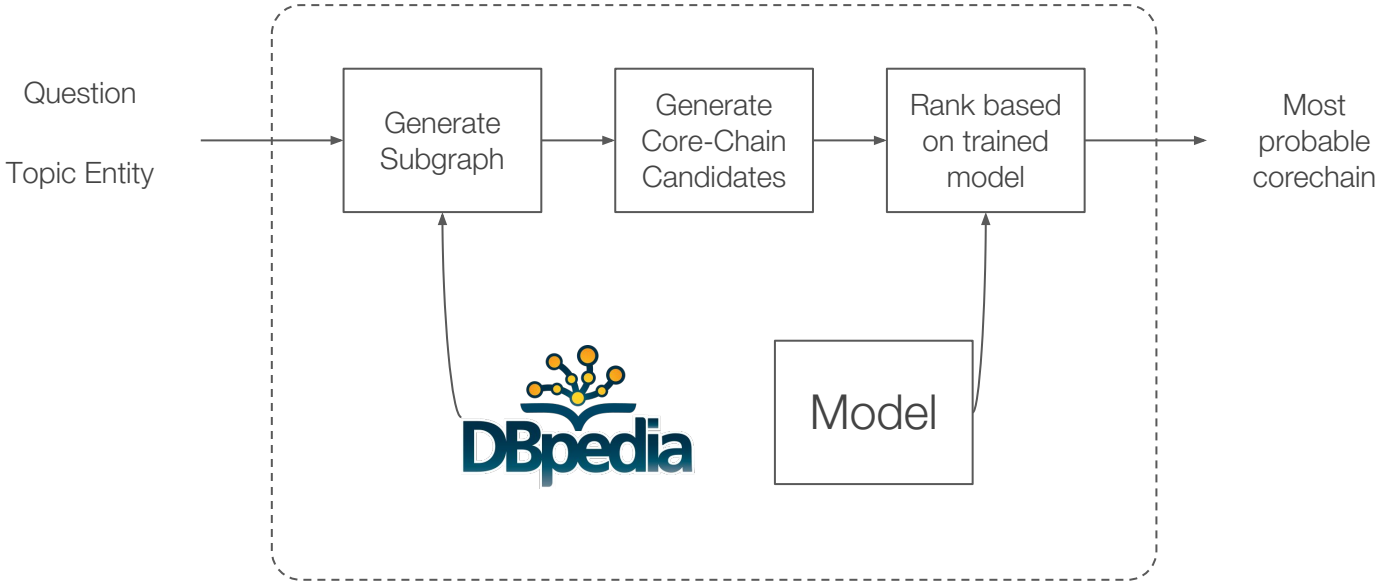
Intermediate entities not mentioned

Have textual resemblance to corresponding question.

`dbo:United_States + dbo:leader + dbo:spouse`



Architecture



Architecture

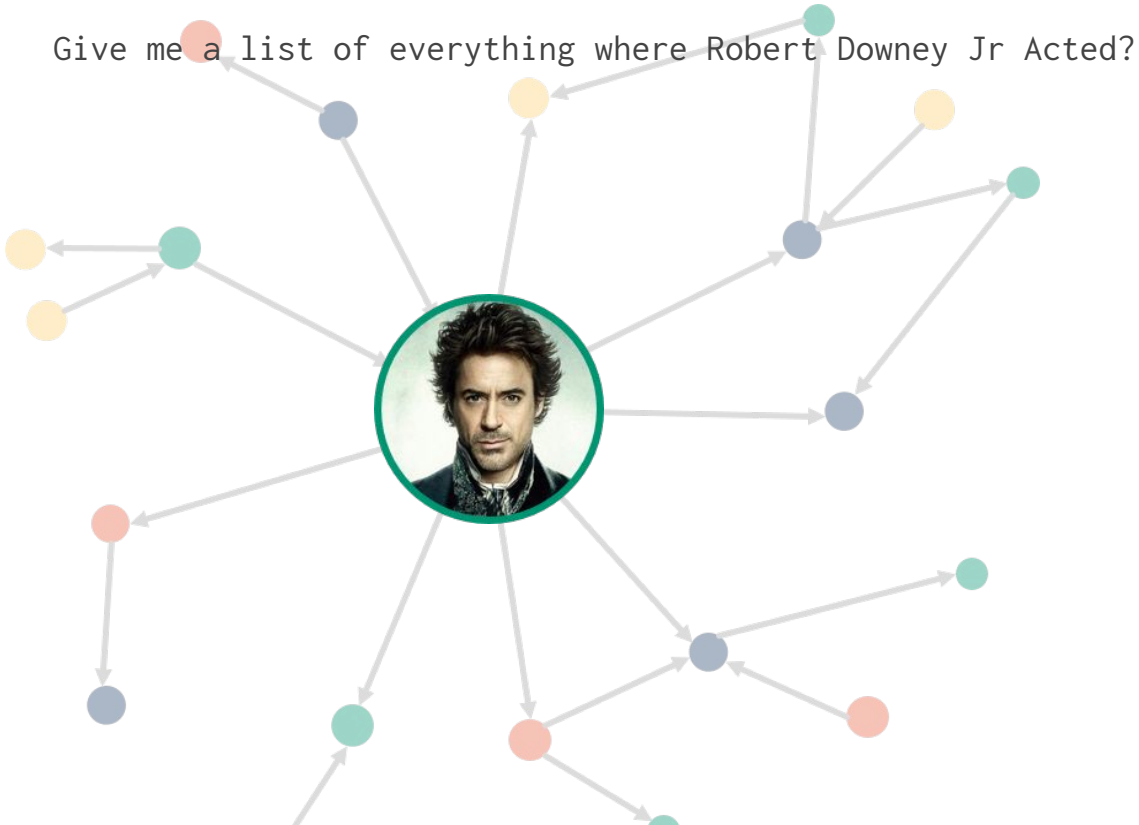
Given: Question, Entity.

`Give me a list of everything where Robert Downey Jr Acted?`

Architecture

Given: Question, Entity.

Collect 2-hop subgraph around it.



Architecture

Given: Question, Entity.

Collect 2-hop subgraph around it.

Generate core-chain candidates

```
Give me a list of everything where Robert Downey Jr Acted?
```

```
dbo:Robert_Downey_Jr + dbo:birthplace
dbo:Robert_Downey_Jr + dbo:parent
dbo:Robert_Downey_Jr + dbo:spouse - dbo:foundedBy
dbo:Robert_Downey_Jr - dbo:starring
dbo:Robert_Downey_Jr - dbo:starring + dbo:director
...
```

Architecture

Given: Question, Entity.

Collect 2-hop subgraph around it.

Generate core-chain candidates

Rank Candidates

```
Give me a list of everything where Robert Downey Jr Acted?

0.10 dbo:Robert_Downey_Jr + dbo:birthplace
0.23 dbo:Robert_Downey_Jr + dbo:parent
0.04 dbo:Robert_Downey_Jr + dbo:spouse - dbo:foundedBy
0.73 dbo:Robert_Downey_Jr - dbo:starring
0.41 dbo:Robert_Downey_Jr - dbo:starring + dbo:director
     ...
```

Architecture

Given: Question, Entity.

Collect 2-hop subgraph around it.

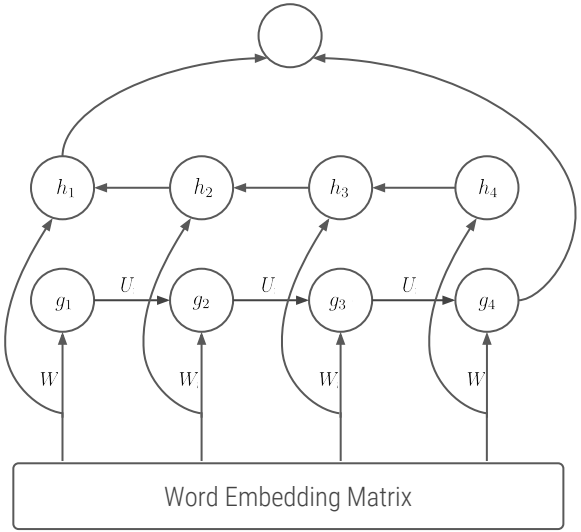
Generate core-chain candidates

Rank Candidates

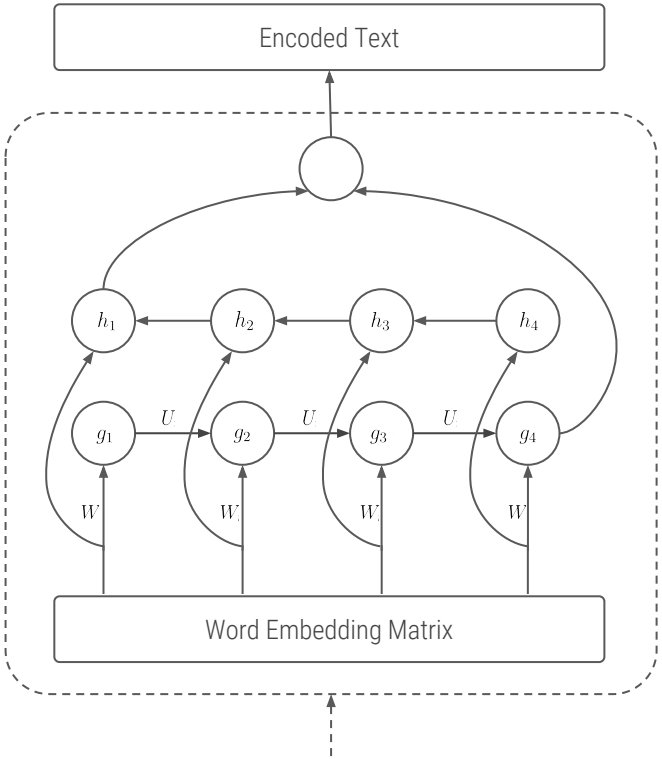
```
Give me a list of everything where Robert Downey Jr Acted?

0.10 dbo:Robert_Downey_Jr + dbo:birthplace
0.23 dbo:Robert_Downey_Jr + dbo:parent
0.04 dbo:Robert_Downey_Jr + dbo:spouse - dbo:foundedBy
0.73 dbo:Robert_Downey_Jr - dbo:starring
0.41 dbo:Robert_Downey_Jr - dbo:starring + dbo:director
     ...
```

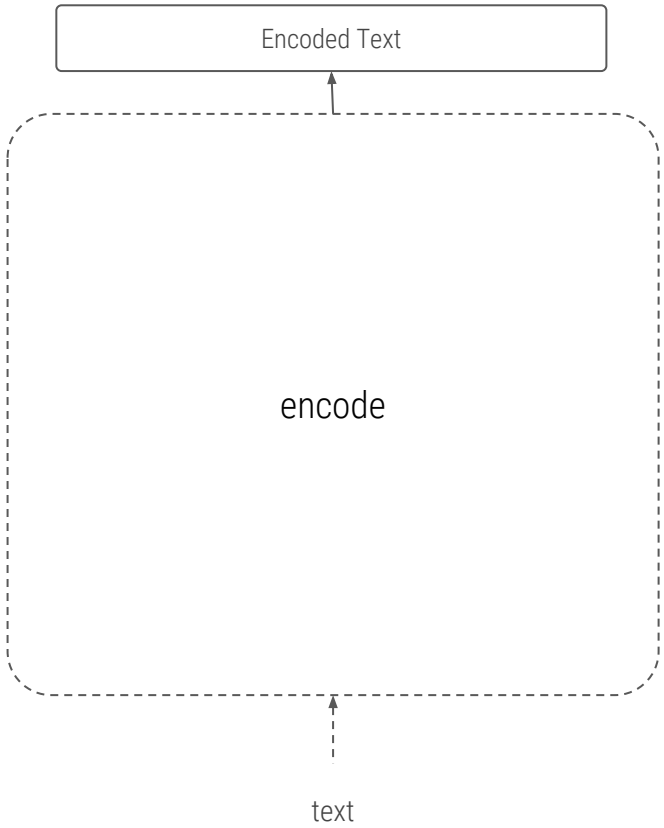
Model



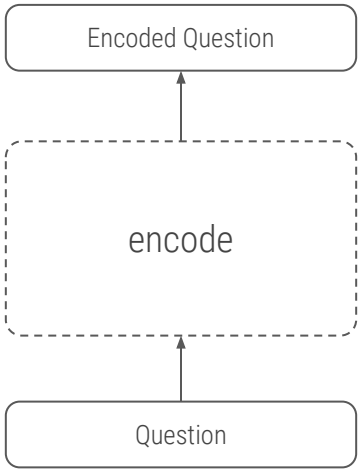
Model


Encoded Text
h_1
h_2
h_3
h_4
g_1
g_2
g_3
g_4
U
U
U
W
W
W
W
Word Embedding Matrix
text

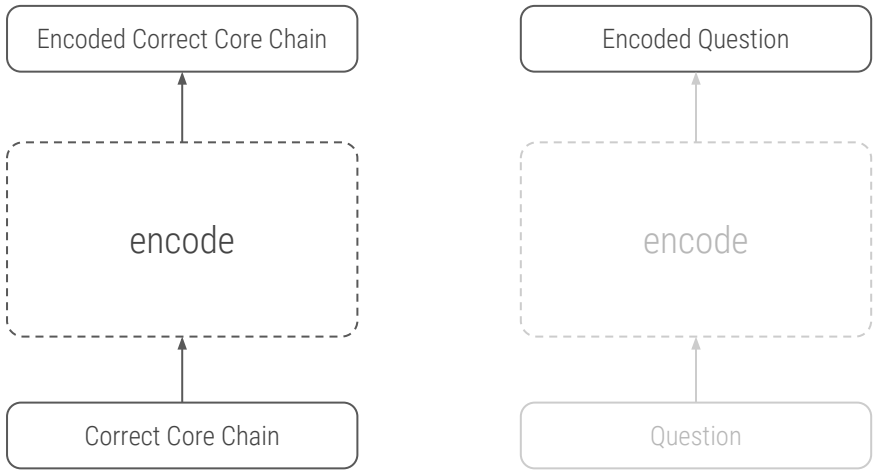
Model



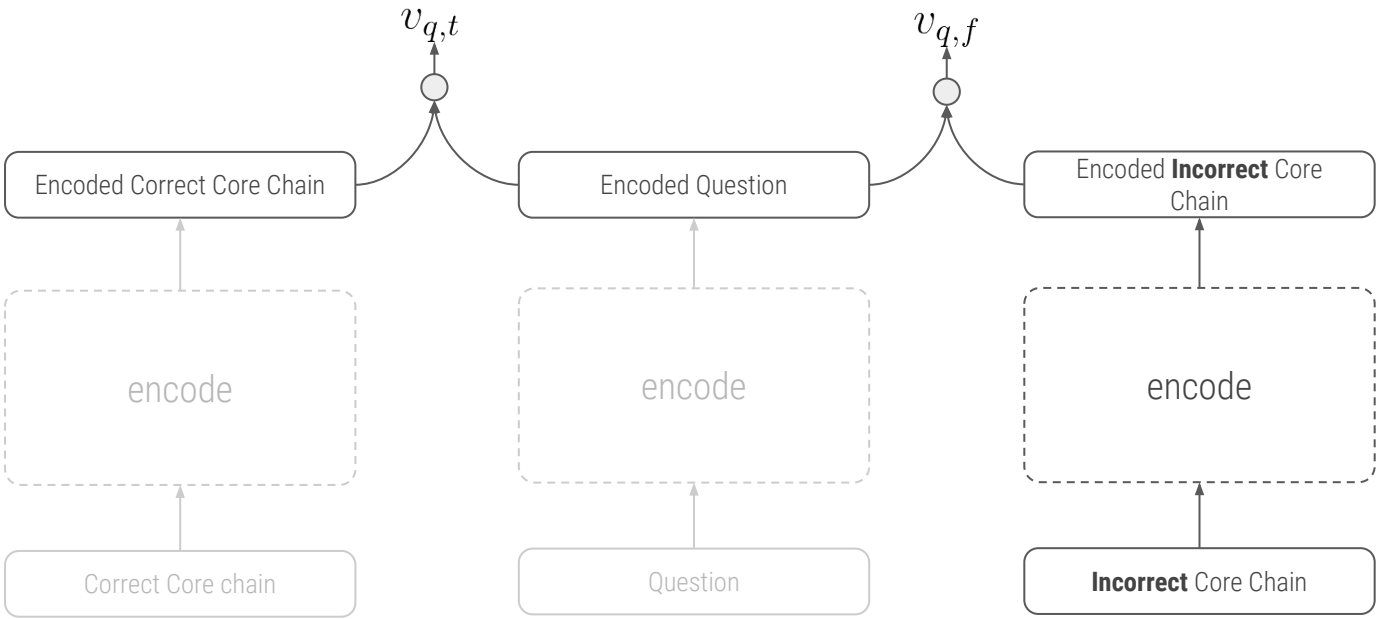
Model



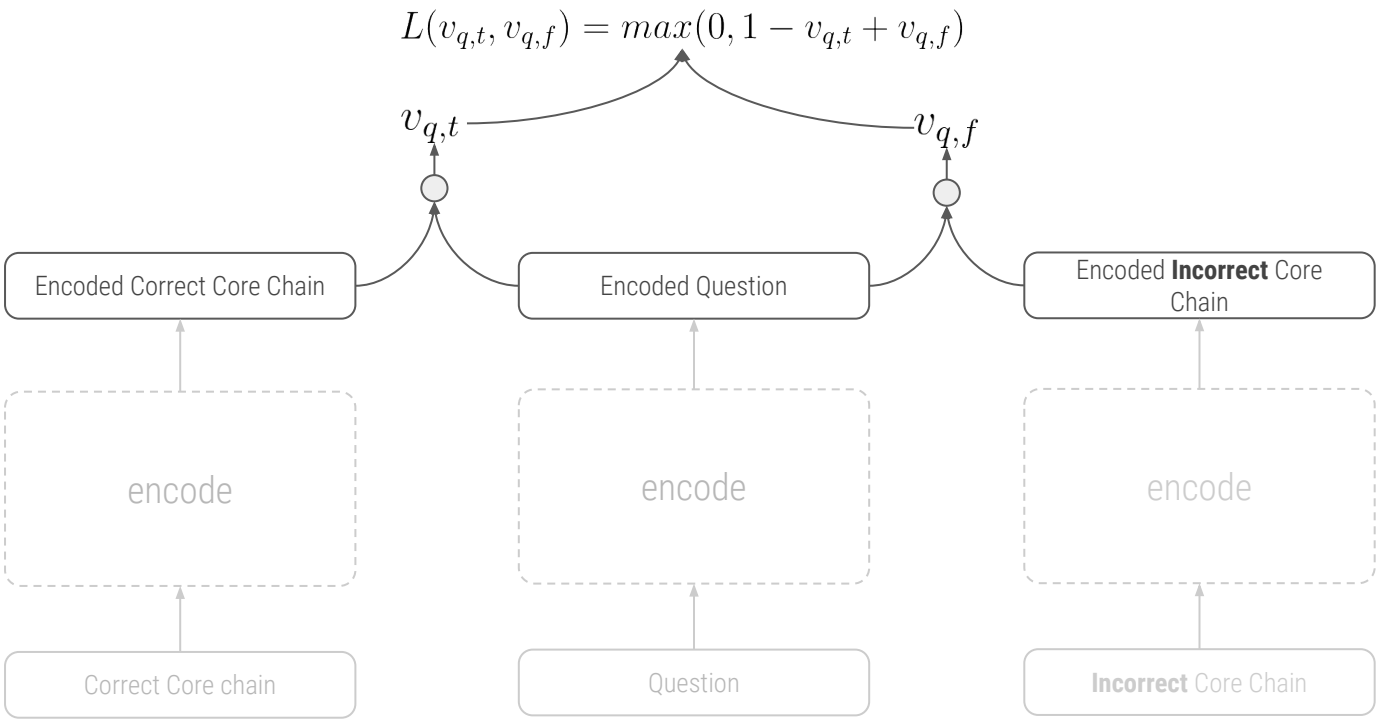
Model


Encoded Correct Core Chain
encode
Correct Core Chain
Encoded Question
encode
Question

Model


$v_{q,t}$
$v_{q,f}$
Encoded Correct Core Chain
Encoded Question
Encoded **Incorrect** Core Chain
encode
encode
encode
Correct Core chain
Question
Incorrect Core Chain

Model


$L(v_{q,t}, v_{q,f}) = max(0, 1 - v_{q,t} + v_{q,f})$
$v_{q,t}$
$v_{q,f}$
Encoded Correct Core Chain
Encoded Question
Encoded **Incorrect** Core Chain
encode
encode
encode
Correct Core chain
Question
Incorrect Core Chain

Experiment

Knowledge Base used: **DBpedia**

Dataset: Subset of QALD

Setup

Setup

Recommended steps for setup

1. Get Anaconda: https://conda.io/miniconda.html
    a. Run the miniconda .sh file
    b. Create environment: >> conda create -n pytorch python=2.7 pip ipython jupyter
    c. Activate environment: >> source activate pytorch
2. Get PyTorch:
    a. Go to https://pytorch.org and follow instructions for your OS
3. Git clone https://github.com/AskNowQA/QA-Tutorial

Setup with poor internet

1. Get Anaconda: https://conda.io/miniconda.html
    a. Run the miniconda .sh file
    b. Create environment: >> conda create -n pytorch python=2.7 pip ipython jupyter
    c. Activate environment: >> source activate pytorch
2. Get repo from stick
3. Go to /session4/pkgs and run install_deps.sh

Programming

Programming

1. Try PyTorch basics
2. Try the neural network building blocks
3. Build the network and test
4. Train the network

See also: https://pytorch.org/tutorials/beginner/deep_learning_60min_blitz.html

Programming - PyTorch basics

(15 min)

1. Tensors in PyTorch
    a. Create some tensors, try some operations
2. Parameters in PyTorch
    a. Create some parameters
3. PyTorch Modules
    a. Create a module with parameters (and submodules), get parameters

USE THE DOCS!!! → https://pytorch.org/docs

Programming - PyTorch NN

(15 min)

1. Try some Embedding
    a. Create embedding layer, apply it on random ints, backprop and inspect
2. Try a feedforward layer: torch.nn.Linear() + torch.nn.Sigmoid()
    a. Create layer, apply on random floats (shape!), backprop and inspect
3. Try a RNN: torch.nn.LSTM()

USE THE DOCS!!! → https://pytorch.org/docs

Programming - build the network

(15 min)

1. Create a bidirectional LSTM encoder in a separate class
    a. Takes a batch of sequences of ints
    b. Outputs a vector for each example
    c. Test with some questions from the data
2. Create a scoring model in a separate class:
    a. Two encoders and dot product in between
    b. Test with some questions and paths from the data

Programming - train the network

1. Load and split data in training (70%), validation (10%) and test (20%)
2. Write training loop
    a. Don’t forget to print losses

BRACE YOURSELF

ERRORS ARE COMING

References.

Robert Downey Jr. image has been taken from
https://commons.wikimedia.org/wiki/File:Robert_Downey,_Jr._2012.jpg