Announcements
- AS due Tues
- FP out Tues, Will discuss in-class

Recap seq-to-seq MT

I make a desk</s>

Je fais un bureau

Encoder

Decoder

whole sentence crammed into a vector

attention

\[
\alpha^{(i)} = \text{softmax} \left( \sum_{j=1}^{n} \frac{h_j^{(e)} \cdot h_j^{(d)}}{\sum_{j'=1}^{n} h_j^{(e)} \cdot h_j^{(d)}} \right)
\]

\[
\overline{c}^{(i)} = \sum_{i=1}^{n} \alpha^{(i)} h_i^{(e)}
\]

(not cell state)
Intuition
- "Residual connection" to input
- Learned end-to-end: extra power given to the model on top of RNN
- Coverage, copy source words

Today
- (see slides)
- NMT systems, details (rare words)
- QA intro
- (if time) CCG parsing \{ not on FP \}

Past 3 wks: generation (LM, MT)

Next up: applications

QA Very broad area

① When was Samuel L. Jackson born?

Knowledge base QA / factoid QA
- KB, build query for the Q
② Who is Iron Man?
- open-ended, answer is a paragraph
- information retrieval + summarization (IR)

③ Who was the villain in Iron Man 1?
- middle ground: single phrase as answer, but probably not in our KB
- retrieve some text, answer from that
- IR + reading comprehension QA

ans
“Obadiah Stane ... serves as the main antagonist in Iron Man.”

Today: #1 KBQA
Tues/FP: #3 Reading comprehension
Knowledge base

**KBQA Two steps:**

① Convert Q to a formal semantic representation

② Execute that representation against KB

**KB: database**

<table>
<thead>
<tr>
<th>name</th>
<th>bday</th>
<th>starsIn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samuel LJ</td>
<td>12/25/48</td>
<td>Pulp Fiction, Captain Marvel</td>
</tr>
<tr>
<td>Brie Larson</td>
<td>10/1/89</td>
<td>Captain Marvel, Scott Pilgrim</td>
</tr>
</tbody>
</table>

**When was SLJ born?**

```map (λr: r.bday, filter (λ r: r.name=SLJ)) => list(12/25/48)```

**Semantic parsing:** map {questions, statements} into logical forms
Logical forms are expressions most typically in lambda calculus.

When was SLT born?

\[ \lambda \text{lambda calculus: } \lambda d. \text{bday} (\text{SLT}, d) \]
(similar to the Python lambdas we wrote down)

Reduce KBQA to a semantic parsing problem
map language \(\Rightarrow\) lambda calculus

What movies did Brie Larson star in? act in?

\[ \lambda m. \text{movie} (m) \land \text{starsIn} (\text{BL}, m) \]

predicate in our KB

How we do this: CCG parsing