Learning and representation in language understanding

Fernando Pereira
Google NLU team
Collaborators

July 2017
I shall also suppose that the number of symbols which may be printed is finite. If we were to allow an infinity of symbols, then there would be symbols differing to an arbitrarily small extent ...

... We will also suppose that the number of states of mind which need be taken into account is finite. The reasons for this are of the same character as those which restrict the number of symbols. If we admitted an infinity of states of mind, some of them will be "arbitrarily close" and will be confused.

ON COMPUTABLE NUMBERS, WITH AN APPLICATION TO THE ENTScheidungsproblem
By A. M. Turing.
[Received 28 May, 1936.—Read 12 November, 1936.]
Machine understanding of language is still a ways away
Statewide smoking ban: On **July 1, 2006**, the Colorado Clean Indoor Air Act went into effect, banning smoking in all enclosed workplaces statewide, including bars and restaurants. Casinos, initially exempt, were added to the ban **Jan. 1, 2008**.

[List of smoking bans in the United States - Wikipedia](https://en.wikipedia.org/wiki/List_of_smoking_bans_in_the_United_States)
Director: Sergio Leone
Machine reading the “old” way
Erik Wesner will talk about his research tomorrow. Though Wesner's parents are from Poland, he was born and raised in Raleigh, NC.
Learning to understand relations  
(still symbolic)

Pixar is the company which Disney acquired.

learned from labeled data

obliqueness hierarchy

... > dobj > ... > nsubj > ....

(punct (nsubj (cop (rcmod (det company the) (nsubj (dobj acquired which) disney) is) pixar) ).)

transformation

∃z. company(Pixar) ∧ acquired(z_e) ∧ arg_1(z_e, Disney) ∧ arg_2(z_e, Pixar)
\[ \exists z. \text{company}(\text{Pixar}) \land \text{acquired}(z_e) \land \text{arg}_1(z_e, \text{Disney}) \land \text{arg}_2(z_e, \text{Pixar}) \]

learned from alignment
(distant supervision)
Can learning be more direct?

Experiments by Rahul Gupta, Janara Christensen, John Blitzer
Some women politicians attended Harvard and Oxford University.
Going implicit

Ankur P. Parikh, Oscar Täckström, Dipanjan Das, Jakob Uszkoreit:
A Decomposable Attention Model for Natural Language Inference. EMNLP 2016: 2249-2255
Premise: Bob is in his room, but because of the thunder and lightning outside, he cannot sleep.

Hypothesis 1: Bob is awake.

Premise: Bob is in his room, but because of the thunder and lightning outside, he cannot sleep.

Hypothesis 2: It is sunny outside.
1. Attend

2. Compare

3. Aggregate

\[ \hat{y} = H ( F ( \text{flute, music} ) + G ( \text{park outside} ) + G ( \text{alice someone} ) + \ldots + G ( \text{flute+ solo music} ) ) \]
Learning without being told

making the registration process more difficult.
<table>
<thead>
<tr>
<th>Input</th>
<th>Recurrent</th>
<th>Self-attention</th>
</tr>
</thead>
<tbody>
<tr>
<td>The animal didn't cross the street because it was too <strong>tired</strong>.</td>
<td>L'animal n'a pas traversé la rue parce <strong>qu'il</strong> était trop fatigué.</td>
<td>L'animal n'a pas traversé la rue parce <strong>qu'il</strong> était trop fatigué.</td>
</tr>
<tr>
<td>The animal didn't cross the street because it was too <strong>wide</strong>.</td>
<td>L'animal n'a pas traversé la rue parce <strong>qu'il</strong> était trop large.</td>
<td>L'animal n'a pas traversé la rue parce <strong>qu'elle</strong> était trop large.</td>
</tr>
</tbody>
</table>
But language is about stuff outside...

Example developed by Marta Recasens
The Jungle Book was produced in 1967 by Walt Disney. Inspired by Rudyard Kipling's book of the same name, it is the 19th Disney animated feature film … The early versions of both the screenplay and the soundtrack followed Kipling's work more closely … Disney released a live-action remake in 1994 and an animated sequel, The Jungle Book 2, in 2003; another live-action adaptation was released in 2016.
The Jungle Book was produced in 1967 by Walt Disney. Inspired by Rudyard Kipling's book of the same name, it is the 19th Disney animated feature film … The early versions of both the screenplay and the soundtrack followed Kipling's work more closely … Disney released a live-action remake in 1994 and an animated sequel, The Jungle Book 2, in 2003; another live-action adaptation was released in 2016.
How to close the loop?
Conference of the Birds is a studio album by the Dave Holland Quartet, recorded in 1972 and released in 1973. It is jazz bassist Holland's second collaboration with composer and saxophonist Anthony Braxton, as well as his second album on ECM Records. The liner notes describe how birds would congregate each morning outside Holland's London apartment and join with one another in song. 

Conference of the Birds is un album du Dave Holland Quartet.

Description

Conference of the Birds est le premier album de Dave Holland en tant que leader, le style du disque est différent de ses futurs albums et parconce ici nettement vers le free jazz. Celui-ci est d'ailleurs écrit comme une excellente introduction au genre par son habilité à combiner les contrastes, les compositions mélodiques de Holland interprétées dans une approche très libre. 

Conference of the Birds is a studio album by the Dave Holland Quartet, recorded in 1972 and released in 1973.