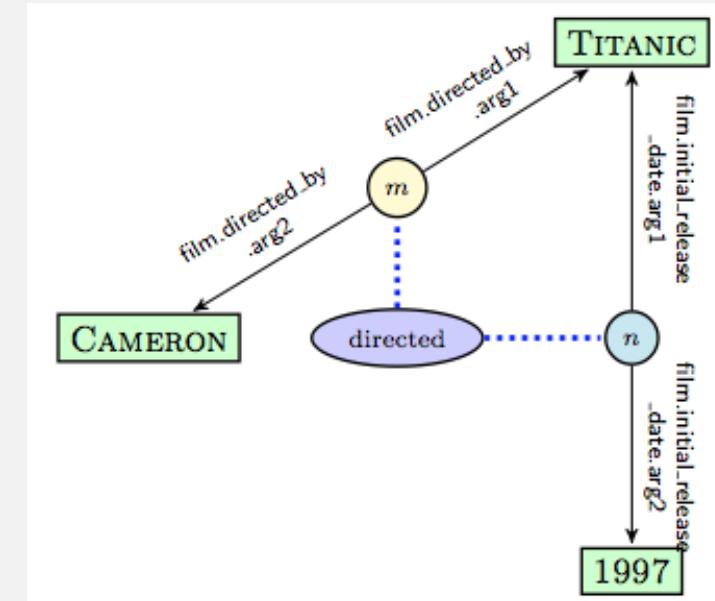


Learning and representation in language understanding

Google™

Fernando Pereira
Google NLU team
Collaborators



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

when did **california** ban smoking in bars



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About 779,000 results (0.64 seconds)

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

movies directed by clint eastwood



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Clint Eastwood > Movies

Director: Sergio Leone



Unforgiven
1992



Gran Torino
2008



The Outlaw
Josey Wales
1976



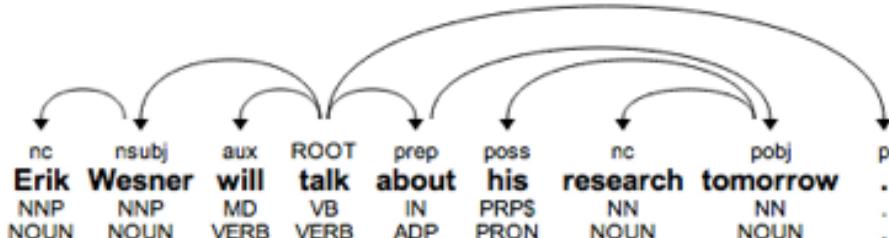
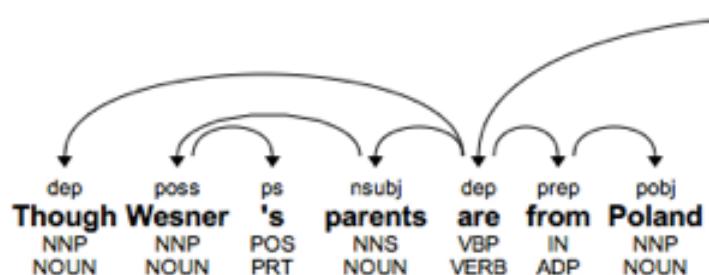
High Plains
Drifter
1973



The Good, the
Bad and the ...
1966

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.

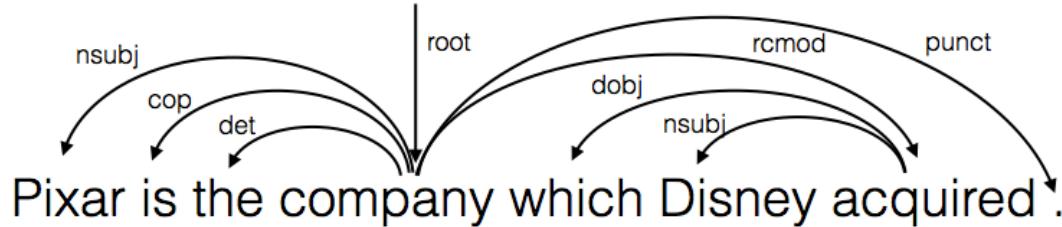


Entity	Type	Gender	Name	Description
E#1	PER	MASCULINE	Erik Wesner	mentions: Erik Wesner, Wesner, he, his
E#3	PER		parents	mentions: parents
E#5	LOC		Poland	profile: Poland mentions: Poland
E#6	LOC		Raleigh, NC	profile: Raleigh, North Carolina mentions: Raleigh, NC

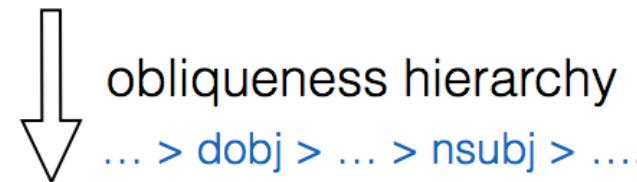
s [Erik Wesner]₁ will talk about [his]₁ research {tomorrow}. s
 Though [Wesner]₁'s [parents]₃ are from [Poland]₅, [he]₁ was
 born and raised in [Raleigh, NC]₆.

Learning to understand relations (still symbolic)

Reddy, S., Täckström, O., Collins, M., Kwiatkowski, T., Das, D., Steedman, M., & Lapata, M. (2016). Transforming Dependency Structures to Logical Forms for Semantic Parsing. *Transactions Of The Association For Computational Linguistics*, 4, 127-140.



learned from
labeled data



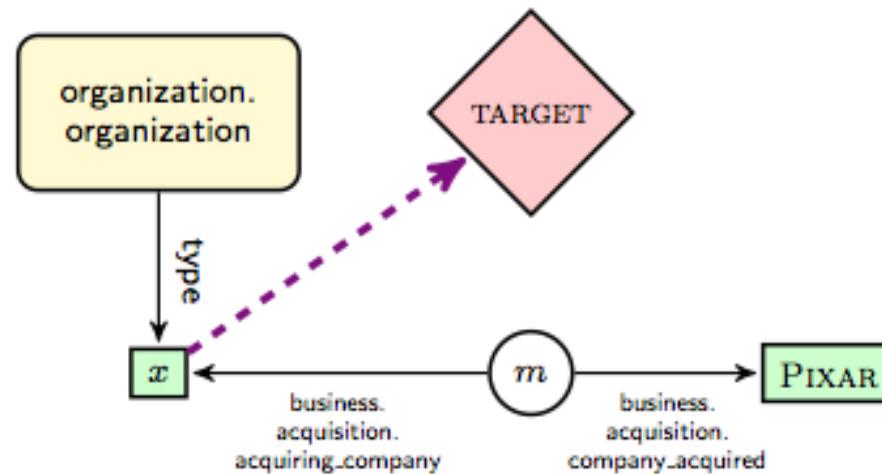
(punct (nsubj (cop (rcmod (det company the)
(nsubj (dobj acquired which) disney) is) pixar) .)



$\exists z. \text{company}(z) \wedge \text{acquired}(z_e) \wedge \text{arg}_1(z_e, \text{Disney}) \wedge \text{arg}_2(z_e, \text{Pixar})$

$$\exists z. \text{company}(\text{Pixar}) \wedge \text{acquired}(z_e) \wedge \arg_1(z_e, \text{Disney}) \wedge \arg_2(z_e, \text{Pixar})$$

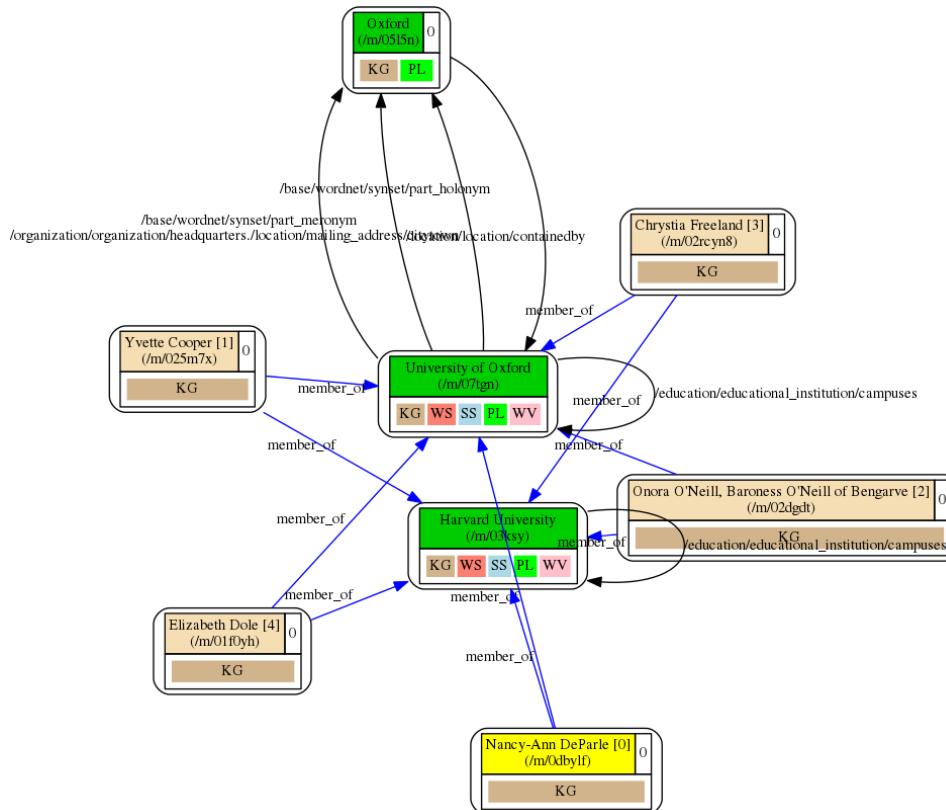
learned from alignment
(distant supervision)



Can learning be more direct?

Experiments by Rahul Gupta, Janara Christensen, John Blitzer

s <women>₁ <politicians>₂ {who}₃ attended [harvard]₄ and [oxford university]₅



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.

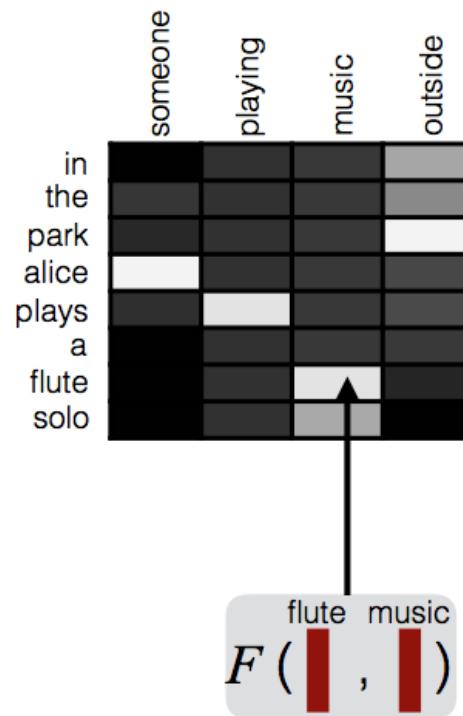
Premise

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

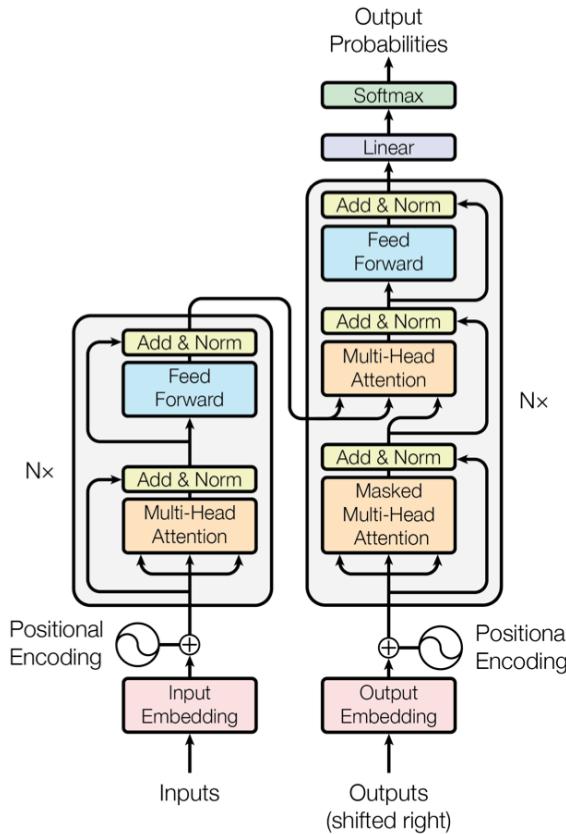
$$\boxed{} = G(\boxed{\text{park}}, \boxed{\text{outside}})$$
$$\boxed{} = G(\boxed{\text{alice}}, \boxed{\text{someone}})$$
$$\dots$$
$$\boxed{} = G(\boxed{\text{flute}}, \boxed{\text{music}})$$

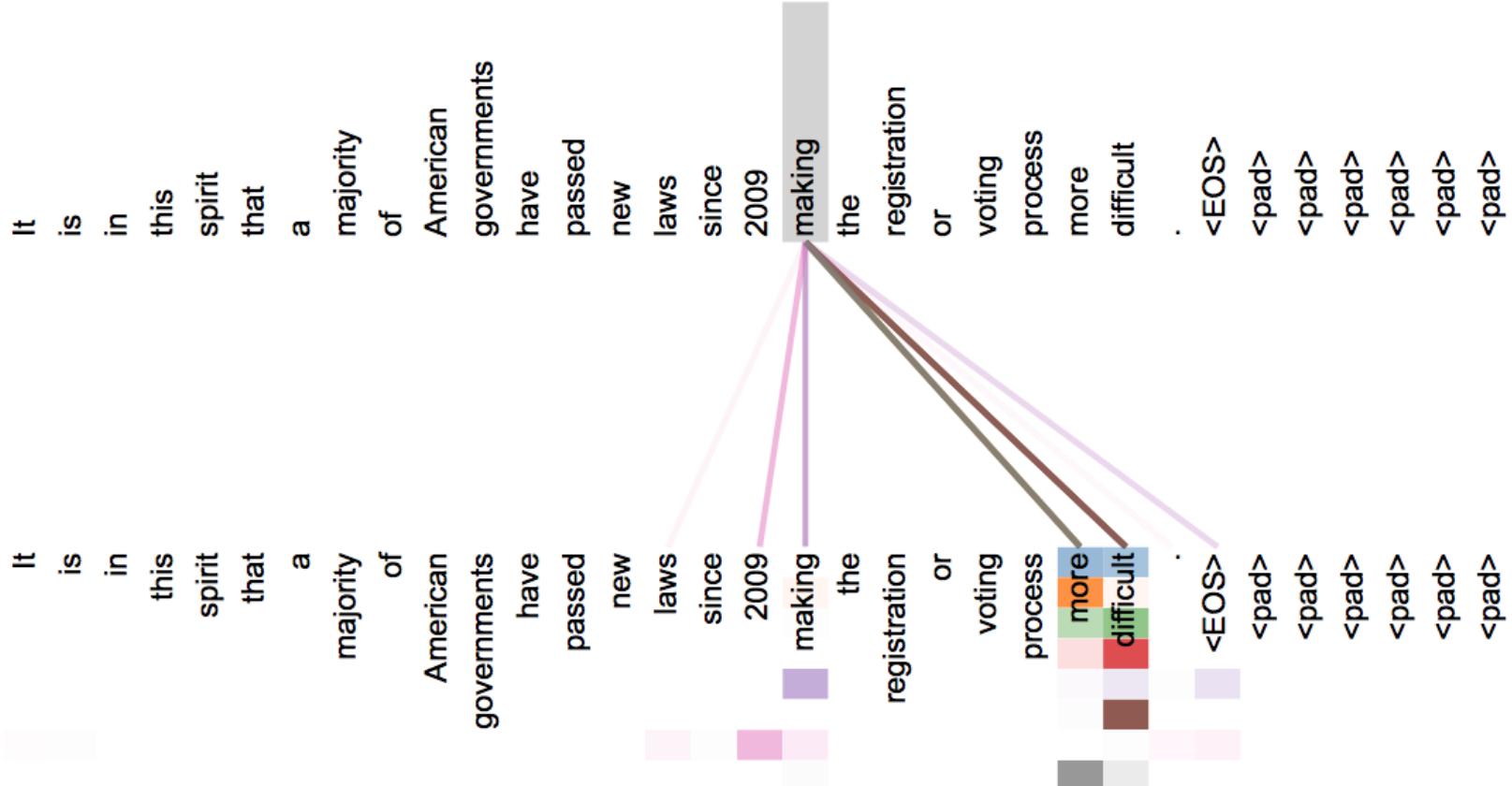
3. Aggregate

$$\hat{y} = H(\boxed{} + \boxed{} + \dots + \boxed{})$$

Learning without being told

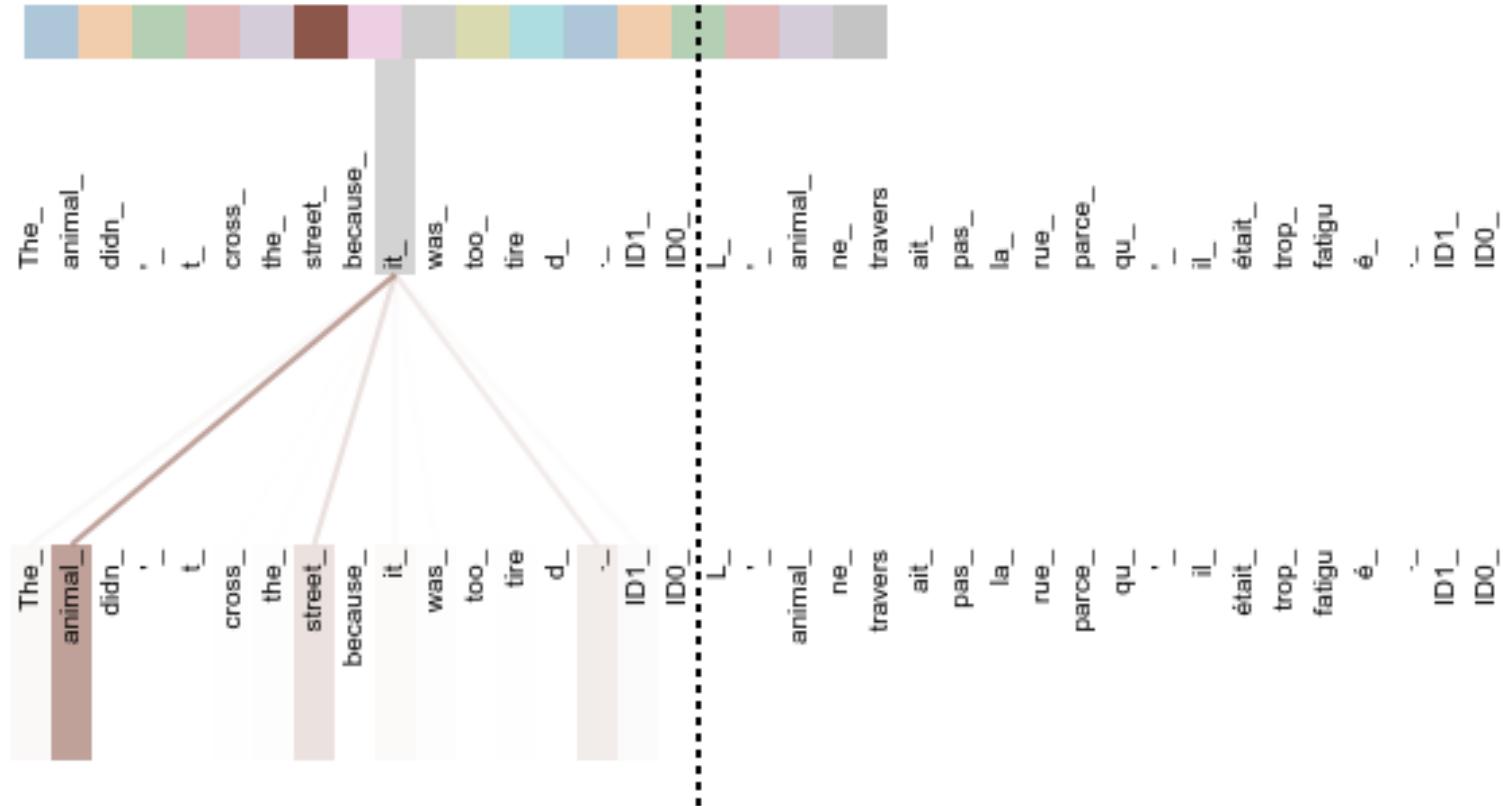
Ashish Vaswani, Noam Shazeer, Niki Parmar, Jakob Uszkoreit, Llion Jones, Aidan N. Gomez, Lukasz Kaiser,
Illia Polosukhin: *Attention Is All You Need.* [CoRR abs/1706.03762](https://arxiv.org/abs/1706.03762) (2017)



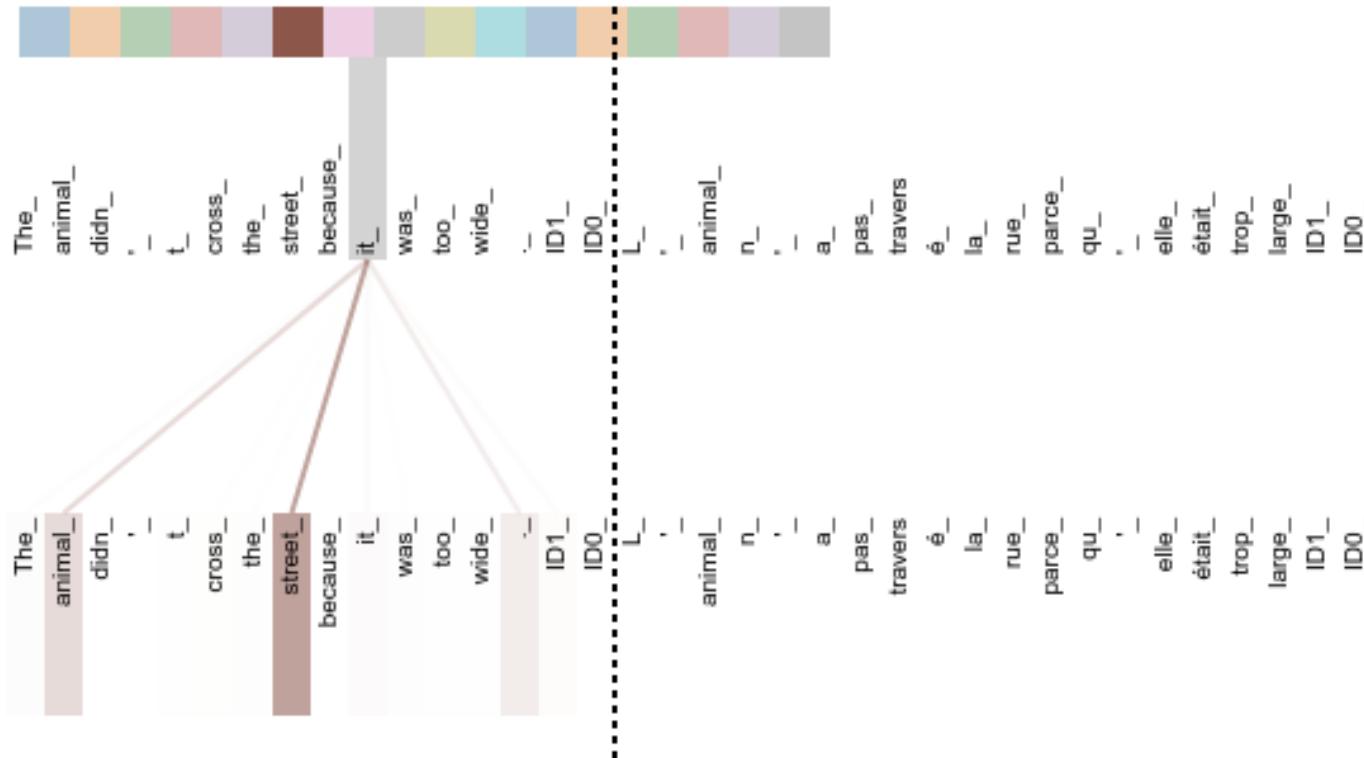


Input	Recurrent	Self-attention
The animal didn't cross the street because it was too tired .	L'animal n'a pas traversé la rue parce qu'il était trop fatigué.	L'animal n'a pas traversé la rue parce qu'il était trop fatigué.
The animal didn't cross the street because it was too wide .	L'animal n'a pas traversé la rue parce qu'il était trop large.	L'animal n'a pas traversé la rue parce qu'elle était trop large.

Layer6



Layer6



But language is about stuff outside...

Example developed by Marta Recasens

WIKIPEDIA
The Free Encyclopedia

Article

Talk

The Jungle Book (1967 film)

From Wikipedia, the free encyclopedia

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.

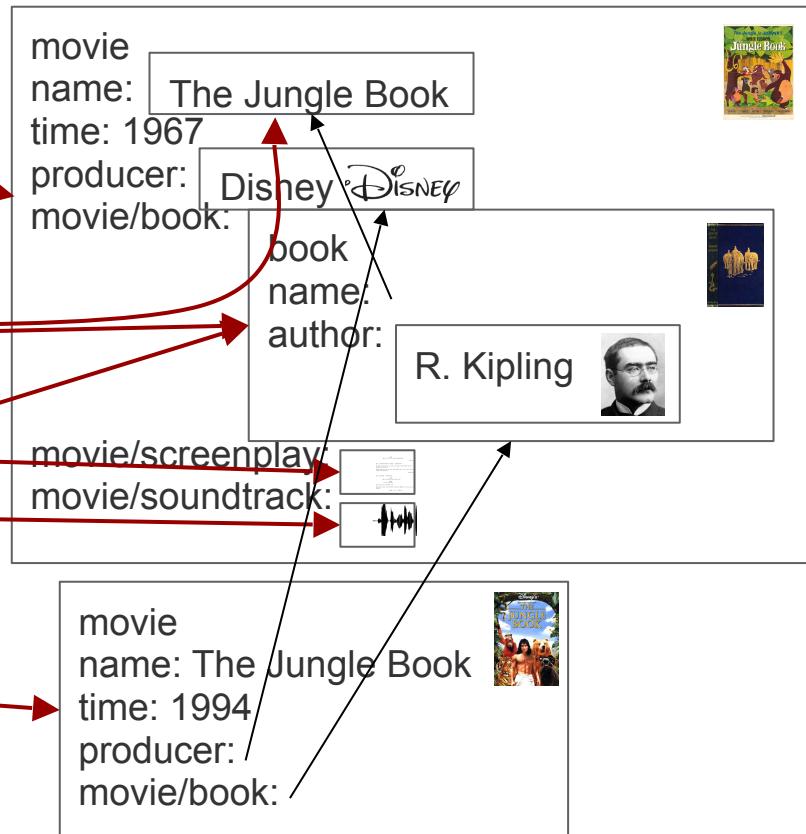


Article Talk

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How to close the loop?

Conference of the Birds (Dave Holland)

From Wikipedia, the free encyclopedia

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.^[1]

Conference of the Birds

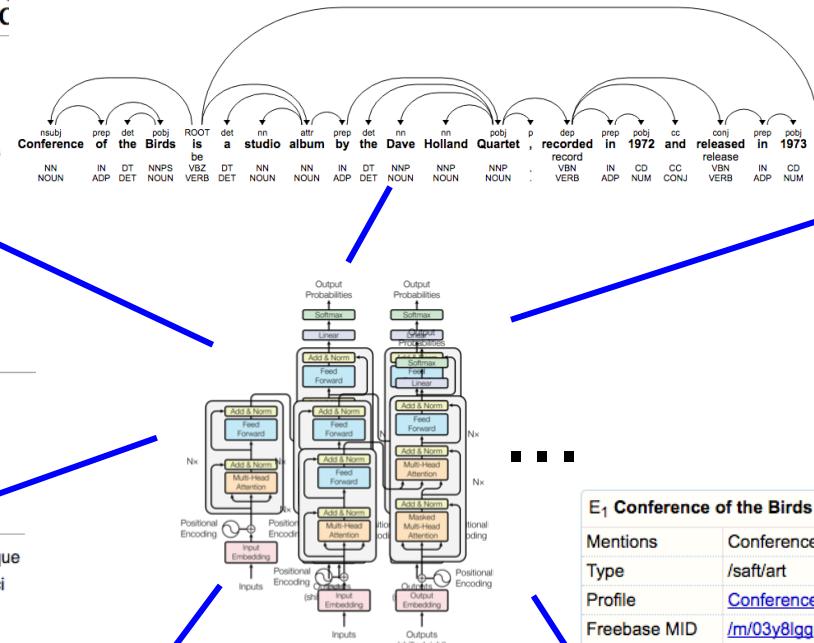
Conference of the Birds est un album du **Dave Holland Quartet**.

Sommaire [afficher]

Description [modifier | modifier le code]

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 penche ici nettement vers le **free jazz**. Celui-ci est d'ailleurs écrit comme une excellente introduction au genre par son habileté à combiner les contrastes, les compositions mélodiques de Holland interprétées dans une approche très libre^{1,2}.

s [**Conference of the Birds**]₁ is a **studio album**₁ by the [**Dave Holland Quartet**]₂, recorded in **1972** and released in **1973**.



Conference of the Birds

Studio album by **Dave Holland**



Conference of the Birds is a studio album by the **Dave Holland Quartet**, recorded in 1972 and released in 1973. [Wikipedia](#)

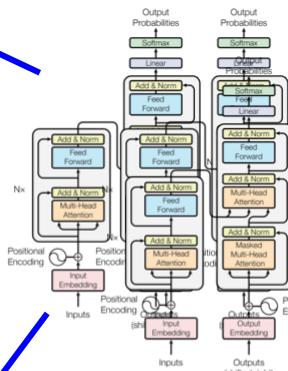
Artist: **Dave Holland**

Release date: 1973

Producer: **Manfred Eicher**

Label: **ECM Records**

Genre: **Avant-garde jazz**



E1 Conference of the Birds

Mentions	Conference of the Birds, studio album
Type	/saft/art
Profile	Conference of the Birds (Dave Holland album)
Freebase MID	/m/03y8lgg
Wikipedia	Conference of the Birds (Dave Holland album)

E2 Dave Holland Quartet

Mentions	Dave Holland Quartet
Type	/saft/organization
Profile	Dave Holland Quartet (band)
Freebase MID	/m/01n7q8x