

ANALYTICS: AN ERA OF CHANGE, AND A CHANGE OF AN ERA

SANDJAI BHULAI

S.BHULAI@VU.NL



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INTRODUCTION

Prof. dr. S. (Sandjai) Bhulai

Full Professor of Business Analytics

Faculty of Science

Vrije Universiteit Amsterdam

Department: Mathematics

s.bhulai@vu.nl



Business Analytics: Optimization of Business Processes



Research / Education:

Decision making under uncertainty

Control of complex high-dimensional systems

Stochastic optimization

Data science / machine learning



VOLUME OF DATA

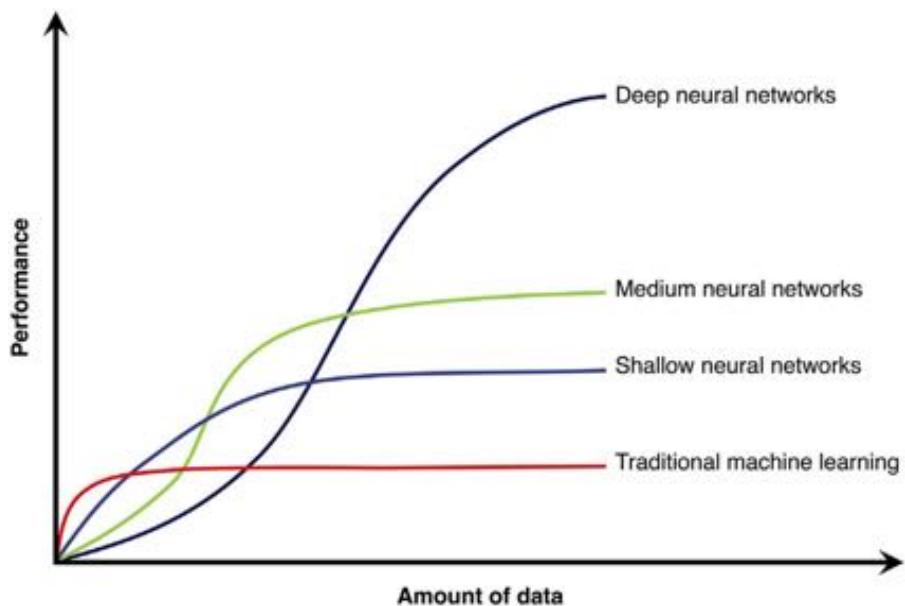


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VOLUME OF DATA



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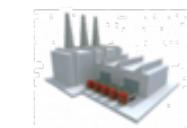


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VARIETY OF DATA



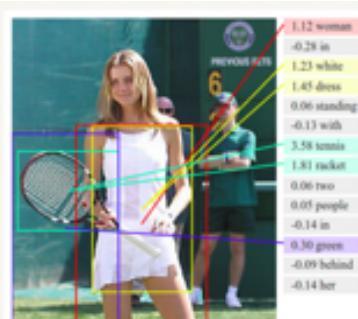
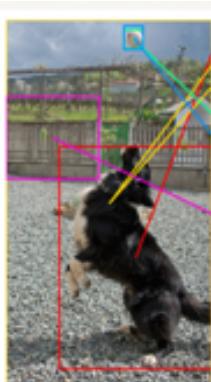
- Structured data
- Unstructured data



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VARIETY OF DATA



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VELOCITY OF DATA

A Minute on the Internet in 2019

Estimated data created on the internet in one minute



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VELOCITY OF DATA



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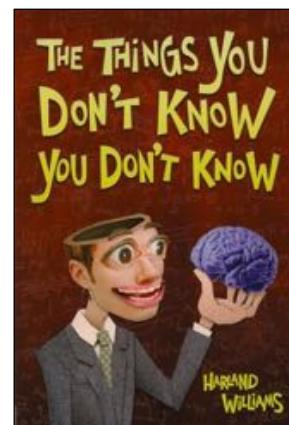
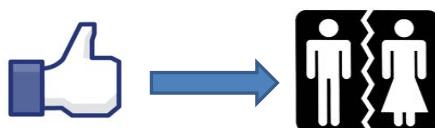


BUSINESS ANALYTICS



Big data is more than simply a matter of size:
it is also about creating insights!

Discovering what you don't know you don't know.....



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BUSINESS ANALYTICS



**Big data is more than simply a matter of size:
it is also about creating insights!**

Business Analytics

- Scientific process of transforming data into insight for making better decisions
 - Used for data-driven decision making, which is often seen as more objective than other alternatives for decision making

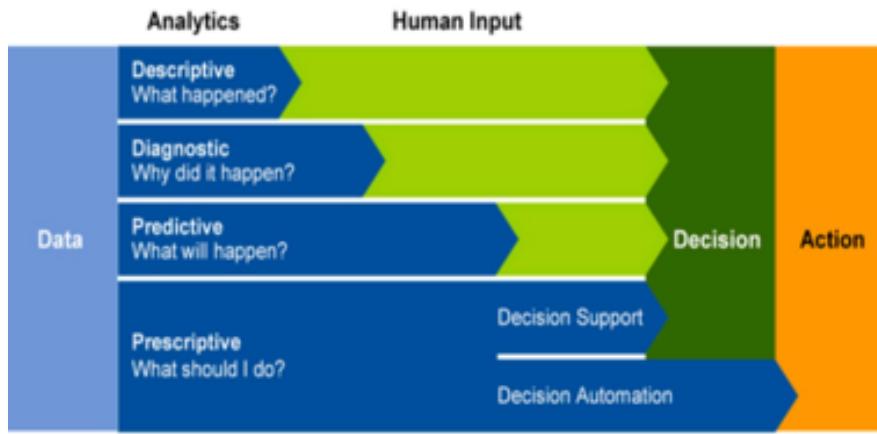


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BUSINESS ANALYTICS



Big data is more than simply a matter of size:
it is also about creating insights!



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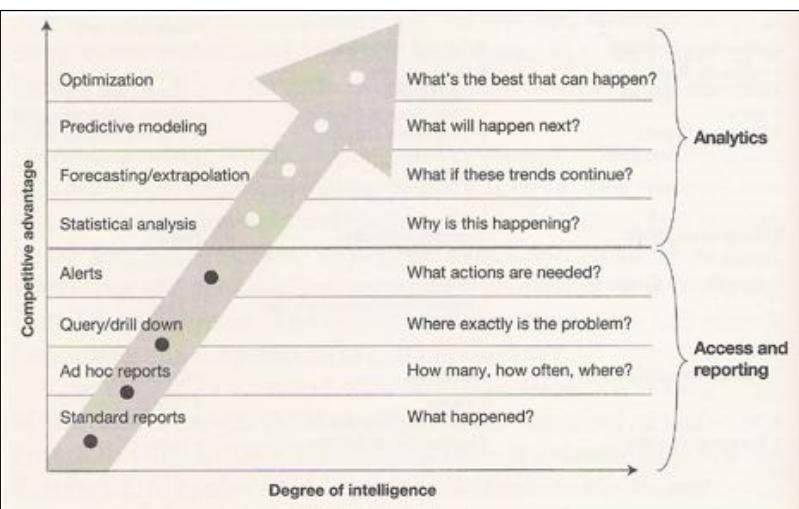


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BUSINESS ANALYTICS



Big data is more than simply a matter of size:
it is also about creating insights!

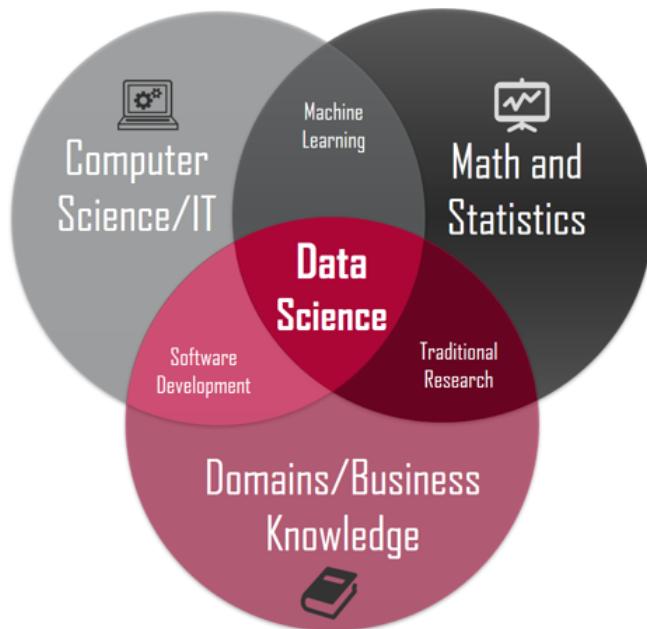


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BUSINESS ANALYTICS



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ANALYTICS: SHIFTING PARADIGMS

Do computers play more intelligently than humans?

Geplaatst op 23/10/2014 || Published in Schaken || Reageren



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ANALYTICS: SHIFTING PARADIGMS



AlphaZero vs Stockfish / artwork by Chess.com.

Google's AlphaZero Destroys Stockfish In 100-Game Match



FM MikeKlein 🇺🇸

Dec 6, 2017, 12:50 PM | 341 | Chess Event Coverage

English ▾

Chess changed forever today. And maybe the rest of the world did, too.



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ANALYTICS: SHIFTING PARADIGMS

Google AI algorithm masters ancient game of Go

Deep-learning software defeats human professional for first time.

Elizabeth Gibney

27 January 2016



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ANALYTICS: SHIFTING PARADIGMS

Zondag 01 december 2019 | Het laatste nieuws het eerst op NU.nl



27 november 2019 15:28

Laatste update: 2 dagen, 22 uur geleden



De Zuid-Koreaanse gospeler Lee Se-dol stopt met zijn professionele carrière in het Chinese bordspel. De topsporter zegt tegen het Zuid-Koreaanse persbureau [Yonhap](#) dat zijn keuze vooral gemotiveerd is door zijn nederlaag tegen software van het Google-zusterbedrijf DeepMind in 2016.



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ANALYTICS: SHIFTING PARADIGMS

Computing

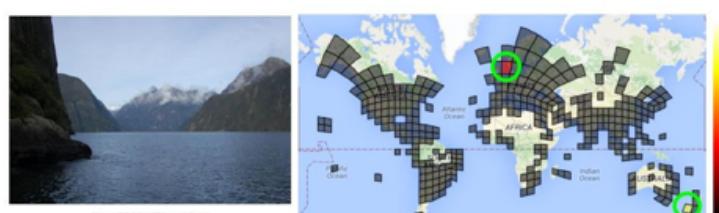
Google Unveils Neural Network with “Superhuman” Ability to Determine the Location of Almost Any Image

Guessing the location of a randomly chosen Street View image is hard, even for well-traveled humans. But Google's latest artificial-intelligence machine manages it with relative ease.

by Emerging Technology from the arXiv
February 24, 2016



(a)

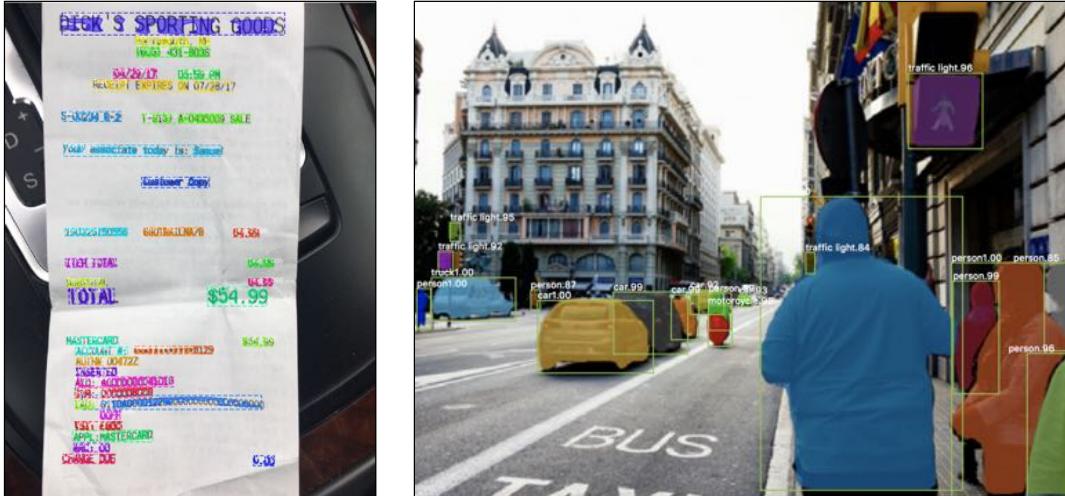


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ANALYTICS: SHIFTING PARADIGMS



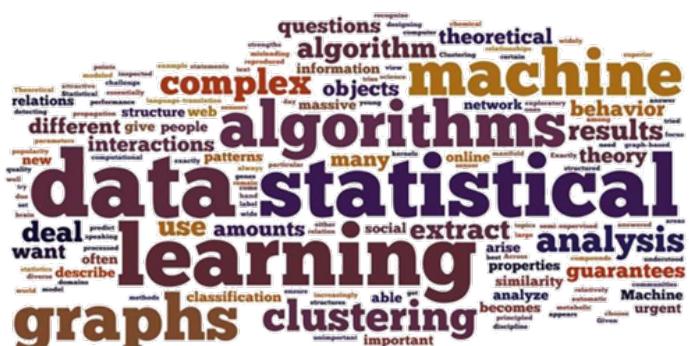
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ANALYTICS: SHIFTING PARADIGMS

- Panama papers (2.6 TB, 11.5 billion documents)
 - > 5 billion emails
 - > 3 billion databases
 - > 2 billion PDF documents
 - > 1 billion images
 - > 320,166 text files
 - > 2,242 other files

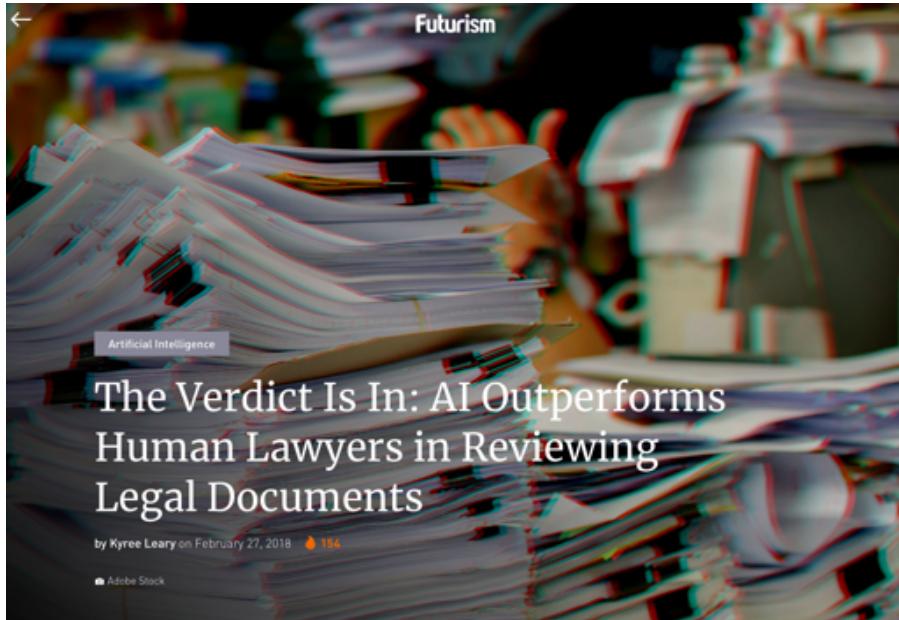


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ANALYTICS: SHIFTING PARADIGMS



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A composite image. On the left, there is a close-up photograph of a dark wooden gavel resting on a light-colored wooden block. On the right, there is a photograph of a man with glasses and a beard, wearing a dark suit and tie, standing at a podium and speaking into a microphone. He appears to be a Supreme Court Justice.

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ANALYTICS: SHIFTING PARADIGMS



Donderdag 09 november 2017 Het laatste nieuws dat u moet weten

Nieuwsgroepen
Netwerken
Algemeen
Achtergronden
Economie
Sport
Tech
Entertainment
Lifestyle
Overig
Wetenschap
Ondernemen
Dieren
Natuur
Auto

NLNU > Onderwerp



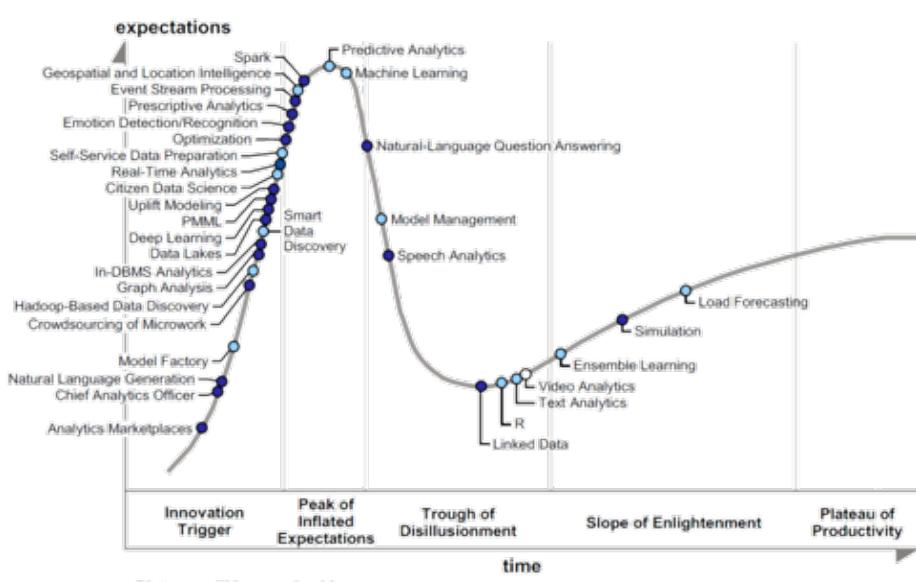
Gebruik van woorden als 'echt' en 'ongelooflijk'
wijst op stress



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ANALYTICS: SHIFTING PARADIGMS



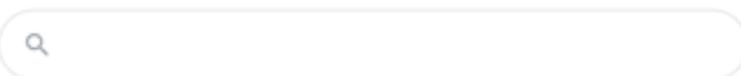
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EXAMPLE 1: MARKOV MODELS

Google



Google Search I'm Feeling Lucky

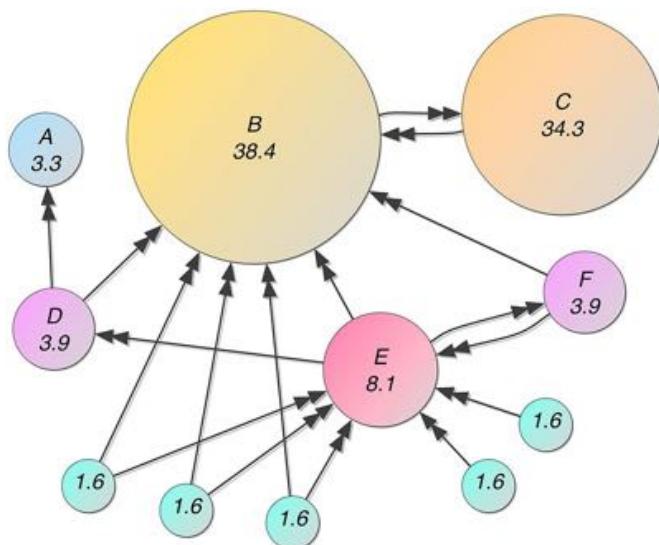
Google offered in: Nederlands Frysk

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EXAMPLE 1: MARKOV MODELS



$$S(V_i) = (1 - d) + d \sum_{j \in \text{In}(V_i)} \frac{1}{|\text{Out}(V_j)|} S(V_j)$$

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EXAMPLE 1: MARKOV MODELS

- The same trick can be applied to sentences
- However, there are no links in sentences

$$\text{Similarity}(S_i, S_j) = \frac{|\{w_k | w_k \in S_i \text{ and } w_k \in S_j\}|}{\log(|S_i|) + \log(|S_j|)}$$

- This creates a system for summarization

27 Sandjai Bhulai (s.bhulai@vu.nl)



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EXAMPLE 1: TEXT SUMMARIZATION

BUSINESS NEWS FEBRUARY 20, 2020 / 12:09 PM / UPDATED 16 HOURS AGO

UBS's tech-savvy new boss Hamers not always loved by the Dutch

Bart H. Meijer, Michael Shields

4 MIN READ



AMSTERDAM/ZURICH (Reuters) - Ralph Hamers made his mark as a tech-savvy chief executive who led Dutch bank ING (INGA.AS) back to profitability after cementing its position as a no-frills lender in Germany and simplifying its product portfolio.



28 Sandjai Bhulai (s.bhulai@vu.nl)



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EXAMPLE 1: TEXT SUMMARIZATION

'Black in Space' Looks at Final Frontier of Civil Rights

In 1959, Ronald Erwin McNair walked into a South Carolina library. The 9-year-old aspiring astronaut wanted to check out a calculus book, but a librarian threatened to call the police if he didn't leave. McNair was black.

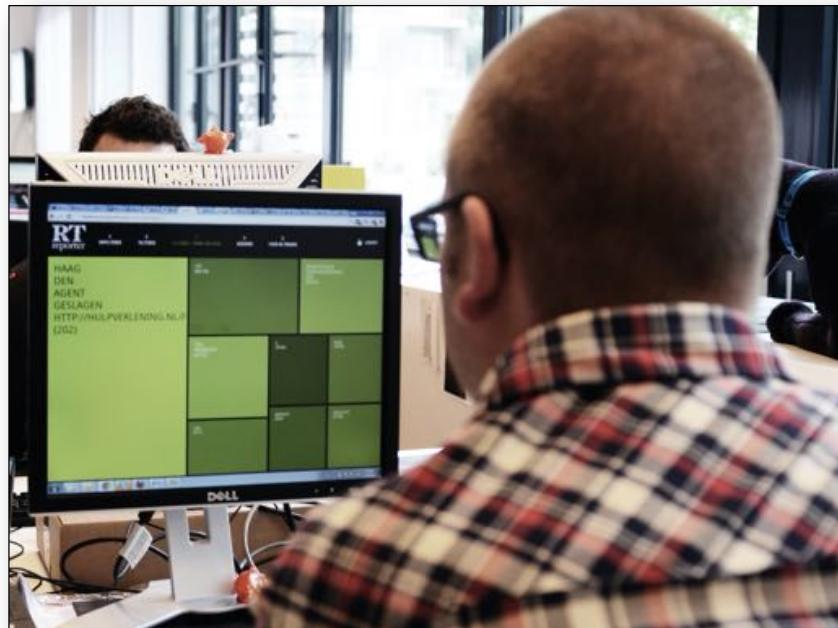
ASSOCIATED PRESS

PUBLISHED 20 FEBRUARY 2020



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EXAMPLE 1: FROM NU.NL TO STRAKS.NL



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VU

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EXAMPLE 1: TWITTER FOR TAXI



31 Sandjai Bhulai (s.bhulai@vu.nl)



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EXAMPLE 1: BIBLICAL HEBREW



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EXAMPLE 1: BIBLICAL HEBREW

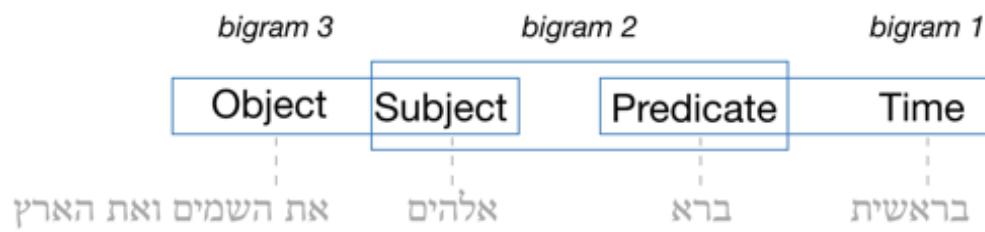
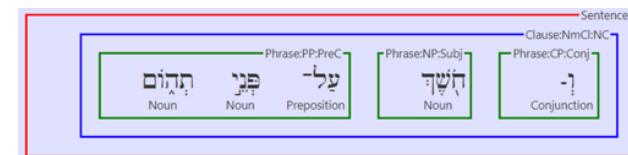
- ETCBC annotation data using Text-Fabric
- Word: part-of-speech: noun, article, preposition, ...
- Phrase: function: object, subject, adjunct, ...
- Phrase: type: verbal (VP), nominal (NP), ...
- Clause: type: Way+X, Way+Qtl, ...
- Clause: domain: Narrivate (N), Discursive (D), Quotation (Q), and Unknown (?)

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EXAMPLE 1: BIBLICAL HEBREW



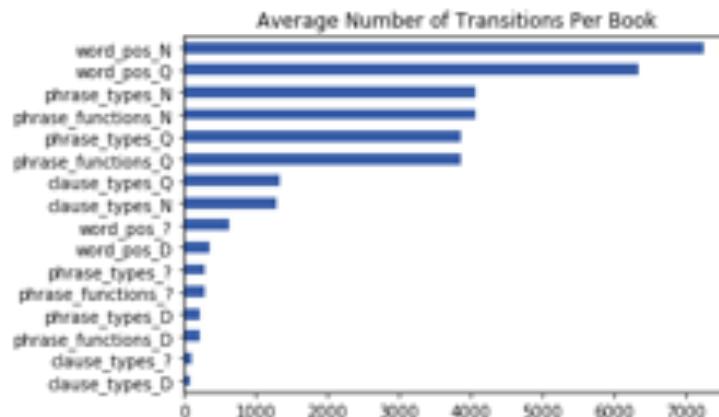
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EXAMPLE 1: BIBLICAL HEBREW

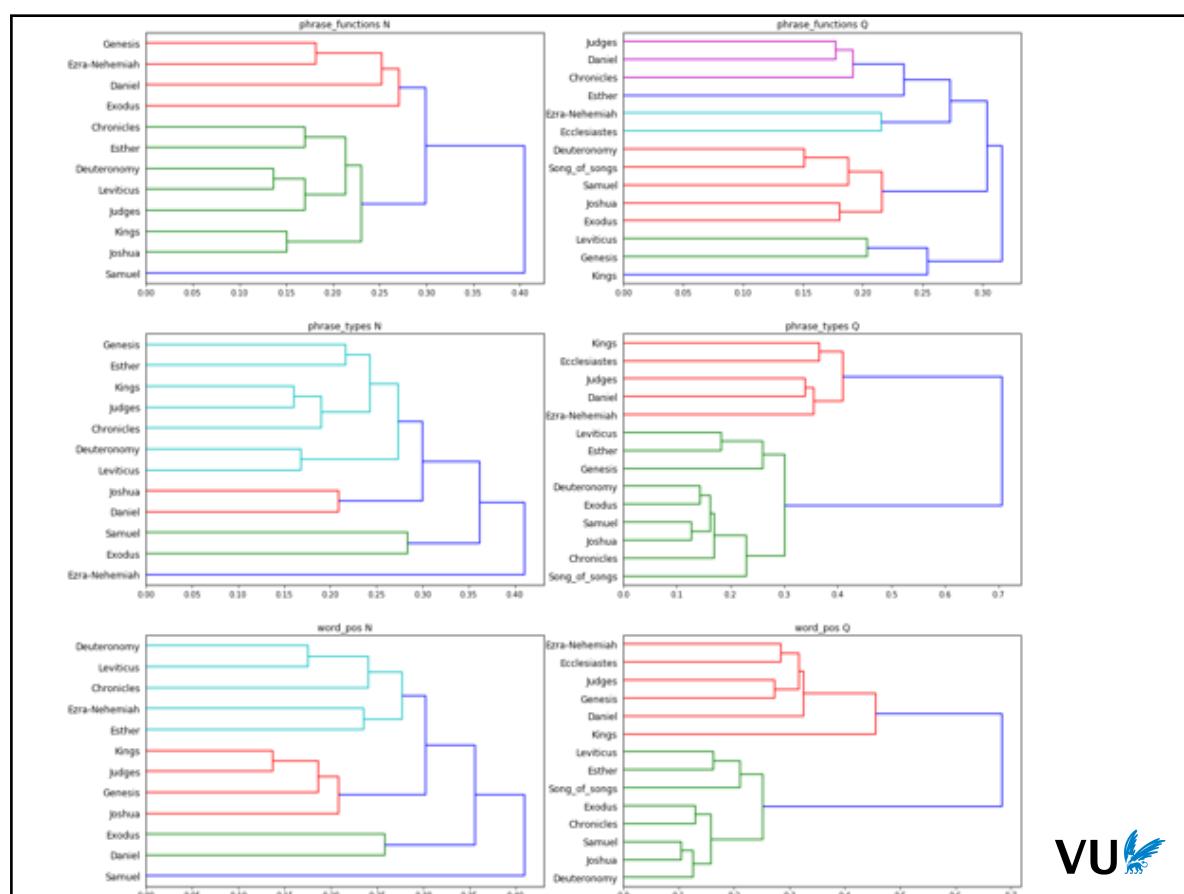
- Transition Matrices are constructed for the domains N and Q on part-of-speech and phrase function/type level



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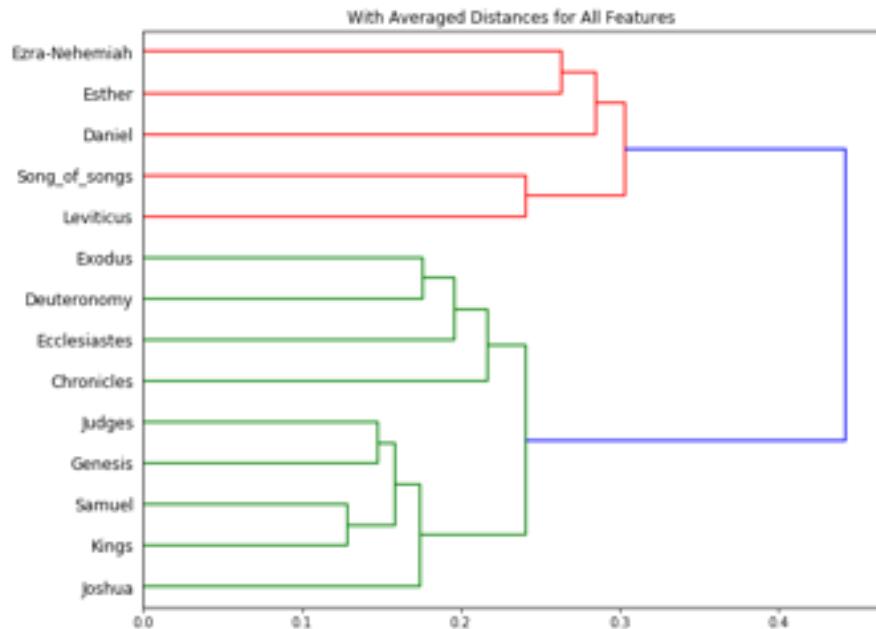
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EXAMPLE 1: BIBLICAL HEBREW

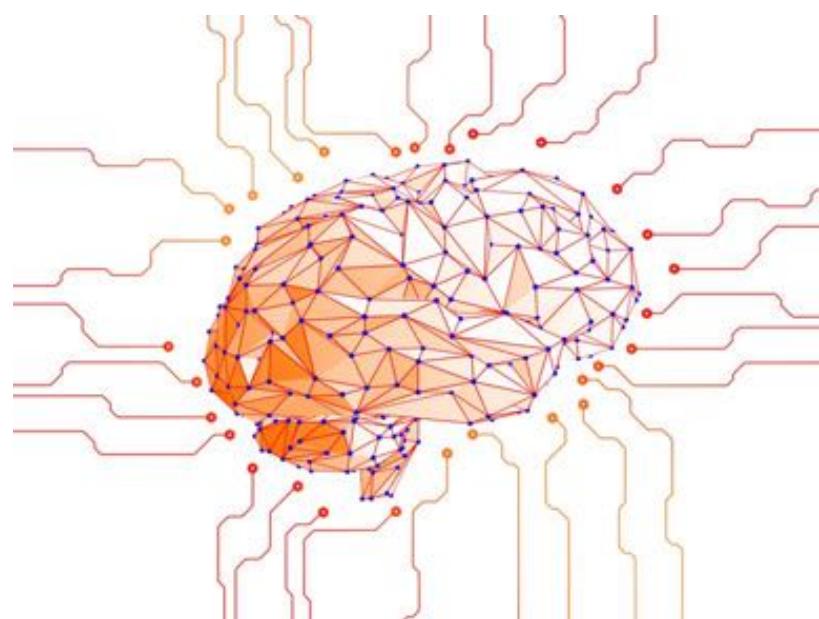


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EXAMPLE 2: NEURAL NETWORKS



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EXAMPLE 2: NEURAL NETWORKS

Speech recognition		→	"The quick brown fox jumped over the lazy dog."
Music generation	\emptyset	→	
Sentiment classification	"There is nothing to like in this movie."	→	
DNA sequence analysis	AGCCCTGTGAGGAAC TAG	→	AGCCCCTGTGAGGAAC TAG
Machine translation	Voulez-vous chanter avec moi?	→	Do you want to sing with me?
Video activity recognition		→	Running
Name entity recognition	Yesterday, Harry Potter met Hermione Granger.	→	Yesterday, Harry Potter met Hermione Granger.

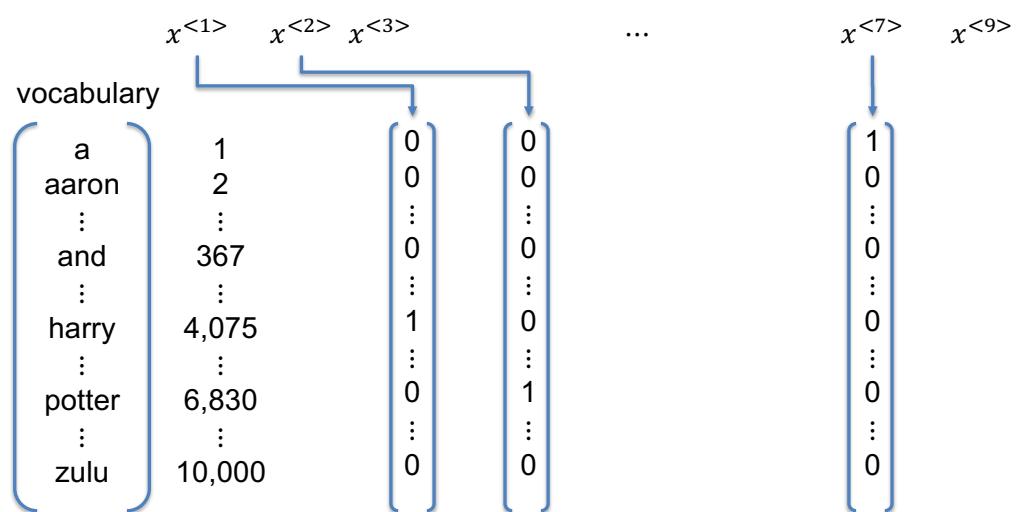
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EXAMPLE 2: NEURAL NETWORKS

x : Harry Potter and Hermione Granger invented a new spell.

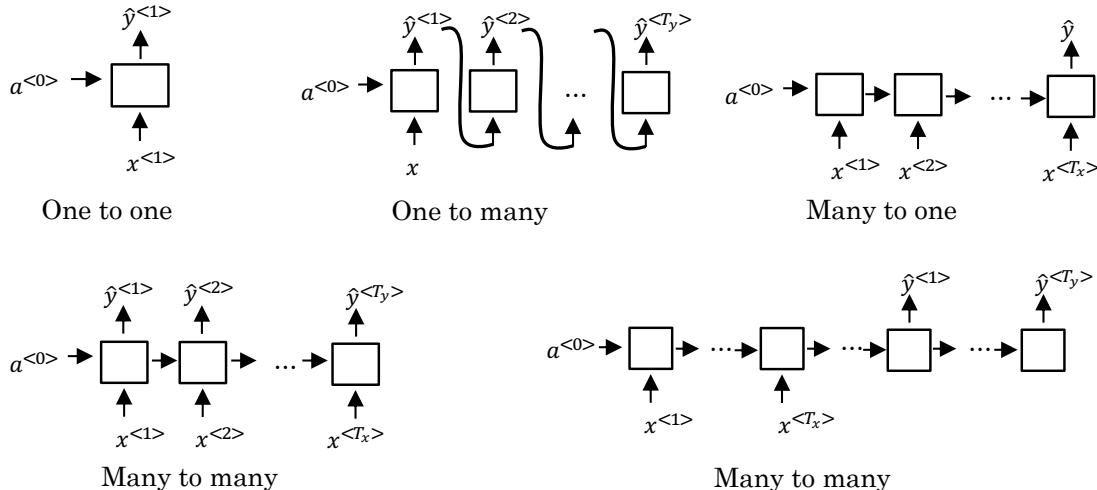


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EXAMPLE 2: RECURRENT NEURAL NETWORKS



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EXAMPLE 2: RECURRENT NEURAL NETWORKS

- Vocabulary: $V = [a, aaron, \dots, zulu, <\text{UNK}>]$

Man (5391)	Woman (9853)	King (4914)	Queen (7157)	Apple (456)	Orange (6257)
$\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ \vdots \\ 1 \\ \vdots \\ 0 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \vdots \\ 1 \\ \vdots \\ 0 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \\ \vdots \\ 0 \\ 0 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ \vdots \\ 0 \\ 0 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 0 \\ \vdots \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ \vdots \\ 1 \\ \vdots \\ 0 \end{bmatrix}$

I want a glass of orange ____.
I want a glass of apple ____.

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EXAMPLE 2: RECURRENT NEURAL NETWORKS

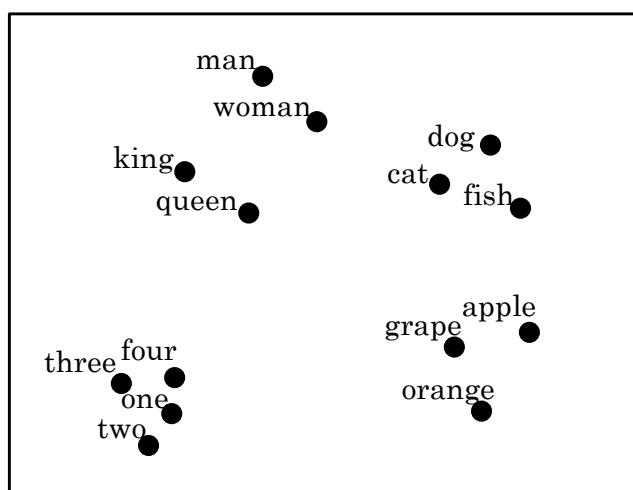
	Man (5391)	Woman (9853)	King (4914)	Queen (7157)	Apple (456)	Orange (6257)
Gender	-1	1	-0.95	0.97	0.00	0.01
Royal	0.01	0.02	0.93	0.95	-0.01	0.00
Age	0.03	0.02	0.7	0.69	0.03	-0.02
Food	0.09	0.01	0.02	0.01	0.95	0.97

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EXAMPLE 2: RECURRENT NEURAL NETWORKS



Visualization with t-SNE

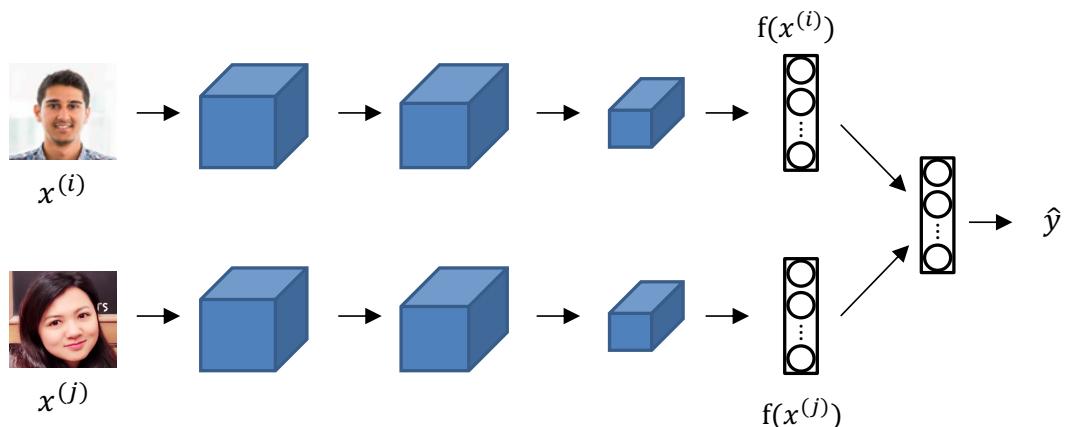
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EXAMPLE 2: RECURRENT NEURAL NETWORKS

- Relation to face encoding



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EXAMPLE 2: RECURRENT NEURAL NETWORKS

- Analogy to word embedding

	Man (5391)	Woman (9853)	King (4914)	Queen (7157)	Apple (456)	Orange (6257)
Gender	-1	1	-0.95	0.97	0.00	0.01
Royal	0.01	0.02	0.93	0.95	-0.01	0.00
Age	0.03	0.02	0.70	0.69	0.03	-0.02
Food	0.09	0.01	0.02	0.01	0.95	0.97

- man → woman as king → ??

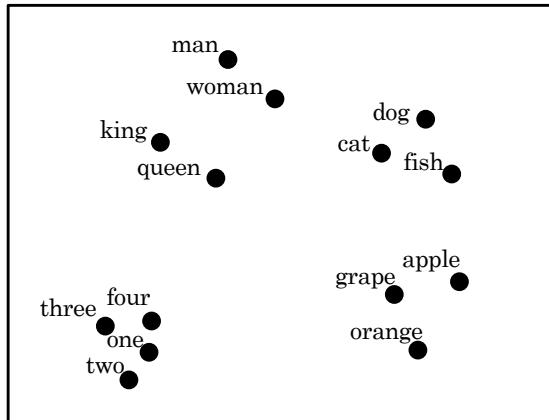
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EXAMPLE 2: RECURRENT NEURAL NETWORKS

- Analogy to word embedding



$$e_{\text{man}} - e_{\text{woman}} \approx e_{\text{king}} - e_{?}$$

EXAMPLE 2: RECURRENT NEURAL NETWORKS

- Similarity function: $\text{sim}(u, v) = \frac{u^T v}{\|u\|_2 \|v\|_2}$

- Examples:

- > Man:Woman as Boy:Girl
- > Ottawa:Canada as Nairobi:Kenya
- > Big:Bigger as Tall:Taller
- > Yen:Japan as Ruble:Russia

EXAMPLE 2: BIBLICAL HEBREW

- ETCBC annotation data using Text-Fabric
- Word: part-of-speech: noun, article, preposition, ...
- Word: verbal stem: Hif'il, Pi'el, Qal, ...
- Phrase: function: object, subject, relative, ...
- Clause: type: nominal, participle, wavyiqtol, ...

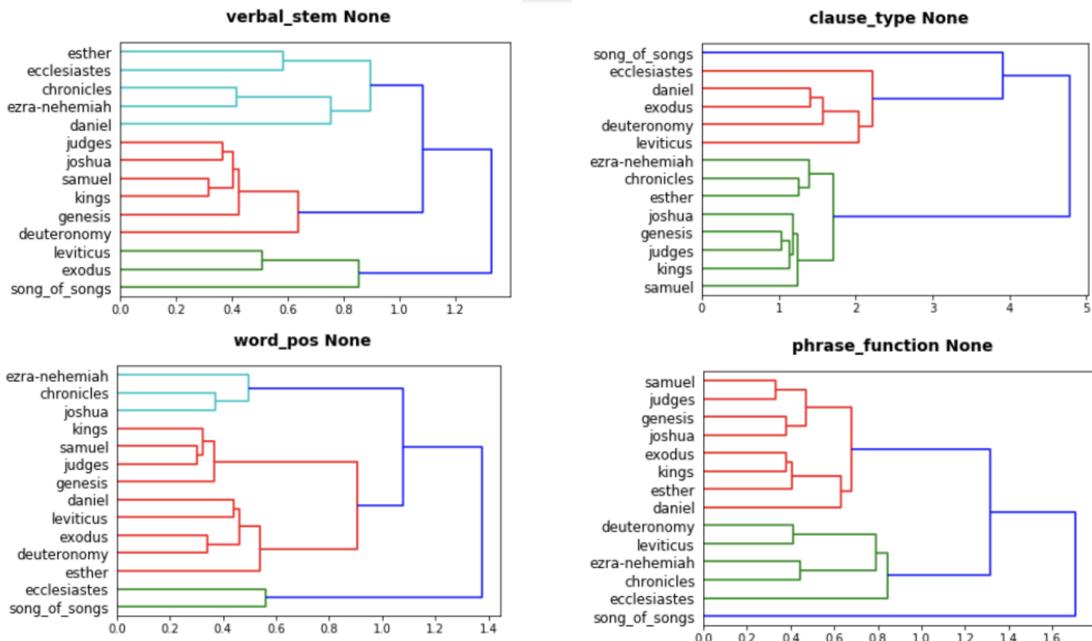
EXAMPLE 2: BIBLICAL HEBREW

- LSTM model is trained on corpus:
 - > Genesis, Exodus, Deuteronomy, Leviticus, Judges, Joshua, Kings, Samuel
 - > Chronicles, Daniel, Ecclesiastes, Esther, Ezra-Nehemiah, Song of Songs

וַיַּעֲשֶׂה מֹשֶׁה כֹּל אֲשֶׁר צִוָּה יְהוָה אֲתָנוּ כֹּן עָשָׂה

וְבָאוּ אֱלֹהִים כָּלֵד הַבְּרִכּוֹת הָאֱלֹהִים | הַשִּׁיגֶר כִּי תִשְׁמַע בְּקוֹל יְהוָה אֱלֹהִים

EXAMPLE 2: BIBLICAL HEBREW

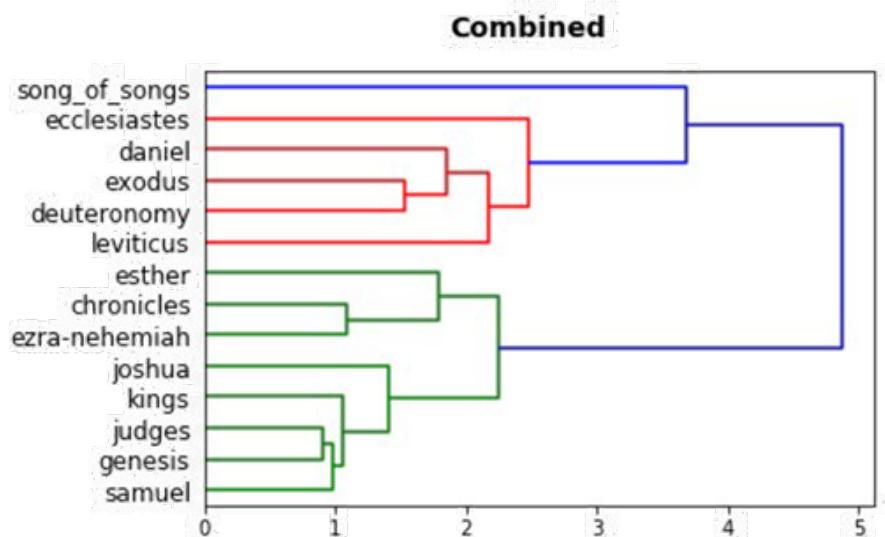


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EXAMPLE 2: BIBLICAL HEBREW



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QUESTIONS

