

Where do you mean?

Vector Semantics and Linguistic Processing

Cody Kingham

github.com/codykingham/where_do_you_mean

cak47@cam.ac.uk



UNIVERSITY OF
CAMBRIDGE

Faculty of Asian and
Middle Eastern Studies



ST JOHN'S COLLEGE
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- distributional hypothesis – Wittgenstein (1953), Firth (1962), Sinclair (1991)

KWIC:
keyword in context
War of the Worlds

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Jupyter Notebook

meat_bread_gold.ipynb

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- measures word behavior within a sample of text data
 - measurement limited by sample size

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- Vector semantics is a way to empirically study the interaction of categories in the mind.

Recipe for a Semantic Vector Space



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- text corpus



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 - n-grams, “bag of words”
 - surface forms, lexemes, syntactic roles
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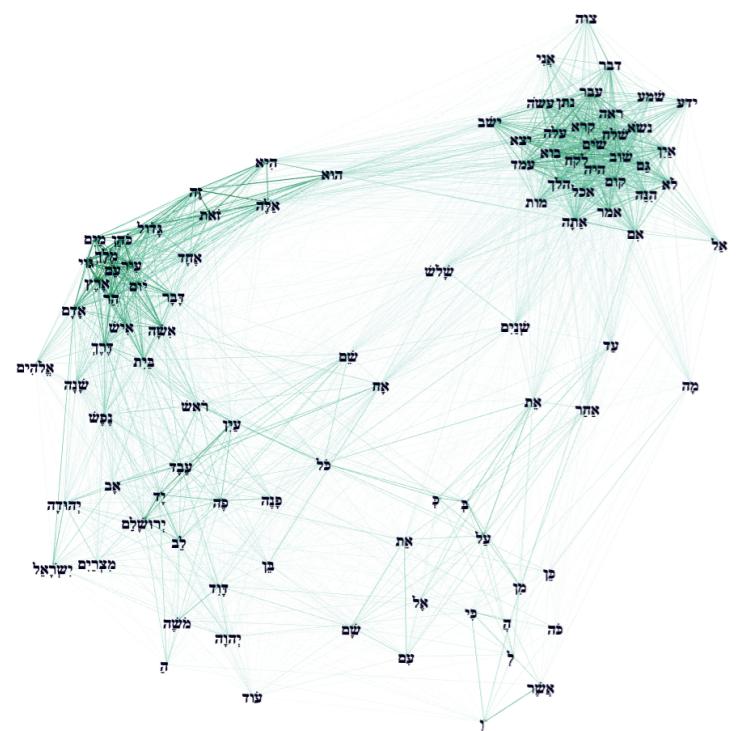
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- method of normalizing raw context frequencies
- method of analysis: e.g. distance formulae, clustering methods





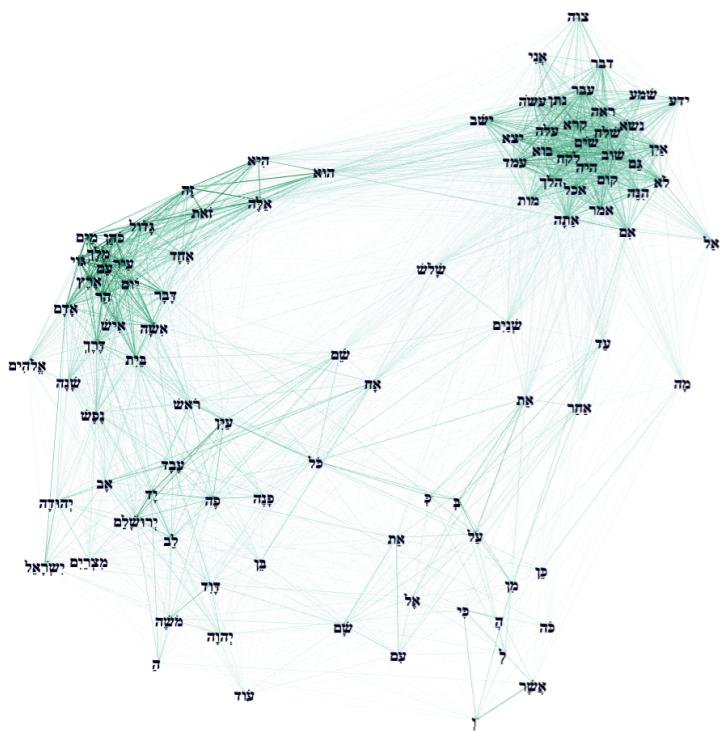


Parts of Speech Model

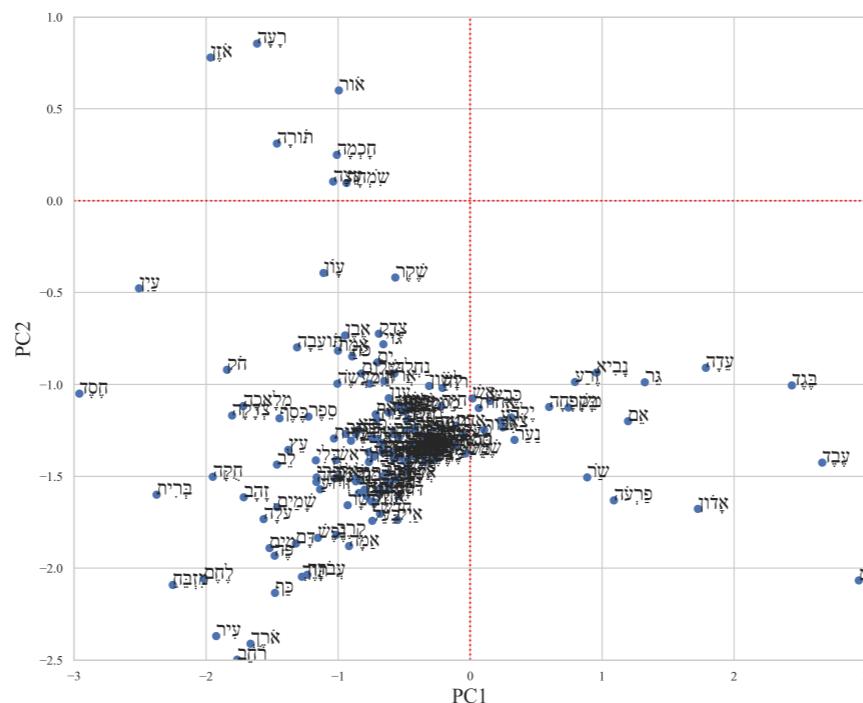




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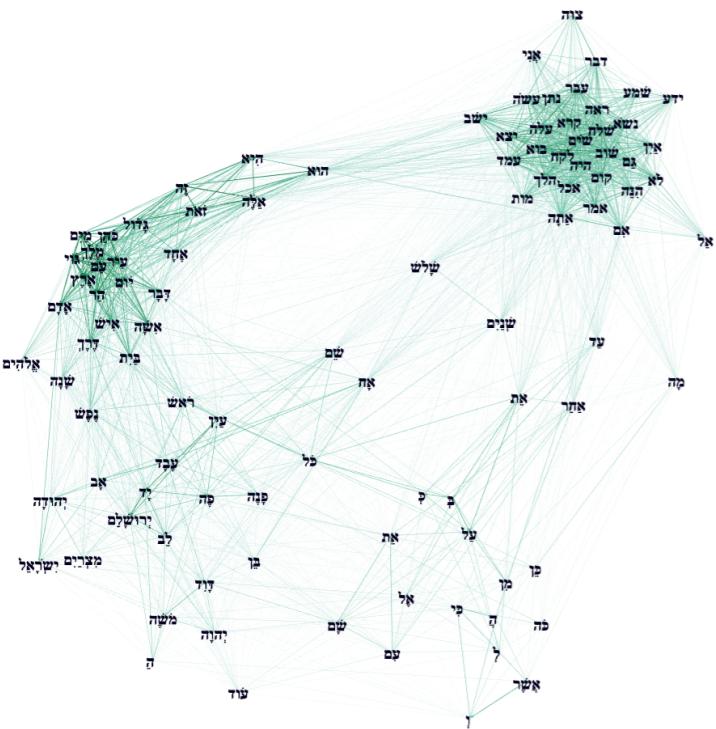


Noun Classes Model

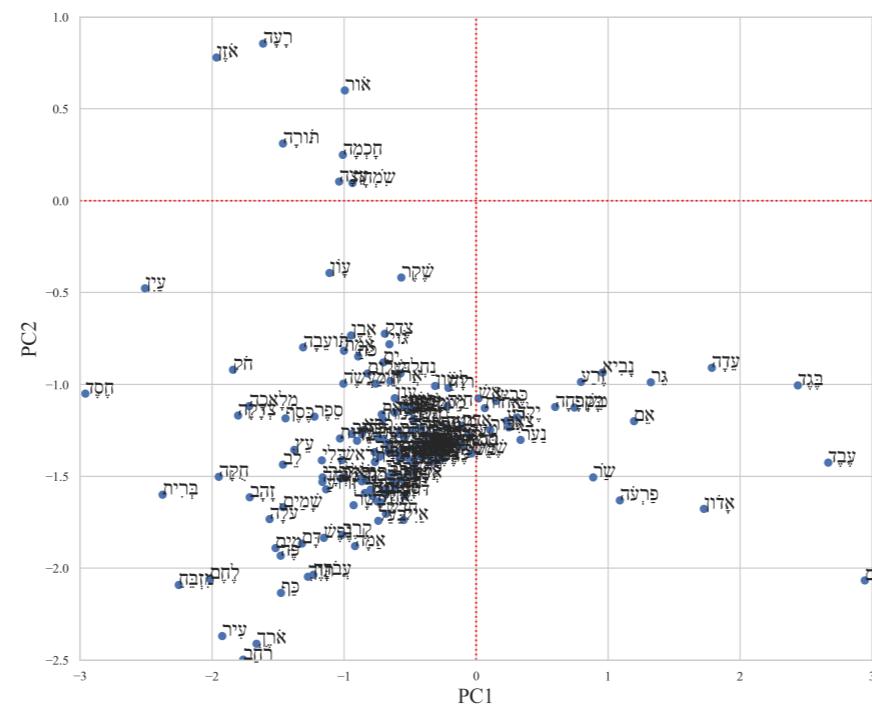




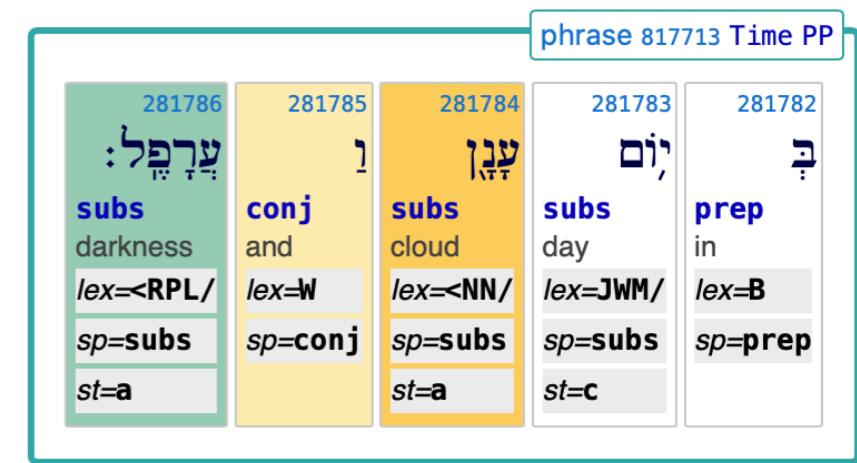
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Coordinate Parsing Model



Parts of Speech Model



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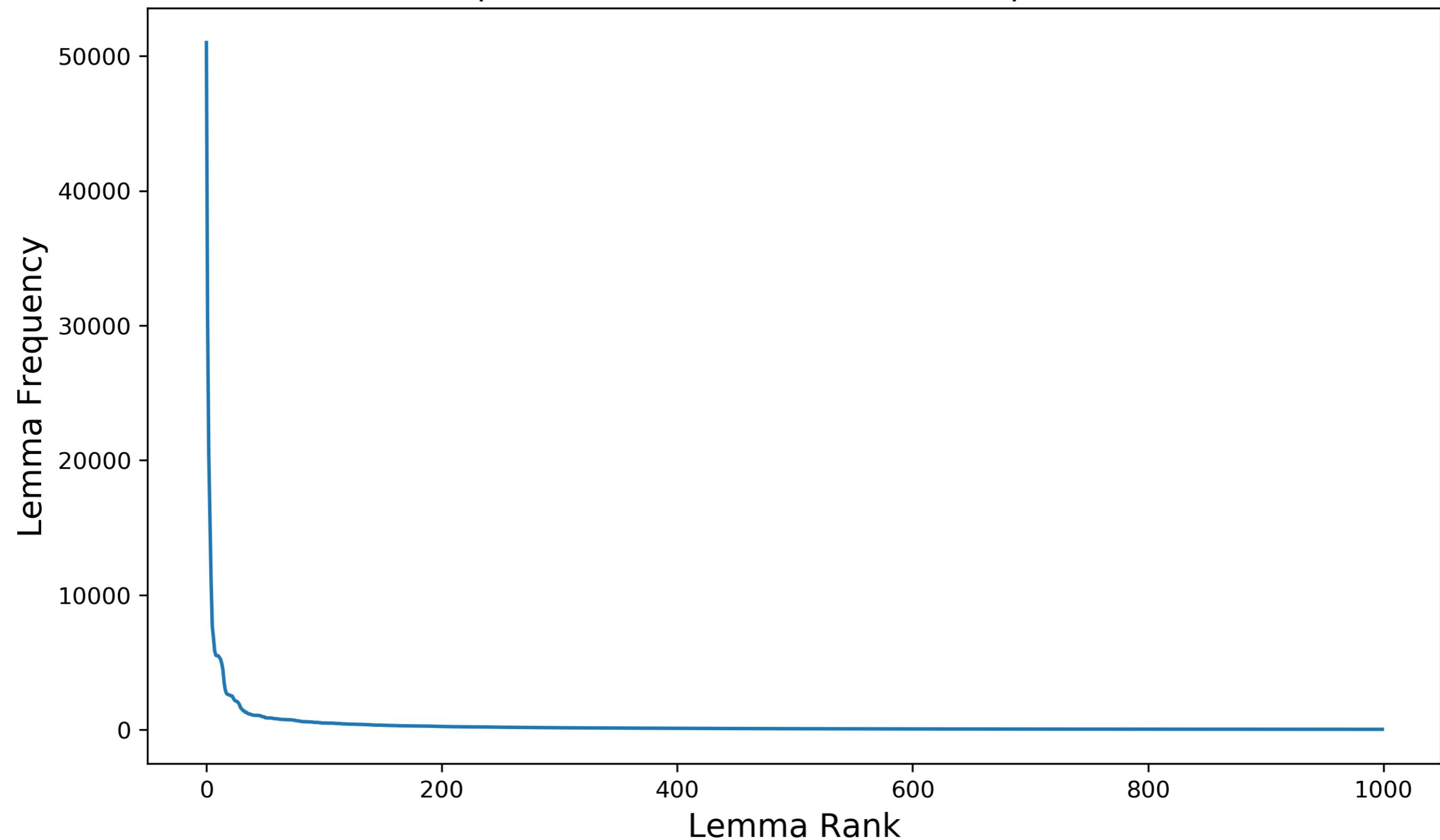


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- **analysis:** cosine similarity + Gephi & ForceAtlas2



Zipfian Curve in Hebrew Word Frequencies



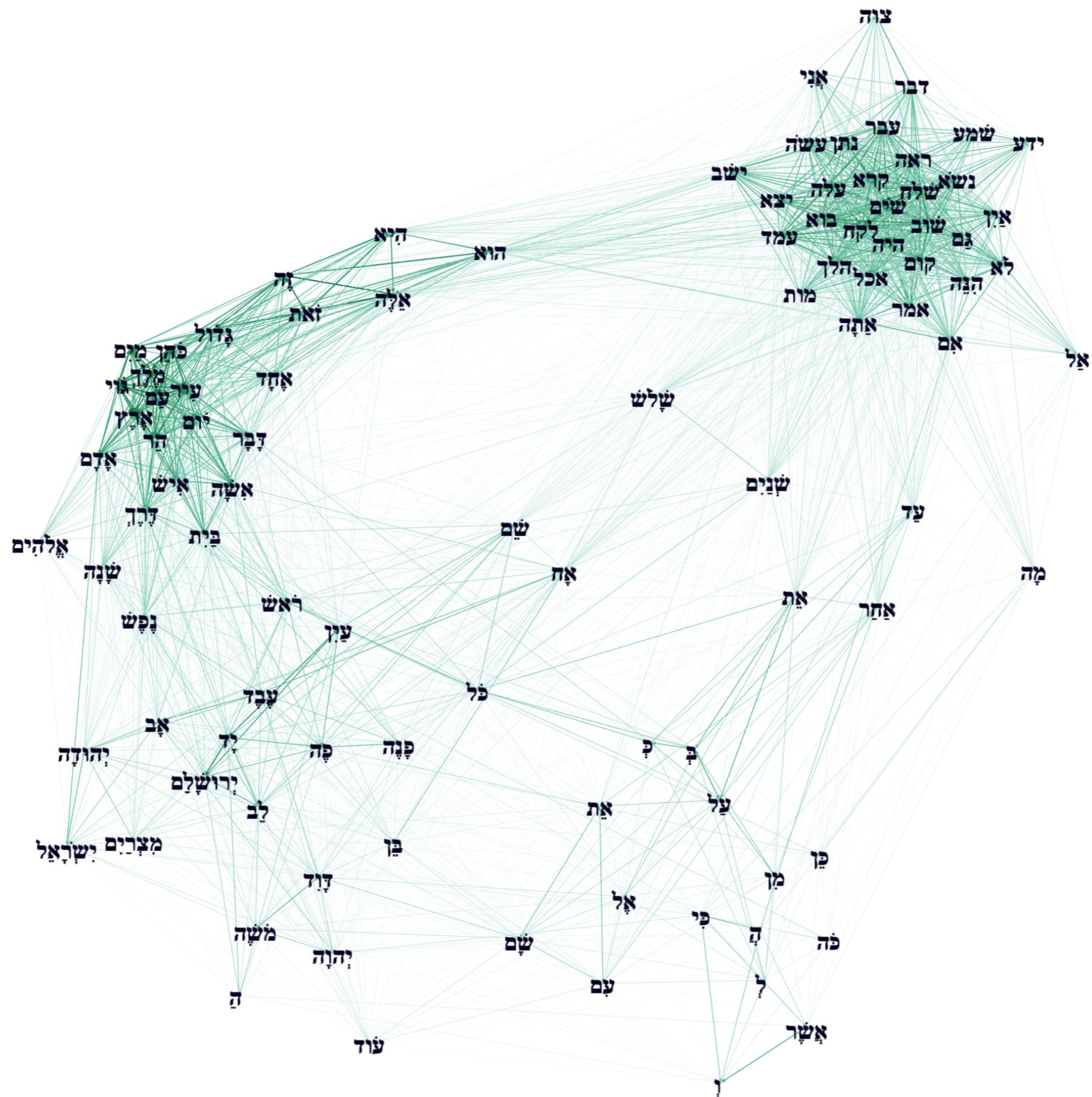
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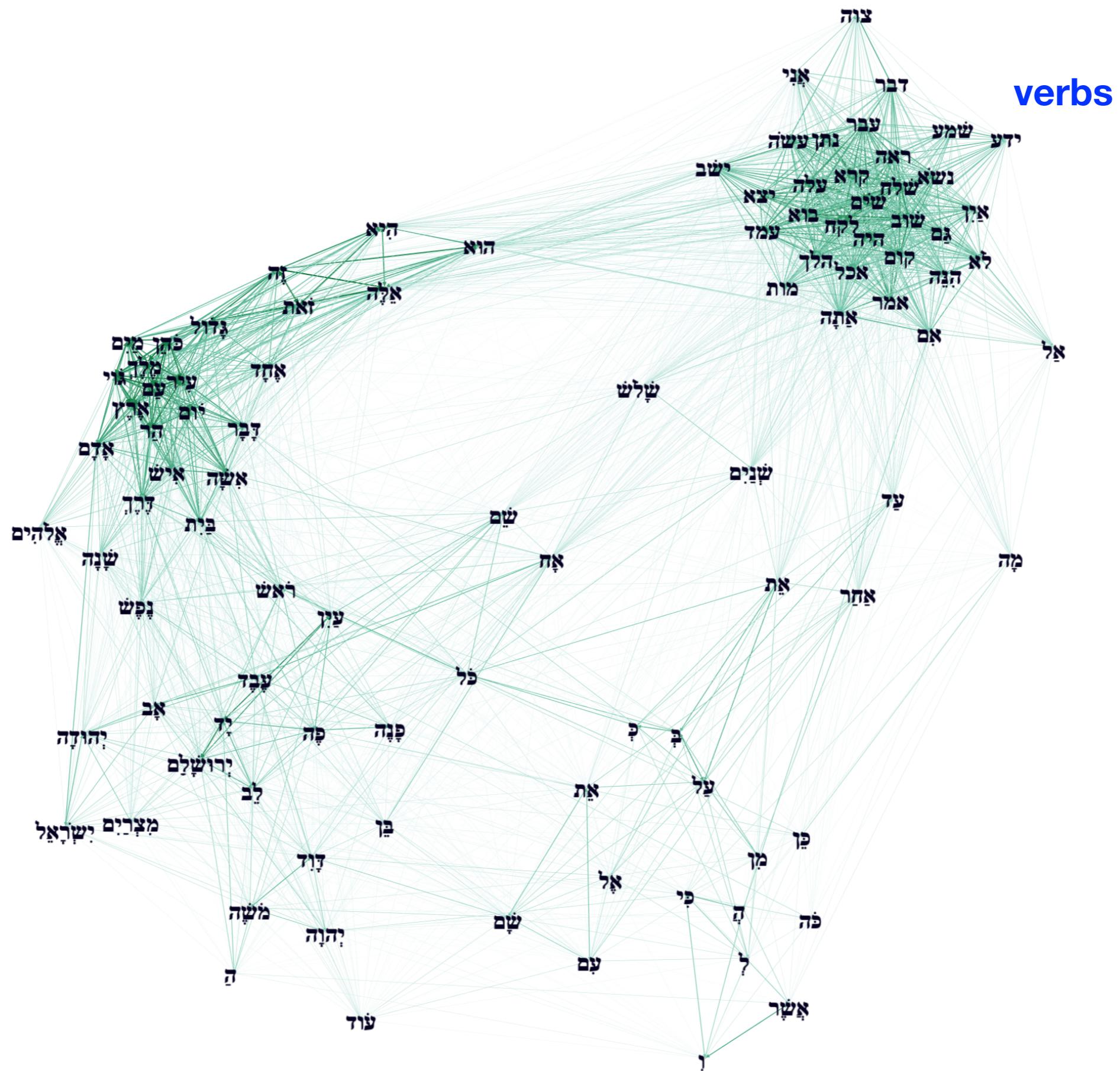
	-3.>T	-2.H	-1.>RY/	1.R>CJT/	2.BR>[3.>LHJM/	-3.MJM/	-2.HJH[
B	-0.001036	0.002353	-0.000477	0.000049	0.000029	0.000127	0.000076	-0.000116
>LHJM/	0.001860	-0.016776	-0.001043	-0.000025	-0.000021	-0.000085	-0.000004	-0.000455
>T	0.012185	-0.007396	-0.000730	0.000026	-0.000021	0.000444	0.000051	-0.001489
H	0.000371	0.004738	-0.000217	-0.000021	-0.000023	-0.000861	0.000142	0.000298
W	0.000662	0.017336	0.000734	-0.000004	-0.000008	-0.000143	-0.000088	-0.001180
>RY/	0.003036	-0.016468	-0.000686	0.000062	0.000066	0.002131	0.000443	0.000134
HJH[-0.003413	-0.009327	-0.000528	0.000080	-0.000021	0.001301	0.000011	0.011531
<L	-0.000648	0.001638	-0.000588	-0.000025	-0.000021	-0.000452	0.000313	-0.000576
PNH/	-0.001612	-0.016103	-0.001107	-0.000025	-0.000021	-0.000213	0.000047	0.001090
MJM/	0.000211	-0.011837	-0.001200	0.000346	-0.000021	-0.000532	0.010140	0.000176

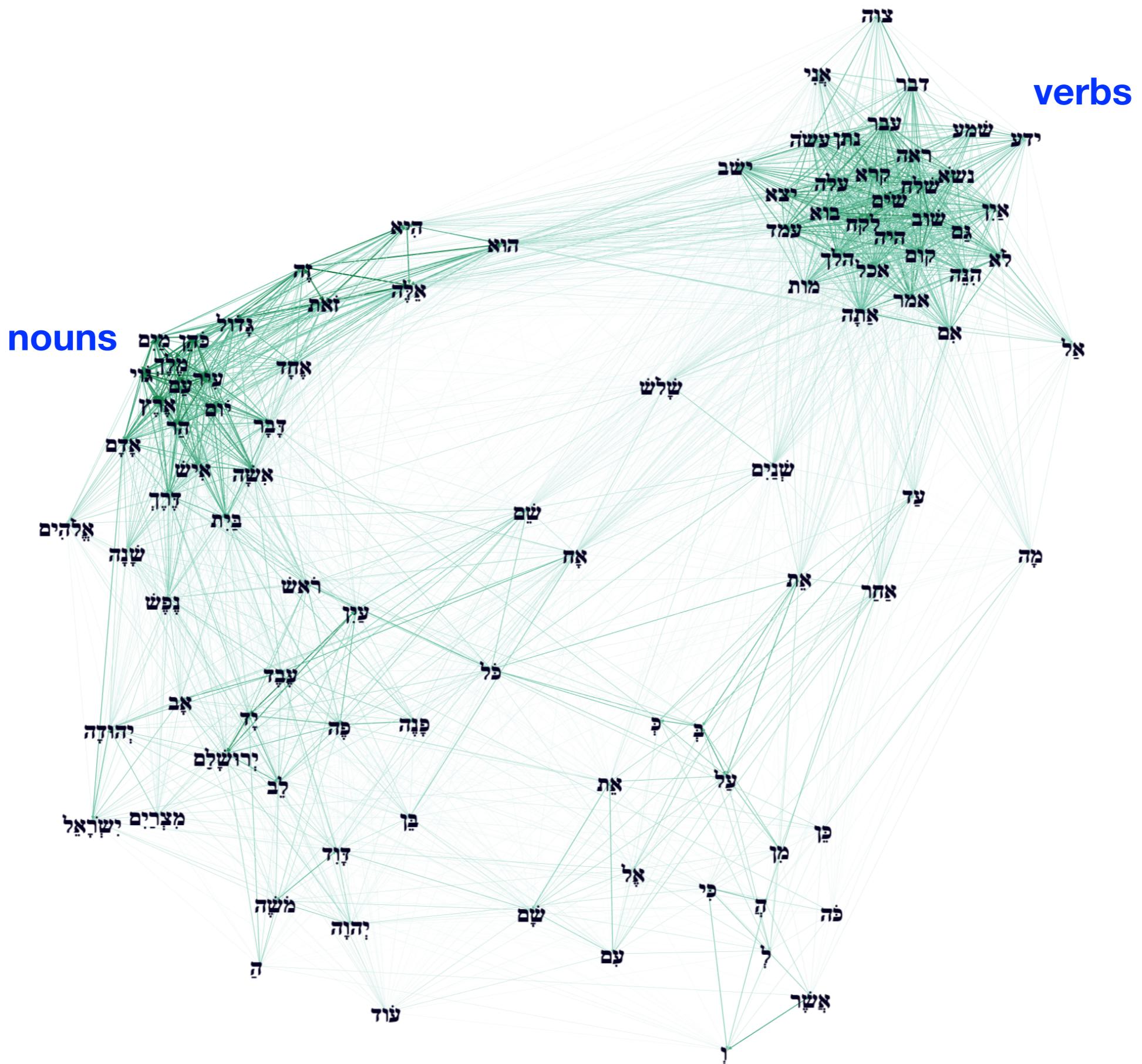
	B	>LHJM/	>T	H	W	>RY/	HJH[<L	PNH/
B	1.000000	-0.136176	0.550530	-0.274051	-0.091999	-0.208063	-0.185976	0.626086	-0.029701
>LHJM/	-0.136176	1.000000	-0.171587	-0.129920	-0.002669	0.300991	-0.153233	-0.158390	0.047568
>T	0.550530	-0.171587	1.000000	-0.272447	-0.376742	-0.266840	0.165530	0.570215	-0.079837
H	-0.274051	-0.129920	-0.272447	1.000000	0.112907	-0.069290	-0.288102	-0.187305	0.091368
W	-0.091999	-0.002669	-0.376742	0.112907	1.000000	-0.189489	-0.548075	-0.095528	-0.198414
>RY/	-0.208063	0.300991	-0.266840	-0.069290	-0.189489	1.000000	-0.204252	-0.241469	-0.027057
HJH[-0.185976	-0.153233	0.165530	-0.288102	-0.548075	-0.204252	1.000000	-0.125302	-0.105253
<L	0.626086	-0.158390	0.570215	-0.187305	-0.095528	-0.241469	-0.125302	1.000000	-0.047564
PNH/	-0.029701	0.047568	-0.079837	0.091368	-0.198414	-0.027057	-0.105253	-0.047564	1.000000
MJM/	-0.125372	0.252663	-0.159008	-0.166524	-0.190084	0.827957	-0.155141	-0.149116	-0.001856
>MR[-0.220878	-0.104413	0.106645	-0.242685	-0.514283	-0.170039	0.664027	-0.218460	0.140998
R>H[-0.128572	-0.145078	0.202005	-0.222007	-0.465541	-0.194255	0.654897	-0.061707	0.004395
KJ	-0.092597	0.177883	-0.385489	0.008535	0.456054	-0.099231	-0.247210	-0.149167	-0.054475
QR>[-0.248269	-0.073924	0.047789	-0.279372	-0.471859	-0.152312	0.820903	-0.196548	-0.085214
L	0.324513	-0.086371	0.183148	-0.202406	0.275984	-0.302039	-0.214334	0.335124	-0.109457

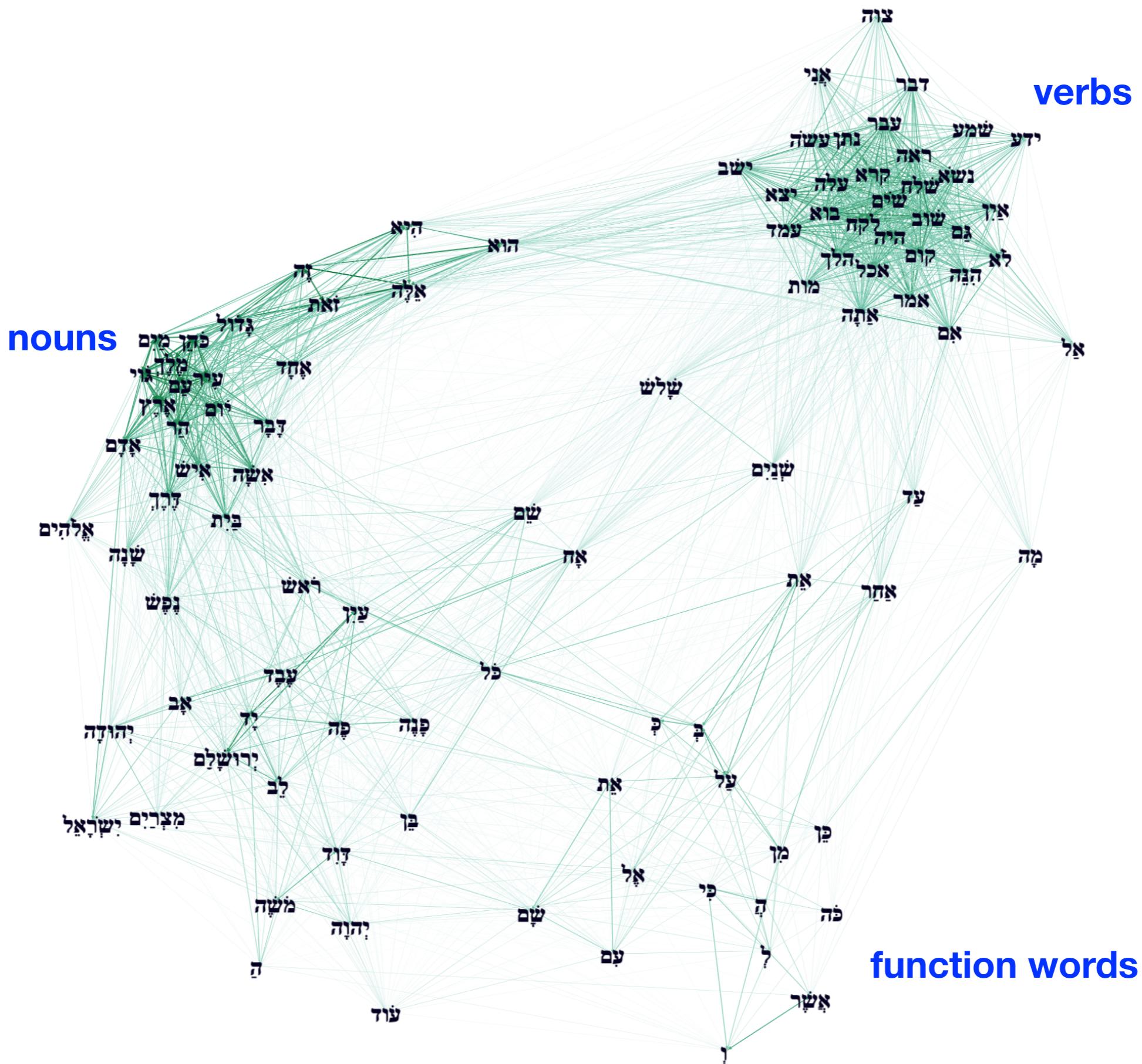
	B	>LHJM/	>T	H	W	>RY/	HJH[<L	PNH/
B	1.000000	-0.136176	0.550530	-0.274051	-0.091999	-0.208063	-0.185976	0.626086	-0.029701
>LHJM/	-0.136176	1.000000	-0.171587	-0.129920	-0.002669	0.300991	-0.153233	-0.158390	0.047568
>T	0.550530	-0.171587	1.000000	-0.272447	-0.376742	-0.266840	0.165530	0.570215	-0.079837
H	-0.274051	-0.129920	-0.272447	1.000000	0.112907	-0.069290	-0.288102	-0.187305	0.091368
W	-0.091999	-0.002669	-0.376742	0.112907	1.000000	-0.189489	-0.548075	-0.095528	-0.198414
>RY/	-0.208063	0.300991	-0.266840	-0.069290	-0.189489	1.000000	-0.204252	-0.241469	-0.027057
HJH[-0.185976	-0.153233	0.165530	-0.288102	-0.548075	-0.204252	1.000000	-0.125302	-0.105253
<L	0.626086	-0.158390	0.570215	-0.187305	-0.095528	-0.241469	-0.125302	1.000000	-0.047564
PNH/	-0.029701	0.047568	-0.079837	0.091368	-0.198414	-0.027057	-0.105253	-0.047564	1.000000
MJM/	-0.125372	0.252663	-0.159008	-0.166524	-0.190084	0.827957	-0.155141	-0.149116	-0.001856
>MR[-0.220878	-0.104413	0.106645	-0.242685	-0.514283	-0.170039	0.664027	-0.218460	0.140998
R>H[-0.128572	-0.145078	0.202005	-0.222007	-0.465541	-0.194255	0.654897	-0.061707	0.004395
KJ	-0.092597	0.177883	-0.385489	0.008535	0.456054	-0.099231	-0.247210	-0.149167	-0.054475
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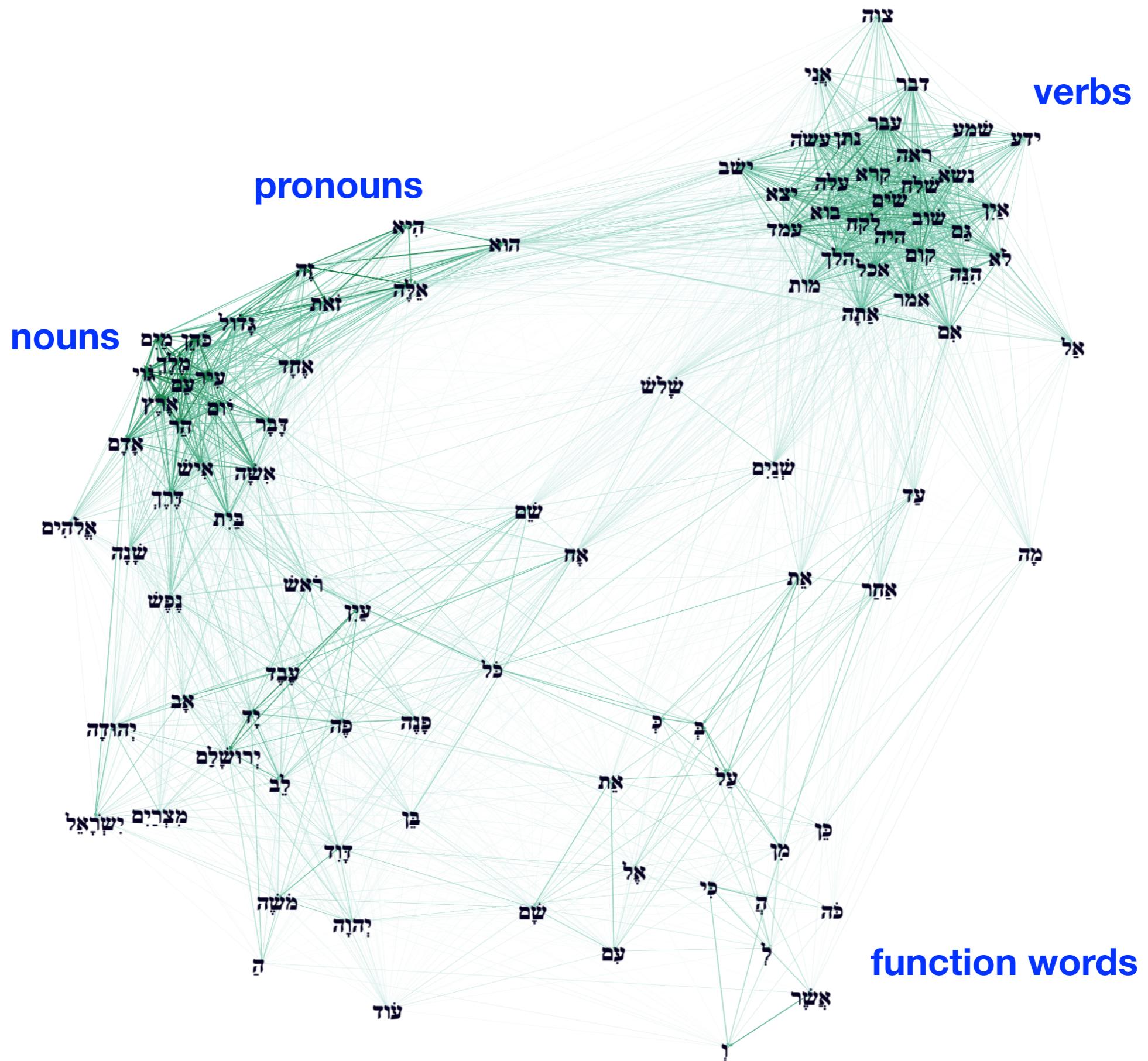
	B	>LHJM/	>T	H	W	>RY/	HJH[<L	PNH/
B	1.000000	-0.136176	0.550530	-0.274051	-0.091999	-0.208063	-0.185976	0.626086	-0.029701
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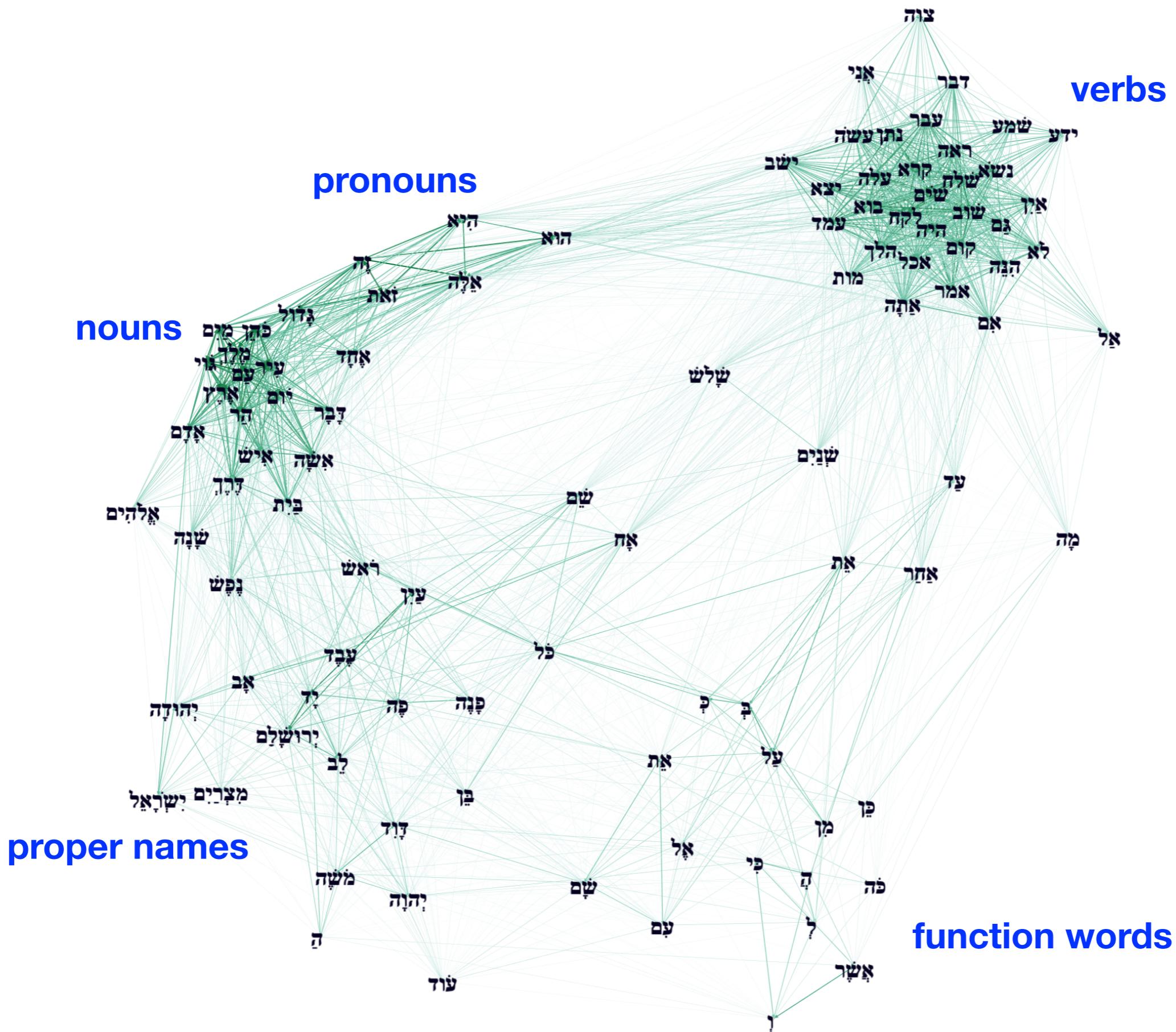


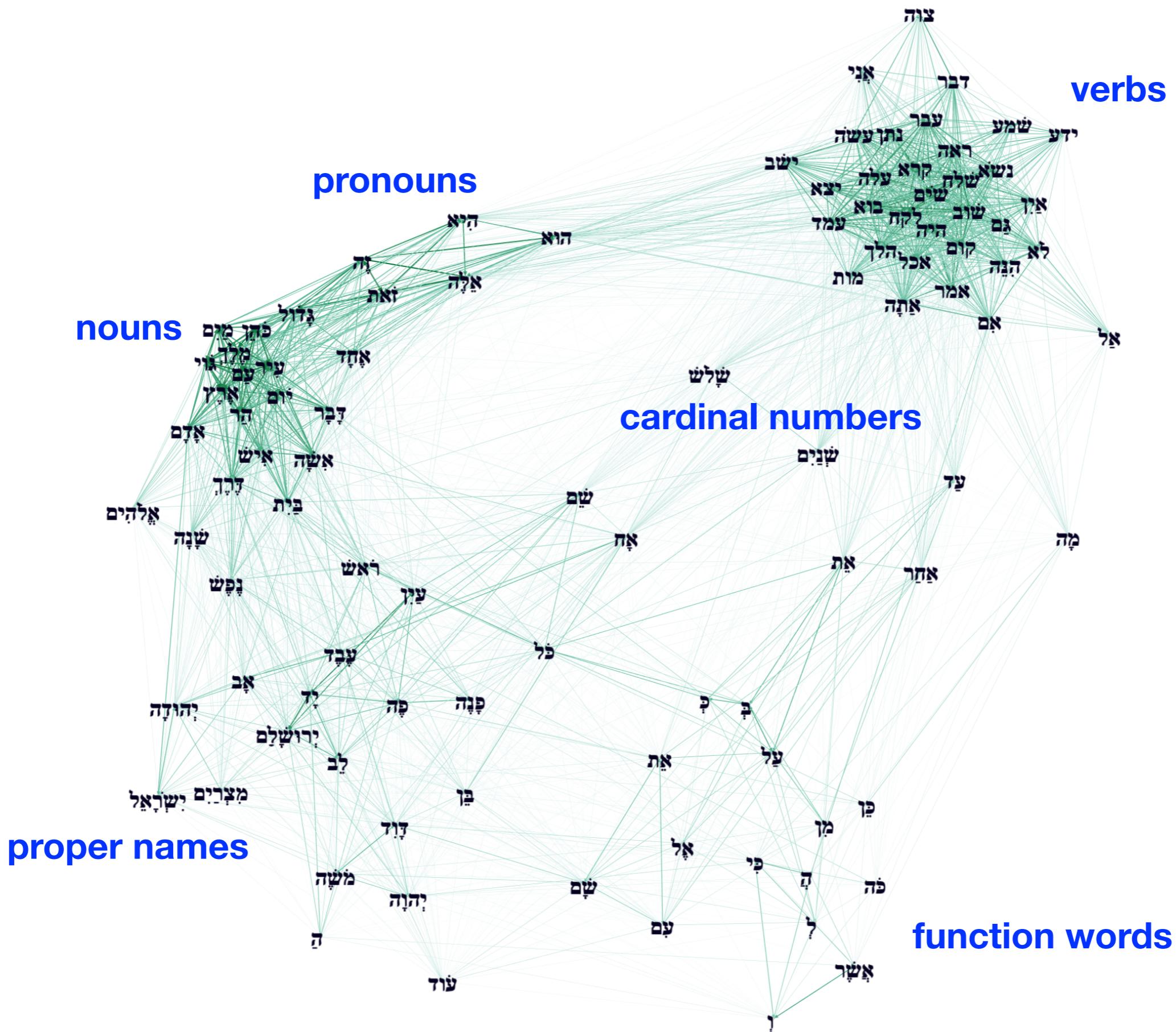












Noun Classes Model



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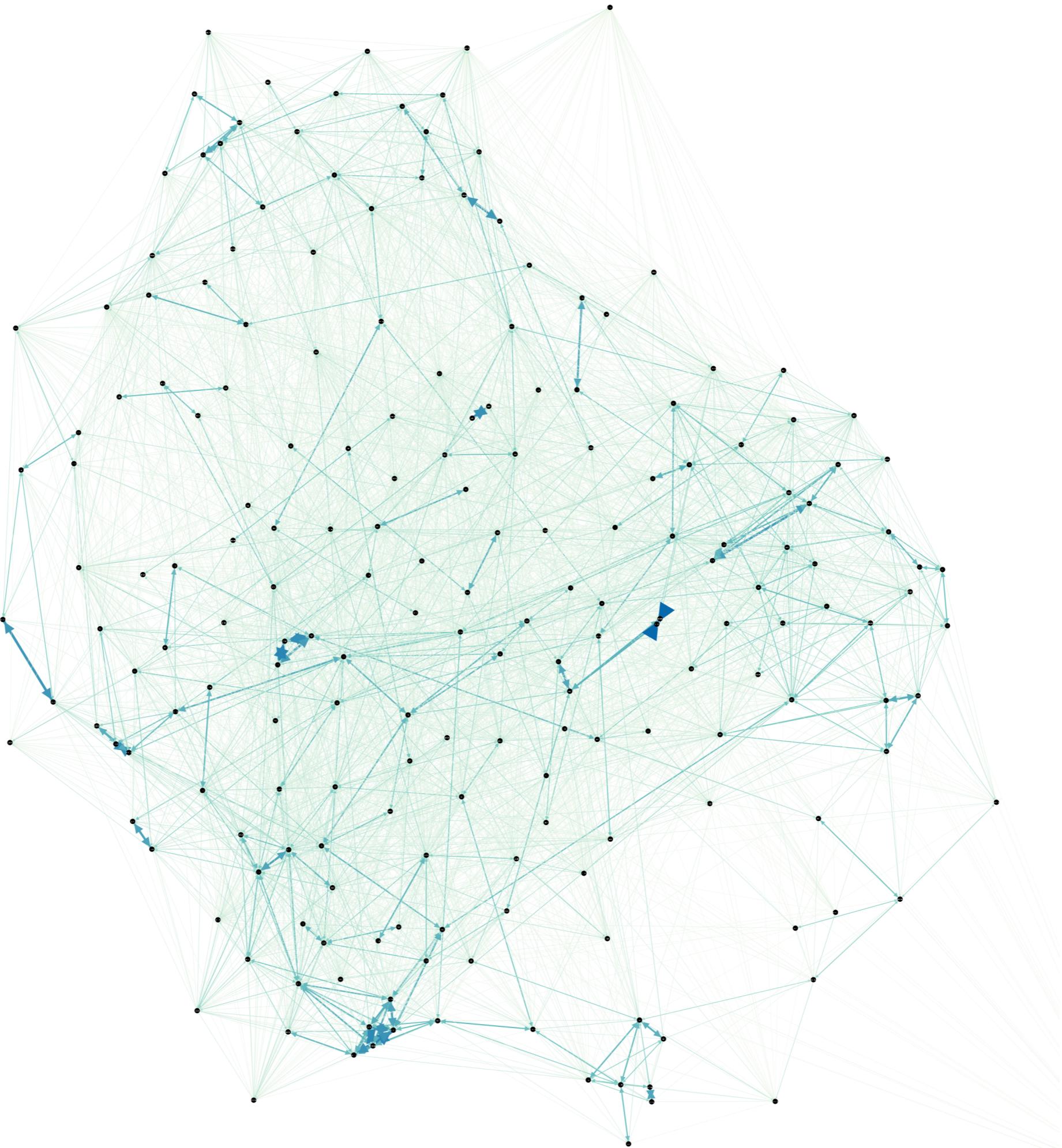
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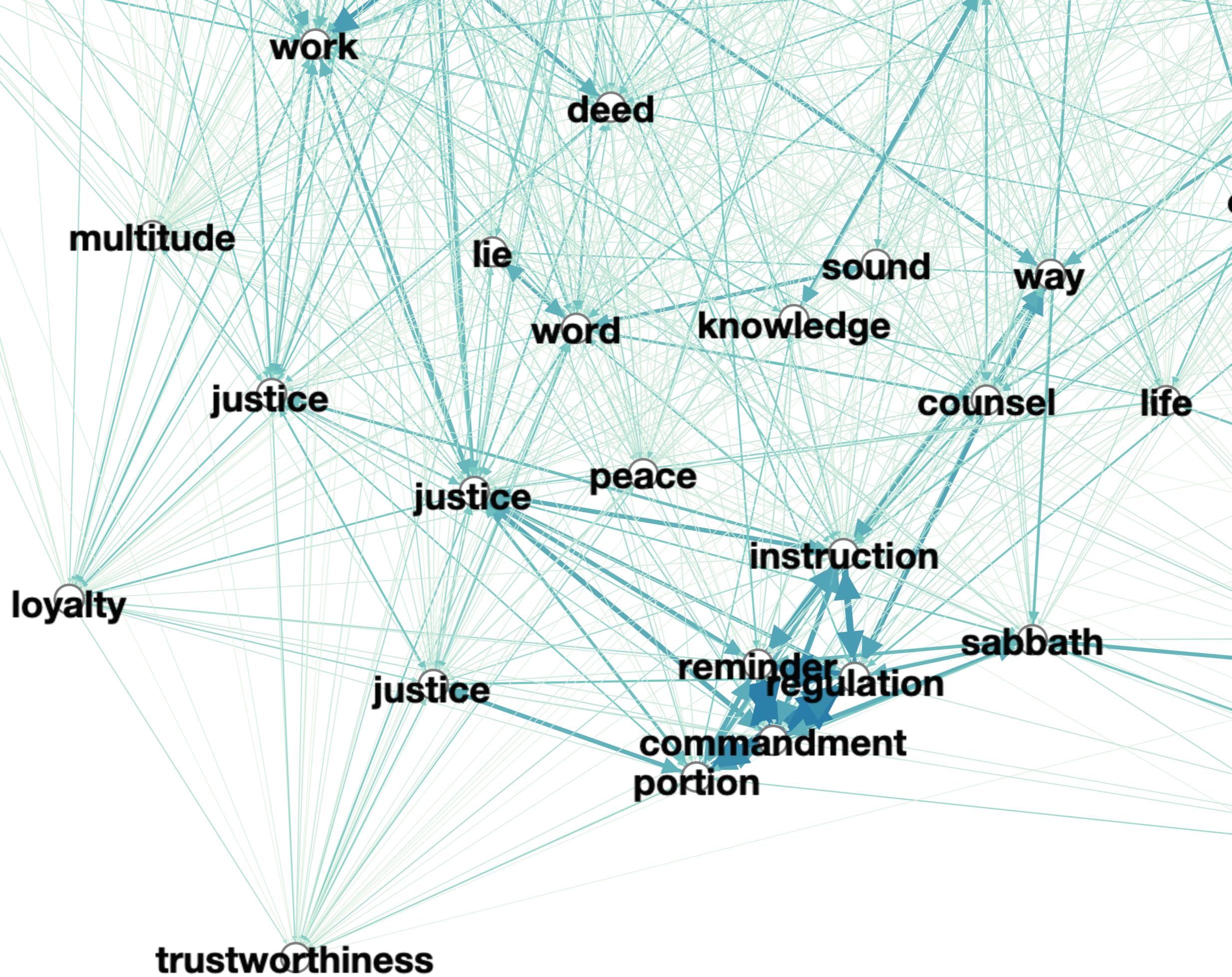
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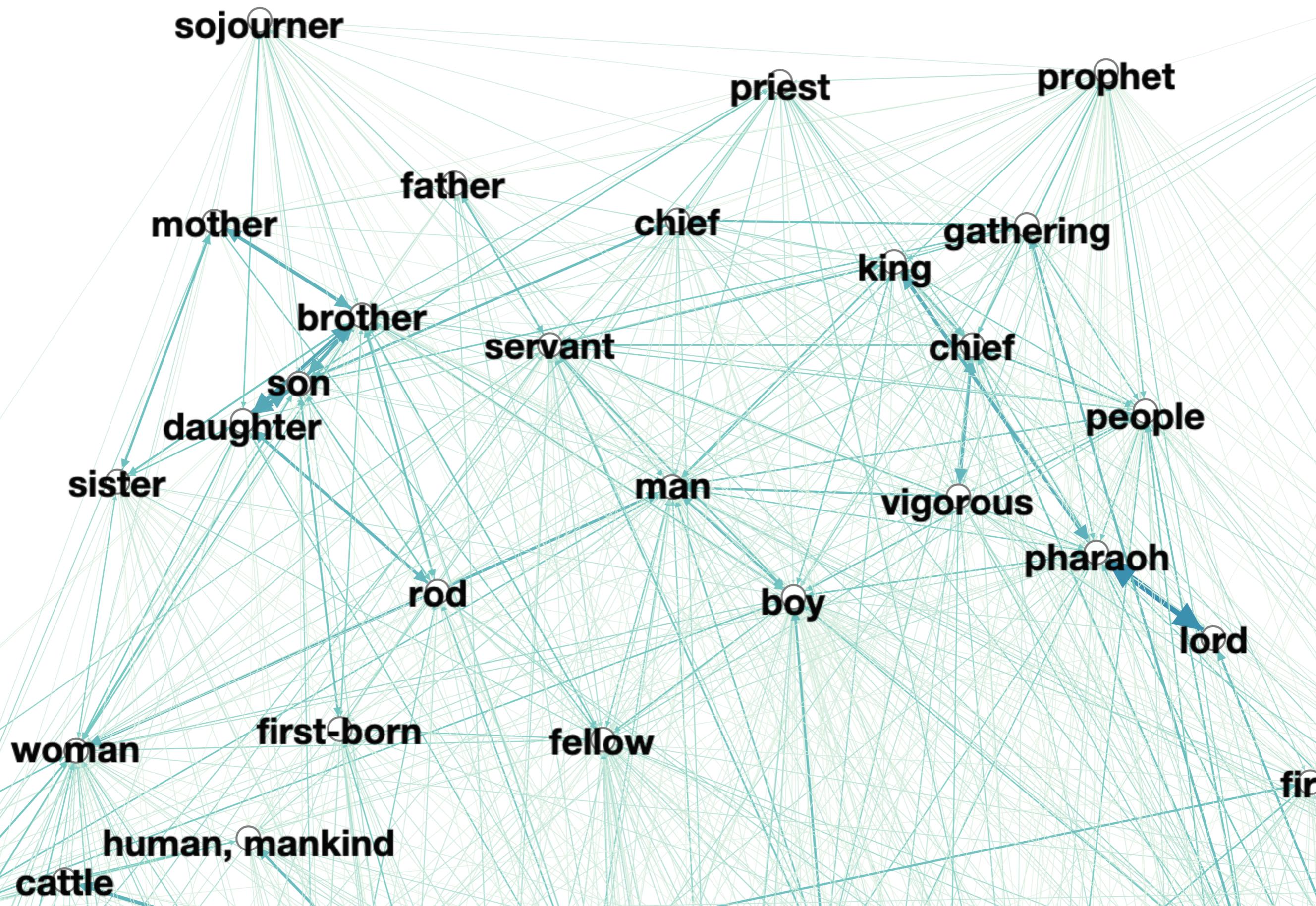
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- phrase relations: adjunct, coordinate, adjectival
 - e.g. זהב “gold” is coordinate with **כסף “silver”**

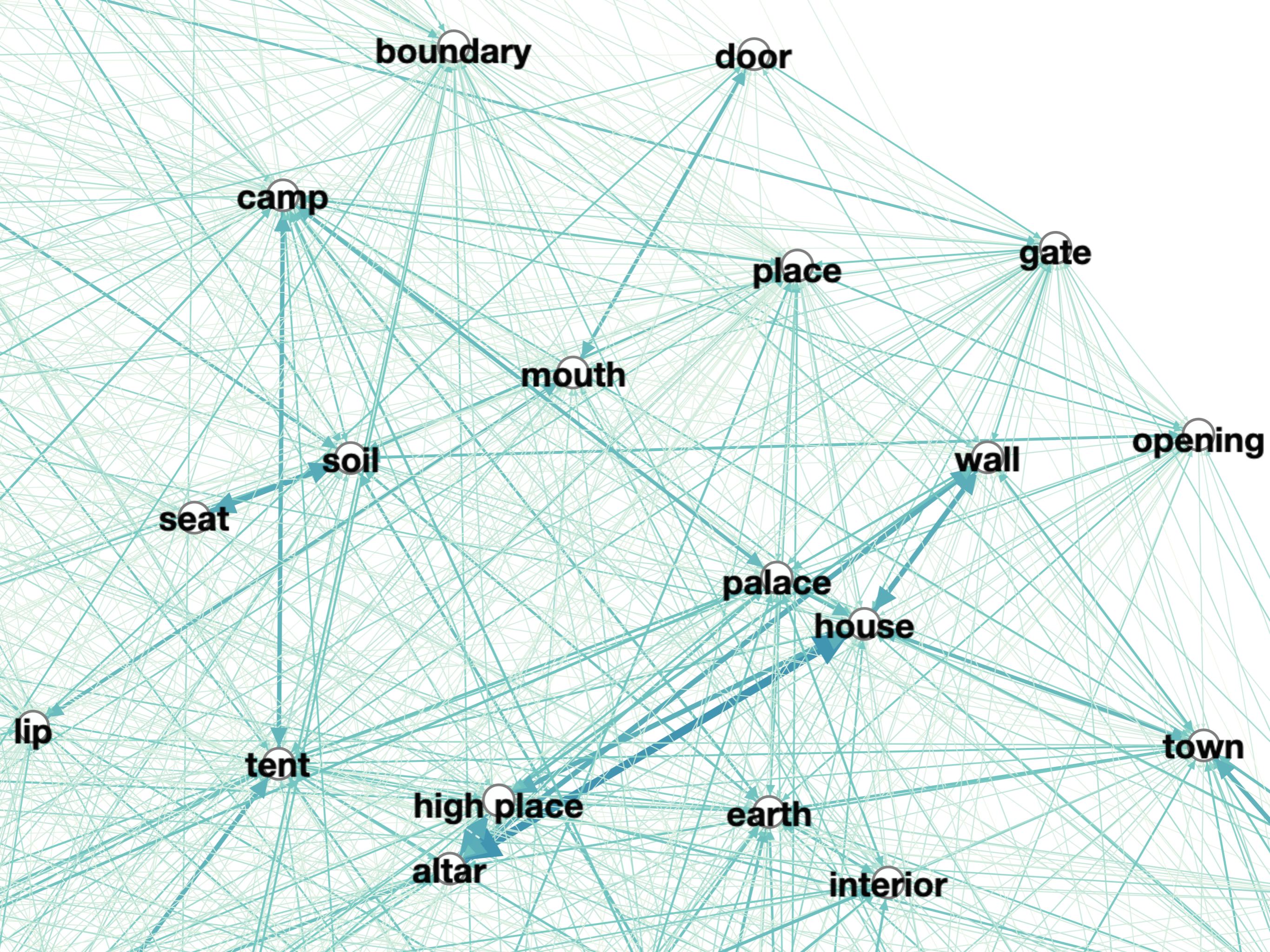
noun		context tag		frequency
לב	Objc ->	piel.	זכה.	1
פתח	Cmpl ->	qal.	עמד.	10
איש	Subj ->	hit.	פקד.	2
ארץ	Loca ->	qal.	גפל.	1

noun		context tag		frequency	
גוי	Adju	- בָּ	qal.	אמר.	2
יד	Cmpl	- מִן	hif.	ישע.	17
עת	Time	- בָּ	nif.	נתן.	1
דרך	Cmpl	- לְ	qal.	פונה.	1

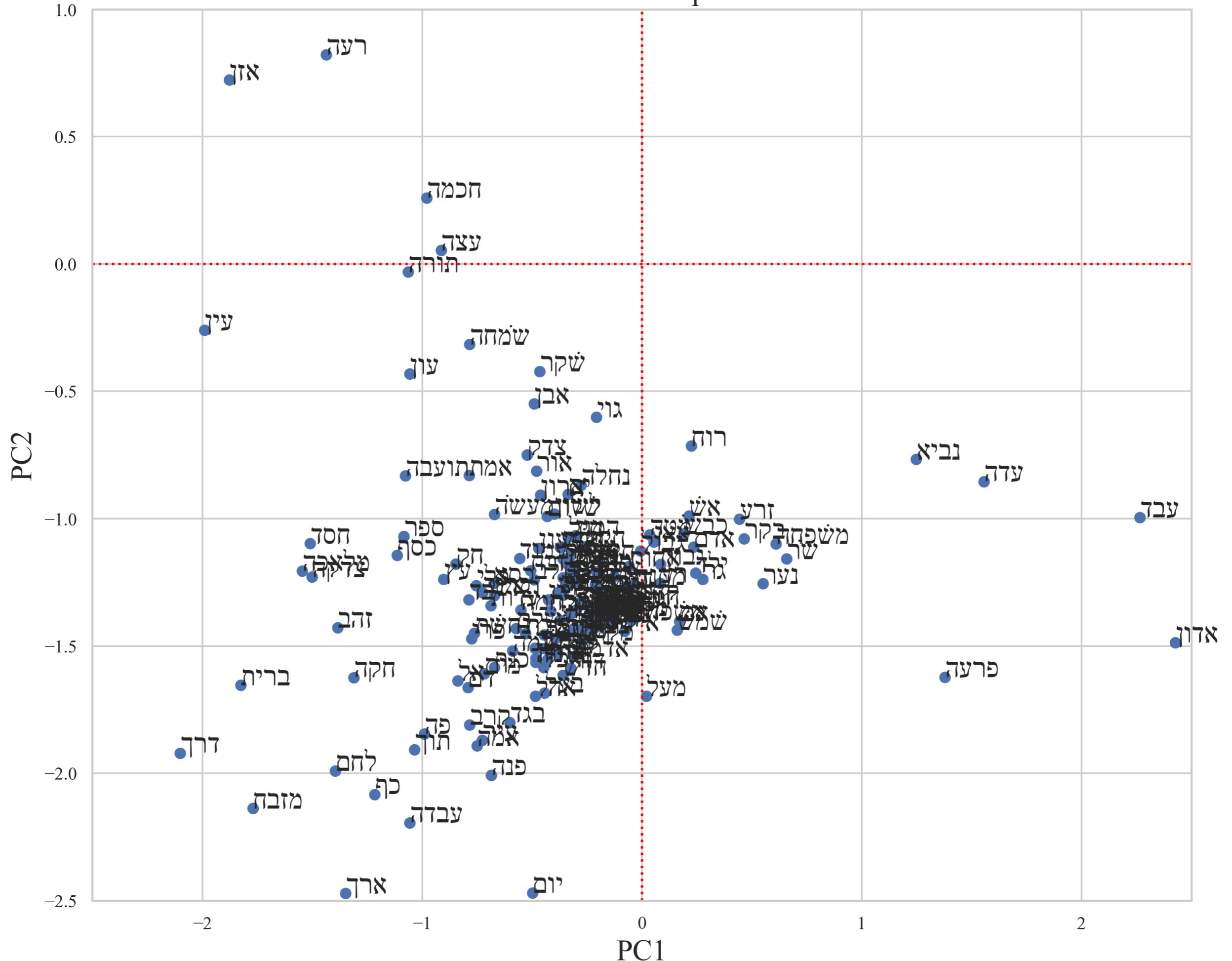




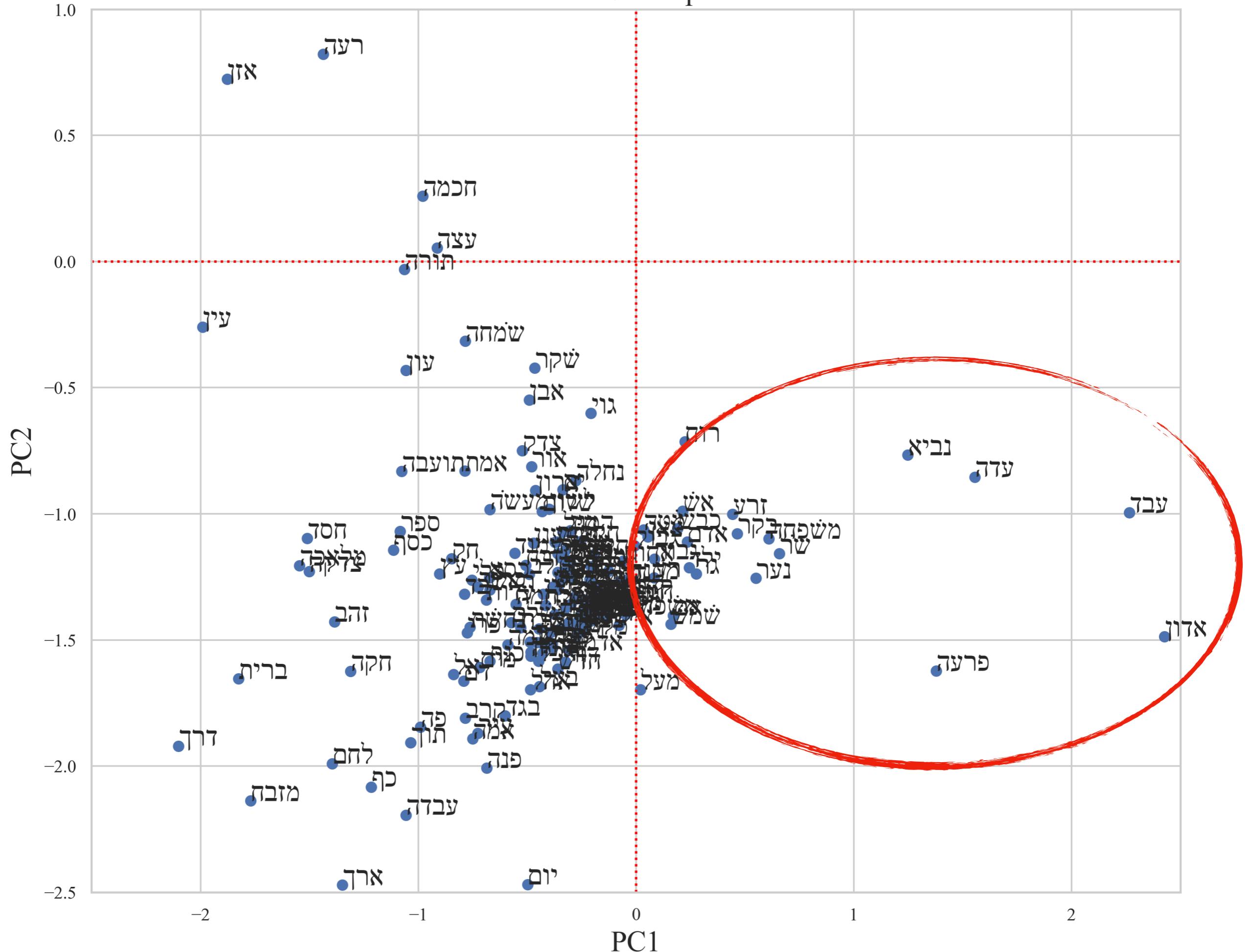




PCA Noun Space



PCA Noun Space



~Animate Group

בן "son" (205.55)	שבט "tribe; rod" (2.94)	גָּרֶר "sojourner" (0.28)
בת "daughter" (26.0)	אָב "father" (2.9)	יַלְדֵּן "boy" (0.24)
אח "brother" (12.1)	אָדוֹן "lord" (2.43)	אָדָם "human, mankind" (0.24)
כהן "priest" (11.03)	עָבֵד "servant" (2.27)	רוֹחַ "wind" (0.22)
פר "young bull" (10.06)	עֲדָה "gathering" (1.56)	אֵשׁ "fire" (0.21)
מלך "king" (9.24)	פְּרָעהּ "pharaoh" (1.38)	כָּבֵשׂ "young ram" (0.19)
אִשָּׁה "woman" (4.62)	נָבִיא "prophet" (1.25)	אֶם "mother" (0.17)
אִישׁ "man" (4.24)	שָׁרֵךְ "chief" (0.66)	שֶׁמֶשׁ "sun" (0.16)
עם "people" (3.86)	מַשְׂפְּחָה "clan" (0.61)	גָּבּוֹר "vigorous" (0.08)
בָּכָר "first-born" (3.81)	גַּעַר "boy" (0.55)	רַע "fellow" (0.08)
נְשִׁיאָה "chief" (3.01)	בָּקָר "cattle" (0.46)	
	זְרֻעָה "seed" (0.44)	

Noun	Context	Hits	Passages	Example
יד.n1	T.Subj→עֲשָׂה.v1.qal	7	Isa 31:7, 41:20, 66:2; Ps 119:73; Job 5:12, 12:9;	אֲשֶׁר עָשָׂה לְכֶם יְדִיכֶם חַטָּאת: (Isa 31:7)
שנה.n1	T.Subj→יִסְף.v1.hif	1	Prov 9:11	וַיֹּסֵיף לְךָ שָׁנָות חַיִים: (Prov 9:11)
יום.n1	T.Subj→חַנָּה.v1.qal	1	Judg 19:9	הַגָּה חַנּוֹת הַיּוֹם (Judg 19:9)
יום.n1	T.Subj→בָּוּא.v1.qal	14	1 Sam 26:10; Isa 13:9; Jer 46:21, 50:27, 50:31; Ezek	אוֹיָם בָּזָא (1 Sam 26:10)
בָּית.n1	T.Subj→מוֹת.v1.qal	2	1 Sam 22:16; 1 Chr 10:6	מוֹת תָּמֹות אַתָּה וּכְלַבָּית אָבִיךָ: (1 Sam 22:16)
בָּית.n1	T.Subj→אָסְף.v1.nif	1	Judg 9:6	וַיַּאֲסַפֵּוּ בְּלִבְנֵי שָׁבֵט וּכְלַבָּית מְלֹא (Judg 9:6)
בָּית.n1	T.Subj→אָכַל.v1.qal	3	Num 18:31; Deut 15:20; 1 Kgs 17:15	וְאָכַלְתֶּם אֹתָן בְּכָל-מִקְומֵם אַתָּם וּבִתְּכֶם (Num 18:31)
ען.n1	T.Subj→שָׁמַר.v1.qal	1	Job 24:15	וְעַן נָאָר שָׁמְרָה גַּשְׁךְ (Job 24:15)
ען.n1	T.Subj→שָׁאַל.v1.qal	1	Eccl 2:10	אֲשֶׁר שָׁאַלְוּ עִינֵּי (Eccl 2:10)
עיר.n1	T.Subj→יִשְׁבּוּ.v1.qal	4	Jer 17:25, 31:24; Ezek 36:35; Lam 1:1	וַיִּשְׁבּוּ הָעִיר-הַזֹּאת לְעוֹלָם: (Jer 17:25)
עיר.n1	T.Subj→זָעַק.v1.qal	1	1 Sam 4:13	וַתָּזַעַק בְּלַהֲעֵיר: (1 Sam 4:13)
צדקה.n1	T.Subj→יִשְׁבּוּ.v1.qal	1	Isa 32:16	וְצִדְקָה בְּפַרְמַל תִּשְׁבּוּ: (Isa 32:16)
מים.n1	T.Subj→בָּוּא.v1.qal	6	Lev 11:34; Num 5:22, 5:24, 5:27; Ezek 47:9; Ps	אֲשֶׁר יָבֹא עַלְיוֹ מִים (Lev 11:34)
מים.n1	T.Subj→הָלַךְ.v1.qal	1	1 Kgs 18:35	וַיָּלֹכוּ הַמִּים סְבִיבָם לְמִזְבֵּחַ (1 Kgs 18:35)
לב.n1	T.Subj→מוֹת.v1.qal	1	1 Sam 25:37	וַיִּמְתַּתְּ לְבָוּ בְּקָרְבָּוּ (1 Sam 25:37)
לב.n1	T.Subj→זָעַק.v1.qal	1	Isa 15:5	לְבֵי לְמוֹאָב זָעַק (Isa 15:5)

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לֵב.n1	T.Subj→ הַלְךָ.v1.qal	2	2 Kgs 5:26; Job 31:7	לֹא־לֶבִי הַלְךָ (2 Kgs 5:26)
לֵב.n1	T.Subj→ נִכָּה.v1.hif	2	1 Sam 24:6; 2 Sam 24:10	וַיַּד לִב־דָּן אֲתָּה (1 Sam 24:6)
עַז.n1	T.Subj→ הַלְךָ.v1.qal	1	Judg 9:8	הַלְׁזֵד הַלְּבָבָ הַעֲצִים (Judg 9:8)
תוֹעַבָּה.n1	T.Subj→ עָשָׂה.v1.qal	1	Jer 32:35	לְעַשְׂוֹת הַתוֹעַבָּה הַזֹּאת (Jer 32:35)
סִפְר.n1	T.Subj→ בָּוֹא.v1.qal	2	2 Kgs 5:6, 10:7	בָּבּוֹא הַסִּפְרָ הַזֶּה אָלִיךָ (2 Kgs 5:6)
נֶפֶש.n1	T.Subj→ מוֹת.v1.qal	3	Num 23:10; Judg 16:30; Job 36:14	תִּמְתַּחַנְתִּי מְמוֹת יִשְׂרָאֵל (Num 23:10)
נֶפֶש.n1	T.Subj→ שָׁמַר.v1.qal	1	Ps 119:167	שָׁמַרְתִּי נֶפֶשִׁי עַד־תִּקְרָב (Ps 119:167)
נֶפֶש.n1	T.Subj→ אָכְל.v1.qal	1	Lev 17:12	כָּל־נֶפֶשׁ מִכֶּם לֹא־תִּאָכְלֶנּוּ דָם (Lev 17:12)
נֶפֶש.n1	T.Subj→ שָׁאֵל.v1.qal	1	Deut 14:26	אֲשֶׁר תִּשְׁאַלְתָּךְ נֶפֶשׁ (Deut 14:26)
נֶפֶש.n1	T.Subj→ הַלְךָ.v1.qal	2	Isa 46:2; Eccl 6:9	וְנֶפֶשׁ בְּשֻׁבִּי הַלְּבָבָ: ס (Isa 46:2)

Coordinate Parsing Model



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Isaiah 17:11

בַּיּוֹם נִחְלָה וּכְאָב אֶנוֹשׁ

in a day of sickness and pain incurable

Cosine Distance

	day	sickness
pain	0.85	0.13

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Proverbs 7:9

בְּאַיִשָׁזֹן לִילָה וּאֲפָלָה

in pupil of night and darkness

Cosine Distance

	night	pupil
darkness	0.47	0.66

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בְּאַיִשָׁזׁוֹן לִילָה וְאַפְלָה

in pupil of night and darkness

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ימֵי עֲנִיה וּמְרוֹדִיחַ

days of humiliation and roving

Cosine Distance

day humiliation

roving 1.41 0.70

Proverbs 7:9

ימֵי עֲנִיה וּמְרוֹדִיה :

days of humiliation and roving

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בָּמוֹת אֲבִיהָ וְאֶמְהָ

at death of her father and her mother

Cosine Distance

	death	father
mother	1.22	0.51

Proverbs 7:9

בָּמוֹת אֲבִיהָ וְאֶמְהָ

at death of her father and her mother

Proverbs 7:9

בַּיּוֹם עֲנָנוֹ וְעַרְפָּלָן

in a day of cloud and darkness

Cosine Distance

	day	cloud
darkness	1.11	0.73

Proverbs 7:9

בַּיּוֹם עָבֵן וְעַרְפֵּל

in a day of cloud and darkness

Looking Ahead

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- e.g. can Zipfian distributions be used as reference points for a machine learning model to classify rare terms?

Works Cited

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