

Learning Antonyms with Paraphrases and a Morphology- aware Neural Network

Sneha Rajana

Department of Computer and Information Science
University of Pennsylvania



What are Antonyms?

cool/not cool boat/rudder good/bad mouse/animal
hot/cold acceptable/intolerable cold/chilly
enemy/fan up/down
ascend/slip spirited/spiritless
like/love nose/human love/hate
penguin/clown
hello/fine cold/lukewarm absence/presence
friend/enemy honest/dishonest
voice/silent agree/disagree happy/joy

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Computing Word-Pair Antonymy
Mohammad et al. (2008)

Defining Antonymy

- Strictest sense: gradable adjectives

hot-cold tall-short

- Broader sense: other adjectives, nouns, and verbs

life-death ascend-descend shout-whisper

- Broadest sense?

Any two words that represent contrasting meanings!

Goal: Antonym Detection

Given two terms x and y , decide whether x and y are antonyms of each other

Phrases expressing the *same meaning* usually occurring in *similar textual contexts* or have *common translations* in other languages

Deriving Antonyms from Paraphrases

not allowed in here ~ not permitted
did not plan ~ had no intention
never mind about that ~ it matters not

Step 1: Seed Set Creation

WORDNET

A large lexical English database

Nouns, verbs, adjectives, adverbs are grouped into sets of cognitive synonyms or sunsets

**Direct
antonyms**

E.g. clean/dirty

Synsets

**Indirect
antonyms**

E.g. clean/foul

E.g. clean/grime



Step 2: Antonym Generation

Used PPDB to retrieve
paraphrase mappings of
2 types

Negating word

(Not X, Y)

-> (X, Y)

Negating prefix

(Neg-Prefix(X), Y)

-> (X, Y)

Negating word

(Not happy, unhappy)

-> (happy, unhappy)

Negating prefix

(unjustifiable,

unreasonable)

-> (justifiable,

unreasonable)

Step 3: Synonym Expansion

$(\sim X, Y)$
→ (X, Y)
→ $(X, \text{synonyms}(Y))$
→ $(\text{synonyms}(X), Y)$

Synsets from WordNet
and paraphrases from
PPDB

→ $(\text{happy}, \text{unhappy})$
→ $(\text{happy}, \text{synsets}(\text{unhappy}))$
→ $(\text{synsets}(\text{happy}), \text{unhappy})$

→ $(\text{justifiable}, \text{unreasonable})$
→ $(\text{justifiable}, \text{paraphrases}(\text{unreasonable}))$
→ $(\text{justifiable}, \text{paraphrases}(\text{unjustifiable}))$

Antonym Generation

WordNet

Direct Antonyms	Indirect Antonyms
clean/dirty	clean/foul
rise/fall	rise/downfall
sleep/wake	sleep/rise
above/below	above/under

Negating Word

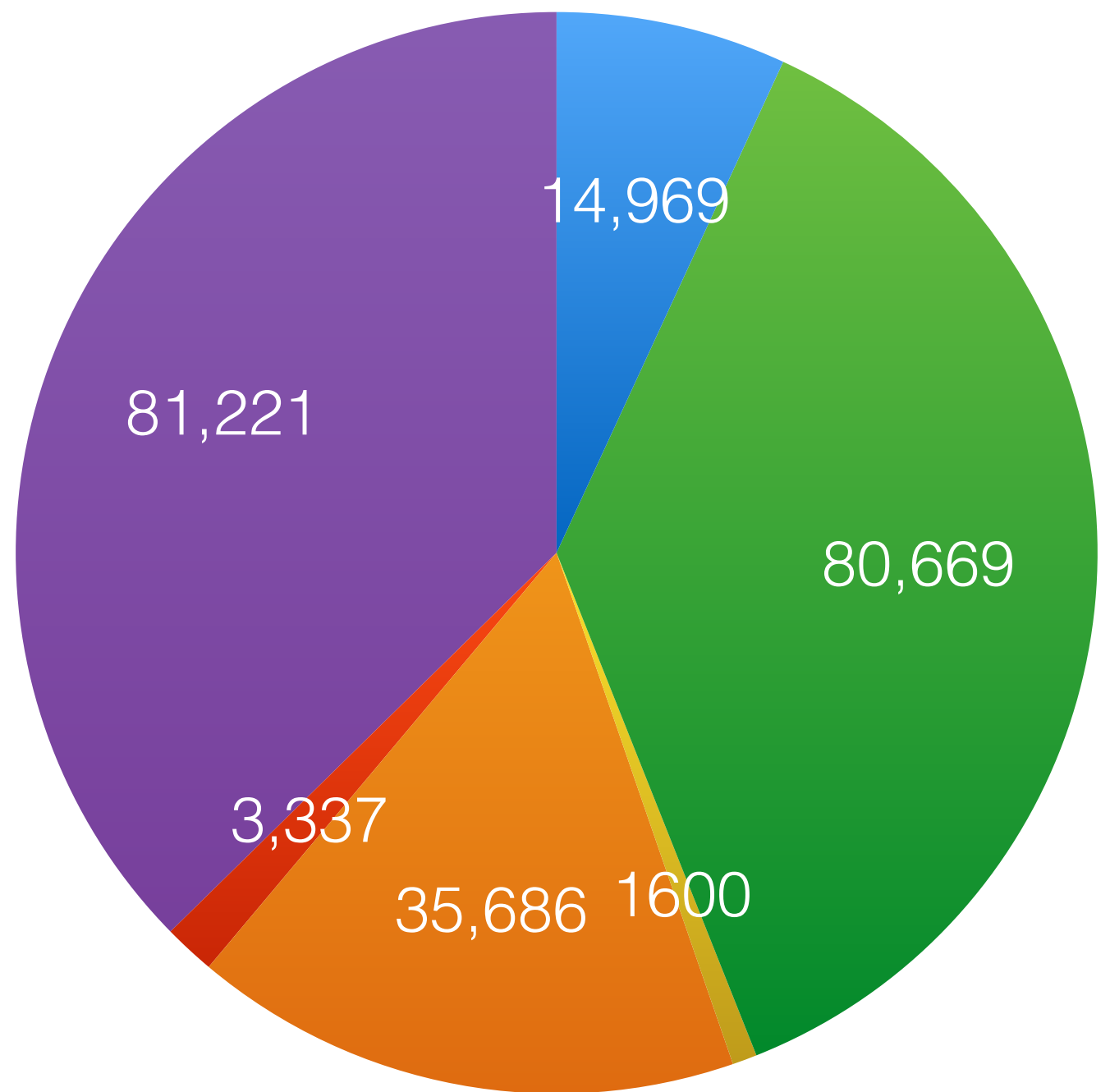
Paraphrase Pair	Antonym Pair
not true/untrue	true/untrue
not identical/different	identical/different
not acceptable/ objectionable	acceptable/ objectionable
not sufficient/ insufficient	sufficient/insufficient

Negating Prefix

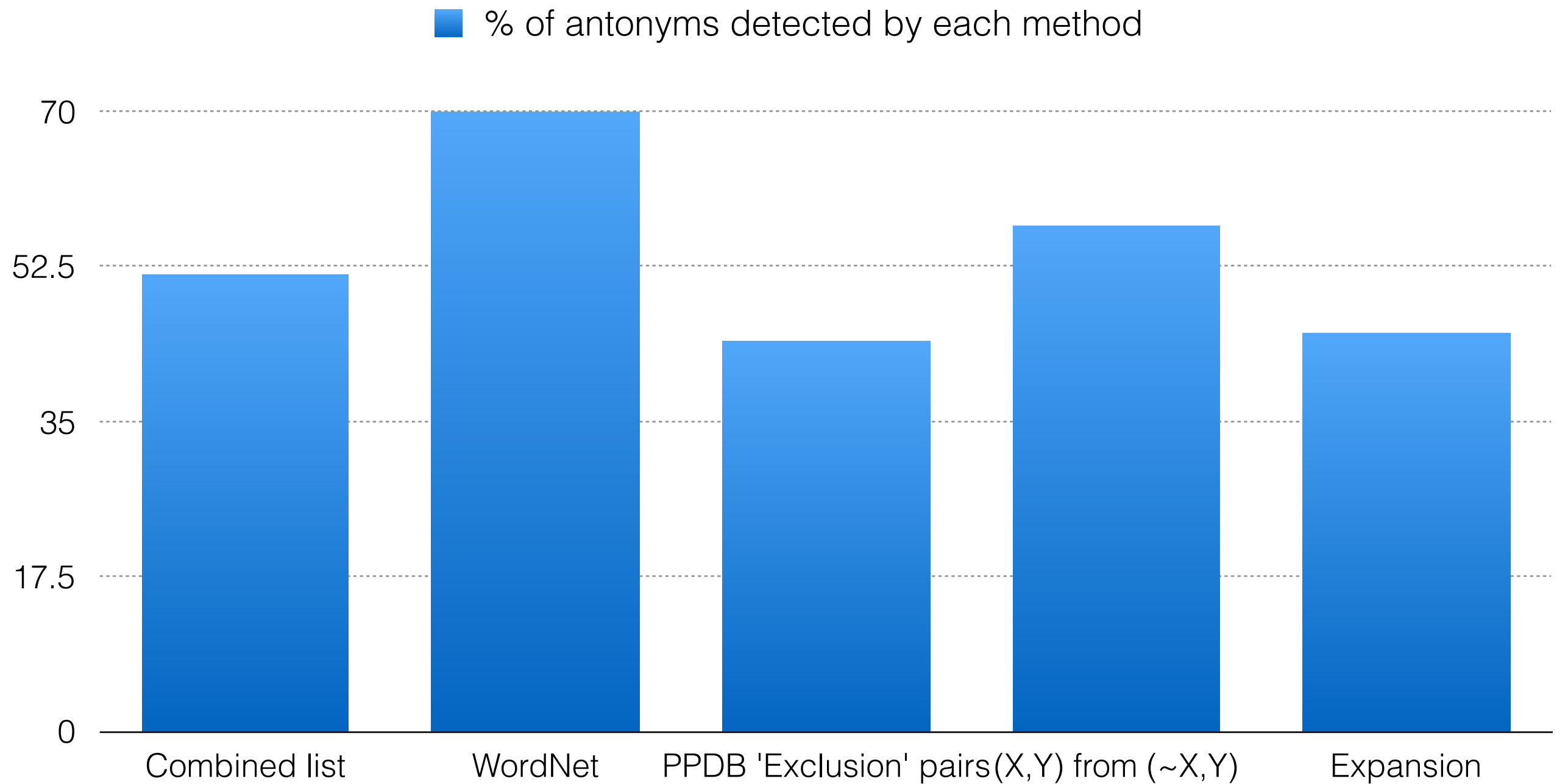
Paraphrase Pair	Antonyms Pair
deactivate/turned off	activate/turned off
unjustifiable/ unreasonable	justifiable/reasonable
deforestation/ destruction	forestation/ destruction
anti-hatred/non- hatred	hatred/non-hatred

Antonyms derived from PPDB

- WordNet-synset
- (X,Y) from (\sim X,Y)
- EVALution
- WordNet Expansion
- WordNet
- PPDB Expansion



Evaluation



Classification of non-antonyms

Paraphrases

simply/merely
correct/that's right
till/until
right/alright

Unrelated

long/rare
much/worthless
disability/present/
equality/gap

Categories

Africa/Asia
Jan/Feb
Black/Red
Blonde/
Brunette

Entailment

valid/equally
valid
significant/
statistically

Other

twinkle/dark
access/available
valuable/premium
naw/not gonna

Learning Antonyms with a Morphology-aware Neural Network

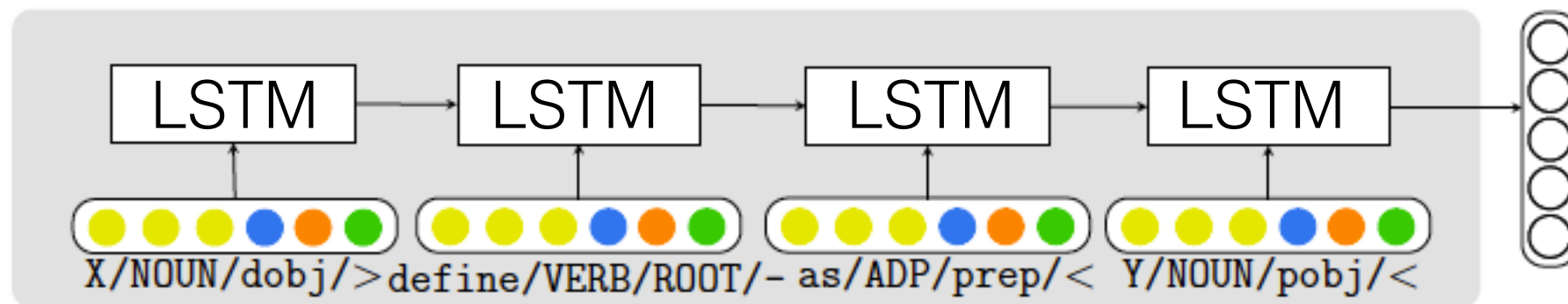
Background

- HypeNET [Vered et al., 2015]: Integrated neural path-based (improved path-based) and distributional method for detecting hypernymy.
- LexNET [Vered et al., 2016]: An extension of HypeNET to classify multiple semantic relations (E.g. meronymy, synonymy, antonymy etc.)

gold	predictions									
		ANT	RANDOM	HYPER	PART_OF	SYN	relation	P	R	F_1
	ANT	40.28	30.28	5.56	5.83	18.06	ANT	0.450	0.403	0.425
	RANDOM	2.35	93.07	1.31	1.37	1.90	RANDOM	0.897	0.931	0.914
	HYPER	10.21	22.77	45.81	6.02	15.18	HYPER	0.616	0.458	0.526
	PART_OF	2.23	37.05	6.70	47.77	6.25	PART_OF	0.510	0.478	0.493
	SYN	25.96	20.43	14.47	7.23	31.91	SYN	0.278	0.319	0.297

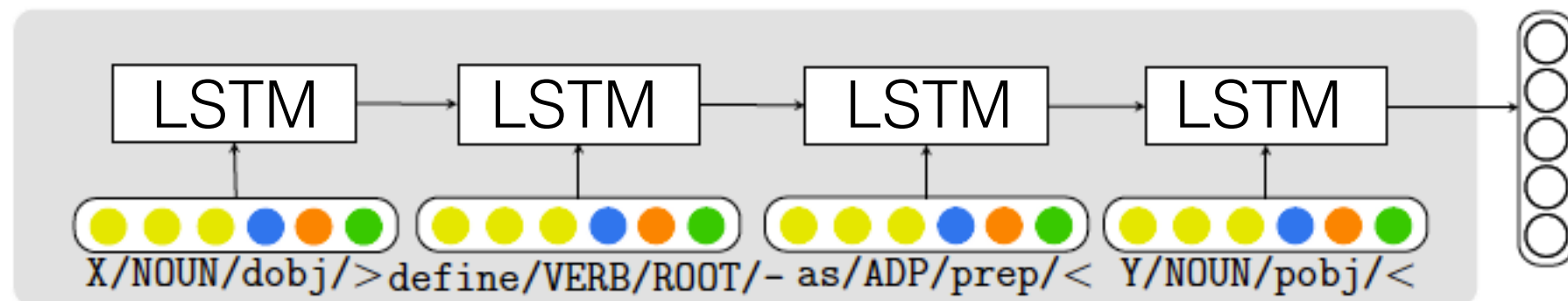
Neural path-based method

- Split each path between X and Y into edges
- Each edge consists of 4 components: lemma/POS/dependency label/direction
- Learn embedding vectors for each component



Neural path-based method

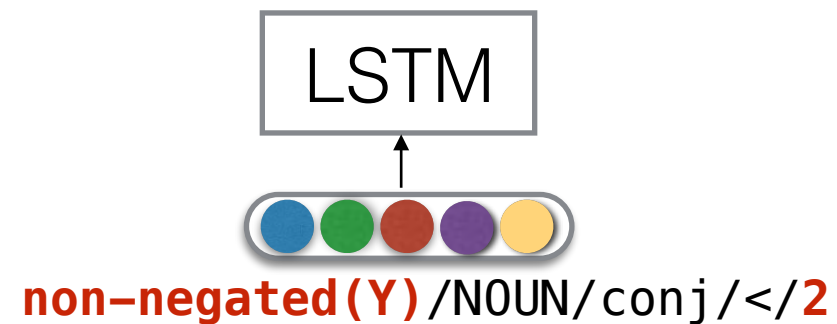
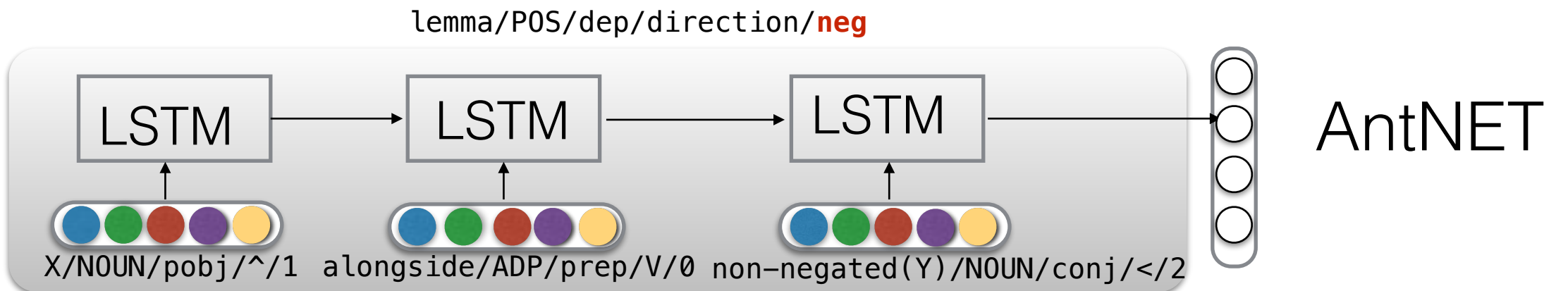
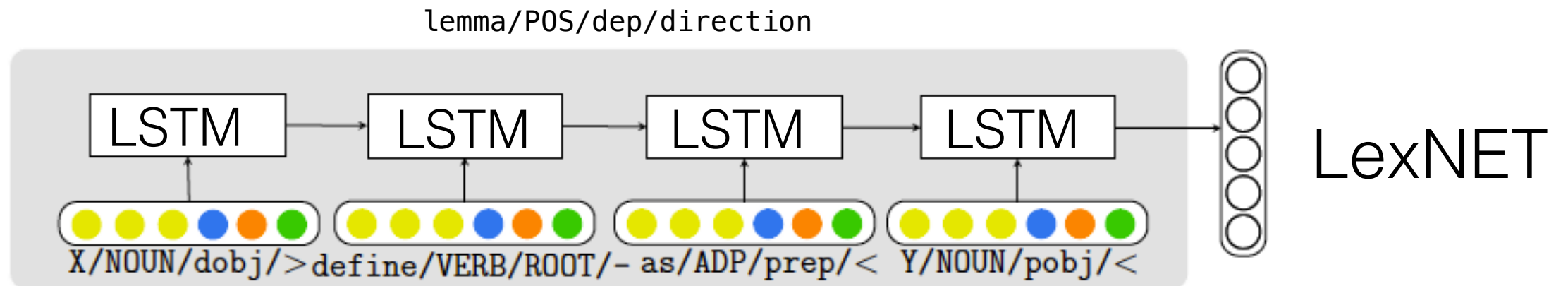
- The LSTM encodes a single path
- Each term-pair has multiple paths
 - Represent a term-pair as its averaged path embedding
- Classify for hypernym



AntNET

- Morphology aware path features
- Handles multi-word expressions
- Outperforms state-of-the-art models for antonym detection

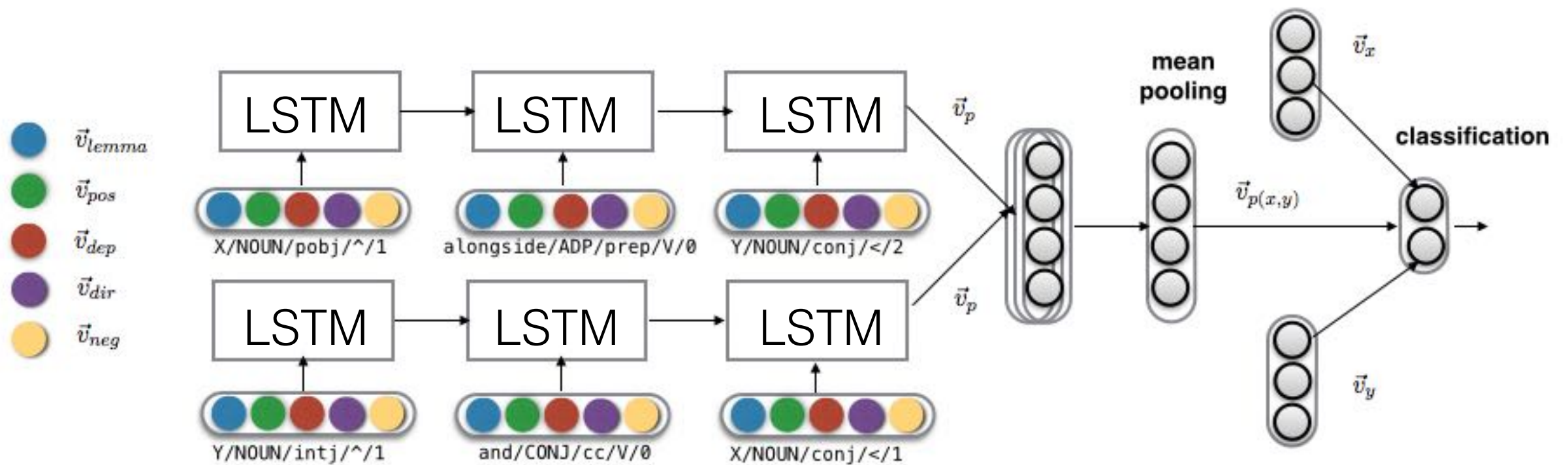
Improvement



Replacement of word embeddings

- Rare Paths: *neither happy nor sad vs. neither happy nor unhappy*
- Seemingly negated words: *valuable - invaluable*
- Multi-Word Expressions: *not happy*

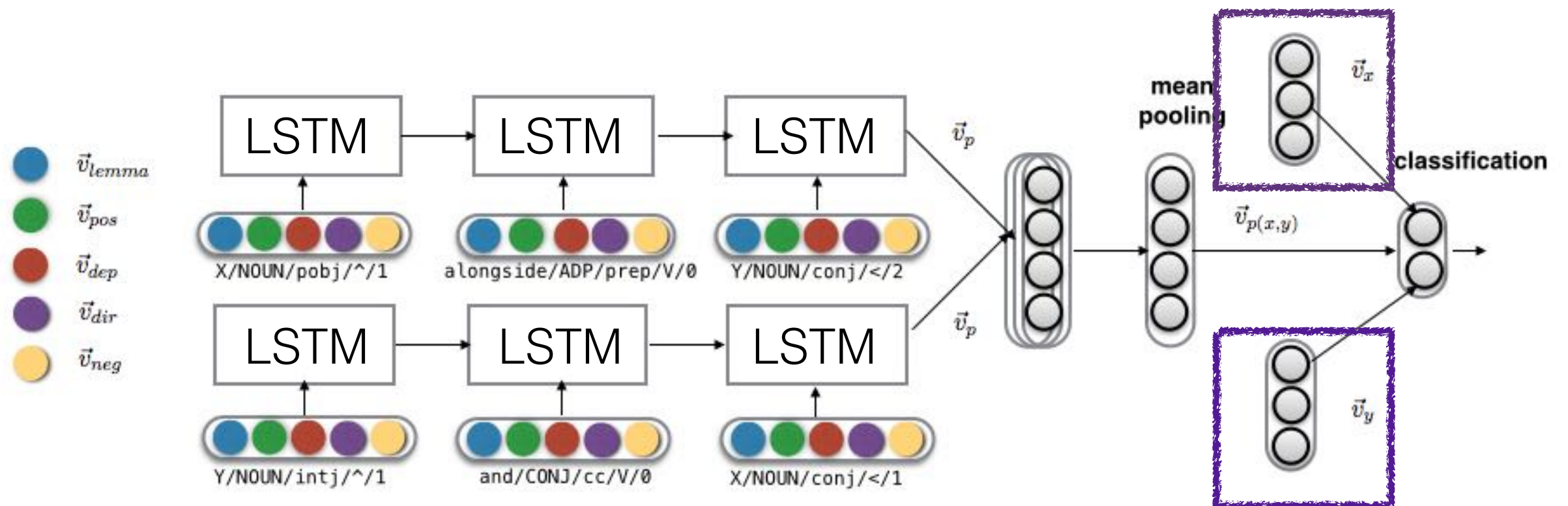
AntNET: Network Architecture



Term-Pair Classification

Integrated Model

- Add distributional information with path information
 - Concatenate x and y's word embeddings to the averaged path
- Classify for antonymy (integrated network)



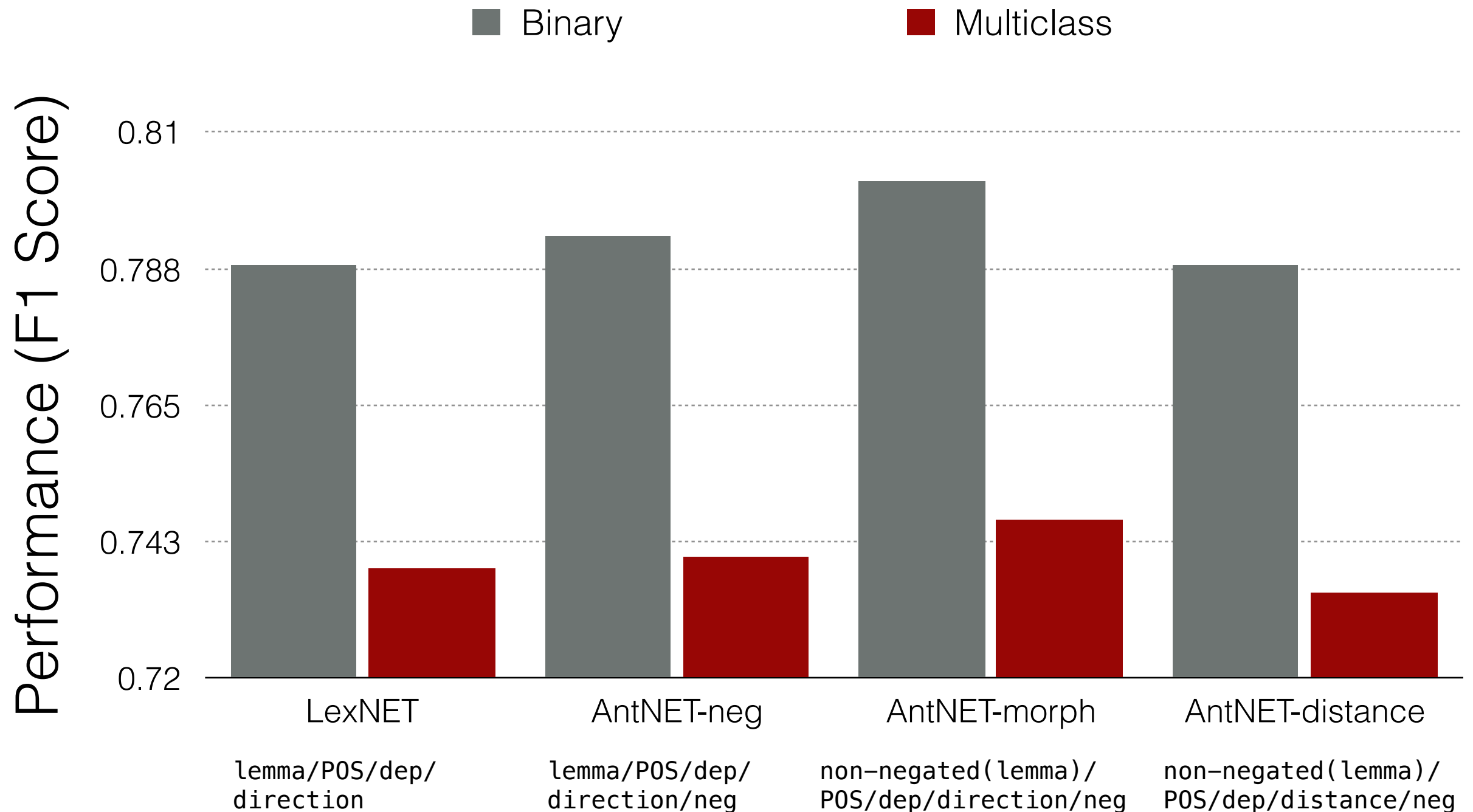
Experiments

AntNET: Results

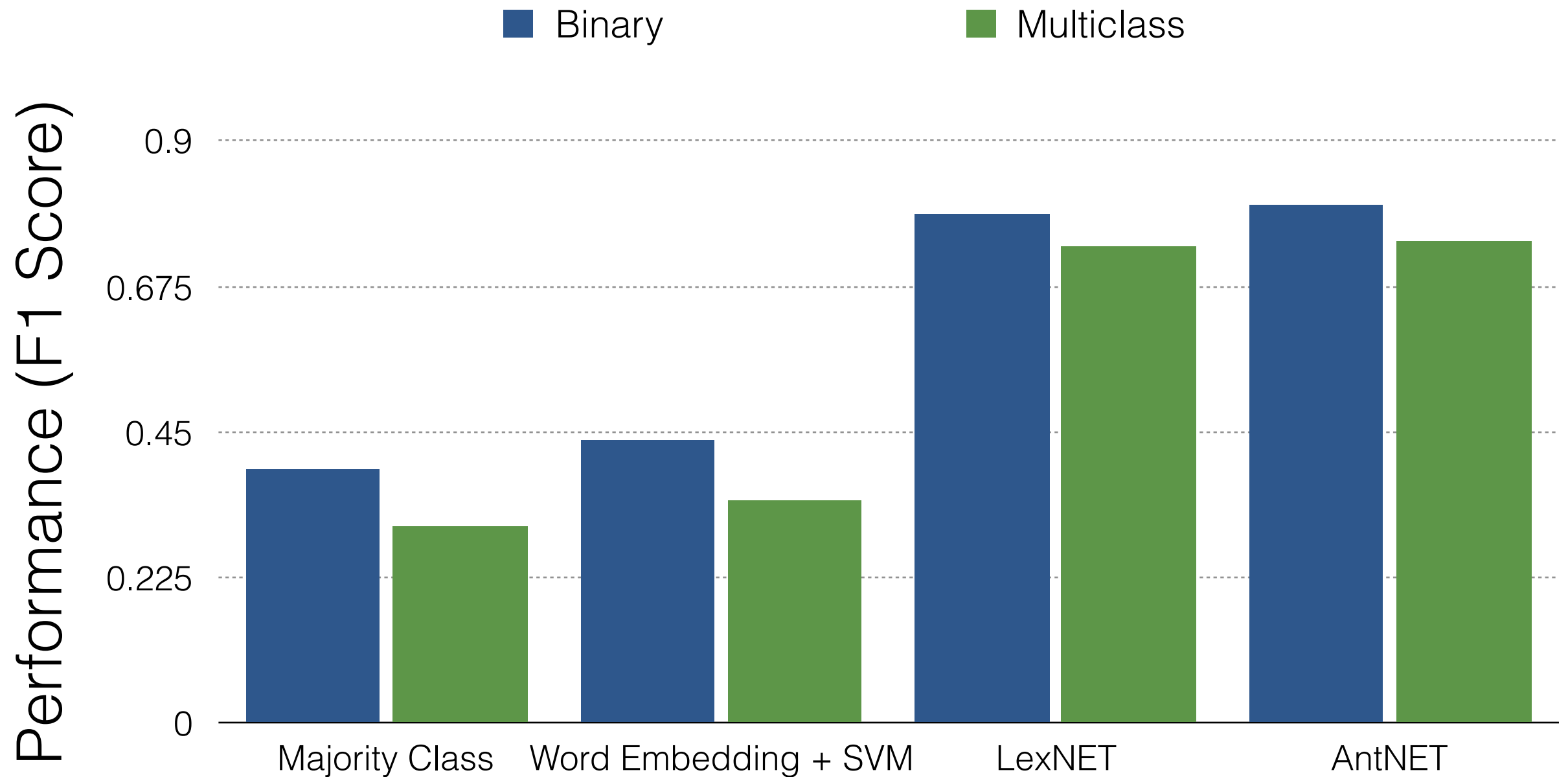
Metric	Model	Binary	Multiclass
Precision	Path-based Combined	0.732 0.803	0.652 0.746
Recall	Path-based Combined	0.724 0.788	0.687 0.757
F1	Path-based Combined	0.713 0.802**	0.661 0.746**

paired t-test, *p<0.1, **p<0.05

Effect of the negation-marking feature



AntNET: Evaluation



AntNET: Evaluation

		predictions	
		True	False
gold	True	79%	21%
	False	19%	81%

		predictions		
		antonym	other	unrelated
gold	antonym	78%	1%	21%
	other	31%	18%	51%
	unrelated	17%	2%	81%

Normalized Confusion Matrix

AntNET: Evaluation

predicted

T

F

T

F

gold

absence-presence
absolute-relative
unfashionable-
fashionable
duck-stand up
imperviousness-
perviousness

ascertain-unclear
spiritless-spirited
ripe-rotten
turn-straight
cisc-risc

japan-korea
spouse-alive
polite-sassy
bad-cunning
large-minimum

indeterminate-influence
pear shaped - square
appropriately-ghastly
salutary-scary
irrelevant-discipline

Thank You!