Deep Learning

Episode 3

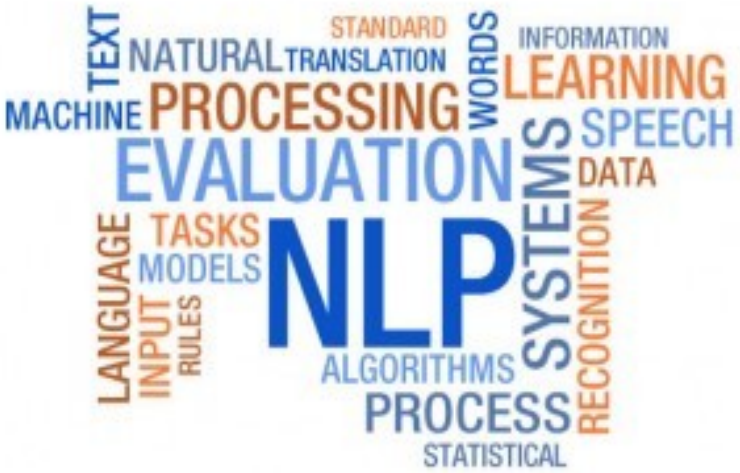
Natural Language Processing

Yandex
Data Factory

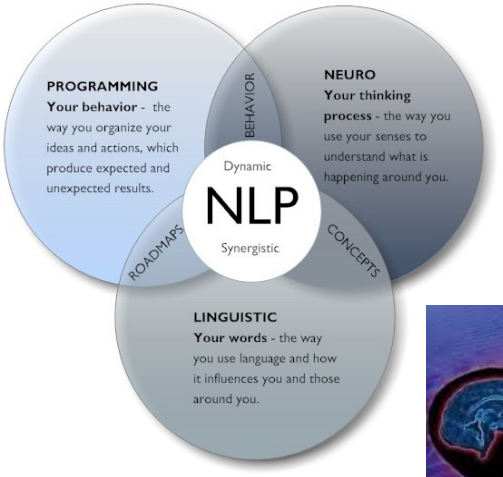
LAMBDA

British Hedgehog
Preservation Society

What is NLP?



NLP
Light side of the force



NLP
Dark side of the force

Text classification/regression

Other usage:

- Adult content filter (safe search)
- Detect age/gender/interests by search querries
- Convert movie review into “stars”
- Survey public opinion for the new iphone Vs old one (SNA)

...

Text 101

text

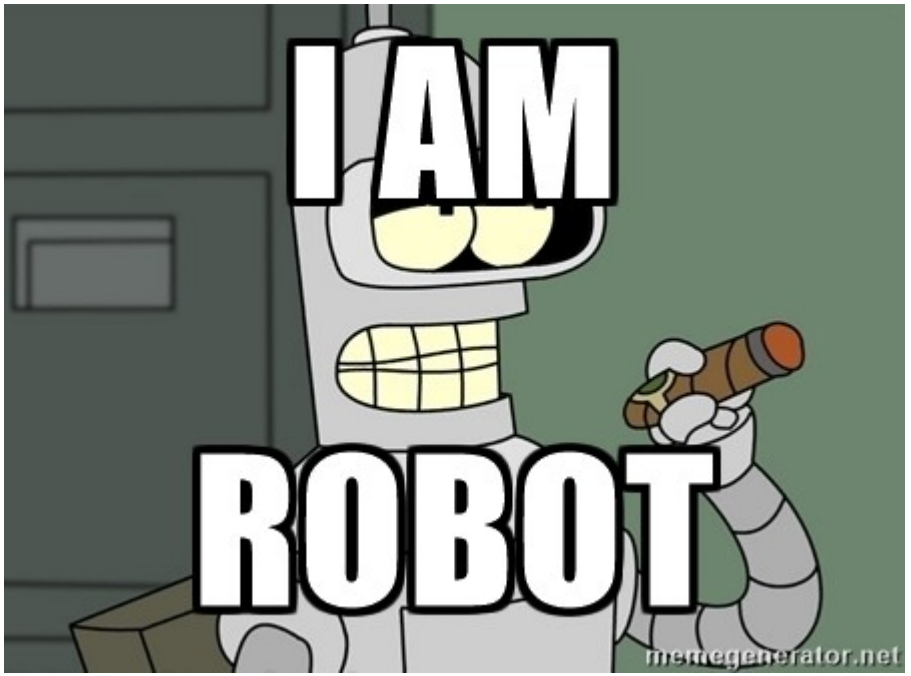
/tɛkst/

noun

1. a book or other written or printed work, regarded in terms of its content rather than its physical form.
   "a text which explores pain and grief"
   synonyms: written work, book, work, printed work, narrative
   "a text which explores pain and grief"

2. the main body of a book or other piece of writing, as distinct from other material such as notes, appendices, and illustrations.
   "the pictures are clear and relate well to the text"
   synonyms: words, wording; More

Text 101: nlp perspective



Text:

A sequence of tokens(words).

Token/word:

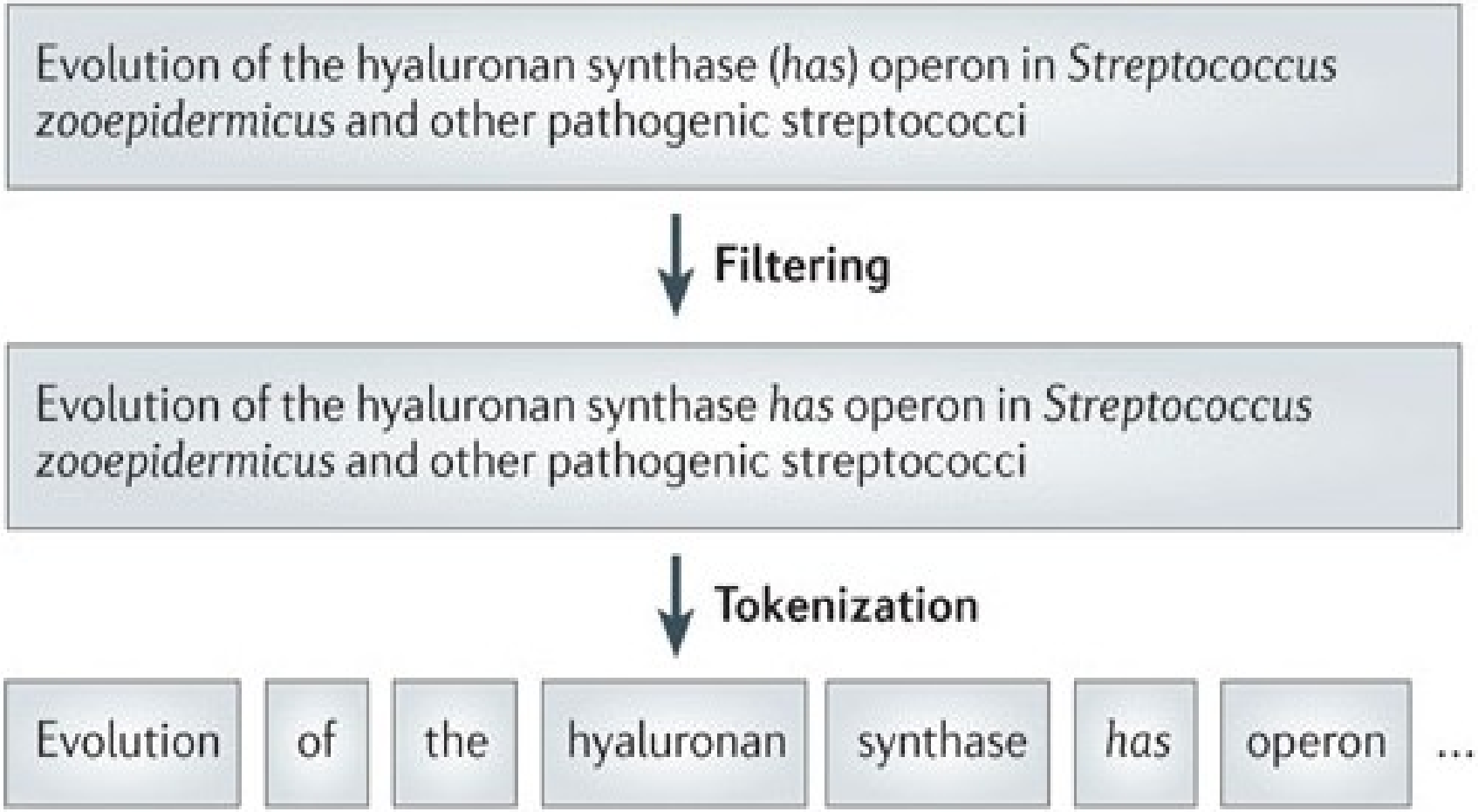
A sequence of characters.

Character:

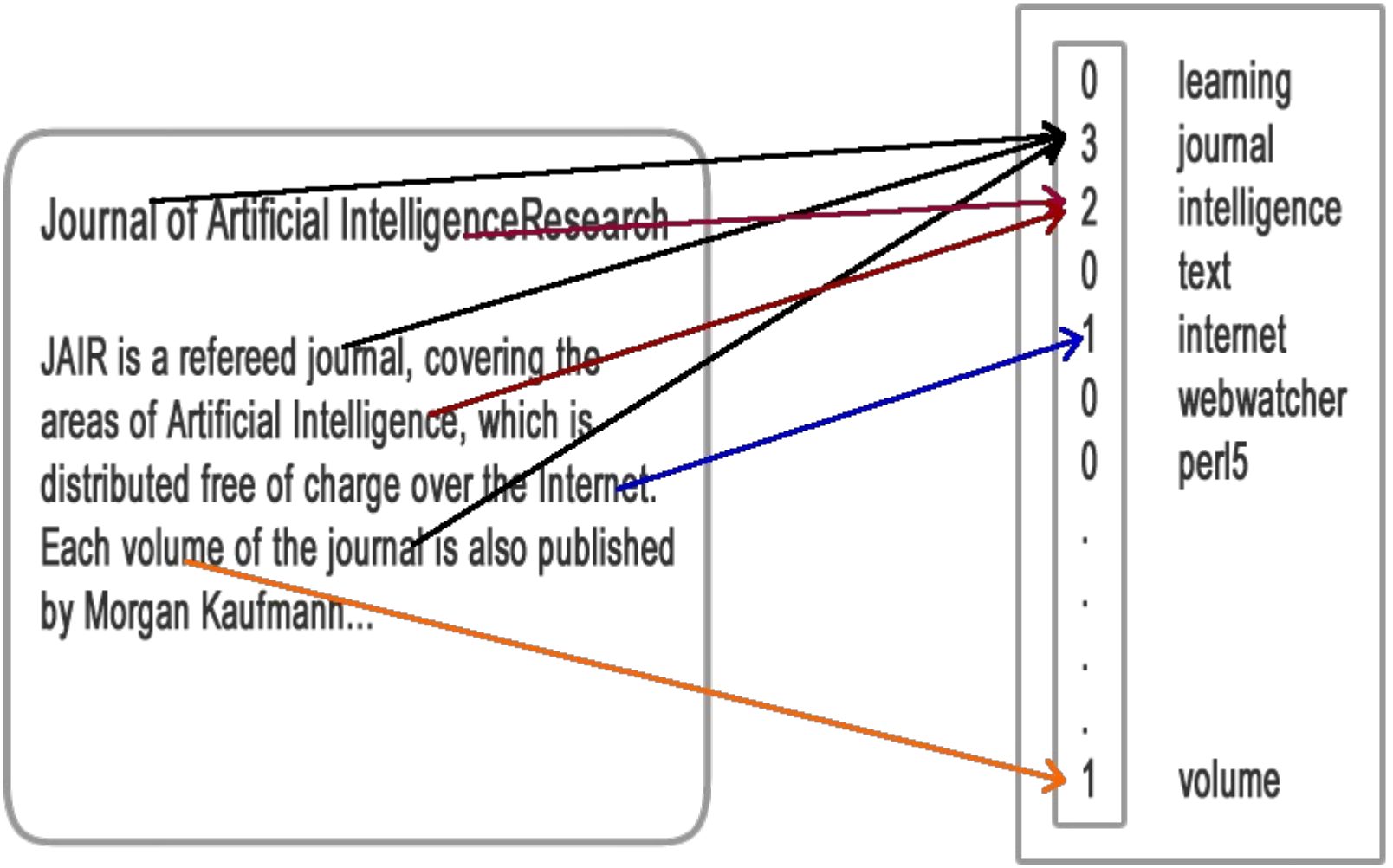
An atomic element of text.

¯_(ツ)_/¯

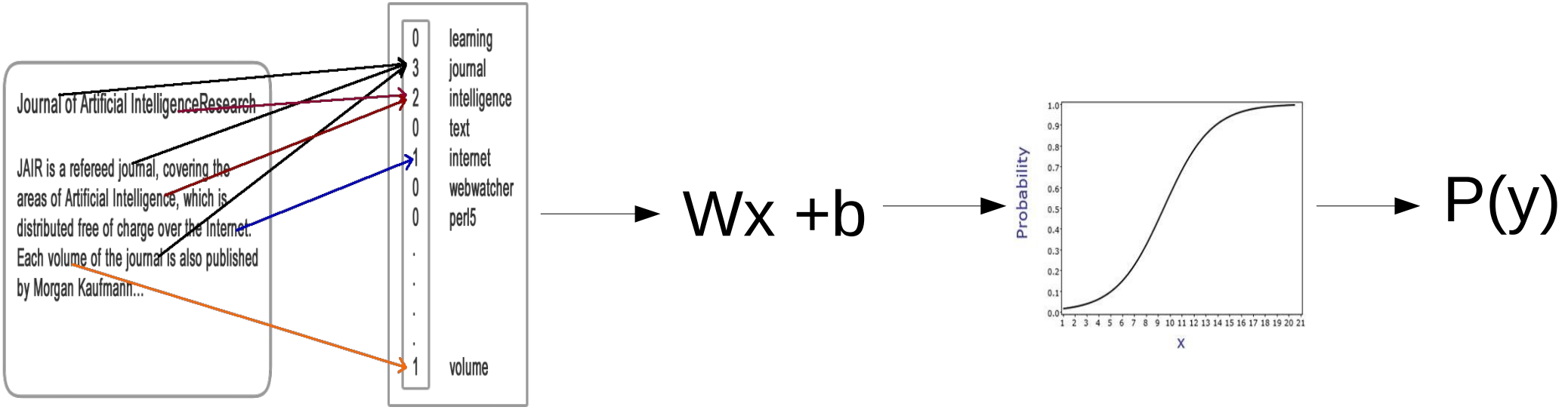
Text 101: tokens



What is a text 101: bag of words

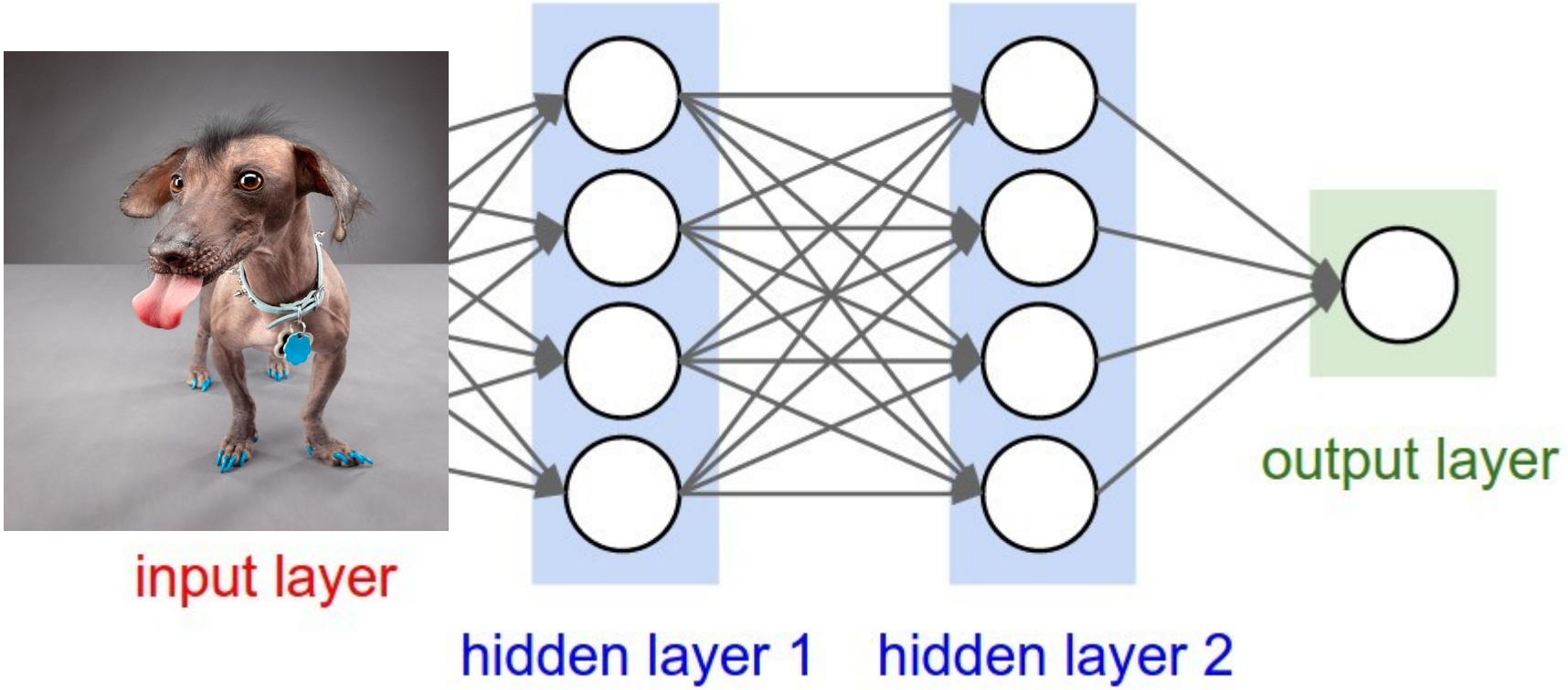


Text classification: BoW + linear



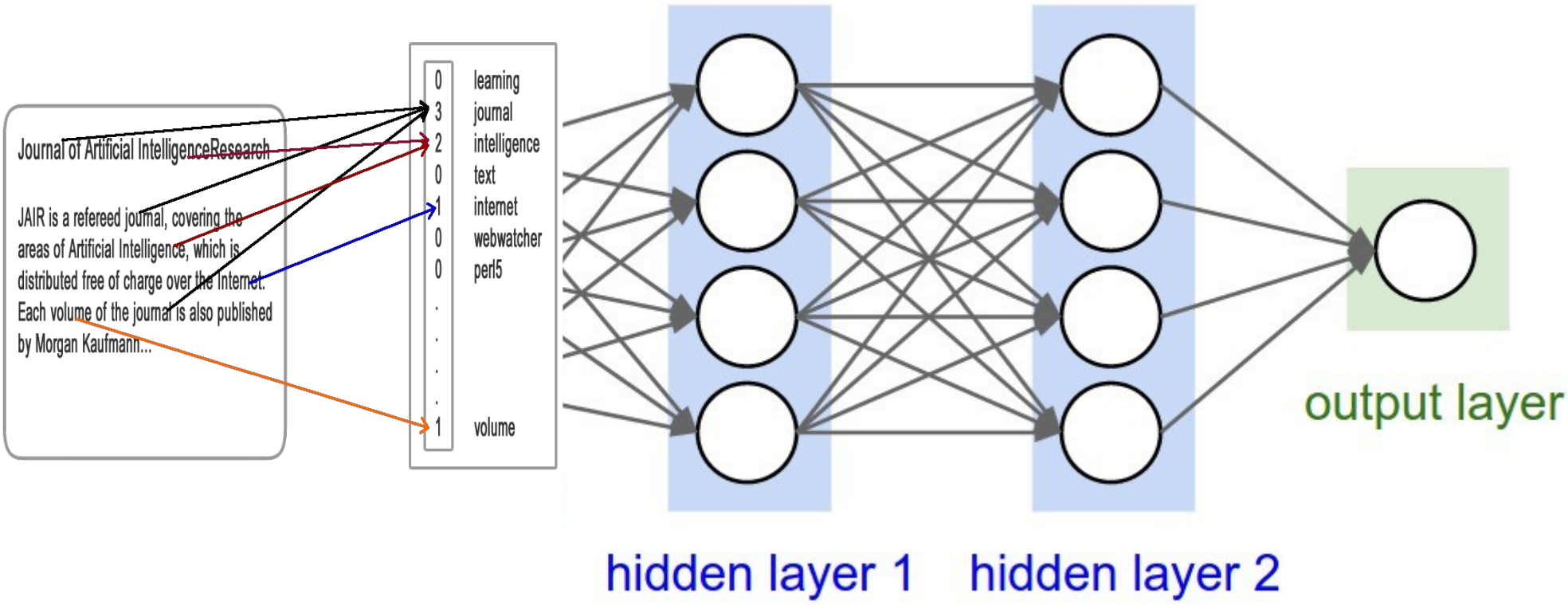
Divination: How many features (approx) will such model have?

Text classification: BoW + linear

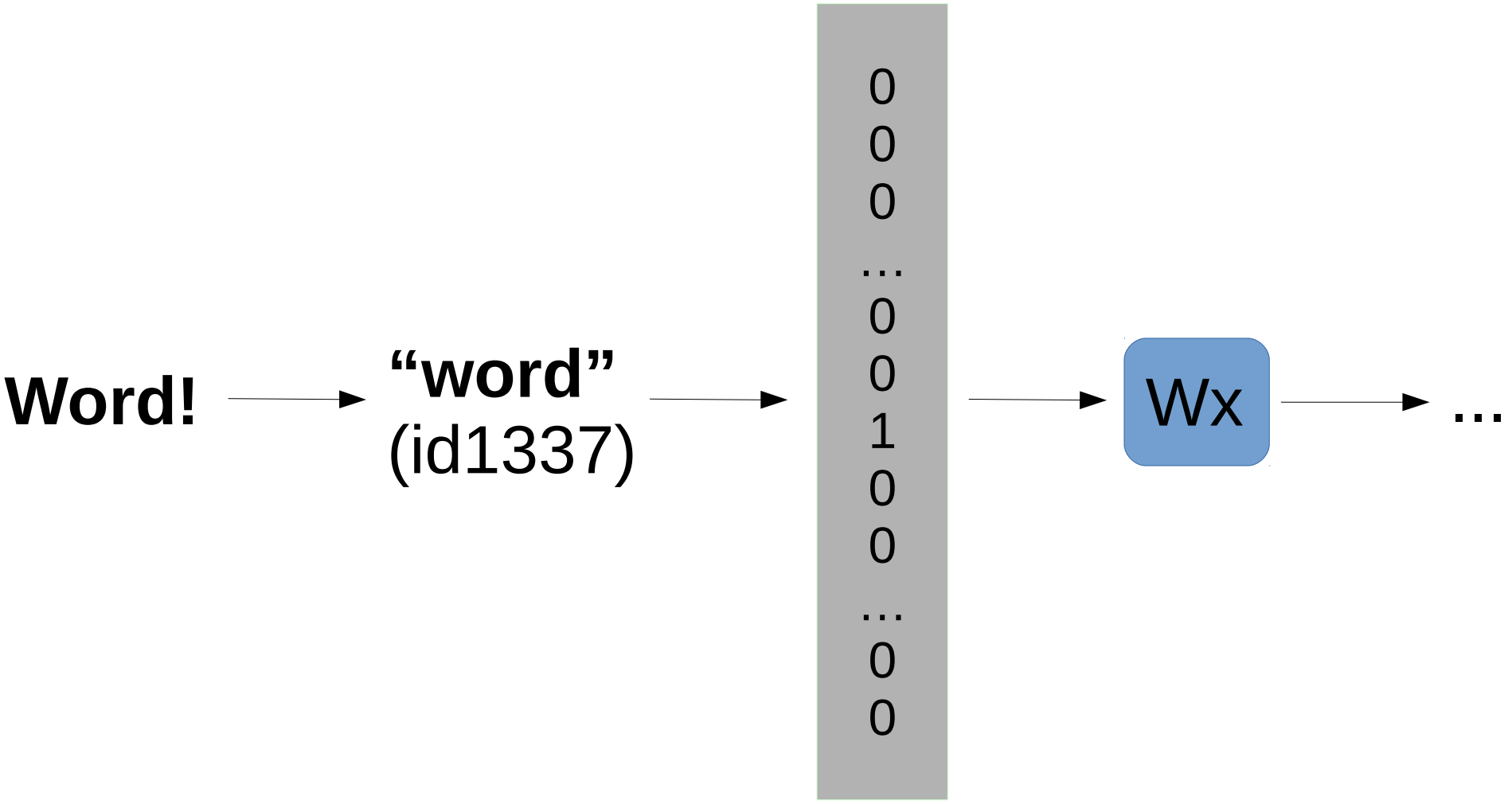


Oops... wrong slide...

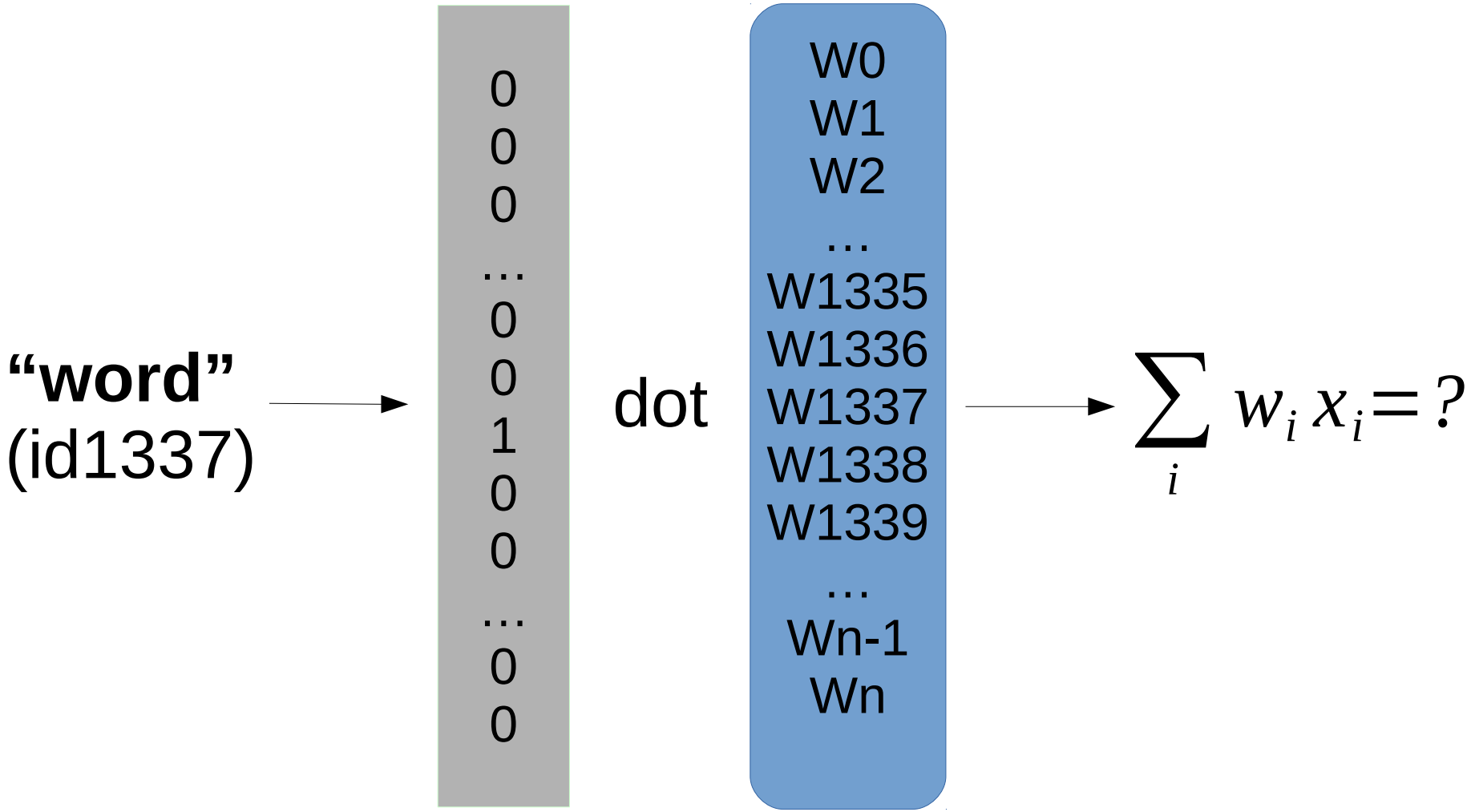
Text classification: BoW + linear



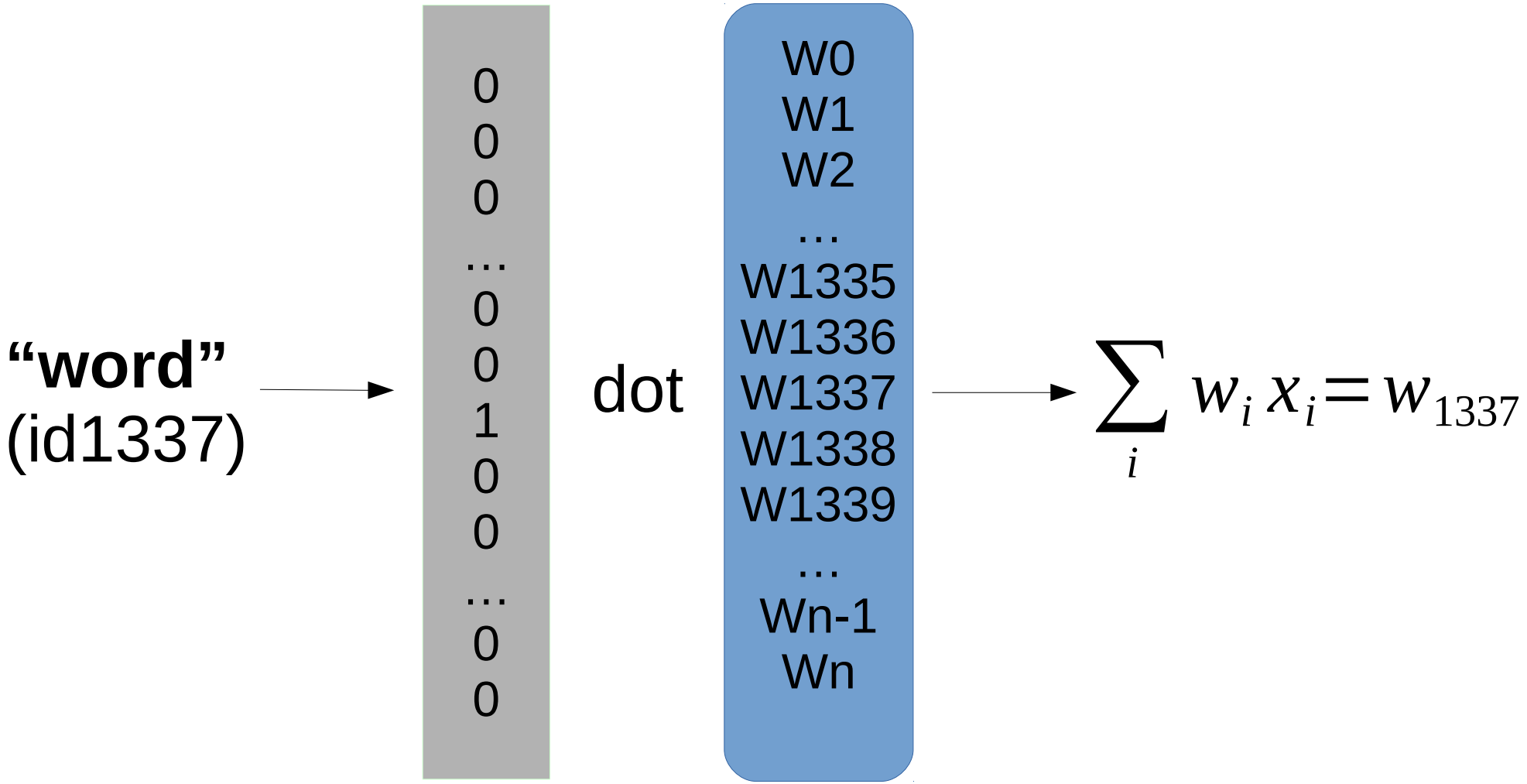
Sparse vector products



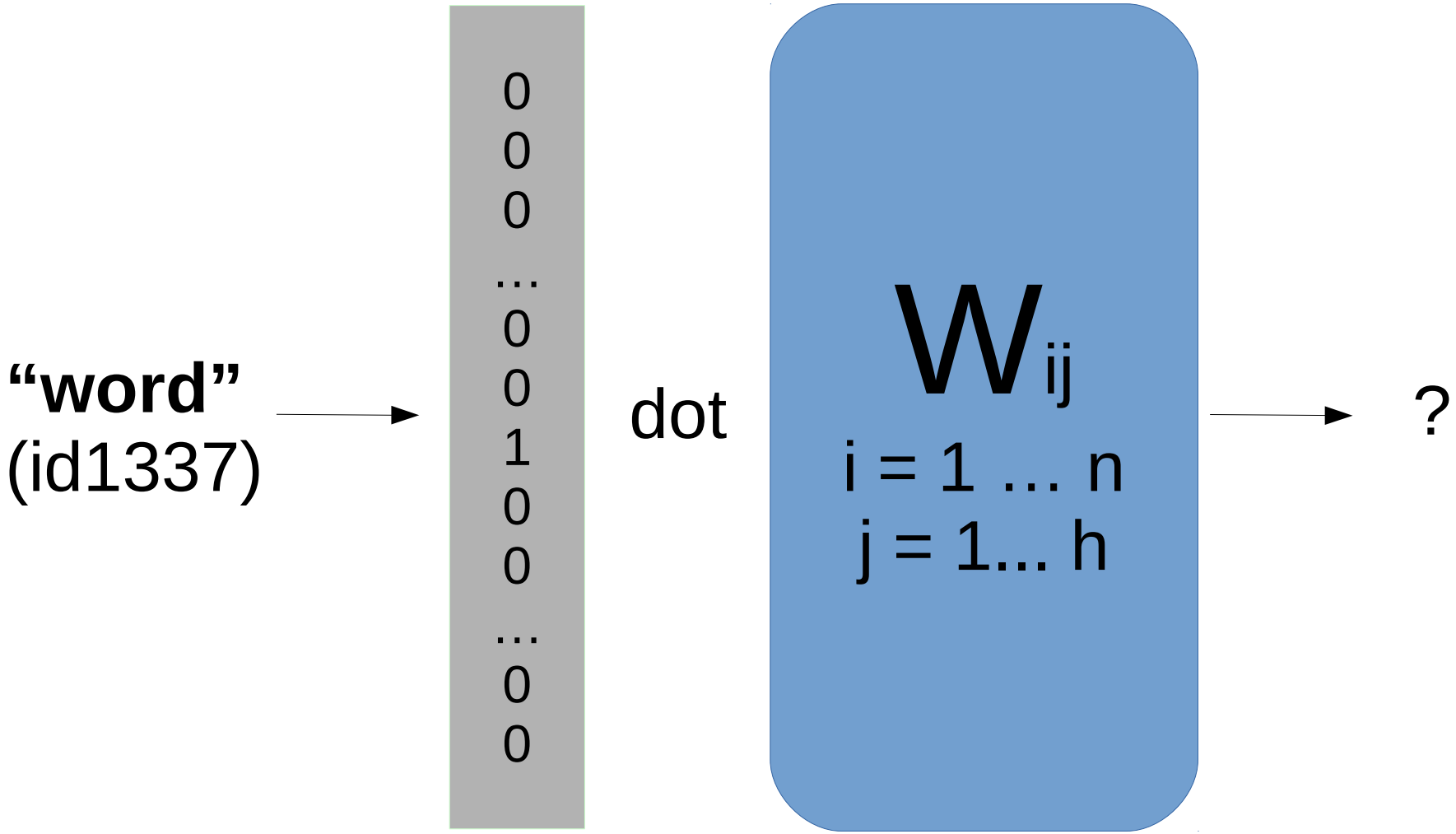
Sparse vector products

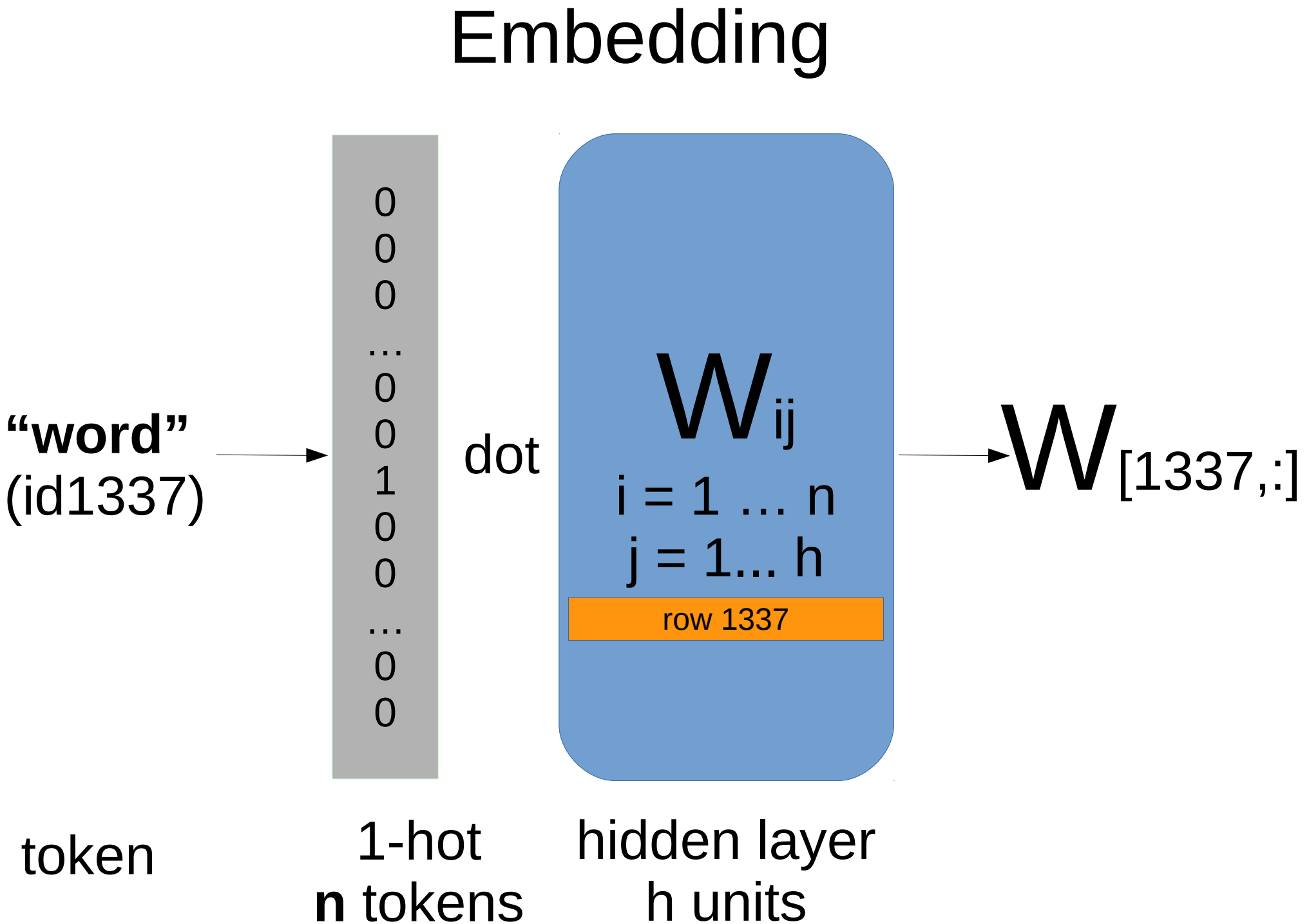


Sparse vector products



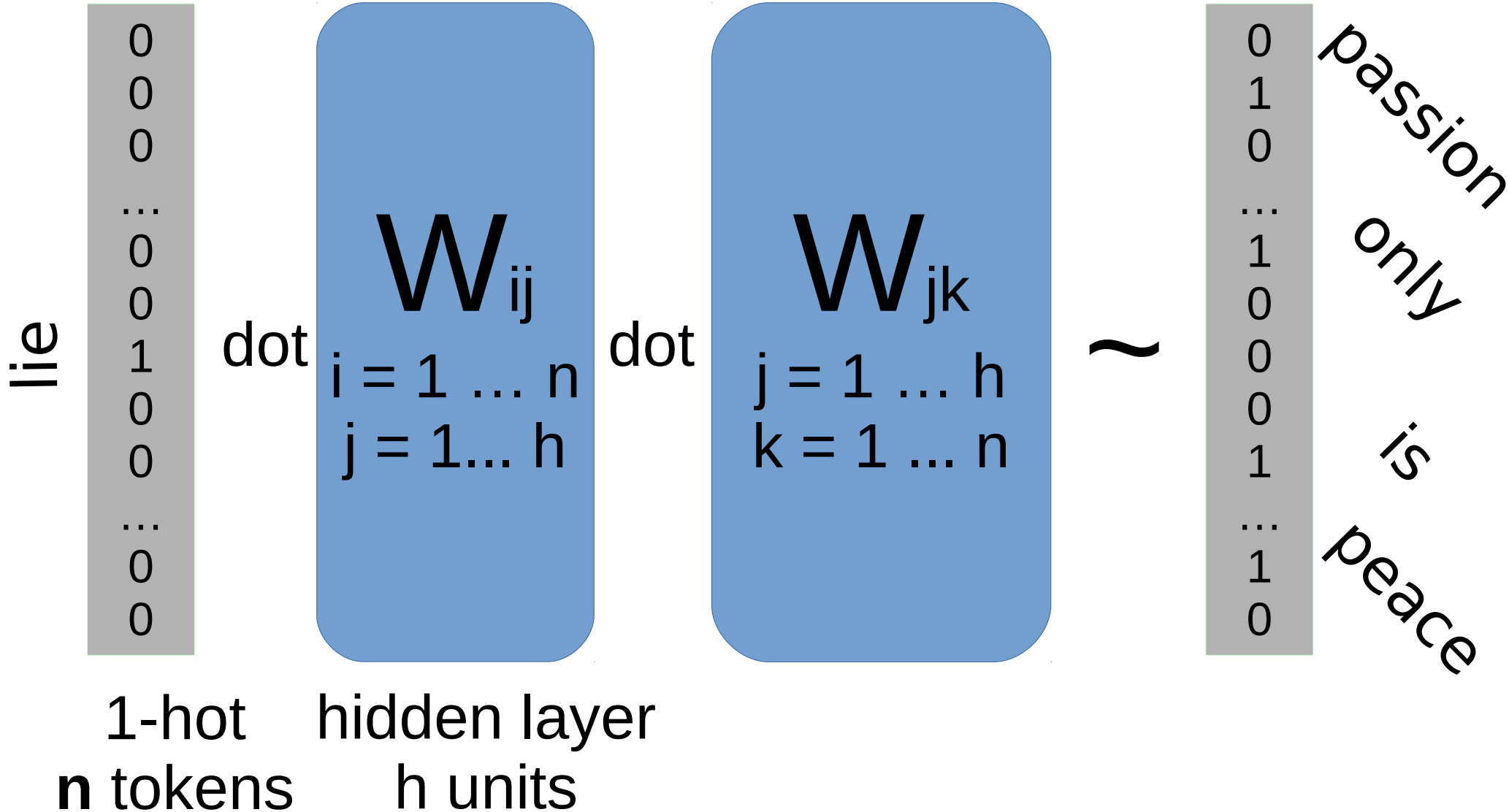
Sparse vector products




Embedding
“word”
(id1337)
0
0
0
...
0
0
1
0
0
...
0
0
dot
W_{ij}
i = 1 … n
j = 1... h
row 1337
$W_{[1337,:]}$
token
1-hot
n tokens
hidden layer
h units

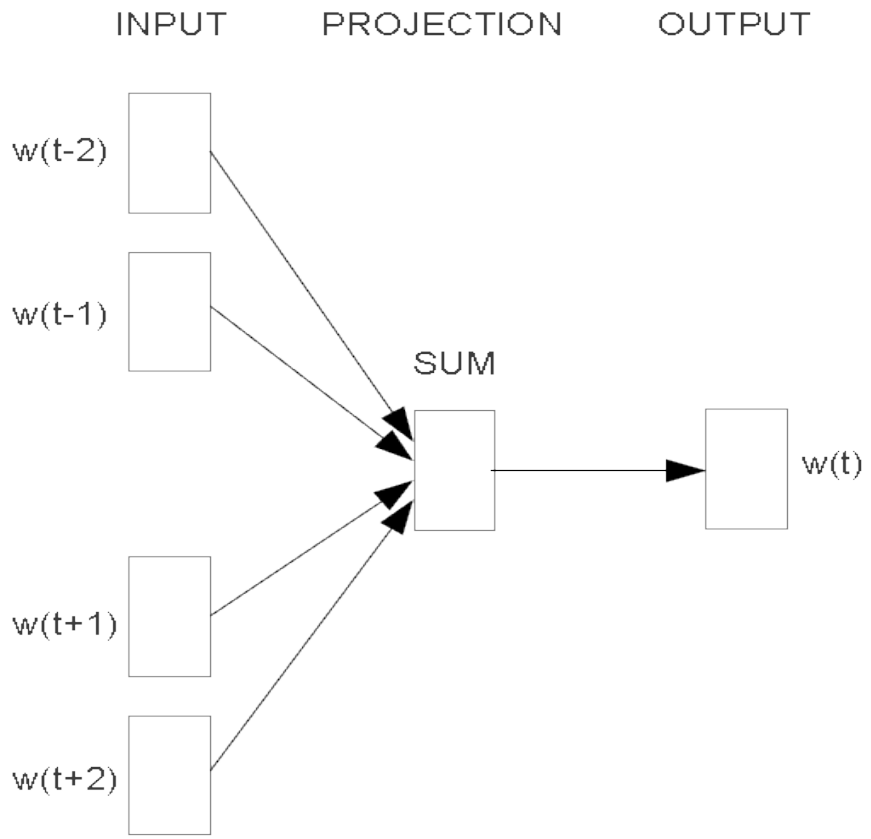
Embedding: word2vec

"Peace is a lie, there is only passion"

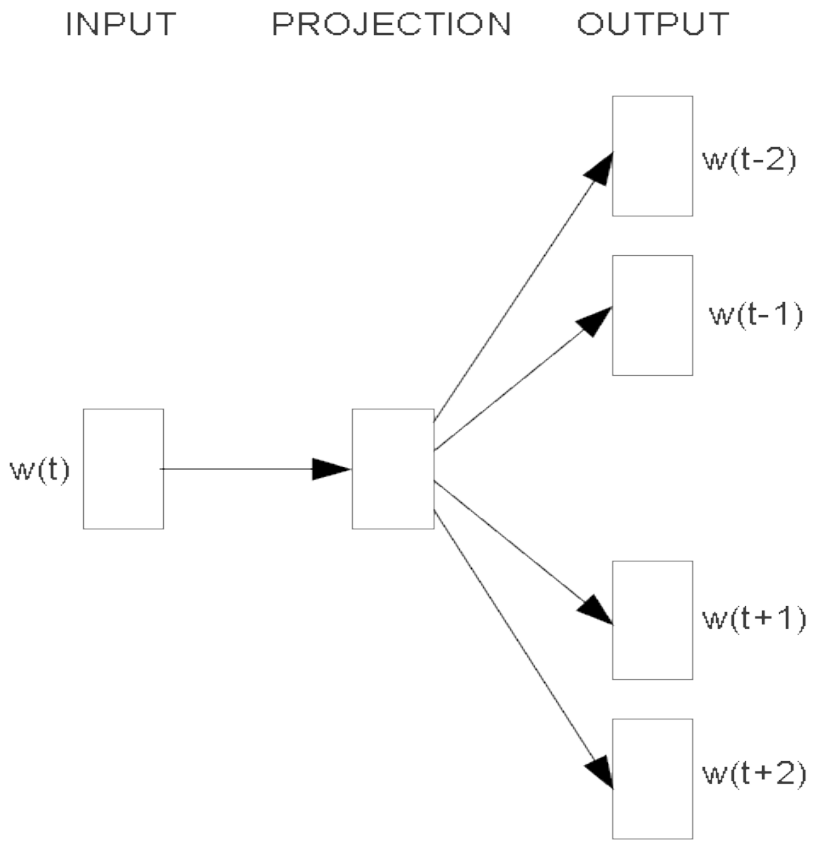


Embedding: word2vec

the *distributional hypothesis* : similar context = similar meaning



CBOW



Skip-gram

Embedding: word2vec

Side effect: synonyms

“nice” ~ “beautiful”

“hard” ~ “difficult”

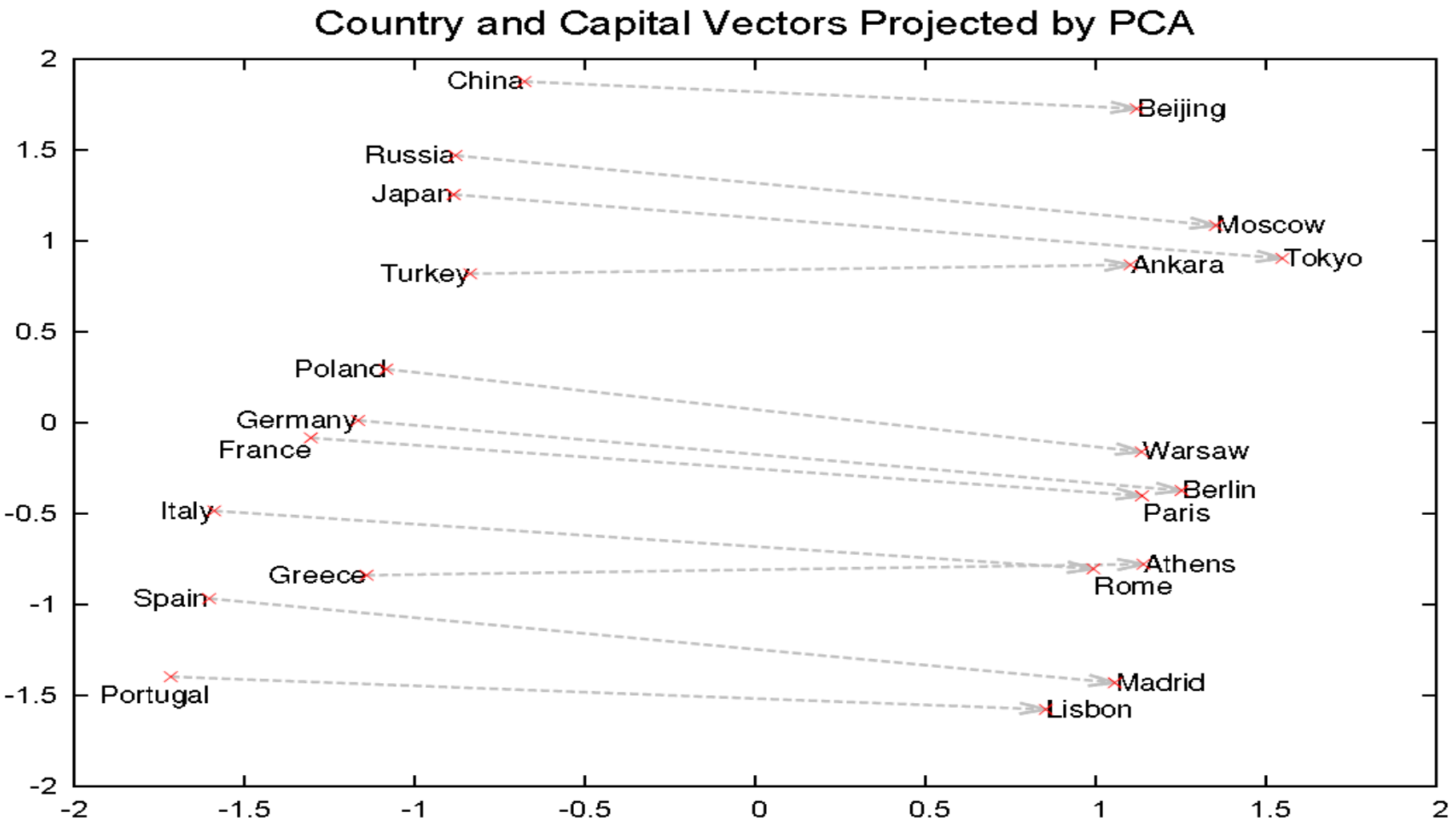
Side effect: word algebra

“king” - “man” + “queen” ~ “queen”

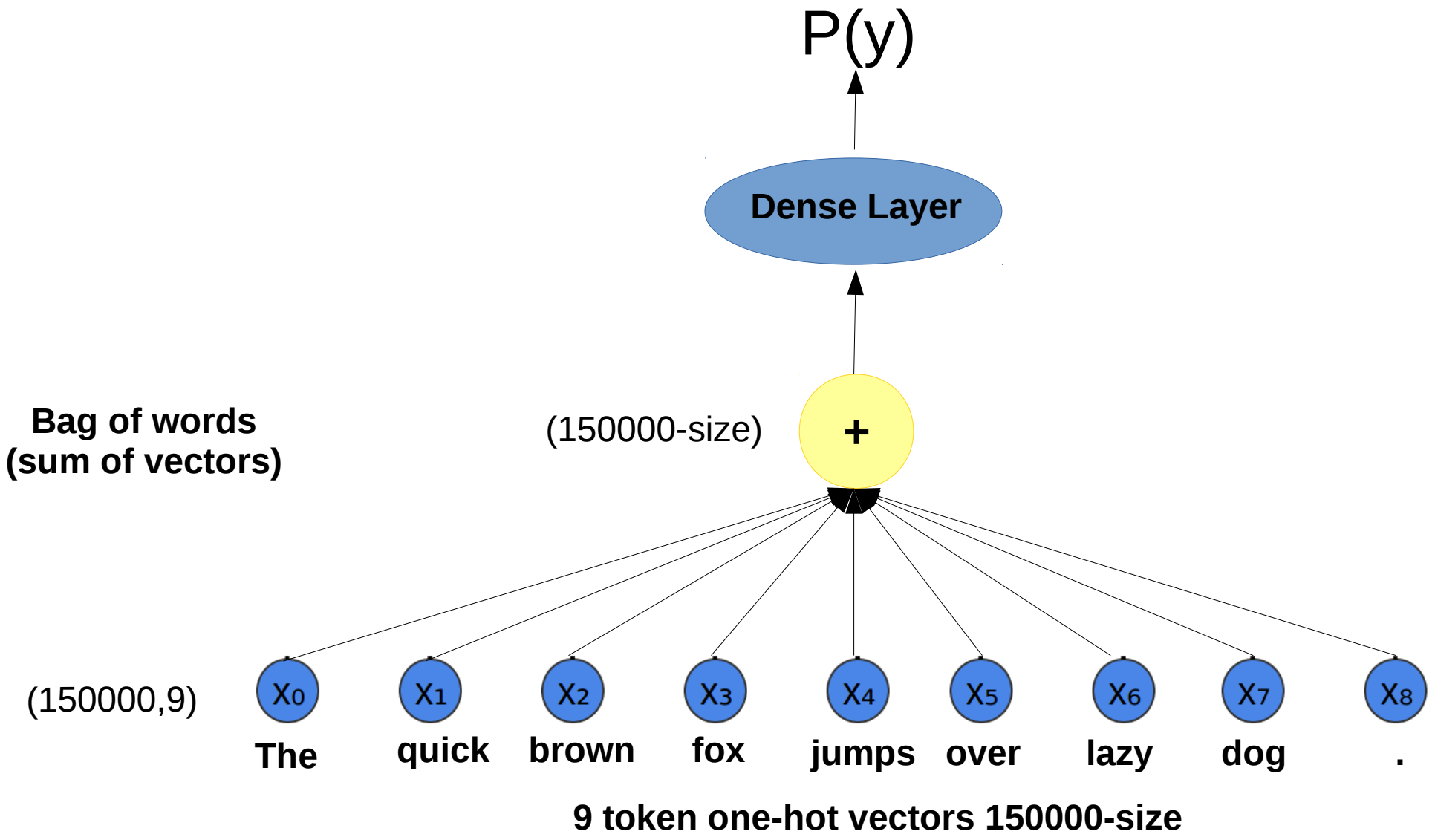
“moscow” - “russia” + “france” ~ “paris”

Embedding: word2vec

Side effect: word algebra



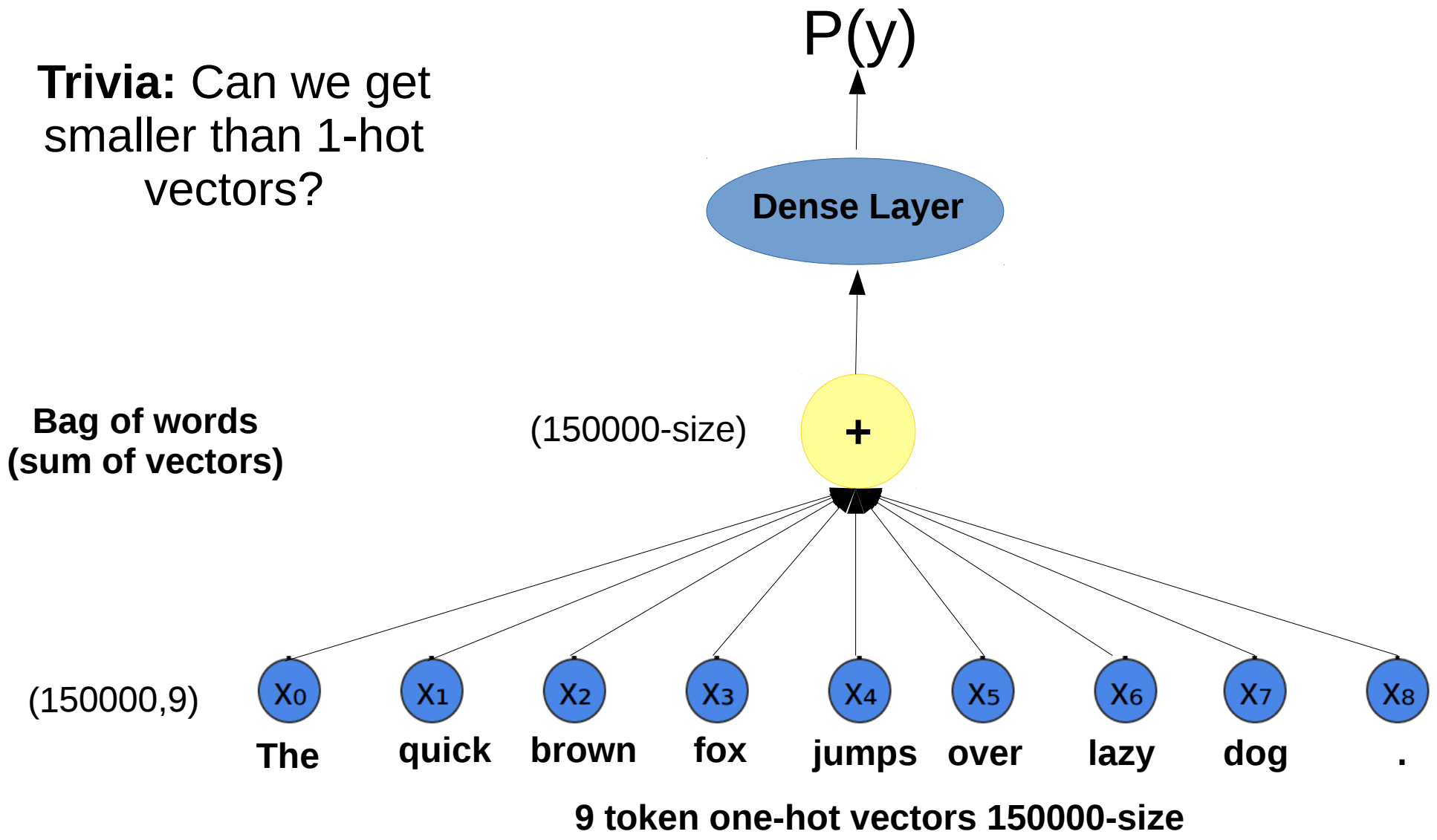
Text NN



Pictures by colah

Text NN

Trivia: Can we get smaller than 1-hot vectors?

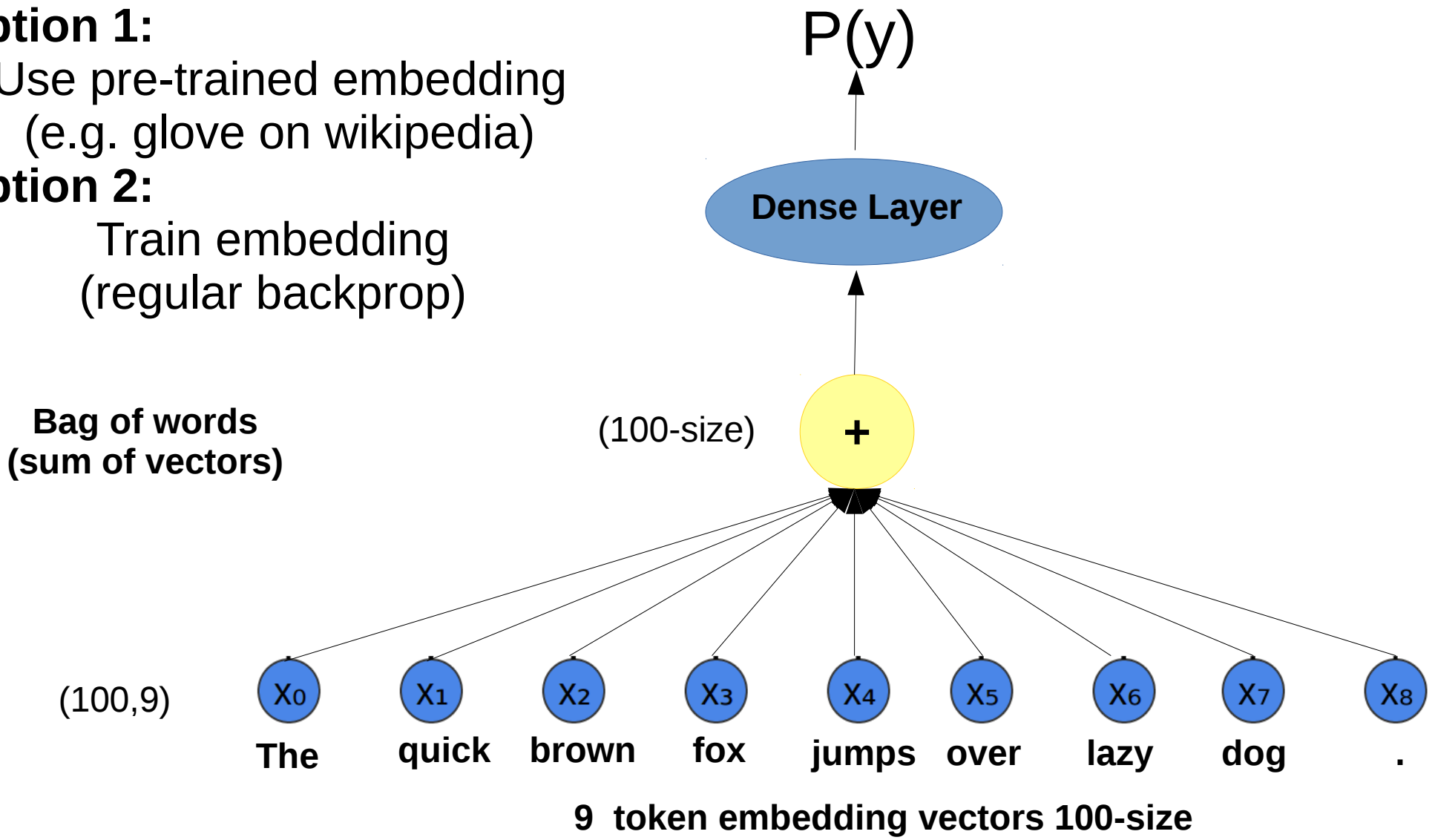


Pictures by colah

Text NN

Option 1:
Use pre-trained embedding
(e.g. glove on wikipedia)

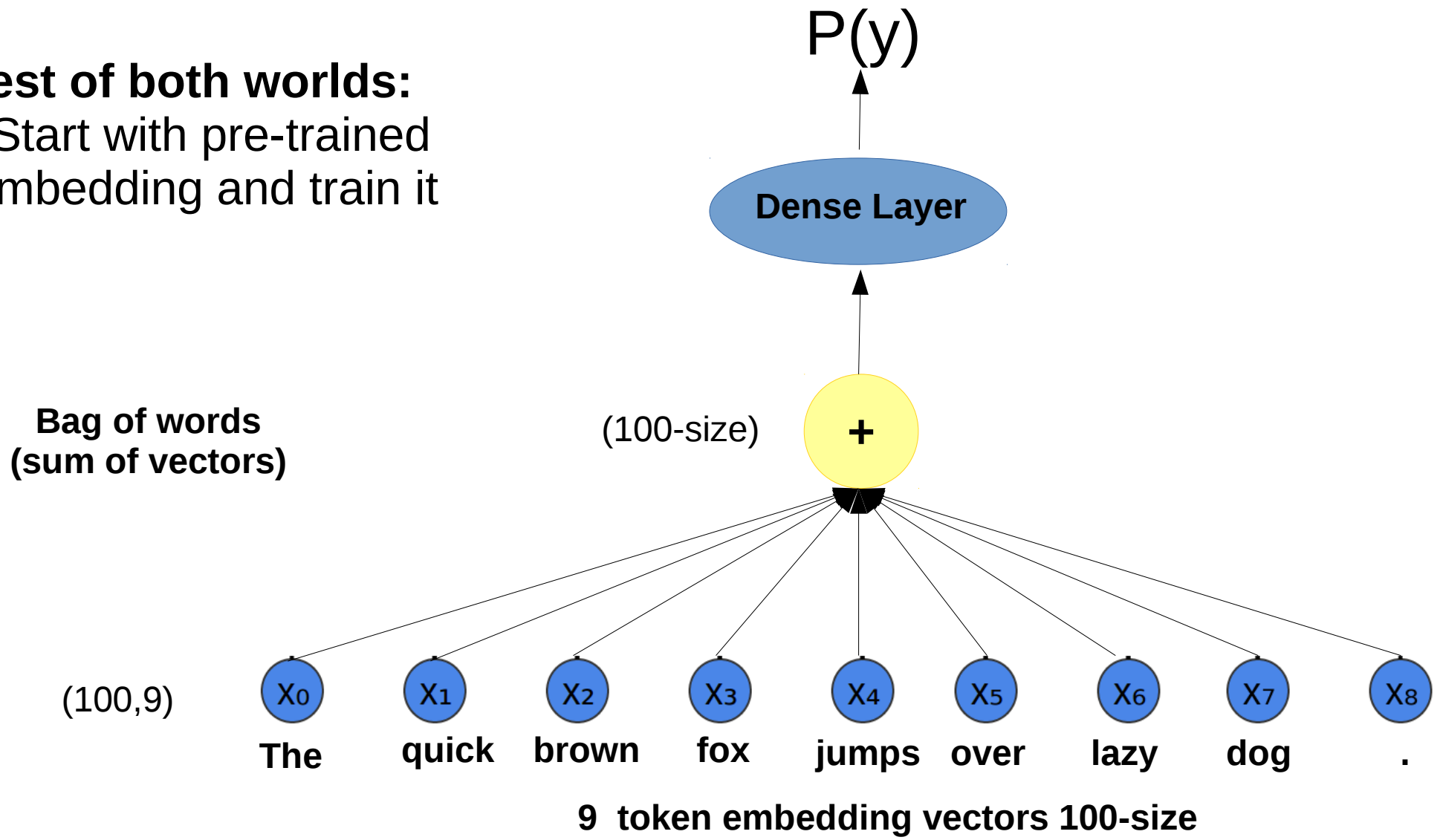
Option 2:
Train embedding
(regular backprop)



Pictures by colah

Text NN

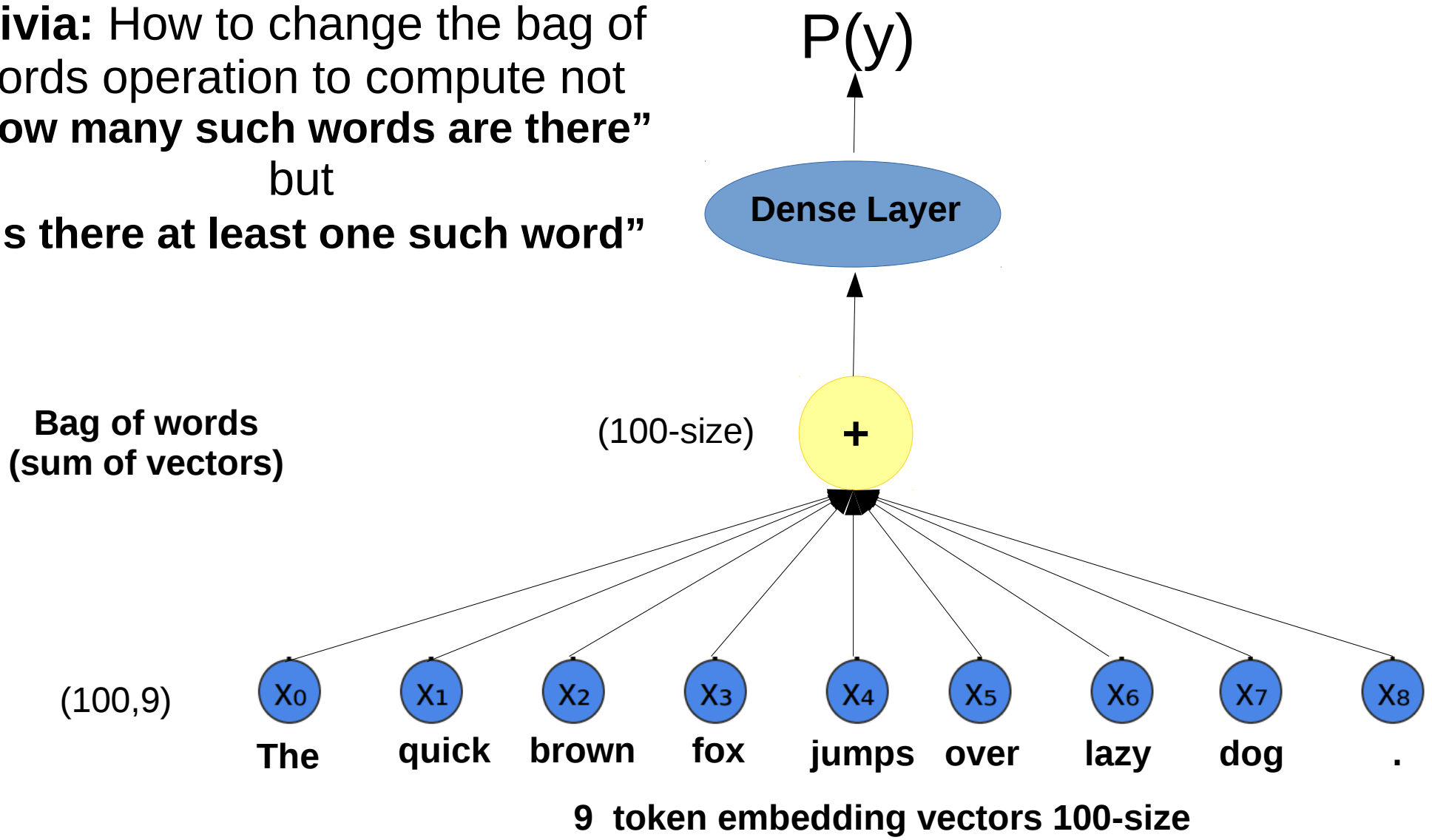
Best of both worlds:
Start with pre-trained embedding and train it



Pictures by colah

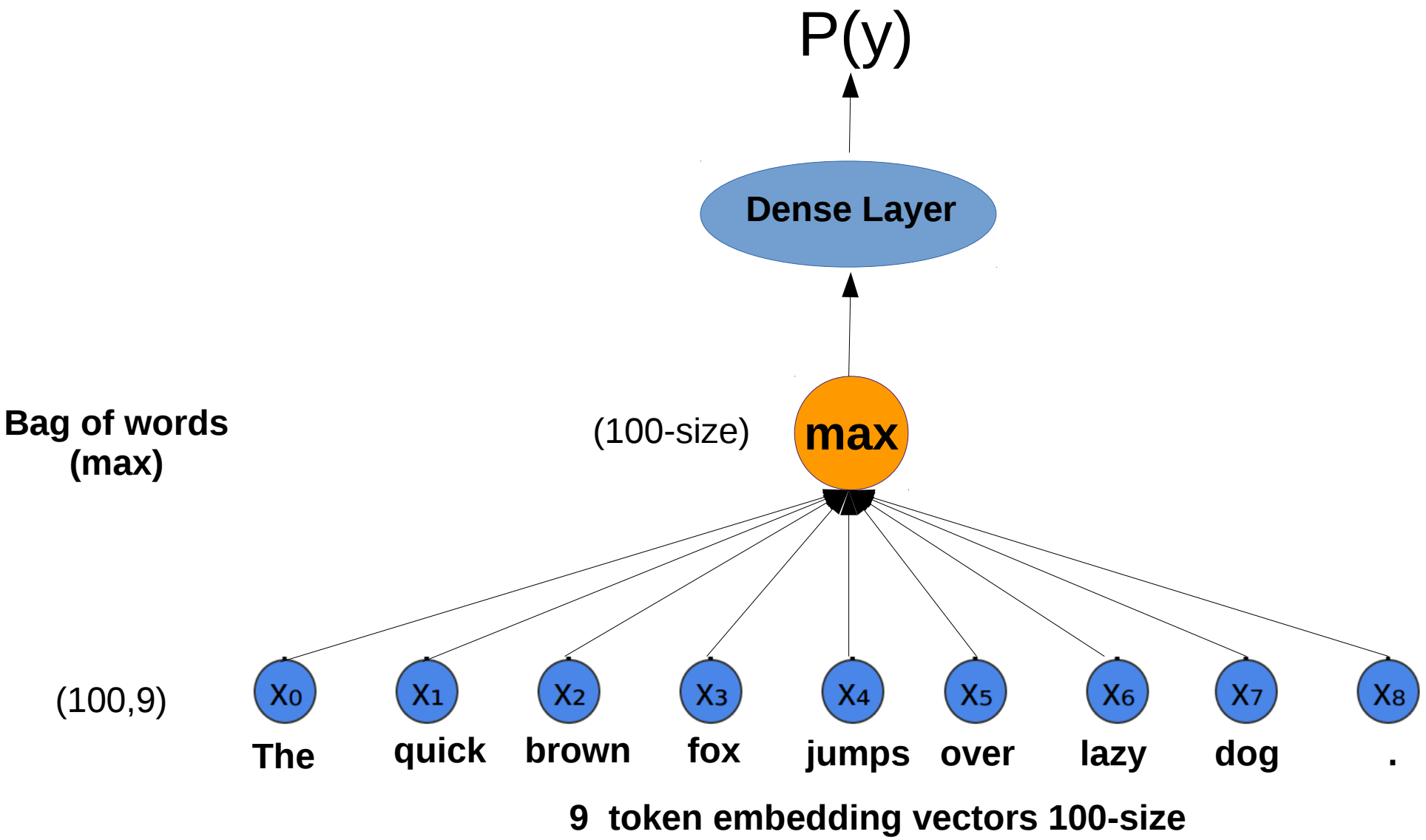
Text NN

Trivia: How to change the bag of words operation to compute not
“how many such words are there”
but
“is there at least one such word”



Pictures by colah

Text NN

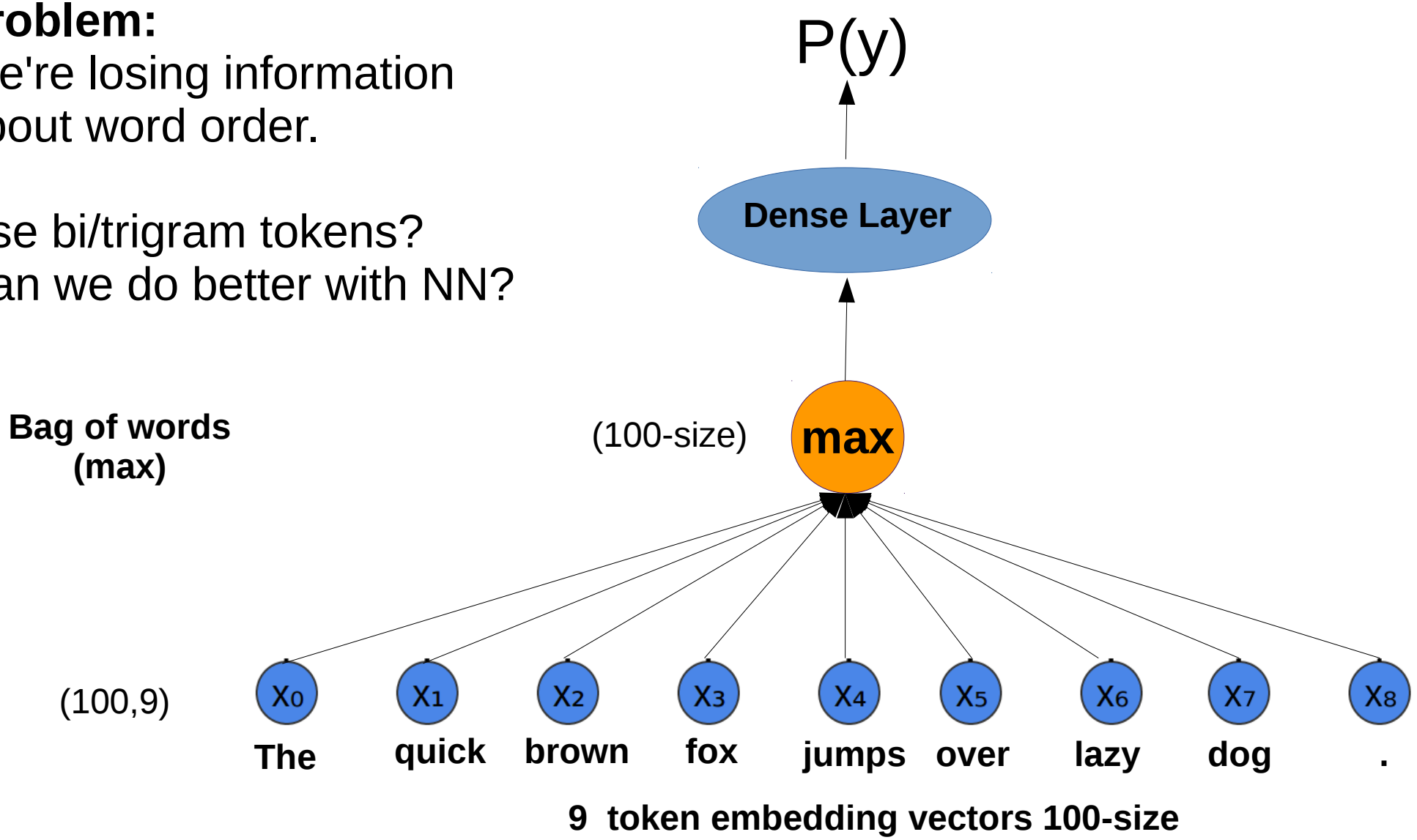


Pictures by colah

Text NN

Problem:
We're losing information about word order.

Use bi/trigram tokens?
Can we do better with NN?



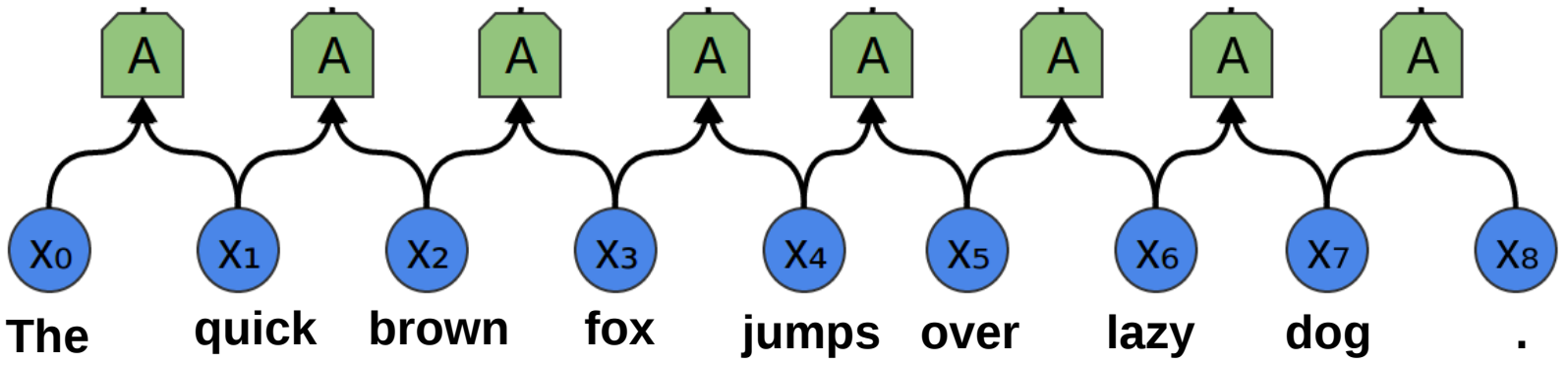
Pictures by colah

Text CNN

(32x8)

convolution 32x(100x2)

(100,9)



9 token embedding vectors 100-size

Pictures by colah

Text CNN

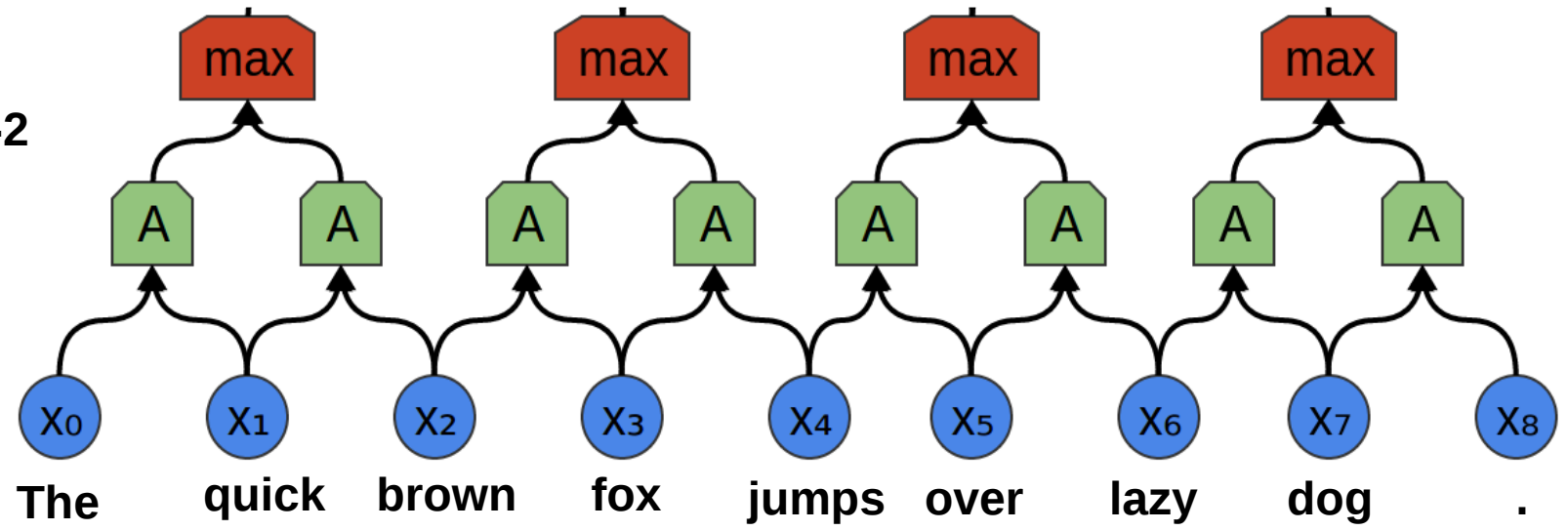
(32x4)

Max pooling size-2

(32x8)

convolution 32x(100x2)

(100,9)



9 token embedding vectors 100-size

Pictures by colah

Text CNN

(64x3)

convolution 64x(32x2)

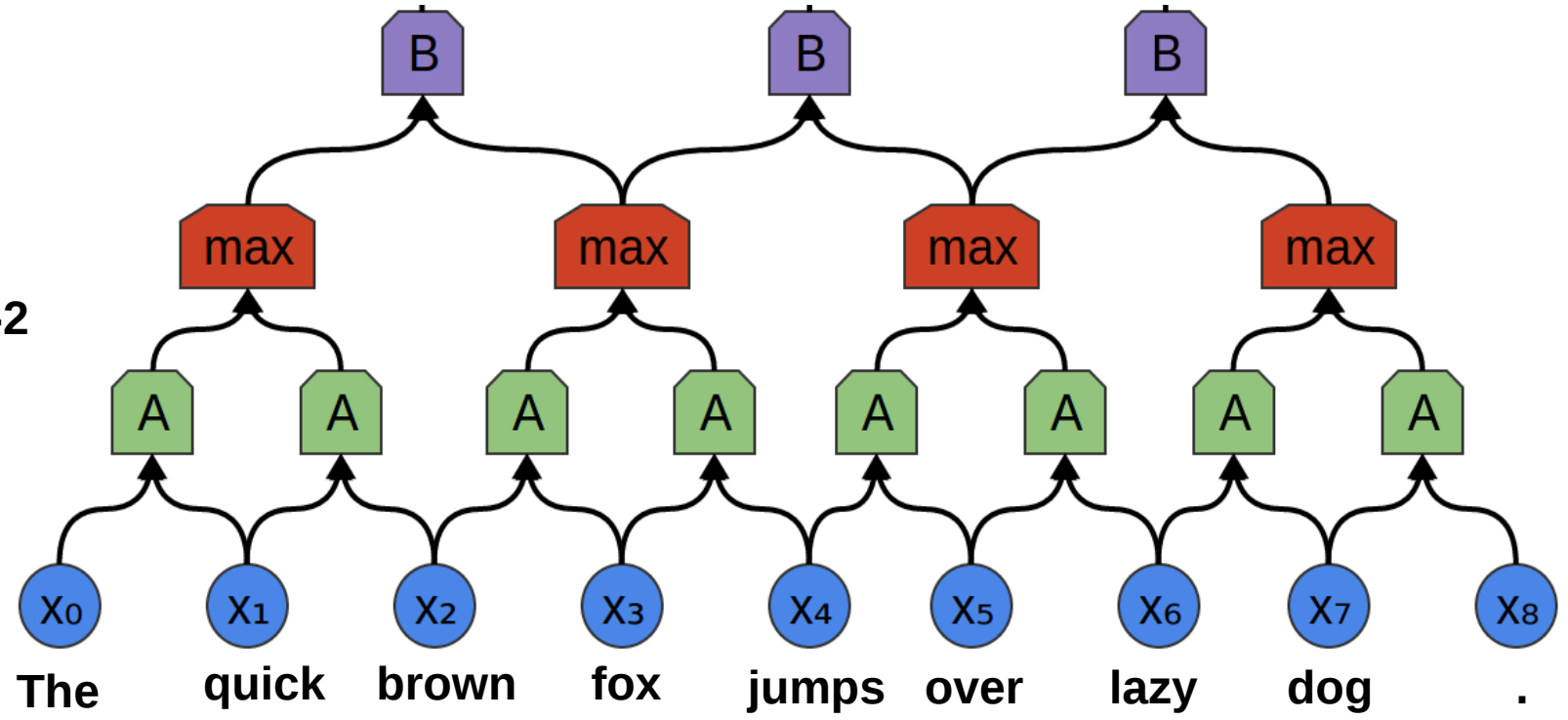
(32x4)

Max pooling size-2

(32x8)

convolution 32x(100x2)

(100,9)

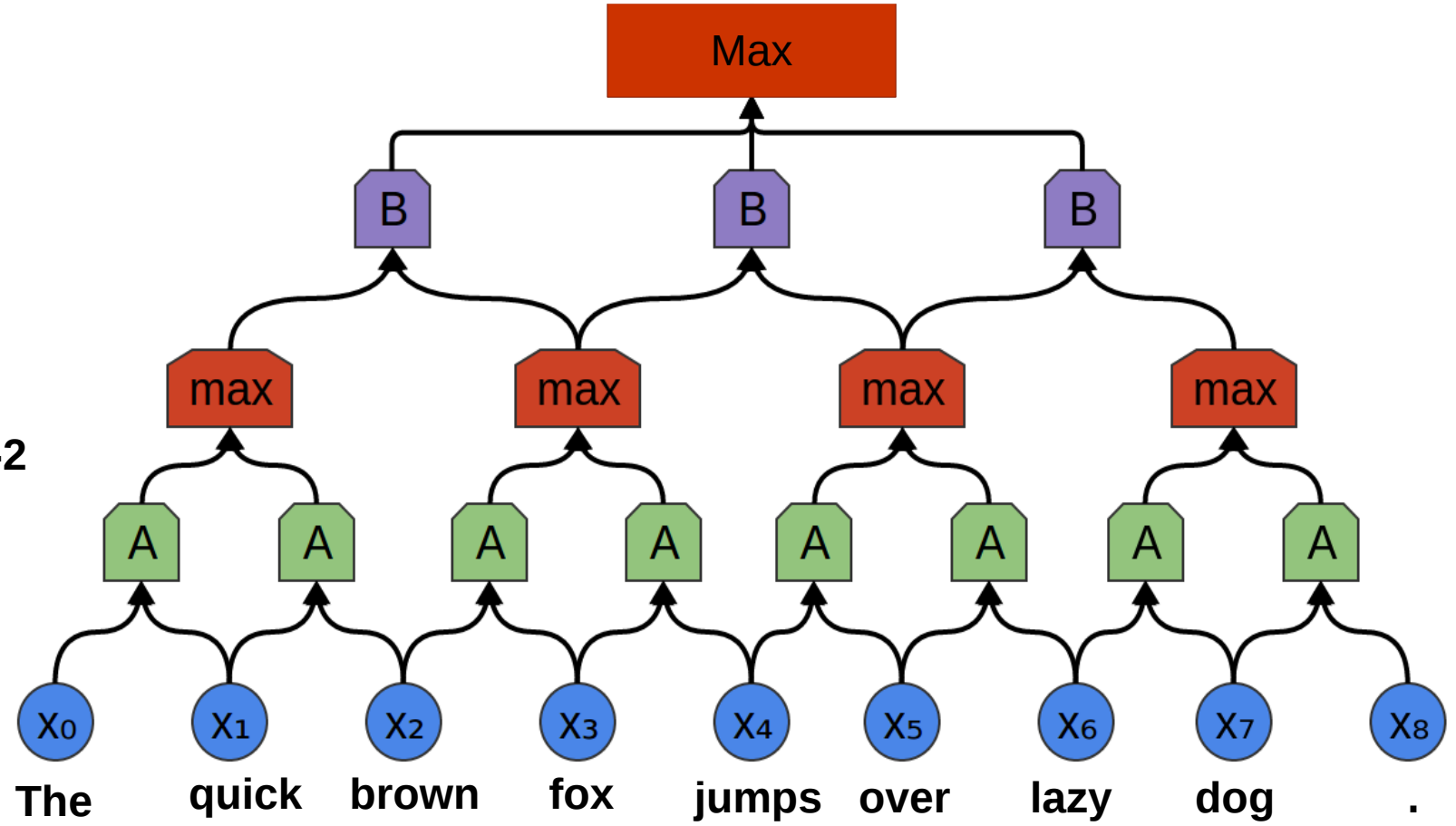


9 token embedding vectors 100-size

Pictures by colah

Text CNN

(64)
Max over time
(64x3)
convolution 64x(32x2)
(32x4)
Max pooling size-2
(32x8)
convolution 32x(100x2)
(100,9)



9 token embedding vectors 100-size

Pictures by colah

Text CNN

(n classes)

Dense

(64)

Max over time

(64x3)

convolution 64x(32x2)

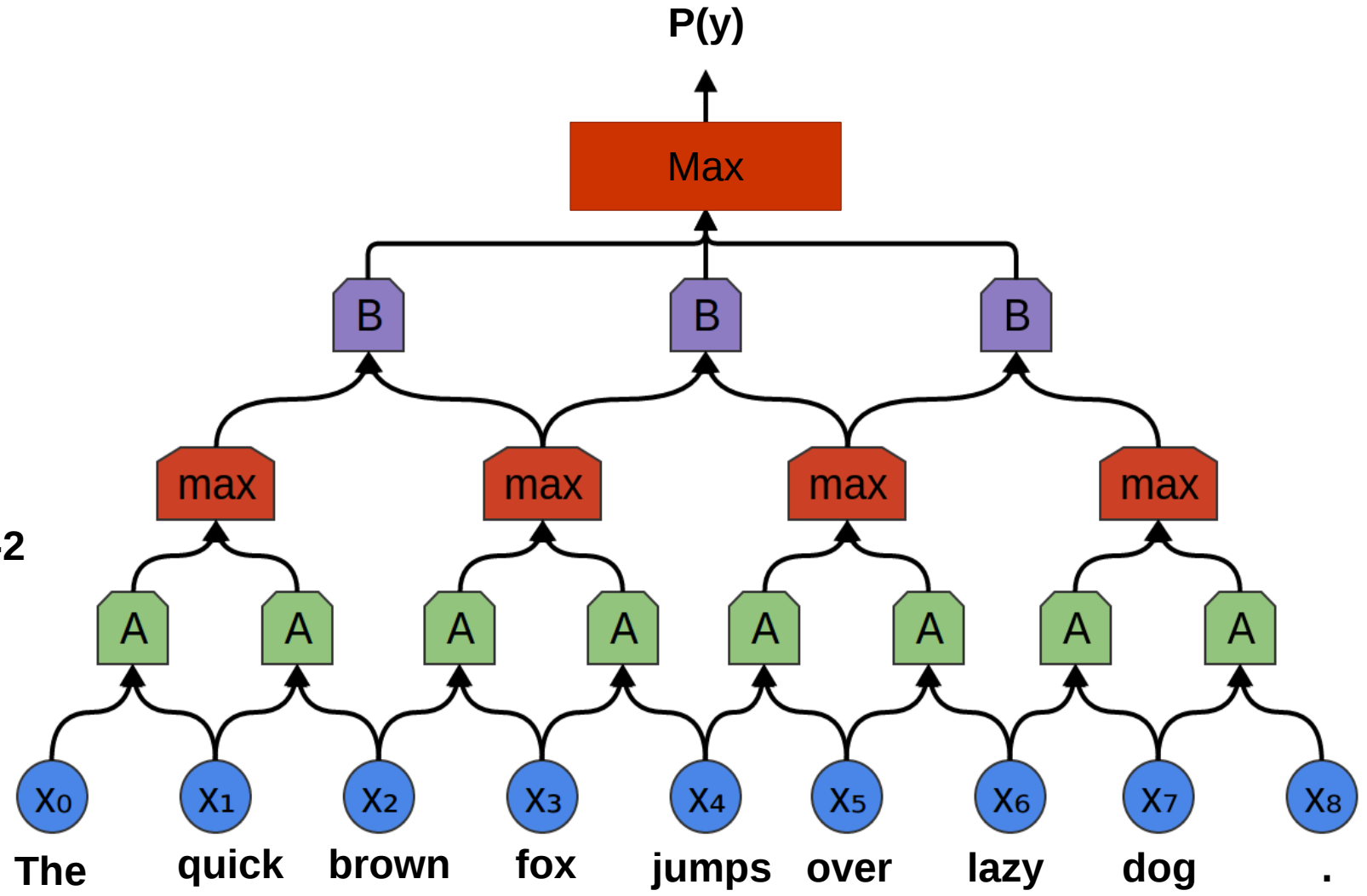
(32x4)

Max pooling size-2

(32x8)

convolution 32x(100x2)

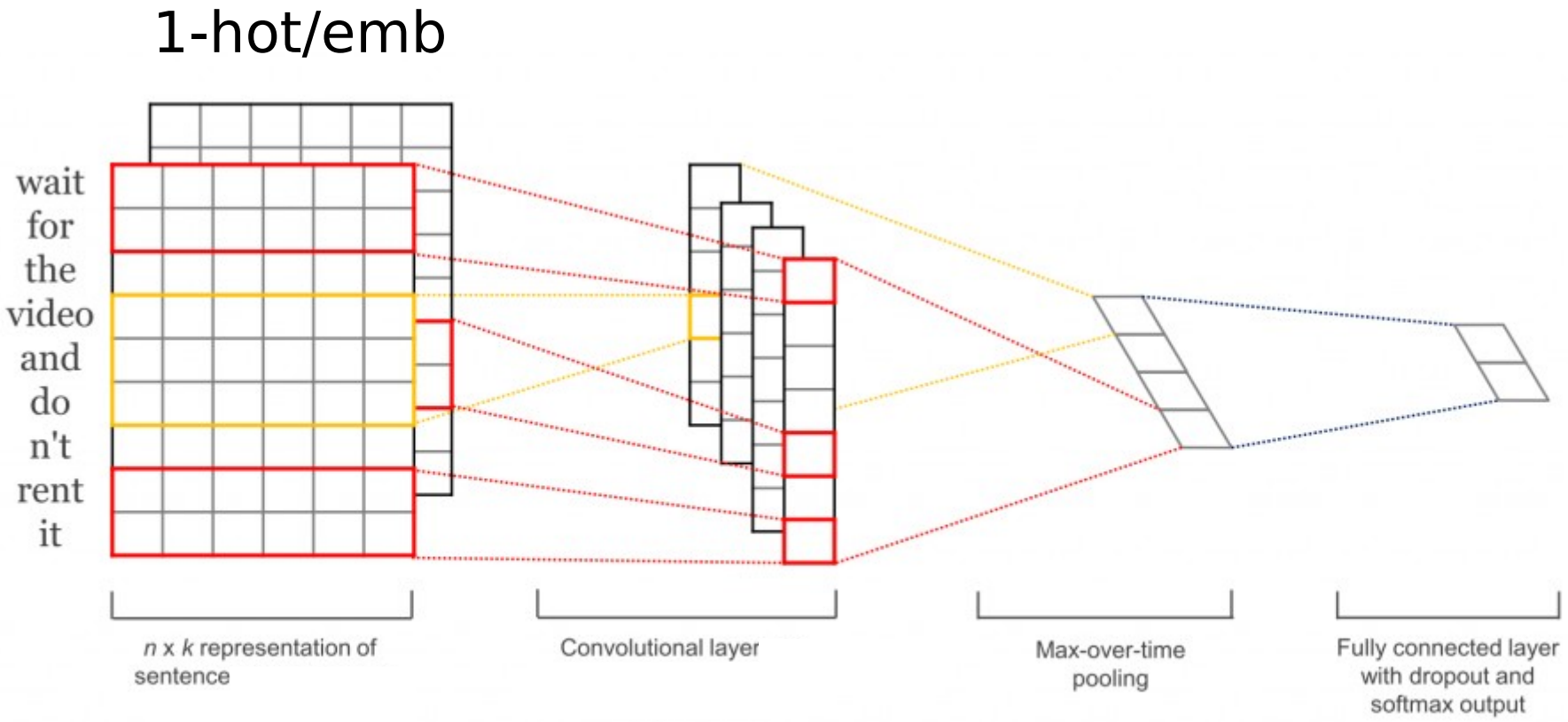
(100,9)



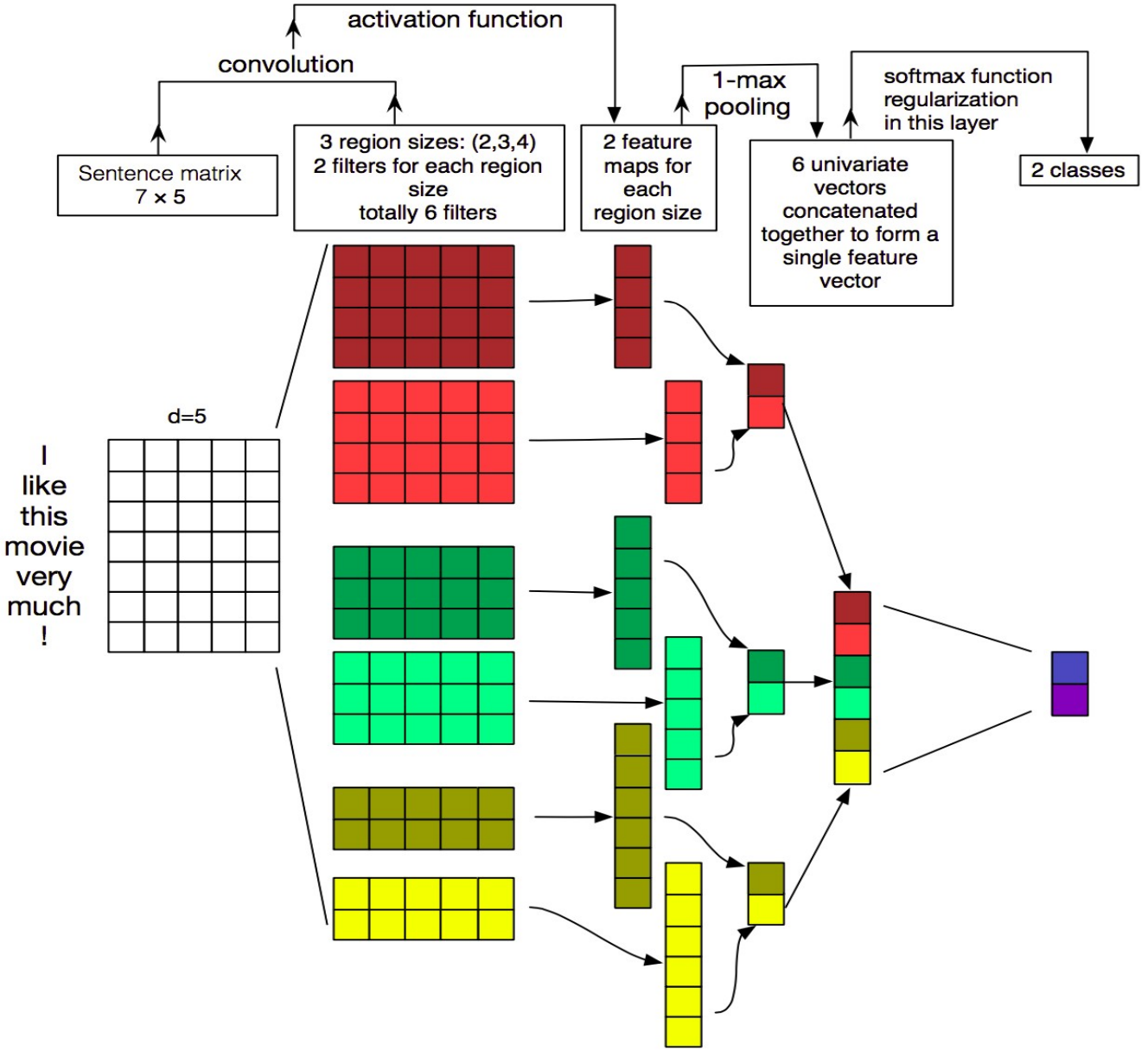
9 token embedding vectors 100-size

Pictures by colah

Text CNN


1-hot/emb
wait
for
the
video
and
do
n't
rent
it
n x k representation of sentence
Convolutional layer
Max-over-time pooling
Fully connected layer with dropout and softmax output

Text CNN: monsters



Text CNN: monsters

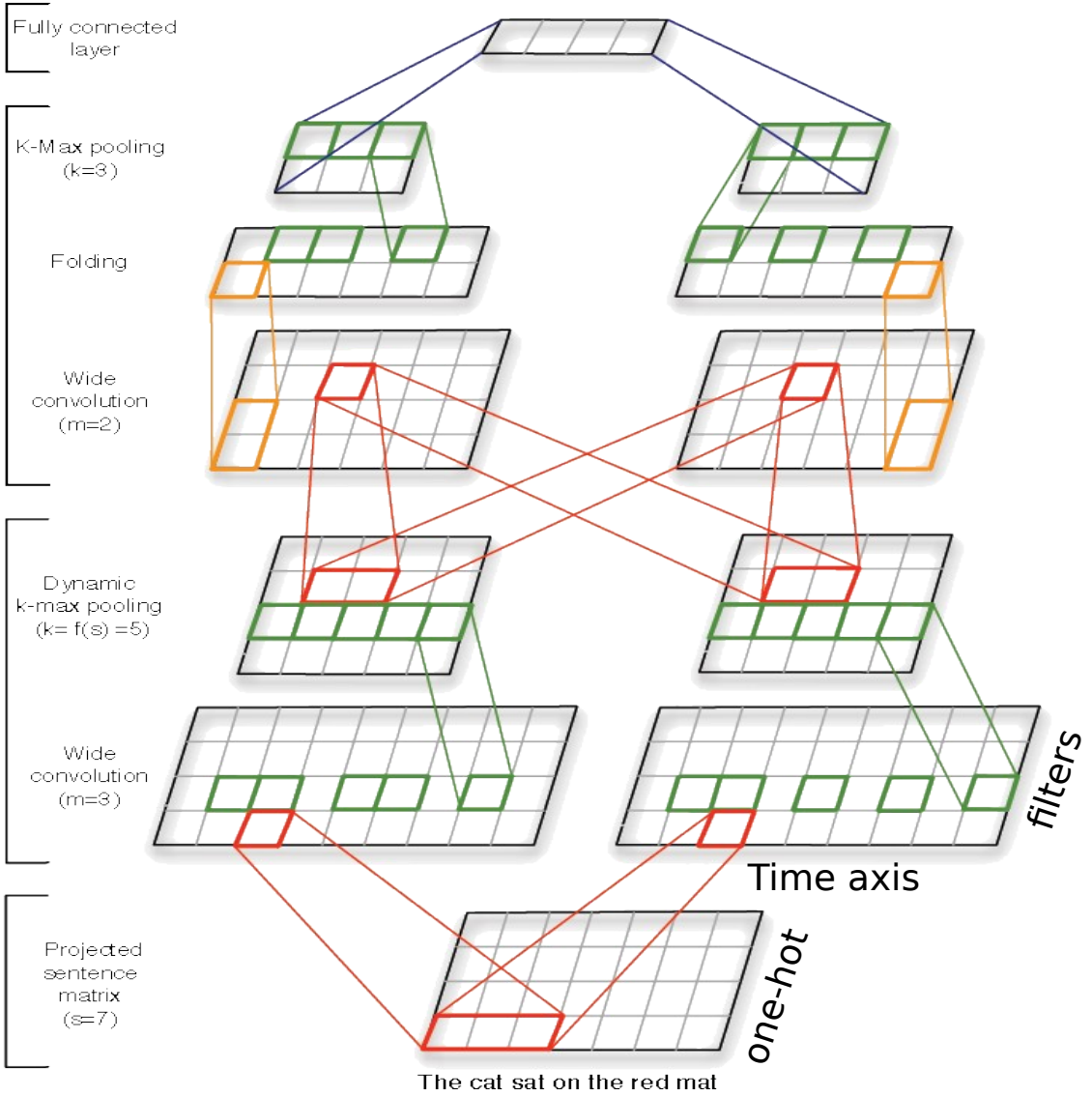
Dense layer

“Folding” = sum pooling along embedding direction

“K-max pooling” = take not 1 but k highest activations in their original order.
E.g. (0,1,3,2,0,1,4,1) → (3,2,4)

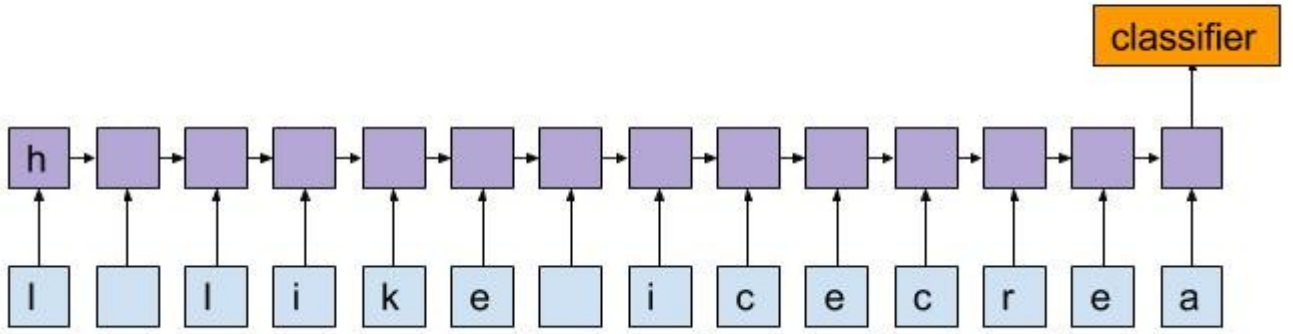
Wide convolution is convolution with full padding

Each word encoded with a vector (e.g. “one-hot”).



Other NLP problems
(coming soon)

Language model

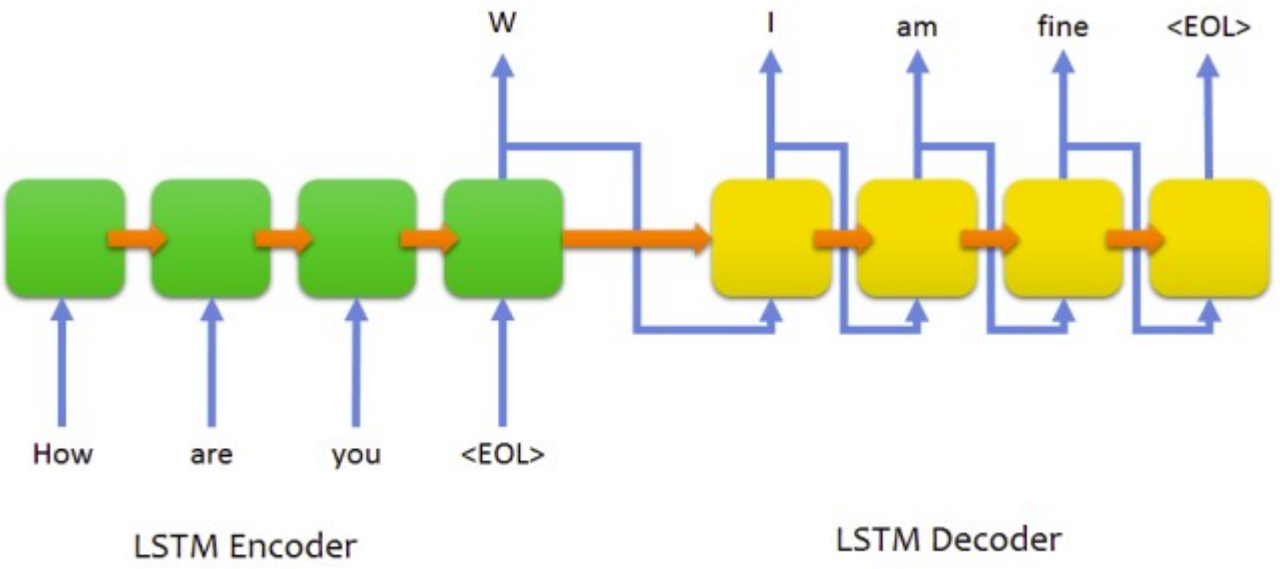


POS tagging

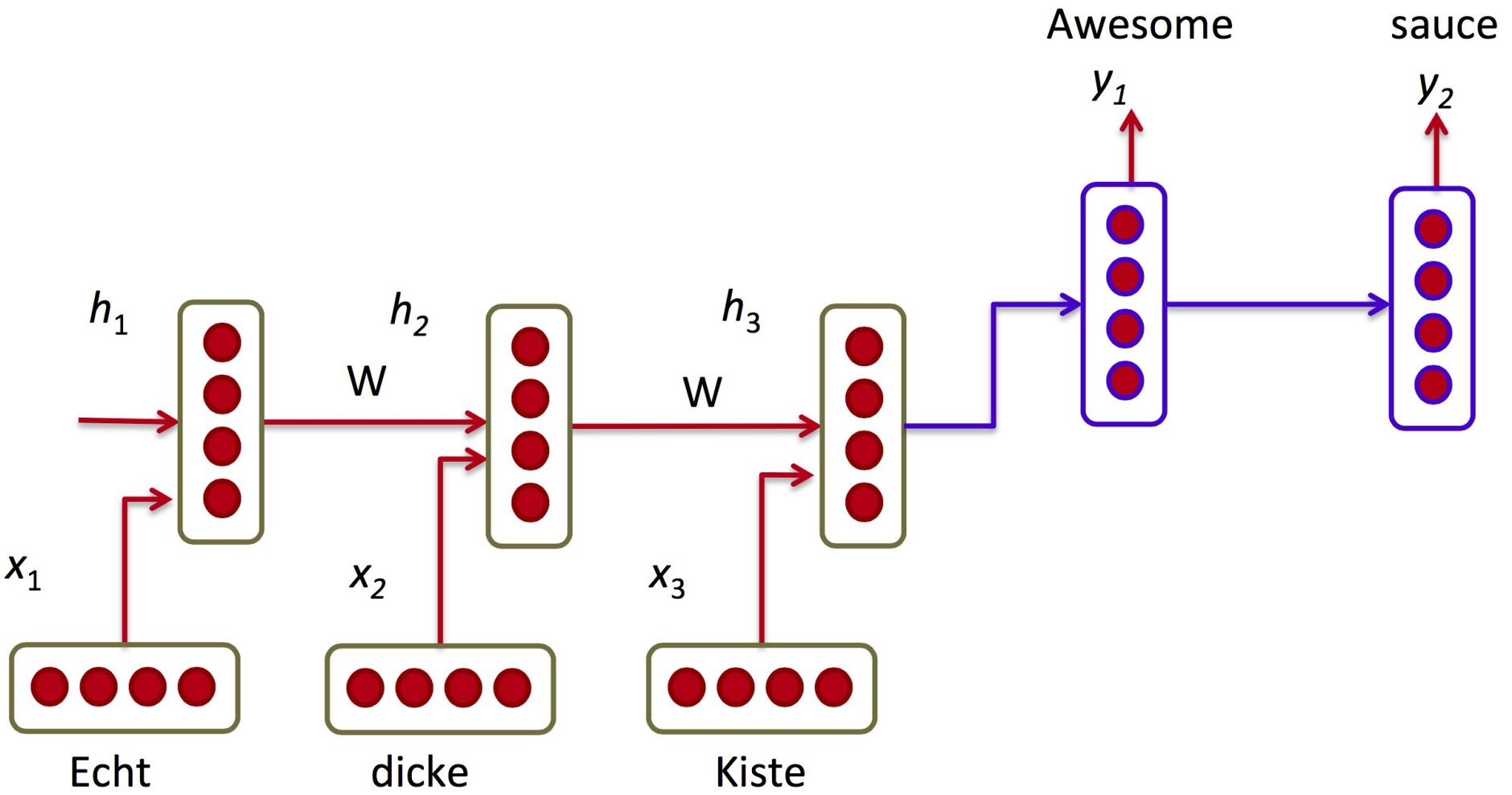
DT/ The JJ/ quick JJ/ brown NN/ fox NNS/ jumps IN/ over DT/ the JJ/ lazy NN/ dog

- -RRB- - Right bracket
- CD - Cardinal number
- EX - Existential there
- IN - Preposition
- JJR - Comparative adjective
- LS - List Item Marker
- NN - Singular noun
- NNP - Proper singular noun
- PDT - Predeterminer
- PRP - Personal pronoun
- RB - Adverb
- RBS - Superlative Adverb
- SYM - Symbol
- UH - Interjection
- VBD - Verb, past tense
- VBN - Verb, past participle
- VBZ - Verb, 3rd ps. sing. present
- WP - wh-pronoun
- WRB - wh-adverb
- CC - Coordinating conjunction
- DT - Determiner
- FW - Foreign word
- JJ - Adjective
- JJS - Superlative adjective
- MD - Modal
- NNS - Plural noun
- NNPS - Proper plural noun
- POS - Possesive ending
- PP$ - Possesive pronoun
- RBR - Comparative adverb
- RP - Particle
- TO - to
- VB - Verb, base form
- VBG - Verb, gerund/present participle
- VBP - Verb, non 3rd ps. sing. present
- WDT - wh-determiner
- WP$ - Possesive wh-pronoun

Conversation model



Machine translation



Nuff

Neural network won't write itself without you!

(except it will https://arxiv.org/abs/1511.06279)