Carnegie Mellon University
Heinz College

Unstructured Data Analysis

Recitation: Sentiment analysis with IMDb reviews; word embeddings; a look at some PyTorch code

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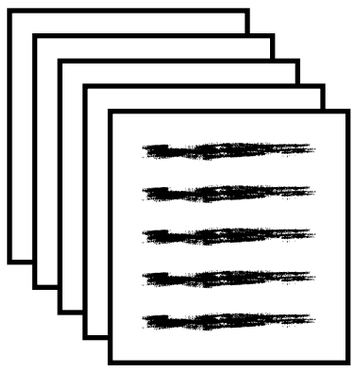
Recitation

- Demo: sentiment analysis with IMDb reviews

- More on word embeddings & fine tuning

- (Time permitting) A little bit of what's under the hood: UDA_pytorch_utils.py

(From Lecture) Sentiment Analysis with IMDb Reviews



Training reviews

Step 1: Tokenize & build vocabulary

Word index	Word	2D Embedding
0	this	[-0.57, 0.44]
1	movie	[0.38, 0.15]
2	rocks	[-0.85, 0.70]
3	sucks	[-0.26, 0.66]

Step 2: Encode each review as a sequence of word indices into the vocab

"this movie sucks" → 0 1 3

Step 3: Use word embeddings to represent each word

[-0.57, 0.44]
[0.38, 0.15]
[-0.26, 0.66]

`embedding_weights` (100-dimensional GloVe embeddings in the demo)

(From Lecture) Sentiment Analysis with IMDb Reviews

In the demo, this part done by creating an instance of the `SpacyEncoder` Python class (`torchnlp` does support other encoders as well in case you don't like spacy/spacy is giving you trouble)

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Sentiment Analysis with IMDb Reviews

Demo

Word Embeddings: Even without labels, we can set up a prediction problem!

Hide part of training data and try to predict what you've hid!

Word Embeddings: word2vec

Can solve tasks like the following:

Man is to King as Woman is to _____

Word Embeddings: word2vec

Can solve tasks like the following:

Man is to King as Woman is to Queen

Word Embeddings: word2vec

Can solve tasks like the following:

Man is to King as Woman is to Queen

Which word doesn’t belong?
blue, red, green, crimson, transparent

Word Embeddings: word2vec

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Word Embeddings: word2vec

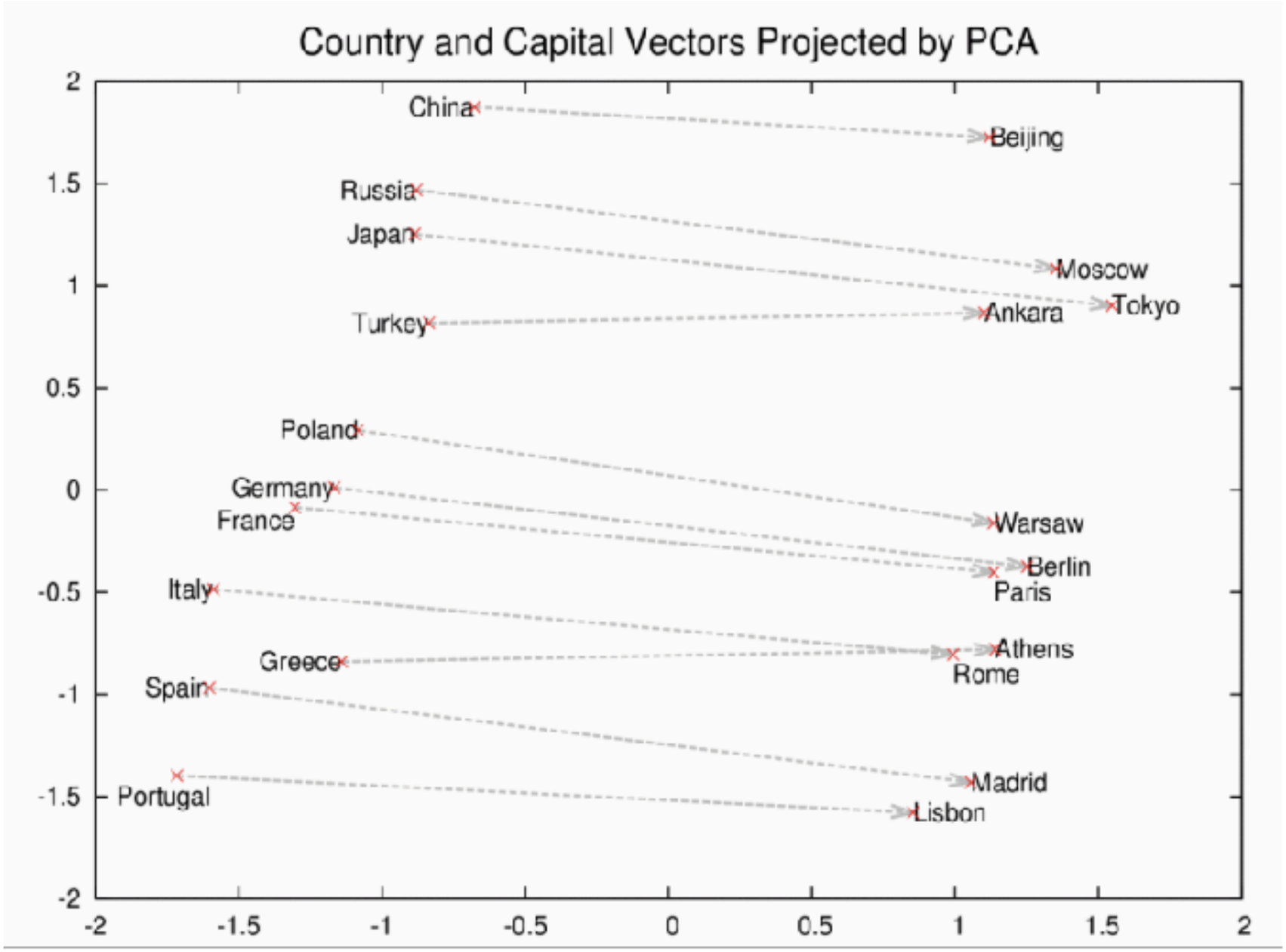


Image source: https://deeplearning4j.org/img/countries_capitals.png

Word Embeddings: word2vec

The opioid epidemic or opioid crisis is the rapid increase in the use of prescription and non-prescription opioid drugs in the United States and Canada in the 2010s.

Predict context of each word!

Training data point: epidemic

“Training labels”: the, opioid, or, opioid

Word Embeddings: word2vec

The opioid epidemic or opioid crisis is the rapid increase in the use of prescription and non-prescription opioid drugs in the United States and Canada in the 2010s.

Predict context of each word!

Training data point: or

“Training labels”: opioid, epidemic, opioid, crisis

Word Embeddings: word2vec

The opioid epidemic or opioid crisis is the rapid increase in the use of prescription and non-prescription opioid drugs in the United States and Canada in the 2010s.

Predict context of each word!

Training data point: opioid

"Training labels": epidemic, or, crisis, is

There are "positive" examples of what context words are for "opioid"

Also provide "negative" examples of words that are *not* likely to be context words (by randomly sampling words elsewhere in document)

Word Embeddings: word2vec

The opioid epidemic or opioid crisis is the rapid increase in the use of prescription and non-prescription opioid drugs in the United States and Canada in the 2010s.

randomly sampled word

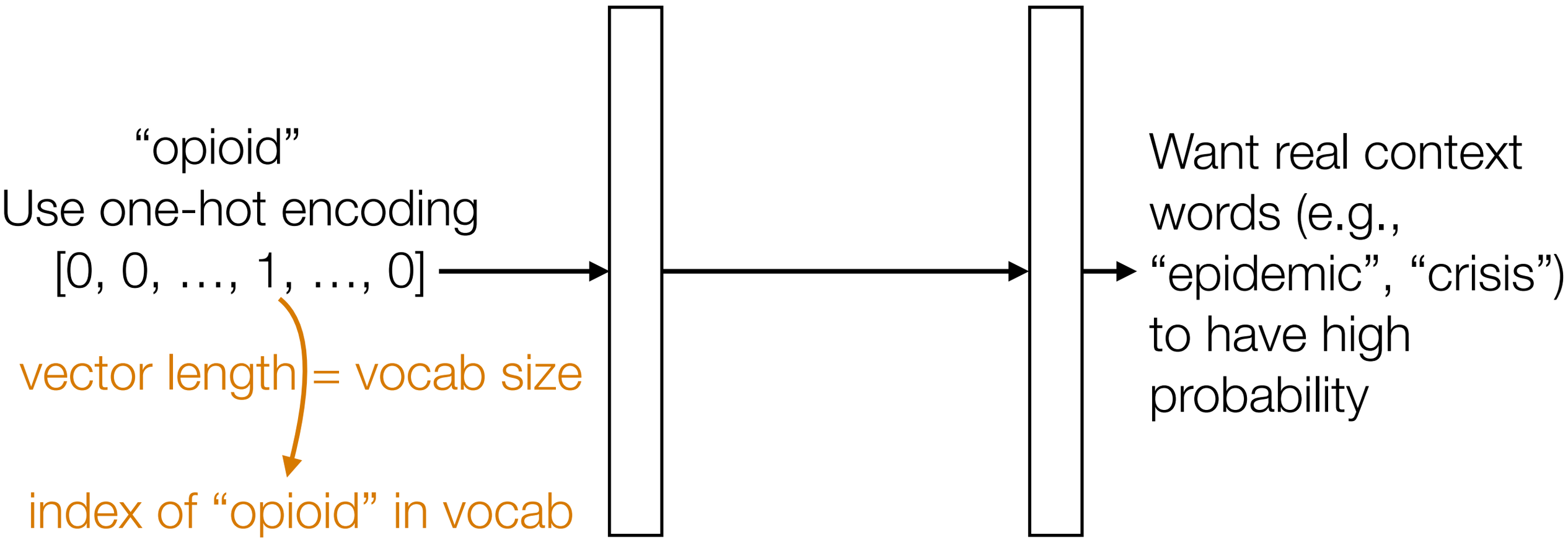
Predict context of each word!

Training data point: opioid

"Negative training label": 2010s

Also provide "negative" examples of words that are *not* likely to be context words (by randomly sampling words elsewhere in document)

Word2vec Neural Net



Learned weight matrix used as word embedding!

(Treat i-th row of weight matrix as word embedding for i-th word)

Word Embeddings as a Special Case of Self-Supervised Learning

- Key idea: hide part of the training data and try to predict hidden part using other parts of the training data
- No actual training labels required — we are defining what the training labels are just using the unlabeled training data!
- This is an *unsupervised* method that sets up a *supervised prediction* task
- Other word embeddings methods are possible

(Flashback)

What about a word that has multiple meanings?

Challenging: try to split up word into multiple words depending on meaning (requires inferring meaning from context)

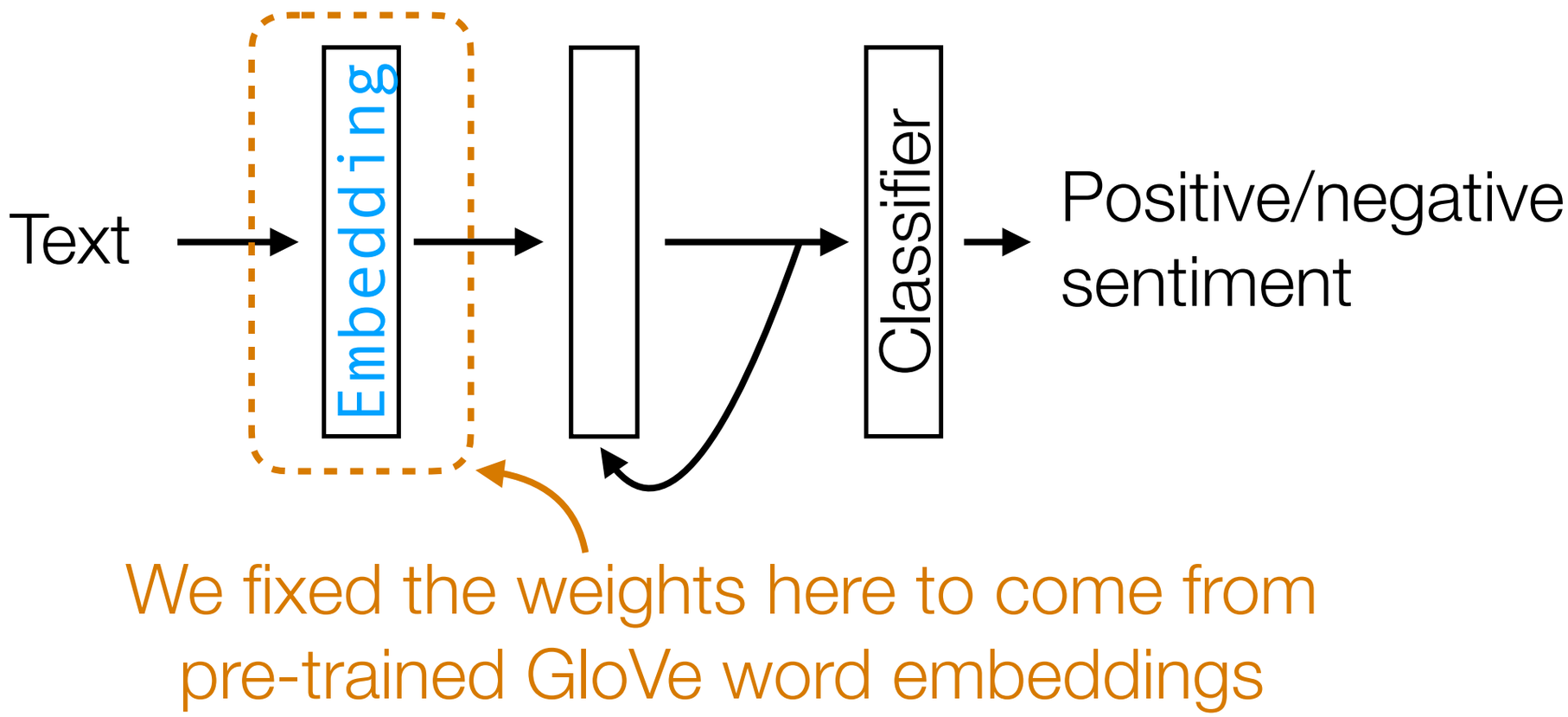
This problem is called **word sense disambiguation** (WSD)

Word Embeddings as a Special Case of Self-Supervised Learning

- Key idea: hide part of the training data and try to predict hidden part using other parts of the training data
- No actual training labels required — we are defining what the training labels are just using the unlabeled training data!
- This is an *unsupervised* method that sets up a *supervised prediction* task
- Other word embeddings methods are possible
  - Word embedding that handles word-sense disambiguation: BERT (current state of the art)
  - **Warning:** the default PyTorch `Embedding` layer does *not* do anything clever like BERT/GloVe/word2vec (best to use pre-trained word embeddings!)

(From Lecture) Fine Tuning

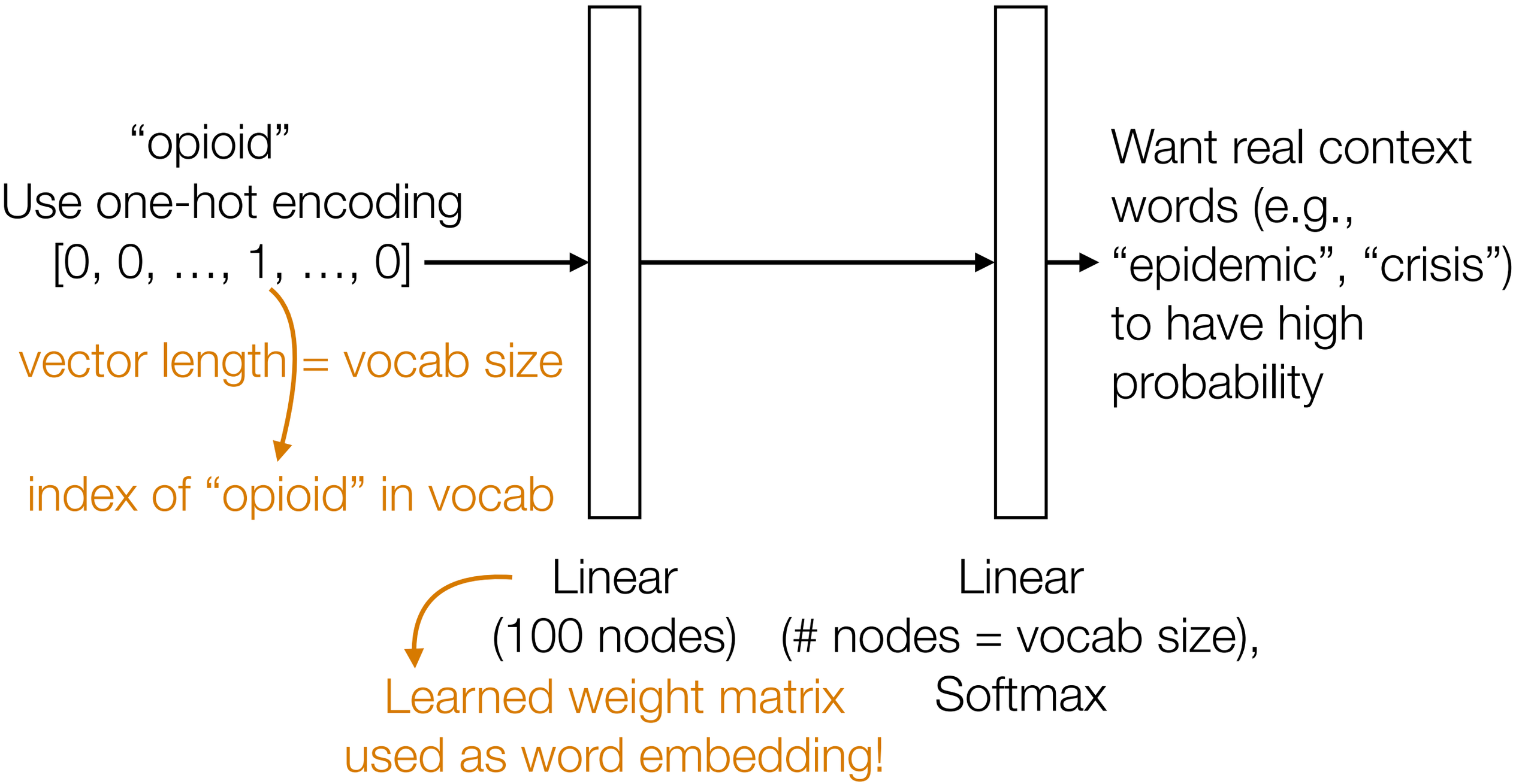
Sentiment analysis RNN demo



GloVe vectors pre-trained on massive dataset (Wikipedia + Gigaword)

IMDb review dataset is small in comparison

(Flashback) Word2vec Neural Net



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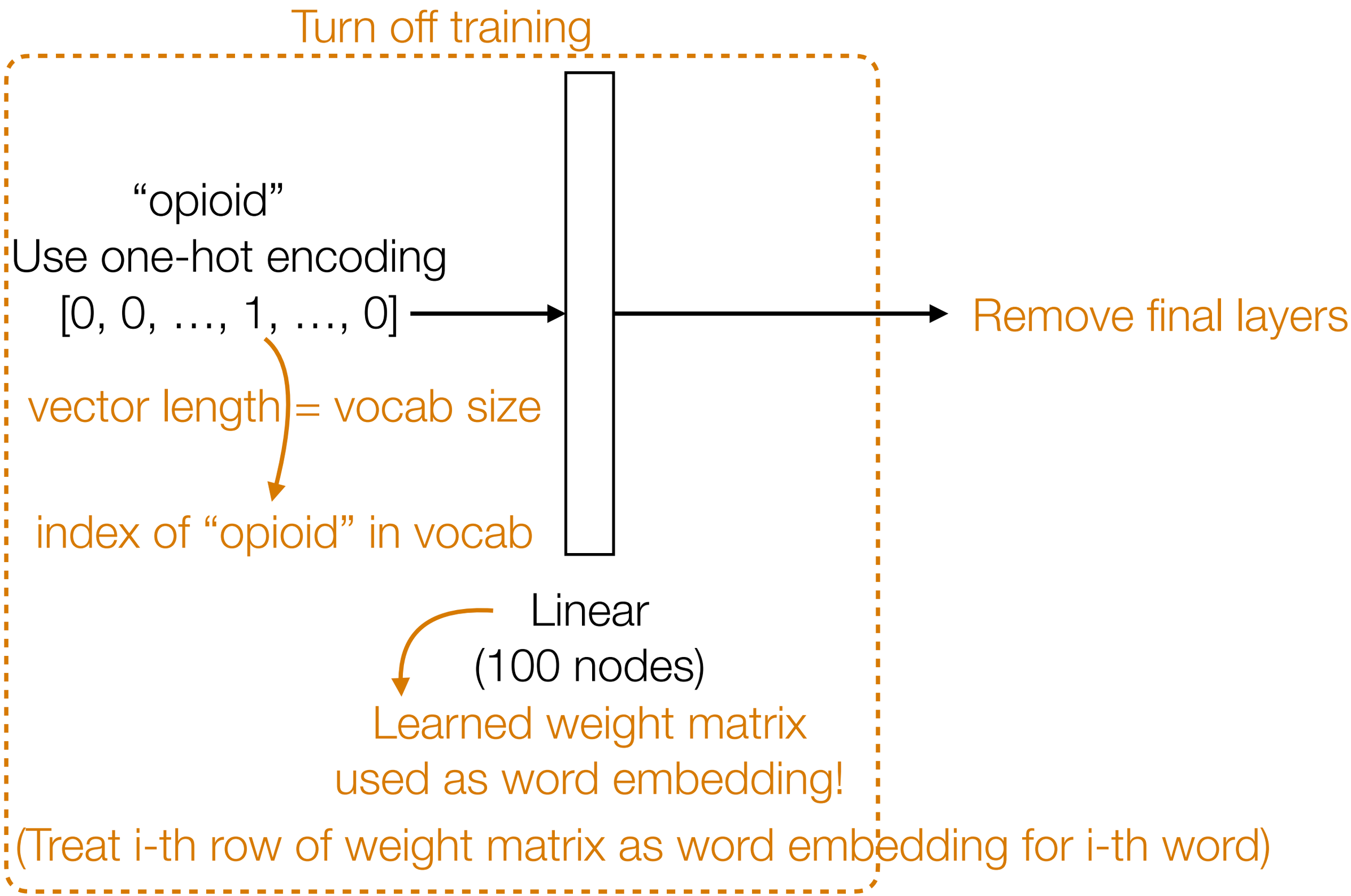
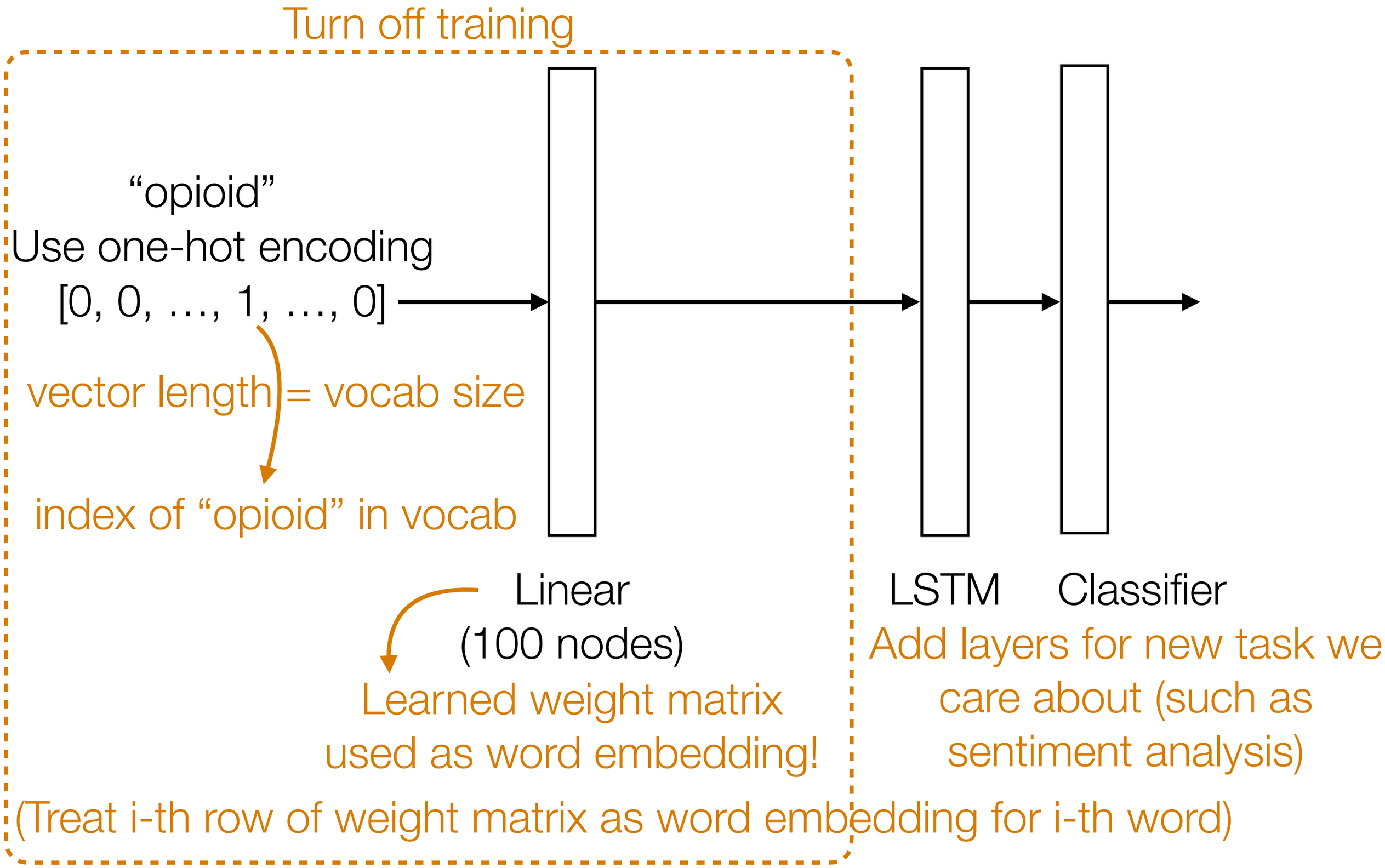
(Flashback) Word2vec Neural Net



(Flashback) Word2vec Neural Net



A Look Under the Hood

UDA_pytorch_utils.py