From Shallow to Deep Language Representations

1 Basics 2 Shallow Models 3 Transformer **4 BERT**

KDD19' Anchorage

Aston Zhang, Haibin Lin, Leonard Lausen, Sheng Zha, Alex Smola

d2l.ai gluon-nlp.mxnet.io

aws

gluon-nlp.mxnet.io

aws

TWO RIVERS
Bank & Trust

gluon-nlp.mxnet.io

aws

TWO RIVERS
Bank & Trust

gluon-nlp.mxnet.io

aws

same word2vec vector for both

gluon-nlp.mxnet.io

aws

CONTEXT IS KING

CONTEXT IS KING

FOR WORD REPRESENTATIONS

Representations

- Context free
  - CBOW/Skip-gram
  - FastText
- Contextual
  - ELMo: Embedding from Language Model
  - **BERT: Bidirectional Embedding Representation from Transformers**

gluon-nlp.mxnet.io

BERT

Bidirectional Embedding from Transformers

gluon-nlp.mxnet.io

General Language Understanding Evaluation (GLUE Benchmark)

Includes datasets for acceptability, sentiment, paraphrase, sentence similarity, natural language inference

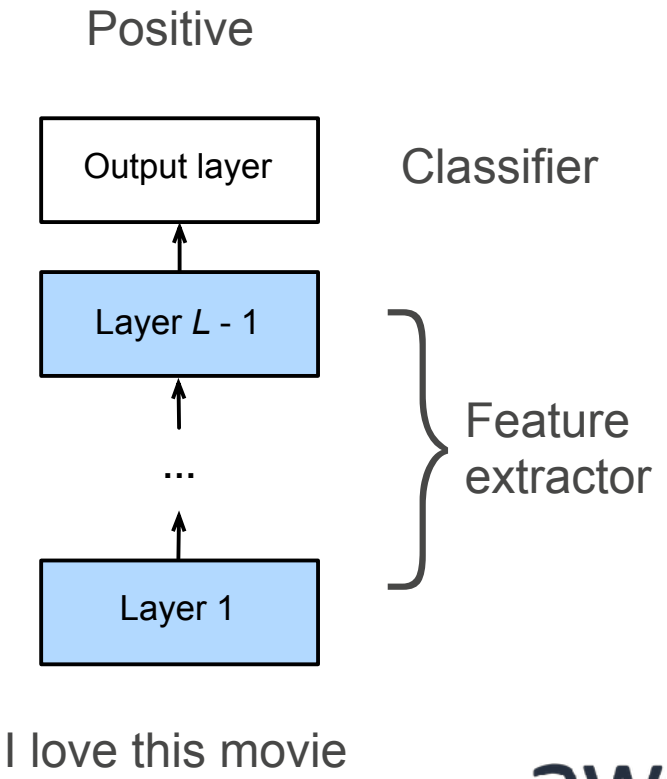
Natural Language Inference Example:
Input_0: A man inspects the uniform of a figure in some East Asian country.
Input_1: The man is sleeping
Output: contradiction

Model	Avg Score
CBOW	58.6
BERT	80.5

gluon-nlp.mxnet.io

BERT

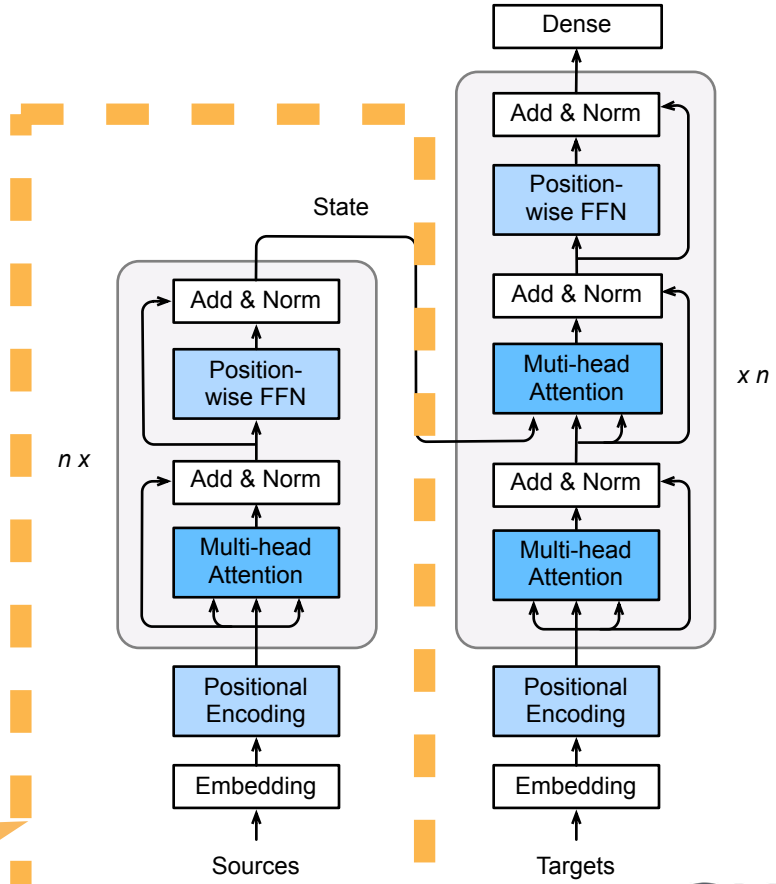
1. Pre-training: learn contextual representation on large scale corpus
2. Fine-tuning: add a simple output layer on BERT and fine-tune with the task at hand



gluon-nlp.mxnet.io

BERT Architecture

- A (big) Transformer encoder
- BERT Base
  - # blocks = 12
  - # parameters = 110M
- BERT Large
  - # blocks = 24
  - # parameter = 340M



gluon-nlp.mxnet.io

BERT Pre-training

- Pre-training tasks:
  - masked language modeling
  - next sentence prediction
- Dataset: Wikipedia and BooksCorpus (>3B words)

gluon-nlp.mxnet.io

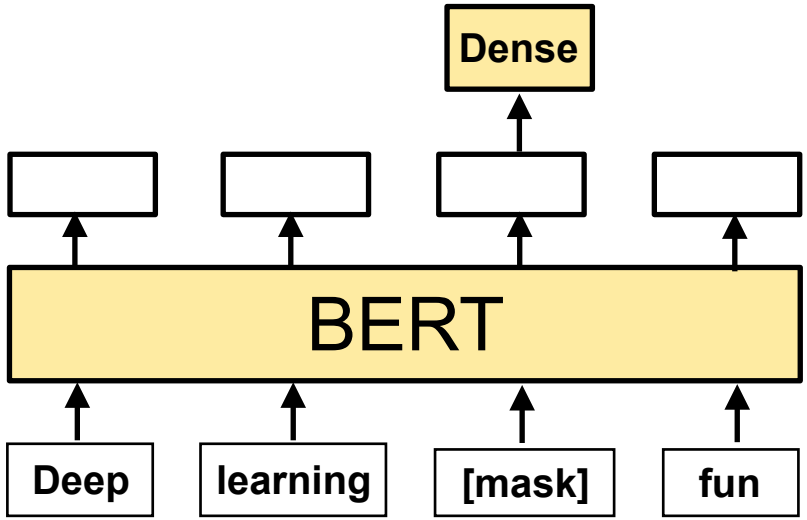
Pre-training Task 1: Masked Language Model

Original sentence:

Deep learning is fun.

Masked sentence:

Deep learning [mask] fun.



$$\text{loss} = -\log p(\text{is} \mid \text{deep}, \text{learning}, [\text{mask}], \text{fun})$$

Pre-training Task 2: Next Sentence Prediction

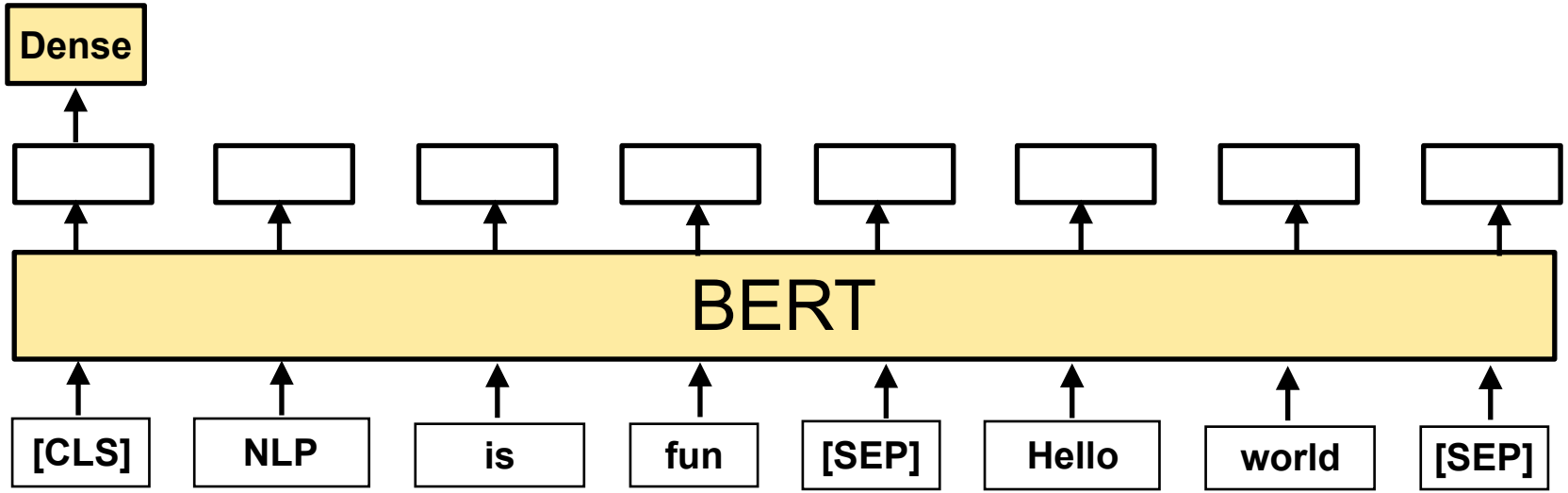
- Each example is a pair of sentences

  is_next_sentence: NLP is fun. GluonNLP is awesome.

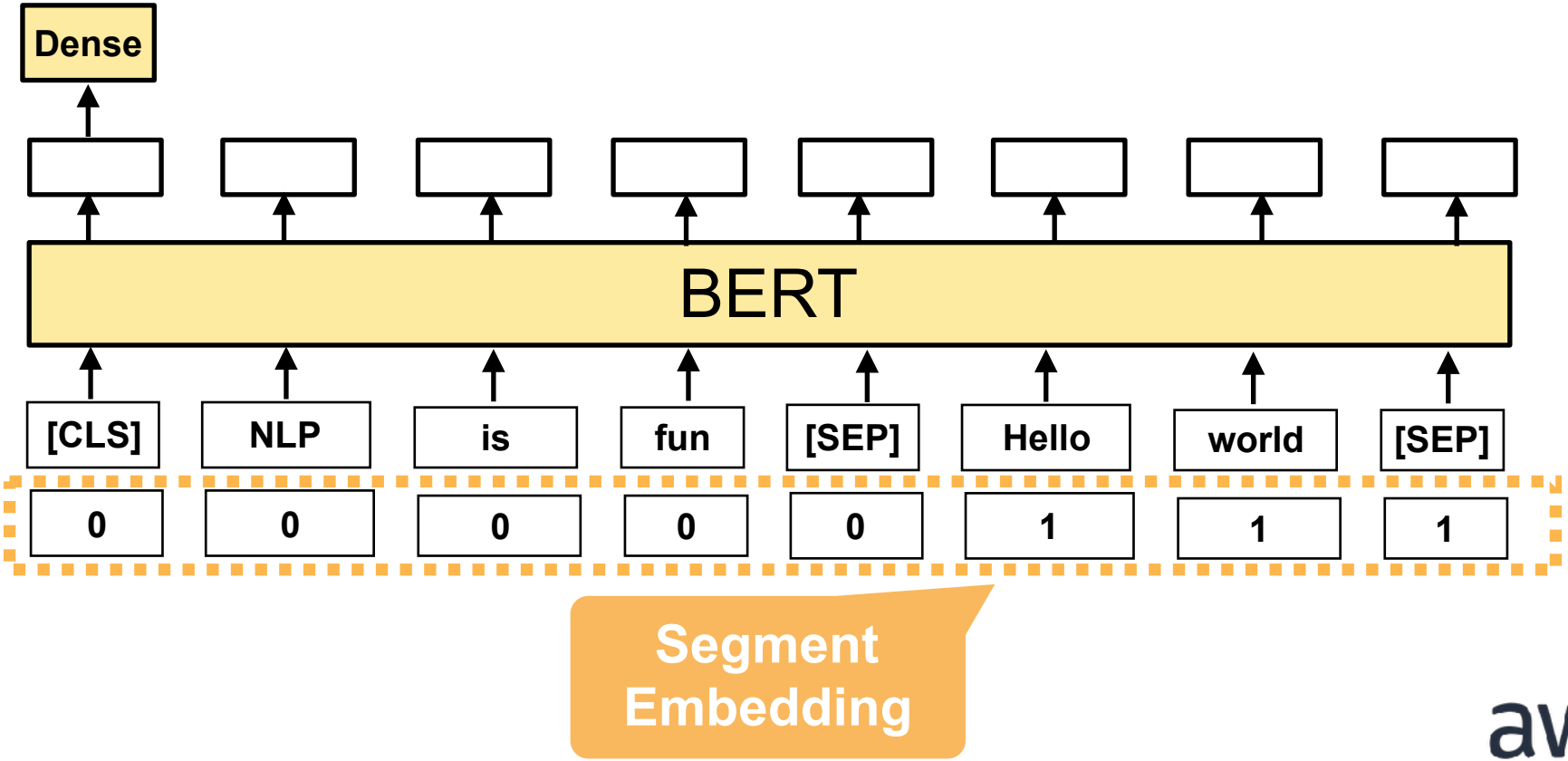
  not_next_sentence: NLP is fun. Hello world.

- Sentence level binary classification

Pre-training Task 2: Next Sentence Prediction



Pre-training Task 2: Next Sentence Prediction



gluon-nlp.mxnet.io

aws

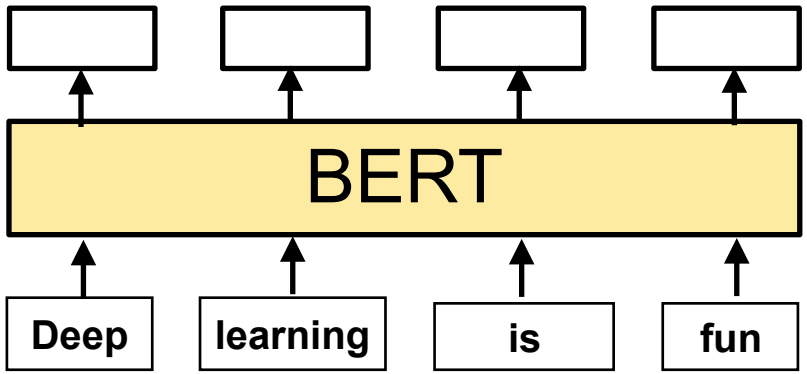
BERT Pre-training

- Pre-training tasks:
  - masked language modeling
  - next sentence prediction
- Dataset: Wikipedia and BooksCorpus (>3B words)

gluon-nlp.mxnet.io

BERT Fine-tuning

- BERT returns a (contextual) feature vector for each token
- Different fine-tuning tasks use a different set of vectors



gluon-nlp.mxnet.io

aws

Fine-tuning: Sentence Classification

Input: This movie is great

Output: positive

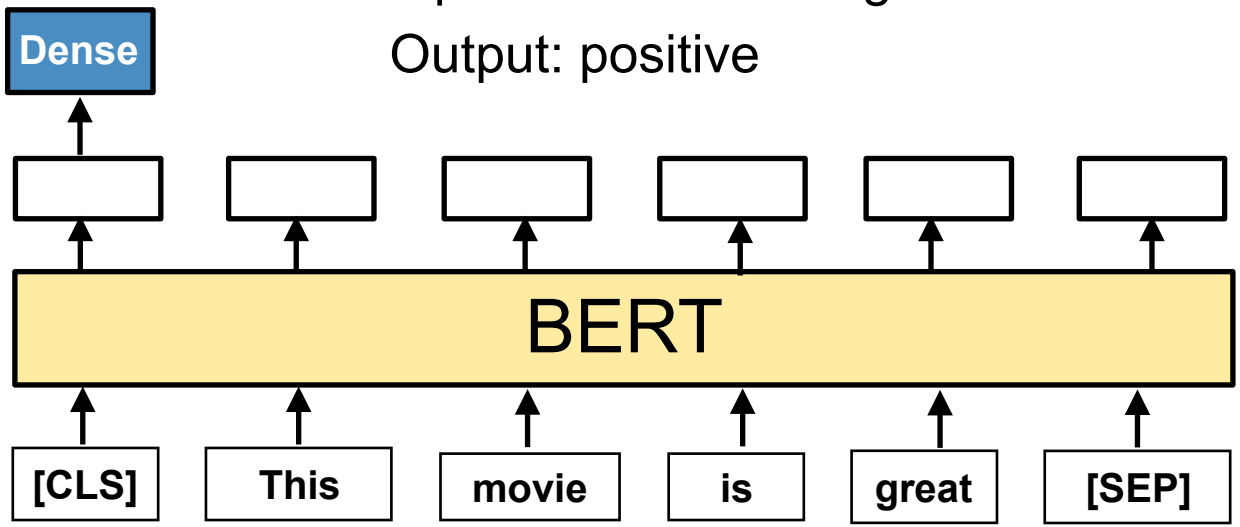
gluon-nlp.mxnet.io

Fine-tuning: Sentence Classification

Feed the [CLS] token vector into a dense output layer.

Input: This movie is great

Output: positive



Fine-tuning: Sentence Pair Classification

Input_0: The processor was announced in San Jose at the Forum.

Input_1: The processor was unveiled at the Forum in San Jose.

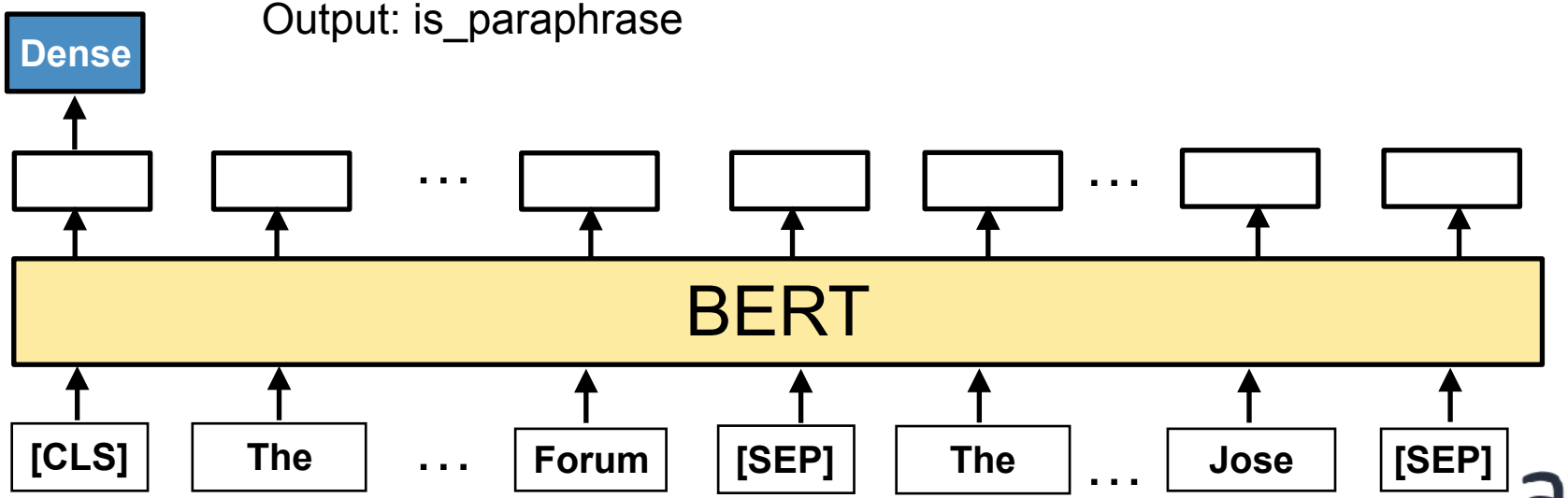
Output: is_paraphrase

Fine-tuning: Sentence Pair Classification

- Feed the [CLS] token vector into a dense output layer.

Input_0: The processor was announced in San Jose at the Forum.
Input_1: The processor was unveiled at the Forum in San Jose.

Output: is_paraphrase



Fine-tuning: Named Entity Recognition

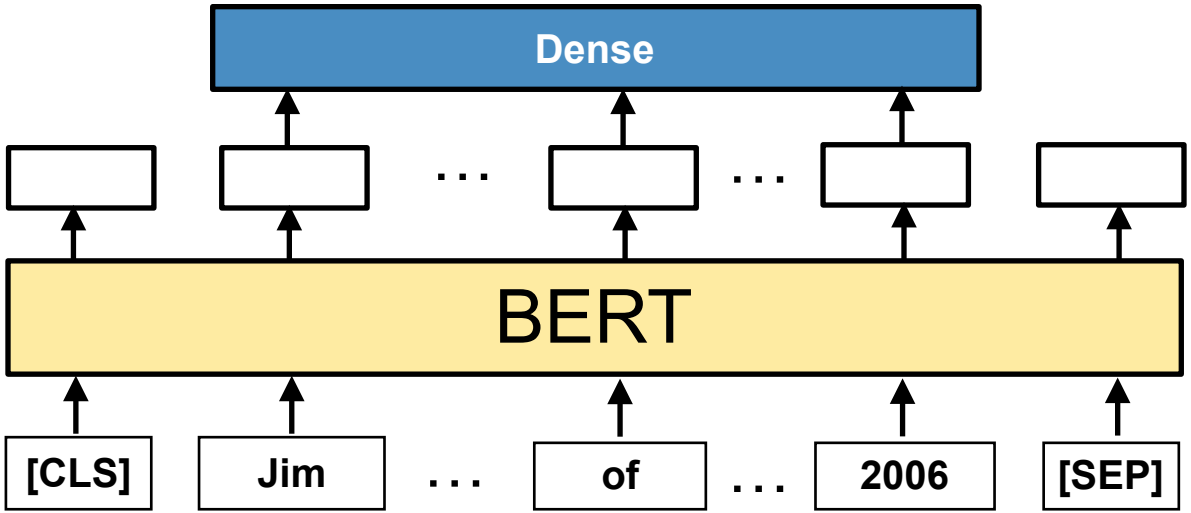
Input: Jim bought 3000 shares of Amazon in 2006.
Output: [person] [organization] [time]

gluon-nlp.mxnet.io

Fine-tuning: Named Entity Recognition

- Feed each non-special token vector into a dense output layer

Input: Jim bought 3000 shares of Amazon in 2006.
Output: [person] [organization] [time]



gluon-nlp.mxnet.io

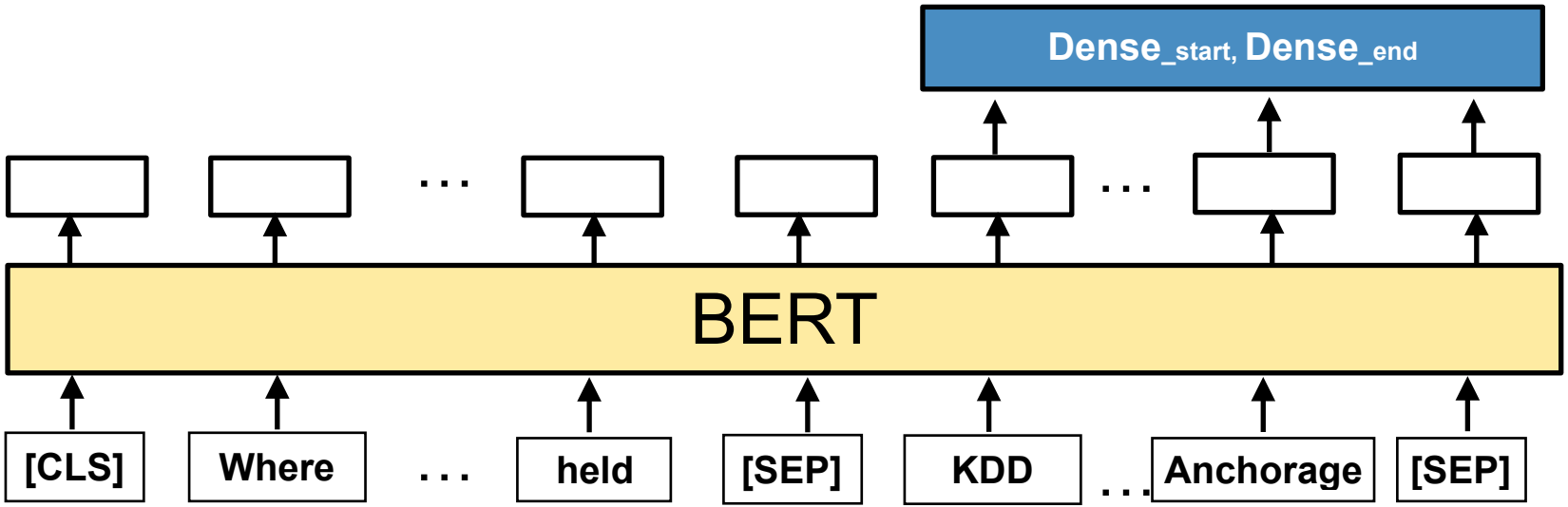
Fine-tuning: Question Answering

Given a question and a description text, find the answer, which is a text segment in the description

Input_0: KDD 2019 is held in Anchorage
Input_1: Where is KDD held
Output: Anchorage

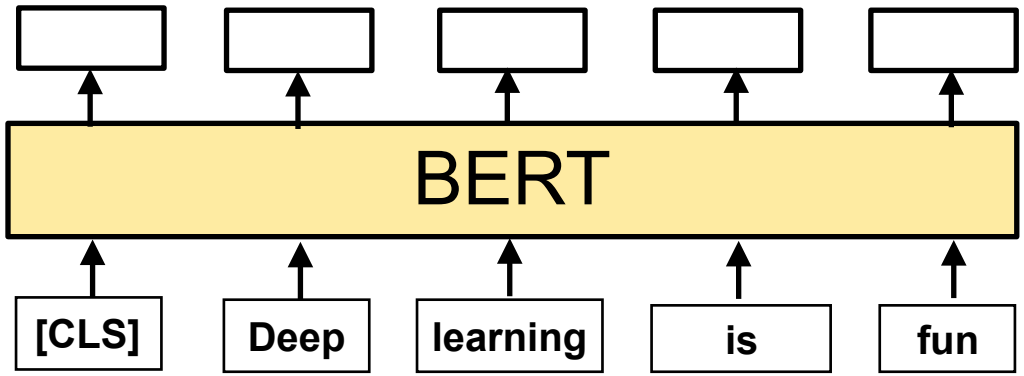
Fine-tuning: Question Answering

Input_0: KDD 2019 is held in Anchorage
Input_1: Where is KDD held
Output: Anchorage



BERT Fine-tuning

- BERT returns a (contextual) feature vector for each token
- Different fine-tuning tasks use a different set of vectors



BERT in GluonNLP

```
from gluonnlp import model
model.get_model(
    “bert_12_768_12”,
    dataset_name=“wiki_cn_cased”
)
```

As well as RoBERTa, XLNet, etc..

	bert_12_768_12	bert_24_1024_16
book_corpus_wiki_en_uncased	✓	✓
book_corpus_wiki_en_cased	✓	✓
openwebtext_book_corpus_wiki_en_uncased	✓	x
wiki_multilingual_uncased	✓	x
wiki_multilingual_cased	✓	x
wiki_cn_cased	✓	x
scibert_scivocab_uncased	✓	x
scibert_scivocab_cased	✓	x
scibert_basevocab_uncased	✓	x
scibert_basevocab_cased	✓	x
biobert_v1.0_pmc_cased		
biobert_v1.0_pubmed_cased		
biobert_v1.0_pubmed_pmc_cas		
biobert_v1.1_pubmed_cased		
clinicalbert_uncased	✓	x
ernie_baidu_cn_uncased	✓	x

Available in GluonNLP

gluon-nlp.mxnet.io

Devlin, Jacob, et al. "Bert: Pre-training of deep bidirectiona
arXiv preprint arXiv:1810.04805 (2018).

Notebook: BERT for Sentiment Analysis

07_bert_app/bert.ipynb