Dive into Deep Learning for NLP

4. Contextual Representations

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13:15-14:15	Natural Language Processing and Deep Learning Basics
14:15-14:25	Break
14:25-15:15	Context-free Representations with Word Embeddings
15:15-15:55	Machine Translation and Sequence Generation
15:55-16:35	Contextual Representations with BERT
16:35-16:45	Break
16:45-17:15	Model Deployment with TVM

Context Matters: Retail Bank or River Bank?

1. I jog along the **bank** of Duwamish River every day.

2. I went to the **bank** to open a savings account.

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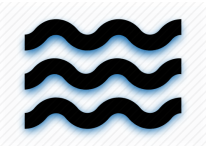
2. I went to the **bank** to open a savings account. 

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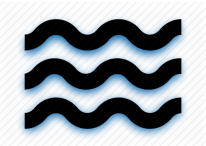

With word embedding, the vector representing “**bank**” is the **same** in both sentences

Can we have representations that depend on the **context**?

Representations

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

BERT

Bidirectional Embedding from Transformers

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General Language Understanding Evaluation (GLUE Benchmark)

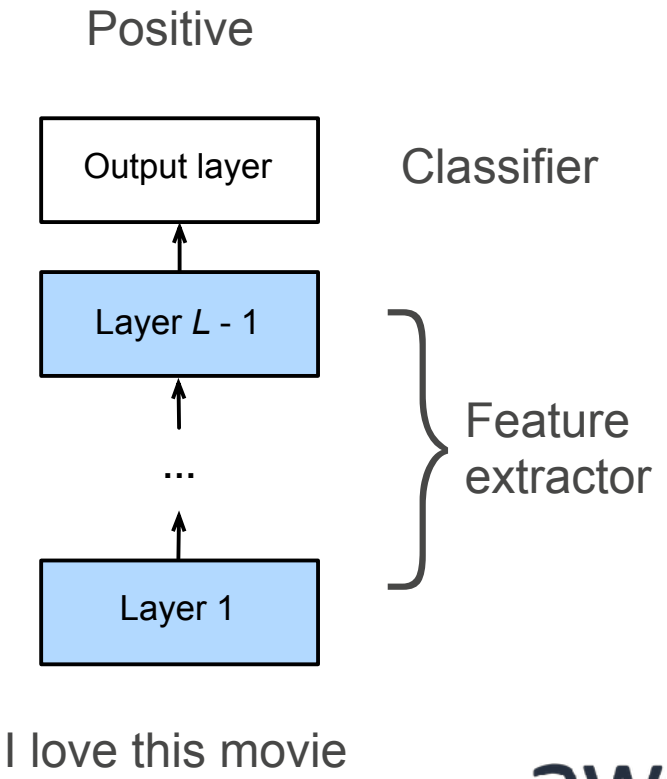
Including datasets for:

- acceptability
- sentiment
- paraphrase
- sentence similarity
- natural language inference

Model	Avg Score
CBOW	58.6
BERT	80.5

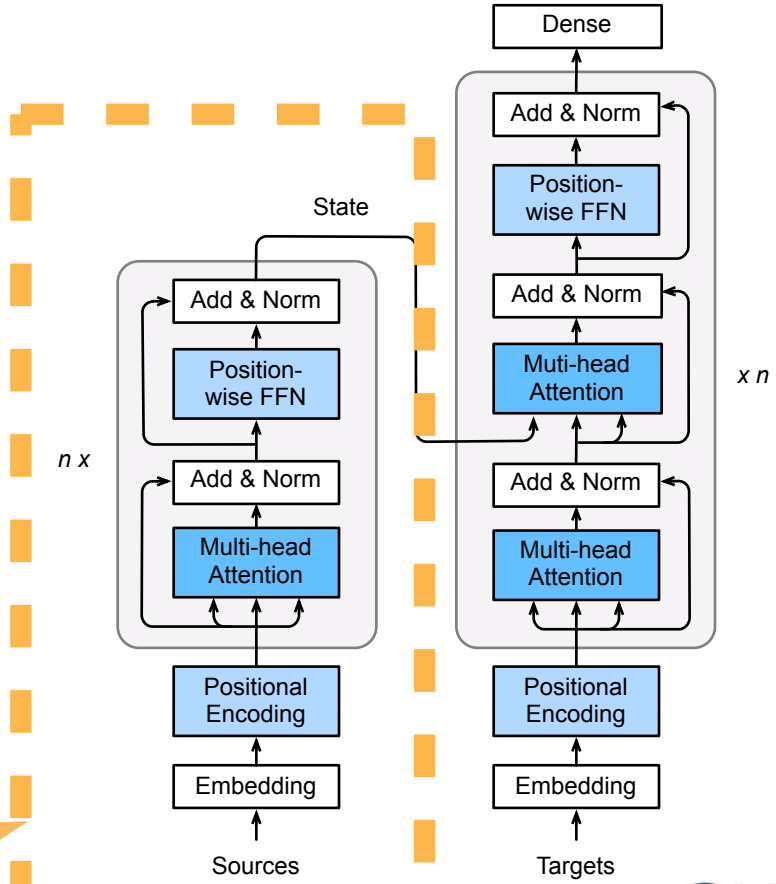
BERT

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



BERT Architecture

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



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BERT Pre-training

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

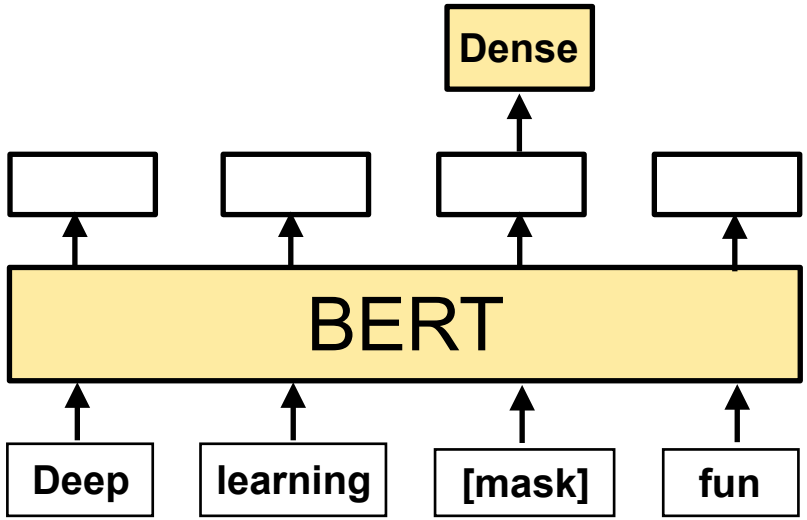
Pre-training Task 1: Masked Language Model

Original sentence:

Deep learning is fun.

Masked sentence:

Deep learning [mask] fun.



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

Pre-training Task 2: Next Sentence Prediction

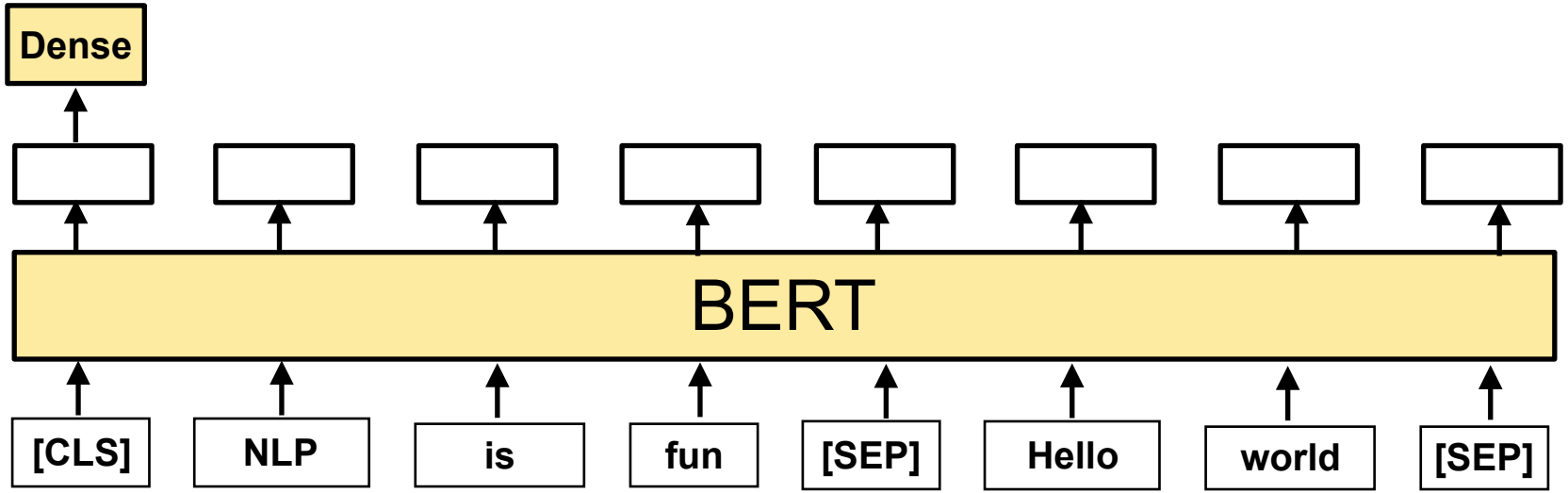
- Each example is a pair of sentences

  is_next_sentence: NLP is fun. GluonNLP is awesome.

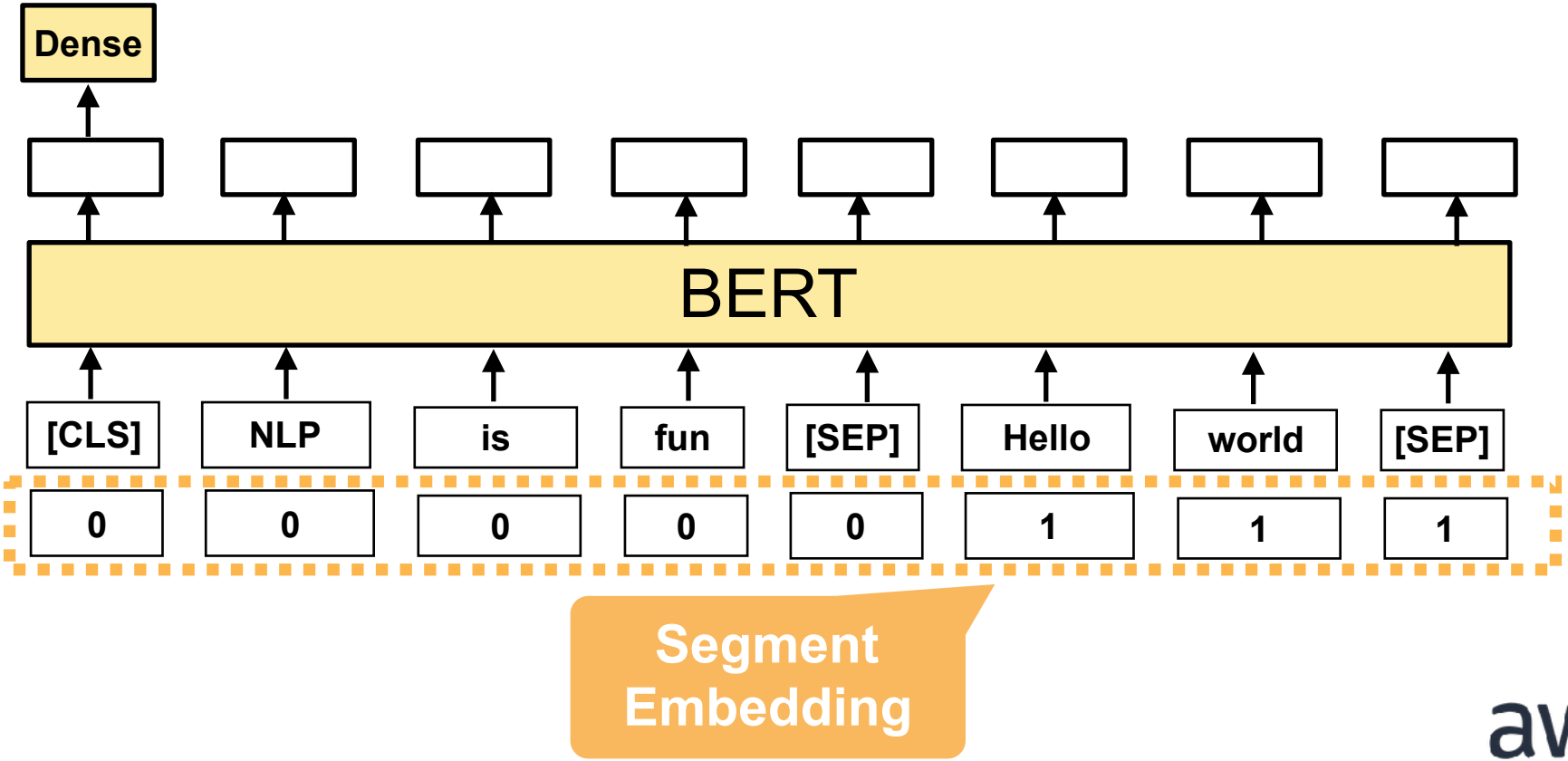
  not_next_sentence: NLP is fun. Hello world.

- Sentence level binary classification

Pre-training Task 2: Next Sentence Prediction

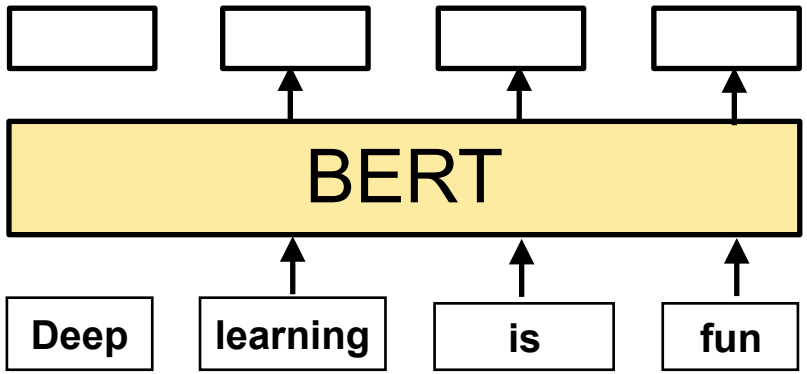


Pre-training Task 2: Next Sentence Prediction



BERT Fine-tuning

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



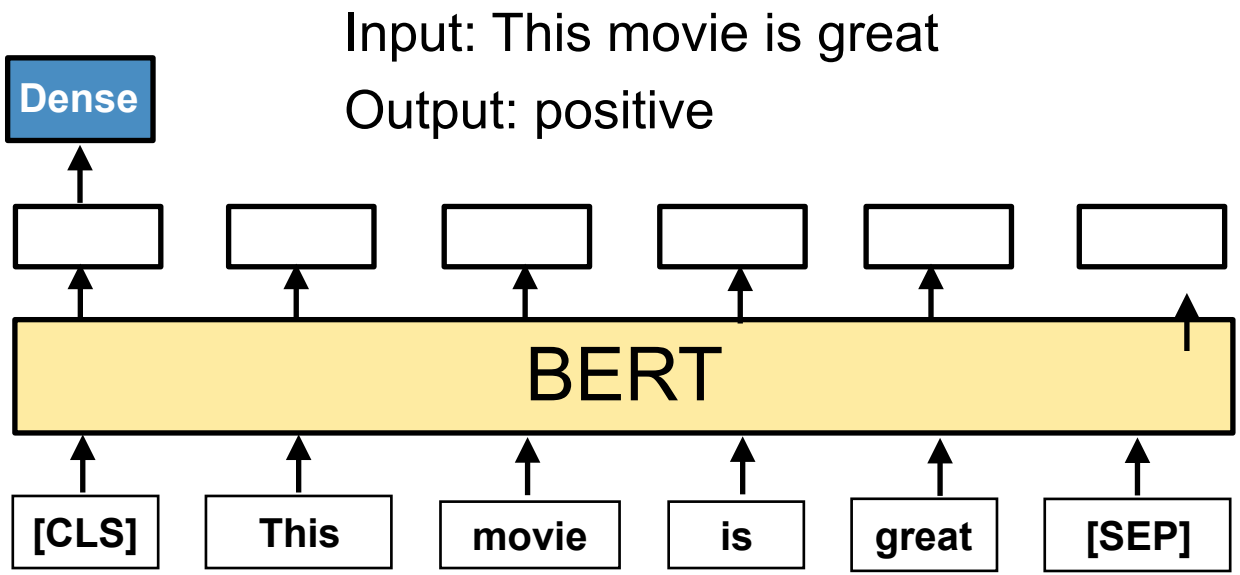
Fine-tuning: Sentence Classification

Input: This movie is great

Output: positive

Fine-tuning: Sentence Classification

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



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

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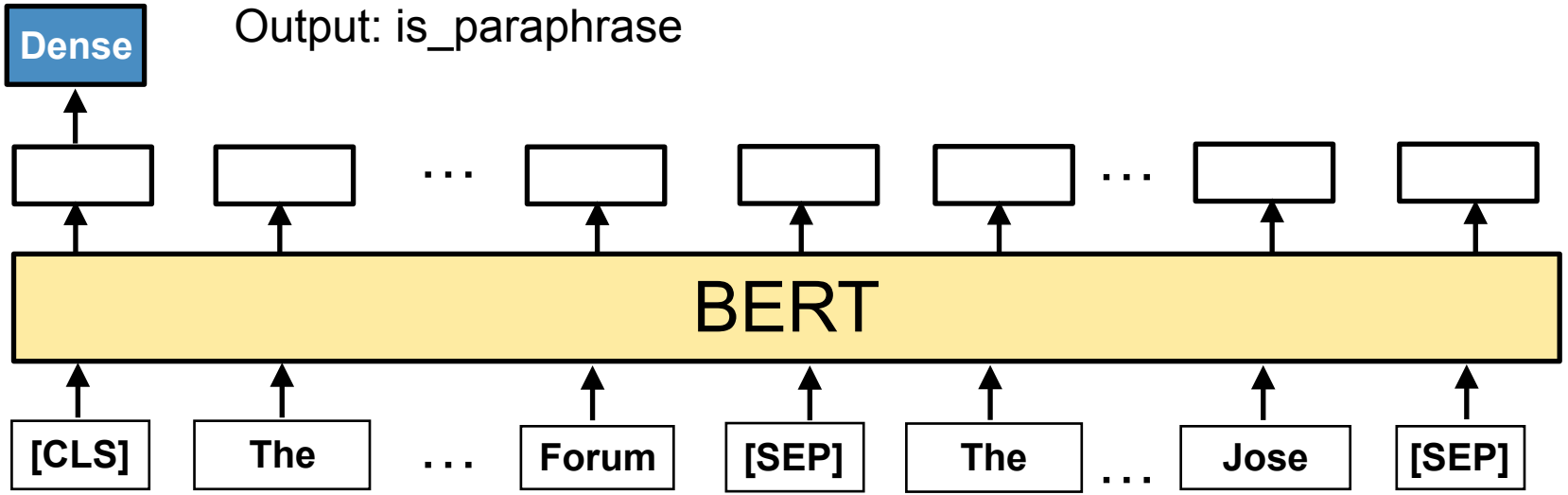
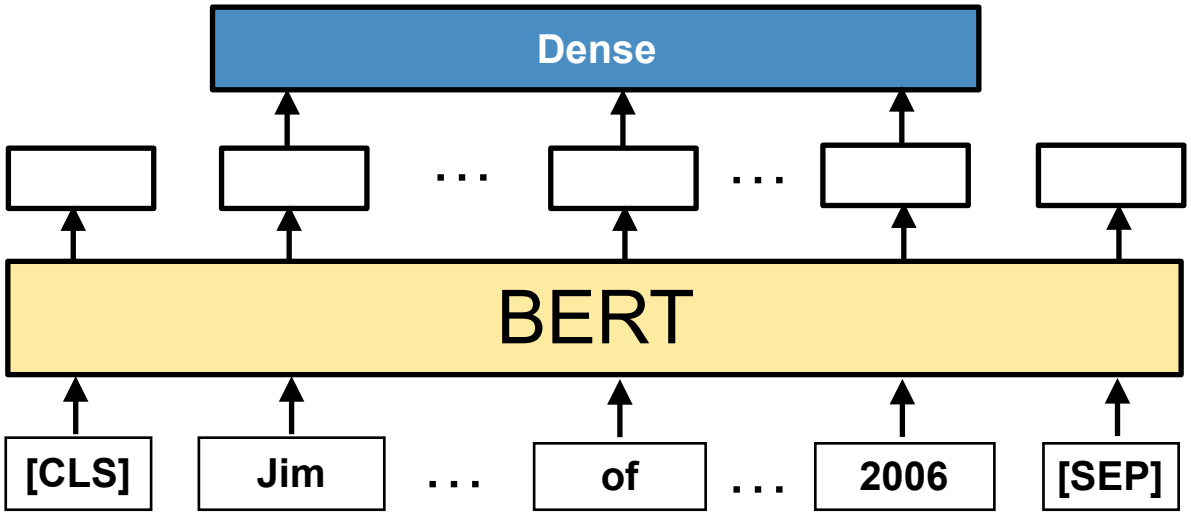


- Feed the [CLS] token vector into a dense output layer.

Fine-tuning: Named Entity Recognition

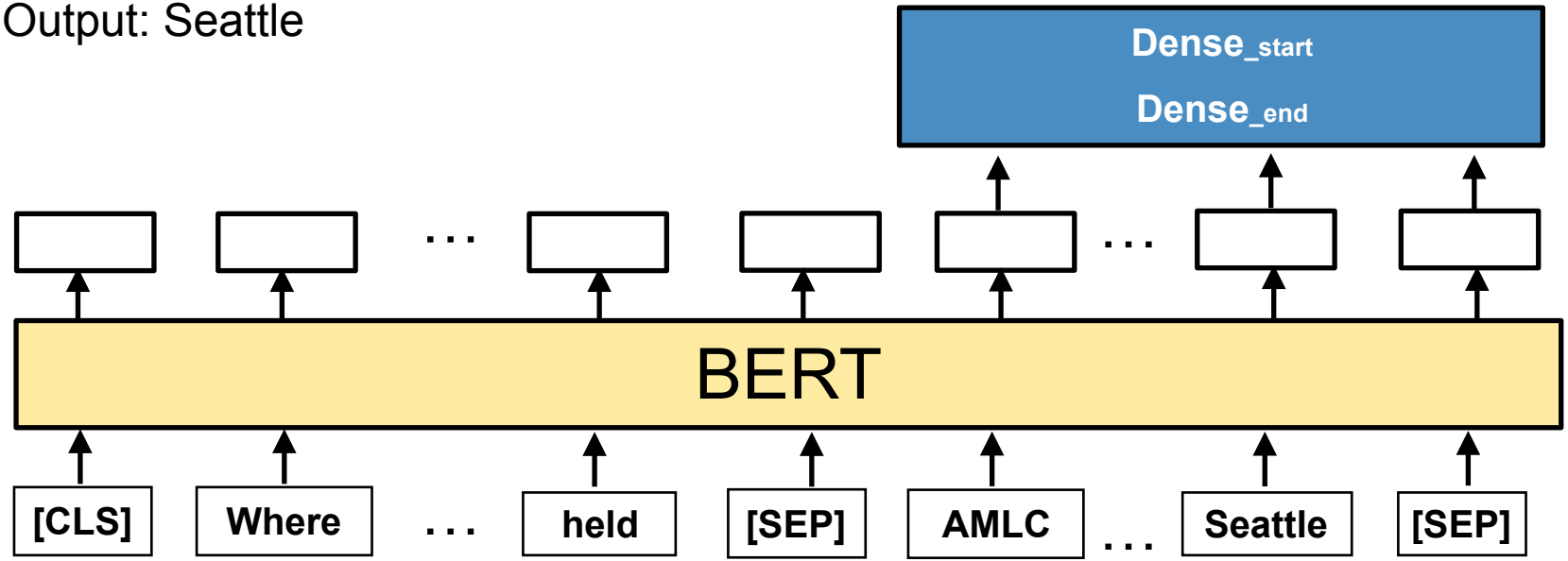
Input: Jim bought 3000 shares of Amazon in 2006.
Output: [person] [organization] [time]



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

Fine-tuning: Question Answering

Input_0: AMLC 2019 is held in Seattle
Input_1: Where is AMLC held
Output: Seattle



BERT

Pre-trained on large scale corpus

	Google		GluonNLP
Num layers	12	24	12
SST-2	93.5	94.9	**95.3**
RTE	66.4	70.1	**73.6**
QQP	71.2	72.1	**72.3**
SQuAD	88.5	90.9	**91.0**
STS-B	85.8	86.5	**87.5**
MNLI	83.4	**85.9**	84.9