Natural Language Processing

Using tensorflow

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Outline

1. Input Shape
2. RNN Feed
3. Model (variables and ops)

Input Shape

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Shape of Input

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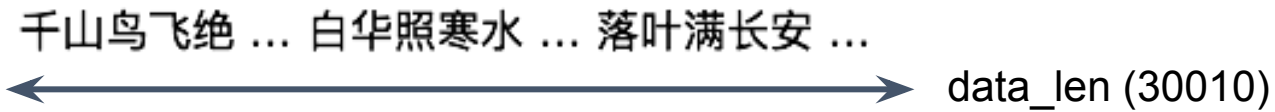
- First, concatenate all characters



- batch_len = data_len // batch_size (300 = 30010 // 100)

Reshape

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```
tf.reshape(raw_data[0:batch_size * batch_len],
                    [batch_size,  batch_len])
```

Drop last 10 words

千山鸟飞绝 … 白华照寒水 … 落叶满长安

reshape

batch_len

batch_size

千山鸟飞绝万径人踪灭 …
白华照寒水怡我适野情 …
梅实迎时雨苍茫值晚春 …
…
西风吹渭水落叶满长安 …

Batch

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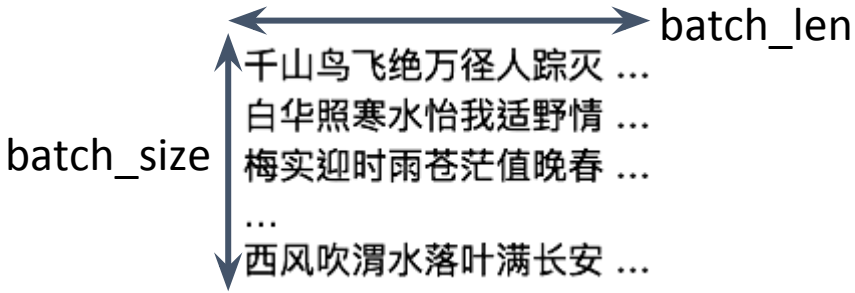
- `epoch_size = (batch_len - 1) // num_steps`

  59 = (300-1) // 5




```
i = tf.train.range_input_producer(epoch_size, shuffle=False).dequeue()
i = 0, 1, 2, …, 58
```

Batch

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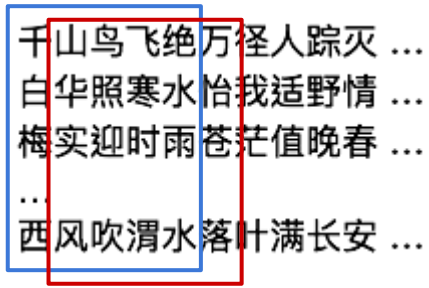
```
i = 0, 1, 2, …, 58
x = data[:, i*num_steps   :(i+1)*num_steps]
y = data[:, i*num_steps+1:(i+1)*num_steps+1]
```

```
x1 = [0:100, 0*5 : 1*5]
y1 = [0:100, 0*5+1 : 1*5+1]
```



Batch

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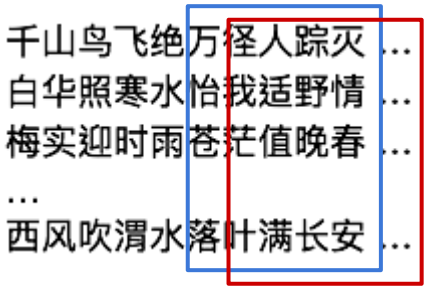
```
i = 0, 1, 2, …, 58
x = data[:, i*num_steps   :(i+1)*num_steps]
y = data[:, i*num_steps+1:(i+1)*num_steps+1]
```

```
x2 = [0:100, 1*5 : 2*5]
y2 = [0:100, 1*5+1 : 2*5+1]
```



Batch

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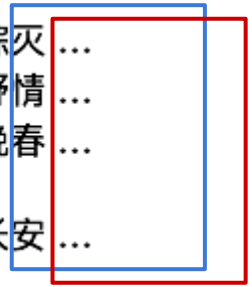
```
i = 0, 1, 2, …, 58
x = data[:, i*num_steps   :(i+1)*num_steps]
y = data[:, i*num_steps+1:(i+1)*num_steps+1]
```

290:295

```
x59 = [0:100, 58*5:59*5]
y59 = [0:100, 58*5+1:59*5+1]
```

291:296

千山鸟飞绝万径人踪灭 …
白华照寒水怡我适野情 …
梅实迎时雨苍茫值晚春 …
…
西风吹渭水落叶满长安 …



- Last part of data that cannot form a batch will be abandoned.

RNN Feed

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Feed During Training

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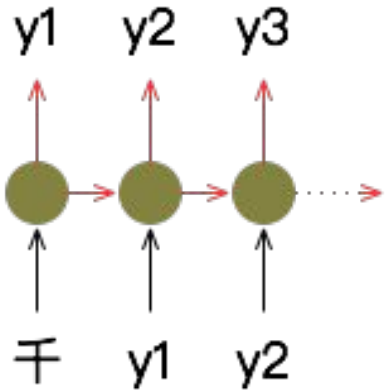

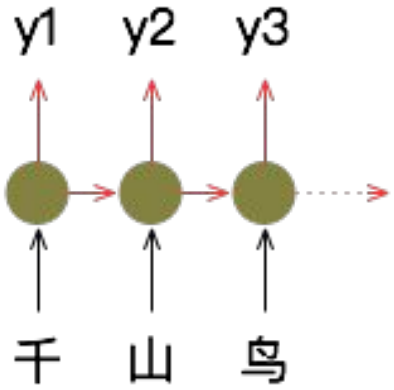

- Less information for the model when predicting > y2 words
- More information
- Simulate the condition where the model can predict the correct word

After Training

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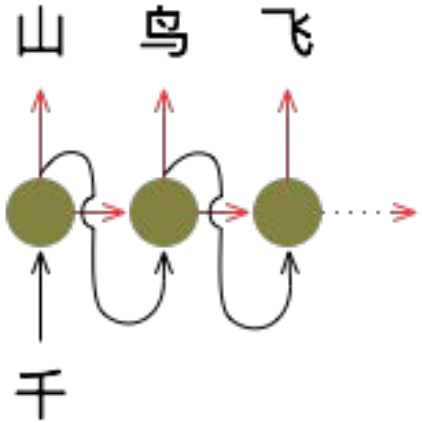

- When the model is well-trained, it should produce correct words on its own

Model: variables and ops

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Variables and ops

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- A layer may contain variables and operations

  variable
  ```
  embedding_weights = tf.get_variable("embedding",
                                      [vocab_size, embedding_size])
  ```

  op
  ```
  embed_inputs =
    tf.nn.embedding_lookup(embedding_weights, input)
  ```

- Or just op, no variable

  ```
  tf.nn.dropout(embed_inputs, ......)
  ```

Can use the same name

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- A layer may contain variables and operations

  variable `embedding_weights = tf.get_variable("embedding", [vocab_size, embedding_size])`

  op `embed_inputs = tf.nn.embedding_lookup`

- Or just op, no variable

  `tf.nn.dropout(embed_inputs, ...`

You can use the same name to connect output of one layer to the input of another layer. (optional)

Step-by-step Building

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- We will demonstrate with variables and operations
- Understand how to go from input to output

Building Blocks

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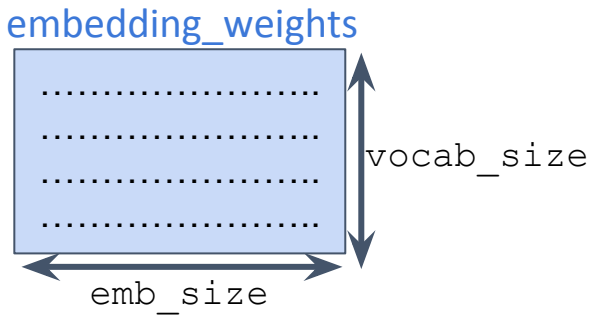
1. Create variable if needed



embedding_weights =

```
tf.get_variable("embedding",
        [vocab_size, embedding_size])
```

Building Blocks

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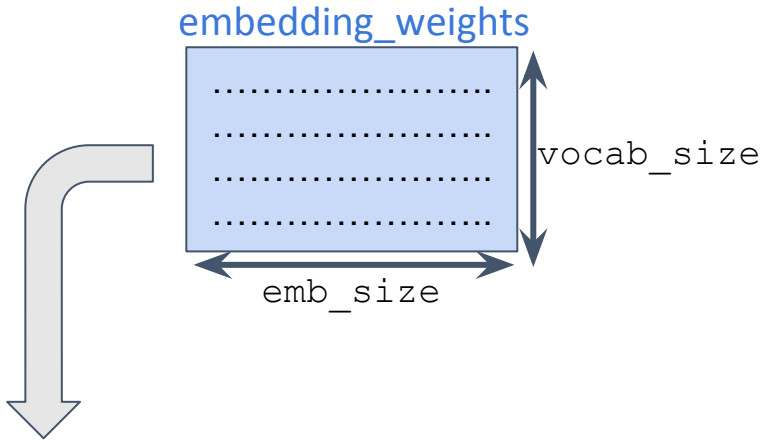
1. Create variable if needed
2. Add op that uses the variable




```
embedding_lookup(embedding_weights, input)
```

Building Blocks

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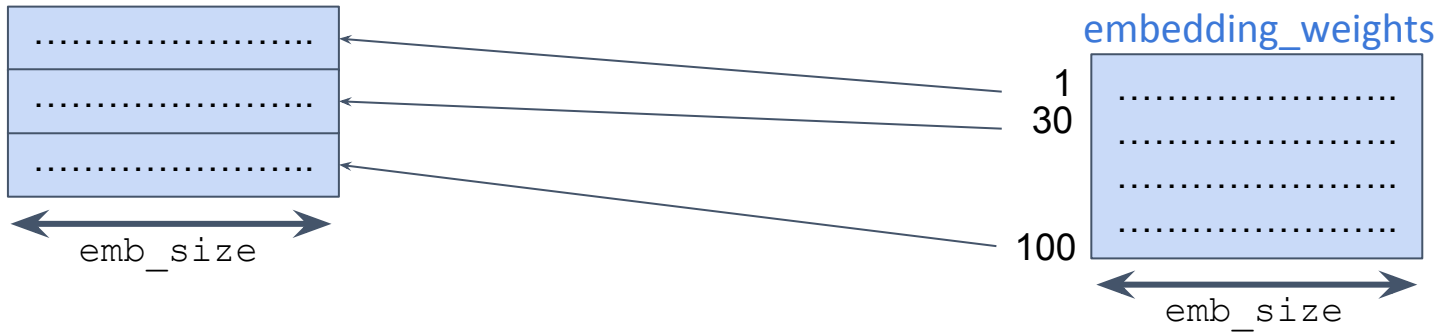
```
embedding_lookup(embedding_weights, [1,30,100])
```



Building Blocks

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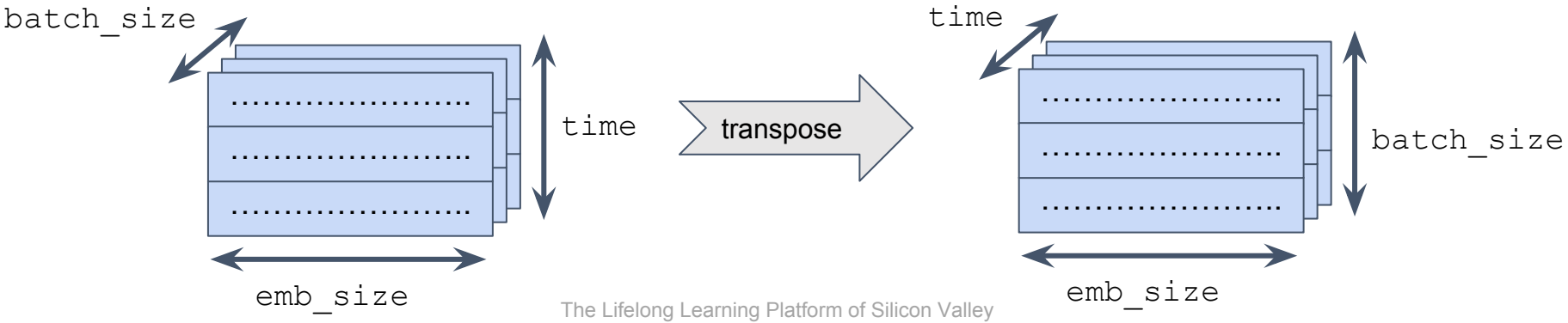
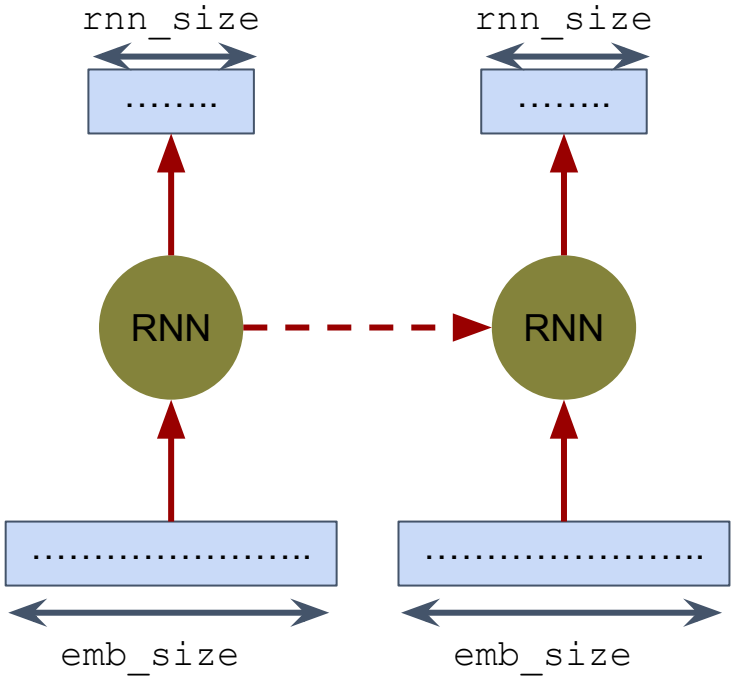
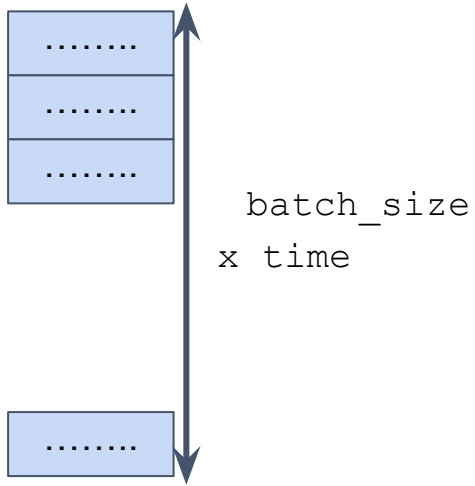
1. Create variable if needed
2. Add op that uses the variable
3. Transpose/reshape if needed before sending to the next layer



Building Blocks



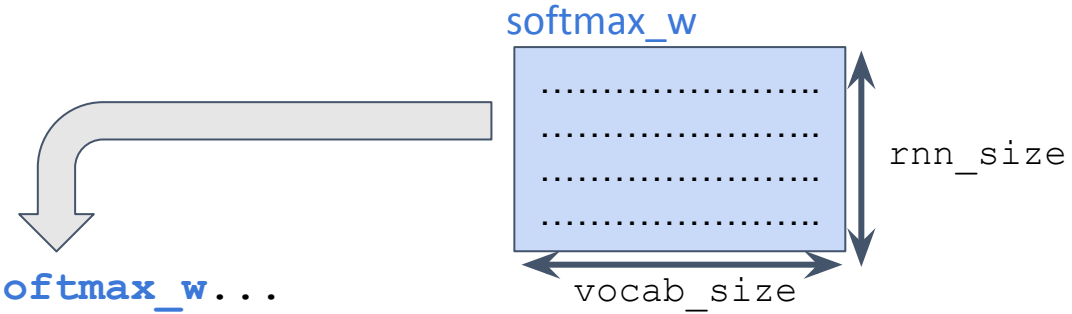
- Merge 1 and 2 dimension of RNN layer output



Building Blocks

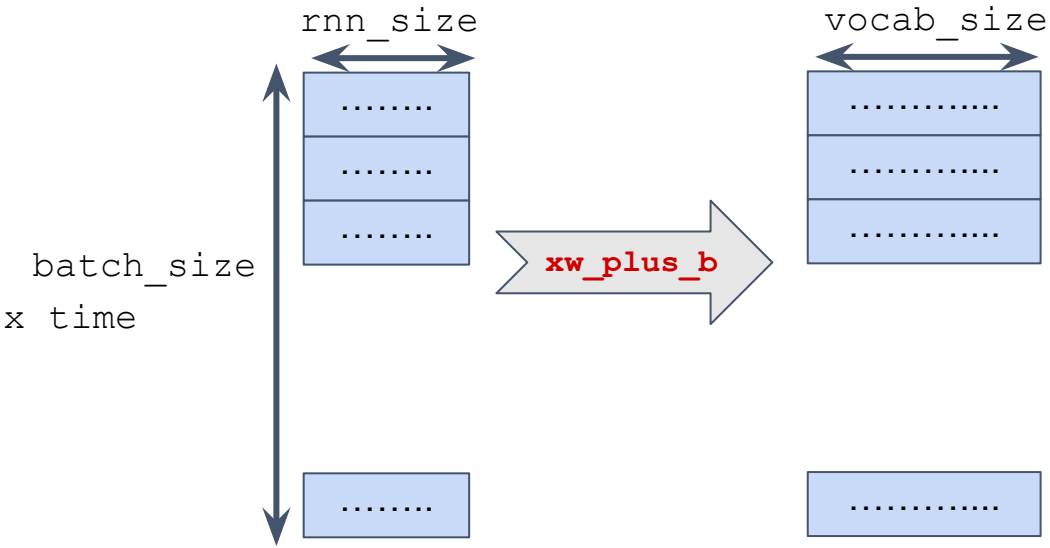
BITTIGER

1. Create variable if needed
2. Add op that uses the variable
3. Transpose/reshape if needed before sending to the next layer

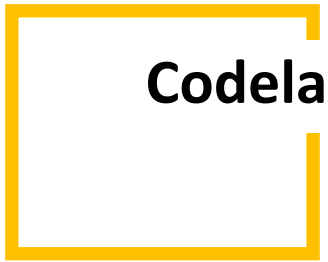



```
xw_plus_b(rnn_output,softmax_w...
```

Building Blocks



- Represent probability of word



Codelab

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Attention

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Concept

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1. Calculate weight over encoder outputs

   Using current decoder memory
2. Weighted sum of encoder outputs, “context vector”
3. Merge context with decoder output (word)
4. Send to decoder for next decoding step
5. Back to 1.

Attention

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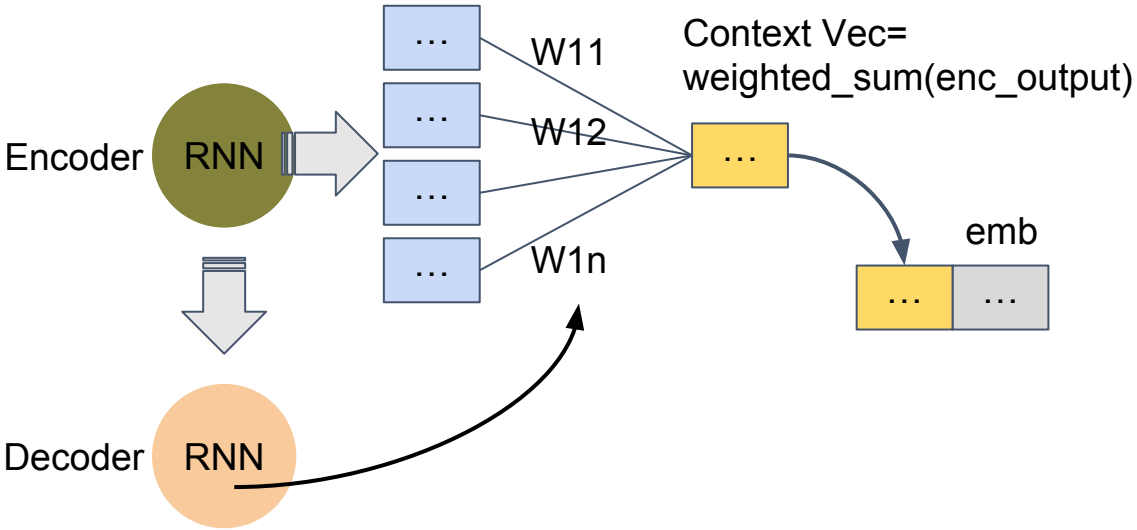
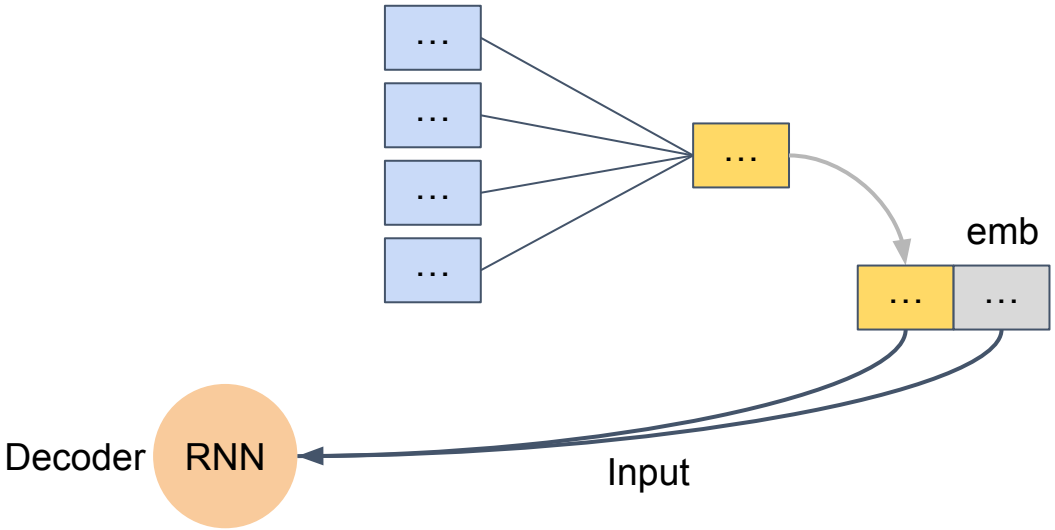


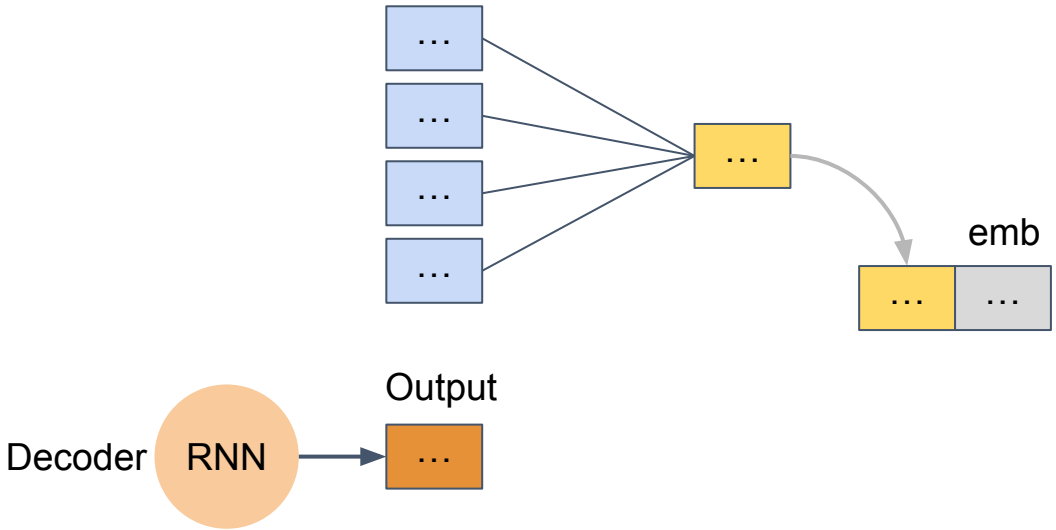
Attention

BITTIGER



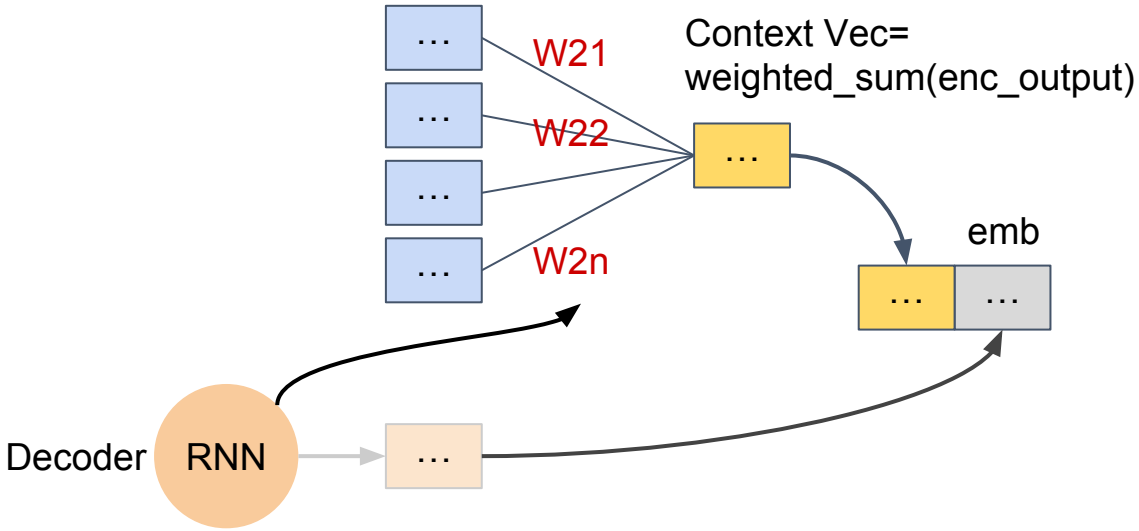
Attention

BITTIGER



Attention

BITTIGER



Attention

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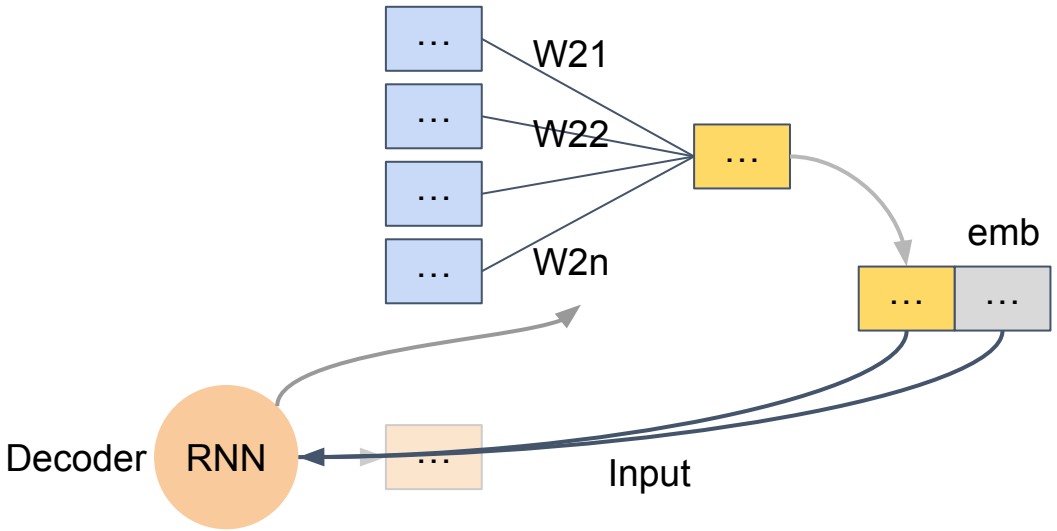

Attention

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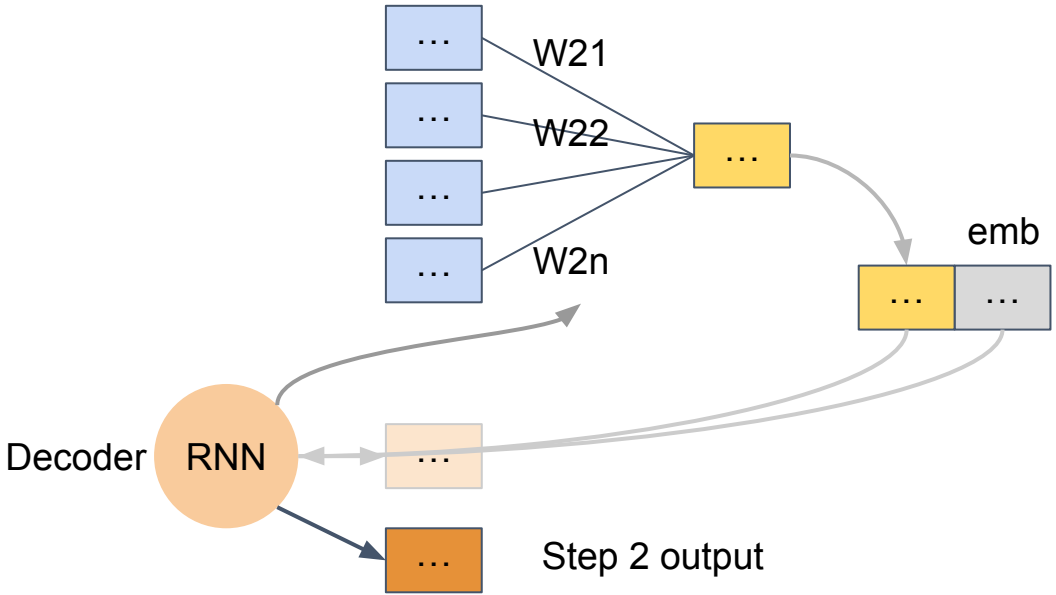

Definition

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1. Calculate weight over encoder outputs

$$\text{score}(\boldsymbol{h}_t, \bar{\boldsymbol{h}}_s) = \boldsymbol{v}_a^\top \tanh\left(\boldsymbol{W_1}\boldsymbol{h}_t + \boldsymbol{W_2}\bar{\boldsymbol{h}}_s\right)$$

2. Normalize weights

$$\alpha_{ts} = \frac{\exp\left(\text{score}(\boldsymbol{h}_t, \bar{\boldsymbol{h}}_s)\right)}{\sum_{s'=1}^{S} \exp\left(\text{score}(\boldsymbol{h}_t, \bar{\boldsymbol{h}}_{s'})\right)}$$

3. Sum to get “context vector”

$$\boldsymbol{c}_t = \sum_s \alpha_{ts} \bar{\boldsymbol{h}}_s$$