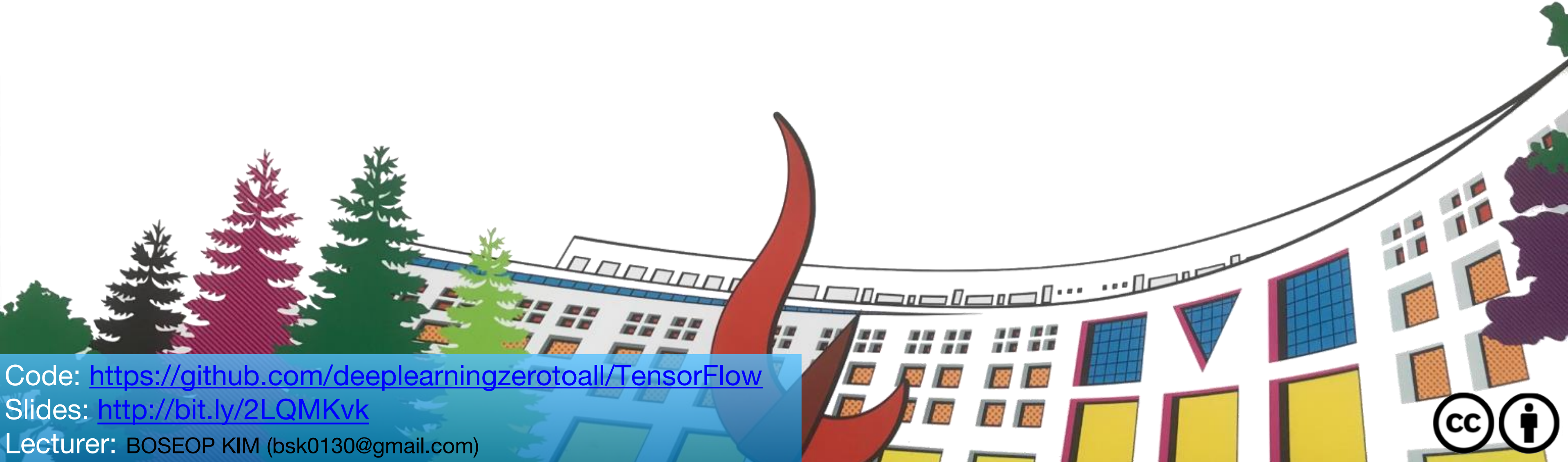
# ML/DL for Everyone Season2

with TensorFlow

# Lab 12-3 many to many

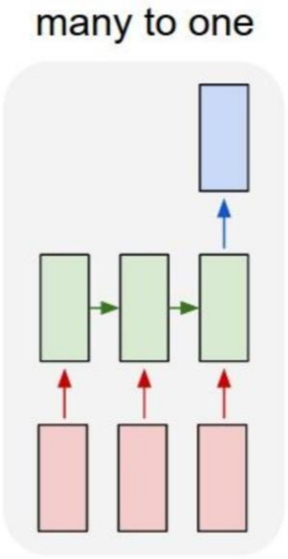


Code: https://github.com/deeplearningzerotoall/TensorFlow
Slides: http://bit.ly/2LQMKvk
Lecturer: BOSEOP KIM (bsk0130@gmail.com)

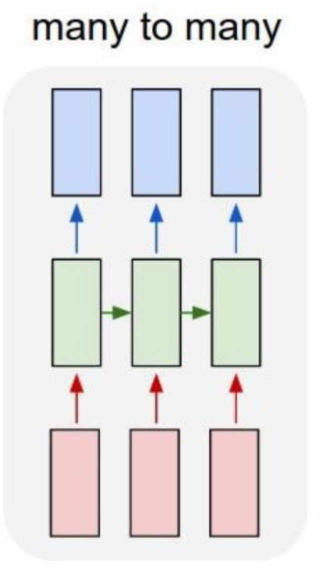
# many to many

- What is “many to many”?
- Example : part of speech tagging
    - Preparing dataset
    - Creating and training model
    - Checking performance

# What is “many to many”?



VS



producing an output for final input it reads in.

producing an output for each input it reads in.

# What is “many to many”?

## Sequence tagging

eg. part of speech tagging

*sequence : sentence, tokens : word*

*[‘tensorflow is very easy’]*

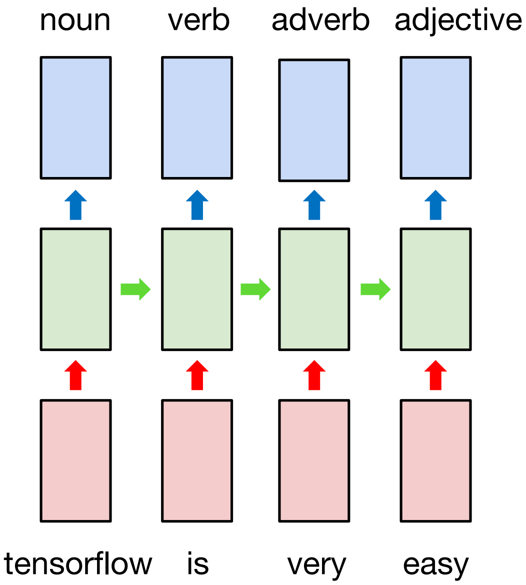
*↓ Tokenization*

*[‘tensorflow’, ‘is’, ‘very’, ‘easy’]*

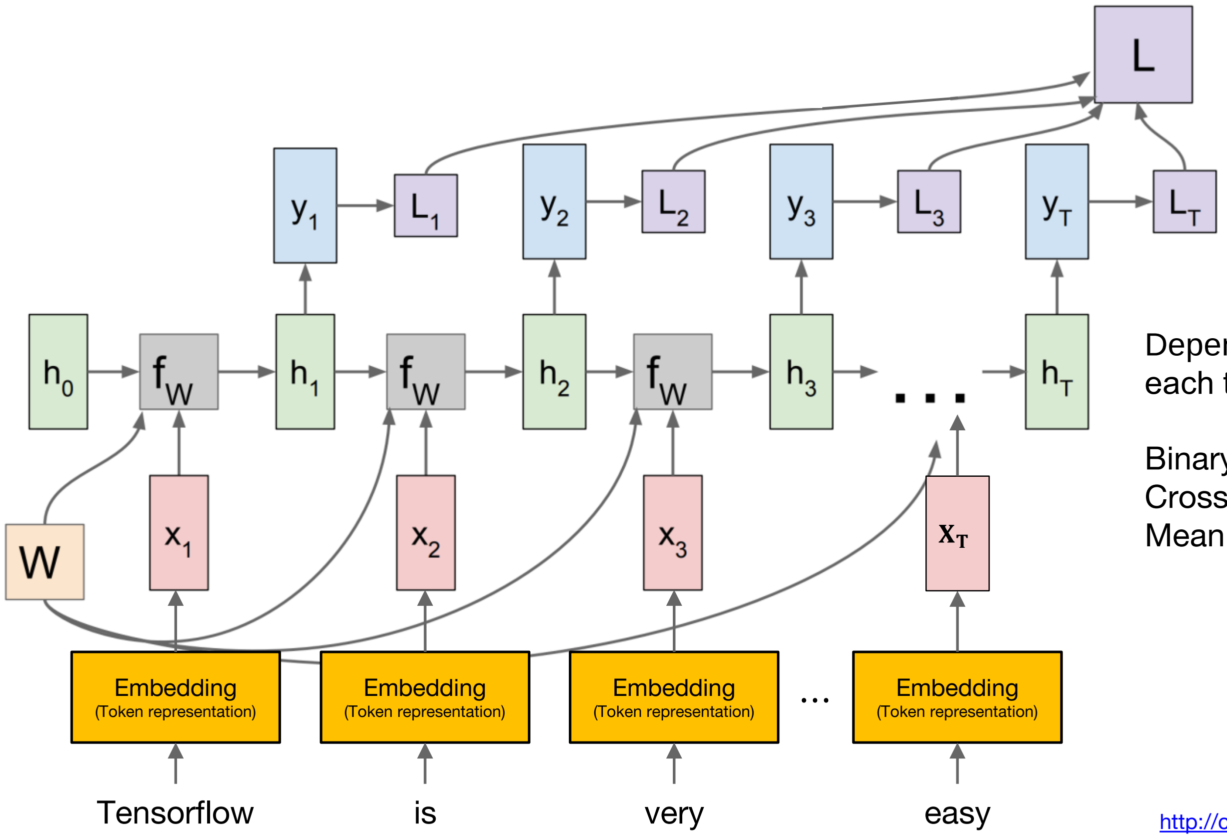
*↓ Tagging*

*[‘noun’, ‘verb’, ‘adverb’, ‘adjective’]*

classification (each time step)



# What is “many to many”?



Depending on the task with regard to each time step…

Binary entropy loss (binary classifier)
Cross entropy loss (softmax classifier)
Mean squared loss (regression)

aka Sequence loss!

http://cs231n.stanford.edu/slides/2018/cs231n_2018_lecture10.pdf

# Example : part of speech tagging

## Preparing dataset

```
# example data
sentences = [['I', 'feel', 'hungry'],
    ['tensorflow', 'is', 'very', 'difficult'],
    ['tensorflow', 'is', 'a', 'framework', 'for', 'deep', 'learning'],
    ['tensorflow', 'is', 'very', 'fast', 'changing']]
pos = [['pronoun', 'verb', 'adjective'],
    ['noun', 'verb', 'adverb', 'adjective'],
    ['noun', 'verb', 'determiner', 'noun', 'preposition', 'adjective', 'noun'],
    ['noun', 'verb', 'adverb', 'adjective', 'verb']]
```

```
# creating a token dictionary for word
word_list = sum(sentences, [])
word_list = sorted(set(word_list))
word_list = ['<pad>'] + word_list
word2idx = {word : idx for idx, word in enumerate(word_list)}
idx2word = {idx : word for idx, word in enumerate(word_list)}

print(word2idx)
print(idx2word)
print(len(idx2word))
```

```
{'<pad>': 0, 'I': 1, 'a': 2, 'changing': 3, 'deep': 4,
'difficult': 5, 'fast': 6, 'feel': 7, 'for': 8, 'framework':
9, 'hungry': 10, 'is': 11, 'learning': 12, 'tensorflow': 13,
'very': 14}
{0: '<pad>', 1: 'I', 2: 'a', 3: 'changing', 4: 'deep', 5:
'difficult', 6: 'fast', 7: 'feel', 8: 'for', 9: 'framework',
10: 'hungry', 11: 'is', 12: 'learning', 13: 'tensorflow', 14:
'very'}
15
```

```
# creating a token dictionary for part of speech
pos_list = sum(pos, [])
pos_list = sorted(set(pos_list))
pos_list = ['<pad>'] + pos_list
pos2idx = {pos : idx for idx, pos in enumerate(pos_list)}
idx2pos = {idx : pos for idx, pos in enumerate(pos_list)}

print(pos2idx)
print(idx2pos)
print(len(pos2idx))
```

```
{'<pad>': 0, 'adjective': 1, 'adverb': 2, 'determiner': 3,
'noun': 4, 'preposition': 5, 'pronoun': 6, 'verb': 7}
{0: '<pad>', 1: 'adjective', 2: 'adverb', 3: 'determiner',
4: 'noun', 5: 'preposition', 6: 'pronoun', 7: 'verb'}
8
```

https://github.com/deeplearningzerotoall/TensorFlow/blob/master/lab-12-3-many-to-many-keras-eager.ipynb

# Example : part of speech tagging

## Preparing dataset

```
# converting sequence of tokens to sequence of indices
max_sequence = 10
x_data = list(map(lambda sentence : [word2idx.get(token) for token in sentence], sentences))
y_data = list(map(lambda sentence : [pos2idx.get(token) for token in sentence], pos))

# padding the sequence of indices
x_data = pad_sequences(sequences = x_data, maxlen = max_sequence, padding='post')
x_data_mask = ((x_data != 0) * 1).astype(np.float32)
x_data_len = list(map(lambda sentence : len(sentence), sentences))

y_data = pad_sequences(sequences = y_data, maxlen = max_sequence, padding='post')

# checking data
print(x_data, x_data_len)
print(x_data_mask)
print(y_data)
```

```
[[ 1  7 10  0  0  0  0  0  0  0]
 [13 11 14  5  0  0  0  0  0  0]
 [13 11  2  9  8  4 12  0  0  0]
 [13 11 14  6  3  0  0  0  0  0]] [3, 4, 7, 5]
[[1. 1. 1. 0. 0. 0. 0. 0. 0. 0.]

 [1. 1. 1. 1. 0. 0. 0. 0. 0. 0.]
 [1. 1. 1. 1. 1. 1. 1. 0. 0. 0.]
 [1. 1. 1. 1. 1. 0. 0. 0. 0. 0.]]

[[6 7 1 0 0 0 0 0 0 0]
 [4 7 2 1 0 0 0 0 0 0]
 [4 7 3 4 5 1 4 0 0 0]
 [4 7 2 1 7 0 0 0 0 0]]
```

https://github.com/deeplearningzerotoall/TensorFlow/blob/master/lab-12-3-many-to-many-keras-eager.ipynb

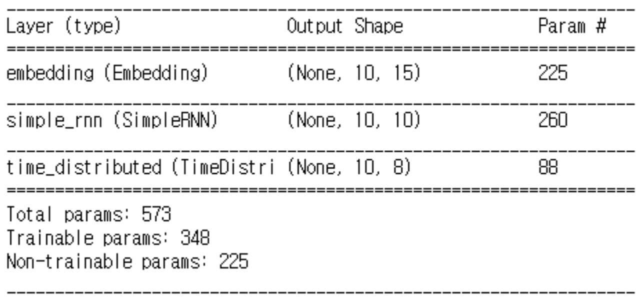
# Example : part of speech tagging

## Creating and training model

```
# creating rnn for "many to many“ sequence tagging
num_classes = len(pos2idx)
hidden_dim = 10

input_dim = len(word2idx)
output_dim = len(word2idx)
one_hot = np.eye(len(word2idx))

model = Sequential()
model.add(layers.Embedding(input_dim=input_dim, output_dim=output_dim, mask_zero=True,
                           trainable=False, input_length=max_sequence,
                           embeddings_initializer=keras.initializers.Constant(one_hot)))
model.add(layers.SimpleRNN(units=hidden_dim, return_sequences=True))
model.add(layers.TimeDistributed(layers.Dense(units=num_classes)))
model.summary()
```



```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embedding (Embedding)        (None, 10, 15)            225
_________________________________________________________________
simple_rnn (SimpleRNN)       (None, 10, 10)            260
_________________________________________________________________
time_distributed (TimeDistri (None, 10, 8)             88
=================================================================
Total params: 573
Trainable params: 348
Non-trainable params: 225
_________________________________________________________________
```

https://github.com/deeplearningzerotoall/TensorFlow/blob/master/lab-12-3-many-to-many-keras-eager.ipynb

# Example : part of speech tagging

## Creating and training model

```
# creating loss function
def loss_fn(model, x, y, x_len, max_sequence):
   masking = tf.sequence_mask(x_len, maxlen=max_sequence, dtype=tf.float32)
   valid_time_step = tf.cast(x_len,dtype=tf.float32)
   sequence_loss = tf.losses.sparse_softmax_cross_entropy(labels=y, logits=model(x),
                                                          reduction='none') * masking
   sequence_loss = tf.reduce_sum(sequence_loss, axis=-1) / valid_time_step
   sequence_loss = tf.reduce_mean(sequence_loss)
   return sequence_loss

# creating and optimizer
lr = 0.1
epochs = 30
batch_size = 2
opt = tf.train.AdamOptimizer(learning_rate = lr)

# generating data pipeline
tr_dataset = tf.data.Dataset.from_tensor_slices((x_data, y_data, x_data_len))
tr_dataset = tr_dataset.shuffle(buffer_size=4)
tr_dataset = tr_dataset.batch(batch_size = 2)

print(tr_dataset)
```

```
<BatchDataset shapes: ((?, 10), (?, 10), (?,)), types: (tf.int32, tf.int32,
tf.int32)>
```

https://github.com/deeplearningzerotoall/TensorFlow/blob/master/lab-12-3-many-to-many-keras-eager.ipynb

# Example : part of speech tagging

## Creating and training model

```
# training
tr_loss_hist = []

for epoch in range(epochs):
   avg_tr_loss = 0
   tr_step = 0

   for x_mb, y_mb, x_mb_len in tr_dataset:
       with tf.GradientTape() as tape:
           tr_loss = loss_fn(model, x=x_mb, y=y_mb, x_len=x_mb_len, max_sequence=max_sequence)
       grads = tape.gradient(target=tr_loss, sources=model.variables)
       opt.apply_gradients(grads_and_vars=zip(grads, model.variables))
       avg_tr_loss += tr_loss
       tr_step += 1
   else:
       avg_tr_loss /= tr_step
       tr_loss_hist.append(avg_tr_loss)

   if (epoch + 1) % 5 == 0:
       print('epoch : {:3}, tr_loss : {:.3f}'.format(epoch + 1, avg_tr_loss))
```

```
epoch :   5, tr_loss : 0.284
epoch :  10, tr_loss : 0.015
epoch :  15, tr_loss : 0.004
epoch :  20, tr_loss : 0.002
epoch :  25, tr_loss : 0.001
epoch :  30, tr_loss : 0.001
```

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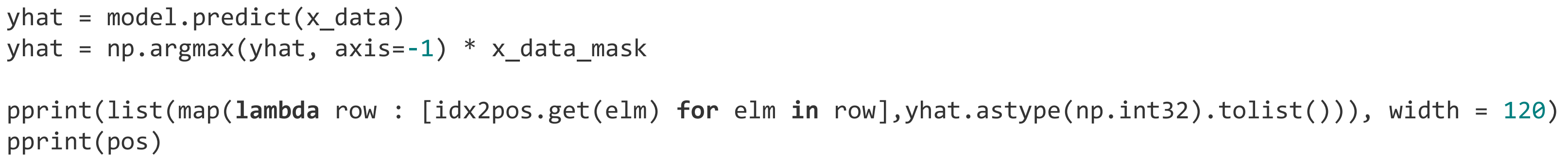
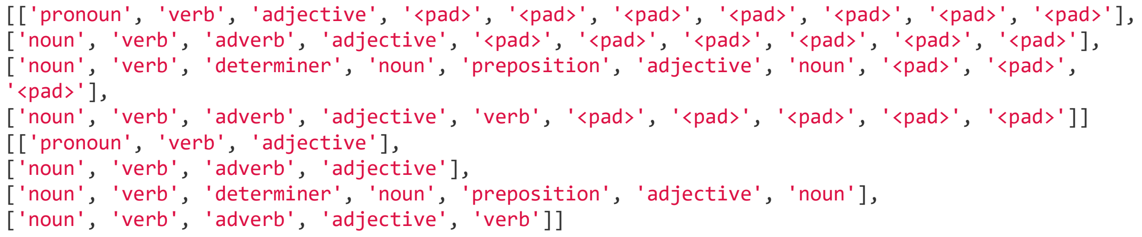
# Example : part of speech tagging

## Checking performance

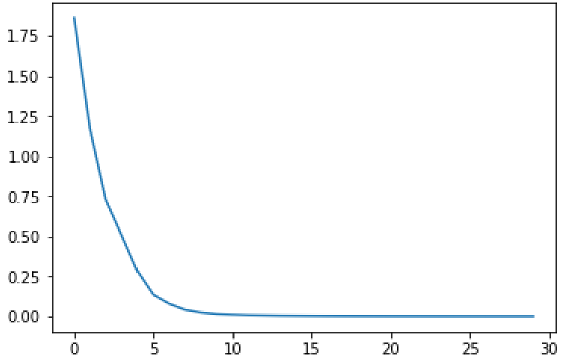


```
yhat = model.predict(x_data)
yhat = np.argmax(yhat, axis=-1) * x_data_mask

pprint(list(map(lambda row : [idx2pos.get(elm) for elm in row],yhat.astype(np.int32).tolist())), width = 120)
pprint(pos)
```



```
[['pronoun', 'verb', 'adjective', '<pad>', '<pad>', '<pad>', '<pad>', '<pad>', '<pad>', '<pad>'],
['noun', 'verb', 'adverb', 'adjective', '<pad>', '<pad>', '<pad>', '<pad>', '<pad>', '<pad>'],
['noun', 'verb', 'determiner', 'noun', 'preposition', 'adjective', 'noun', '<pad>', '<pad>',
'<pad>'],
['noun', 'verb', 'adverb', 'adjective', 'verb', '<pad>', '<pad>', '<pad>', '<pad>', '<pad>']]
[['pronoun', 'verb', 'adjective'],
['noun', 'verb', 'adverb', 'adjective'],
['noun', 'verb', 'determiner', 'noun', 'preposition', 'adjective', 'noun'],
['noun', 'verb', 'adverb', 'adjective', 'verb']]
```



https://github.com/deeplearningzerotoall/TensorFlow/blob/master/lab-12-3-many-to-many-keras-eager.ipynb

# What’s Next?

- many to many bidirectional