Dynamic Unrolling Through Time

The `dynamic_rnn()` function uses a `while_loop()` operation to run over the cell the appropriate number of times, and you can set `swap_memory=True` if you want it to swap the GPU's memory to the CPU's memory during backpropagation to avoid OOM errors. Conveniently, it also accepts a single tensor for all inputs at every time step (shape `[None, n_steps, n_inputs]`) and it outputs a single tensor for all outputs at every time step (shape `[None, n_steps, n_neurons]`); there is no need to stack, unstack, or transpose. The following code creates the same RNN as earlier using the `dynamic_rnn()` function. It's so much nicer!

```
X = tf.placeholder(tf.float32, [None, n_steps, n_inputs])

basic_cell = tf.contrib.rnn.BasicRNNCell(num_units=n_neurons)
outputs, states = tf.nn.dynamic_rnn(basic_cell, X, dtype=tf.float32)
```

During backpropagation, the `while_loop()` operation does the appropriate magic: it stores the tensor values for each iteration during the forward pass so it can use them to compute gradients during the reverse pass.

Handling Variable Length Input Sequences

So far we have used only fixed-size input sequences (all exactly two steps long). What if the input sequences have variable lengths (e.g., like sentences)? In this case you should set the `sequence_length` parameter when calling the `dynamic_rnn()` (or `static_rnn()`) function; it must be a 1D tensor indicating the length of the input sequence for each instance. For example:

```
seq_length = tf.placeholder(tf.int32, [None])

[...]
outputs, states = tf.nn.dynamic_rnn(basic_cell, X, dtype=tf.float32,
                                    sequence_length=seq_length)
```

For example, suppose the second input sequence contains only one input instead of two. It must be padded with a zero vector in order to fit in the input tensor `X` (because the input tensor's second dimension is the size of the longest sequence—i.e., 2).

```
X_batch = np.array([
        # step 0     step 1
        [[0, 1, 2], [9, 8, 7]], # instance 0
        [[3, 4, 5], [0, 0, 0]], # instance 1 (padded with a zero vector)
        [[6, 7, 8], [6, 5, 4]], # instance 2
        [[9, 0, 1], [3, 2, 1]], # instance 3
    ])
seq_length_batch = np.array([2, 1, 2, 2])
```