Example pattern extraction from text with a convolutional neural network

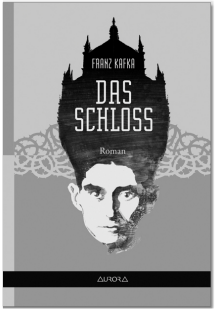
ch

2018

internal

https://github.com/chambrock/bob-andrews

input data



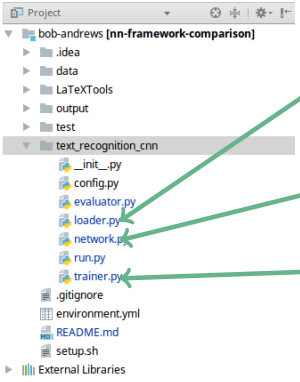
e- eine intrigante natur- scheinbar sinnlos arbeitend wie der wind- nach fernen- fremden aufträgen- in die man nie einsicht bekam---kaum hatte er ein paar schritte auf der landstraSSe gemacht- als er i, truth:0.0

nn man in seinem gedankengange bleibt- nur die einzige wirkliche amtliche verbindung helfen- die er mit klamm hat- also dieses protokoll- nur dieses habe ich gesagt- und wer etwas anderes behauptet- v, truth:0.0

r es still- fritz erkundigte sich drüben- und hier wartete man auf die antwort- k- blieb wie bisher- drehte sich nicht einmal um- schien gar nicht neugierig- sah vor sich hin- die erzählung schwarzers, truth:1.0

- extract 'sentences' (200 letters each) and match pattern with reegex

project structure



x, y_{truth}

$n(w, x) \rightarrow y$

$\text{loss}(n(w, x), y_{\text{truth}}) \rightarrow w|_{@\min}$

standard convolution examples

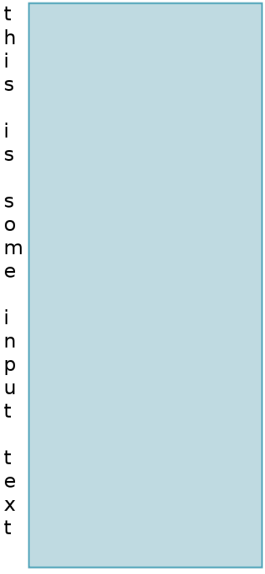
No padding, no strides

No padding but strides

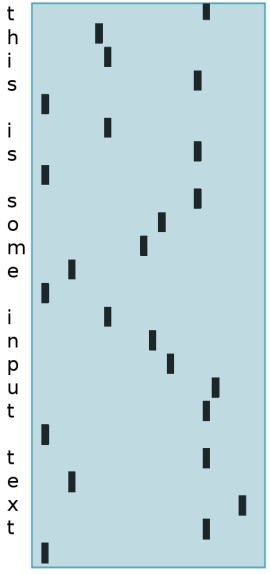
Arbitrary padding, no strides

padding and strides

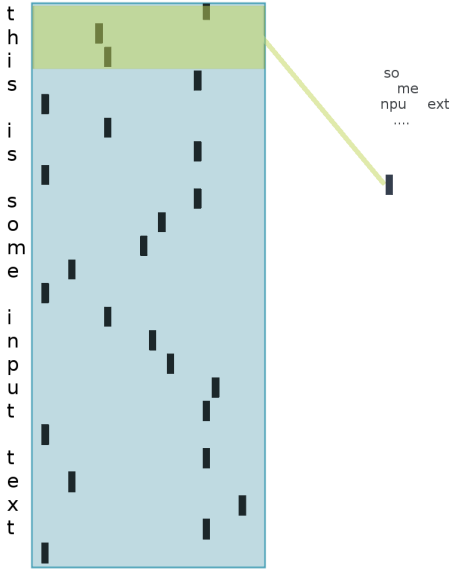
convolutions example



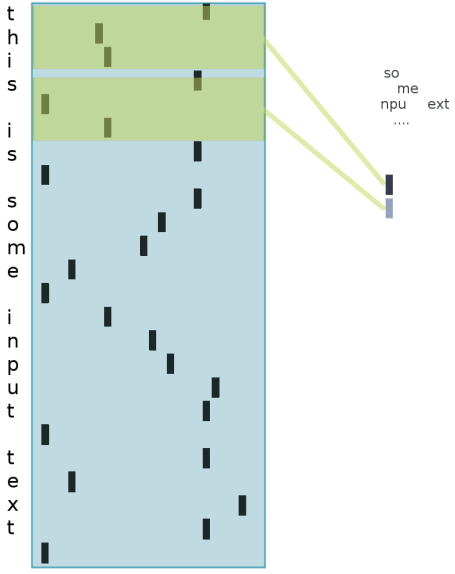
convolutions example



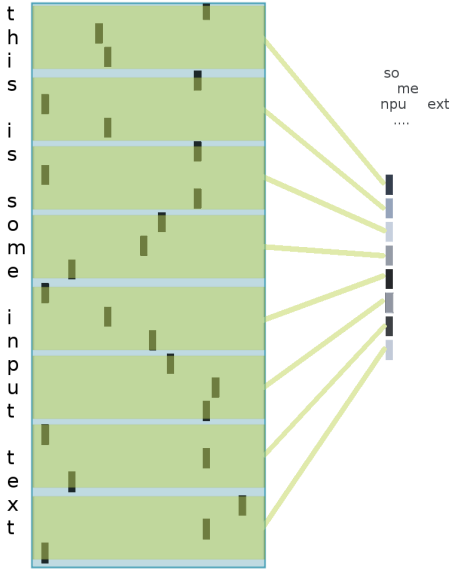
convolutions example



convolutions example



convolutions example



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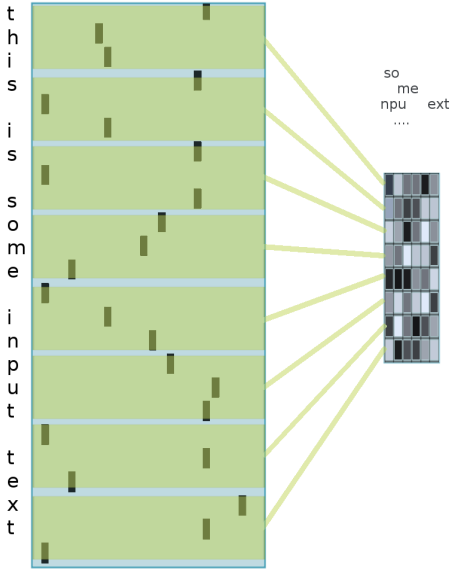

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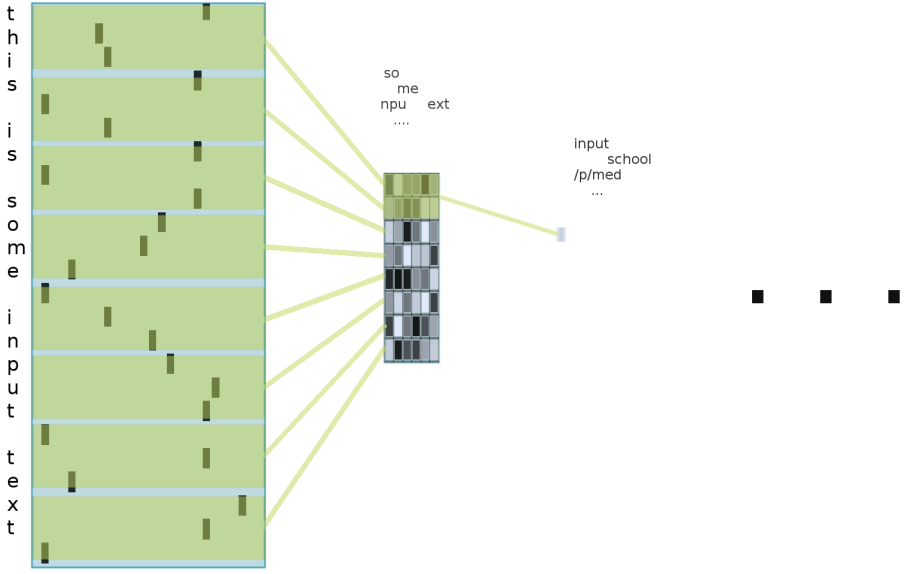
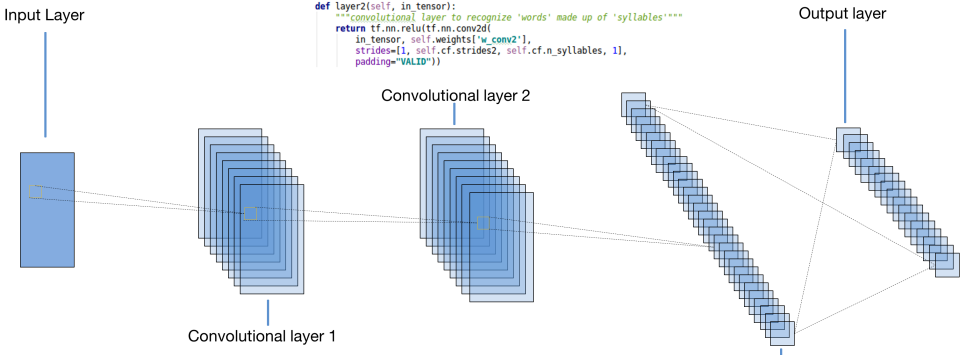


network

```python
def layer0(self, in_tensor):
    """Reshape to make standard input (picture recognition), last is the possible color channel"""
    return tf.reshape(in_tensor, shape=[-1, self.cf.string_length, self.cf.n_chars, 1])
```

```python
def layer4(self, in_tensor):
    """output feed forward layer"""
    return tf.nn.sigmoid(tf.matmul(in_tensor, self.weights['out']) + self.biases['out'])
```




```python
def layer2(self, in_tensor):
    """convolutional layer to recognize 'words' made up of 'syllables'"""
    return tf.nn.relu(tf.nn.conv2d(
        in_tensor, self.weights['w_conv2'],
        strides=[1, self.cf.strides2, self.cf.n_syllables, 1],
        padding="VALID"))
```

```python
def layer1(self, in_tensor):
    """convolutional layer to recognize 'syllables'"""
    return tf.nn.relu(tf.nn.conv2d(
        in_tensor,
        self.weights['w_conv1'],
        strides=[1, self.cf.strides1, self.cf.n_chars, 1],
        padding="VALID"))
```

```python
def layer3(self, in_tensor):
    """flatten everything and make a standard feed forward layer"""
    fc_input = tf.reshape(in_tensor, [-1, self.len_layer2_out * self.cf.n_words])
    return tf.matmul(fc_input, self.weights['w_fc']) + self.biases['b_fc']
```

step through code

1 datamart

run.py

```
import ...

output_map_batch = {"batch_count": [], "accuracy_train": [], "cost_train": []}
output_map_epoch = {"epoch": [], "batch_count": [], "cost_test": [], "accuracy_test": []}

cf = cf.Config()
tex_writer = TeXwriter(".././output", "doc")
tex_writer.addSection("Parameters")
tex_writer.addText(cf.to_tex())
loader = ld.Loader(cf)
char_trf = loader.char_trf
network = nw.Network(cf)
trainer = tn.Trainer(cf, network)
evaluator = ev.Evaluator(cf, network)

with tf.Session() as sess:

    sess.run(tf.global_variables_initializer())

    while loader.epochs < cf.epochs:
        batch_x, batch_y = loader.get_next_train_batch(cf.batch_size, shuffle=cf.shuffle)
        current_output = trainer.train(sess, batch_x, batch_y)

        output_map_batch["batch_count"].append(loader.batches)
        output_map_batch["accuracy_train"].append(current_output[3])
        output_map_batch["cost_train"].append(current_output[1])

        if loader.new_epoch:
            x, y = loader.get_test_data()
            current_test_output = trainer.test(sess, x, y)
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step through code

1. datamart
2. network ini

run.py

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step through code

1. datamart
2. network ini

network.py

```python
import tensorflow as tf

class Network:
    """dims: [batch, height, width, channels]"""
    weights = None
    biases = None

    def __init__(self, config):
        self.cf = config

        self.len_layer1_out = self._how_many_strides_fit(self.cf.string_length, self.cf.syllable_length, self.cf.str
        self.len_layer2_out = self._how_many_strides_fit(self.len_layer1_out, self.cf.word_length, self.cf.strides2)

        self._initialize_params_()

    def _how_many_strides_fit(self, tot_length, window_size, stride_width):
        """calculate how many non-padded strides fit"""
        return int((tot_length - window_size) / stride_width) + 1

    def _initialize_params_(self):
        """initialize all parameters which are later optimized by tensorflow"""
        rand_std = 0.01

        self.weights = {
                'w_conv1': tf.Variable(tf.random_normal(
                    [self.cf.syllable_length, self.cf.n_chars, 1, self.cf.n_syllables],
                    stddev=rand_std)),
                'w_conv2': tf.Variable(tf.random_normal(
                    [self.cf.word_length, 1, self.cf.n_syllables, self.cf.n_words],
                    stddev=rand_std)),
                'w_fc': tf.Variable(tf.random_normal(
                    [self.len_layer2_out * self.cf.n_words, self.cf.output_number],
                    stddev=rand_std)),
                'out': tf.Variable(tf.random_normal(
                    [self.cf.output_number, self.cf.n_classes],
                    stddev=rand_std))
            }

        self.biases = {
                'b_fc': tf.Variable(tf.random_normal([self.cf.output_number])),
                'out': tf.Variable(tf.random_normal([self.cf.n_classes]))
            }
```

step through code

1. datamart
2. network ini
3. graph ini

run.py

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        if loader.new_epoch:
            x, y = loader.get_test_data()
            current_test_output = trainer.test(sess, x, y)
```

step through code

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trainer.py

```python
class Trainer(object):

    def __init__(self, config, network):
        self.cf = config
        self.network = network

        self.x = None
        self.y = None
        self.train_output = None
        self.test_output = None
        self.initialize_graph()

    def initialize_graph(self):
        """build graph"""
        self.x = tf.placeholder(tf.float32, [None, self.cf.string_length, self.cf.n_chars])
        self.y = tf.placeholder(tf.float32, [None, self.cf.n_classes])

        self.pred = self.network.predict(self.x)
        self.cost = self._loss_(self.pred, self.y)
        self.optimizer = tf.train.AdamOptimizer(learning_rate=self.cf.learning_rate).minimize(self.cost)

        correct = tf.equal(tf.argmax(self.pred, 1), tf.argmax(self.y, 1))
        self.accuracy = tf.reduce_mean(tf.cast(correct, 'float'))

    def _loss_(self, prediction, y):
        """loss function"""
        #single_loss = tf.nn.softmax_cross_entropy_with_logits(logits=prediction, labels=y)
        single_loss = tf.pow(prediction - y, 2)
        return tf.reduce_mean(single_loss)
```

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network.py

```python
def predict(self, input_features):
    """glue together all layers to transform features to predictions"""
    out_layer0 = self.layer0(input_features)
    out_layer1 = self.layer1(out_layer0)
    out_layer2 = self.layer2(out_layer1)
    out_layer3 = self.layer3(out_layer2)
    out_layer4 = self.layer4(out_layer3)

    return out_layer4

def layer0(self, in_tensor):
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def layer3(self, in_tensor):
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```

step through code

1. datamart
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4. fitting 

$$w_{\mathrm{I}}$$

$$w_{\mathrm{I}} - \gamma \sum_{\mathrm{batch}} \frac{\partial \mathrm{loss}}{\partial w_{\mathrm{I}}}$$

run.py

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```

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2. network ini
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4. fitting 

trainer.py

```
def _loss_(self, prediction, y):
    """loss function """
    #single_loss = tf.nn.softmax_cross_entropy_with_logits(logits=prediction, labels=y)
    single_loss = tf.pow(prediction - y, 2)
    return tf.reduce_mean(single_loss)

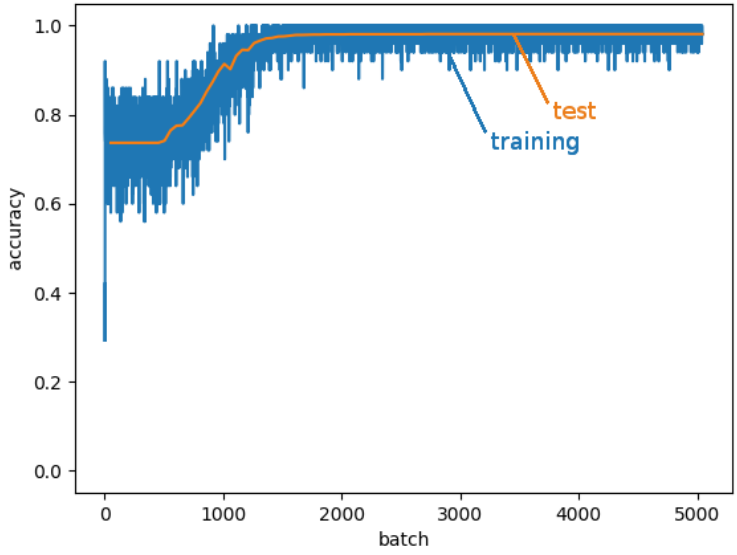
def train(self, sess, batch_x, batch_y):
    """run the graph build in the constructor"""
    self.train_output = sess.run(
          [self.optimizer, self.cost, self.network.weights, self.accuracy],
          feed_dict={self.x: batch_x, self.y: batch_y})
    return self.train_output

def test(self, sess, x, y):
    """same as train, only do not include the optimizer to not move the weights when generating output"""
    self.test_output = sess.run([self.cost, self.accuracy], feed_dict={self.x: x, self.y: y})
    return self.test_output
```

w_{I}

$$w_{\mathrm{I}} - \gamma \sum_{\mathrm{batch}} \frac{\partial \mathrm{loss}}{\partial w_{\mathrm{I}}}$$

training results - convergence



training results - character importance

cht- -sie verfolgen dich-- - -hast du es denn nicht bemerkt-- fragte frieda- -nein-- sagte k- und suchte sich vergeblich an einzelheiten zu erinnern- -zudringliche und lüsterne jungen sind es wohl- ab, truth:1.0, pred: 1.0

sie dir diese waffe anvertraut in der hoffnung- daSS du sie in einer für mich besonders schlimmen oder entscheidungsreichen stunde anwenden würdest- miSSbrauche ich dich- so miSSbraucht sie dich ähnlich-, truth:0.0, pred: 0.01

elfen wolle- und er danke ihm für die gute absicht- es sei ja möglich- daSS er später einmal etwas brauchen werde- dann werde er sich an ihn wenden- die adresse habe er ja- dagegen könne vielleicht er-, truth:1.0, pred: 1.0

er unterredung ab- es kann manches zur sprache kommen- aber das wichtigste ist doch für mich- daSS ich ihm gegenüberstehe- ich habe nämlich noch mit keinem wirklichen beamten unmittelbar gesprochen- es, truth:0.0, pred: 0.0

te wie ein offenbarungswort untersuchen und von der deutung das eigene lebensglück abhängig machen- nichts kann verfehlter sein- freilich habe auch ich- nicht anders als du- mich von ihm beirren lasse, truth:0.0, pred: 0.01

urfte- nicht hoch ein- fern war ihm bewunderung oder gar neid- denn nicht klamms nähe an sich war ihm das erstrebenswerte- sondern daSS er- k-- nur er- kein anderer mit seinen- mit keines anderen wünsc, truth:1.0, pred: 0.99