October 3, 2019

[1]:
```
#the sample code
#load datasets
def load_pickle(f):
    version = platform.python_version_tuple()
    if version[0] == '2':
        return  pickle.load(f)
    elif version[0] == '3':
        return  pickle.load(f, encoding='latin1')
    raise ValueError("invalid python version: {}".format(version))

def load_CIFAR_batch(filename):
    """ load single batch of cifar """
    with open(filename, 'rb') as f:
        datadict = load_pickle(f)
        X = datadict['data']
        Y = datadict['labels']
        X = X.reshape(10000, 3, 32, 32).transpose(0,2,3,1).astype("float")
        Y = np.array(Y)
        return X, Y

def load_CIFAR10(ROOT):
    """ load all of cifar """
    xs = []
    ys = []
    for b in range(1,6):
        f = os.path.join(ROOT, 'data_batch_%d' % (b, ))
        X, Y = load_CIFAR_batch(f)
        xs.append(X)
        ys.append(Y)
    Xtr = np.concatenate(xs)
    Ytr = np.concatenate(ys)
    del X, Y
    Xte, Yte = load_CIFAR_batch(os.path.join(ROOT, 'test_batch'))
    return Xtr, Ytr, Xte, Yte

#
class Adam:
```

```
    """Adam (http://arxiv.org/abs/1412.6980v8)"""

    def __init__(self, lr=0.001, beta1=0.9, beta2=0.999):
        self.lr = lr
        self.beta1 = beta1
        self.beta2 = beta2
        self.iter = 0
        self.m = None
        self.v = None

    def update(self, params, grads):
        if self.m is None:
            self.m, self.v = {}, {}
            for key, val in params.items():
                self.m[key] = np.zeros_like(val)
                self.v[key] = np.zeros_like(val)

        self.iter += 1
        lr_t  = self.lr * np.sqrt(1.0 - self.beta2**self.iter) / (1.0 - self.
↪beta1**self.iter)

        for key in params.keys():
            #self.m[key] = self.beta1*self.m[key] + (1-self.beta1)*grads[key]
            #self.v[key] = self.beta2*self.v[key] + (1-self.
↪beta2)*(grads[key]**2)
            self.m[key] += (1 - self.beta1) * (grads[key] - self.m[key])
            self.v[key] += (1 - self.beta2) * (grads[key]**2 - self.v[key])

            params[key] -= lr_t * self.m[key] / (np.sqrt(self.v[key]) + 1e-7)

            #unbias_m += (1 - self.beta1) * (grads[key] - self.m[key]) #␣
↪correct bias
            #unbisa_b += (1 - self.beta2) * (grads[key]*grads[key] - self.
↪v[key]) # correct bias
            #params[key] += self.lr * unbias_m / (np.sqrt(unbisa_b) + 1e-7)


 #
def numerical_gradient(f, x):
    h = 1e-4 # 0.0001
    grad = np.zeros_like(x)

    it = np.nditer(x, flags=['multi_index'], op_flags=['readwrite'])
    while not it.finished:
        idx = it.multi_index
        tmp_val = x[idx]
```

```
        x[idx] = float(tmp_val) + h
        fxh1 = f(x) # f(x+h)

        x[idx] = tmp_val - h
        fxh2 = f(x) # f(x-h)
        grad[idx] = (fxh1 - fxh2) / (2*h)

        x[idx] = tmp_val #
        it.iternext()

    return grad

#
class Relu:
    def __init__(self):
        self.mask = None
        self.mask1 = None

    def forward(self, x):
        self.mask = (x <= 0)
        self.mask1 = (x >= 6)
        out = x.copy()
        out[self.mask] = 0
        out[self.mask1] = 6

        return out

    def backward(self, dout):
        dout[self.mask] = 0
        dout[self.mask1] = 0
        dx = dout

        return dx

#softmax
class SoftmaxWithLoss:
    def __init__(self):
        self.loss = None
        self.y = None # softmax
        self.t = None #

    def forward(self, x, t):
        self.t = t
        self.y = softmax(x)
        self.loss = cross_entropy_error(self.y, self.t)

        return self.loss
```

```
    def backward(self, dout=1):
        batch_size = self.t.shape[0]
        if self.t.size == self.y.size: #    one-hot-vector
            dx = (self.y - self.t) / batch_size
        else:
            dx = self.y.copy()
            dx[np.arange(batch_size), self.t] -= 1
            dx = dx / batch_size

        return dx

#dropout
class Dropout:
    """
    http://arxiv.org/abs/1207.0580
    """
    def __init__(self, dropout_ratio=0.5):
        self.dropout_ratio = dropout_ratio
        self.mask = None

    def forward(self, x, train_flg=True):
        if train_flg:
            self.mask = np.random.rand(*x.shape) > self.dropout_ratio
            return x * self.mask
        else:
            return x * (1.0 - self.dropout_ratio)

    def backward(self, dout):
        return dout * self.mask

#
def gradient(self, x, t):
    # forward
    self.loss(x, t)

    # backward
    dout = 1
    dout = self.last_layer.backward(dout)

    tmp_layers = self.layers.copy()
    tmp_layers.reverse()
    for layer in tmp_layers:
        dout = layer.backward(dout)

    #
    grads = {}
```

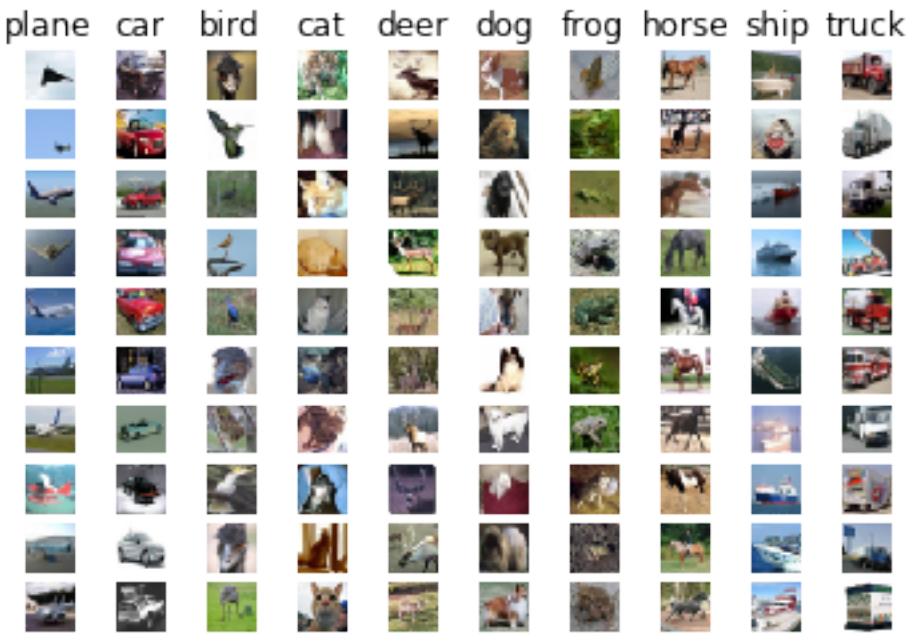
```
    for i, layer_idx in enumerate((0, 2, 5, 7, 10, 12, 15, 18)):
        grads['W' + str(i+1)] = self.layers[layer_idx].dW
        grads['b' + str(i+1)] = self.layers[layer_idx].db

    return grads
```

[2]:
```
import random
import numpy as np
import matplotlib.pyplot as plt
from collections import OrderedDict
from builtins import range
from six.moves import cPickle as pickle
from imageio import imread
import platform
import sys, os
```

[3]:
```
#process the data
cifar10_dir = 'cifar-10-batches-py/'
X_train, y_train, X_test, y_test = load_CIFAR10(cifar10_dir)
#
print('Training data shape: ', X_train.shape)  #np.array  shape
print('Training labels shape: ', y_train.shape)
print('Test data shape: ', X_test.shape)
print('Test labels shape: ', y_test.shape)
#
```

```
Training data shape:  (50000, 32, 32, 3)
Training labels shape:  (50000,)
Test data shape:  (10000, 32, 32, 3)
Test labels shape:  (10000,)
```

[4]:
```
classes = ['plane', 'car', 'bird', 'cat', 'deer', 'dog', 'frog', 'horse',␣
 ↪'ship', 'truck']
num_classes = len(classes)
samples_per_class = 10 #   10
for y, clss in enumerate(classes): #enumerate          y  cls
    idxs = np.flatnonzero(y_train == y) #
    idxs = np.random.choice(idxs, samples_per_class, replace=False)
    #    10  replace
    for i, idx in enumerate(idxs): #
        plt_idx = i * num_classes + y + 1 #
        plt.subplot(samples_per_class, num_classes, plt_idx) #
        plt.imshow(X_train[idx].astype('uint8'))
        plt.axis('off') #
        if i == 0:  #
            plt.title(clss)
plt.show()
```



[6]:
```
#
y_train_one_hot = np.zeros((50000,10)) #
y_test_one_hot = np.zeros((10000,10))
for i, num in enumerate(y_train):  # one-hot
    y_train_one_hot[i][num] = 1

for i, num in enumerate(y_test):
    y_test_one_hot[i][num] = 1

print(y_train[0:3])
print(y_test[0:3])
print(y_train_one_hot[0:3])
print(y_test_one_hot[0:3])
```

```
[6 9 9]
[3 8 8]
[[0. 0. 0. 0. 0. 0. 1. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 1.]
 [0. 0. 0. 0. 0. 0. 0. 0. 0. 1.]]
[[0. 0. 0. 1. 0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0. 1. 0.]
 [0. 0. 0. 0. 0. 0. 0. 0. 1. 0.]]
```

[8]:
```
X_train_turn = X_train.reshape((50000, 3, 32, 32))
X_test_turn = X_test.reshape((10000, 3, 32, 32))
X_train_shape = X_train.reshape((50000, 3072))
```

```
X_test_shape = X_test.reshape((10000, 3072))

print(X_train_turn.shape)
print(X_test_turn.shape)
print(X_train_shape.shape)
print(X_test_shape.shape)
```

```
(50000, 3, 32, 32)
(10000, 3, 32, 32)
(50000, 3072)
(10000, 3072)
```

[10]:
```
#
X_train_shape = X_train_shape / 255
X_test_shape = X_test_shape / 255
X_train_turn = X_train_turn / 255
X_test_turn = X_test_turn / 255
#  0
X_train_shape = X_train_shape - np.mean(X_train_shape)
X_test_shape = X_test_shape - np.mean(X_test_shape)
X_train_turn = X_train_turn - np.mean(X_train_turn)
X_test_turn = X_test_turn - np.mean(X_test_turn)

print(X_train_shape[0])
print(X_test_shape[0])
print(X_train_turn[0][0][0])
print(X_test_turn[0][0][0])
```

```
[-9.48982163e-04 -9.02846061e-04 -8.87467361e-04 …  3.52546694e-05
 -4.41485046e-04 -7.49059056e-04]
[ 0.00056087 -0.00014655 -0.0011154  … -0.00154601 -0.00083859
 -0.0001773 ]
[-0.24199045 -0.23022575 -0.22630418 -0.30473555 -0.29297084 -0.29689241
 -0.27728457 -0.28512771 -0.30473555 -0.20669633 -0.26159829 -0.30865712
 -0.08904927 -0.18708849 -0.26944143 -0.00669633 -0.11650026 -0.22630418
  0.07173504 -0.05375516 -0.17924535  0.09526445 -0.04199045 -0.15963751
  0.11095073 -0.01453947 -0.12434339  0.11095073 -0.00277477 -0.10865712
  0.04036249 -0.06944143]
[ 0.14302292 -0.03736923 -0.28442806  0.14694449 -0.0412908  -0.2922712
  0.1704739  -0.02168296 -0.27658492  0.17439547 -0.01383982 -0.26874178
  0.15086606 -0.03736923 -0.29619276  0.13517979 -0.04913394 -0.31580061
  0.1587092  -0.02560453 -0.2922712   0.14694449 -0.03344767 -0.30011433
  0.14302292 -0.0412908  -0.3040359   0.14694449 -0.03344767 -0.31580061
  0.15478763 -0.02168296]
```

[ ]:
```
=== epoch:1, train acc:0.09, test acc:0.103 ===
=== epoch:2, train acc:0.274, test acc:0.304 ===
```

```
=== epoch:3, train acc:0.336, test acc:0.335 ===
=== epoch:4, train acc:0.353, test acc:0.377 ===
=== epoch:5, train acc:0.363, test acc:0.38 ===
=== epoch:6, train acc:0.425, test acc:0.403 ===
=== epoch:7, train acc:0.448, test acc:0.419 ===
=== epoch:8, train acc:0.426, test acc:0.422 ===
=== epoch:9, train acc:0.453, test acc:0.451 ===
=== epoch:10, train acc:0.467, test acc:0.454 ===
=== epoch:11, train acc:0.499, test acc:0.473 ===
```