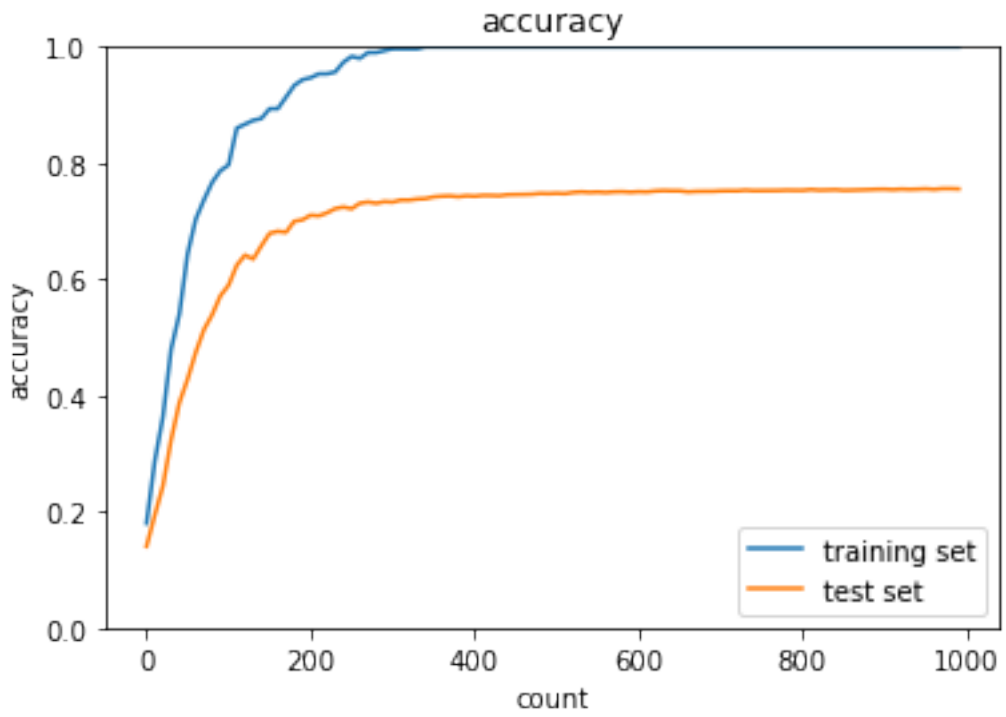
2_5_overfiting

August 16, 2020

1 overfiting

[1]:
```
import sys, os
sys.path.append(os.pardir)  #
import numpy as np
from collections import OrderedDict
from common import layers
from data.mnist import load_mnist
import matplotlib.pyplot as plt
from multi_layer_net import MultiLayerNet
from common import optimizer


(x_train, d_train), (x_test, d_test) = load_mnist(normalize=True)

print("     ")

#
x_train = x_train[:300]
d_train = d_train[:300]

network = MultiLayerNet(input_size=784, hidden_size_list=[100, 100, 100, 100,␣
 ↪100, 100], output_size=10)
optimizer = optimizer.SGD(learning_rate=0.01)

iters_num = 1000
train_size = x_train.shape[0]
batch_size = 100

train_loss_list = []
accuracies_train = []
accuracies_test = []

plot_interval=10


for i in range(iters_num):
```

```
    batch_mask = np.random.choice(train_size, batch_size)
    x_batch = x_train[batch_mask]
    d_batch = d_train[batch_mask]

    grad = network.gradient(x_batch, d_batch)
    optimizer.update(network.params, grad)

    loss = network.loss(x_batch, d_batch)
    train_loss_list.append(loss)

    if (i+1) % plot_interval == 0:
        accr_train = network.accuracy(x_train, d_train)
        accr_test = network.accuracy(x_test, d_test)
        accuracies_train.append(accr_train)
        accuracies_test.append(accr_test)

#         print('Generation: ' + str(i+1) + '.   (    ) = ' + str(accr_train))
#         print('                : ' + str(i+1) + '.   (  ) = ' +␣
 ↪str(accr_test))

lists = range(0, iters_num, plot_interval)
plt.plot(lists, accuracies_train, label="training set")
plt.plot(lists, accuracies_test,  label="test set")
plt.legend(loc="lower right")
plt.title("accuracy")
plt.xlabel("count")
plt.ylabel("accuracy")
plt.ylim(0, 1.0)
#
plt.show()
```



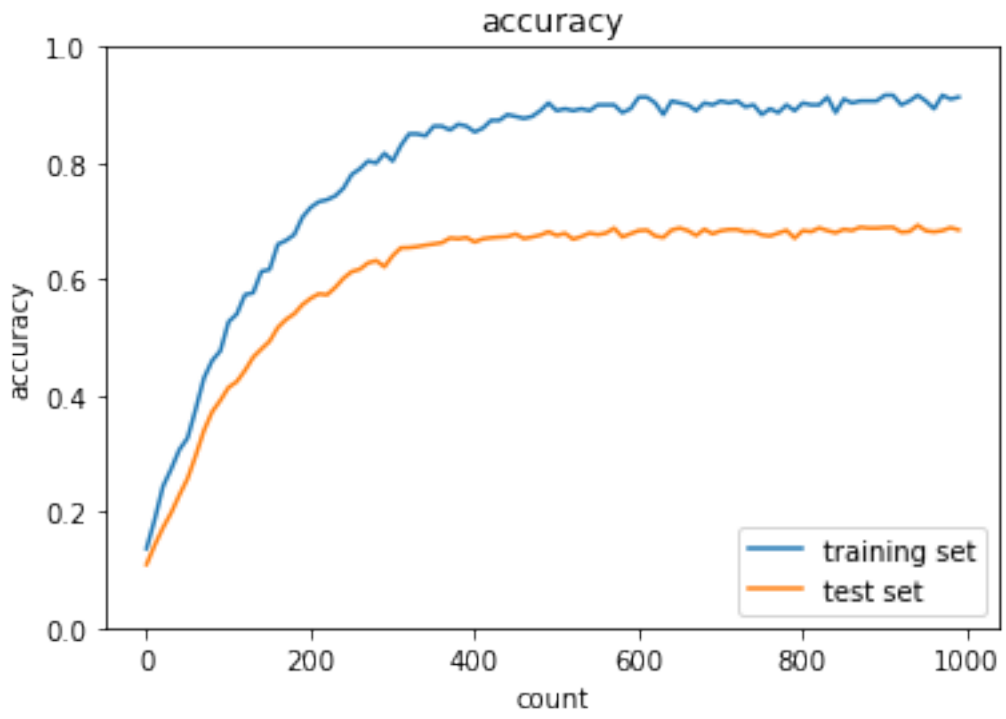
1.1 weight decay

1.1.1 L2

[2]:
```
from common import optimizer

(x_train, d_train), (x_test, d_test) = load_mnist(normalize=True)

print("     ")

#
x_train = x_train[:300]
d_train = d_train[:300]


network = MultiLayerNet(input_size=784, hidden_size_list=[100, 100, 100, 100,␣
↪100, 100], output_size=10)


iters_num = 1000
train_size = x_train.shape[0]
batch_size = 100
learning_rate=0.01
```

```
train_loss_list = []
accuracies_train = []
accuracies_test = []

plot_interval=10
hidden_layer_num = network.hidden_layer_num

#      ====================================
weight_decay_lambda = 0.1
# ================================================

for i in range(iters_num):
    batch_mask = np.random.choice(train_size, batch_size)
    x_batch = x_train[batch_mask]
    d_batch = d_train[batch_mask]

    grad = network.gradient(x_batch, d_batch)
    weight_decay = 0

    for idx in range(1, hidden_layer_num+1):
        grad['W' + str(idx)] = network.layers['Affine' + str(idx)].dW +␣
 ↪weight_decay_lambda * network.params['W' + str(idx)]
        grad['b' + str(idx)] = network.layers['Affine' + str(idx)].db
        network.params['W' + str(idx)] -= learning_rate * grad['W' + str(idx)]
        network.params['b' + str(idx)] -= learning_rate * grad['b' + str(idx)]
        weight_decay += 0.5 * weight_decay_lambda * np.sqrt(np.sum(network.
 ↪params['W' + str(idx)] ** 2))

    loss = network.loss(x_batch, d_batch) + weight_decay
    train_loss_list.append(loss)

    if (i+1) % plot_interval == 0:
        accr_train = network.accuracy(x_train, d_train)
        accr_test = network.accuracy(x_test, d_test)
        accuracies_train.append(accr_train)
        accuracies_test.append(accr_test)

#         print('Generation: ' + str(i+1) + '.   (    ) = ' + str(accr_train))
#         print('                : ' + str(i+1) + '.   (  ) = ' +␣
 ↪str(accr_test))


lists = range(0, iters_num, plot_interval)
plt.plot(lists, accuracies_train, label="training set")
plt.plot(lists, accuracies_test,  label="test set")
plt.legend(loc="lower right")
plt.title("accuracy")
```

```
plt.xlabel("count")
plt.ylabel("accuracy")
plt.ylim(0, 1.0)
#
plt.show()
```

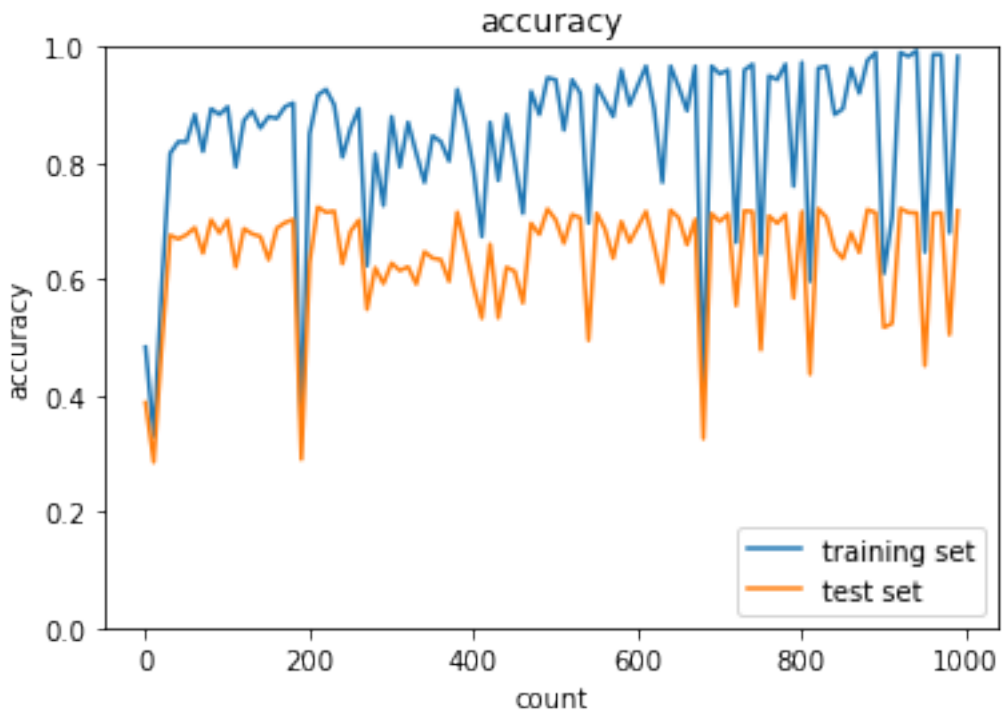


1.1.2 L1

[3]:
```
(x_train, d_train), (x_test, d_test) = load_mnist(normalize=True)

print("     ")

#
x_train = x_train[:300]
d_train = d_train[:300]

network = MultiLayerNet(input_size=784, hidden_size_list=[100, 100, 100, 100,␣
 ↪100, 100], output_size=10)


iters_num = 1000
```

```
train_size = x_train.shape[0]
batch_size = 100
learning_rate=0.1

train_loss_list = []
accuracies_train = []
accuracies_test = []

plot_interval=10
hidden_layer_num = network.hidden_layer_num

#      ======================================
weight_decay_lambda = 0.005
# ================================================

for i in range(iters_num):
    batch_mask = np.random.choice(train_size, batch_size)
    x_batch = x_train[batch_mask]
    d_batch = d_train[batch_mask]

    grad = network.gradient(x_batch, d_batch)
    weight_decay = 0

    for idx in range(1, hidden_layer_num+1):
        grad['W' + str(idx)] = network.layers['Affine' + str(idx)].dW +␣
 ↪weight_decay_lambda * np.sign(network.params['W' + str(idx)])
        grad['b' + str(idx)] = network.layers['Affine' + str(idx)].db
        network.params['W' + str(idx)] -= learning_rate * grad['W' + str(idx)]
        network.params['b' + str(idx)] -= learning_rate * grad['b' + str(idx)]
        weight_decay += weight_decay_lambda * np.sum(np.abs(network.params['W'␣
 ↪+ str(idx)]))

    loss = network.loss(x_batch, d_batch) + weight_decay
    train_loss_list.append(loss)

    if (i+1) % plot_interval == 0:
        accr_train = network.accuracy(x_train, d_train)
        accr_test = network.accuracy(x_test, d_test)
        accuracies_train.append(accr_train)
        accuracies_test.append(accr_test)

#         print('Generation: ' + str(i+1) + '.   (    ) = ' + str(accr_train))
#         print('                  : ' + str(i+1) + '.   (  ) = ' +␣
 ↪str(accr_test))

lists = range(0, iters_num, plot_interval)
plt.plot(lists, accuracies_train, label="training set")
```

```
plt.plot(lists, accuracies_test,  label="test set")
plt.legend(loc="lower right")
plt.title("accuracy")
plt.xlabel("count")
plt.ylabel("accuracy")
plt.ylim(0, 1.0)
#
plt.show()
```



[try] weigth_decay_lambda

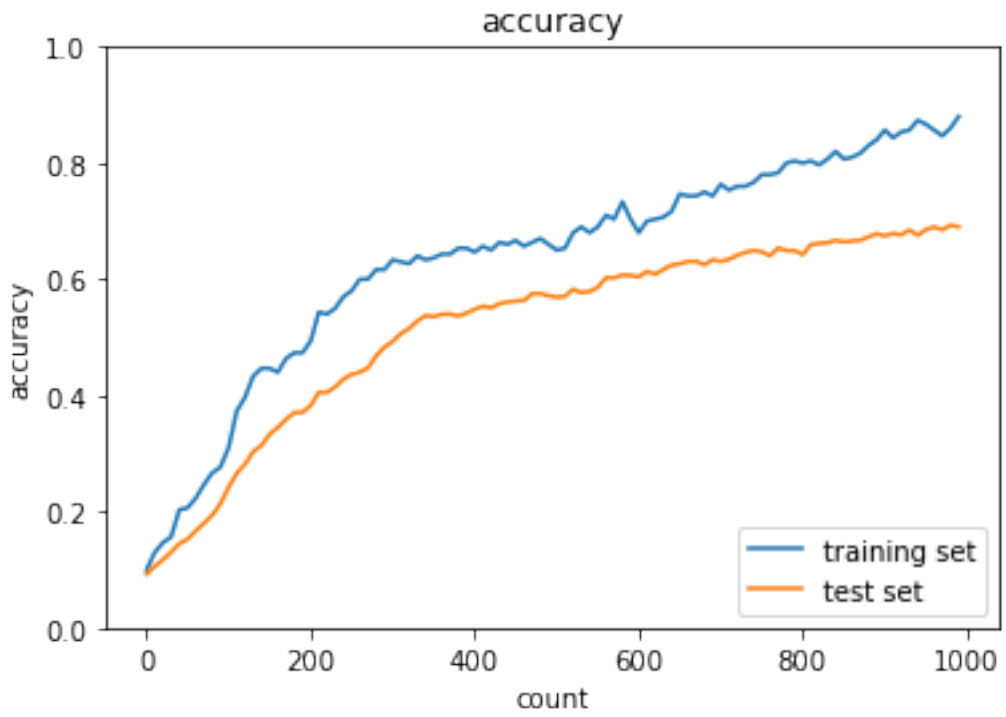
1.2 Dropout

[4]:
```
class Dropout:
    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
```

[5]:
```
from common import optimizer
(x_train, d_train), (x_test, d_test) = load_mnist(normalize=True)

print("     ")

#
x_train = x_train[:300]
d_train = d_train[:300]

#       ======================================
use_dropout = True
dropout_ratio = 0.15
# ====================================================

network = MultiLayerNet(input_size=784, hidden_size_list=[100, 100, 100, 100,␣
 ↪100, 100], output_size=10,
                        weight_decay_lambda=weight_decay_lambda, use_dropout =␣
 ↪use_dropout, dropout_ratio = dropout_ratio)
optimizer = optimizer.SGD(learning_rate=0.01)
# optimizer = optimizer.Momentum(learning_rate=0.01, momentum=0.9)
# optimizer = optimizer.AdaGrad(learning_rate=0.01)
# optimizer = optimizer.Adam()

iters_num = 1000
train_size = x_train.shape[0]
batch_size = 100

train_loss_list = []
accuracies_train = []
accuracies_test = []

plot_interval=10


for i in range(iters_num):
    batch_mask = np.random.choice(train_size, batch_size)
    x_batch = x_train[batch_mask]
    d_batch = d_train[batch_mask]

    grad = network.gradient(x_batch, d_batch)
```

```
    optimizer.update(network.params, grad)

    loss = network.loss(x_batch, d_batch)
    train_loss_list.append(loss)

    if (i+1) % plot_interval == 0:
        accr_train = network.accuracy(x_train, d_train)
        accr_test = network.accuracy(x_test, d_test)
        accuracies_train.append(accr_train)
        accuracies_test.append(accr_test)

#         print('Generation: ' + str(i+1) + '.   (    ) = ' + str(accr_train))
#         print('                : ' + str(i+1) + '.   (  ) = ' +␣
 ↪str(accr_test))

lists = range(0, iters_num, plot_interval)
plt.plot(lists, accuracies_train, label="training set")
plt.plot(lists, accuracies_test,  label="test set")
plt.legend(loc="lower right")
plt.title("accuracy")
plt.xlabel("count")
plt.ylabel("accuracy")
plt.ylim(0, 1.0)
#
plt.show()
```



1.3 [try] dropout_ratio

1.4 ## [try] optimizer dropout_ratio

1.5 Dropout + L1

[6]:
```
from common import optimizer
(x_train, d_train), (x_test, d_test) = load_mnist(normalize=True)

print("     ")

#
x_train = x_train[:300]
d_train = d_train[:300]

#       ====================================
use_dropout = True
dropout_ratio = 0.08
# ====================================================

network = MultiLayerNet(input_size=784, hidden_size_list=[100, 100, 100, 100,␣
 ↪100, 100], output_size=10,
```

```
                        use_dropout = use_dropout, dropout_ratio =␣
↪dropout_ratio)

iters_num = 1000
train_size = x_train.shape[0]
batch_size = 100
learning_rate=0.01

train_loss_list = []
accuracies_train = []
accuracies_test = []
hidden_layer_num = network.hidden_layer_num

plot_interval=10

#      =====================================
weight_decay_lambda=0.004
# ================================================

for i in range(iters_num):
    batch_mask = np.random.choice(train_size, batch_size)
    x_batch = x_train[batch_mask]
    d_batch = d_train[batch_mask]

    grad = network.gradient(x_batch, d_batch)
    weight_decay = 0

    for idx in range(1, hidden_layer_num+1):
        grad['W' + str(idx)] = network.layers['Affine' + str(idx)].dW +␣
↪weight_decay_lambda * np.sign(network.params['W' + str(idx)])
        grad['b' + str(idx)] = network.layers['Affine' + str(idx)].db
        network.params['W' + str(idx)] -= learning_rate * grad['W' + str(idx)]
        network.params['b' + str(idx)] -= learning_rate * grad['b' + str(idx)]
        weight_decay += weight_decay_lambda * np.sum(np.abs(network.params['W'␣
↪+ str(idx)]))

    loss = network.loss(x_batch, d_batch) + weight_decay
    train_loss_list.append(loss)

    if (i+1) % plot_interval == 0:
        accr_train = network.accuracy(x_train, d_train)
        accr_test = network.accuracy(x_test, d_test)
        accuracies_train.append(accr_train)
        accuracies_test.append(accr_test)

#         print('Generation: ' + str(i+1) + '.   (    ) = ' + str(accr_train))
```

```
#         print('                    : ' + str(i+1) + '.   (  ) = ' +␣
 ↪str(accr_test))

lists = range(0, iters_num, plot_interval)
plt.plot(lists, accuracies_train, label="training set")
plt.plot(lists, accuracies_test,  label="test set")
plt.legend(loc="lower right")
plt.title("accuracy")
plt.xlabel("count")
plt.ylabel("accuracy")
plt.ylim(0, 1.0)
#
plt.show()
```