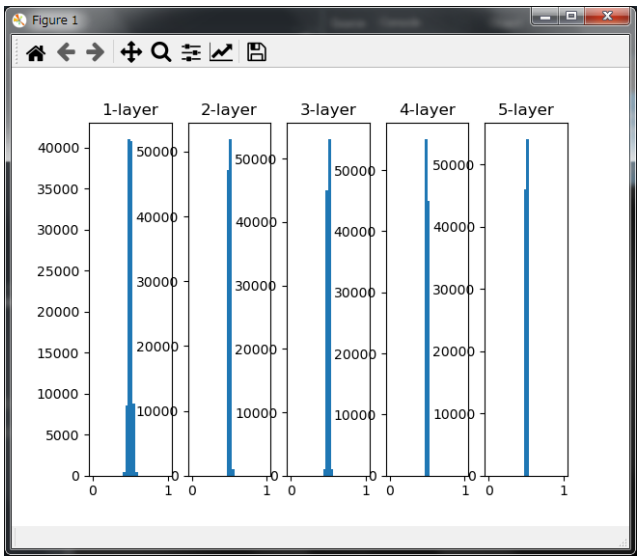
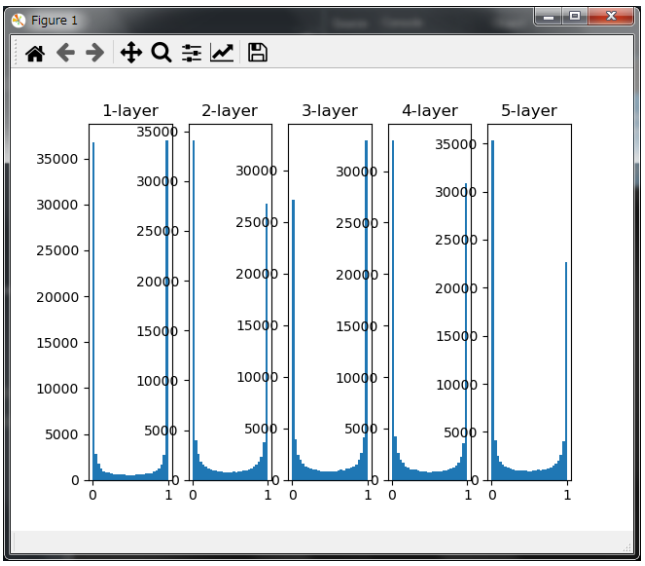
1　Section1_勾配消失問題

```python
import numpy as np
import matplotlib.pyplot as plt

def sigmoid(x):
    return 1 / (1 + np.exp(-x))

x = np.random.randn(1000, 100)
node_num = 100
hidden_layer_size = 5
activations = {}

for i in range(hidden_layer_size):
    if i != 0:
        x = activations[i-1]

    w = np.random.randn(node_num, node_num) * 1

    z = np.dot(x, w)
    a = sigmoid(z)
    activations[i] = a

for i, a in activations.items():
    plt.subplot(1, len(activations), i+1)
    plt.title(str(i+1) + "-layer")
    plt.hist(a.flatten(), 30, range=(0,1))
plt.show()
```

重みの標準偏差を０．０１にする。

```
#w = np.random.randn(node_num, node_num) * 1
w = np.random.randn(node_num, node_num) * 0.01
```





2　Section2_学習率最適化手法

学習率＝０．１

```python
import numpy as np

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

    for idx in range(x.size):
        tmp_val = x[idx]
        x[idx] = tmp_val + h
        fxh1 = f(x)

        x[idx] = tmp_val - h
        fxh2 = f(x)

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

    return grad

def gradient_descent(f, init_x, lr=0.01, step_num=100):
    x = init_x

    for i in range(step_num):
        grad = numerical_gradient(f, x)
        x -= lr * grad

    return x

def function_2(x):
    return (x[0]**2 + x[1]**2)

init_x = np.array([-3.0, 4.0])
out = gradient_descent(function_2, init_x=init_x, lr=0.1, step_num=100)
print(out)
```

解は（０，０）

```
[-6.11110793e-10  8.14814391e-10]
```

学習率＝１０．０

```
[-2.58983747e+13 -1.29524862e+12]
```

学習率＝1e-10

```
[-2.99999994  3.99999992]
```

モーメンタム、Adagrad

```python
import numpy as np

class Momentum:
    def __init__(self, lr=0.01, momentum=0.9):
        self.lr = lr
        self.momentum = momentum
        self.v = None

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

            for key in params.keys():
                self.v[key] = self.momentum*self.c[key] - self.lr*grads[key]
                params[key] += self.v[key]

class Adagrad:
    def __init__(self, lr=0.01):
        self.lr = lr
        self.h = None

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

        for key in params.keys():
            self.h[key] += grads[key] * grads[key]
            params[key] -= self.lr * grads[key] / (np.sqrt(self.h[key]) + 1e-7)
```

３　Section3_過学習

MNIST データセットの訓練データを本来の６０，０００個から３００個だけにする。

```python
import numpy as np
import sys, os
sys.path.append(os.pardir)
from dataset.mnist import load_mnist

(x_train, t_train), (x_test, t_test) = load_mnist(normalize= True)
x_train = x_train[:300]
t_train = t_train[:300]

network = MultiLayerNet(input_size=784, hidden_size_list=[100, 100, 100, 100, 100,
                                                          100], output_size=10)
optimizer = SGD(lr=0.01)

max_epochs = 201
train_size = x_train.shape[0]
batch_size = 100

train_loss_list = []
train_acc_list = []
test_acc_list = []

iter_per_epoch = max(train_size / batch_size, 1)
epoch_cnt = 0
```

```python

for i in range(1000000000):
    batch_mask = np.random.choice(train_size, batch_size)
    x_batch = x_train[batch_mask]
    t_batch = t_train[batch_mask]

    grads = network.gradient(x_batch, t_batch)
    optimizer.update(x_batch, t_batch)

    if i % iter_per_epoch == 0:
        train_acc = network.accurancy(x_train, t_train)
        test_acc = network.accurancy(x_test, t_test)
        train_acc_list.append(train_acc)
        test_acc_list.append(test_acc)

        epoch_cnt += 1
        if epoch_cnt >= max_epochs:
            break

```

4　Section4_畳み込みニューラルネットワーク

1）Convolution レイヤ

```python
import numpy as np
import sys, os
sys.path.append(os.pardir)
from common.util import im2col

x1 = np.random.rand(1, 3, 7, 7)
col11 = im2col(x1, 5, 5, stride=1, pad=0)
print(col1.shape)

x2 = np.random.rand(10, 3, 7, 7)
col2 = im2col(x2, 5, 5, stride=1, pad= 0)
print(col2.shape)

class convolution:
    def __init__(self, w, b, stride=1, pad= 0):
        self.w = w
        self.b = b
        self.stride = stride
        self.pad = pad

    def forward(self, x):
        FN, C, FH, FW = self.W.shape
        N, C, H, W = x.shape
        out_h = int(1 + (H + 2*self.pad - FH) / self.stride)
        out_w = int(1 + (W + 2*self.pad - FW) / self.stride)

        col = im2col(x, FH, FW, self.stride, self.pad)
        col_W = self.W.reshape(FN, -1).T
        out = np.dot(col, col_W) + self.b

        out = out.reshape(N, out_h, out_w, -1).transpose(0, 3, 1, 2)

        return out
```

2）pooling レイヤ

```python
import numpy as np
import sys, os
sys.path.append(os.pardir)
from common.util import im2col

class pooling:
    def __init__(self, pool_h, pool_w, stride=1, pad=0):
        self.pool_h = pool_h
        self.pool_w = pool_w
        self.stride = stride
        self.pad = pad

    def foreard(self, x):
        N, C, H, W = x.shape
        out_h = int(1 + (H - self.pool_h) / self.stride)
        out_w = int(1 + (W - self.pool_w) / self.stride)

        col = im2col(x, self.pool_h, self.pool_w, self.stride, self.pad)
        col = col.reshape(-1, self.pool_h*self.pool_w)

        out = np.max(col, axis=1)

        out = out.reshape(N, out_h, out_w, C).trnspose(0, 3, 1, 2)

        return out
```

5　Section5_最新の CNN

CNN の実装

```python
import numpy as np
import sys, os
sys.path.append(os.pardir)
from common.util import im2col

class SimpleConvNet:
    def __init__(self, input_dim=(1, 28, 28),
                 conv_param={'filter_num':30, 'filter_size':5,
                             'pad':0, 'sride':1},
                 hidden_size=100, output_size=10, weight_init_std=0.01):
        filter_num = conv_param['filter_num']
        filter_size = conv_param['filter_size']
        filter_pad = conv_param['filter_pad']
        filter_stride = conv_param['filter_stride']
        input_size = input_dim[1]
        conv_output_size = (input_size - filter_size + 2*filter_pad) / filter_stride + 1
        pool_output_size = int(filter_num * (conv_output_size/2)*(conv_output_size/2))

        self.params = {}
        self.params['W'] = weight_init_std * np.randam.randn(filter_num, input_dim[0],
                                                             filter_size, filter_size)
        self.params['b1'] = np.zeros(filter_num)
        self.params['w2'] = weight_init_std * np.randam.randn(pool_output_size,
                                                              hidden_size)
        self.params['b2'] = np.zeros(hidden_size)
        self.params['w3'] = weight_init_std * np.randam.randn(hidden_size, output_size)
        self.params['b3'] = np.zeros(output_size)

        self.layers = OrderedDict()
        self.layers['Conv1'] = Convolution(self.params['w1'],
                                           self.params['b1'],
                                           conv_param['stride'],
                                           conv_param['pad'])
        self.layers['Relu1'] = Relu()
        self.layers['Pool1'] = Pooling(pool_h=2, pool_w=2, stride=2)
        self.layers['Affine1'] = Affine(self.params['W2'], self.params['b2'])
        self.layers['Relu2'] = Relu()
        self.layers['Affine2'] = Affine(self.params['W3'], self.params['b3'])
```

```python
        self.last_layer = SoftmaxwithLoss()

```