第七章作业

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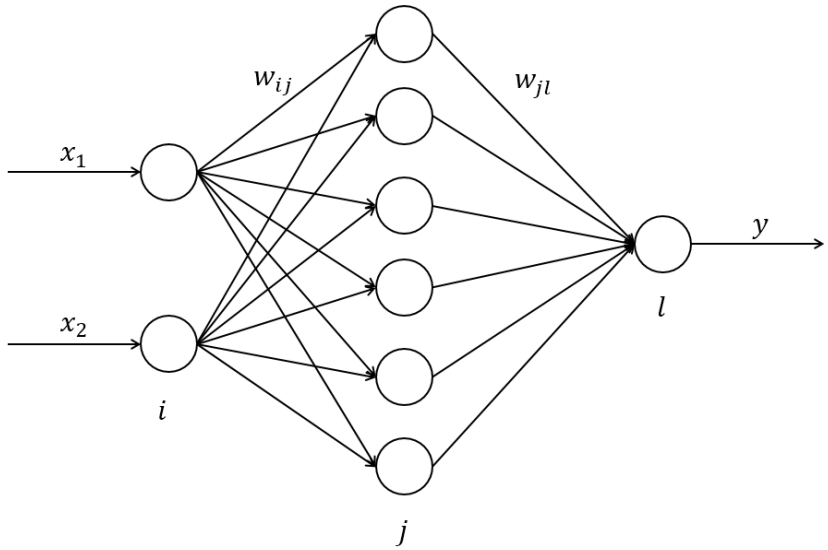
7-1

> **采用BP网络进行模式识别。训练样本为3对两输入单输出样本，见下表。**

输 入		输 出
1	0	1
0	0	0
0	1	−1

> **试采用BP网络对训练样本进行训练，并针对一组实际样本进行测试，用于测试的3组样本输入分别为1，0.1；0.5，0.5和0.1，1。**

解：我们设置BP网络为2-6-1结构，权值w_{ij}，w_{jl}的初始值取$[-1,+1]$之间的随机值，学习参数取$\eta=0.50$，$\alpha=0.05$。网络结构如下：



在本题中，BP网络模式识别程序包括网络训练程序7_1a.m和网络测试程序7_1b.m，具体代码如下：

- **网络训练程序**

```
clc, clear;
eta = 0.50;
alpha = 0.05;

w1 = rands(2,6);
w1_1 = w1;
w1_2 = w1;
```

```
dw1 = 0*w1;

w2 = rands(6,1);
w2_1 = w2;
w2_2 = w2;

I = [0,0,0,0,0,0]';
Iout = [0,0,0,0,0,0]';
FI = [0,0,0,0,0,0]';

OUT = 2;
k = 0;
E = 1.0;
NS = 3;

while E >= 1e-20
    k = k+1;
    times(k) = k;
    for s = 1:NS
        xs = [1,0;0,0;0,1];
        ys = [1,0,-1]';
        x = xs(s,:);
        for j = 1:6
            I(j) = x*w1(:,j);
            Iout(j) = 1/(1+exp(-I(j)));
        end
        y1 = w2'*Iout;
        e1 = 0;
        y = ys(s,:);
        e1 = e1+0.5*(y(1)-y1(1))^2;
        es(s) = e1;
        E = 0;
        if s == NS
            for s = 1:NS
                E = E+es(s);
            end
        end
        ey = y-y1;
        w2 = w2_1 +eta*Iout*ey+alpha*(w2_1-w2_2);
        for j=1:6
            S = 1/(1+exp(-I(j)));
            FI(j) = S*(1-S);
        end
        for i = 1:2
            for j = 1:6
                dw1(i,j) = eta*FI(j)*x(i)*ey(1)*w2(j,1);
            end
        end
        w1 = w1_1+dw1+alpha*(w1-w1_2);
        w1_2 = w1_1;
        w1_1 = w1;
        w2_2 = w2_1;
        w2_1 = w2;
    end
    Ek(k) = E;
end

figure(1);
```

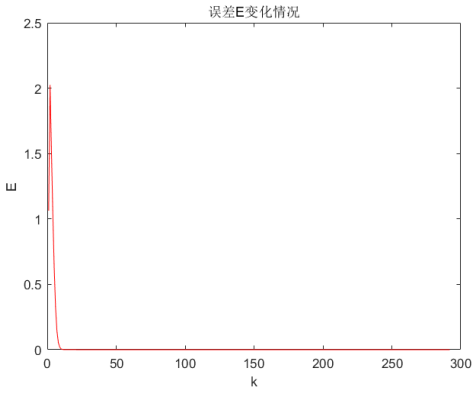
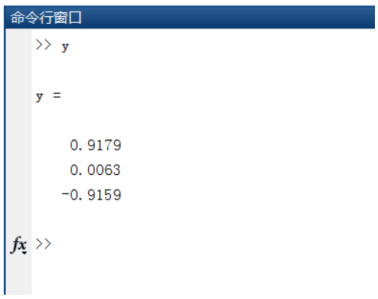
```
plot(times, Ek, 'r');
xlabel('k');
ylabel('E');
save wfile w1 w2;
```

- **网络测试程序**

```
clc, clear;
load wfile w1 w2;

x = [1,0.1;0.5,0.5;0.1,1];
for i = 1:3
    for j = 1:6
        I(i,j) = x(i,:)*w1(:,j);
        Iout(i,j) = 1/(1+exp(-I(i,j)));
    end
end
y = w2'*Iout';
y = y';
```

- **运行过程&预测结果**

误差变化情况	预测结果
	

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> **采用BP网络、RBF网络逼近非线性对象$y(k)=(u(k-1)-0.9y(k-1))/(1+y(k-1)^2)$，分别进行Matlab仿真。**

解：根据要求，有：

- **采用BP网络逼近对象**

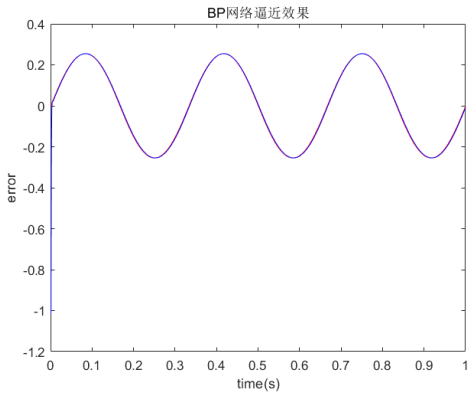
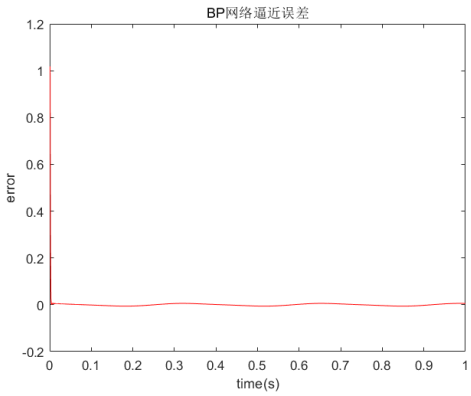
采样时间取1ms。输入信号为$u(t)=0.5sin(6\pi t)$。神经网络为2-6-1结构，权值W_1，W_2的初始值取$[-1,1]$之间的随机值，取$\eta=0.50$，$\alpha=0.05$。BP网络Matlab仿真代码如下所示：

```
clc, clear;
```

```
eta = 0.50;
alpha = 0.05;

w1 = rands(2,6);
w1_1 = w1;
w1_2 = w1;
w2 = rands(6,1);
w2_1 = w2;
w2_2 = w2;
dw1 = 0*w1;
x = [0,0]';
u_1 = 0;
y_1 = 0;

I = [0,0,0,0,0,0]';
Iout = [0,0,0,0,0,0]';
FI = [0,0,0,0,0,0]';

ts = 0.001;
for k = 1:1000
    time(k) =  k*ts;
    u(k) = 0.50*sin(6*pi*k*ts);
    y(k) = (u_1-0.9*y_1)/(1+y_1^2);
    for j = 1:6
        I(j) = x'*w1(:,j);
        Iout(j) = 1/(1+exp(-I(j)));
    end
    yn(k) = w2'*Iout;
    e(k) = y(k)-yn(k);
    w2 = w2_1+(eta*e(k))*Iout+alpha*(w2_1-w2_2);
    for j = 1:6
        FI(j) = exp(-I(j))/(1+exp(-I(j)))^2;
    end
    for i = 1:2
        for j = 1:6
            dw1(i,j) = e(k)*eta*FI(j)*w2(j)*x(i);
        end
    end
    w1 = w1_1+dw1+alpha*(w1_1-w1_2);

    yu = 0;
    for j = 1:6
        yu = yu+w2(j)*w1(1,j)*FI(j);
    end
    dyu(k) = yu;
    x(1) = u(k);
    x(2) = y(k);
    w1_2 = w1_1;
    w1_1 = w1;
    w2_2 = w2_1;
    w2_1 = w2;
    u_1 = u(k);
    y_1 = y(k);
end

figure(1);
plot(time,y,'r',time,yn,'b');
xlabel('time(s)');
```

```
ylabel('error');
title('BP网络逼近效果');
figure(2);
plot(time,y-yn,'r');
xlabel('time(s)');
ylabel('error');
title('BP网络逼近误差');
figure(3);
plot(time,dyu);
xlabel('time(s)');
ylabel('dy');
title('Jacobian信息的辨识');

```

实验结果如下所示：

BP网络逼近效果	BP网络逼近误差
	

- **采用RBF网络逼近对象**

采样时间取1ms。输入信号为$u(t)=0.5sin(6\pi t)$。网络为2-5-1结构，权值的初始值随机取值，$\eta=0.50$，$\alpha=0.05$。RBF网络Matlab仿真代码如下所示：

```
clc, clear;
eta = 0.50;
alpha = 0.05;

x = [0,0]';
b = 1.5*ones(5,1);
c = [-1.5, -0.5, 0, 0.5, 1.5;
    -1.5, 0.5, 0, 0.5, 1.5];

w = rands(5,1);
w_1 = w;
w_2 = w;
u_1 = 0;
y_1 = 0;

ts = 0.001;
for k = 1:1000
    time(k) = k*ts;
    u(k) = 0.50*sin(6*pi*k*ts);
    y(k) = (u_1-0.9*y_1)/(1+y_1^2);
```

```
    x(1) = u(k);
    x(2) = y(k);
    for j = 1:5
        h(j) = exp(-norm(x-c(:,j))^2/(2*b(j)*b(j)));
    end
    ym(k) = w'*h';
    em(k) = y(k)-ym(k);
    d_w = eta*em(k)*h';
    w = w_1+d_w+alpha*(w_1-w_2);
    y_1 = y(k);
    u_1 = u(k);
    w_2 = w_1;
    w_1 = w;
end

figure(1);
plot(time,y,'r',time,ym,'b');
xlabel('time(s)');
ylabel('error');
title('RBF网络逼近效果');
figure(2);
plot(time,y-ym,'r');
xlabel('time(s)');
ylabel('error');
title('RBF网络逼近误差');
```

实验结果如下所示：

RBF网络逼近效果	RBF网络逼近误差