第三章作业

> 专业：计算机科学与技术
>
> 学号：17341178
>
> 姓名：薛伟豪

3-1

> **已知年龄的论域为$[0,200]$，且设“年老O”和“年轻Y”两个模糊集的隶属函数分别为**

$$\mu_O(a)=\begin{cases}0 & 0\le a\le 50\\ \frac{a-50}{20} & 50\le a\le 70\\ 1.0 & a\ge 70\end{cases}$$

$$\mu_Y(a)=\begin{cases}1.0 & 0\le a\le 25\\ \frac{70-a}{45} & 25\le a\le 70\\ 0 & a\ge 70\end{cases}$$

> **试设计“很年轻W”、“不老也不年轻V”两个模糊集的隶属函数，并采用Matlab实现针对上述四个隶属函数的仿真。**

解：我们利用语言算子的隶属函数计算方法。假设$\mu_{很A}=\mu_A^2$可以得到

$$\mu_W(a)=[\mu_Y(a)]^2=\begin{cases}0 & 0\le a\le 25\\ (\frac{70-a}{45})^2 & 25\le a\le 70\\ 1.0 & a\ge 70\end{cases}$$

根据$\mu_{\overline{O}}(a)=1-\mu_O(a)$ 和 $\mu_{\overline{Y}}(a)=1-\mu_Y(a)$，我们可以得到

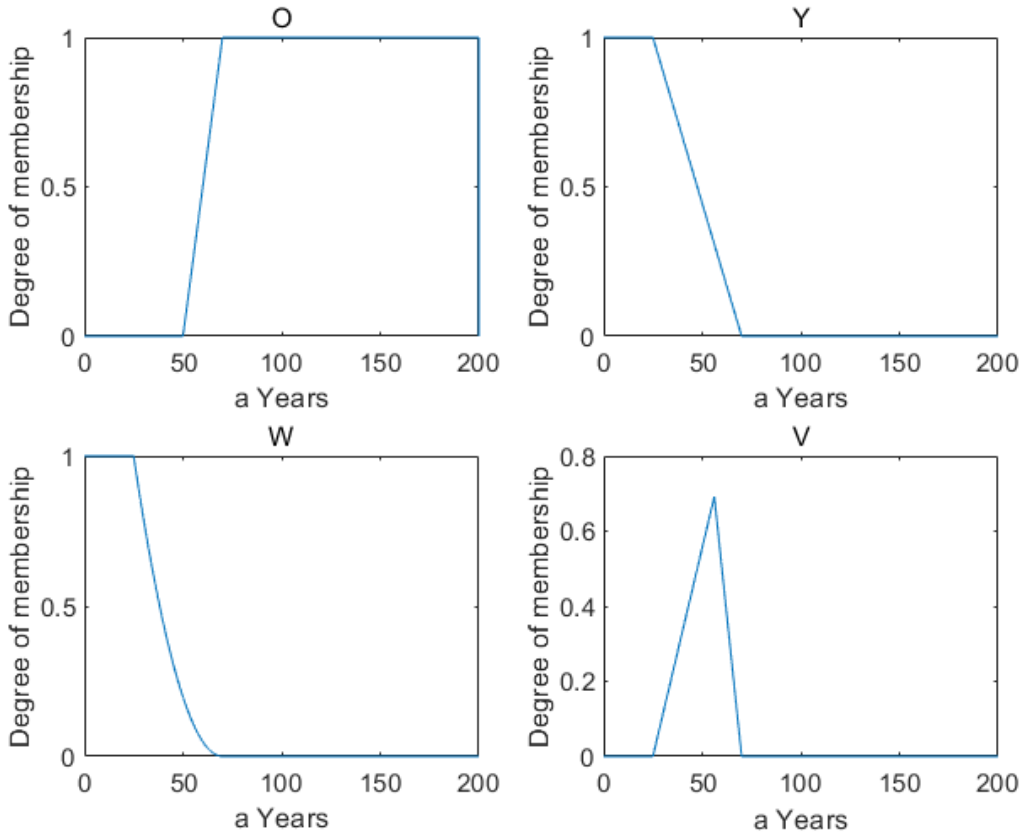
$$\begin{aligned}\mu_V(a)&=\mu_{\overline{O}}(a)\bigcap\mu_{\overline{Y}}(a)\\ &=(1-\mu_O(a))\bigcap(1-\mu_Y(a))\\ &=\begin{cases}1.0 & 0\le a\le 50\\ \frac{70-a}{20} & 50\le a\le 70\\ 0 & a\ge 70\end{cases}\bigcap\begin{cases}0 & 0\le a\le 25\\ \frac{a-25}{45} & 25\le a\le 70\\ 1.0 & a\ge 70\end{cases}\\ &=\begin{cases}0 & 0\le a\le 25\\ \frac{a-25}{45} & 25\le a\le \frac{730}{13}\\ \frac{70-a}{20} & \frac{730}{13}\le a\le 70\\ 0 & a\ge 70\end{cases}\end{aligned}$$

Matlab仿真代码（文件m3_1.m）如下所示：

```
clc, clear;
%3-1进行四个隶属函数的仿真
a = 0:200/1e5:200; %自变量
o = zeros(size(a)); %隶属函数o
y = zeros(size(a)); %隶属函数y
w = zeros(size(a)); %隶属函数w
v = zeros(size(a)); %隶属函数v

%定义隶属函数o
for i = 1:1e5
    if a(i)>=0 && a(i)<=50
        o(i) = 0;
    elseif a(i)>=50 && a(i)<=70
        o(i) = (a(i)-50)/20;
    elseif a(i)>=70
        o(i) = 1;
    end
end

%定义隶属函数y
for i = 1:1e5
    if a(i)>=0 && a(i)<=25
        y(i) = 1;
    elseif a(i)>=25 && a(i)<=70
        y(i) = (70-a(i))/45;
    elseif a(i)>=70
        y(i) = 0;
    end
end

%定义隶属函数w
for i = 1:1e5
    if a(i)>=0 && a(i)<=25
        w(i) = 1;
    elseif a(i)>=25 && a(i)<=70
        w(i) = ((70-a(i))/45)^2;
    elseif a(i)>=70
        w(i) = 0;
    end
end

%定义隶属函数v
for i = 1:1e5
    if a(i)>=0 && a(i)<=25
        v(i) = 0;
    elseif a(i)>=25 && a(i)<=730/13
        v(i) = (a(i)-25)/45;
    elseif a(i)>=730/13 && a(i)<=70
        v(i) = (70-a(i))/20;
    elseif a(i)>=70
        v(i) = 0;
    end
end

%绘制函数图像
```

```
subplot(2,2,1);
plot(a,o);
title('O');xlabel('a Years');ylabel('Degree of membership');
subplot(2,2,2);
plot(a,y);
title('Y');xlabel('a Years');ylabel('Degree of membership');
subplot(2,2,3);
plot(a,w);
title('W');xlabel('a Years');ylabel('Degree of membership');
subplot(2,2,4);
plot(a,v);
title('V');xlabel('a Years');ylabel('Degree of membership');
```

仿真结果如下所示:



3-2

> **已知模糊矩阵**P，Q，R，S，$P=\begin{bmatrix}0.6 & 0.9\\ 0.2 & 0.7\end{bmatrix}$，$Q=\begin{bmatrix}0.5 & 0.7\\ 0.1 & 0.4\end{bmatrix}$，$R=\begin{bmatrix}0.2 & 0.3\\ 0.7 & 0.7\end{bmatrix}$，$S=\begin{bmatrix}0.1 & 0.2\\ 0.6 & 0.5\end{bmatrix}$。**求：**
>
> **(1)** $(P\circ Q)\circ R$　　**(2)** $(P\bigcup Q)\circ S$　　**(3)** $(P\circ S)\bigcup(Q\circ S)$

解：（1）

$$(P \circ Q) \circ R = (\begin{bmatrix} 0.6 & 0.9 \\ 0.2 & 0.7 \end{bmatrix} \circ \begin{bmatrix} 0.5 & 0.7 \\ 0.1 & 0.4 \end{bmatrix}) \circ \begin{bmatrix} 0.2 & 0.3 \\ 0.7 & 0.7 \end{bmatrix}$$

$$= \begin{bmatrix} (0.6 \wedge 0.5) \vee (0.9 \wedge 0.1) & (0.6 \wedge 0.7) \vee (0.9 \wedge 0.4) \\ (0.2 \wedge 0.5) \vee (0.7 \wedge 0.1) & (0.2 \wedge 0.7) \vee (0.7 \wedge 0.4) \end{bmatrix} \circ \begin{bmatrix} 0.2 & 0.3 \\ 0.7 & 0.7 \end{bmatrix}$$

$$= \begin{bmatrix} 0.5 & 0.6 \\ 0.2 & 0.4 \end{bmatrix} \circ \begin{bmatrix} 0.2 & 0.3 \\ 0.7 & 0.7 \end{bmatrix}$$

$$= \begin{bmatrix} (0.5 \wedge 0.2) \vee (0.6 \wedge 0.7) & (0.5 \wedge 0.3) \vee (0.6 \wedge 0.7) \\ (0.2 \wedge 0.2) \vee (0.4 \wedge 0.7) & (0.2 \wedge 0.3) \vee (0.4 \wedge 0.7) \end{bmatrix}$$

$$= \begin{bmatrix} 0.6 & 0.6 \\ 0.4 & 0.4 \end{bmatrix}$$

(2)

$$(P \bigcup Q) \circ R = (\begin{bmatrix} 0.6 & 0.9 \\ 0.2 & 0.7 \end{bmatrix} \bigcup \begin{bmatrix} 0.5 & 0.7 \\ 0.1 & 0.4 \end{bmatrix}) \circ \begin{bmatrix} 0.1 & 0.2 \\ 0.6 & 0.5 \end{bmatrix}$$

$$= \begin{bmatrix} 0.6 \vee 0.5 & 0.9 \vee 0.7 \\ 0.2 \vee 0.1 & 0.7 \vee 0.4 \end{bmatrix} \circ \begin{bmatrix} 0.1 & 0.2 \\ 0.6 & 0.5 \end{bmatrix}$$

$$= \begin{bmatrix} 0.6 & 0.9 \\ 0.2 & 0.7 \end{bmatrix} \circ \begin{bmatrix} 0.1 & 0.2 \\ 0.6 & 0.5 \end{bmatrix}$$

$$= \begin{bmatrix} (0.6 \wedge 0.1) \vee (0.9 \wedge 0.6) & (0.6 \wedge 0.2) \vee (0.9 \wedge 0.5) \\ (0.2 \wedge 0.1) \vee (0.7 \wedge 0.6) & (0.2 \wedge 0.2) \vee (0.7 \wedge 0.5) \end{bmatrix}$$

$$= \begin{bmatrix} 0.6 & 0.5 \\ 0.6 & 0.5 \end{bmatrix}$$

(3)

$$(P \circ S) \bigcup (Q \circ S) = (\begin{bmatrix} 0.6 & 0.9 \\ 0.2 & 0.7 \end{bmatrix} \circ \begin{bmatrix} 0.1 & 0.2 \\ 0.6 & 0.5 \end{bmatrix}) \bigcup (\begin{bmatrix} 0.5 & 0.7 \\ 0.1 & 0.4 \end{bmatrix} \circ \begin{bmatrix} 0.1 & 0.2 \\ 0.6 & 0.5 \end{bmatrix})$$

$$= \begin{bmatrix} (0.6 \wedge 0.1) \vee (0.9 \wedge 0.6) & (0.6 \wedge 0.2) \vee (0.9 \wedge 0.5) \\ (0.2 \wedge 0.1) \vee (0.7 \wedge 0.6) & (0.2 \wedge 0.2) \vee (0.7 \wedge 0.5) \end{bmatrix} \bigcup (\begin{bmatrix} 0.5 & 0.7 \\ 0.1 & 0.4 \end{bmatrix} \circ \begin{bmatrix} 0.1 & 0.2 \\ 0.6 & 0.5 \end{bmatrix})$$

$$= \begin{bmatrix} 0.6 & 0.5 \\ 0.6 & 0.5 \end{bmatrix} \bigcup \begin{bmatrix} (0.5 \wedge 0.1) \vee (0.7 \wedge 0.6) & (0.5 \wedge 0.2) \vee (0.7 \wedge 0.5) \\ (0.1 \wedge 0.1) \vee (0.4 \wedge 0.6) & (0.1 \wedge 0.2) \vee (0.4 \wedge 0.5) \end{bmatrix}$$

$$= \begin{bmatrix} 0.6 & 0.5 \\ 0.6 & 0.5 \end{bmatrix} \bigcup \begin{bmatrix} 0.6 & 0.5 \\ 0.4 & 0.4 \end{bmatrix}$$

$$= \begin{bmatrix} 0.6 \vee 0.6 & 0.5 \vee 0.5 \\ 0.6 \vee 0.4 & 0.5 \vee 0.4 \end{bmatrix}$$

$$= \begin{bmatrix} 0.6 & 0.5 \\ 0.6 & 0.5 \end{bmatrix}$$

3-3

> **求解模糊关系方程**

$$\begin{bmatrix} 0.8 & 0.5 & 0.6 \\ 0.4 & 0.8 & 0.5 \end{bmatrix} \circ \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0.5 \\ 0.6 \end{bmatrix}$$

解：依题意，有

$$\begin{bmatrix} 0.8 & 0.5 & 0.6 \\ 0.4 & 0.8 & 0.5 \end{bmatrix} \circ \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} (0.8 \wedge x_1) \vee (0.5 \wedge x_2) \vee (0.6 \wedge x_3) \\ (0.4 \wedge x_1) \vee (0.8 \wedge x_2) \vee (0.5 \wedge x_3) \end{bmatrix} = \begin{bmatrix} 0.5 \\ 0.6 \end{bmatrix}$$

由此，我们可以得到两个等式如下，需要求解三个变量使得这两个等式恒成立。

$$(0.8 \wedge x_1) \vee (0.5 \wedge x_2) \vee (0.6 \wedge x_3) = 0.5 \tag{1}$$

$$(0.4 \wedge x_1) \vee (0.8 \wedge x_2) \vee (0.5 \wedge x_3) = 0.6 \tag{2}$$

对于等式(1)中的三个项，要让等式恒成立，则有

$$\begin{cases} 0.8 \wedge x_1 \leq 0.5 \\ 0.5 \wedge x_2 \leq 0.5 \\ 0.6 \wedge x_3 \leq 0.5 \end{cases} \tag{3}$$

三个式子至少有一个取得等号。分别解三个方程式，(3)-2恒成立，故得到

$$\begin{cases} x_1 \leq 0.5 \\ x_3 \leq 0.5 \end{cases} \tag{4}$$

同理，对于等式(2)中的三个项，要让等式恒成立，则有

$$\begin{cases} 0.4 \wedge x_1 \leq 0.6 \\ 0.8 \wedge x_2 \leq 0.6 \\ 0.5 \wedge x_3 \leq 0.6 \end{cases} \tag{5}$$

三个式子中至少有一个取得等号。分别解三个方程式，不等式1、3恒成立，因此式2必须取得等号。解等式$0.8 \wedge x_2 = 0.6$得到

$$x_2 = 0.6 \tag{6}$$

由此，我们等到模糊关系方程的解集为

$$\begin{cases} x_1 \leq 0.5 \\ x_2 = 0.6 \\ x_3 \leq 0.5 \end{cases} \tag{7}$$

将(7)代回(1)(2)验证，等式均成立。因此(7)为该模糊关系方程的解集。

3-4

> **如果**$A=\frac{1}{x_1}+\frac{0.5}{x_2}$**且**$B=\frac{0.1}{y_1}+\frac{0.5}{y_2}+\frac{1}{y_3}$**，则**$C=\frac{0.2}{z_1}+\frac{1}{z_2}$**。现已知**$A_1=\frac{0.8}{x_1}+\frac{0.1}{x_2}$**且**$B_1=\frac{0.5}{y_1}+\frac{0.2}{y_2}+\frac{0}{y_3}$**，利用模糊推理公式（3.27）和式（3.28）求**C_1**，并采用Matlab进行仿真。**

$$R=(A\times B)^{T1}\circ C \tag{3.27}$$

$$C_1=(A_1\times B_1)^{T2}\circ R \tag{3.28}$$

解：依题意，根据式（3.27），得

$$\begin{aligned}R&=(A\times B)^{T1}\circ C\\&=(\begin{bmatrix}1\\0.5\end{bmatrix}\circ[0.1\quad 0.5\quad 1])^{T1}\circ[0.2\quad 1]\\&=\begin{bmatrix}0.1&0.5&1\\0.1&0.5&0.5\end{bmatrix}^{T1}\circ[0.2\quad 1]=\begin{bmatrix}0.1\\0.5\\1\\0.1\\0.5\\0.5\end{bmatrix}\circ[0.2\quad 1]\\&=\begin{bmatrix}0.1&0.1\\0.2&0.5\\0.2&1\\0.1&0.1\\0.2&0.5\\0.2&0.5\end{bmatrix}\end{aligned}$$

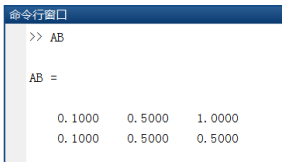
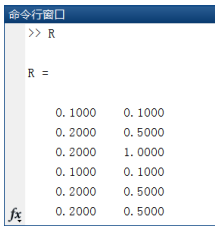
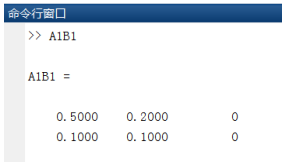
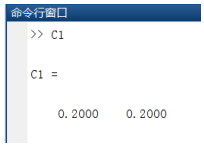
再根据式（3.28），得

$$\begin{aligned}C_1&=(A_1\times B_1)^{T2}\circ R\\&=(\begin{bmatrix}0.8\\0.1\end{bmatrix}\circ[0.5\quad 0.2\quad 0])^{T2}\circ\begin{bmatrix}0.1&0.1\\0.2&0.5\\0.2&1\\0.1&0.1\\0.2&0.5\\0.2&0.5\end{bmatrix}\\&=\begin{bmatrix}0.5&0.2&0\\0.1&0.1&0\end{bmatrix}^{T2}\circ\begin{bmatrix}0.1&0.1\\0.2&0.5\\0.2&1\\0.1&0.1\\0.2&0.5\\0.2&0.5\end{bmatrix}=[0.5\quad 0.2\quad 0\quad 0.1\quad 0.1\quad 0]\circ\begin{bmatrix}0.1&0.1\\0.2&0.5\\0.2&1\\0.1&0.1\\0.2&0.5\\0.2&0.5\end{bmatrix}\\&=\begin{bmatrix}(0.5\wedge 0.1)\vee(0.2\wedge 0.2)\vee(0\wedge 0.2)\vee(0.1\wedge 0.1)\vee(0.1\wedge 0.2)\vee(0\wedge 0.2)\\(0.5\wedge 0.1)\vee(0.2\wedge 0.5)\vee(0\wedge 1)\vee(0.1\wedge 0.1)\vee(0.1\wedge 0.5)\vee(0\wedge 0.5)\end{bmatrix}^T\\&=[0.2\quad 0.2]\end{aligned}$$

Matlab仿真代码（文件m3_4.m）如下所示：

```
clc, clear;
%设置隶属度
A = [1,0.5];
B = [0.1,0.5,1];
C = [0.2,1];
%合成A和B
AB = zeros(size(A,2),size(B,2));
for i = 1:size(AB,1)
    for j = 1:size(AB,2)
        AB(i,j) = min(A(i),B(j));
    end
end
%将AB转成列向量
ABT1 = AB';
AB_T1 = ABT1(:);
%确定模糊关系矩阵R
R = zeros(size(AB_T1,1),size(C,2));
for i = 1:size(R,1)
    for j = 1:size(R,2)
        R(i,j) = min(AB_T1(i),C(j));
    end
end

%设置隶属度
A1 = [0.8,0.1];
B1 = [0.5,0.2,0];
%合成A1和B1
A1B1 = zeros(size(A1,2),size(B1,2));
for i = 1:size(A1B1,1)
    for j = 1:size(A1B1,2)
        A1B1(i,j) = min(A1(i),B1(j));
    end
end
%将A1B1转成行向量
A1B1_T2 = reshape(A1B1,1,size(A1B1,1)*size(A1B1,2));
%确定输出矩阵C1
tmp = zeros(size(R,2),size(R,1));
for i = 1:size(tmp,1)
    for j = 1:size(tmp,2)
        tmp(i,j) = min(A1B1_T2(j),R(j,i));
    end
end
C1 = (max(tmp,[],2))';
```

仿真结果如下所示：

AB	R	A1B1	C1
			

Matlab仿真结果与预期相符。