2.27.

$\Sigma_1 = \Sigma_2 = \Sigma$.

boundary: $w^T(x - x_0) = 0$.

$$w = \Sigma^{-1}(\mu_1 - \mu_2).$$

$$x_0 = \frac{1}{2}(\mu_1 + \mu_2) - \frac{\ln[P(\omega_1)/P(\omega_2)]}{(\mu_1-\mu_2)^T\Sigma^{-1}(\mu_1-\mu_2)}(\mu_1-\mu_2).$$

Bayes decision boundary not pass between the two means.

$$\begin{cases} w^T(\mu_1 - x_0) \geq 0 \text{ and } w^T(\mu_2 - x_0) > 0 \\ \text{or } w^T(\mu_1 - x_0) < 0 \text{ and } w^T(\mu_2 - x_0) < 0 \end{cases}$$

$$w^T(\mu_1 - x_0) = \frac{1}{2}(\mu_1-\mu_2)^T\Sigma^{-1}(\mu_1-\mu_2) - \ln[P(\omega_1)/P(\omega_2)]$$
$$= \frac{1}{2}(\mu_1-\mu_2)^T\Sigma^{-1}(\mu_1-\mu_2) - \ln[P(\omega_1)/P(\omega_2)].$$

$$w^T(\mu_2 - x_0) = \frac{1}{2}(\mu_1-\mu_2)^T\Sigma^{-1}(\mu_2-\mu_1) - \ln[P(\omega_1)/P(\omega_2)].$$

$$\begin{cases} \frac{1}{2}(\mu_1-\mu_2)^T\Sigma^{-1}(\mu_1-\mu_2) > \ln[P(\omega_1)/P(\omega_2)] \\ -\frac{1}{2}(\mu_1-\mu_2)^T\Sigma^{-1}(\mu_1-\mu_2) > \ln[P(\omega_1)/P(\omega_2)] \end{cases}$$

$$\text{or} \begin{cases} \frac{1}{2}(\mu_1-\mu_2)^T\Sigma^{-1}(\mu_1-\mu_2) < \ln[P(\omega_1)/P(\omega_2)] \\ -\frac{1}{2}(\mu_1-\mu_2)^T\Sigma^{-1}(\mu_1-\mu_2) \leq \ln[P(\omega_1)/P(\omega_2)]. \end{cases}$$

Zhiqian Zhou
Hw3 Question 2

Scan input and transform the text to the corresponding feature and number. Calculate the joint pdf.

```
function ret = pabxcd_cond_abxcd(varargin)

    [a,b,x,c,d,ca,cb,cx,cc,cd] = scaninput(varargin);
    p1 = pabxcd(a,b,x,c,d);
    p2 = pabxcd(ca,cb,cx,cc,cd);
    ret = p1/p2;

end
```

Calculate the possibility for Question2.

```
p1 = pabxcd_cond_abxcd('summer','north','sea','dark','thin');
p2 = pabxcd_cond_abxcd('x1','c1','b2');
p3 = pabxcd_cond_abxcd('x2','c1','b2');
p4 = pabxcd_cond_abxcd('south','light');
p5 = pabxcd_cond_abxcd('x1','|','c1','b2');
p6 = pabxcd_cond_abxcd('x2','|','c1','b2');

p2a = pabxcd_cond_abxcd('salmon','|','light','thin','south','winter');
p2b1 = pabxcd_cond_abxcd('winter','|','thin','dark','south');
p2b2 = pabxcd_cond_abxcd('spring','|','thin','dark','south');
p2b3 = pabxcd_cond_abxcd('summer','|','thin','dark','south');
p2b4 = pabxcd_cond_abxcd('autumn','|','thin','dark','south');
p2c = pabxcd_cond_abxcd('north','|','dark','wide','summer');
```

The result was shown below.

```
P(a3,b1,x2,c3,d2) = 0.018
P(x1,c1,b2) = 0.114
P(x2,c1,b2) = 0.042
P(c1,b2) = 0.156
P(x1|c1,b2) = 0.73077
P(x2|c1,b2) = 0.26923
P(salmon|light,thin,south,winter) = 0.92453
P(winter|thin,dark,south) = 0.23032
P(spring|thin,dark,south) = 0.22157
P(summer|thin,dark,south) = 0.2828
P(autumn|thin,dark,south) = 0.26531
P(north|dark,wide,summer) = 0.52577
```