**Problem 1**

**a)** According to Bayes rule:

=

According to the model ri,j = sign(φi,j):

=

=

Therefore, when ri,j = 1, p(φij|rij, ui, vj) = TN1(uiTvj, σ2) and when rij = -1, p(φij|rij, ui, vj) = TN-1(uiTvj, σ2)

Then, we can derive q(φ) by :

q(φ) =

=

=

**b)** According to EM algorithm:

 (U, V) =

According to Bayes rule:

 (U, V) =

Since is only defined on values of when , lnp(R|) = 0. And is a constant . Then we can get:

 (U, V)

Because of the independence of each ui, vj:

Then we can get:

 (U, V)

=

**c)**

Solving for ▽U,V(U, V) = 0, we can find that one solution is:

**d)**

1. Initializing U0, V0 to vectors generated from normal distribution

2.For interation t = 1,2, …, T

(a)E-step: Calculate E = {}, where

if rij = 1

=

if rij = -1

(b)M-step: Update vector U, V using the expectations above in the following equations

(c)Calculate ln p(U,V,R) using the equation

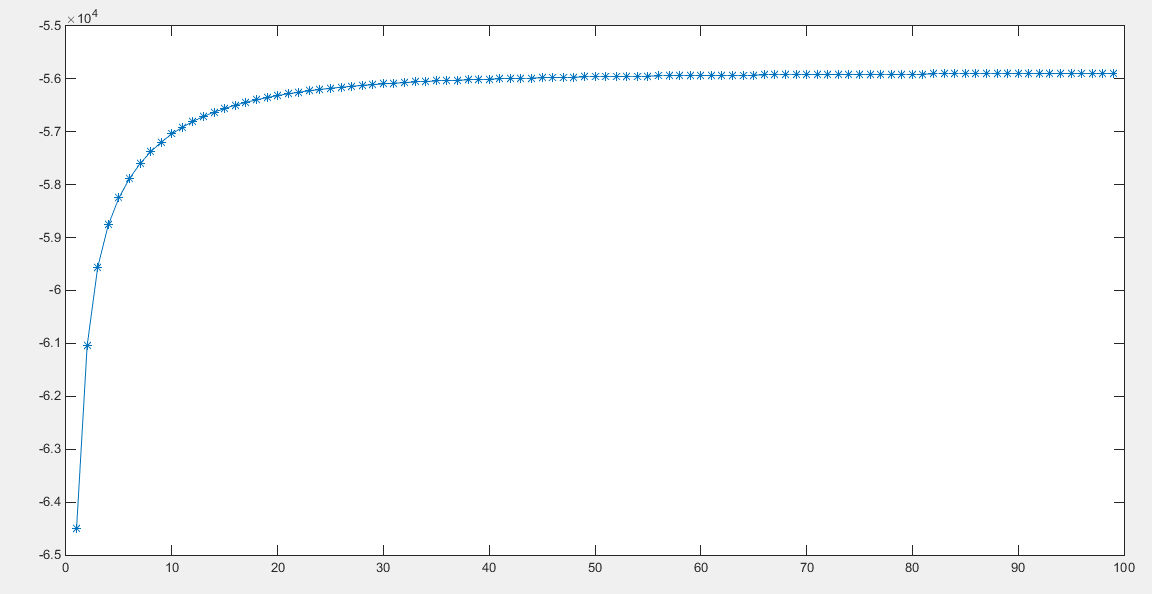
ln p(U,V,R)=

u(x) is the step function

**Problem 2**

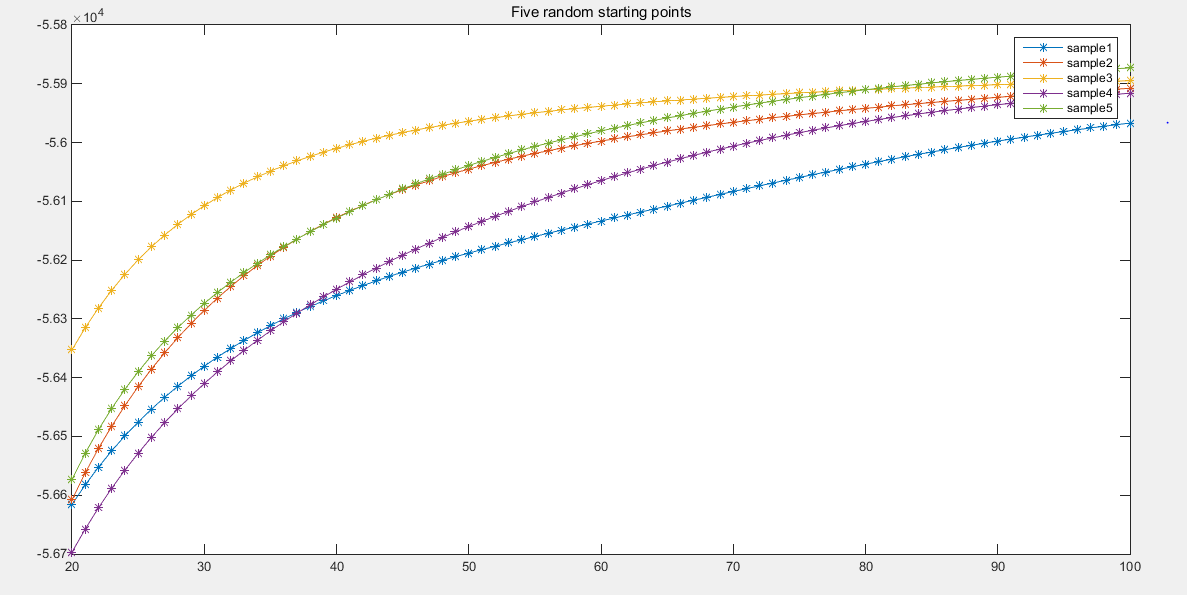


Value of ln p(U,V,R) for iterations 2 through 100



**b)**

Value of ln p(U,V,R) for iterations 20 through 100 with 5 random starting points



**c)**

confusion matrix:

predicted\_like predicted\_dislike

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like 2145 589

dislike 824 1442