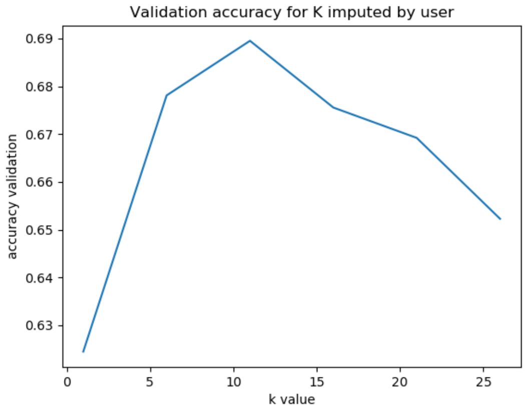
1.

(a)

```
Validation Accuracy: 0.6244707874682472
Validation Accuracy: 0.6780976573525261
Validation Accuracy: 0.6895286480383855
Validation Accuracy: 0.6755574372001129
Validation Accuracy: 0.6692068868190799
Validation Accuracy: 0.6522720858029918
```

← k = 1
← k = 6
← k = 11 max
← k = 16
← k = 21
← k = 26

Then code in knn.py



(b)

```
For user part we choose k = 11
Validation Accuracy: 0.6841659610499576
The final test accuracy is 0.6841659610499576
```

By user validation accuracy set.

We choose k = 11

Then final test accuracy is :

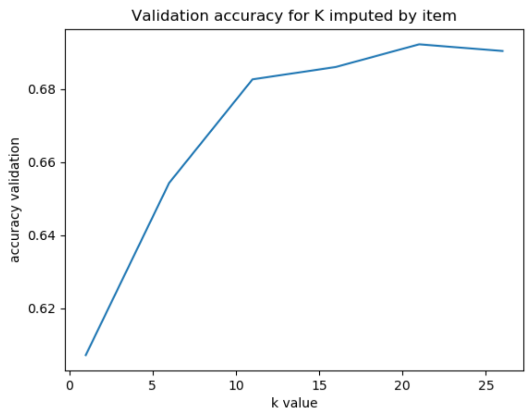
0.6841659610499576 for k = 11

(c)

```
For k = 1
validation accuracy imputed by item is:
0.607112616426757
For k = 6
validation accuracy imputed by item is:
0.6542478125882021
For k = 11
validation accuracy imputed by item is:
0.682613604290149 6
```

```
For k = 16
validation accuracy imputed by item is:
0.6860005644933672
For k = 21
validation accuracy imputed by item is:
0.6922099915325995
For k = 26
validation accuracy imputed by item is:
0.69037538808919
```

k = 21 accuracy is max



Based on item validation accuracy we choose k = 21 which we get

```
For item part we choose k = 21
Validation Accuracy: 0.6683601467682755
The final test accuracy is 0.6683601467682755
```

Final test accuracy is 0.6683601467682755

(d) By user validation accuracy set.

We choose $k=11$

Then final test accuracy is:

0.6841659610499576 for $k=11$

Based on item validation accuracy

we choose $k=21$

Final test accuracy is 0.6683601467682755

we get a better performs for user-based

collaborative

(e)

(1) Knn need a long computation time with

lots of memory (A lot of matrix multiplication)

(2) For task given

we have 542 students and 1774

diagnostic questions, that may lead to

curse of dimensionality.

(3)

prediction accuracy is a little bit

low.

2.

(a)

$$p(C_{ij}=1 \mid \theta_i, \beta_j) = \frac{e^{(\theta_i - \beta_j)}}{1+e^{(\theta_i - \beta_j)}}$$

For all students and questions

$$p(C \mid \theta, \beta) =$$

$$\prod_{i=1}^{542} \prod_{j=1}^{1774} \left[\left(\frac{e^{(\theta_i - \beta_j)}}{1+e^{(\theta_i-\beta_j)}} \right)^{I(C_{ij}=1)} \left(\frac{1}{1+e^{(\theta_i-\beta_j)}} \right)^{I(C_{ij}=0)} \right]$$

So $\log p(C \mid \theta, \beta)$

$$= \sum_{i=1}^{542} \sum_{j=1}^{1774} \left[I(C_{ij}=1)(\theta_i - \beta_j) - I(C_{ij}=0 \text{ or } C_{ij}=1) \log(1+e^{\theta_i - \beta_j}) \right]$$

$$\frac{\partial \log p(C \mid \theta, \beta)}{\partial \theta_i}$$

$$= \sum_{j=1}^{1774} \left[I(C_{ij}=1) - I(C_{ij}=0 \text{ or } C_{ij}=1) \frac{e^{\theta_i - \beta_j}}{1+e^{\theta_i - \beta_j}} \right]$$

$$\frac{\partial \log p(c \mid \theta, \beta)}{\partial \beta_j}$$

$$= \sum_{i=1}^{541} \left[- I(c_{ij}=1) + I(c_{ij}=0 \text{ or } c_{ij}=1) \frac{e^{\theta_i - \beta_j}}{1+e^{\theta_i - \beta_j}} \right]$$

(b) learning rate : 0.01

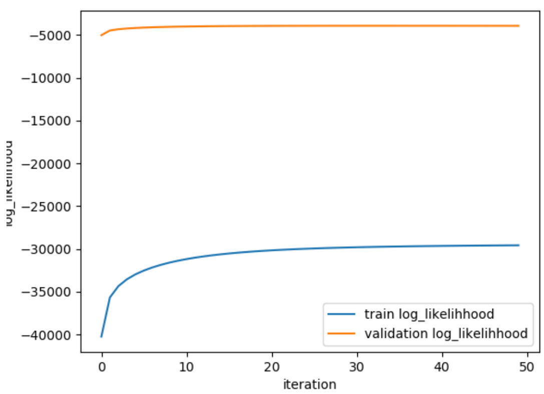
Number of iterations : 50

θ zero vector

β zero vector.

hyperparmeters we selected

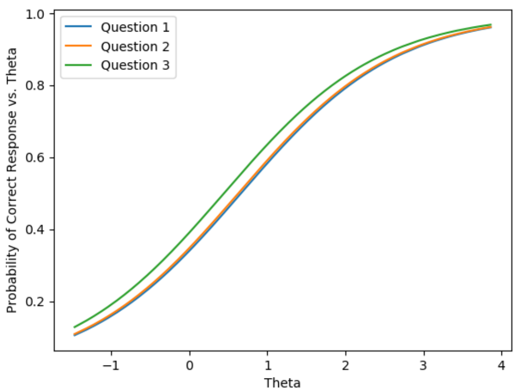
Training curve



(c)

```
For learning rate = 0.01, iteration = 50
the final validation accuracy is 0.7058989556872707
the final test accuracy is 0.7075924357888794
```

(d) The curve of 3 Questions



These curve shows that probability of correct response increase as the ability of student increase.