**1 EM algorithm Report**

The below table summarizes the various approaches and the values obtained by doing so:

|  |  |  |  |
| --- | --- | --- | --- |
| K: | Mean | Variance | Log likelyhood |
| K = 2; Initialization: 1  Variance: Non-uniform  EM type: 1 | 25.494544086831798  8.467209495764003 | 0.9797315994740571  20.101448283087038 | 3.525234996817786 |
| K = 2;Initialization 1  Variance: Non-uniform  EM type: 2 | 25.494515373439306  8.467313786837371 | 0.9797986394609637  20.100168403252127 | 3.52523722219159 |
| K = 2;Initialization: 1  Variance: 1.0  EM type: 1 | 25.49451434901088  8.467317504520231 | 0.9798010319025184  20.100122785722334 | 3.5252373014939833 |
| K = 2;Initialization: 1  Variance: 1.0  EM type: 2 | 25.494615344507213  8.466948045938606 | 0.9795657024109587  20.104661780913613 | 3.5252293966157207 |
| K = 2; Initialization: 2  Variance: Non-uniform  EM type: 1 | 25.494542796473254  8.467214184966487 | 0.9797346117162917    20.10139073092873 | 3.5252350968963566 |
| K = 2;Initialization 2  Variance: Non-uniform  EM type: 2 | 25.49454279745375  8.467214181403557 | 0.9797346094274596  20.101390774657485 | 3.5252350968203174 |
| K = 2; Initialization: 2  EM type:1 ;  Variance: 1.0  K = 2; Initialization: 2  EM type: 2;  Variance: 1.0 | 25.494507240213345    8.467343098563706  25.49454690576832  8.467199250675083 | 0.9798176716976522  20.09980910423416  0.9797250190788018  20.1015740266054 | 3.5252378457885607  3.525234778155543 |
| K = 3; Initialization: 1  EM type: 1  Variance: Non-uniform | 25.486713946815968  12.735884382925747  8.496815506941084 | 0.9979311425286891  4.35413243461321  3.3905935473803757 | 3.8441597921373876 |
| K = 3; Initialization: 1  EM type: 2  Variance: Non-uniform | 25.494542350762348  8.467214958845647  8.46862639657841 | 0.9797358076996978  20.101382751205726  0.0 | 3.747864702449007 |
| K = 3; Initialization: 1  EM type: 1  Variance: 1.0 | 25.4968568571862  8.722780781536756  8.459044926547616 | 0.9747999603690536  20.053768723608844  0.07128077597244988 | 3.7536995582268293 |
| K = 3; Initialization: 1  EM type: 2  Variance: 1.0 | 15.555173730504903  9.837974555776363  3.397210252046896 | 0.5248796314755589  6.395802406922156  176.96567914509896 | 3.360040558118202 |
| K= 3; Initialization: 2  EM type: 1  Variance: Non-Uniform | 25.486777449761846  12.698124094584909  8.496657489296421 | 0.9977574482133171  4.58218826954604  3.3725910740090934 | 3.8433492051820486 |
| K= 3; Initialization: 2  EM type: 2  Variance: Non-Uniform | 25.486777303806782  12.698201413402211  12.698201413402211 | 0.9977578454620162  4.581714658127353  3.3726285222270542 | 3.8433508661943763 |
| K=3; Initialization: 2  EM type: 1  Variance: Non-Uniform | 25.48677761217752  12.698034115805369  8.4966570824625 | 0.9977570061750142  4.582734143985381  3.3725451902884003 | 3.843347272442722 |
| K=3; Initialization: 2  EM type: 2  Variance: Non-Uniform | 25.486777350850463  12.69817271936193  8.496657737496273 | 0.997757717423146  4.581885382083048  3.372612444101551 | 3.843350250006622 |
| K=3; Initialization: 2  EM type: 1  Variance: 1.0 | 25.486674326567705  12.765748122506245  8.496912625115367 | 0.9980407341970743  4.176037175683618  3.4025541999457376 | 3.844800032621555 |
| K=3; Initialization: 2  EM type: 2  Variance: 1.0 | 25.496071868014358  8.524452247403222  8.462259344912793 | 0.9764210098910894  20.15335631030078  0.005972756128043273 | 3.7490988988061553 |

**Terminologies from the above table**:

**Initialization can take two values**:

**Initialization = 1:** Take K random points from the data set and assign them as means for respective clusters

**Initialization = 2:**  Traverse the data points by picking random numbers and selecting summation of those points divided by the number of data points that went to the same cluster

**Variance can take values:**

**Variance = 1:** Regular variance calculated using the summation of squared difference of a point and mean and divided by the number of points

**Variance = 2:**  Initialized variance of 1.0 to all the clusters

**EM-type 1:** EM Generalization method for GMMs

**EM-type 2:** EM for GMMs with known variance

**Conclusions:**

The calculations are repeated by varying different parameters and also K value and I observe that when I set the variance as 1.0, it takes a longer time to converge with variance being not spread-out. In case of generalized EM with variance calculated by using random points I observe that the variance is spread out and also it converges at a faster rate. Initialization 2 with variance 1 worked better in my case and this is observable from the above values.