

HW3-1 Report

Local Differential Privacy

For unary encoding following equations were used:

- User: each bit is encoded using the given probability

$$p = \frac{e^\varepsilon}{e^\varepsilon + 1} \quad q = \frac{1}{e^\varepsilon + 1}$$

- Aggregator: unbiased estimation $f_i^* = \frac{f_i - q}{p - q}$

For Generalized Random Response

- User: biased coin toss with probability p

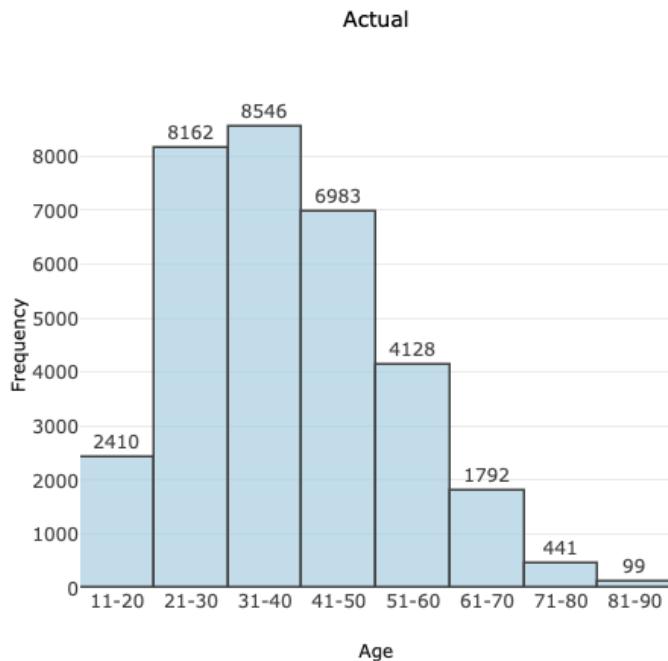
$$p = \frac{e^\varepsilon}{e^\varepsilon + d - 1} \quad q = \frac{1}{e^\varepsilon + d - 1}$$

- Aggregator: unbiased estimation $c(v) = \frac{I_v - n * q}{p - q}$

Task 1(b): Compare the accuracy of the two protocols with different ε for 100% of all the adults/users

ε varies from 1 to 10

Actual Result:



- $\epsilon=1$

Unary Encoding (UE)

```

Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_unary.java - Eclipse IDE
Console Problems Debug Shell History
terminated: hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 1:44:13 PM - 1:44:22 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
1
Enter value of k
0
Enter value of n
100
Results:
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.62245935
q = 0.3775468
Actual frquency
395 558 712 753 728 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 780 778 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
Estimated frequency
50701.0 50435.605 51252.283 51713.582 51080.72 50905.152 51150.13 50982.727 51350.195 51207.293 50888.82 51321.617 51227.707 50631.59 51435.938 51174.63 51121.55 51852.402 51529.848 50925.566
L1 distance = 3667991.4921875

```

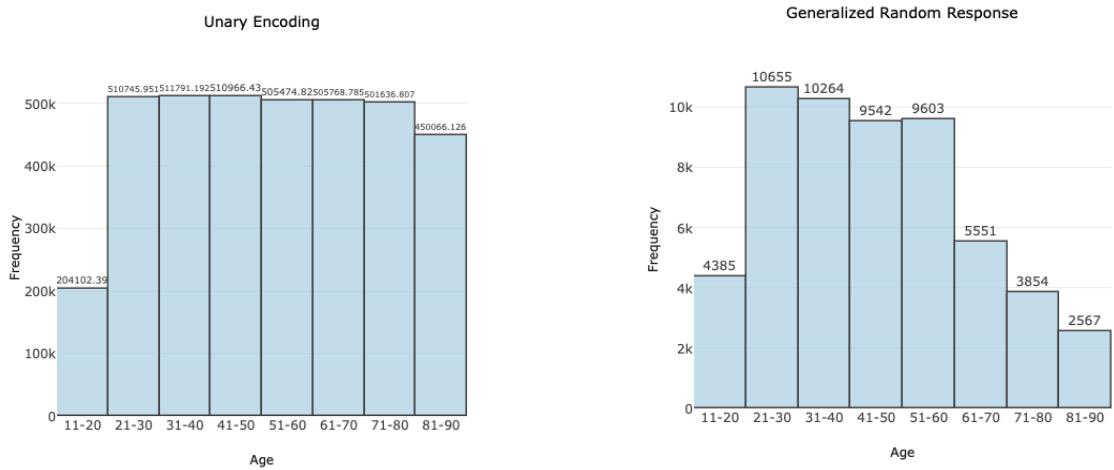
Generalized Random Response (GRR)

```

Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_unary.java - Eclipse IDE
Console Problems Debug Shell History
terminated: hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 1:45:42 PM - 1:45:50 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
1
Enter value of k
0
Enter value of n
100
Results:
Actual Freq (17=395, 18=558, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.03638043
q = 0.013383605
n = 32561
Estimated frequency:
(17=1531, 18=183, 19=879, 20=1792, 21=2661, 22=357, 23=835, 24=1140, 25=1357, 26=313, 27=1574, 28=1487, 29=705, 30=226, 31=618, 32=1574, 33=1487, 34=661, 35=1053, 36=1096, 37=183, 38=835, 39=1
L1 distance = 37687.0

```

Results



- $\epsilon=2$

UE

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console 38 Problems Debug Shell History
<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 2:40:23 PM - 2:40:29 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
100
|
Results:

D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.7310586
q = 0.26894143

Actual freqency
395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 780 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208

Estimated freqency
19377.621 19446.867 19626.477 19914.281 19933.758 19301.883 19780.117 19829.887 19912.117 19760.64 19663.264 19836.379 19734.674 19535.59 19643.787 19784.445 19814.74 19503.13 19756.312 19840.

L1 distance = 1382699.986328125

```

GRR

```

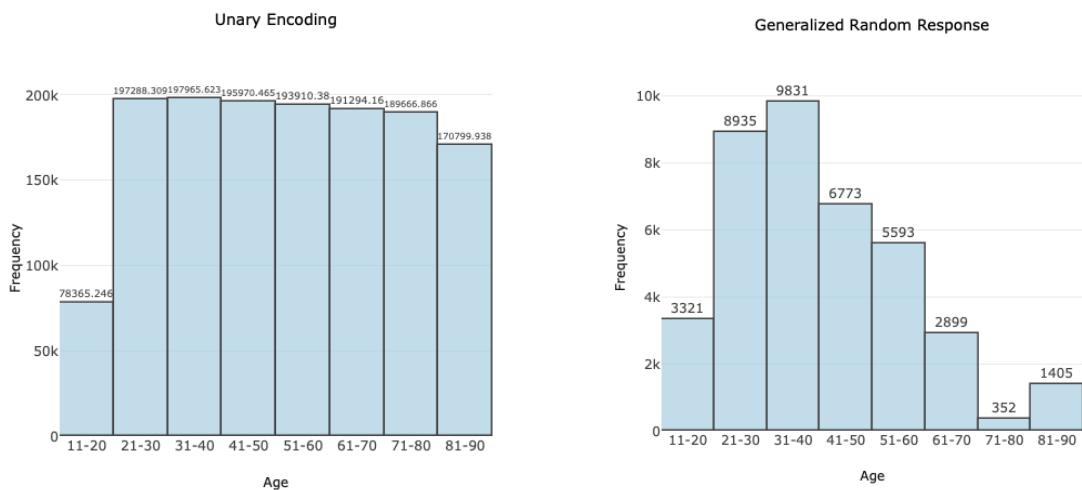
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console 38 Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 2:48:23 PM - 2:48:31 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
100
|
Results:

Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.69307394
q = 0.012596195
n = 3261

Estimated frequency:
{17=743, 18=669, 19=1141, 20=768, 21=768, 22=830, 23=1104, 24=917, 25=855, 26=656, 27=1352, 28=917, 29=830, 30=706, 31=1066, 32=892, 33=1315, 34=1029, 35=1128, 36=1228, 37=669, 38=843, 39=868,
L1 distance = 11133.0

```

Results



- $\epsilon=3$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_unary.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 3:12:49 PM - 3:12:53 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  3
  Enter value of k
  0
  Enter value of n
  100
  Results:

  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.8175745
  q = 0.18242553

  Actual frequency
  395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 788 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
  Estimated frequency
  9699.799 9923.368 10172.129 10082.386 10080.812 9943.836 10068.216 10046.174 10287.0625 10039.876 10168.9795 10250.851 10211.489 10076.088 10309.1045 10335.87 10143.789 10324.849 10487.016 100
  L1 distance = 682125.8955078125

```

GRR

```

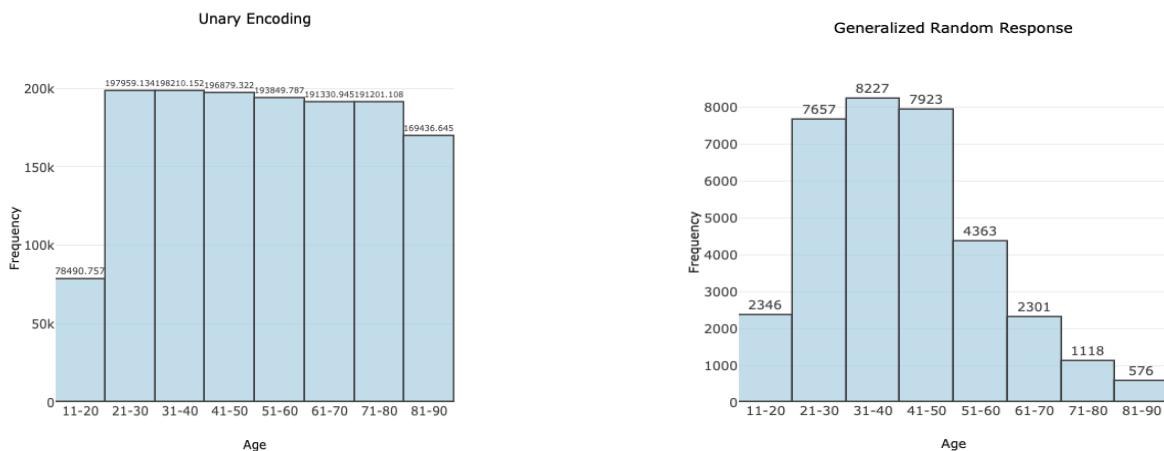
  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_unary.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 3:13:43 PM - 3:13:48 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  3
  Enter value of k
  0
  Enter value of n
  100
  Results:

  Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.21811825
  q = 0.010859468
  n = 32561

  Estimated frequency:
  {17=402, 18=576, 19=778, 20=590, 21=630, 22=547, 23=836, 24=629, 25=846, 26=744, 27=971, 28=682, 29=865, 30=899, 31=822, 32=894, 33=952, 34=711, 35=827, 36=913, 37=716, 38=773, 39=807, 40=812,
  L1 distance = 5891.0

```

Results



- $\epsilon=4$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 3:44:17 PM - 3:44:26 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  4
  Enter value of k
  0
  Enter value of n
  100
  |
  Results:

  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.8887971
  q = 0.1192892
  Actual freqency
  395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 788 770 724 734 737 788 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
  Estimated freqency
  5525.0957 5866.485 5925.572 5685.286 5773.26 5837.598 5957.0845 5997.7886 6080.51 5861.233 5890.1196 5976.78 6072.632 6022.7363 5928.1978 6084.4487 6087.075 6067.3794 5945.267 5991.2236 5912.4
  L1 distance = 373229.0029296875
  
```

GRR

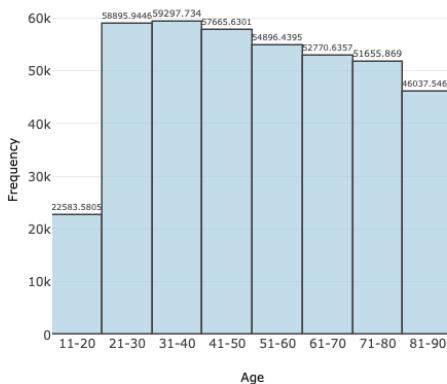
```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 3:45:02 PM - 3:45:14 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  4
  Enter value of k
  0
  Enter value of n
  100
  |
  Results:

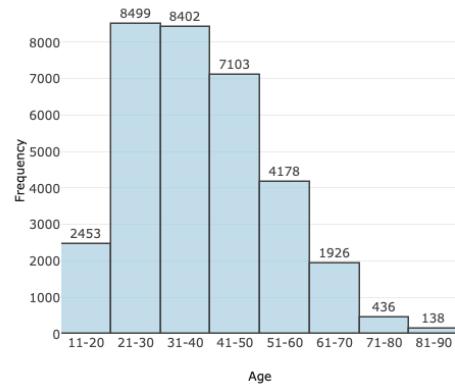
  Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.4312713
  q = 0.00789901
  n = 32561
  Estimated frequency:
  {17=377, 18=573, 19=753, 20=750, 21=757, 22=835, 23=901, 24=804, 25=866, 26=889, 27=880, 28=920, 29=847, 30=880, 31=864, 32=762, 33=899, 34=899, 35=828, 36=878, 37=871, 38=816, 39=788, 40=804,
  L1 distance = 2509.0
  
```

Results

Unary Encoding



Generalized Random Response



- $\epsilon=5$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1 Unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 3:55:56 PM - 3:56:05 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  5
  Enter value of k
  0
  Enter value of n
  100
  |
  Results:

  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.9241418
  q = 0.07585176

  Actual frequency
  395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 780 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
  Estimated frequency
  3301.872 3461.0168 3623.6985 3626.0562 3654.3484 3655.5273 3826.4607 3693.2505 3676.7466 3584.7964 3714.47 3884.0625 3734.5103 3738.0469 3697.966 3721.543 3821.7454 3845.3223 3819.3877 3787.55
  L1 distance = 212389.44506835938

```

GRR

```

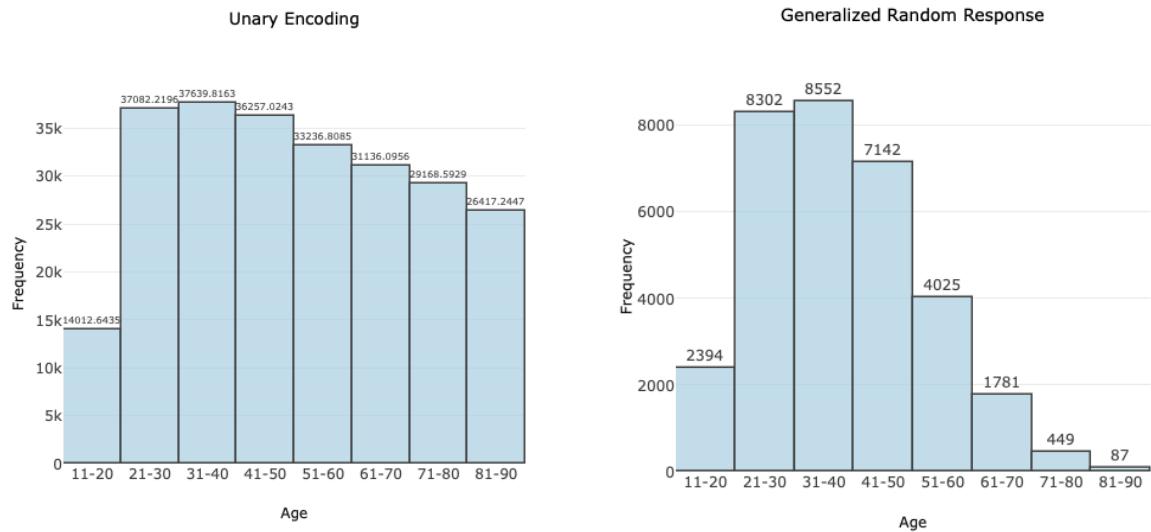
  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 3:56:11 PM - 3:56:19 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  5
  Enter value of k
  0
  Enter value of n
  100
  |
  Results:

  Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.67334074
  q = 0.004536934
  n = 32561

  Estimated frequency:
  {17=444, 18=540, 19=698, 20=712, 21=740, 22=816, 23=902, 24=827, 25=879, 26=815, 27=798, 28=852, 29=825, 30=848, 31=924, 32=810, 33=830, 34=884, 35=861, 36=855, 37=907, 38=831, 39=843, 40=807,
  L1 distance = 1488.0

```

Results



- $\epsilon=6$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_ue [Java Application] /Library/Java/JavaVirtualMachines/dk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 4:08:19 PM - 4:08:26 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  6
  Enter value of k
  0
  Enter value of n
  100
  Results:
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.95257413
  q = 0.047425874
  Actual frequency
  395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 788 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
  Estimated frequency
  2112.3866 2218.3687 2381.878 2476.89 2396.2402 2501.1953 2596.2075 2482.4138 2613.884 2434.908 2519.9768 2544.2822 2580.7402 2585.1594 2698.9531 2591.7883 2527.7104 2613.884 2587.3691 2603.941
  L1 distance = 124956.32958984375

```

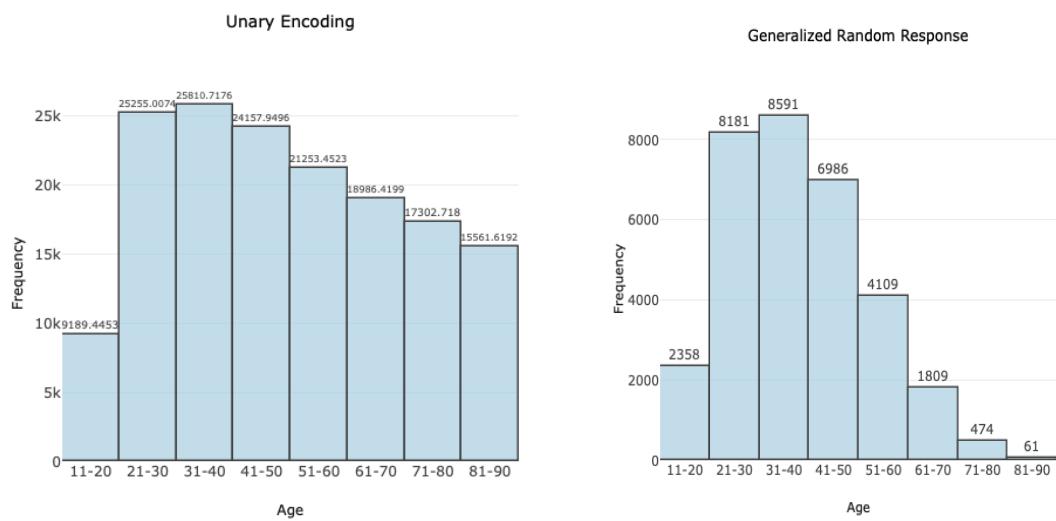
GRR

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/dk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 4:08:31 PM - 4:08:37 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  6
  Enter value of k
  0
  Enter value of n
  100
  Results:
  Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.6485578
  q = 0.0021033643
  n = 32561
  Estimated frequency:
  {17=390, 18=522, 19=698, 20=748, 21=728, 22=772, 23=889, 24=788, 25=846, 26=766, 27=850, 28=868, 29=795, 30=879, 31=880, 32=816, 33=873, 34=906, 35=870, 36=899, 37=891, 38=844, 39=811, 40=801,
  L1 distance = 761.0

```

Results



- $\epsilon=7$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 4:16:09 PM - 4:16:15 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  7
  Enter value of k
  0
  Enter value of n
  100
  Results:
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.97668775
  q = 0.02311223
  Actual frequency
  395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 780 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
  Estimated frequency
  1328.8754 1539.2059 1702.7963 1779.2802 1756.9723 1769.7196 1919.5005 1845.1412 1788.8406 1760.1592 1848.328 1929.0609 1790.9652 1919.5005 1949.2441 1819.6466 1870.6357 1896.1304 1929.0609 193
  L1 distance = 73880.2359008789

```

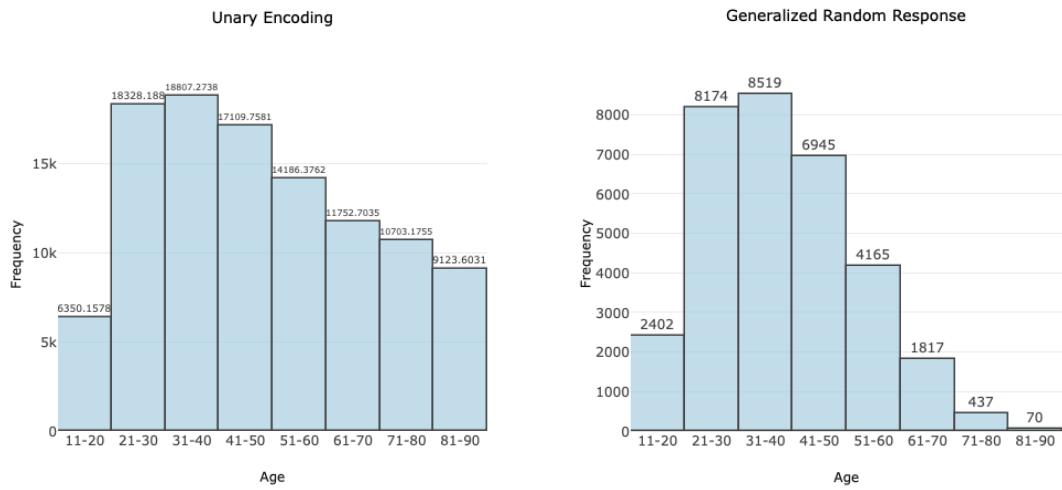
GRR

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 4:16:21 PM - 4:16:25 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  7
  Enter value of k
  0
  Enter value of n
  100
  Results:
  Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=820, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.93838954
  q = 8.557005E-4
  n = 32561
  Estimated frequency:
  {17=375, 18=552, 19=715, 20=760, 21=714, 22=752, 23=875, 24=801, 25=851, 26=786, 27=844, 28=856, 29=828, 30=867, 31=896, 32=819, 33=863, 34=873, 35=870, 36=893, 37=856, 38=836, 39=808, 40=805,
  L1 distance = 456.0

```

Results



- $\epsilon=8$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1 Unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 4:23:49 PM - 4:23:54 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
8
Enter value of k
0
Enter value of n
100
Results:

D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.98201376
q = 0.0179621

Actual frequency
395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 780 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208

Estimated frequency
1004.16205 1138.953 1331.8936 1300.7742 1341.2294 1375.4608 1481.2668 1402.431 1384.7966 1382.722 1452.222 1437.6997 1399.319 1459.4833 1533.1327 1430.4385 1485.4161 1482.3042 1483.3416 1468.8

L1 distance = 43822.3876953125

```

GRR

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1 generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 4:23:59 PM - 4:24:06 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
8
Enter value of k
0
Enter value of n
100
Results:

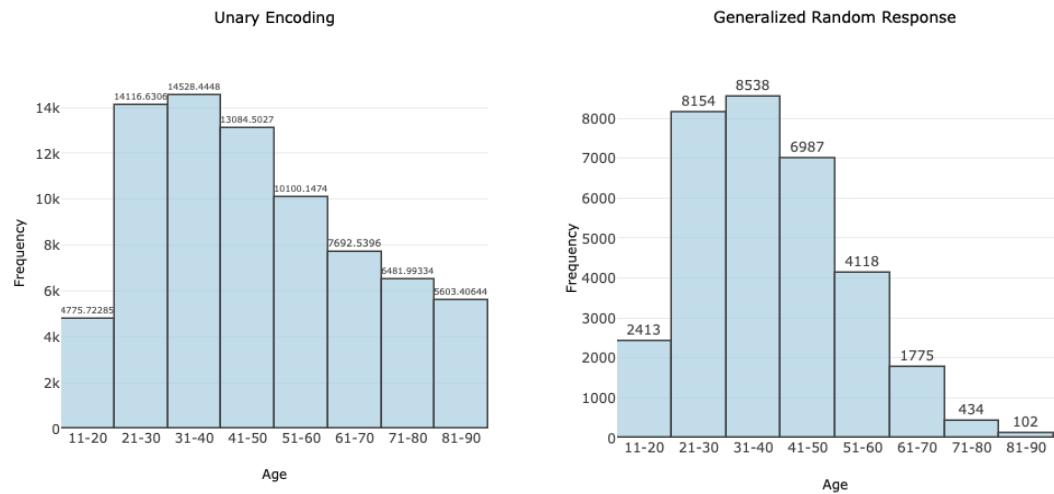
Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=805, 40=792, 41=751, 42=721, 43=760, 44=801, 45=833, 46=786, 47=826, 48=869, 49=821, 50=861, 51=898, 52=828, 53=876, 54=878, 55=876, 56=827, 57=857, 58=814, 59=805, 60=792, 61=751, 62=721, 63=760, 64=801, 65=833, 66=786, 67=826, 68=869, 69=821, 70=861, 71=898, 72=828, 73=876, 74=878, 75=876, 76=892, 77=857, 78=827, 79=814, 80=792, 81=751, 82=721, 83=760, 84=801, 85=833, 86=786, 87=826, 88=869, 89=821, 90=861, 91=898, 92=828, 93=876, 94=878, 95=876, 96=892, 97=857, 98=827, 99=814, 100=792}

Estimated frequency:
{17=396, 18=548, 19=718, 20=751, 21=721, 22=760, 23=876, 24=801, 25=833, 26=786, 27=826, 28=869, 29=821, 30=861, 31=898, 32=828, 33=876, 34=878, 35=876, 36=892, 37=857, 38=827, 39=814, 40=792, 41=750, 42=720, 43=760, 44=801, 45=833, 46=786, 47=826, 48=869, 49=821, 50=861, 51=898, 52=828, 53=876, 54=878, 55=876, 56=827, 57=857, 58=814, 59=805, 60=792, 61=751, 62=721, 63=760, 64=801, 65=833, 66=786, 67=826, 68=869, 69=821, 70=861, 71=898, 72=828, 73=876, 74=878, 75=876, 76=892, 77=857, 78=827, 79=814, 80=792, 81=751, 82=721, 83=760, 84=801, 85=833, 86=786, 87=826, 88=869, 89=821, 90=861, 91=898, 92=828, 93=876, 94=878, 95=876, 96=892, 97=857, 98=827, 99=814, 100=792}

L1 distance = 205.0

```

Results



- $\epsilon=9$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/dk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 4:44:00 PM - 4:44:04 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
9
Enter value of k
0
Enter value of n
100
|
Results:

D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.9890131
q = 0.010966943

Actual frquency
395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 788 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
Estimated frquency
768.88434 987.93994 1067.445 1155.3771 1113.4559 1140.04 1222.86 1161.5118 1181.9613 1163.5569 1212.6353 1201.3882 1153.3322 1211.6128 1265.8036 1206.5005 1269.8934 1250.4666 1209.5679 1252.51
L1 distance = 26687.106872558594

```

GRR

```

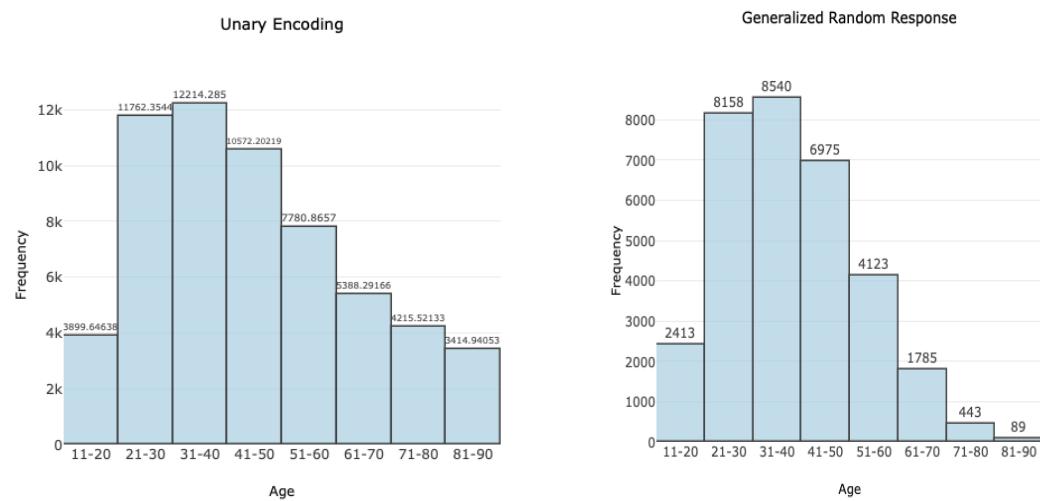
  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/dk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 4:44:14 PM - 4:44:22 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
9
Enter value of k
0
Enter value of n
100
|
Results:

Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.98901276
q = 1.223229E-4
n = 32561

Estimated frequency:
{17=395, 18=550, 19=713, 20=755, 21=721, 22=768, 23=876, 24=800, 25=840, 26=775, 27=838, 28=867, 29=814, 30=859, 31=880, 32=827, 33=873, 34=890, 35=879, 36=903, 37=857, 38=825, 39=816, 40=798,
L1 distance = 166.0

```

Results



- $\epsilon=10$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1 Unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 4:51:44 PM - 4:51:49 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
10
Enter value of k
0
Enter value of n
100
Results:
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.9993872
q = 0.000692851
Actual frequency
395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 780 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
Estimated frequency
648.6763 789.3621 927.4072 986.19415 925.3801 988.22125 1116.9443 1019.64185 1066.266 1011.5333 1073.361 1078.4287 1028.7639 1107.8223 1101.7408 1057.1438 1083.4966 1085.5237 1107.8223 1118.97
L1 distance = 16290.418762207031

```

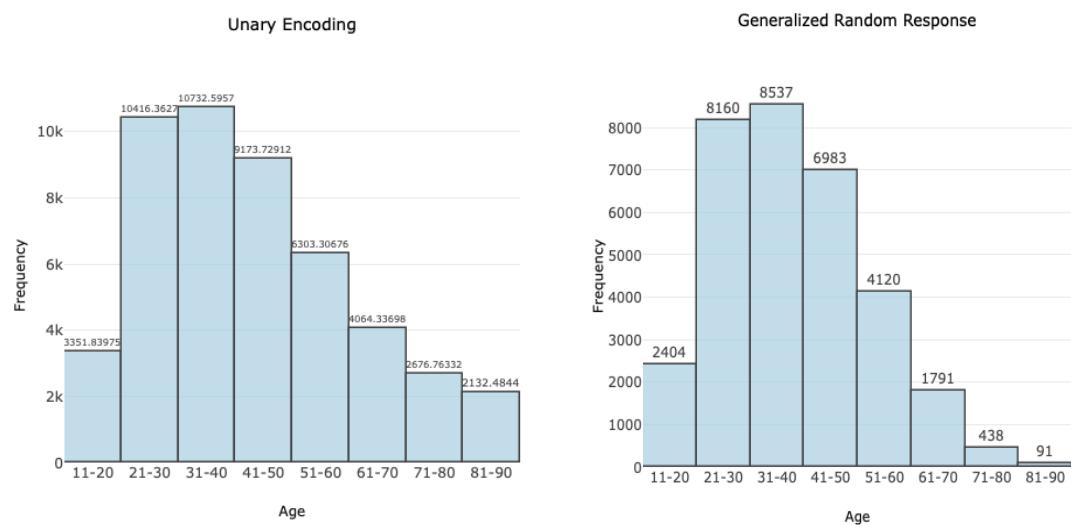
GRR

```

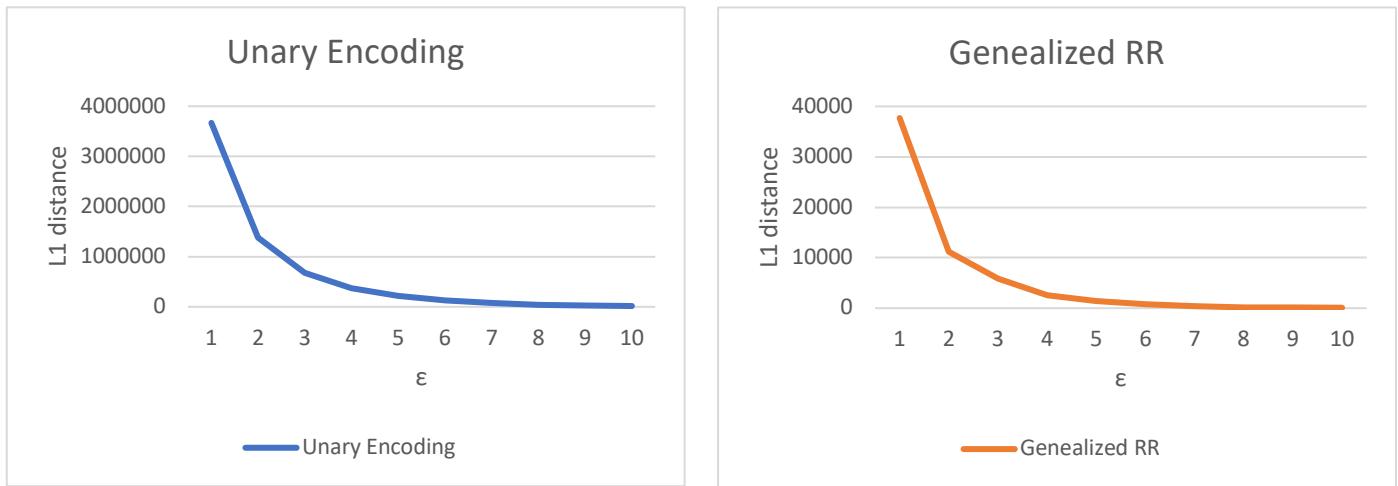
  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:51:57 PM - 4:52:01 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
10
Enter value of k
0
Enter value of n
100
Results:
Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.999374183
q = 4.5252801E-5
n = 32561
Estimated frequency:
{17=392, 18=549, 19=710, 20=753, 21=720, 22=767, 23=877, 24=800, 25=842, 26=785, 27=833, 28=865, 29=811, 30=860, 31=886, 32=829, 33=875, 34=885, 35=874, 36=893, 37=857, 38=823, 39=820, 40=795,
L1 distance = 91.0

```

Results



- Graph comparing the difference of L1 distance between unary encoding and generalized random response for $\epsilon = 1$ to 10, n=100%



Looking at the histograms and L1 distance graph for Unary Encoding and Generalized Random Response, Unary Encoding provides better privacy as compared to Generalized Random Response. As the value of ϵ increase the privacy decrease for both protocols, but comparatively more for Generalized Encoding.

The L1 distance is much greater for Unary Encoding as compared to Generalized Random Response, therefore when ϵ is small the accuracy is less for Unary Encoding when compared with Generalized Random Response. As ϵ increase accuracy for both protocols increase, but Unary Encoding still provides more privacy.

Task 1(c) accuracy of the two protocols with different numbers of adults/users n and discuss your findings with fixed $\epsilon = 2$.

- $\epsilon = 2 \text{ & } n=10\%$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 8:10:48 PM - 8:10:53 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
10
Results:

D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.7310586
q = 0.26949413

Actual freqency
43 45 69 88 55 73 88 88 79 78 84 83 74 88 102 84 69 96 92 80 83 79 71 81 98 90 85 84 76 73 83 57 62 59 64 47 47 43 42 35 37 35 35 30 37 18 23 25 20 15 13 9 9 7 9 8 4 7 8 5 3 2 1 2 2 1 1 5

Estimated freqency
1884.2214 1953.468 1868.418 1996.7471 2001.075 1972.9436 1946.9761 1968.6156 1985.9272 1910.1888 1964.2877 1957.7959 1979.4354 1946.9761 2076.8132 2081.141 1966.4517 2009.7307 1994.5831 1985.9

L1 distance = 129688.01892089844

```

GRR

```

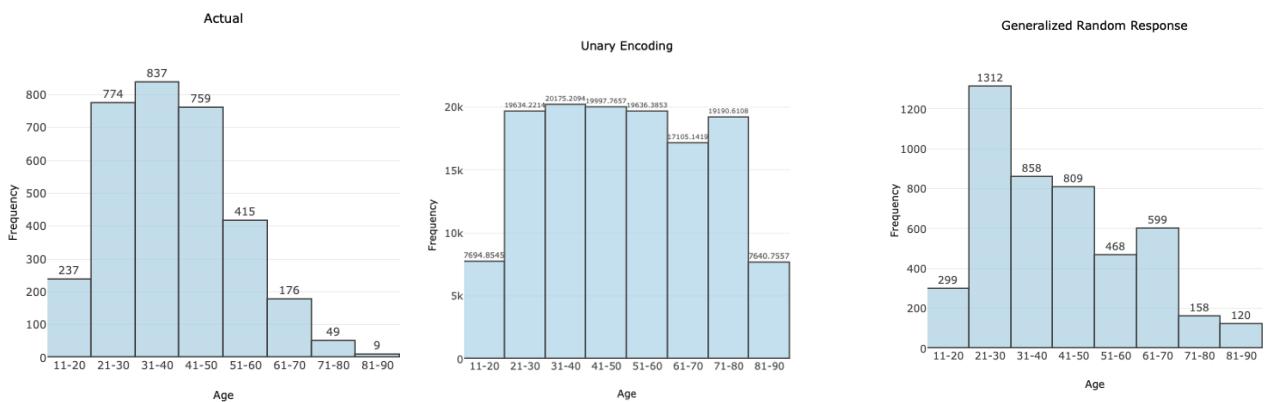
  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 8:11:24 PM - 8:11:28 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
10
Results:

Actual Freq {17=43, 18=45, 19=69, 20=88, 21=55, 22=73, 23=88, 24=80, 25=79, 26=78, 27=84, 28=83, 29=74, 30=80, 31=102, 32=84, 33=69, 34=96, 35=92, 36=80, 37=83, 38=79, 39=71, 40=81, 41=90, 42=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.69932989
q = 0.013442838
n = 3256

Estimated frequency:
17=2, 18=188, 19=72, 20=37, 21=107, 22=95, 23=282, 24=0, 25=200, 26=177, 27=177, 28=2, 29=247, 30=25, 31=177, 32=60, 33=14, 34=49, 35=258, 36=2, 37=84, 38=49, 39=165, 40=0, 41=107, 42=60, 43=
L1 distance = 3488.0

```

Results



- $\epsilon = 2$ & $n=20\%$

UE

```

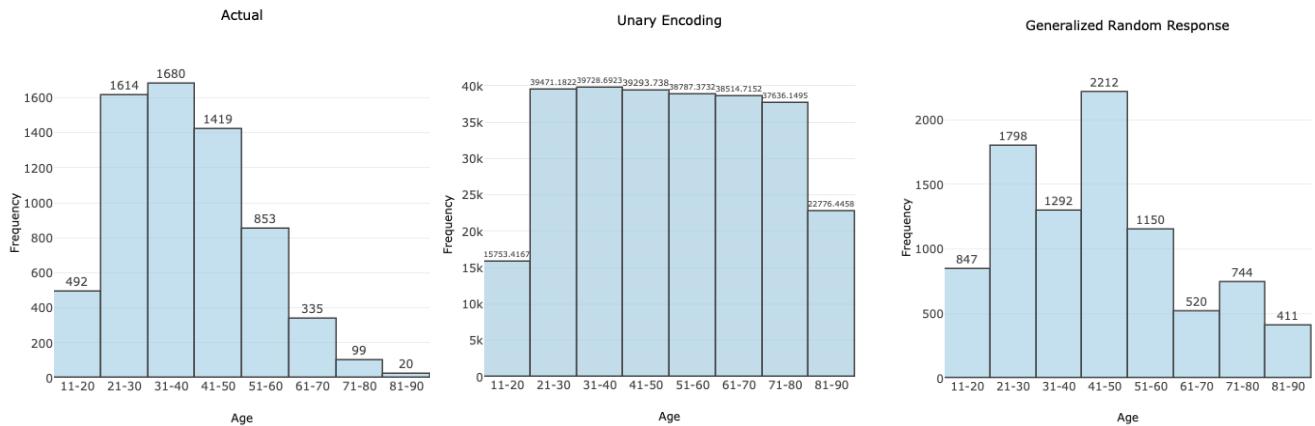
  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 8:23:55 PM - 8:23:59 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  2
  Enter value of k
  0
  Enter value of n
  20
  Results:
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.7318586
  q = 0.2689413
  Actual frequency
  72 105 146 169 135 153 177 151 184 159 161 161 158 175 198 164 170 178 183 148 170 150 158 161 174 159 160 156 135 155 149 98 123 110 133 99 96 86 86 73 81 68 72 59 62 36 55 42 34 31 26 19 15
  Estimated frequency
  4622.2073 3760.3691 3972.4365 3998.4038 3957.2888 3985.4202 3922.6655 3955.1248 4015.7156 3782.0085 3946.469 3914.0098 3996.24 3996.24 4134.733 3844.7632 3911.8457 3836.1074 3991.912 3965.9446
  L1 distance = 265449.712646484
  
```

GRR

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 8:24:05 PM - 8:24:09 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  2
  Enter value of k
  0
  Enter value of n
  20
  Results:
  Actual Freq {17=72, 18=105, 19=146, 20=169, 21=135, 22=153, 23=177, 24=151, 25=184, 26=159, 27=161, 28=161, 29=158, 30=175, 31=198, 32=164, 33=170, 34=178, 35=183, 36=148, 37=170, 38=150, 39=1
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.696729256
  q = 0.013098881
  n = 6512
  Estimated frequency:
  {17=224, 18=152, 19=152, 20=319, 21=319, 22=260, 23=80, 24=319, 25=0, 26=224, 27=92, 28=260, 29=236, 30=8, 31=200, 32=68, 33=80, 34=128, 35=164, 36=92, 37=104, 38=200, 39=128, 40=128, 41=164, ...
  L1 distance = 5906.0
  
```

Results



- $\epsilon = 2$ & $n=30\%$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1 Unary [Java Application] /Library/Java/JavaVirtualMachines/dk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 8:39:32 PM - 8:39:44 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  2
  Enter value of k
  0
  Enter value of n
  30
  Results:
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.7318586
  q = 0.2689413
  Actual freqency
  98 157 228 252 212 236 267 239 263 238 249 246 247 259 289 253 270 266 272 248 260 229 237 243 253 231 231 224 202 239 233 153 188 163 182 143 140 122 119 107 110 112 100 90 85 66 76 66 47 43
  Estimated freqency
  5792.321 5867.535 5861.5674 5982.749 5967.601 6000.0605 5915.6665 5898.3545 6004.388 5781.5015 5907.0107 5857.2397 6013.0444 6043.3394 6019.536 5863.7314 5870.223 6110.4224 5874.5513 5930.814
  L1 distance = 404245.8310546875

```

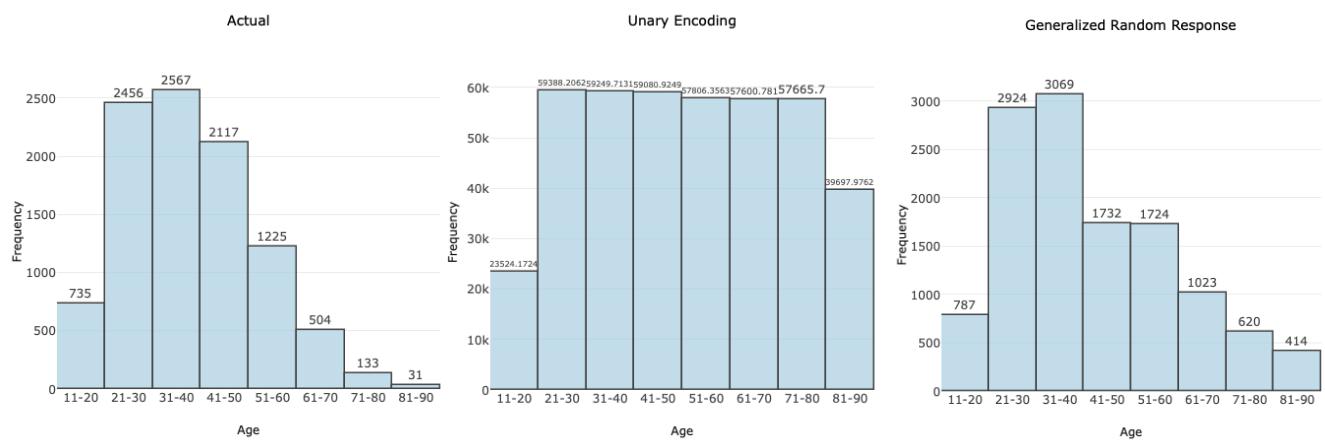
GRR

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/dk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 8:39:49 PM - 8:39:53 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  2
  Enter value of k
  0
  Enter value of n
  30
  Results:
  Actual Freq {17=98, 18=157, 19=228, 20=252, 21=212, 22=236, 23=267, 24=239, 25=263, 26=238, 27=249, 28=246, 29=247, 30=259, 31=289, 32=253, 33=270, 34=266, 35=272, 36=248, 37=260, 38=229, 39=2
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.89547935
  q = 0.0129217245
  n = 9768
  Estimated frequency:
  {17=9, 18=45, 19=288, 20=445, 21=833, 22=142, 23=215, 24=191, 25=336, 26=263, 27=384, 28=191, 29=21, 30=348, 31=445, 32=130, 33=348, 34=288, 35=433, 36=336, 37=263, 38=251, 39=263, 40=312, 41=
  L1 distance = 6155.0

```

Results



- $\epsilon = 2$ & $n=40\%$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_ue [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 8:50:39 PM - 8:50:45 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  2
  Enter value of k
  0
  Enter value of n
  40
  |
  Results:

  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.7318586
  q = 0.2689413

  Actual frequency
  148 218 286 327 271 315 348 329 348 312 340 350 343 342 360 318 360 342 366 341 360 317 329 316 321 304 306 293 288 309 301 215 249 235 241 197 174 157 159 147 144 141 130 118 111 85 100 86 71
  Estimated frequency
  7682.7 7975.75 7975.75 8025.521 7750.6987 7813.4536 8034.177 7867.5522 7737.715 8066.636 7869.7163 7960.602 8118.571 7787.486 7956.2744 7845.9126 8051.4883 7854.5684 7832.929 7776.666 7800.469
  L1 distance = 537431.4174884688

```

GRR

```

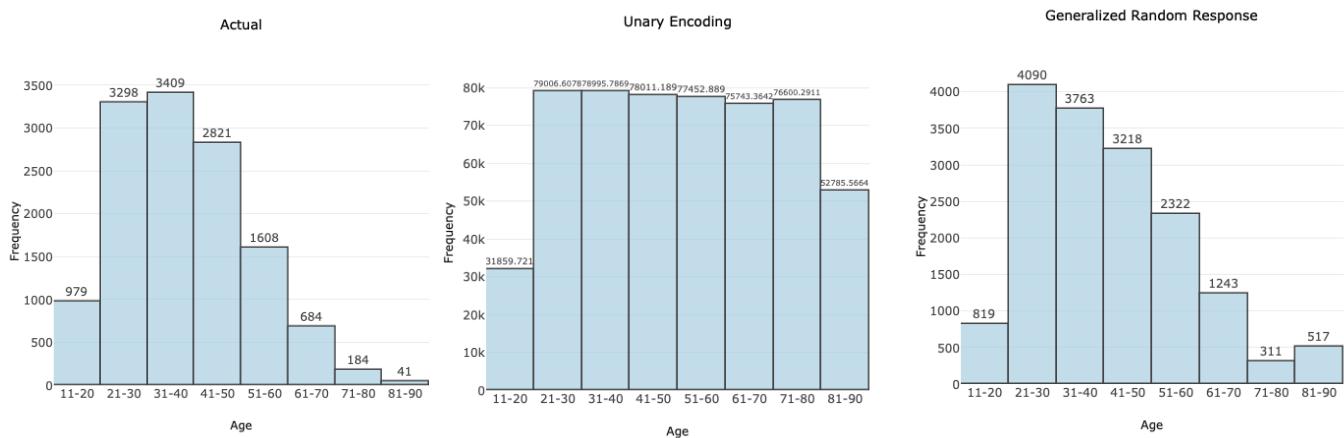
  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 8:50:49 PM - 8:50:54 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  2
  Enter value of k
  0
  Enter value of n
  40
  |
  Results:

  Actual Freq {17=148, 18=218, 19=286, 20=327, 21=271, 22=315, 23=348, 24=329, 25=348, 26=312, 27=340, 28=350, 29=343, 30=342, 31=360, 32=318, 33=360, 34=342, 35=366, 36=341, 37=360, 38=317, 39=
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.49547935
  q = 0.0129217245
  n = 13024

  Estimated frequency:
  {17=153, 18=93, 19=129, 20=444, 21=553, 22=214, 23=650, 24=529, 25=202, 26=456, 27=335, 28=856, 29=166, 30=129, 31=117, 32=141, 33=468, 34=468, 35=287, 36=585, 37=541, 38=456, 39=287, 40=493, ...
  L1 distance = 7770.0

```

Result



- $\epsilon = 2$ & $n=50\%$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_unary.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 9:10:12 PM - 9:10:16 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
50
Results:
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.7318586
q = 0.2689413
Actual frequency
182 266 357 404 343 396 440 415 430 372 422 439 413 431 451 409 442 435 443 435 443 408 419 404 391 379 384 360 360 367 371 280 300 292 300 239 223 205 199 186 189 185 165 147 138 116 125 105
Estimated frequency
9702.585 9828.094 9884.356 10029.342 9702.585 9949.275 10187.311 9862.718 9873.537 9854.062 9758.848 9893.013 10061.001 10087.769 10087.782 9942.783 9693.929 9882.193 9869.209 9968.751 9773.99
L1 distance = 673858.61132815

```

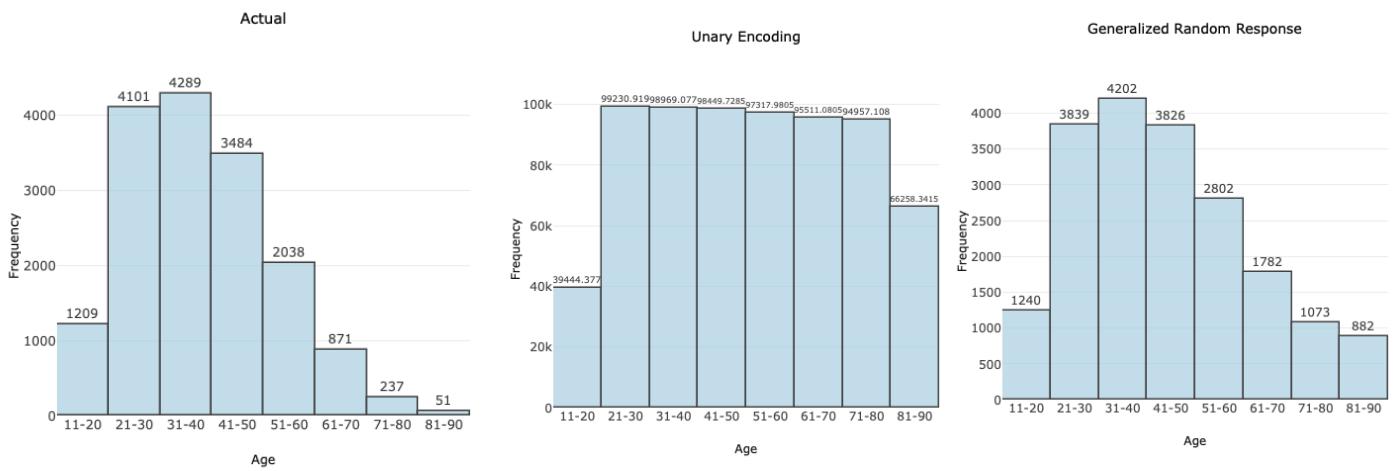
GRR

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (05-Nov-2020, 9:10:24 PM - 9:10:29 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
50
Results:
Actual Freq {17=182, 18=266, 19=357, 20=404, 21=343, 22=396, 23=440, 24=415, 25=430, 26=372, 27=422, 28=439, 29=413, 30=431, 31=451, 32=409, 33=442, 34=435, 35=443, 36=435, 37=443, 38=408, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.09247935
q = 0.0129217245
n = 16280
Estimated frequency:
{17=443, 18=201, 19=322, 20=274, 21=383, 22=189, 23=104, 24=395, 25=455, 26=383, 27=576, 28=504, 29=746, 30=104, 31=576, 32=298, 33=56, 34=322, 35=540, 36=589, 37=649, 38=540, 39=56, 40=576, 41=4202
L1 distance = 10658.0

```

Results



- $\epsilon = 2$ & $n=60\%$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_unary.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 2:07:21 PM - 2:07:26 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
60
|
Results:

D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.7318586
q = 0.2689413

Actual frequency
222 320 415 459 424 466 542 486 513 467 507 513 484 521 549 490 538 516 522 536 532 483 498 477 471 451 467 464 438 445 429 331 354 355 356 287 277 241 238 215 227 235 283 174 159 143 149 125
Estimated frequency
11481.3545 11557.893 12002.867 11992.048 11979.063 11855.719 11747.5205 11886.014 11818.931 11849.227 11881.686 11654.471 11974.735 11695.586 11855.719 11966.08 11823.259 11974.735 11896.833 1
L1 distance = 806752.0625

```

GRR

```

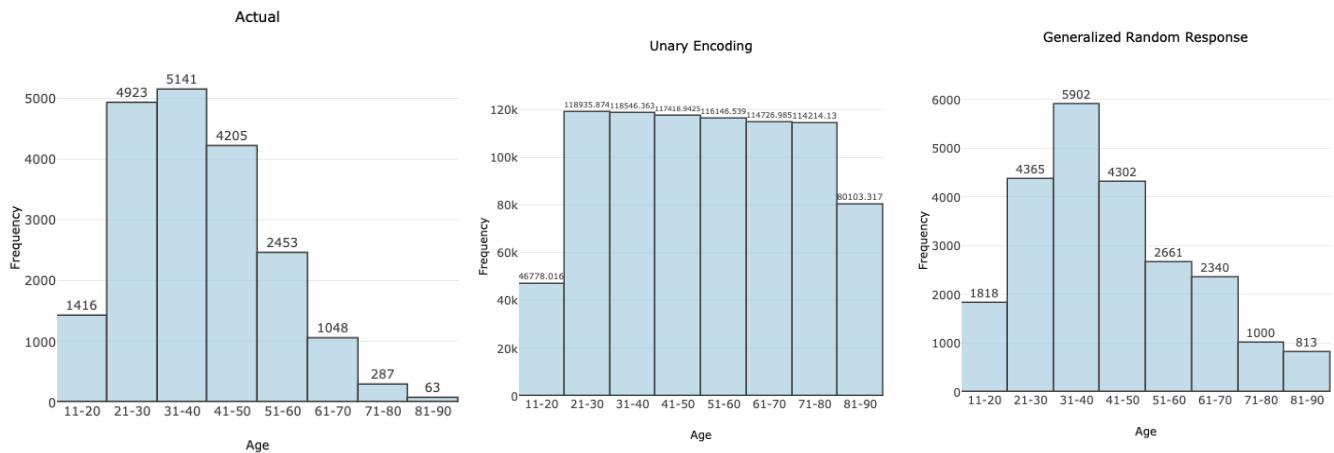
  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 12:21:04 PM - 12:21:08 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
60
|
Results:

Actual Freq {17~222, 18=320, 19=415, 20=459, 21=424, 22=466, 23=542, 24=486, 25=513, 26=467, 27=507, 28=513, 29=484, 30=521, 31=549, 32=490, 33=538, 34=516, 35=522, 36=536, 37=532, 38=483, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.69547935
q = 0.8129217245
n = 19536

Estimated frequency:
{17~224, 18=648, 19=588, 20=358, 21=249, 22=624, 23=249, 24=261, 25=576, 26=358, 27=527, 28=854, 29=479, 30=188, 31=576, 32=1000, 33=539, 34=515, 35=660, 36=963, 37=382, 38=697, 39=382, 40=188
L1 distance = 10761.0

```

Results



- $\epsilon = 2$ & $n=70\%$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_unary.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 2:09:47 PM - 2:09:55 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
70
|
Results:

D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.7318586
q = 0.2689413

Actual frequency
263 374 484 532 503 543 632 561 604 558 582 597 551 609 624 571 629 615 612 619 624 564 575 569 554 530 548 536 506 514 506 383 407 409 408 341 329 284 293 252 259 266 242 208 185 167 172 142
Estimated frequency
13556.586 13573.897 13677.768 13738.357 13580.39 14030.491 13632.324 13959.081 13930.949 13952.589 13766.489 13673.439 13779.473 13627.996 13913.638 13926.622 14004.524 13824.916 13965.573 138
L1 distance = 939833.783203125

```

GRR

```

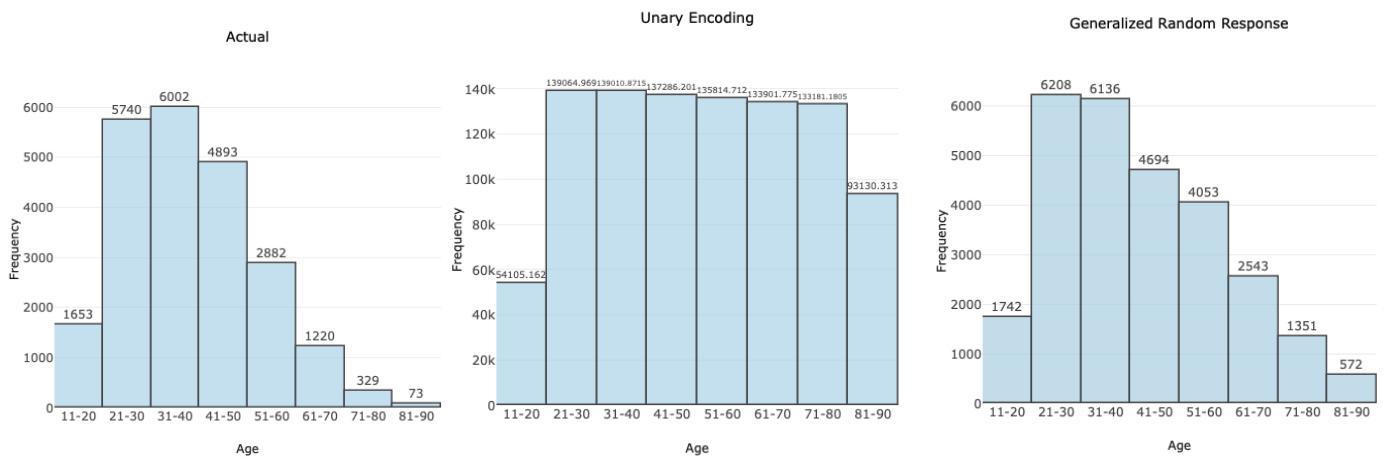
  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_generalizedrr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizedrr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 12:43:34 PM - 12:43:39 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
70
|
Results:

Actual Freq {17=263, 18=374, 19=484, 20=532, 21=503, 22=543, 23=632, 24=561, 25=604, 26=558, 27=582, 28=597, 29=551, 30=609, 31=624, 32=571, 33=629, 34=615, 35=612, 36=619, 37=624, 38=564, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.9547935
q = 0.0159217245
n = 22792

Estimated frequency:
{17=260, 18=587, 19=466, 20=429, 21=720, 22=429, 23=769, 24=599, 25=478, 26=720, 27=660, 28=1059, 29=151, 30=623, 31=938, 32=514, 33=672, 34=490, 35=914, 36=454, 37=466, 38=805, 39=526, 40=357
L1 distance = 10009.0

```

Results



- $\epsilon = 2$ & $n=80\%$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_unary.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 2:07:37 PM - 2:07:42 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  2
  Enter value of k
  0
  Enter value of n
  80
  Results:

  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.7310586
  q = 0.26894143

  Actual frquency
  310 427 574 612 575 609 708 639 678 626 660 682 651 689 720 661 700 688 697 697 711 643 659 653 638 611 625 594 585 592 579 437 461 473 465 388 382 326 329 301 294 309 283 242 212 200 192 161

  Estimated frequency
  15467.356 15763.818 15512.8 15424.077 15255.289 15828.736 15649.129 15722.783 15923.951 15579.882 15720.539 15761.654 15538.767 15759.49 16203.101 15668.6045 15651.293 15787.622 15904.476 1581
  L1 distance = 1091548.7216796875

```

GRR

```

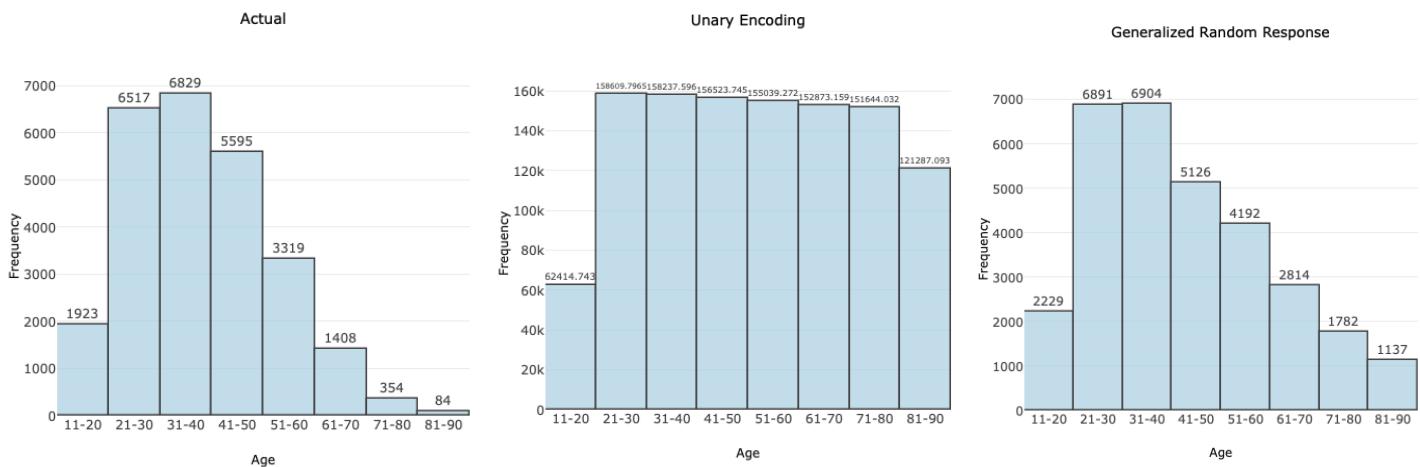
  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
  eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
  Console Problems Debug Shell History
  <terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 12:54:44 PM - 12:54:48 PM)
  Enter full path for the dataset file
  adult.data.txt
  Enter value of epsilon
  2
  Enter value of k
  0
  Enter value of n
  80
  Results:

  Actual Freq {17=310, 18=427, 19=574, 20=612, 21=575, 22=609, 23=708, 24=639, 25=678, 26=626, 27=660, 28=682, 29=651, 30=689, 31=720, 32=661, 33=700, 34=688, 35=697, 36=697, 37=711, 38=643, 39=
  D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
  p = 0.094261326
  q = 0.012756863
  n = 26048

  Estimated frequency:
  {17=462, 18=474, 19=892, 20=401, 21=695, 22=818, 23=511, 24=683, 25=904, 26=560, 27=879, 28=487, 29=867, 30=487, 31=609, 32=830, 33=364, 34=1076, 35=793, 36=524, 37=757, 38=769, 39=352, 40=830
  L1 distance = 130885.0

```

Results



- $\epsilon = 2$ & $n=90\%$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_unary.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 2:07:45 PM - 2:07:49 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
90
Results:

D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.7318586
q = 0.2689413

Actual frequency
354 476 658 682 642 674 795 722 766 711 753 780 726 779 805 749 784 786 793 802 781 747 742 721 724 698 694 653 648 664 641 489 519 533 528 430 423 373 372 331 321 335 325 275 259 228 213 183
Estimated frequency
17458.719 17267.242 17626.982 17789.28 17412.75 17659.441 17858.525 17888.822 17780.623 17607.506 17761.148 17754.656 17802.264 17685.408 18243.709 17871.51 17746.0 18167.97 18068.43 17906.133
L1 distance = 1227889.37109375

```

GRR

```

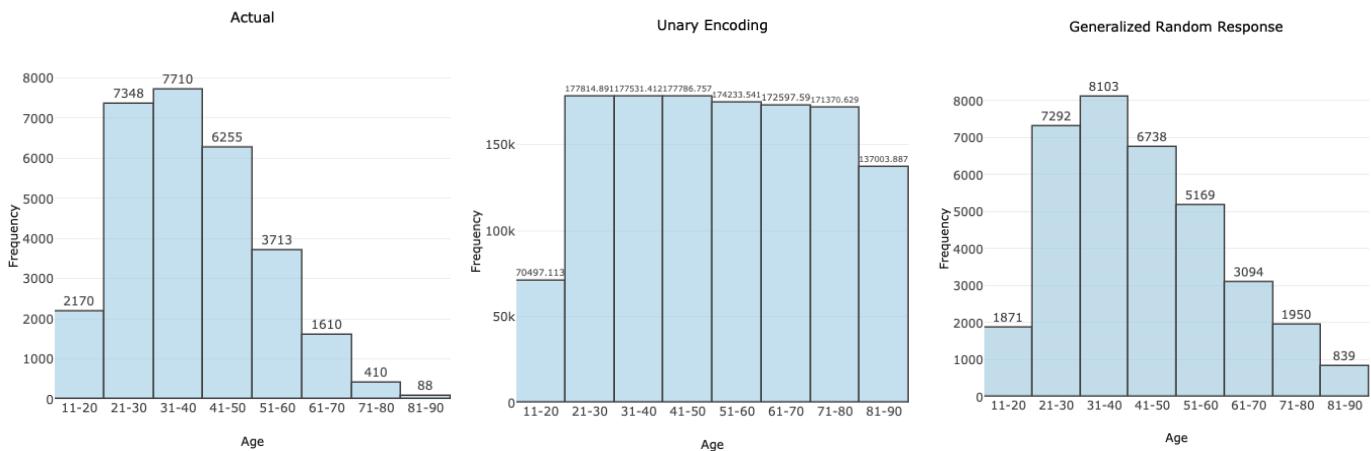
  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_generalizedrr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizedrr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 1:55:06 PM - 1:55:10 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
90
Results:

Actual Freq {17=354, 18=476, 19=658, 20=682, 21=642, 22=674, 23=795, 24=722, 25=766, 26=711, 27=753, 28=780, 29=726, 30=779, 31=805, 32=749, 33=784, 34=786, 35=793, 36=802, 37=781, 38=747, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.094261326
q = 0.01756883
n = 29304

Estimated frequency:
{17=38, 18=443, 19=640, 20=750, 21=578, 22=897, 23=934, 24=946, 25=959, 26=664, 27=910, 28=431, 29=517, 30=456, 31=775, 32=272, 33=1192, 34=1204, 35=738, 36=480, 37=750, 38=578, 39=1020, 40=10
L1 distance = 13509.0

```

Results



- $\epsilon = 2$ & $n=100\%$

UE

```

  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_unary.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/dk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 2:07:52 PM - 2:07:59 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
100
Results:
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.7310586
q = 0.2689413
Actual frequency
395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 788 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
Estimated frequency
19403.588 19268.768 19981.365 19810.412 19665.428 19775.79 20128.514 19812.576 19881.822 19784.445 19552.902 19403.588 19946.74 19899.135 19706.543 19905.625 20124.186 19877.494 19604.836 1979
L1 distance = 1384682.171875

```

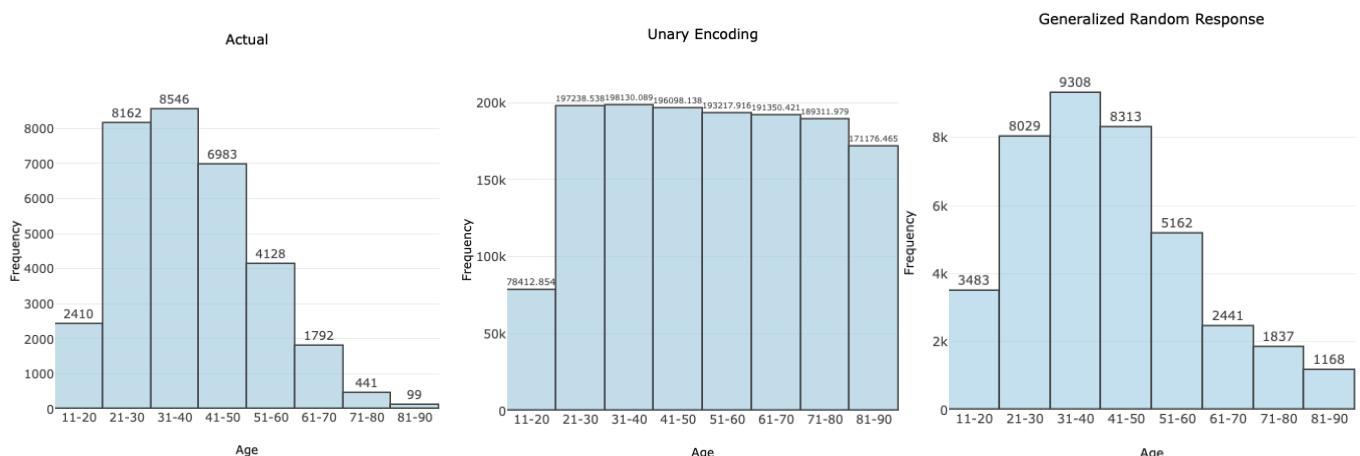
GRR

```

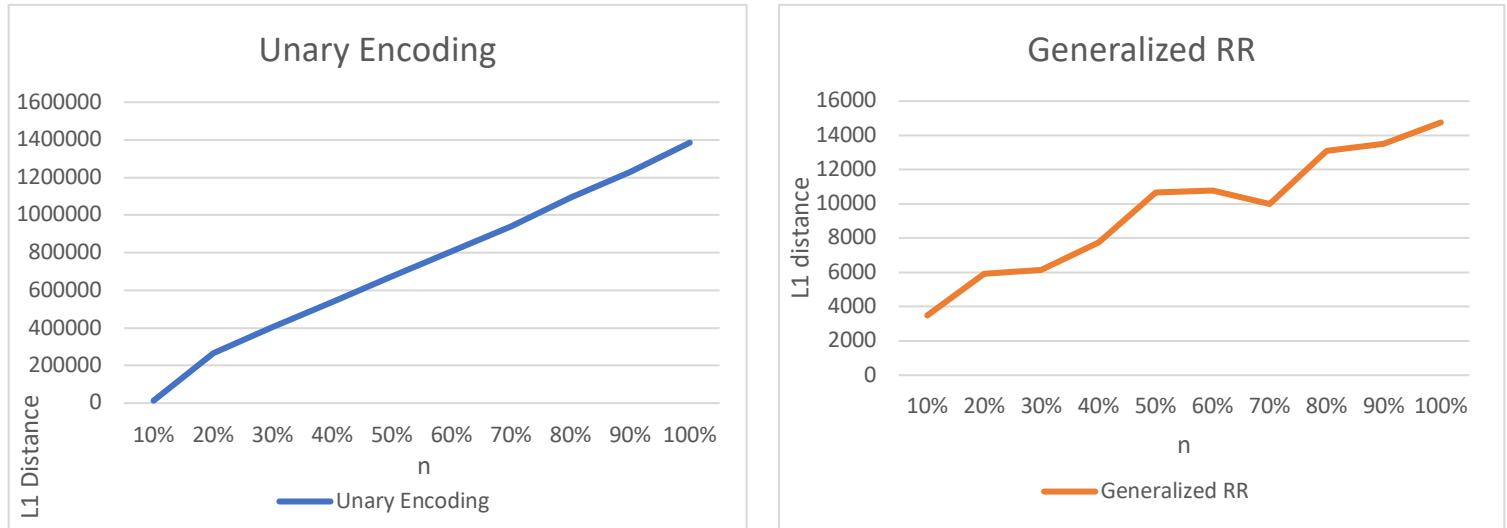
  Eclipse File Edit Source Refactor Navigate Search Project Run Window Help
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/dk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 2:04:53 PM - 2:04:58 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
0
Enter value of n
100
Results:
Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.89387394
q = 0.012596195
n = 32561
Estimated frequency:
{17=607, 18=1203, 19=805, 20=868, 21=756, 22=768, 23=954, 24=855, 25=383, 26=594, 27=308, 28=1228, 29=992, 30=1191, 31=743, 32=979, 33=1141, 34=756, 35=880, 36=1215, 37=656, 38=805, 39=1191, 4
L1 distance = 14753.0

```

Results



- Graph comparing the difference of L1 distance between unary encoding and generalized random response for $\epsilon = 2$ and n=10% to 100%



When n is small, the value of the items in the dataset is less. So, the value of p keeps on decreasing for generalized random response which affects the accuracy of the protocol.

For unary encoding the value of p remains constant throughout as it is not dependent on the size of the items in the dataset (d) and its accuracy is not affected.

Task 1(d) Compare the accuracy of the two protocols with top-k frequent age for fixed $\epsilon = 2$ and all the adults/users in the dataset.

k varies from 10% to 100% of all the distinct ages.

- $\epsilon = 2, n=100\% \text{ & } k=10\%$

UE

```
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:15:02 PM - 4:15:06 PM)
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:15:02 PM - 4:15:06 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
10
Enter value of n
100
Results:

D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.7310586
q = 0.26894143

Actual frquency
395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 780 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
Estimated frquency
19182.865 19423.864 19394.934 19723.854 19661.1 19643.787 19977.037 19825.56 19860.184 19576.705 19877.494 19799.592 19812.576 20076.578 19883.986 19944.576 19637.295 20165.3 19890.479 19795.2
Estimated Top-7 frequent age
34
38
43
23
32
41
35

L1 distance for top-7 frequent age = 30.0
```

GRR

```
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:15:50 PM - 4:15:54 PM)
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:15:50 PM - 4:15:54 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
10
Enter value of n
100
Results:

Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.093073994
q = 0.012596195
n = 3261

Estimated frequency:
{17=116, 18=495, 19=644, 20=855, 21=681, 22=942, 23=843, 24=1166, 25=1352, 26=930, 27=321, 28=1265, 29=1017, 30=855, 31=905, 32=607, 33=718, 34=930, 35=781, 36=1352, 37=507, 38=743, 39=1079, ...
Estimated Top-7 frequent age
25
36
43
28
50
24
17

L1 distance for top-7 frequent age = 65.0
```

- $\epsilon = 2$, $n=100\%$ & $k=20\%$

UE

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_ue [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:17:11 PM - 4:17:21 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
20
Enter value of n
100
|
Results:

D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.7318586
q = 0.2689413

Actual frquency
395 510 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 780 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
Estimated frquency
19546.574 19784.379 19397.098 20020.316 19494.475 19855.855 19762.805 19959.725 19619.984 19741.166 19632.969 19617.82 20031.135 19747.658 20035.463 19730.346 20065.758 19416.572 19905.625 199
Estimated Top-14 frequent age
33
31
29
28
24
37
36
35
42
47
22
44
45
39

L1 distance for top-14 frequent age = 99.0

```

GRR

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:17:26 PM - 4:17:30 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
20
Enter value of n
100
|
Results:

Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.093073994
q = 0.812596195
n = 32561

Estimated frequency:
{17=110, 18=520, 19=1128, 20=942, 21=1526, 22=1804, 23=793, 24=544, 25=669, 26=1166, 27=445, 28=905, 29=1004, 30=731, 31=781, 32=1817, 33=495, 34=1526, 35=830, 36=706, 37=594, 38=967, 39=582, 40=110, 41=110, 42=110, 43=110, 44=110, 45=110, 46=110, 47=110, 48=110, 49=110, 50=110, 51=110, 52=110, 53=110, 54=110, 55=110, 56=110, 57=110, 58=110, 59=110, 60=110, 61=110, 62=110, 63=110}

Estimated Top-14 frequent age
21
34
46
45
41
26
48
19
47
32
22
29
42
38

L1 distance for top-14 frequent age = 126.0

```

- $\epsilon = 2$, $n=100\%$ & $k=30\%$

UE

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Fri 6 Nov 4:18:39 PM Prajaka Rajhans

<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:18:33 PM - 4:18:38 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
30
Enter value of n
100
|
Results:

D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.7318586
q = 0.26894143

Actual frequency
395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 780 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
Estimated frequency
1913.62 1926.332 19907.79 19494.475 19557.229 20007.332 19700.05 19615.656 19570.213 19929.43 19771.46 19615.656 19736.838 19626.477 19687.066 20050.611 19706.543 19706.543 19706.543 19886.1
Estimated Top-21 frequent age
32
22
26
19
44
36
39
55
37
45
27
29
33
34
35
41
23
47
43
31
46

L1 distance for top-21 frequent age = 151.0

```

GRR

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Fri 6 Nov 4:18:50 PM Prajaka Rajhans

<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:18:44 PM - 4:18:48 PM)
Enter full path for the dataset file
adult.data.txt
Enter value of epsilon
2
Enter value of k
30
Enter value of n
100
|
Results:

Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.093073994
q = 0.012596195
n = 32561

Estimated frequency:
{17=476, 18=271, 19=1452, 20=644, 21=1141, 22=731, 23=428, 24=1029, 25=1066, 26=1017, 27=805, 28=855, 29=992, 30=992, 31=507, 32=768, 33=1017, 34=669, 35=1066, 36=1141, 37=1315, 38=1091, 39=63
Estimated Top-21 frequent age
19
41
37
21
36
38
25
35
45
24
26
33
29
30
54
51
43
53
28
48
27

L1 distance for top-21 frequent age = 166.0

```

- $\epsilon = 2$, $n=100\%$ & $k=40\%$

UE

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Fri 6 Nov 4:20:37 PM Prajaka Rajhans

<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:20:30 PM - 4:20:35 PM)
100

Results:

D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.7310586
q = 0.26894143

Actual frequency
395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 788 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
Estimated freqency
19310.54 19483.654 19407.916 19676.246 19695.723 19548.574 19981.365 19754.148 19814.74 19777.953 19500.967 19964.053 19654.607 19855.855 19927.266 19890.479 19777.953 19823.396 19596.18 19671

Estimated Top-29 frequent age
42
23
28
51
37
32
30
34
40
25
41
26
33
24
43
46
21
39
20
36
44
29
38
57
35
50
48
22
49

L1 distance for top-29 frequent age = 280.0

```

GRR

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Fri 6 Nov 4:40:09 PM Prajaka Rajhans

<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:40:01 PM - 4:40:06 PM)
100

Results:

Actual Freq {17=395, 18=550, 19=712, 20=753, 21=720, 22=765, 23=877, 24=798, 25=841, 26=785, 27=835, 28=867, 29=813, 30=861, 31=888, 32=828, 33=875, 34=886, 35=876, 36=898, 37=858, 38=827, 39=
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.093073994
q = 0.012596195
n = 32561

Estimated frequency:
{17=110, 18=756, 19=1017, 20=1041, 21=830, 22=221, 23=1029, 24=656, 25=793, 26=1054, 27=1625, 28=1166, 29=743, 30=1389, 31=1439, 32=1004, 33=1054, 34=1004, 35=681, 36=1004, 37=1253, 38=880, 39=19671

Estimated Top-29 frequent age
27
31
30
39
28
46
40
26
33
20
23
19
32
34
36
43
53
38
52
49
21
45
25
41
18
29
48
35

L1 distance for top-29 frequent age = 321.0

```

- $\epsilon = 2$, $n=100\%$ & $k=50\%$

UE

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:24:23 PM - 4:24:27 PM)
q = 0.26894143
Actual frquency
395 550 712 753 720 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 808 780 770 724 734 737 708 543 577 602 595 478 464 415 419 366 358 366 355 312 300 258 230 208
Estimated frquency
19611.328 19407.916 19702.215 20312.45 19957.56 19611.328 19829.887 19795.264 20256.186 19619.984 19851.527 19853.691 19641.623 19892.643 19749.822 19907.79 20087.398 19860.184 19868
Estimated Top-36 frequent age
20
25
34
21
33
37
45
31
36
35
28
27
23
42
39
24
32
19
38
41
47
44
29
30
57
26
40
17
22
46
52
43
50
60
55
18
L1 distance for top-36 frequent age = 372.0

```

GRR

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:24:31 PM - 4:24:37 PM)
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63,
p = 0.893073994
q = 0.812596195
n = 32261
Estimated frequency:
{17=967, 18=433, 19=855, 20=420, 21=805, 22=507, 23=669, 24=880, 25=1340, 26=582, 27=743, 28=930, 29=942, 30=644, 31=1538, 32=830, 33=1302, 34=868, 35=1091, 36=408, 37=979, 38=930, 39=731, 40=1797, 41=1020, 42=1200, 43=1100, 44=1000, 45=900, 46=800, 47=700, 48=600, 49=500, 50=400, 51=300, 52=200, 53=100, 54=50, 55=20, 56=10, 57=5, 58=2, 59=1}
Estimated Top-36 frequent age
31
25
42
35
49
44
50
37
17
29
45
28
38
24
34
19
32
21
40
27
39
52
41
48
23
47
30
66
26
64
54
43
22
51
L1 distance for top-36 frequent age = 430.0

```

- $\epsilon = 2$, n=100% & k=60%

UE

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Fri 6 Nov 4:22:17 PM Prajakta Rajhans

Console Problems Debug Shell History
<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:22:09 PM - 4:22:16 PM)

Estimated Top-43 frequent age
28
22
37
24
29
27
41
21
26
35
42
44
40
43
19
30
32
39
25
50
46
47
23
53
20
34
36
33
18
45
54
31
51
49
38
75
61
52
58
85
57
65
87

L1 distance for top-43 frequent age = 490.0

```

GRR

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Fri 6 Nov 4:22:45 PM Prajakta Rajhans

Console Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:22:37 PM - 4:22:43 PM)

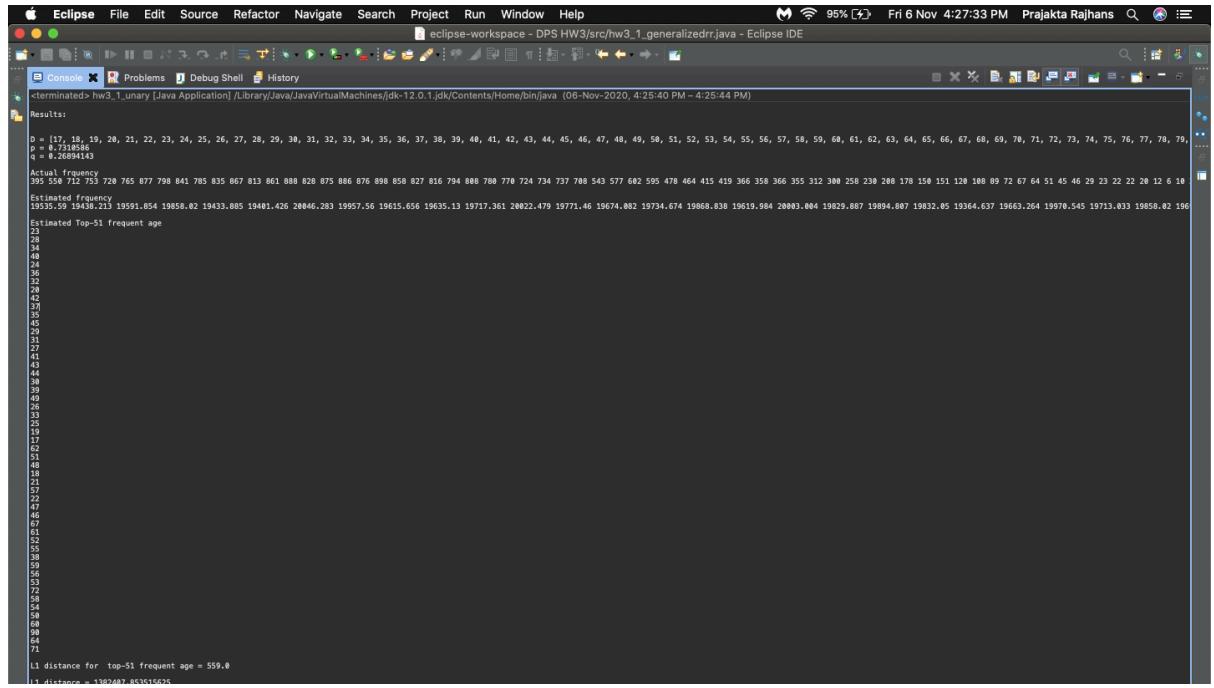
Estimated Top-43 frequent age
37
22
47
26
31
42
27
21
34
28
33
32
43
48
24
29
60
51
30
36
52
41
45
53
72
39
58
20
19
40
49
35
46
73
38
56
18
23
25
44
64
63
55

L1 distance for top-43 frequent age = 507.0

```

- $\epsilon = 2$, $n=100\%$ & $k=70\%$

UE

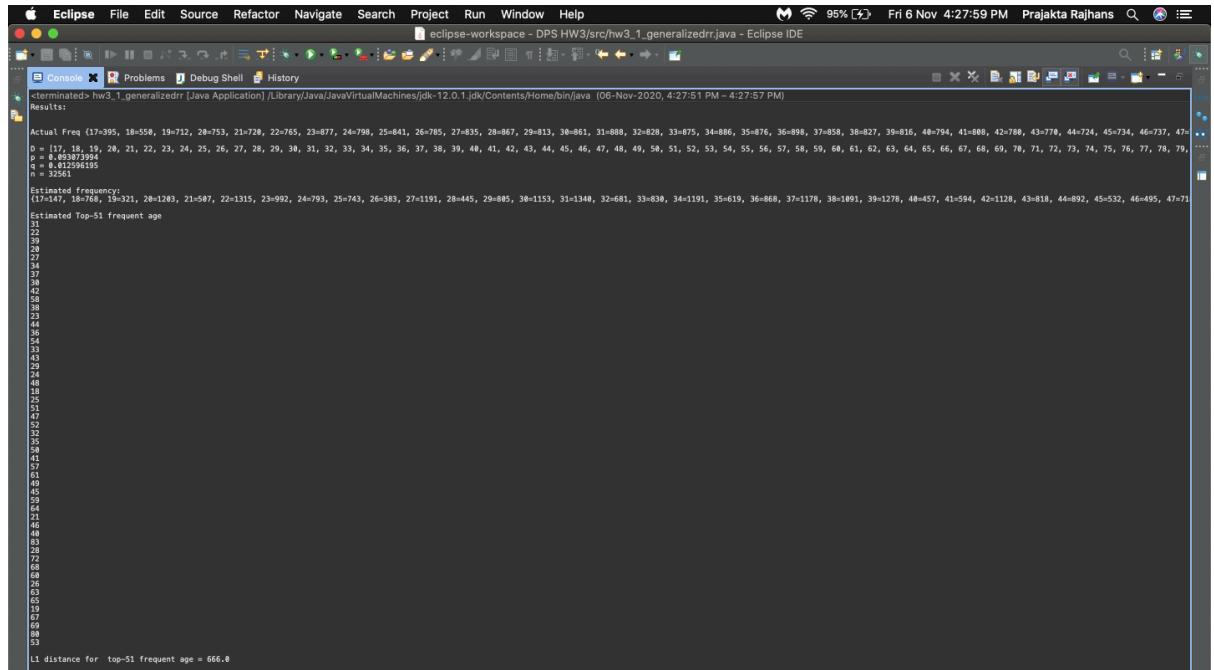


```

Eclipse - Console - Problems - Debug Shell - History
<terminated> hw3_1 Unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:25:40 PM - 4:25:44 PM)
Results:
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79,
p = 0.26894143
q = 0.26894143
Actual frequency
395 558 712 753 728 765 877 798 841 785 835 867 813 861 888 828 875 886 876 898 858 827 816 794 888 788 778 724 734 737 788 543 577 682 595 478 464 415 419 366 358 366 355 312 308 258 238 288 178 158 151 120 188 89 72 67 64 51 45 46 29 23 22 22 12 5 18
Estimated frequency
19355.59 19438.213 19591.854 19858.82 19433.885 19491.426 20846.283 19957.56 19615.656 19635.13 19717.361 20022.479 19771.46 19674.882 19734.674 19868.838 19619.984 20883.884 19829.887 19894.887 19832.85 19364.637 19663.264 19970.545 19713.033 19856.82 196
Estimated Top-51 frequent age
23
28
46
24
30
32
39
42
37]
53
45
29
31
27
43
44
38
39
40
26
33
25
19
17
62
51
48
18
21
57
22
47
46
19
61
53
55
38
50
56
53
72
54
58
68
98
71
L1 distance for top-51 frequent age = 559.0
L1 distance = 1392487.653516625.

```

GRR



```

Eclipse - Console - Problems - Debug Shell - History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:27:51 PM - 4:27:57 PM)
Results:
D = [17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79,
p = 0.893873994
q = 0.893873994
n = 32651
Estimated frequency:
17=547, 18=766, 19=321, 20=1283, 21=587, 22=1315, 23=992, 24=793, 25=743, 26=383, 27=1191, 28=445, 29=895, 30=1153, 31=1340, 32=681, 33=830, 34=1191, 35=619, 36=868, 37=1178, 38=1891, 39=1278, 40=457, 41=594, 42=1128, 43=818, 44=892, 45=532, 46=495, 47=71
Estimated Top-51 frequent age
11
22
39
23
27
34
37
38
42
58
39
23
44
54
33
43
29
24
48
38
25
51
41
52
32
35
34
45
57
15
49
45
64
21
46
48
83
28
72
68
68
26
63
19
69
88
53
L1 distance for top-51 frequent age = 666.0

```

- $\epsilon = 2$, n=100% & k=80%

UE

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
<terminated> hw3_1_unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:29:02 PM – 4:29:08 PM)
4 = 0.19521952
n = 32561
Estimated frequency:
36 542.852 19552.962 19754.148 19611.328 19563.72 19658.936 19710.871 19751.984 19667.592 19754.148 19799.592 19953.232 19667.592 19849.363 19652.443 19730.346 19880.248 19764.960 19938.086 20150.152 19780.117 19814.74 19933.758 19877.494 19684.982 19834.21
Estimated Top-58 frequent age
36
38
39
40
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
L1 distance for top-58 frequent age = 543.0

```

GRR

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:29:14 PM – 4:29:19 PM)
4 = 0.125965195
n = 32561
Estimated frequency:
15 718. 18=544, 19=594, 20=557, 21=731, 22=830, 23=1054, 24=781, 25=1153, 26=868, 27=694, 28=1290, 29=1141, 30=607, 31=992, 32=935, 33=992, 34=888, 35=930, 36=1283, 37=1817, 38=838, 39=938, 40=0, 41=917, 42=985, 43=868, 44=967, 45=1327, 46=756, 47=843, 48=1000
Estimated Top-58 frequent age
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
L1 distance for top-58 frequent age = 684.0

```

- $\epsilon = 2$, n=100% & k=90%

UE

```

<terminated> hw3_1.unary [Java Application] /Library/Java/JavaVirtualMachines/dk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:30:16 PM - 4:30:20 PM)
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Estimated Top-65 frequent age
13
38
31
35
36
21
32
38
40
47
39
20
28
34
45
44
48
37
49
33
41
27
19
53
54
52
29
22
24
18
57
68
43
49
17
24
42
52
33
68
88
55
63
55
53
72
58
64
65
71
62
59
51
88
88
69
79
82
73
77
88
78
85
74
L1 distance for top-65 frequent age = 654.0

```

GRR

```

<terminated> hw3_1.generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/dk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:30:27 PM - 4:30:32 PM)
eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Estimated Top-65 frequent age
28
42
41
24
43
39
32
33
38
21
23
23
31
39
66
37
46
29
45
45
22
44
27
38
38
34
32
18
74
33
48
33
65
71
47
52
53
26
49
55
54
68
86
58
64
68
17
48
59
70
76
62
69
72
53
81
17
75
73
85
88
61
77
L1 distance for top-65 frequent age = 677.0

```

- $\epsilon = 2$, n=100% & k=100%

UE

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1 Unary [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:31:19 PM - 4:31:24 PM)
Estimated Top-73 frequent age
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
L1 distance for top-73 frequent age = 712.0

```

GRR

```

eclipse-workspace - DPS HW3/src/hw3_1_generalizeddr.java - Eclipse IDE
Console Problems Debug Shell History
<terminated> hw3_1_generalizeddr [Java Application] /Library/Java/JavaVirtualMachines/jdk-12.0.1.jdk/Contents/Home/bin/java (06-Nov-2020, 4:32:40 PM - 4:32:46 PM)
t1mzv9, s8qjz9, 191161, 2epj93, 21h78d, 23h855, 24h942, 25h889, 26h967, 28h120, 29h119, 30h044, 31h929, 32h097, 34h104, 35h819, 36h135, 37h008, 38h164, 39h921, 41h922, 42h926, 43h825, 44h1229, 45h1054, 46h819, 47h009, 48h820, 49h924, 50h133, 51h118
Estimated Top-73 frequent age
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88
L1 distance for top-73 frequent age = 1078.0

```

- Graph comparing the difference of L1 distance between unary encoding and generalized random response for $\epsilon = 2$, n=100% & k=10% to 100% of distinct ages



There is not much difference between the L1 distance of unary encoding and generalized random response, but the L1 distance of unary encoding is slightly less when compared to generalized random response.

So, we can state that unary encoding estimates the top-k frequent age a little more accurately as compared to generalized random response.