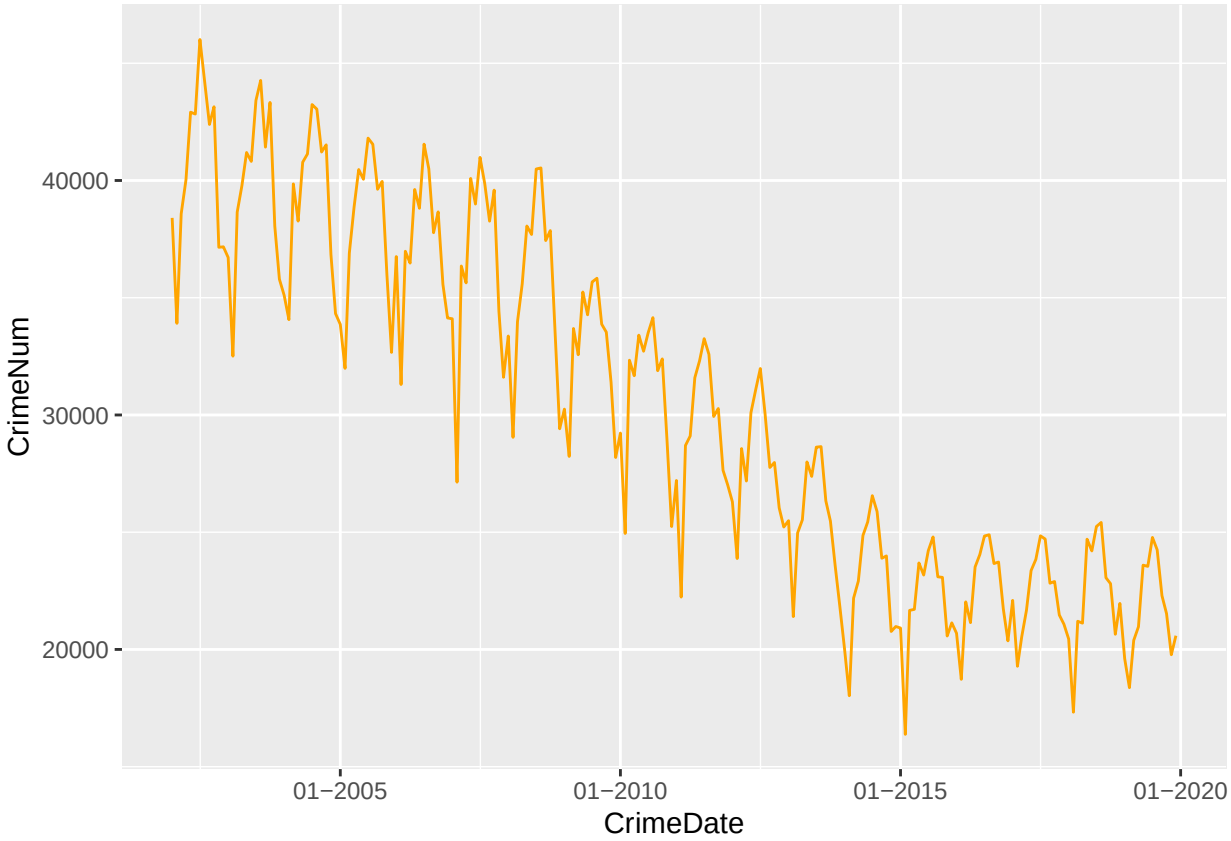
Assignment 3

Ziyuan Wang

Exercise 2



This is part of the panel data.

```
##         month district period tot_crime violent property p50_inc p_black p_hisp
## 1  2002-01-01        1      1      1476     242      859      NA      NA     NA
## 2  2002-01-01        2      1      1610     537      642      NA      NA     NA
## 3  2002-01-01        3      1      1908     673      711      NA      NA     NA
## 4  2002-01-01        4      1      2044     674      893      NA      NA     NA
## 5  2002-01-01        5      1      1664     605      590      NA      NA     NA
## 6  2002-01-01        6      1      1989     624      950      NA      NA     NA
## 7  2002-01-01        7      1      2247     870      767      NA      NA     NA
## 8  2002-01-01        8      1      2387     616     1323      NA      NA     NA
## 9  2002-01-01        9      1      1900     507      867      NA      NA     NA
## 10 2002-01-01       10      1      1532     488      611      NA      NA     NA
##    p_white
## 1       NA
## 2       NA
```

```
## 3       NA
## 4       NA
## 5       NA
## 6       NA
## 7       NA
## 8       NA
## 9       NA
## 10      NA
```

Exercise 3

```
##
## Call:
## lm(formula = arrest ~ tenure + tot_crime + p50_inc + p_black +
##     p_hisp + p_white, data = paneldata)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5017 -0.4993 -0.4981  0.5008  5.5025
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  5.067e-01  1.278e-02  39.644   <2e-16 ***
## tenure      -4.161e-06  8.354e-06  -0.498    0.618
## tot_crime    2.229e-07  1.805e-06   0.124    0.902
## p50_inc      1.618e-08  9.186e-08   0.176    0.860
## p_black     -8.102e-03  1.340e-02  -0.604    0.546
## p_hisp      -5.363e-03  1.391e-02  -0.385    0.700
## p_white     -1.207e-02  1.632e-02  -0.740    0.460
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.7068 on 1077898 degrees of freedom
##   (4 observations deleted due to missingness)
## Multiple R-squared:  2.032e-06,  Adjusted R-squared:  -3.535e-06
## F-statistic: 0.365 on 6 and 1077898 DF,  p-value: 0.9014
```

The coefficients are shown above, where β:tenure; γ:tot_crime,p50_inc, p_black,p_hisp,p_white.

Exercise 4

```
##
## Call:
## lm(formula = arrest ~ tenure + tot_crime + p50_inc + p_black +
##     p_hisp + p_white + factor(district) + factor(period), data = paneldata)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.5282 -0.5003 -0.4920  0.5008  5.5163
##
## Coefficients:
##                      Estimate Std. Error t value Pr(>|t|)
## (Intercept)         6.362e-01  1.061e-01   5.996 2.03e-09 ***
## tenure             -3.810e-06  8.525e-06  -0.447   0.6549
## tot_crime          -6.320e-06  5.305e-06  -1.191   0.2335
```

```
## p50_inc            -4.910e-07  6.505e-07  -0.755   0.4504
## p_black            -9.201e-02  1.043e-01  -0.882   0.3775
## p_hisp             -1.398e-01  2.028e-01  -0.690   0.4904
## p_white            -1.013e-01  1.818e-01  -0.557   0.5773
## factor(district)2  -2.438e-02  1.901e-02  -1.282   0.1998
## factor(district)3  -2.001e-02  2.128e-02  -0.940   0.3471
## factor(district)4  -3.633e-05  3.221e-02  -0.001   0.9991
## factor(district)5  -1.580e-02  2.106e-02  -0.750   0.4531
## factor(district)6  -1.386e-02  2.275e-02  -0.609   0.5424
## factor(district)7  -2.109e-02  2.271e-02  -0.928   0.3532
## factor(district)8   2.343e-02  6.598e-02   0.355   0.7226
## factor(district)9   3.110e-03  6.192e-02   0.050   0.9599
## factor(district)10  7.682e-03  6.920e-02   0.111   0.9116
## factor(district)11 -1.134e-02  2.276e-02  -0.498   0.6185
## factor(district)12  4.412e-04  4.463e-02   0.010   0.9921
## factor(district)13 -3.064e-03  4.251e-02  -0.072   0.9425
## factor(district)14  2.441e-02  5.880e-02   0.415   0.6781
## factor(district)15 -2.027e-02  2.122e-02  -0.956   0.3393
## factor(district)16  7.288e-03  5.178e-02   0.141   0.8881
## factor(district)17  1.080e-03  4.859e-02   0.022   0.9823
## factor(district)18  4.017e-03  2.594e-02   0.155   0.8770
## factor(district)19  8.935e-03  3.625e-02   0.247   0.8053
## factor(district)20 -1.545e-02  3.378e-02  -0.457   0.6475
## factor(district)21 -3.672e-02  2.291e-02  -1.603   0.1090
## factor(district)22 -6.345e-04  1.390e-02  -0.046   0.9636
## factor(district)23 -1.097e-02  4.180e-02  -0.262   0.7929
## factor(district)24 -1.540e-02  3.085e-02  -0.499   0.6177
## factor(district)25  2.203e-02  7.539e-02   0.292   0.7702
## factor(period)62    2.747e-03  1.112e-02   0.247   0.8049
## factor(period)63    5.425e-03  1.098e-02   0.494   0.6213
## factor(period)64   -4.433e-03  1.100e-02  -0.403   0.6868
## factor(period)65    9.642e-03  1.105e-02   0.872   0.3830
## factor(period)66   -1.518e-02  1.100e-02  -1.380   0.1675
## factor(period)67   -2.476e-03  1.107e-02  -0.224   0.8230
## factor(period)68   -9.283e-03  1.101e-02  -0.843   0.3992
## factor(period)69    2.832e-03  1.096e-02   0.258   0.7962
## factor(period)70    5.532e-03  1.098e-02   0.504   0.6145
## factor(period)71    3.270e-03  1.088e-02   0.300   0.7638
## factor(period)72   -8.522e-03  1.089e-02  -0.783   0.4339
## factor(period)73   -1.580e-02  1.090e-02  -1.450   0.1470
## factor(period)74   -7.936e-03  1.096e-02  -0.724   0.4691
## factor(period)75   -7.042e-03  1.090e-02  -0.646   0.5182
## factor(period)76    7.880e-03  1.089e-02   0.723   0.4695
## factor(period)77    1.890e-02  1.091e-02   1.732   0.0833 .
## factor(period)78    1.043e-03  1.088e-02   0.096   0.9237
## factor(period)79   -1.992e-05  1.092e-02  -0.002   0.9985
## factor(period)80    1.040e-03  1.093e-02   0.095   0.9242
## factor(period)81    9.368e-03  1.086e-02   0.863   0.3882
## factor(period)82   -3.356e-03  1.085e-02  -0.309   0.7571
## factor(period)83   -1.542e-03  1.083e-02  -0.142   0.8868
## factor(period)84    1.093e-02  1.088e-02   1.005   0.3149
## factor(period)85   -6.007e-03  1.086e-02  -0.553   0.5801
## factor(period)86   -5.783e-03  1.092e-02  -0.530   0.5964
## factor(period)87   -8.894e-03  1.085e-02  -0.820   0.4124
```

```
## factor(period)88   -4.911e-03  1.087e-02  -0.452   0.6515
## factor(period)89   -1.545e-03  1.086e-02  -0.142   0.8869
## factor(period)90    4.206e-03  1.086e-02   0.387   0.6986
## factor(period)91    5.471e-03  1.087e-02   0.503   0.6147
## factor(period)92   -4.667e-03  1.087e-02  -0.429   0.6678
## factor(period)93   -4.795e-03  1.087e-02  -0.441   0.6592
## factor(period)94   -1.586e-03  1.087e-02  -0.146   0.8840
## factor(period)95   -5.210e-03  1.088e-02  -0.479   0.6322
## factor(period)96   -9.886e-03  1.095e-02  -0.902   0.3668
## factor(period)97    1.815e-03  1.094e-02   0.166   0.8682
## factor(period)98    3.620e-03  1.116e-02   0.324   0.7457
## factor(period)99   -8.878e-03  1.099e-02  -0.808   0.4192
## factor(period)100   7.082e-03  1.100e-02   0.644   0.5198
## factor(period)101  -3.414e-03  1.101e-02  -0.310   0.7565
## factor(period)102  -5.868e-03  1.102e-02  -0.532   0.5944
## factor(period)103  -1.353e-02  1.102e-02  -1.228   0.2196
## factor(period)104   9.875e-03  1.103e-02   0.895   0.3708
## factor(period)105   2.215e-03  1.103e-02   0.201   0.8408
## factor(period)106  -2.548e-03  1.103e-02  -0.231   0.8172
## factor(period)107  -9.175e-03  1.110e-02  -0.827   0.4084
## factor(period)108  -4.759e-03  1.122e-02  -0.424   0.6715
## factor(period)109  -8.207e-03  1.119e-02  -0.733   0.4633
## factor(period)110  -5.389e-03  1.145e-02  -0.471   0.6378
## factor(period)111  -4.549e-03  1.121e-02  -0.406   0.6849
## factor(period)112  -1.189e-03  1.120e-02  -0.106   0.9154
## factor(period)113  -5.307e-04  1.117e-02  -0.048   0.9621
## factor(period)114   1.207e-04  1.115e-02   0.011   0.9914
## factor(period)115   4.004e-03  1.113e-02   0.360   0.7191
## factor(period)116  -1.043e-04  1.114e-02  -0.009   0.9925
## factor(period)117  -1.135e-02  1.101e-02  -1.031   0.3027
## factor(period)118   1.049e-02  1.100e-02   0.954   0.3399
## factor(period)119  -6.974e-03  1.106e-02  -0.631   0.5283
## factor(period)120   2.879e-04  1.109e-02   0.026   0.9793
## factor(period)121  -1.045e-02  1.113e-02  -0.939   0.3477
## factor(period)122   2.973e-03  1.121e-02   0.265   0.7909
## factor(period)123   1.820e-03  1.105e-02   0.165   0.8692
## factor(period)124   4.576e-03  1.114e-02   0.411   0.6812
## factor(period)125   4.361e-03  1.107e-02   0.394   0.6936
## factor(period)126  -2.065e-03  1.107e-02  -0.187   0.8520
## factor(period)127   6.781e-04  1.107e-02   0.061   0.9512
## factor(period)128  -5.126e-03  1.111e-02  -0.461   0.6445
## factor(period)129   2.322e-03  1.117e-02   0.208   0.8353
## factor(period)130  -1.458e-02  1.117e-02  -1.305   0.1919
## factor(period)131   3.463e-03  1.125e-02   0.308   0.7582
## factor(period)132  -1.687e-02  1.130e-02  -1.494   0.1352
## factor(period)133   3.795e-03  1.131e-02   0.335   0.7373
## factor(period)134  -8.078e-03  1.156e-02  -0.699   0.4847
## factor(period)135  -1.585e-02  1.137e-02  -1.395   0.1631
## factor(period)136   3.512e-03  1.133e-02   0.310   0.7565
## factor(period)137   1.411e-02  1.123e-02   1.257   0.2088
## factor(period)138   7.059e-03  1.125e-02   0.628   0.5303
## factor(period)139   1.753e-02  1.122e-02   1.563   0.1180
## factor(period)140  -2.732e-03  1.122e-02  -0.244   0.8076
## factor(period)141   3.037e-03  1.130e-02   0.269   0.7882
```

```
## factor(period)142  -8.699e-03  1.134e-02  -0.767   0.4430
## factor(period)143  -5.810e-03  1.144e-02  -0.508   0.6117
## factor(period)144   3.319e-03  1.155e-02   0.287   0.7738
## factor(period)145  -1.496e-02  1.171e-02  -1.278   0.2011
## factor(period)146   2.499e-03  1.186e-02   0.211   0.8331
## factor(period)147  -4.441e-03  1.155e-02  -0.385   0.7005
## factor(period)148  -1.862e-02  1.148e-02  -1.622   0.1049
## factor(period)149  -5.901e-03  1.137e-02  -0.519   0.6038
## factor(period)150  -1.761e-03  1.130e-02  -0.156   0.8762
## factor(period)151   5.575e-03  1.126e-02   0.495   0.6206
## factor(period)152  -1.113e-03  1.130e-02  -0.098   0.9215
## factor(period)153   1.055e-03  1.134e-02   0.093   0.9259
## factor(period)154  -1.730e-03  1.133e-02  -0.153   0.8787
## factor(period)155  -8.539e-03  1.154e-02  -0.740   0.4591
## factor(period)156  -7.021e-03  1.153e-02  -0.609   0.5427
## factor(period)157  -4.922e-03  1.157e-02  -0.425   0.6705
## factor(period)158  -9.308e-03  1.196e-02  -0.778   0.4363
## factor(period)159   4.154e-03  1.153e-02   0.360   0.7187
## factor(period)160  -3.524e-03  1.156e-02  -0.305   0.7604
## factor(period)161  -6.722e-03  1.142e-02  -0.589   0.5561
## factor(period)162  -7.111e-03  1.143e-02  -0.622   0.5340
## factor(period)163  -8.631e-03  1.138e-02  -0.758   0.4483
## factor(period)164  -5.341e-03  1.136e-02  -0.470   0.6383
## factor(period)165  -1.012e-03  1.147e-02  -0.088   0.9297
## factor(period)166  -8.335e-03  1.147e-02  -0.727   0.4673
## factor(period)167   2.320e-03  1.162e-02   0.200   0.8418
## factor(period)168  -7.373e-03  1.161e-02  -0.635   0.5253
## factor(period)169  -5.344e-03  1.166e-02  -0.458   0.6467
## factor(period)170  -7.099e-03  1.180e-02  -0.601   0.5476
## factor(period)171  -1.453e-02  1.155e-02  -1.258   0.2084
## factor(period)172   9.818e-03  1.160e-02   0.846   0.3973
## factor(period)173   9.858e-03  1.145e-02   0.861   0.3891
## factor(period)174  -5.147e-03  1.141e-02  -0.451   0.6520
## factor(period)175  -1.082e-02  1.138e-02  -0.951   0.3417
## factor(period)176  -1.921e-02  1.134e-02  -1.694   0.0903 .
## factor(period)177  -1.542e-03  1.141e-02  -0.135   0.8925
## factor(period)178   3.118e-03  1.141e-02   0.273   0.7847
## factor(period)179  -1.398e-02  1.155e-02  -1.210   0.2261
## factor(period)180  -1.290e-02  1.163e-02  -1.109   0.2673
## factor(period)181   8.784e-05  1.159e-02   0.008   0.9940
## factor(period)182  -5.838e-03  1.179e-02  -0.495   0.6205
## factor(period)183   6.054e-03  1.171e-02   0.517   0.6050
## factor(period)184  -5.738e-03  1.164e-02  -0.493   0.6222
## factor(period)185   8.410e-03  1.154e-02   0.729   0.4660
## factor(period)186  -1.219e-02  1.151e-02  -1.059   0.2894
## factor(period)187  -6.123e-03  1.146e-02  -0.534   0.5930
## factor(period)188  -2.664e-03  1.148e-02  -0.232   0.8165
## factor(period)189  -8.493e-03  1.157e-02  -0.734   0.4628
## factor(period)190  -9.683e-03  1.155e-02  -0.839   0.4017
## factor(period)191  -1.685e-02  1.166e-02  -1.444   0.1486
## factor(period)192  -8.924e-03  1.166e-02  -0.765   0.4442
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 0.7068 on 1077743 degrees of freedom
##   (4 observations deleted due to missingness)
## Multiple R-squared:  0.0001208,  Adjusted R-squared:  -2.854e-05
## F-statistic: 0.8089 on 161 and 1077743 DF,  p-value: 0.964
```

The coefficients are shown above, where β:tenure; γ:tot_crime,p50_inc, p_black,p_hisp,p_white; φ:factor(district)2~25; κ:factor(period)62~192.

Exercise 5

5-1: Within Estimator

```
##
## Call:
## lm(formula = WE_A ~ WE_tau, data = WE_data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -1.9884 -0.5082 -0.4077  0.4887  5.5079
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 2.399e-03  4.583e-03   0.523    0.601
## WE_tau      1.490e-05  2.815e-05   0.529    0.597
##
## Residual standard error: 0.6997 on 1077907 degrees of freedom
## Multiple R-squared:  2.597e-07,  Adjusted R-squared:  -6.681e-07
## F-statistic: 0.2799 on 1 and 1077907 DF,  p-value: 0.5968
```

5-2: Between Estimator

```
##
## Call:
## lm(formula = A_i_bar ~ tau_i_bar, data = BE_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.50032 -0.04997  0.00028  0.04633  2.49982
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  5.003e-01  1.747e-04 2864.59  < 2e-16 ***
## tau_i_bar   -7.792e-06  9.753e-07   -7.99 1.35e-15 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.07831 on 1077907 degrees of freedom
## Multiple R-squared:  5.922e-05,  Adjusted R-squared:  5.829e-05
## F-statistic: 63.84 on 1 and 1077907 DF,  p-value: 1.352e-15
```

5-3: First Difference Estimator

```
##
## Call:
## lm(formula = ITdiff_arrest ~ ITdiff_tenure, data = FD_data)
##
## Residuals:
##    Min     1Q Median     3Q    Max
##     -8     -1      0      1      8
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    3.823e-05  1.384e-03   0.028    0.978
## ITdiff_tenure -8.613e-05  8.816e-04  -0.098    0.922
##
## Residual standard error: 1.415 on 1046618 degrees of freedom
##   (31287 observations deleted due to missingness)
## Multiple R-squared:  9.119e-09,  Adjusted R-squared:  -9.463e-07
## F-statistic: 0.009544 on 1 and 1046618 DF,  p-value: 0.9222
```

β_{WE}=1.490e-05; β_{BE}=-7.792e-06; β_{FD}=-8.613e-05. Comparison: Between estimator and First difference estimator have the same negative sign, which indicate that the longer tenure the lower probability of arrest, and are consistent with the result in exercise 4. Regarding the magnitude, the between estimator is the closest one to both exercise 3 and 4. But the Within estimator has a positive sign, which is inconsistent with other estimations.

5-4: GMM approach

```
##                    [,1]
## cons       6.361725e-01
## tenure    -3.809782e-06
## tot_crime -6.320360e-06
## p50_inc   -4.910055e-07
## p_black   -9.200883e-02
## p_hisp    -1.398480e-01
## p_white   -1.012976e-01
## J2        -2.437791e-02
## J3        -2.001211e-02
## J4        -3.632792e-05
## J5        -1.580178e-02
## J6        -1.385754e-02
## J7        -2.108532e-02
## J8         2.342640e-02
## J9         3.109577e-03
## J10        7.681503e-03
## J11       -1.133599e-02
## J12        4.412437e-04
## J13       -3.063905e-03
## J14        2.440896e-02
## J15       -2.027398e-02
## J16        7.288093e-03
## J17        1.080353e-03
## J18        4.016512e-03
## J19        8.935392e-03
## J20       -1.544846e-02
## J21       -3.671653e-02
```

```
## J22       -6.345301e-04
## J23       -1.097174e-02
## J24       -1.539638e-02
## J25        2.202628e-02
## T2         2.746517e-03
## T3         5.425086e-03
## T4        -4.433449e-03
## T5         9.642377e-03
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## T8        -9.283480e-03
## T9         2.831905e-03
## T10        5.531776e-03
## T11        3.270094e-03
## T12       -8.522393e-03
## T13       -1.580319e-02
## T14       -7.935551e-03
## T15       -7.042028e-03
## T16        7.880029e-03
## T17        1.889847e-02
## T18        1.042877e-03
## T19       -1.992463e-05
## T20        1.040177e-03
## T21        9.368277e-03
## T22       -3.356443e-03
## T23       -1.541507e-03
## T24        1.093272e-02
## T25       -6.007364e-03
## T26       -5.783149e-03
## T27       -8.894307e-03
## T28       -4.911125e-03
## T29       -1.544614e-03
## T30        4.205706e-03
## T31        5.471119e-03
## T32       -4.666546e-03
## T33       -4.795034e-03
## T34       -1.586495e-03
## T35       -5.210196e-03
## T36       -9.885677e-03
## T37        1.814697e-03
## T38        3.619692e-03
## T39       -8.878372e-03
## T40        7.082318e-03
## T41       -3.414388e-03
## T42       -5.868300e-03
## T43       -1.353438e-02
## T44        9.875346e-03
## T45        2.215222e-03
## T46       -2.548071e-03
## T47       -9.174658e-03
## T48       -4.759482e-03
## T49       -8.207417e-03
## T50       -5.389484e-03
## T51       -4.548749e-03
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## T52       -1.189441e-03
## T53       -5.307481e-04
## T54        1.206606e-04
## T55        4.004173e-03
## T56       -1.042689e-04
## T57       -1.134552e-02
## T58        1.049381e-02
## T59       -6.974074e-03
## T60        2.879175e-04
## T61       -1.044974e-02
## T62        2.973167e-03
## T63        1.819509e-03
## T64        4.576250e-03
## T65        4.361146e-03
## T66       -2.065034e-03
## T67        6.780647e-04
## T68       -5.126210e-03
## T69        2.322100e-03
## T70       -1.457656e-02
## T71        3.462557e-03
## T72       -1.687488e-02
## T73        3.795055e-03
## T74       -8.077931e-03
## T75       -1.585271e-02
## T76        3.512273e-03
## T77        1.410776e-02
## T78        7.059393e-03
## T79        1.753106e-02
## T80       -2.731977e-03
## T81        3.036804e-03
## T82       -8.699381e-03
## T83       -5.810358e-03
## T84        3.319051e-03
## T85       -1.496478e-02
## T86        2.499075e-03
## T87       -4.441004e-03
## T88       -1.862457e-02
## T89       -5.901253e-03
## T90       -1.760679e-03
## T91        5.574852e-03
## T92       -1.112962e-03
## T93        1.054709e-03
## T94       -1.729819e-03
## T95       -8.539207e-03
## T96       -7.021181e-03
## T97       -4.922362e-03
## T98       -9.307792e-03
## T99        4.154443e-03
## T100      -3.524368e-03
## T101      -6.722439e-03
## T102      -7.111330e-03
## T103      -8.631208e-03
## T104      -5.340895e-03
## T105      -1.012199e-03
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## T107       2.320336e-03
## T108      -7.372761e-03
## T109      -5.343684e-03
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## T111      -1.453481e-02
## T112       9.817929e-03
## T113       9.858467e-03
## T114      -5.146654e-03
## T115      -1.082352e-02
## T116      -1.921383e-02
## T117      -1.541889e-03
## T118       3.117914e-03
## T119      -1.397966e-02
## T120      -1.289825e-02
## T121       8.783616e-05
## T122      -5.838321e-03
## T123       6.054365e-03
## T124      -5.737714e-03
## T125       8.409860e-03
## T126      -1.219203e-02
## T127      -6.123435e-03
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## T131      -1.684569e-02
## T132      -8.924383e-03
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