mixed_models

```r
library(lmerTest) #lmer
```

```
## Loading required package: lme4
```

```
## Loading required package: Matrix
```

```
##
## Attaching package: 'lmerTest'
```

```
## The following object is masked from 'package:lme4':
##
##     lmer
```

```
## The following object is masked from 'package:stats':
##
##     step
```

```r
library(tidyverse)
```

```
## -- Attaching packages --------------------------------------------------- tidyverse 1.3.0 --
```

```
## v ggplot2 3.3.0     v purrr   0.3.3
## v tibble  2.1.3     v dplyr   0.8.5
## v tidyr   1.0.2     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.5.0
```

```
## -- Conflicts ------------------------------------------------------ tidyverse_conflicts() --
## x tidyr::expand() masks Matrix::expand()
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
## x tidyr::pack()   masks Matrix::pack()
## x tidyr::unpack() masks Matrix::unpack()
```

```r
df <- read.csv("/Users/amitsasson/PycharmProjects/DSSGx/final_dfs/df_final_with_clusters.csv")
head(df)
```

```
##   X data_index cluster                    kreis ags5 ags2 supermarkets_population
## 1 0          0       2          Flensburg, Stadt 1001    1                      92
## 2 1          1       0 Kiel, Landeshauptstadt 1002    1                      92
## 3 2          2       0      Lübeck, Hansestadt 1003    1                      90
## 4 3          3       2        Neumünster, Stadt 1004    1                      85
## 5 4          4       2             Dithmarschen 1051    1                      51
## 6 5          5       2      Herzogtum Lauenburg 1053    1                      63
##   supermarkets_average_distance public_transport_availability
## 1                           500                            35
## 2                           460                            37
## 3                           532                            37
## 4                           588                            37
## 5                          1864                            35
## 6                          1545                            37
##   average_distance_bus_stop average_distance_train_station
```

```
## 1                             240                        2901
## 2                             268                        2037
## 3                             297                        1927
## 4                             316                        1648
## 5                             448                        3517
## 6                             468                        3308
##   average_distance_public_transport Unnamed._0 number_of_students
## 1                               240          0              11610
## 2                               265          1              23898
## 3                               294          2              20478
## 4                               313          3              10380
## 5                               443          4              13158
## 6                               456          5              19320
##   number_of_hospitals number_of_hospital_beds number_of_hospital_beds_adj
## 1                   3                     860                         9.6
## 2                  16                    2498                        10.1
## 3                  13                    1975                         9.1
## 4                   5                     693                         8.7
## 5                   3                     656                         4.9
## 6                   5                     604                         3.1
##   hospital_patiants households_of_1_person households_of_2_person
## 1             18796                  25107                  16482
## 2             53016                  68879                  41792
## 3             53406                  57781                  41983
## 4             19792                  14953                  17073
## 5             32195                  15617                  39929
## 6             48662                  26848                  43650
##   households_of_3_person households_of_4_person households_of_5_person_or_more
## 1                   5165                   3534                            332
## 2                  13932                  10623                           2019
## 3                  12226                   8290                           1078
## 4                   4749                   3428                            441
## 5                   7318                   3236                            546
## 6                  15240                   7496                           1337
##   household_with_kids household_with_kids_under_3
## 1                9586                        1783
## 2               27434                        4954
## 3               22583                        3908
## 4                9004                        1396
## 5                9795                        1374
## 6               22941                        3678
##   household_with_kids_over_3_under_6 household_with_kids_over_6_under_10
## 1                               1599                               2109
## 2                               4487                               5586
## 3                               3668                               4719
## 4                               1422                               1906
## 5                               1474                               2065
## 6                               3578                               4683
##   household_with_kids_over_10_under_15 household_with_kids_over_15_under_18
## 1                                 2371                                1529
## 2                                 7062                                4083
## 3                                 5792                                3664
## 4                                 2445                                1540
## 5                                 2803                                1807
```

```
## 6                                             6070                        3881
##   household_with_double_income_no_kids car_density
## 1                                 5347         427
## 2                                14410         385
## 3                                13044         408
## 4                                 5073         464
## 5                                 8248         572
## 6                                12032         552
##   no_of_paths_per_person_and_day kilometers_per_person_and_day
## 1                        3.12269                       36.0747
## 2                        3.19762                       33.8711
## 3                        3.11096                       33.1605
## 4                        3.11408                       37.1178
## 5                        3.06017                       40.8078
## 6                        3.03130                       40.3404
##   X_percentage_out_of_home share_of_journeys_on_foot share_of_journeys_on_bike
## 1                     84.6                      22.8                      16.2
## 2                     85.2                      22.7                      17.0
## 3                     85.3                      23.9                      19.1
## 4                     84.7                      21.2                      15.6
## 5                     83.9                      19.2                      10.3
## 6                     85.1                      20.7                      10.9
##   proportion_of_motorised_vehicle_passenger share_of_motorised_vehicle_driver
## 1                                      13.1                              39.4
## 2                                      12.5                              37.1
## 3                                      12.0                              34.1
## 4                                      13.3                              41.8
## 5                                      14.8                              48.4
## 6                                      14.1                              44.0
##   share_of_public_transport_ public_transport_per_1000_inhabitants
## 1                        8.5                              265.4287
## 2                       10.7                              342.1453
## 3                       10.9                              339.0946
## 4                        8.1                              252.2405
## 5                        7.3                              223.3924
## 6                       10.3                              312.2239
##   activity_index municipal_dept_per_capita municipal_tax_per_capita
## 1       63.53466                    1282.4                    767.3
## 2       61.51832                    2269.4                    755.3
## 3       58.66422                    3039.8                    724.8
## 4       65.26858                    1650.6                    775.4
## 5       69.84888                    1831.6                    824.7
## 6       69.37571                    1251.8                    791.1
##   municipal_tax_per_capita.1 no_of_births_in_2018 X2018_population
## 1                       78.1                  916            89504
## 2                       87.5                 2480           247548
## 3                       80.8                 1971           217198
## 4                       73.8                  687            79487
## 5                       46.8                 1036           133210
## 6                       36.0                 1828           197264
##   X2019_population X2018_men_population X2018_women_population
## 1            90164                44599                  44905
## 2           246794               120566                 126982
## 3           216530               104371                 112827
```

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```
## 4            80196              39241              40246
## 5           133193              65720              67490
## 6           198019              96881             100383
##   X2018_population_under_3_yrs X2018_population_3_to_6 X2018_population_6_to_10
## 1                         2629                   2332                     3115
## 2                         7047                   6361                     7815
## 3                         5826                   5431                     6982
## 4                         2082                   2120                     2794
## 5                         3249                   3216                     4469
## 6                         5777                   5552                     7227
##   X2018_population_10_to_15 X2018_population_15_to_18 X2018_population_18_to_20
## 1                      3611                     2241                     2201
## 2                      9567                     5835                     5432
## 3                      9014                     5434                     4490
## 4                      3707                     2333                     1942
## 5                      6037                     4179                     3031
## 6                      9595                     6176                     4280
##   X2018_population_20_to_25 X2018_population_25_to_30 X2018_population_30_to_35
## 1                      8558                     8057                     5838
## 2                     22002                    24488                    19806
## 3                     13765                    15014                    14052
## 4                      4618                     5167                     4886
## 5                      7374                     6833                     6670
## 6                      9020                     9540                    10932
##   X2018_population_35_to_40 X2018_population_40_to_45 X2018_population_45_to_50
## 1                      4962                     4749                     5443
## 2                     16018                    13691                    15247
## 3                     13070                    12129                    14378
## 4                      4576                     4364                     5359
## 5                      6748                     6936                     9209
## 6                     11818                    11685                    13933
##   X2018_population_50_to_55 X2018_population_55_to_60 X2018_population_60_to_65
## 1                      6662                     6057                     5061
## 2                     18332                    16398                    13540
## 3                     17690                    16199                    13326
## 4                      6543                     6081                     4963
## 5                     11696                    11101                     9500
## 6                     18427                    16361                    12831
##   X2018_population_65_to_75 X2018_population_above_75 X2019_population_under_5
## 1                      8525                     9463                     4399
## 2                     21566                    24403                    11333
## 3                     22610                    27788                     9419
## 4                      8181                     9771                     3613
## 5                     15894                    17068                     5371
## 6                     19921                    24189                     9511
##   X2019_population_5_to_15 X2019_population_15_to_35 X2019_population_35_to_60
## 1                     7573                    27036                    27783
## 2                    19424                    76854                    79062
## 3                    17818                    52653                    72503
## 4                     7239                    19242                    26839
## 5                    11593                    27964                    45170
## 6                    18856                    39697                    71949
##   X2019_population_60_to_80 X2019_population_above_80 no_of_foreigners_2018
## 1                     17810                     5563                    12702
```

4

```
## 2                    45970                      14151                  28564
## 3                    47637                      16500                  21984
## 4                    17452                       5811                   9216
## 5                    33194                       9901                   7597
## 6                    43504                      14502                  15399
##   proportion_of_foreigners_in_2018 no_of_births_per_capita
## 1                            14.19             0.010234179
## 2                            11.54             0.010018259
## 3                            10.12             0.009074669
## 4                            11.59             0.008642923
## 5                             5.70             0.007777194
## 6                             7.81             0.009266769
##   Number_of_Commuters_place_of_work Number_of_Commuters_on_place_of_residence.
## 1                             23363                                      11096
## 2                             61487                                      27950
## 3                             43805                                      24823
## 4                             22314                                      11699
## 5                              6825                                      12991
## 6                             18792                                      45481
##   Commuter_Balance Proportion_of_in_commuters Share_of_out_commuters
## 1            12267                       52.4                   34.2
## 2            33537                       49.1                   30.3
## 3            18982                       43.6                   31.3
## 4            10615                       54.5                   38.6
## 5             6166                       70.8                   73.5
## 6            26689                       71.7                   79.7
##   Relative_Commuter_Balance Commute_within_50km Commute_within_150km
## 1                      27.7                14.0                  7.7
## 2                      27.1                13.1                  4.6
## 3                      17.9                15.0                  3.9
## 4                      25.9                14.7                  4.4
## 5                     -15.8                16.7                  4.0
## 6                     -52.4                15.6                  4.1
##   Commute_within_300km number_accomodation_establishments number_of_beds
## 1                  3.6                                 21           1761
## 2                  3.4                                 47           4763
## 3                  3.0                                103          10626
## 4                  3.6                                 12           1097
## 5                  3.1                                326          11221
## 6                  2.9                                 99           4650
##   number_of_guests guests_staying_overnight number_of_companies
## 1           188390                   322191                5078
## 2           385648                   805038               12702
## 3           754190                  1825115               10896
## 4            93659                   187823                4052
## 5           350821                  1685871                8472
## 6           204571                   674982               10336
##   number_of_companies_agriculture number_of_companies_mining
## 1                              15                          0
## 2                              35                          2
## 3                              76                          2
## 4                              26                          2
## 5                             399                          8
## 6                             351                          7
```

```
##   number_of_companies_manufacturing number_of_companies_energy
## 1                               194                         43
## 2                               511                         47
## 3                               448                         24
## 4                               186                          4
## 5                               336                        301
## 6                               441                         47
##   number_of_companies_water_and_sewage number_of_companies_construction
## 1                                   11                              240
## 2                                   27                              640
## 3                                   34                              661
## 4                                   20                              327
## 5                                   35                              627
## 6                                   44                              817
##   number_of_companies_repair_motor_vehicles number_of_companies_transport
## 1                                        877                           116
## 2                                       1920                           247
## 3                                       1762                           359
## 4                                        752                           108
## 5                                       1152                           194
## 6                                       1598                           217
##   number_of_companies_hospitality number_of_companies_communication
## 1                             223                               151
## 2                             540                               410
## 3                             525                               245
## 4                             167                                72
## 5                             582                                78
## 6                             378                               221
##   number_of_companies_financial_and_insurance number_of_companies_real_estat
## 1                                          339                            314
## 2                                          705                            425
## 3                                          534                            365
## 4                                          244                            130
## 5                                          505                            208
## 6                                          588                            345
##   number_of_companies_technical_services number_of_companies_economic_services
## 1                                     611                                   275
## 2                                    1710                                   714
## 3                                    1385                                   630
## 4                                     419                                   263
## 5                                     771                                   428
## 6                                    1122                                   629
##   number_of_companies_administration number_of_companies_education
## 1                                 40                           126
## 2                                136                           389
## 3                                 86                           247
## 4                                 42                           129
## 5                                138                           204
## 6                                157                           267
##   number_of_companies_health_and_social_services
## 1                                             442
## 2                                            1242
## 3                                            1003
## 4                                             283
```

```
## 5                                                      537
## 6                                                      737
##    number_of_companies_arts_entertainment
## 1                                       126
## 2                                       335
## 3                                       275
## 4                                       111
## 5                                       248
## 6                                       305
##    number_of_companies_rendering_other_services
## 1                                           760
## 2                                          2217
## 3                                          1867
## 4                                           615
## 5                                          1369
## 6                                          1651
##    number_of_companies_domestic_staff number_of_companies_extraterritorial
## 1                                   0                                    0
## 2                                   1                                    0
## 3                                   0                                    0
## 4                                   0                                    0
## 5                                   0                                    0
## 6                                   0                                    0
##    number_of_companies_1_to_4_employees number_of_companies_5_to_49_employees
## 1                                  2396                                  1284
## 2                                  6151                                  2925
## 3                                  5802                                  2362
## 4                                  1976                                  1004
## 5                                  4336                                  1762
## 6                                  5624                                  2053
##    number_of_companies_50_to_400_employees
## 1                                      116
## 2                                      248
## 3                                      226
## 4                                      101
## 5                                      103
## 6                                      134
##    number_of_companies_500_or_more_employees mean_unemployed
## 1                                         12        4494.357
## 2                                         52       11290.750
## 3                                         29        9083.571
## 4                                         11        3689.357
## 5                                         12        4128.964
## 6                                          7        5449.250
##    mean_unemployment_rate mean_registerd_jobs
## 1               8.614286            770.5000
## 2               8.128571           2615.5714
## 3               7.864286           2430.0357
## 4               8.578571           1146.1786
## 5               5.925000            969.2143
## 6               5.171429           1399.8571
##    mean_unemployment_benefit_recipients employees_social_security_at_residence
## 1                              1283.500                               32548.33
## 2                              2531.833                               92457.67
```

```
## 3                                    2466.583                              80897.17
## 4                                     941.750                              30258.17
## 5                                    1403.750                              49071.50
## 6                                    1963.708                              76134.50
##   employees_social_security_at_work no_of_hairdressers no_of_restraunts
## 1                           44834.33                 82              131
## 2                          126471.33                213              343
## 3                          100578.67                219              277
## 4                           41293.17                 81              115
## 5                           43052.00                155              250
## 6                           49149.17                165              168
##   no_of_branches no_of_commertial_units no_of_shopping_malls no_of_clubs
## 1            361                   5856                    6         185
## 2            621                  14017                    9         611
## 3            674                  12357                   14         491
## 4            296                   4639                    7         120
## 5            386                   8984                    3         248
## 6            456                  11296                    1         383
##   no_of_slaughterhouse no_of_education_centers no_of_shopping no_of_free_time
## 1                    0                      93            754              62
## 2                    0                     238           1543             173
## 3                    2                     162           1521             115
## 4                    1                      57            616              50
## 5                    5                     110           1118             121
## 6                   13                     128           1281             165
##   no_of_tourism_points no_of_food_and_drink no_of_public_institution
## 1                   32                  145                       37
## 2                   62                  393                      107
## 3                  102                  361                       87
## 4                   14                  126                       34
## 5                  326                  292                       62
## 6                   90                  246                      128
##   no_of_traffic_centers no_of_health_centers no_of_business total_area
## 1                   115                  378           941       56.7
## 2                   185                 1106          2189      118.7
## 3                   193                  904          1921      214.2
## 4                   109                  272           762       71.7
## 5                   195                  476          1375     1428.2
## 6                   213                  625          1871     1263.1
##   Residential_area_percentage industrial_._commertial_area_percentage
## 1                       24.66                                    8.03
## 2                       24.15                                    6.88
## 3                       15.39                                    5.40
## 4                       23.64                                    9.93
## 5                        3.14                                    0.91
## 6                        4.21                                    0.86
##   dump_area_percentage mining_area_percentage
## 1                 0.05                      0
## 2                 0.00                      0
## 3                 0.00                      0
## 4                 0.00                      0
## 5                 0.00                      0
## 6                 0.00                      0
##   open_pit._mine._quarry_area_percentage mixed_use_area_percentage
```

```
## 1                                          0.00                       3.58
## 2                                          0.00                       2.90
## 3                                          0.17                       2.44
## 4                                          0.00                       4.33
## 5                                          0.10                       3.33
## 6                                          0.16                       2.28
##   special_functional_character_land_percentage
## 1                                         3.76
## 2                                         5.09
## 3                                         2.06
## 4                                         2.67
## 5                                         0.29
## 6                                         0.29
##   sport._leisure._recreation_area_percentage cemetry_area_percentage
## 1                                       6.02                    0.83
## 2                                       9.82                    0.71
## 3                                       4.88                    0.44
## 4                                       5.49                    0.63
## 5                                       0.55                    0.07
## 6                                       0.97                    0.11
##   road_area_percentage space_area_percentage rail_traffic_area_percentage
## 1                 1.99                  0.74                         0.99
## 2                 2.96                  0.90                         0.79
## 3                 1.34                  0.55                         0.55
## 4                 1.10                  0.77                         0.68
## 5                 0.26                  0.07                         0.09
## 6                 0.28                  0.05                         0.08
##   air_traffic_area_percentage shipping_area_percentage agri_area_percentage
## 1                        1.50                     0.18                17.78
## 2                        0.94                     1.06                21.31
## 3                        0.66                     0.52                29.70
## 4                        0.54                     0.00                36.18
## 5                        0.03                     0.04                79.47
## 6                        0.01                     0.01                57.12
##   forrest_area_percentage wood_area_percentage health_area_percentage
## 1                    8.61                 3.16                   0.00
## 2                    8.92                 2.36                   0.00
## 3                   16.29                 2.64                   0.30
## 4                    6.12                 1.62                   0.00
## 5                    3.99                 0.62                   0.00
## 6                   27.40                 1.22                   0.06
##   moor_area_percentage swamp_area_percentage without_vegetation_area_percentage
## 1                 0.04                  0.00                               4.04
## 2                 0.30                  0.73                               1.60
## 3                 0.02                  0.05                               3.44
## 4                 2.50                  0.00                               1.82
## 5                 1.44                  0.05                               2.11
## 6                 0.31                  0.02                               0.83
##   flowing_water_percentage harbor_basin_percentage standing_water_percentage
## 1                     0.00                    0.00                      0.44
## 2                     1.27                    0.30                      1.05
## 3                     5.76                    0.06                      6.97
## 4                     0.01                    0.00                      1.96
## 5                     2.55                    0.04                      0.76
```

```
## 6                       0.54                       0.01                       3.18
##   sea_percentage median_income purchasing_power_per_household
## 1          13.60          2986                         34496
## 2           5.93          3304                         35246
## 3           0.34          3036                         37219
## 4           0.00          2842                         38141
## 5           0.06          2914                         46945
## 6           0.00          2832                         49759
##   purchasing_power_per_person debtor_quota household_in_income_calss_1
## 1                       19556         16.0                       13209
## 2                       19612         12.1                       22126
## 3                       20820         15.1                       22881
## 4                       19561         17.9                        7208
## 5                       23486         12.8                       11806
## 6                       23969         10.1                        9081
##   household_in_income_calss_2 household_in_income_calss_3
## 1                       12385                       13092
## 2                       38523                       39483
## 3                       30159                       32571
## 4                       13291                       10435
## 5                       11575                       17816
## 6                       14562                       25004
##   household_in_income_calss_4 household_in_income_calss_5
## 1                        5441                        3096
## 2                       18567                       11162
## 3                       15805                       10999
## 4                        3812                        3201
## 5                        9873                        7834
## 6                       16206                       13565
##   household_in_income_calss_6
## 1                        3497
## 2                        7841
## 3                        9039
## 4                        2805
## 5                        7676
## 6                       16539
```

```r
df$ags2 <- factor(df$ags2)
df$ags5 <- factor(df$ags5)
df$cluster <- factor(df$cluster)
```

#without clutster/kreis

```r
fit1 <- lmer(mean_unemployment_rate ~ median_income + total_area + X2019_population + (1 | ags2), df)
```

```
## Warning: Some predictor variables are on very different scales: consider
## rescaling
```

```
## Warning: Some predictor variables are on very different scales: consider
## rescaling
```

```r
summary(fit1)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula:
```

```
## mean_unemployment_rate ~ median_income + total_area + X2019_population +
##     (1 | ags2)
##    Data: df
##
## REML criterion at convergence: 1512.4
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.4826 -0.6273 -0.1208  0.4044  4.6288
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ags2     (Intercept) 3.925    1.981
##  Residual             1.942    1.394
## Number of obs: 401, groups:  ags2, 16
##
## Fixed effects:
##                    Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)       6.585e+00  9.232e-01 1.147e+02   7.133 9.46e-11 ***
## median_income     2.343e-04  2.485e-04 3.969e+02   0.943    0.346
## total_area       -1.167e-03  1.253e-04 3.939e+02  -9.313  < 2e-16 ***
## X2019_population  3.796e-07  4.314e-07 1.211e+02   0.880    0.381
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##            (Intr) mdn_nc totl_r
## median_incm -0.798
## total_area  -0.433  0.409
## X2019_ppltn  0.050 -0.289 -0.155
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
```

#with clutster

```r
fit2 <- lmer(mean_unemployment_rate ~ median_income + cluster + X2019_population + (1 | ags2), df)
```

```
## Warning: Some predictor variables are on very different scales: consider
## rescaling
```

```
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```

```r
summary(fit2)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: mean_unemployment_rate ~ median_income + cluster + X2019_population +
##     (1 | ags2)
##    Data: df
##
## REML criterion at convergence: 1520.5
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -2.7785 -0.5951 -0.1538  0.4724  4.1973
```

```
## 
## Random effects:
##  Groups    Name        Variance Std.Dev.
##  ags2     (Intercept) 3.844    1.961
##  Residual             2.090    1.446
## Number of obs: 401, groups:  ags2, 16
## 
## Fixed effects:
##                   Estimate Std. Error        df t value Pr(>|t|)
## (Intercept)      6.162e+00  9.853e-01  9.552e+01   6.254 1.12e-08 ***
## median_income    7.035e-04  2.466e-04  3.956e+02   2.853  0.00456 **
## cluster1         7.362e+00  2.343e+00  4.873e+01   3.143  0.00285 **
## cluster2        -1.944e+00  2.674e-01  3.930e+02  -7.272 1.94e-12 ***
## X2019_population -2.856e-06  6.249e-07  3.655e+02  -4.571 6.66e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Correlation of Fixed Effects:
##             (Intr) mdn_nc clstr1 clstr2
## median_incm -0.785
## cluster1    -0.019  0.041
## cluster2    -0.488  0.283 -0.250
## X2019_ppltn -0.167 -0.090 -0.633  0.482
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
coef(fit2)

## $ags2
##    (Intercept) median_income cluster1  cluster2 X2019_population
## 1     6.001840  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 2     3.715475  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 3     5.877090  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 4     9.402382  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 5     6.642150  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 6     4.640153  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 7     5.144632  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 8     3.468858  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 9     3.339264  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 10    5.785512  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 11    8.607538  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 12    7.045026  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 13    8.295388  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 14    6.626868  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 15    7.842966  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 16    6.148958  0.0007034981 7.362252 -1.944172    -2.856195e-06
## 
## attr(,"class")
## [1] "coef.mer"
```

#with kreis

```
#fit3 <- lmer(mean_unemployment_rate ~ median_income + ags5 + X2019_population + (1 | ags2), df)
#summary(fit3)
```

Time data

```
df <- read.csv("/Users/amitsasson/PycharmProjects/DSSGx/final_dfs/df_final_without_labor_with_clusters.c
df %>% select(cluster) %>% table()
```

creating the dataset needed

```
## .
##   0   1   2
## 333   2  66
```

```
df <- df %>% select(-data_index)
labor <- read.csv("/Users/amitsasson/PycharmProjects/DSSGx/final_dfs/labor_market_by_date.csv")
df <- df %>% left_join(labor, by = c("ags5" = "ags5", "ags2" = "ags2"))
df$ags2 <- factor(df$ags2)
df$ags5 <- factor(df$ags5)
df$cluster <- factor(df$cluster)

df <- df %>%
      filter(variable == "unemployment_rate") %>%
      select(-variable) %>%
      rename(unemployment_rate = value) %>%
      mutate(date = as.Date(as.character(date)))

head(df)
```

```
##   X.x cluster           kreis ags5 ags2 supermarkets_population
## 1   0       0 Flensburg, Stadt 1001    1                      92
## 2   0       0 Flensburg, Stadt 1001    1                      92
## 3   0       0 Flensburg, Stadt 1001    1                      92
## 4   0       0 Flensburg, Stadt 1001    1                      92
## 5   0       0 Flensburg, Stadt 1001    1                      92
## 6   0       0 Flensburg, Stadt 1001    1                      92
##   supermarkets_average_distance public_transport_availability
## 1                           500                            35
## 2                           500                            35
## 3                           500                            35
## 4                           500                            35
## 5                           500                            35
## 6                           500                            35
##   average_distance_bus_stop average_distance_train_station
## 1                       240                           2901
## 2                       240                           2901
## 3                       240                           2901
## 4                       240                           2901
## 5                       240                           2901
## 6                       240                           2901
##   average_distance_public_transport Unnamed._0 number_of_students
## 1                               240          0              11610
## 2                               240          0              11610
## 3                               240          0              11610
## 4                               240          0              11610
## 5                               240          0              11610
## 6                               240          0              11610
##   number_of_hospitals number_of_hospital_beds number_of_hospital_beds_adj
```

```
##  1                                3                            860                          9.6
##  2                                3                            860                          9.6
##  3                                3                            860                          9.6
##  4                                3                            860                          9.6
##  5                                3                            860                          9.6
##  6                                3                            860                          9.6
##    hospital_patiants households_of_1_person households_of_2_person
##  1             18796                  25107                  16482
##  2             18796                  25107                  16482
##  3             18796                  25107                  16482
##  4             18796                  25107                  16482
##  5             18796                  25107                  16482
##  6             18796                  25107                  16482
##    households_of_3_person households_of_4_person households_of_5_person_or_more
##  1                   5165                   3534                            332
##  2                   5165                   3534                            332
##  3                   5165                   3534                            332
##  4                   5165                   3534                            332
##  5                   5165                   3534                            332
##  6                   5165                   3534                            332
##    household_with_kids household_with_kids_under_3
##  1                9586                        1783
##  2                9586                        1783
##  3                9586                        1783
##  4                9586                        1783
##  5                9586                        1783
##  6                9586                        1783
##    household_with_kids_over_3_under_6 household_with_kids_over_6_under_10
##  1                               1599                               2109
##  2                               1599                               2109
##  3                               1599                               2109
##  4                               1599                               2109
##  5                               1599                               2109
##  6                               1599                               2109
##    household_with_kids_over_10_under_15 household_with_kids_over_15_under_18
##  1                                 2371                                 1529
##  2                                 2371                                 1529
##  3                                 2371                                 1529
##  4                                 2371                                 1529
##  5                                 2371                                 1529
##  6                                 2371                                 1529
##    household_with_double_income_no_kids car_density
##  1                                 5347         427
##  2                                 5347         427
##  3                                 5347         427
##  4                                 5347         427
##  5                                 5347         427
##  6                                 5347         427
##    no_of_paths_per_person_and_day kilometers_per_person_and_day
##  1                        3.12269                       36.0747
##  2                        3.12269                       36.0747
##  3                        3.12269                       36.0747
##  4                        3.12269                       36.0747
##  5                        3.12269                       36.0747
```

```
## 6                             3.12269                        36.0747
##   X_percentage_out_of_home share_of_journeys_on_foot share_of_journeys_on_bike
## 1                     84.6                       22.8                       16.2
## 2                     84.6                       22.8                       16.2
## 3                     84.6                       22.8                       16.2
## 4                     84.6                       22.8                       16.2
## 5                     84.6                       22.8                       16.2
## 6                     84.6                       22.8                       16.2
##   proportion_of_motorised_vehicle_passenger share_of_motorised_vehicle_driver
## 1                                      13.1                              39.4
## 2                                      13.1                              39.4
## 3                                      13.1                              39.4
## 4                                      13.1                              39.4
## 5                                      13.1                              39.4
## 6                                      13.1                              39.4
##   share_of_public_transport_ public_transport_per_1000_inhabitants
## 1                        8.5                             265.4287
## 2                        8.5                             265.4287
## 3                        8.5                             265.4287
## 4                        8.5                             265.4287
## 5                        8.5                             265.4287
## 6                        8.5                             265.4287
##   activity_index municipal_dept_per_capita municipal_tax_per_capita
## 1       63.53466                    1282.4                    767.3
## 2       63.53466                    1282.4                    767.3
## 3       63.53466                    1282.4                    767.3
## 4       63.53466                    1282.4                    767.3
## 5       63.53466                    1282.4                    767.3
## 6       63.53466                    1282.4                    767.3
##   municipal_tax_per_capita.1 no_of_births_in_2018 X2018_population
## 1                       78.1                  916            89504
## 2                       78.1                  916            89504
## 3                       78.1                  916            89504
## 4                       78.1                  916            89504
## 5                       78.1                  916            89504
## 6                       78.1                  916            89504
##   X2019_population X2018_men_population X2018_women_population
## 1            90164                44599                  44905
## 2            90164                44599                  44905
## 3            90164                44599                  44905
## 4            90164                44599                  44905
## 5            90164                44599                  44905
## 6            90164                44599                  44905
##   X2018_population_under_3_yrs X2018_population_3_to_6 X2018_population_6_to_10
## 1                         2629                   2332                     3115
## 2                         2629                   2332                     3115
## 3                         2629                   2332                     3115
## 4                         2629                   2332                     3115
## 5                         2629                   2332                     3115
## 6                         2629                   2332                     3115
##   X2018_population_10_to_15 X2018_population_15_to_18 X2018_population_18_to_20
## 1                      3611                     2241                     2201
## 2                      3611                     2241                     2201
## 3                      3611                     2241                     2201
```

```
## 4                       3611                      2241                      2201
## 5                       3611                      2241                      2201
## 6                       3611                      2241                      2201
##   X2018_population_20_to_25 X2018_population_25_to_30 X2018_population_30_to_35
## 1                      8558                      8057                      5838
## 2                      8558                      8057                      5838
## 3                      8558                      8057                      5838
## 4                      8558                      8057                      5838
## 5                      8558                      8057                      5838
## 6                      8558                      8057                      5838
##   X2018_population_35_to_40 X2018_population_40_to_45 X2018_population_45_to_50
## 1                      4962                      4749                      5443
## 2                      4962                      4749                      5443
## 3                      4962                      4749                      5443
## 4                      4962                      4749                      5443
## 5                      4962                      4749                      5443
## 6                      4962                      4749                      5443
##   X2018_population_50_to_55 X2018_population_55_to_60 X2018_population_60_to_65
## 1                      6662                      6057                      5061
## 2                      6662                      6057                      5061
## 3                      6662                      6057                      5061
## 4                      6662                      6057                      5061
## 5                      6662                      6057                      5061
## 6                      6662                      6057                      5061
##   X2018_population_65_to_75 X2018_population_above_75 X2019_population_under_5
## 1                      8525                      9463                     4399
## 2                      8525                      9463                     4399
## 3                      8525                      9463                     4399
## 4                      8525                      9463                     4399
## 5                      8525                      9463                     4399
## 6                      8525                      9463                     4399
##   X2019_population_5_to_15 X2019_population_15_to_35 X2019_population_35_to_60
## 1                     7573                    27036                    27783
## 2                     7573                    27036                    27783
## 3                     7573                    27036                    27783
## 4                     7573                    27036                    27783
## 5                     7573                    27036                    27783
## 6                     7573                    27036                    27783
##   X2019_population_60_to_80 X2019_population_above_80 no_of_foreigners_2018
## 1                     17810                     5563                 12702
## 2                     17810                     5563                 12702
## 3                     17810                     5563                 12702
## 4                     17810                     5563                 12702
## 5                     17810                     5563                 12702
## 6                     17810                     5563                 12702
##   proportion_of_foreigners_in_2018 no_of_births_per_capita
## 1                            14.19              0.01023418
## 2                            14.19              0.01023418
## 3                            14.19              0.01023418
## 4                            14.19              0.01023418
## 5                            14.19              0.01023418
## 6                            14.19              0.01023418
##   Number_of_Commuters_place_of_work Number_of_Commuters_on_place_of_residence.
## 1                             23363                                      11096
```

```
## 2                          23363                                       11096
## 3                          23363                                       11096
## 4                          23363                                       11096
## 5                          23363                                       11096
## 6                          23363                                       11096
##   Commuter_Balance Proportion_of_in_commuters Share_of_out_commuters
## 1          12267                       52.4                   34.2
## 2          12267                       52.4                   34.2
## 3          12267                       52.4                   34.2
## 4          12267                       52.4                   34.2
## 5          12267                       52.4                   34.2
## 6          12267                       52.4                   34.2
##   Relative_Commuter_Balance Commute_within_50km Commute_within_150km
## 1                      27.7                  14                  7.7
## 2                      27.7                  14                  7.7
## 3                      27.7                  14                  7.7
## 4                      27.7                  14                  7.7
## 5                      27.7                  14                  7.7
## 6                      27.7                  14                  7.7
##   Commute_within_300km number_accomodation_establishments number_of_beds
## 1                  3.6                                 21           1761
## 2                  3.6                                 21           1761
## 3                  3.6                                 21           1761
## 4                  3.6                                 21           1761
## 5                  3.6                                 21           1761
## 6                  3.6                                 21           1761
##   number_of_guests guests_staying_overnight number_of_companies
## 1           188390                   322191                5078
## 2           188390                   322191                5078
## 3           188390                   322191                5078
## 4           188390                   322191                5078
## 5           188390                   322191                5078
## 6           188390                   322191                5078
##   number_of_companies_agriculture number_of_companies_mining
## 1                              15                          0
## 2                              15                          0
## 3                              15                          0
## 4                              15                          0
## 5                              15                          0
## 6                              15                          0
##   number_of_companies_manufacturing number_of_companies_energy
## 1                               194                         43
## 2                               194                         43
## 3                               194                         43
## 4                               194                         43
## 5                               194                         43
## 6                               194                         43
##   number_of_companies_water_and_sewage number_of_companies_construction
## 1                                   11                              240
## 2                                   11                              240
## 3                                   11                              240
## 4                                   11                              240
## 5                                   11                              240
## 6                                   11                              240
```

```
##   number_of_companies_repair_motor_vehicles number_of_companies_transport
## 1                                       877                            116
## 2                                       877                            116
## 3                                       877                            116
## 4                                       877                            116
## 5                                       877                            116
## 6                                       877                            116
##   number_of_companies_hospitality number_of_companies_communication
## 1                             223                               151
## 2                             223                               151
## 3                             223                               151
## 4                             223                               151
## 5                             223                               151
## 6                             223                               151
##   number_of_companies_financial_and_insurance number_of_companies_real_estat
## 1                                          339                            314
## 2                                          339                            314
## 3                                          339                            314
## 4                                          339                            314
## 5                                          339                            314
## 6                                          339                            314
##   number_of_companies_technical_services number_of_companies_economic_services
## 1                                     611                                   275
## 2                                     611                                   275
## 3                                     611                                   275
## 4                                     611                                   275
## 5                                     611                                   275
## 6                                     611                                   275
##   number_of_companies_administration number_of_companies_education
## 1                                  40                           126
## 2                                  40                           126
## 3                                  40                           126
## 4                                  40                           126
## 5                                  40                           126
## 6                                  40                           126
##   number_of_companies_health_and_social_services
## 1                                             442
## 2                                             442
## 3                                             442
## 4                                             442
## 5                                             442
## 6                                             442
##   number_of_companies_arts_entertainment
## 1                                     126
## 2                                     126
## 3                                     126
## 4                                     126
## 5                                     126
## 6                                     126
##   number_of_companies_rendering_other_services
## 1                                           760
## 2                                           760
## 3                                           760
## 4                                           760
```

```
## 5                                                    760
## 6                                                    760
##   number_of_companies_domestic_staff number_of_companies_extraterritorial
## 1                                   0                                    0
## 2                                   0                                    0
## 3                                   0                                    0
## 4                                   0                                    0
## 5                                   0                                    0
## 6                                   0                                    0
##   number_of_companies_1_to_4_employees number_of_companies_5_to_49_employees
## 1                                 2396                                  1284
## 2                                 2396                                  1284
## 3                                 2396                                  1284
## 4                                 2396                                  1284
## 5                                 2396                                  1284
## 6                                 2396                                  1284
##   number_of_companies_50_to_400_employees
## 1                                     116
## 2                                     116
## 3                                     116
## 4                                     116
## 5                                     116
## 6                                     116
##   number_of_companies_500_or_more_employees no_of_hairdressers no_of_restraunts
## 1                                        12                 82              131
## 2                                        12                 82              131
## 3                                        12                 82              131
## 4                                        12                 82              131
## 5                                        12                 82              131
## 6                                        12                 82              131
##   no_of_branches no_of_commertial_units no_of_shopping_malls no_of_clubs
## 1            361                   5856                    6         185
## 2            361                   5856                    6         185
## 3            361                   5856                    6         185
## 4            361                   5856                    6         185
## 5            361                   5856                    6         185
## 6            361                   5856                    6         185
##   no_of_slaughterhouse no_of_education_centers no_of_shopping no_of_free_time
## 1                    0                      93            754              62
## 2                    0                      93            754              62
## 3                    0                      93            754              62
## 4                    0                      93            754              62
## 5                    0                      93            754              62
## 6                    0                      93            754              62
##   no_of_tourism_points no_of_food_and_drink no_of_public_institution
## 1                   32                  145                       37
## 2                   32                  145                       37
## 3                   32                  145                       37
## 4                   32                  145                       37
## 5                   32                  145                       37
## 6                   32                  145                       37
##   no_of_traffic_centers no_of_health_centers no_of_business total_area
## 1                   115                  378            941       56.7
## 2                   115                  378            941       56.7
```

```
## 3                             115                 378         941        56.7
## 4                             115                 378         941        56.7
## 5                             115                 378         941        56.7
## 6                             115                 378         941        56.7
##   Residential_area_percentage industrial_._commertial_area_percentage
## 1                       24.66                                    8.03
## 2                       24.66                                    8.03
## 3                       24.66                                    8.03
## 4                       24.66                                    8.03
## 5                       24.66                                    8.03
## 6                       24.66                                    8.03
##   dump_area_percentage mining_area_percentage
## 1                 0.05                      0
## 2                 0.05                      0
## 3                 0.05                      0
## 4                 0.05                      0
## 5                 0.05                      0
## 6                 0.05                      0
##   open_pit._mine._quarry_area_percentage mixed_use_area_percentage
## 1                                      0                      3.58
## 2                                      0                      3.58
## 3                                      0                      3.58
## 4                                      0                      3.58
## 5                                      0                      3.58
## 6                                      0                      3.58
##   special_functional_character_land_percentage
## 1                                         3.76
## 2                                         3.76
## 3                                         3.76
## 4                                         3.76
## 5                                         3.76
## 6                                         3.76
##   sport._leisure._recreation_area_percentage cemetry_area_percentage
## 1                                       6.02                    0.83
## 2                                       6.02                    0.83
## 3                                       6.02                    0.83
## 4                                       6.02                    0.83
## 5                                       6.02                    0.83
## 6                                       6.02                    0.83
##   road_area_percentage space_area_percentage rail_traffic_area_percentage
## 1                 1.99                  0.74                         0.99
## 2                 1.99                  0.74                         0.99
## 3                 1.99                  0.74                         0.99
## 4                 1.99                  0.74                         0.99
## 5                 1.99                  0.74                         0.99
## 6                 1.99                  0.74                         0.99
##   air_traffic_area_percentage shipping_area_percentage agri_area_percentage
## 1                         1.5                     0.18                17.78
## 2                         1.5                     0.18                17.78
## 3                         1.5                     0.18                17.78
## 4                         1.5                     0.18                17.78
## 5                         1.5                     0.18                17.78
## 6                         1.5                     0.18                17.78
##   forrest_area_percentage wood_area_percentage health_area_percentage
```

```
## 1                      8.61                3.16                       0
## 2                      8.61                3.16                       0
## 3                      8.61                3.16                       0
## 4                      8.61                3.16                       0
## 5                      8.61                3.16                       0
## 6                      8.61                3.16                       0
##   moor_area_percentage swamp_area_percentage without_vegetation_area_percentage
## 1                 0.04                     0                               4.04
## 2                 0.04                     0                               4.04
## 3                 0.04                     0                               4.04
## 4                 0.04                     0                               4.04
## 5                 0.04                     0                               4.04
## 6                 0.04                     0                               4.04
##   flowing_water_percentage harbor_basin_percentage standing_water_percentage
## 1                        0                       0                      0.44
## 2                        0                       0                      0.44
## 3                        0                       0                      0.44
## 4                        0                       0                      0.44
## 5                        0                       0                      0.44
## 6                        0                       0                      0.44
##   sea_percentage median_income purchasing_power_per_household
## 1           13.6          2986                          34496
## 2           13.6          2986                          34496
## 3           13.6          2986                          34496
## 4           13.6          2986                          34496
## 5           13.6          2986                          34496
## 6           13.6          2986                          34496
##   purchasing_power_per_person debtor_quota household_in_income_calss_1
## 1                       19556           16                       13209
## 2                       19556           16                       13209
## 3                       19556           16                       13209
## 4                       19556           16                       13209
## 5                       19556           16                       13209
## 6                       19556           16                       13209
##   household_in_income_calss_2 household_in_income_calss_3
## 1                       12385                       13092
## 2                       12385                       13092
## 3                       12385                       13092
## 4                       12385                       13092
## 5                       12385                       13092
## 6                       12385                       13092
##   household_in_income_calss_4 household_in_income_calss_5
## 1                        5441                        3096
## 2                        5441                        3096
## 3                        5441                        3096
## 4                        5441                        3096
## 5                        5441                        3096
## 6                        5441                        3096
##   household_in_income_calss_6 X.y unemployment_rate       date
## 1                        3497  80               8.2 2019-01-01
## 2                        3497  81               7.8 2019-02-01
## 3                        3497  82               7.8 2019-03-01
## 4                        3497  83               7.6 2019-04-01
## 5                        3497  84               7.7 2019-05-01
```
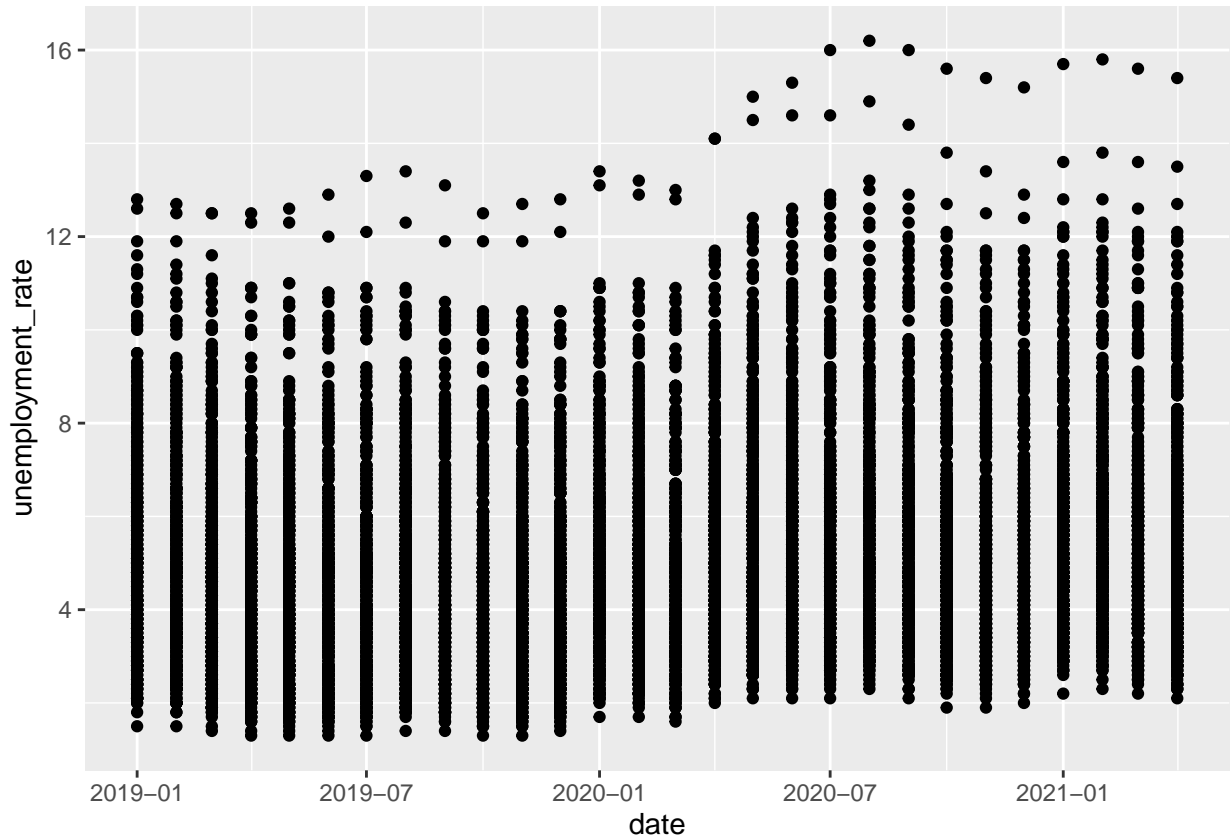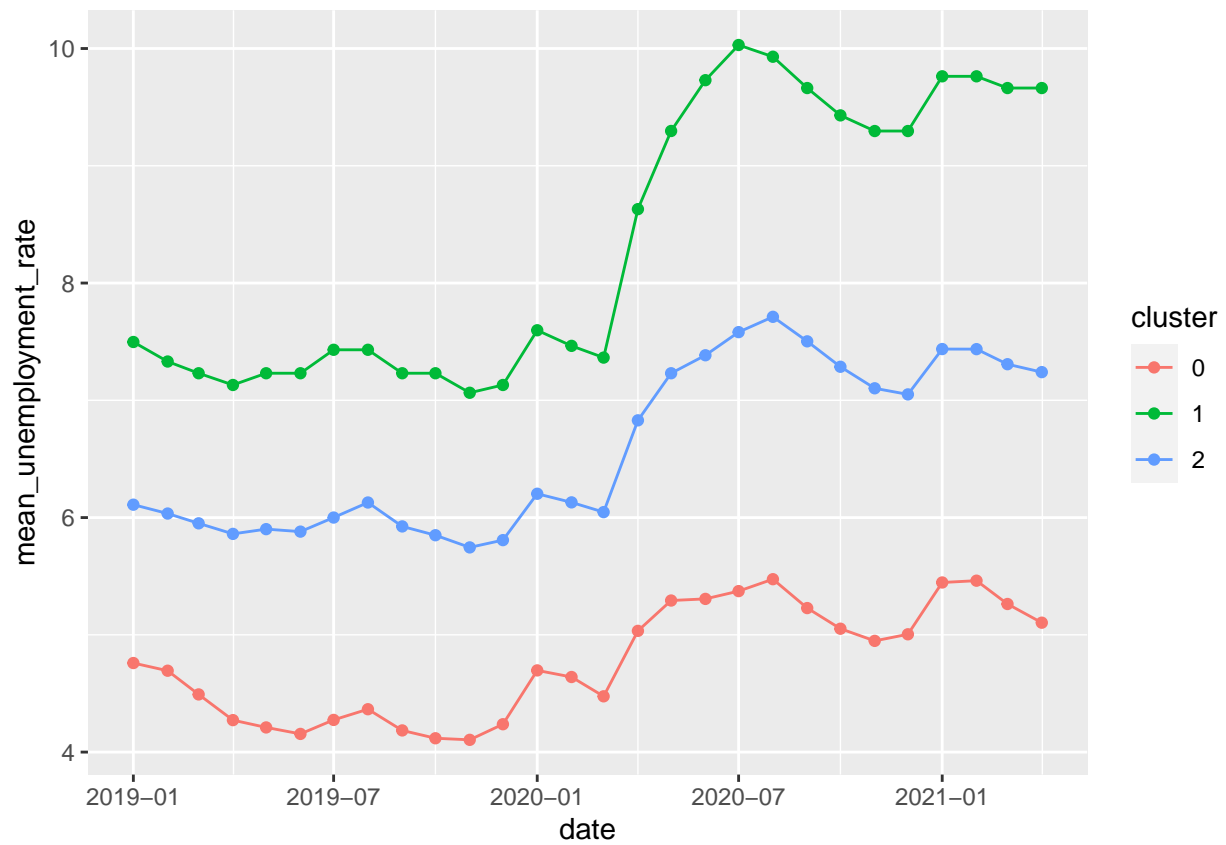
```
## 6                          3497  85              7.7 2019-06-01
```

```r
ggplot(df, aes(x = date, y = unemployment_rate)) +
  geom_point()
```
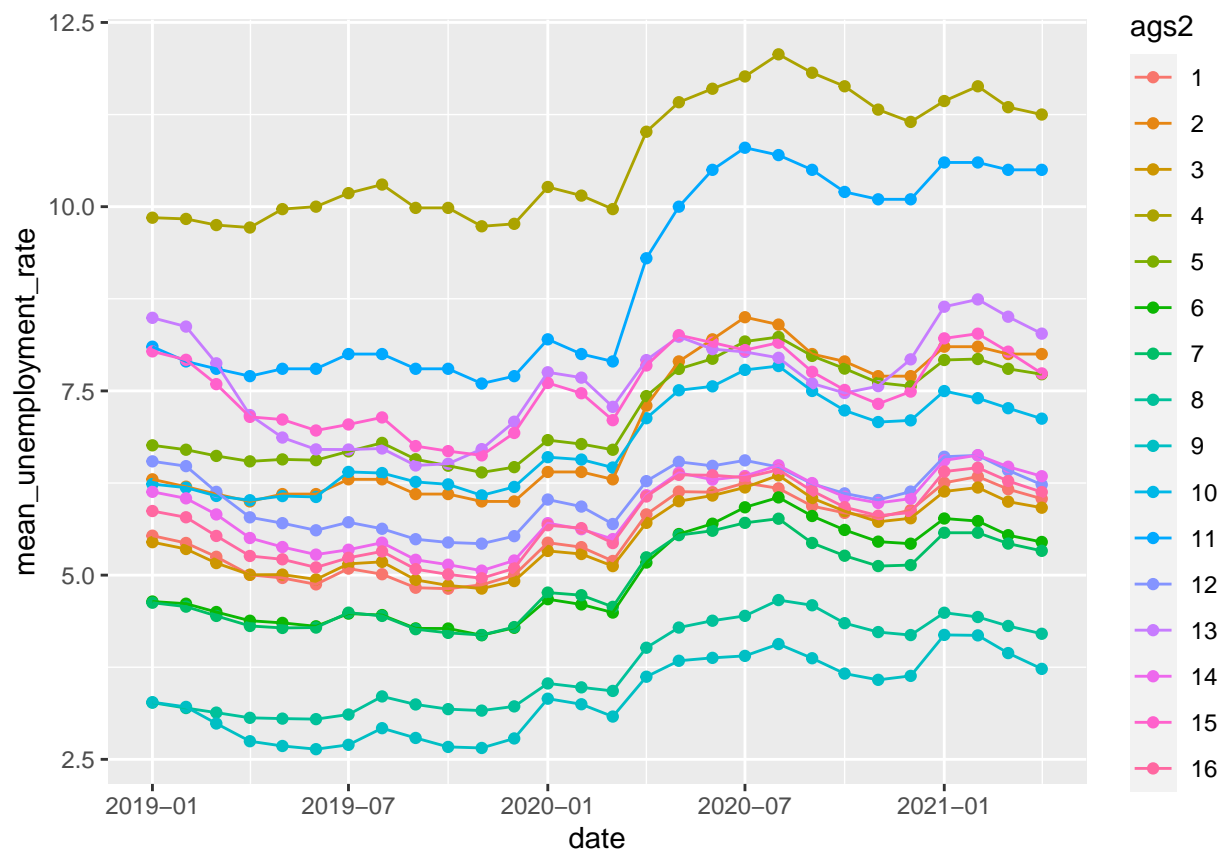

plot

```r
df %>%
  group_by(cluster, date) %>%
  summarise(mean_unemployment_rate = sum(unemployment_rate %*% X2019_population)/sum(X2019_population))
ggplot(aes(x = date, y = mean_unemployment_rate, color = cluster)) +
  geom_point()  +
  geom_line()
```

```
df %>%
  group_by(ags2, date) %>%
  summarise(mean_unemployment_rate = sum(unemployment_rate %*% X2019_population)/sum(X2019_population))
ggplot(aes(x = date, y = mean_unemployment_rate, color = ags2)) +
  geom_point()  +
  geom_line()
```

```
fit4 <- lmer(unemployment_rate ~ date + cluster + median_income + X2019_population + (1 | ags2) + (1 | a
```

```
## Warning: Some predictor variables are on very different scales: consider
## rescaling
```

```
## Warning: Some predictor variables are on very different scales: consider
## rescaling
```

```
summary(fit4)
```

```
## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula:
## unemployment_rate ~ date + cluster + median_income + X2019_population +
##     (1 | ags2) + (1 | ags5)
##    Data: df
##
## REML criterion at convergence: 15879.7
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.6370 -0.6748 -0.0913  0.6000  5.7760
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ags5     (Intercept) 2.0930   1.4467
##  ags2     (Intercept) 4.4658   2.1132
##  Residual             0.1945   0.4411
```

```
## Number of obs: 11228, groups:  ags5, 401; ags2, 16
##
## Fixed effects:
##                     Estimate Std. Error         df t value Pr(>|t|)
## (Intercept)       -2.539e+01  9.661e-01  7.258e+01 -26.282  < 2e-16 ***
## date               1.616e-03  1.691e-05  1.083e+04  95.570  < 2e-16 ***
## cluster1           9.270e+00  2.509e+00  4.871e+01   3.695 0.000557 ***
## cluster2           1.902e+00  2.720e-01  3.911e+02   6.993 1.17e-11 ***
## median_income      7.398e-04  2.475e-04  3.949e+02   2.989 0.002974 **
## X2019_population  -2.879e-06  6.337e-07  3.693e+02  -4.544 7.50e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##             (Intr) date   clstr1 clstr2 mdn_nc
## date        -0.320
## cluster1    -0.073  0.000
## cluster2     0.229  0.000  0.348
## median_incm -0.727  0.000  0.009 -0.280
## X2019_ppltn -0.043  0.000 -0.651 -0.493 -0.089
## fit warnings:
## Some predictor variables are on very different scales: consider rescaling
```