

Final Project 632 Rough Draft

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Abstract (100 words) - Nic

The young man wanted a role model. He looked long and hard in his youth, but that role model never materialized. His only choice was to embrace all the people in his life he didn't want to be like. The young man wanted a role model. He looked long and hard in his youth, but that role model never materialized. His only choice was to embrace all the people in his life he didn't want to be like. The young man wanted a role model. He looked long and hard in his youth, but that role model never materialized. His only choice was to embrace all the people in his life he didn't want to be like.

Problem and Motivation (200 words) - Sri

The young man wanted a role model. He looked long and hard in his youth, but that role model never materialized. His only choice was to embrace all the people in his life he didn't want to be like. The young man wanted a role model. He looked long and hard in his youth, but that role model never materialized. His only choice was to embrace all the people in his life he didn't want to be like. The young man wanted a role model. He looked long and hard in his youth, but that role model never materialized. His only choice was to embrace all the people in his life he didn't want to be like.

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Data Description - Nic

This data set is a collection of governmental sources at national, regional, and city levels from 190 countries for COVID19. It includes time series of vaccines, test, cases, deaths, recovered, intensive therapy, and policy measures by Oxford COVID-19 Government Response Tracker. We will use the World Bank Google Mobility Reports as well.

There are 16 variables in the base data set that we will be using for our regression. We will be limiting the location data strictly to California and using data from 3/15/2020 - 3/15/2021.

Variables in the base data set

date, confirmed, tests, population, latitude, longitude, school_closing, workplace_closing, cancel_events, transport_closing, stay_home_restrictions, internal_movement_restrictions, international_movement_restrictions, information_campaigns, testing_policy, contact_tracing, stringency_index

Variables used on top of base data set

key_google_mobility - Identifier used in Google Mobility Reports.

key_apple_mobility - Identifier used in Apple Mobility Reports.

wb - World Bank Data

Questions of Interest

Using the base data set

1. What model using the policy measures is the best predictor of deaths / confirmed?

- Response: deaths / confirmed
- Predictors: Base data set

2.

Using the World Bank Data

1. How does the economic profile of the country affect the mortality rate from COVID over the year 2020?

- Response: Number of deaths/Confirmed Cases
- Predictors: GDP per capita, GDP per capita growth, Poverty rate, base data set

2. What is the effect of air pollution (or exposure to air pollution) to the number of cases and the mortality rate from COVID?

- Response: Number of cases and Number of deaths/Confirmed Cases
- Predictors: Pollution in mcg, base data set

Using the Google Mobility Data

1. Are policy measures that are non-restrictive with movement significant in preventing spread of Covid-19?

- Response: deaths
- Predictors: any of the policy measures that don't specifically prevent people from freely moving/travelling (i.e. testing policy, info campaigns, contract tracing)

2. Are policy measures that are restrictive with movement more significant than non-restrictive measures in preventing the spread of Covid-19

- Response: deaths
- Predictors: looking at both movement restrictive and non-restrictive and comparing their significance

Regression Analysis, Results and Interpretation

Important Details

Exploratory Analysis

We started by filtering the data first by United States of America, secondly by California, and finally by date. We ended with 365 rows of data for California.

```
## We have invested a lot of time and effort in creating COVID-19 Data Hub, please cite the following work
##
##   Guidotti, E., Ardia, D., (2020), "COVID-19 Data Hub", Journal of Open
##   Source Software 5(51):2376, doi: 10.21105/joss.02376.
##
## A BibTeX entry for LaTeX users is
##
##   @Article{,
##     title = {COVID-19 Data Hub},
##     year = {2020},
##     doi = {10.21105/joss.02376},
##     author = {Emanuele Guidotti and David Ardia},
##     journal = {Journal of Open Source Software},
##     volume = {5},
##     number = {51},
##     pages = {2376},
##   }
##
## To retrieve citation and metadata of the data sources see ?covid19cite. To hide this message use 've

## # A tibble: 6 x 38
## # Groups:   id [1]
##   id      date      vaccines tests confirmed recovered deaths hosp  vent  icu
##   <chr>   <date>      <dbl> <dbl>      <dbl>      <int> <int> <dbl> <int> <int>
## 1 1c20e6~ 2020-03-15      NA  8773      478          NA      6     NA     NA     NA
## 2 1c20e6~ 2020-03-16      NA 10874      588          NA     11     NA     NA     NA
## 3 1c20e6~ 2020-03-17      NA 13162      732          NA     14     NA     NA     NA
## 4 1c20e6~ 2020-03-18      NA 16063      893          NA     17     NA     NA     NA
## 5 1c20e6~ 2020-03-19      NA 19497     1067          NA     19     NA     NA     NA
## 6 1c20e6~ 2020-03-20      NA 25598     1283          NA     24     NA     NA     NA
## # ... with 28 more variables: population <dbl>, school_closing <int>,
## #   workplace_closing <int>, cancel_events <int>,
## #   gatherings_restrictions <int>, transport_closing <int>,
## #   stay_home_restrictions <int>, internal_movement_restrictions <int>,
## #   international_movement_restrictions <int>, information_campaigns <int>,
## #   testing_policy <int>, contact_tracing <int>, stringency_index <dbl>,
## #   iso_alpha_3 <chr>, iso_alpha_2 <chr>, iso_numeric <int>, currency <chr>,
## #   administrative_area_level <int>, administrative_area_level_1 <chr>,
## #   administrative_area_level_2 <chr>, administrative_area_level_3 <lgl>,
## #   latitude <dbl>, longitude <dbl>, key <chr>, key_google_mobility <chr>,
## #   key_apple_mobility <chr>, key_numeric <int>, key_alpha_2 <chr>

## # A tibble: 6 x 38
## # Groups:   id [1]
```

```
##   id      date      vaccines tests confirmed recovered deaths hosp vent  icu
##   <chr> <date>      <dbl> <dbl>      <dbl>      <int> <int> <dbl> <int> <int>
## 1 1c20e~ 2021-03-09 10925581 4.32e7   3608022      NA  54620 4007   NA  1045
## 2 1c20e~ 2021-03-10 11062505 4.34e7   3611490      NA  54877 3900   NA  1009
## 3 1c20e~ 2021-03-11 11220508 4.36e7   3615049      NA  55132 3766   NA  1013
## 4 1c20e~ 2021-03-12 11428034 4.38e7   3617356      NA  55336 3649   NA   976
## 5 1c20e~ 2021-03-13 11881857 4.39e7   3621094      NA  56349 3534   NA   939
## 6 1c20e~ 2021-03-14 11883375 4.40e7   3623342      NA  56499 3502   NA   912
## # ... with 28 more variables: population <dbl>, school_closing <int>,
## #   workplace_closing <int>, cancel_events <int>,
## #   gatherings_restrictions <int>, transport_closing <int>,
## #   stay_home_restrictions <int>, internal_movement_restrictions <int>,
## #   international_movement_restrictions <int>, information_campaigns <int>,
## #   testing_policy <int>, contact_tracing <int>, stringency_index <dbl>,
## #   iso_alpha_3 <chr>, iso_alpha_2 <chr>, iso_numeric <int>, currency <chr>,
## #   administrative_area_level <int>, administrative_area_level_1 <chr>,
## #   administrative_area_level_2 <chr>, administrative_area_level_3 <lg1>,
## #   latitude <dbl>, longitude <dbl>, key <chr>, key_google_mobility <chr>,
## #   key_apple_mobility <chr>, key_numeric <int>, key_alpha_2 <chr>
```

We then looked at all of the variables to look at what variables we should use. We narrowed it down to date, confirmed, deaths, tests, population, latitude, longitude, school closing, workplace closing, canceled events, transport closing, stay home restrictions, internal movement restrictions, international movement restrictions, information campaigns, testing policy, contact tracing, and stringency index for the base data set.

We realized that the policy measures needed to be turned into factors before we could run a regression model. We discovered that factors need to have 2 or more levels in order to work so we removed cancel_events, international_movement, and transport_closing.

```
## # A tibble: 6 x 16
##   date      confirmed deaths tests latitude longitude population school_closing
##   <date>      <dbl> <int> <dbl>      <dbl>      <dbl>      <dbl>      <int>
## 1 2020-03-15      478     6  8773      36.6      -117.    39512223         2
## 2 2020-03-16      588    11 10874      36.6      -117.    39512223         2
## 3 2020-03-17      732    14 13162      36.6      -117.    39512223         3
## 4 2020-03-18      893    17 16063      36.6      -117.    39512223         3
## 5 2020-03-19     1067    19 19497      36.6      -117.    39512223         3
## 6 2020-03-20     1283    24 25598      36.6      -117.    39512223         3
## # ... with 8 more variables: workplace_closing <int>,
## #   gatherings_restrictions <int>, stay_home_restrictions <int>,
## #   internal_movement_restrictions <int>, information_campaigns <int>,
## #   testing_policy <int>, contact_tracing <int>, stringency_index <dbl>
```

The following object is masked from package:tidyr:

```
##
##   population
```

```
## # A tibble: 6 x 24
##   date      confirmed deaths tests latitude longitude population school_closing
##   <date>      <dbl> <int> <dbl>      <dbl>      <dbl>      <dbl>      <int>
## 1 2020-03-15      478     6  8773      36.6      -117.    39512223         2
## 2 2020-03-16      588    11 10874      36.6      -117.    39512223         2
## 3 2020-03-17      732    14 13162      36.6      -117.    39512223         3
```

```
## 4 2020-03-18      893      17 16063      36.6      -117.      39512223      3
## 5 2020-03-19     1067      19 19497      36.6      -117.      39512223      3
## 6 2020-03-20     1283      24 25598      36.6      -117.      39512223      3
## # ... with 16 more variables: workplace_closing <int>,
## #   gatherings_restrictions <int>, stay_home_restrictions <int>,
## #   internal_movement_restrictions <int>, information_campaigns <int>,
## #   testing_policy <int>, contact_tracing <int>, stringency_index <dbl>,
## #   fschool_closing <fct>, fworkplace_closing <fct>,
## #   fgatherings_restrictions <fct>, fstay_home_restrictions <fct>,
## #   finternal_movement_restrictions <fct>, finformation_campaigns <fct>,
## #   ftesting_policy <fct>, fcontact_tracing <fct>

## tibble [365 x 24] (S3: tbl_df/tbl/data.frame)
##  $ date                : Date[1:365], format: "2020-03-15" "2020-03-16" ...
##  $ confirmed            : num [1:365] 478 588 732 893 1067 ...
##  $ deaths               : int [1:365] 6 11 14 17 19 24 28 35 39 52 ...
##  $ tests                : num [1:365] 8773 10874 13162 16063 19497 ...
##  $ latitude             : num [1:365] 36.6 36.6 36.6 36.6 36.6 ...
##  $ longitude            : num [1:365] -117 -117 -117 -117 -117 ...
##  $ population           : num [1:365] 39512223 39512223 39512223 39512223 39512223 ...
##  $ school_closing       : int [1:365] 2 2 3 3 3 3 3 3 3 3 ...
##  $ workplace_closing    : int [1:365] 1 1 3 3 3 3 3 3 3 3 ...
##  $ gatherings_restrictions : int [1:365] 2 4 4 4 4 4 4 4 4 4 ...
##  $ stay_home_restrictions : int [1:365] 1 1 2 2 2 2 2 2 2 2 ...
##  $ internal_movement_restrictions : int [1:365] 0 1 1 1 2 2 2 2 2 2 ...
##  $ information_campaigns : int [1:365] 1 2 2 2 2 2 2 2 2 2 ...
##  $ testing_policy       : int [1:365] 1 1 1 1 1 1 1 1 1 1 ...
##  $ contact_tracing      : int [1:365] 1 1 1 1 1 1 1 1 1 1 ...
##  $ stringency_index     : num [1:365] 43.5 60.2 73.2 73.2 82.4 ...
##  $ fschool_closing      : Factor w/ 2 levels "2","3": 1 1 2 2 2 2 2 2 2 2 ...
##  $ fworkplace_closing   : Factor w/ 3 levels "1","2","3": 1 1 3 3 3 3 3 3 3 3 ...
##  $ fgatherings_restrictions : Factor w/ 3 levels "2","3","4": 1 3 3 3 3 3 3 3 3 3 ...
##  $ fstay_home_restrictions : Factor w/ 2 levels "1","2": 1 1 2 2 2 2 2 2 2 2 ...
##  $ finternal_movement_restrictions: Factor w/ 3 levels "0","1","2": 1 2 2 2 3 3 3 3 3 3 ...
##  $ finformation_campaigns : Factor w/ 2 levels "1","2": 1 2 2 2 2 2 2 2 2 2 ...
##  $ ftesting_policy      : Factor w/ 3 levels "1","2","3": 1 1 1 1 1 1 1 1 1 1 ...
##  $ fcontact_tracing     : Factor w/ 2 levels "1","2": 1 1 1 1 1 1 1 1 1 1 ...
```

We set the null and full models using the data with factors.

```
mod.0 <- lm(deaths ~ 1, data = fbase_data)
mod.full <- lm(deaths ~ date + confirmed + tests + latitude + longitude + population + fschool_closing +
  fworkplace_closing + fgatherings_restrictions + fstay_home_restrictions + finternal_movement_restrictions +
  finformation_campaigns + ftesting_policy + fcontact_tracing + stringency_index, data = fbase_data)
```

We ran a basic ANOVA to make sure that there was at least one significant variable in our model. We accordingly can now reject the null hypothesis and assume that there is at least one significant predictor in this model.

```
anova(mod.0, mod.full)
```

```
## Analysis of Variance Table
##
```

```
## Model 1: deaths ~ 1
## Model 2: deaths ~ date + confirmed + tests + latitude + longitude + population +
##      fschool_closing + fworkplace_closing + fgatherings_restrictions +
##      fstay_home_restrictions + finternal_movement_restrictions +
##      finformation_campaigns + ftesting_policy + fcontact_tracing +
##      stringency_index
##   Res.Df      RSS Df Sum of Sq      F      Pr(>F)
## 1     364 8.1637e+10
## 2     350 3.9122e+08 14 8.1245e+10 5191.8 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

We ran the pairs() to start looking to see if the assumptions have been met however, there are too many variables for it to be useful. We then

```
summary(mod.full)
```

```
##
## Call:
## lm(formula = deaths ~ date + confirmed + tests + latitude + longitude +
##      population + fschool_closing + fworkplace_closing + fgatherings_restrictions +
##      fstay_home_restrictions + finternal_movement_restrictions +
##      finformation_campaigns + ftesting_policy + fcontact_tracing +
##      stringency_index, data = fbase_data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3566.1  -505.1   -32.9    620.1   3424.5
##
## Coefficients: (5 not defined because of singularities)
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   3.509e+05  1.839e+05   1.908 0.057233 .
## date         -2.033e+01  1.002e+01  -2.028 0.043331 *
## confirmed      3.721e-04  1.201e-03   0.310 0.756880
## tests         1.346e-03  1.645e-04   8.185 5.12e-15 ***
## latitude              NA           NA      NA      NA
## longitude              NA           NA      NA      NA
## population              NA           NA      NA      NA
## fschool_closing3    -4.101e+03  5.041e+02  -8.136 7.21e-15 ***
## fworkplace_closing2  2.478e+03  1.332e+03   1.860 0.063680 .
## fworkplace_closing3  3.272e+03  1.651e+03   1.981 0.048372 *
## fgatherings_restrictions3 -9.722e+03  2.024e+03  -4.802 2.33e-06 ***
## fgatherings_restrictions4 -1.176e+04  2.167e+03  -5.428 1.07e-07 ***
## fstay_home_restrictions2 -6.354e+03  2.874e+02 -22.112 < 2e-16 ***
## finternal_movement_restrictions1 3.422e+03  4.510e+02   7.588 2.96e-13 ***
## finternal_movement_restrictions2      NA           NA      NA      NA
## finformation_campaigns2      NA           NA      NA      NA
## ftesting_policy2      1.364e+03  3.776e+02   3.613 0.000347 ***
## ftesting_policy3      5.707e+02  4.851e+02   1.176 0.240293
## fcontact_tracing2     -1.238e+03  3.033e+02  -4.083 5.51e-05 ***
## stringency_index      5.017e+02  7.626e+01   6.579 1.73e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Residual standard error: 1057 on 350 degrees of freedom
## Multiple R-squared:  0.9952, Adjusted R-squared:  0.995
## F-statistic: 5192 on 14 and 350 DF,  p-value: < 2.2e-16
```

We ran through two more rounds of summary and removed `information_campaign` and `internal_movement_restrictions` due to singularities leaving with our final full model called `mod.full3`.

```
mod.full3 <- lm(deaths ~ date + confirmed + tests + fschool_closing +
               fworkplace_closing + fgatherings_restrictions + fstay_home_restrictions +
               ftesting_policy + fcontact_tracing + stringency_index, data = fbase_data)
```

```
summary(mod.full3)
```

```
##
## Call:
## lm(formula = deaths ~ date + confirmed + tests + fschool_closing +
##     fworkplace_closing + fgatherings_restrictions + fstay_home_restrictions +
##     ftesting_policy + fcontact_tracing + stringency_index, data = fbase_data)
##
## Residuals:
```

	Min	1Q	Median	3Q	Max
	-3788.9	-589.2	64.8	561.7	3993.8

```
##
## Coefficients:
```

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	7.733e+05	1.889e+05	4.093	5.28e-05 ***
date	-4.260e+01	1.033e+01	-4.124	4.65e-05 ***
confirmed	-2.746e-03	1.216e-03	-2.258	0.02459 *
tests	1.678e-03	1.709e-04	9.819	< 2e-16 ***
fschool_closing3	-5.062e+03	5.258e+02	-9.627	< 2e-16 ***
fworkplace_closing2	6.630e+03	1.309e+03	5.066	6.58e-07 ***
fworkplace_closing3	8.446e+03	1.621e+03	5.211	3.22e-07 ***
fgatherings_restrictions3	-2.095e+03	1.894e+03	-1.107	0.26925
fgatherings_restrictions4	-2.955e+03	1.972e+03	-1.498	0.13492
fstay_home_restrictions2	-6.451e+03	3.094e+02	-20.853	< 2e-16 ***
ftesting_policy2	1.876e+03	4.004e+02	4.686	3.99e-06 ***
ftesting_policy3	8.261e+02	5.215e+02	1.584	0.11409
fcontact_tracing2	-1.026e+03	3.254e+02	-3.154	0.00175 **
stringency_index	1.799e+02	6.830e+01	2.634	0.00881 **

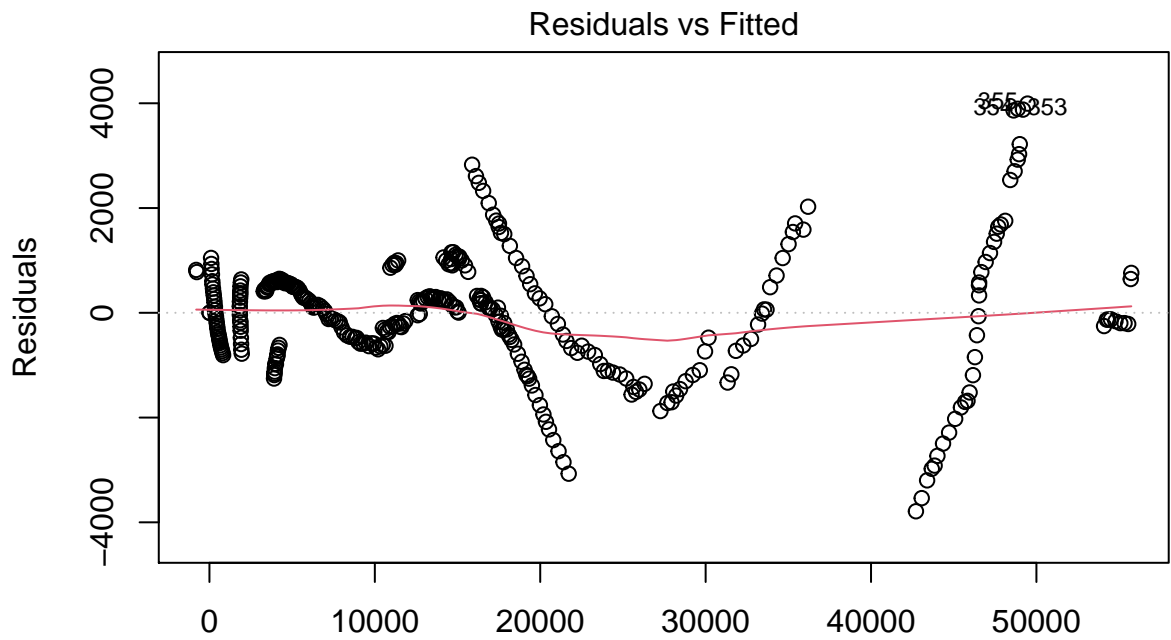
```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1139 on 351 degrees of freedom
## Multiple R-squared:  0.9944, Adjusted R-squared:  0.9942
## F-statistic: 4811 on 13 and 351 DF,  p-value: < 2.2e-16
```

Diagnostic Checks

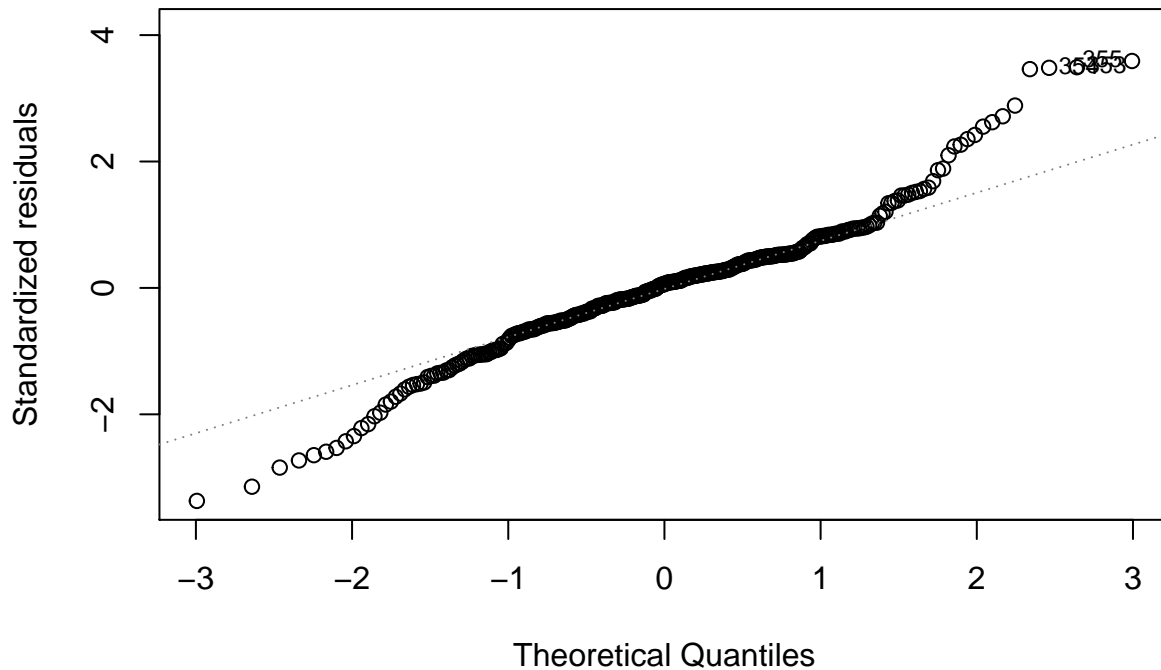
```
plot(mod.full3, 1:2)
```



```
## Warning: not plotting observations with leverage one:
## 1, 2
```



lm(deaths ~ date + confirmed + tests + fschool_closing + fworkplace_closing ...
Normal Q-Q



lm(deaths ~ date + confirmed + tests + fschool_closing + fworkplace_closing ...

This is heavy tailed and the residuals have a distinct pattern. So we need to look at transforming the data.

```
pt <- powerTransform(cbind(confirmed, tests, fschool_closing,
                           fworkplace_closing, fgatherings_restrictions, fstay_home_restrictions ,
                           ftesting_policy, fcontact_tracing, stringency_index) ~ 1, data = fbase_data)
```

```
## Warning in estimateTransform.default(X, Y, weights, family, ...): Convergence
## failure: return code = 1
```

```
summary(pt)
```

```
## bcPower Transformations to Multinormality
##
##               Est Power Rounded Pwr Wald Lwr Bnd Wald Up Bnd
## confirmed              0.2110      0.21      0.1802      0.2418
## tests                  0.2453      0.25      0.2095      0.2811
## fschool_closing        30.7964     30.80     27.6370     33.9559
## fworkplace_closing      0.9074      1.00      0.6364      1.1783
## fgatherings_restrictions 9.8307      9.83      8.6249     11.0366
## fstay_home_restrictions -3.3439     -3.34     -3.9247     -2.7632
## ftesting_policy         2.0148      2.00      1.6925      2.3372
## fcontact_tracing        2.5139      2.00      1.9626      3.0653
## stringency_index        1.1694      1.00      0.7609      1.5779
##
## Likelihood ratio test that transformation parameters are equal to 0
## (all log transformations)
##
##               LRT df      pval
## LR test, lambda = (0 0 0 0 0 0 0 0 0) 2653.09  9 < 2.22e-16
##
## Likelihood ratio test that no transformations are needed
##
##               LRT df      pval
## LR test, lambda = (1 1 1 1 1 1 1 1 1) 2977.719  9 < 2.22e-16
```

Interpretation

Conclusions (200 words) - Thomas

The young man wanted a role model. He looked long and hard in his youth, but that role model never materialized. His only choice was to embrace all the people in his life he didn't want to be like. The young man wanted a role model. He looked long and hard in his youth, but that role model never materialized. His only choice was to embrace all the people in his life he didn't want to be like. The young man wanted a role model. He looked long and hard in his youth, but that role model never materialized. His only choice was to embrace all the people in his life he didn't want to be like.

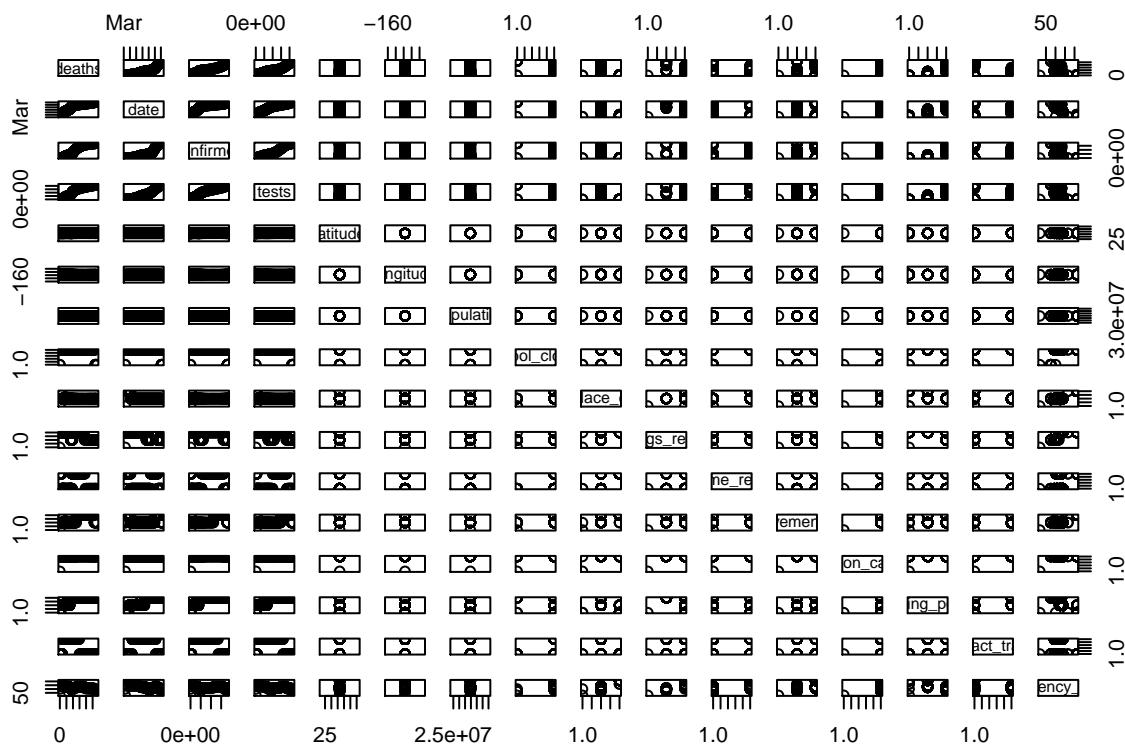
The young man wanted a role model. He looked long and hard in his youth, but that role model never materialized. His only choice was to embrace all the people in his life he didn't want to be like. The young man wanted a role model. He looked long and hard in his youth, but that role model never materialized. His only choice was to embrace all the people in his life he didn't want to be like. The young man wanted a role model. He looked long and hard in his youth, but that role model never materialized. His only choice was to embrace all the people in his life he didn't want to be like.

Appendices

Appendix 1: R Code

Appendix 2 (optional): Exploratory analysis not used in final paper

```
pairs(deaths ~ date + confirmed + tests + latitude + longitude + population + fschool_closing +
      fworkplace_closing + fgatherings_restrictions + fstay_home_restrictions + finternal_movemen
      finformation_campaigns + ftesting_policy + fcontact_tracing + stringency_index, data = fbase)
```



Appendix 3: Data Variable Description

- **date** - Observation date
- **confirmed** - Cumulative number of confirmed cases
- **tests** - Cumulative number of tests
- **population** - Total population
- **latitude** - Latitude (Check to see if more than 1 since we are only using CA)
- **longitude** - Longitude (Check to see if more than 1 since we are only using CA)
- **school_closing** - 0: No measures - 1: Recommend closing - 2: Require closing (only some levels or categories, eg just high school, or just public schools - 3: Require closing all levels
- **workplace_closing** - 0: No measures - 1: Recommend closing (or work from home) - 2: require closing for some sectors or categories of workers - 3: require closing (or work from home) all-but-essential workplaces (eg grocery stores, doctors).
- **cancel_events** - 0: No measures - 1: Recommend canceling - 2: Require canceling gatherings_restrictions 0: No restrictions - 1: Restrictions on very large gatherings (the limit is above 1000 people) - 2: Restrictions on gatherings between 100-1000 people - 3: Restrictions on gatherings between 10-100 people - 4: Restrictions on gatherings of less than 10 people.

- **transport_closing** - 0: No measures - 1: Recommend closing (or significantly reduce volume/route/means of transport available) - 2: Require closing (or prohibit most citizens from using it).
- **stay_home_restrictions** - 0: No measures - 1: recommend not leaving house - 2: require not leaving house with exceptions for daily exercise, grocery shopping, and “essential” trips - 3: Require not leaving house with minimal exceptions (e.g. allowed to leave only once every few days, or only one person can leave at a time, etc.).
- **internal_movement_restrictions** - 0: No measures - 1: Recommend closing (or significantly reduce volume/route/means of transport) - 2: Require closing (or prohibit most people from using it).
- **international_movement_restrictions** - 0: No measures - 1: Screening - 2: Quarantine arrivals from high-risk regions - 3: Ban on high-risk regions - 4: Total border closure.
- **information_campaigns** - 0: No COVID-19 public information campaign - 1: public officials urging caution about COVID-19 - 2: coordinated public information campaign (e.g. across traditional and social media).
- **testing_policy** - 0: No testing policy - 1: Only those who both (a) have symptoms AND (b) meet specific criteria (eg key workers, admitted to hospital, came into contact with a known case, returned from overseas) - 2: testing of anyone showing COVID-19 symptoms - 3: open public testing (eg “drive through” testing available to asymptomatic people).
- **contact_tracing** - 0: No contact tracing - 1: Limited contact tracing, not done for all cases - 2: Comprehensive contact tracing, done for all cases.

stringency_index - Stringency of governmental responses. ## Source

<URL: <https://covid19datahub.io>>

References

Guidotti, E., Ardia, D., (2020), "COVID-19 Data Hub", Journal of Open Source Software 5(51):2376, doi: 10.21105/joss.02376 (URL: <https://doi.org/10.21105/joss.02376>).