MLR Model

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Imports and Constants

```
library("tidyverse")
```

```
## -- Attaching packages ---------------------------------------------------------------------------
## v ggplot2 3.3.5     v purrr   0.3.4
## v tibble  3.1.6     v dplyr   1.0.8
## v tidyr   1.2.0     v stringr 1.4.0
## v readr   2.1.2     v forcats 0.5.1
## -- Conflicts ------------------------------------------------------------------------------------
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
source('./gibbs_util.R')
```

```
## Loading required package: Matrix
##
## Attaching package: 'Matrix'
## The following objects are masked from 'package:tidyr':
##
##     expand, pack, unpack
## Loading required package: stats4
## Loading required package: gmm
## Loading required package: sandwich
##
## Attaching package: 'pracma'
## The following objects are masked from 'package:Matrix':
##
##     expm, lu, tril, triu
## The following object is masked from 'package:purrr':
##
##     cross
## Loading required package: reshape2
##
## Attaching package: 'reshape2'
```

```
## The following object is masked from 'package:tidyr':
##
##     smiths
```

```
RANDOM_SEED = 440
```

Data Loading / Cleaning

```
load('./burritodata.Rda')
head(burrito)
```

```
##              Location Cost Hunger Length Circum Volume Tortilla Temp Meat
## 1   Donato's taco shop 6.49    3.0     NA     NA     NA        3  5.0  3.0
## 2 Oscar's Mexican food 5.45    3.5     NA     NA     NA        2  3.5  2.5
## 3 Oscar's Mexican food 4.85    1.5     NA     NA     NA        3  2.0  2.5
## 4 Oscar's Mexican food 5.25    2.0     NA     NA     NA        3  2.0  3.5
## 5         Pollos Maria 6.59    4.0     NA     NA     NA        4  5.0  4.0
## 6         Pollos Maria 6.99    4.0     NA     NA     NA        3  4.0  5.0
##   Fillings Meat_filling Uniformity Salsa Synergy Wrap Reviewer overall Beef
## 1      3.5          4.0        4.0   4.0     4.0    4    Scott    3.80    1
## 2      2.5          2.0        4.0   3.5     2.5    5    Scott    3.00    1
## 3      3.0          4.5        4.0   3.0     3.0    5    Emily    3.00    0
## 4      3.0          4.0        5.0   4.0     4.0    5  Ricardo    3.75    1
## 5      3.5          4.5        5.0   2.5     4.5    4    Scott    4.20    1
## 6      3.5          2.5        2.5   2.5     4.0    1    Emily    3.20    0
##   Pico Guac Cheese Fries Sour_cream Pork Chicken Shrimp Fish Rice Beans Lettuce
## 1    1    1      1     1          0    0       0      0    0    0     0       0
## 2    1    1      1     1          0    0       0      0    0    0     0       0
## 3    1    1      0     0          0    1       0      0    0    0     0       0
## 4    1    1      0     0          0    0       0      0    0    0     0       0
## 5    1    0      1     1          0    0       0      0    0    0     0       0
## 6    0    1      1     0          1    0       1      0    0    1     1       1
##   Tomato Bell_peper Carrots Cabbage Sauce Cilantro Onion Taquito Pineapple Ham
## 1      0          0       0       0     0        0     0       0         0   0
## 2      0          0       0       0     0        0     0       0         0   0
## 3      0          0       0       0     0        0     0       0         0   0
## 4      0          0       0       0     0        0     0       0         0   0
## 5      0          0       0       0     0        0     0       0         0   0
## 6      1          0       0       0     0        0     0       0         0   0
##   Chile_relleno Nopales Lobster Egg Mushroom Bacon Sushi Avocado Corn Zucchini
## 1             0       0       0   0        0     0     0       0    0        0
## 2             0       0       0   0        0     0     0       0    0        0
## 3             0       0       0   0        0     0     0       0    0        0
## 4             0       0       0   0        0     0     0       0    0        0
## 5             0       0       0   0        0     0     0       0    0        0
## 6             0       0       0   0        0     0     0       0    0        0
```

```
# Count Remove NA Cost rows
which(is.na(burrito$Cost))
```

```
## [1] 113 135
```

```
burrito = burrito[!is.na(burrito$Cost),]
nrow(burrito)
```

```
## [1] 237
```

```
burrito<-burrito%>%mutate(Vegetable=as.logical(Pineapple+Bell_peper+Tomato+Cabbage+Mushroom+Corn+Carrots
burrito<-burrito%>%mutate(Breakfast=as.logical(Egg+Bacon+Ham))
burrito<-burrito%>%mutate(Other=as.logical(Fish+Taquito+Chile_relleno+Nopales+Sushi+Lobster))
burrito<-select(burrito, -c('Pineapple','Bell_peper','Tomato','Cabbage','Mushroom','Corn','Carrots','Zu
burrito<-burrito%>%mutate_at(c('Vegetable','Other','Breakfast'),as.double)
head(burrito)
```

```
##               Location Cost Hunger Length Circum Volume Tortilla Temp Meat
## 1   Donato's taco shop 6.49    3.0     NA     NA     NA        3  5.0  3.0
## 2 Oscar's Mexican food 5.45    3.5     NA     NA     NA        2  3.5  2.5
## 3 Oscar's Mexican food 4.85    1.5     NA     NA     NA        3  2.0  2.5
## 4 Oscar's Mexican food 5.25    2.0     NA     NA     NA        3  2.0  3.5
## 5         Pollos Maria 6.59    4.0     NA     NA     NA        4  5.0  4.0
## 6         Pollos Maria 6.99    4.0     NA     NA     NA        3  4.0  5.0
##   Fillings Meat_filling Uniformity Salsa Synergy Wrap Reviewer overall Beef
## 1      3.5          4.0        4.0   4.0     4.0    4    Scott    3.80    1
## 2      2.5          2.0        4.0   3.5     2.5    5    Scott    3.00    1
## 3      3.0          4.5        4.0   3.0     3.0    5    Emily    3.00    0
## 4      3.0          4.0        5.0   4.0     4.0    5  Ricardo    3.75    1
## 5      3.5          4.5        5.0   2.5     4.5    4    Scott    4.20    1
## 6      3.5          2.5        2.5   2.5     4.0    1    Emily    3.20    0
##   Pico Guac Cheese Fries Sour_cream Pork Chicken Shrimp Rice Beans Lettuce
## 1    1    1      1     1          0    0       0      0    0     0       0
## 2    1    1      1     1          0    0       0      0    0     0       0
## 3    1    1      0     0          0    1       0      0    0     0       0
## 4    1    1      0     0          0    0       0      0    0     0       0
## 5    1    0      1     1          0    0       0      0    0     0       0
## 6    0    1      1     0          1    0       1      0    1     1       1
##   Sauce Cilantro Onion Avocado Vegetable Breakfast Other
## 1     0        0     0       0         0         0     0
## 2     0        0     0       0         0         0     0
## 3     0        0     0       0         0         0     0
## 4     0        0     0       0         0         0     0
## 5     0        0     0       0         0         0     0
## 6     0        0     0       0         1         0     0
```

```
ingredient_cols = colnames(burrito)[18:36]

ingredient_X = as.matrix(burrito[ingredient_cols])
dim(ingredient_X); head(ingredient_X)
```

```
## [1] 237  19
```

```
##   Beef Pico Guac Cheese Fries Sour_cream Pork Chicken Shrimp Rice Beans Lettuce
## 1    1    1    1      1     1          0    0       0      0    0     0       0
## 2    1    1    1      1     1          0    0       0      0    0     0       0
## 3    0    1    1      0     0          0    1       0      0    0     0       0
## 4    1    1    1      0     0          0    0       0      0    0     0       0
## 5    1    1    0      1     1          0    0       0      0    0     0       0
## 6    0    0    1      1     0          1    0       1      0    1     1       1
##   Sauce Cilantro Onion Avocado Vegetable Breakfast Other
## 1     0        0     0       0         0         0     0
## 2     0        0     0       0         0         0     0
## 3     0        0     0       0         0         0     0
```

```
## 4     0        0     0       0         0         0     0
## 5     0        0     0       0         0         0     0
## 6     0        0     0       0         1         0     0
```

```
cost_y = burrito$Cost
length(cost_y); head(cost_y)
```

```
## [1] 237
```

```
## [1] 6.49 5.45 4.85 5.25 6.59 6.99
```

Model Fit with Gibbs Sampler

```
set.seed(RANDOM_SEED)

p = ncol(ingredient_X) + 1
tau_2 = 4
prior_sigma = 1.5
a = 1 / (prior_sigma^4)
b = 1 / (prior_sigma^2)

post_dist = mlr_gibbs(ingredient_X, cost_y, mu=rep(0, p), tau_2, a, b)
post_dist = post_dist[5001:1000, ]
head(post_dist)
```

```
##      Intercept       Beef        Pico        Guac     Cheese      Fries
## [1,]  6.506788 0.09686817 -0.18251001  0.26545818 -0.2869089 0.29514165
## [2,]  6.541831 0.64982427 -0.34775682 -0.09303093 -0.1523263 0.03973934
## [3,]  6.204584 0.46851815 -0.01437294  0.21059807 -0.2027316 0.28410215
## [4,]  6.077799 0.45299753  0.13264876  0.01923345 -0.4316204 0.46342567
## [5,]  5.912361 0.57193168 -0.44384438  0.51599411 -0.1427372 0.51734692
## [6,]  6.035877 0.75904784 -0.11267814  0.15892978 -0.3561099 0.34476768
##       Sour_cream      Pork   Chicken    Shrimp         Rice      Beans
## [1,]  0.59709291 0.2459553 0.5840233 1.7151745 -0.686199825  0.1193568
## [2,]  0.18334495 0.2494273 0.9673843 1.1384892 -0.002155284 -0.8704678
## [3,]  0.29768881 0.4181917 0.6235629 1.9792503 -0.065241397 -0.5402507
## [4,]  0.11722193 0.3835778 0.9269230 0.7928062  0.202960870 -0.5812086
## [5,] -0.05186082 0.9808450 0.9484185 2.1825055 -0.156712741 -0.1569054
## [6,]  0.37848879 0.4896129 0.8541657 1.4110235  0.089645907 -0.8382675
##         Lettuce      Sauce   Cilantro       Onion     Avocado   Vegetable
## [1,] 0.62828215 0.29798725 -1.4142392  0.87985468 -0.40975195  0.26161601
## [2,] 0.15855096 0.03519916  1.2027066 -1.36797163  0.33847853  0.25346854
## [3,] 0.23922257 0.11636027 -0.8696048  0.47879767 -0.28633039 -0.07340536
## [4,] 0.51157172 0.62853600 -0.3619922  0.30005401  0.01253204 -0.02179466
## [5,] 0.08106538 0.10343207 -1.0354165 -0.01855306 -0.32655176  0.11178819
## [6,] 0.33648958 0.33053762  1.0206551 -1.60634063 -0.10665331  0.40786583
##       Breakfast    Other    sigma
## [1,] -0.6930503 1.258141 1.088328
## [2,] -0.6089437 1.675402 1.162526
## [3,] -0.7084383 1.774583 1.167411
## [4,]  0.1445543 1.358570 1.123471
## [5,] -1.5834869 1.150852 1.194266
## [6,]  0.2979476 1.142007 1.172517
```

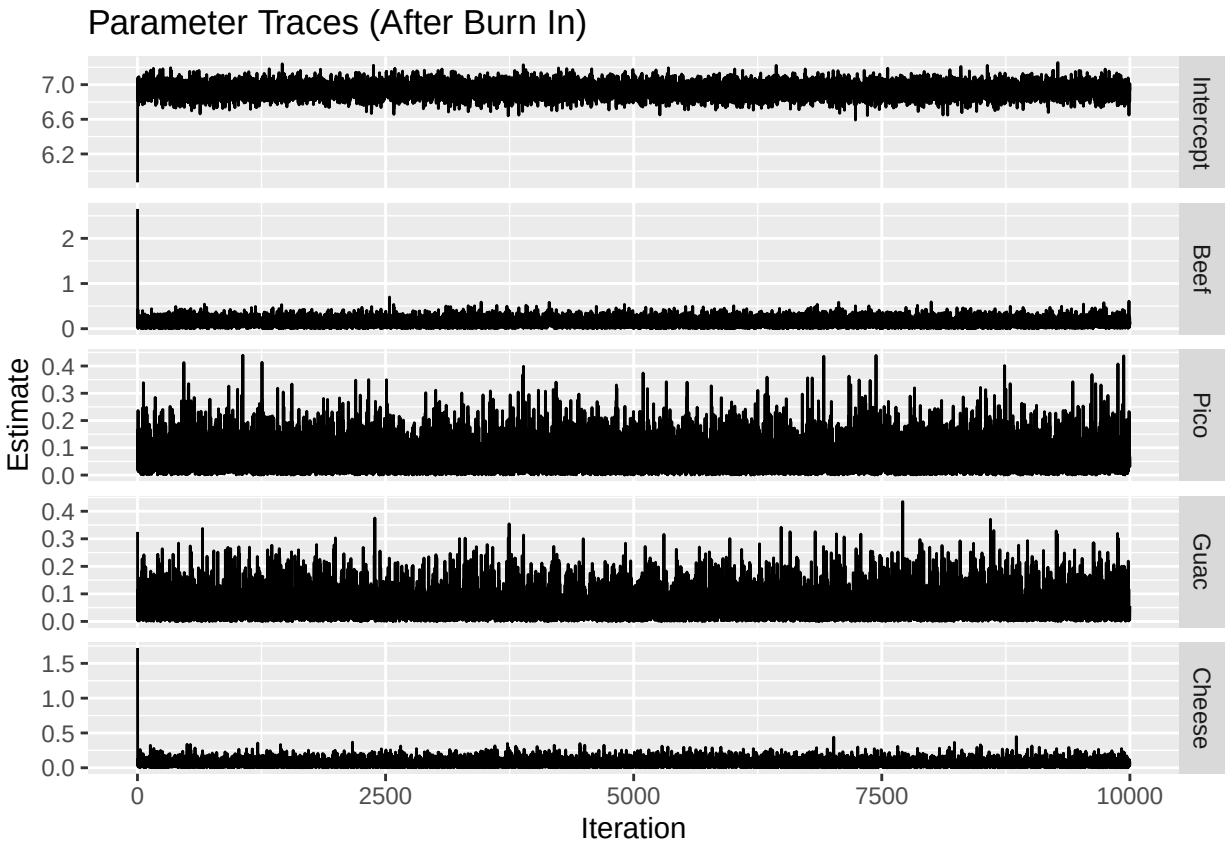
Truncated Gibs

```
set.seed(RANDOM_SEED)

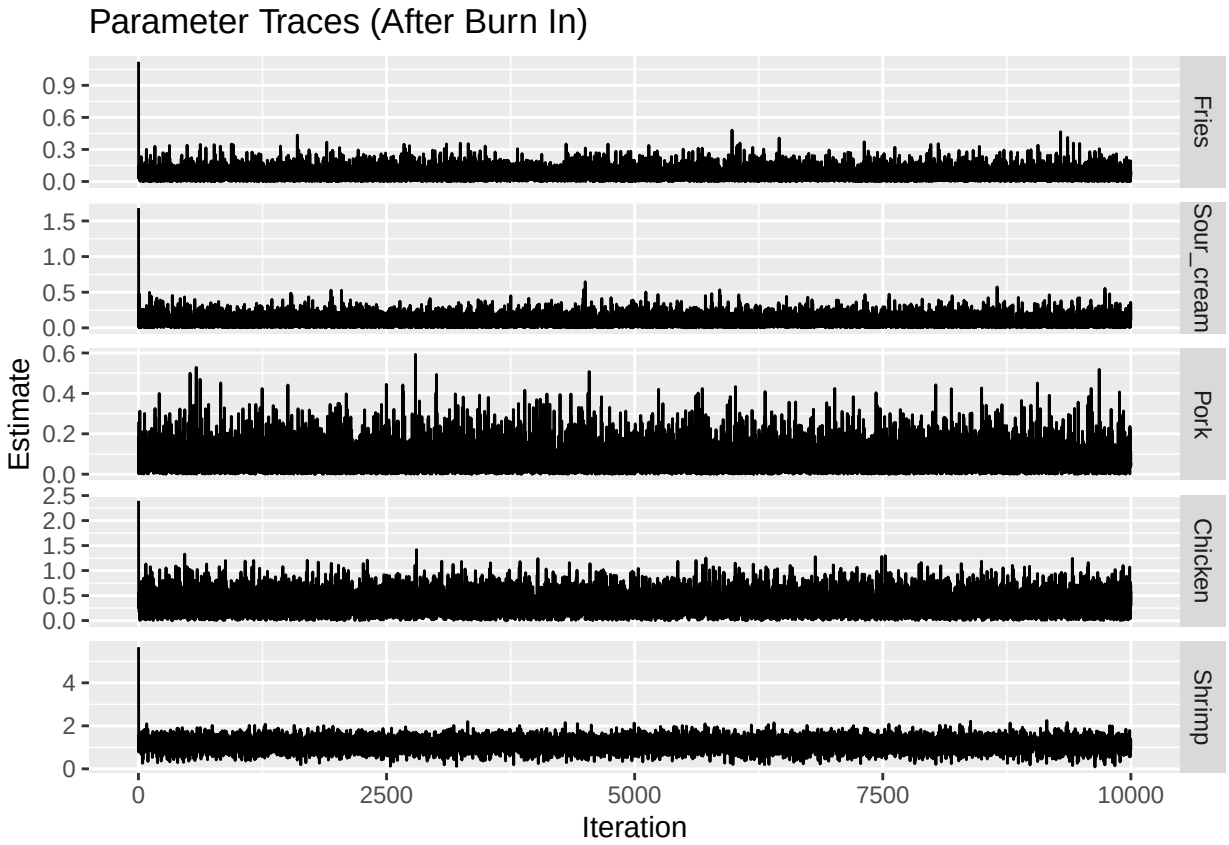
post_dist<-truncated_gibbs(ingredient_X, cost_y, mu=rep(1, p), tau_2, a, b, lb=rep(0,p), ub=rep(Inf,p))
```

Model Diagnostics

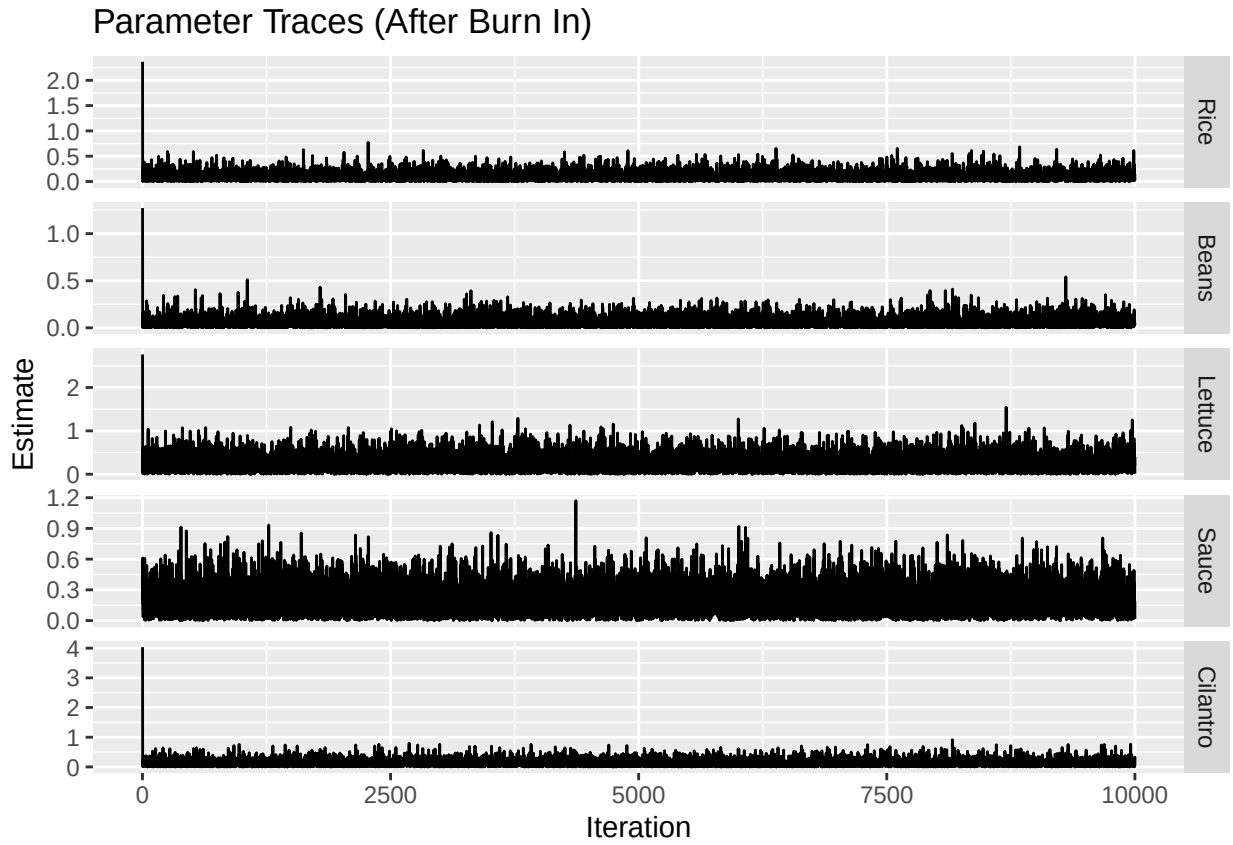
```
plot_traces(post_dist[,1:5], 'Parameter Traces (After Burn In)')
```



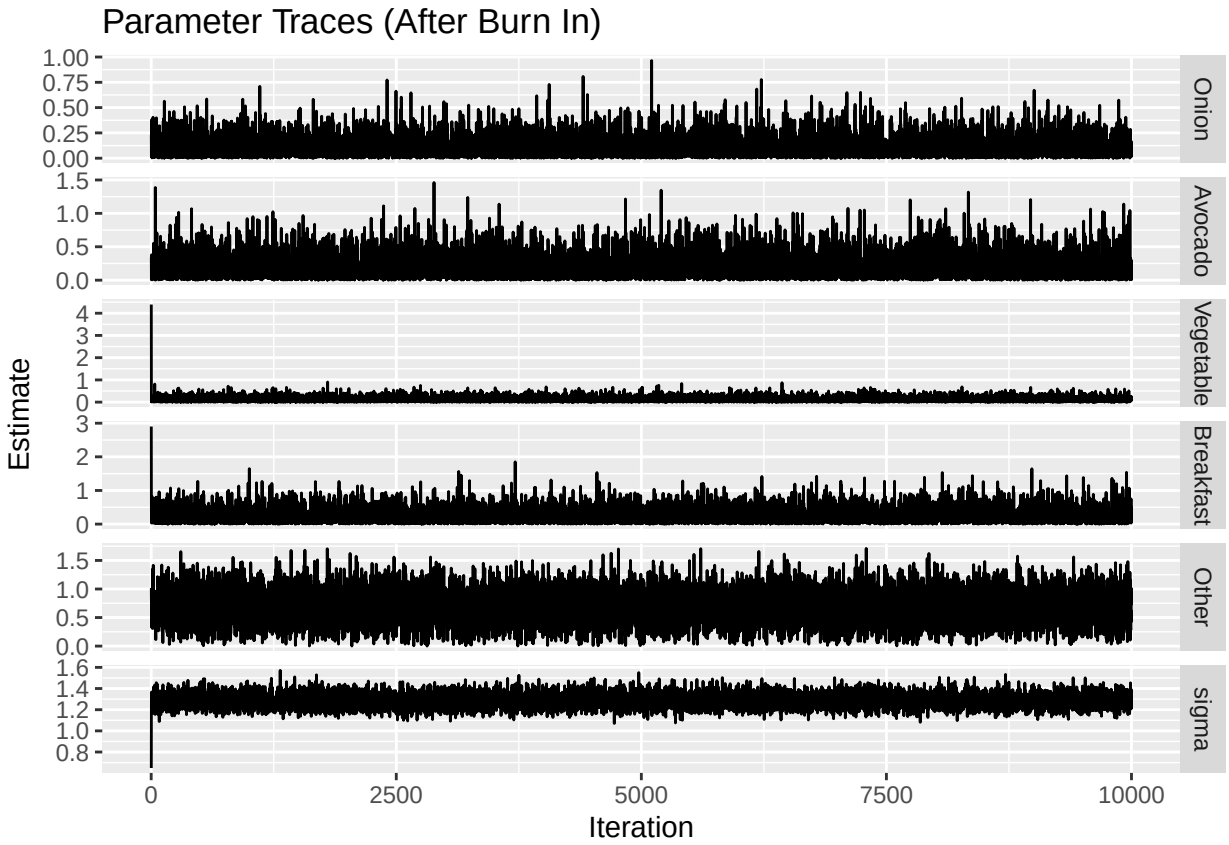

```
plot_traces(post_dist[,6:10], 'Parameter Traces (After Burn In)')
```



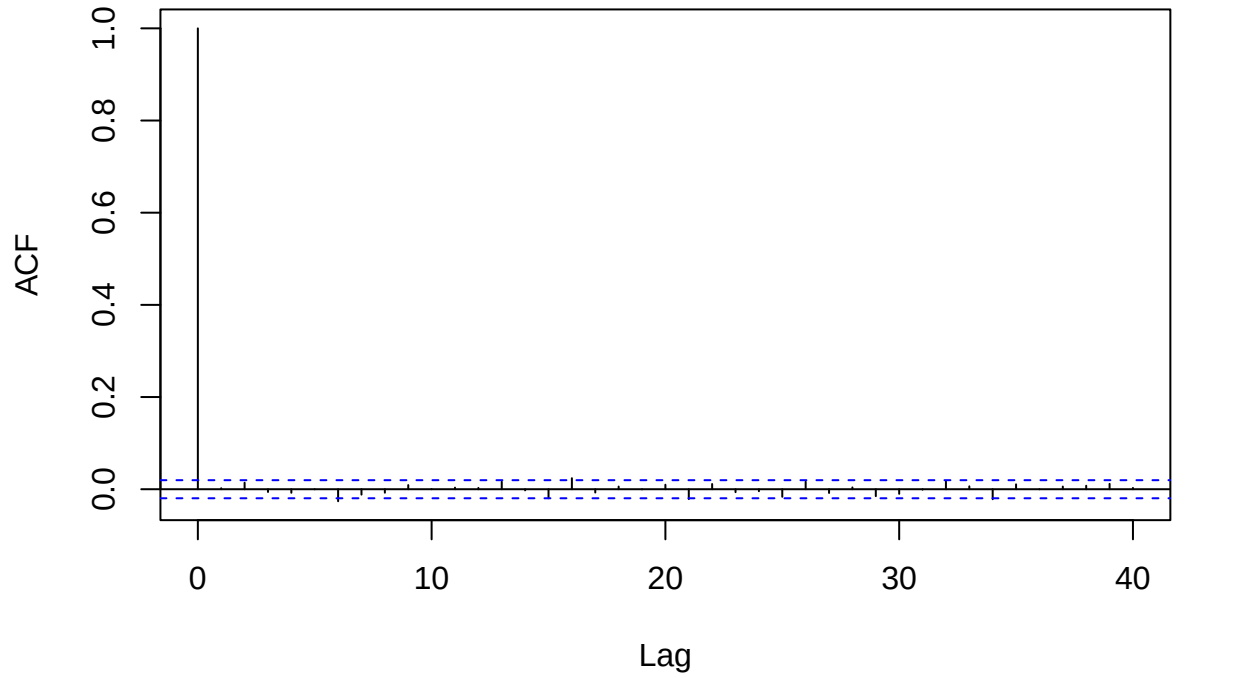

```
plot_traces(post_dist[,11:15], 'Parameter Traces (After Burn In)')
```




```
plot_traces(post_dist[,16:21], 'Parameter Traces (After Burn In)')
```




```
acf_plots(post_dist[,1:5])
```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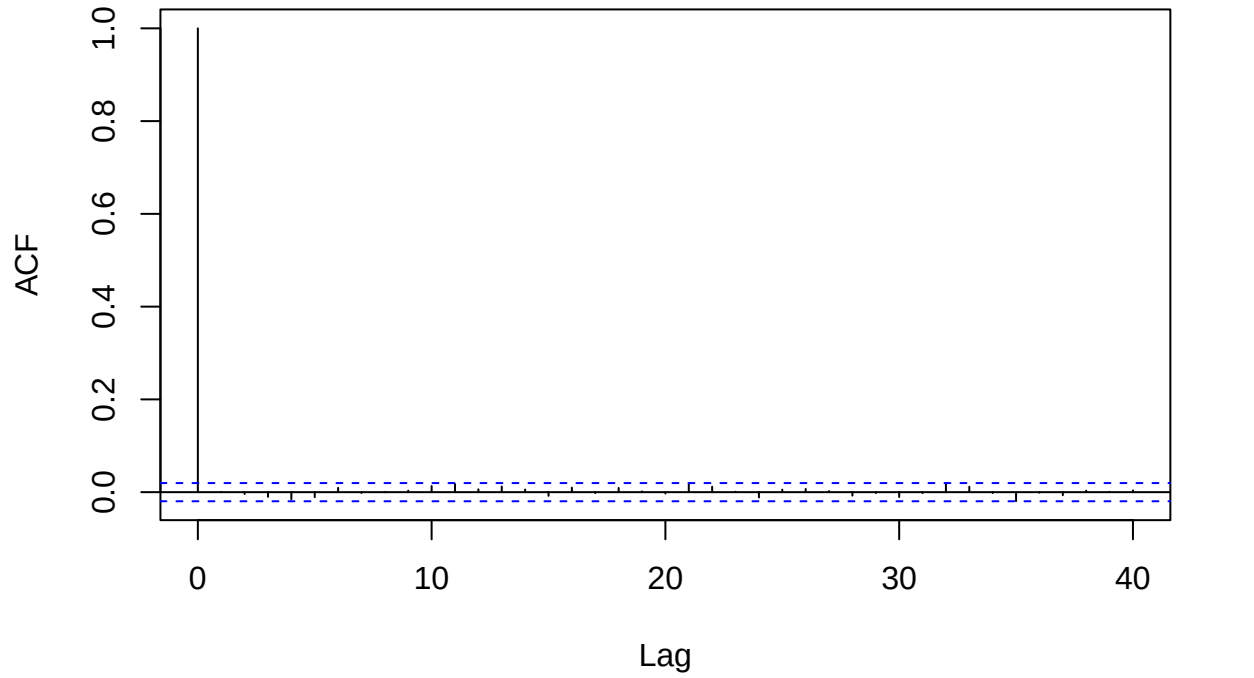
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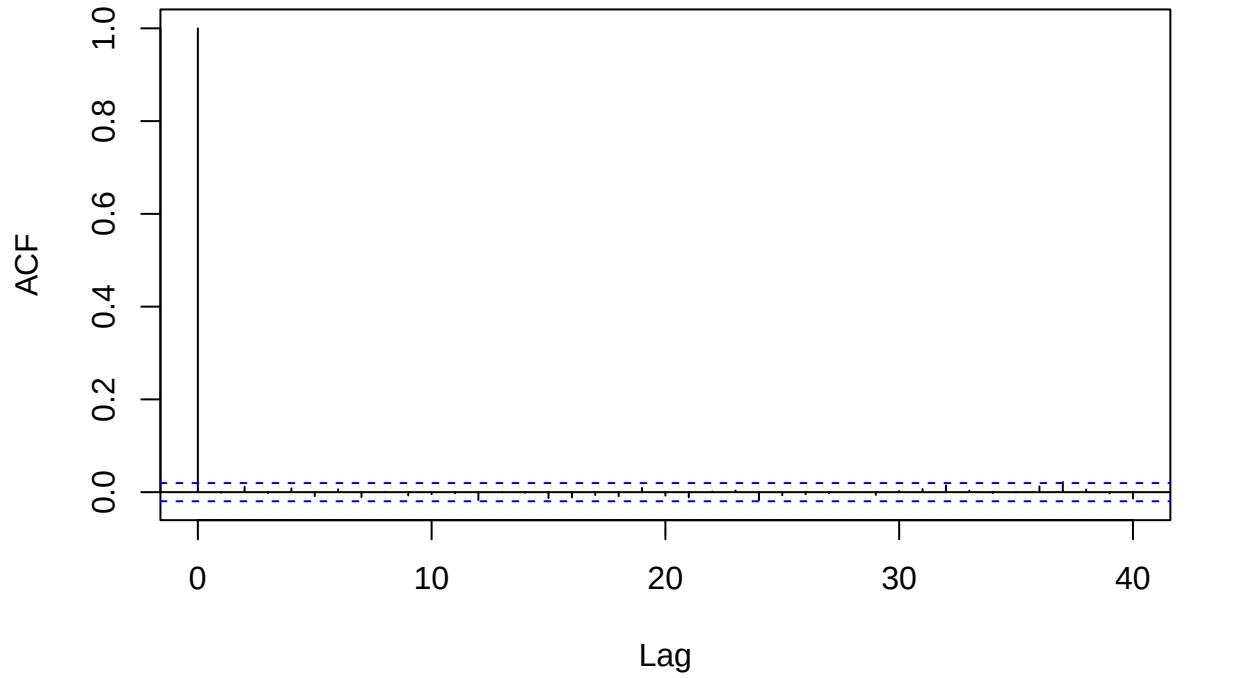
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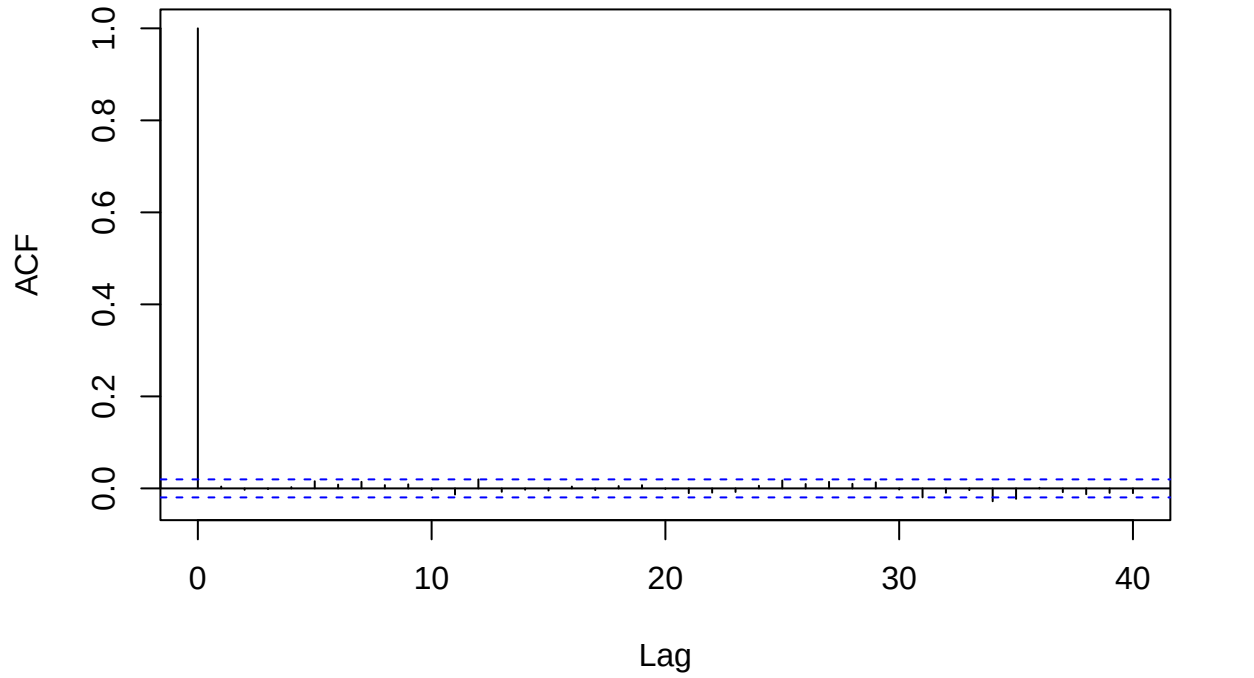
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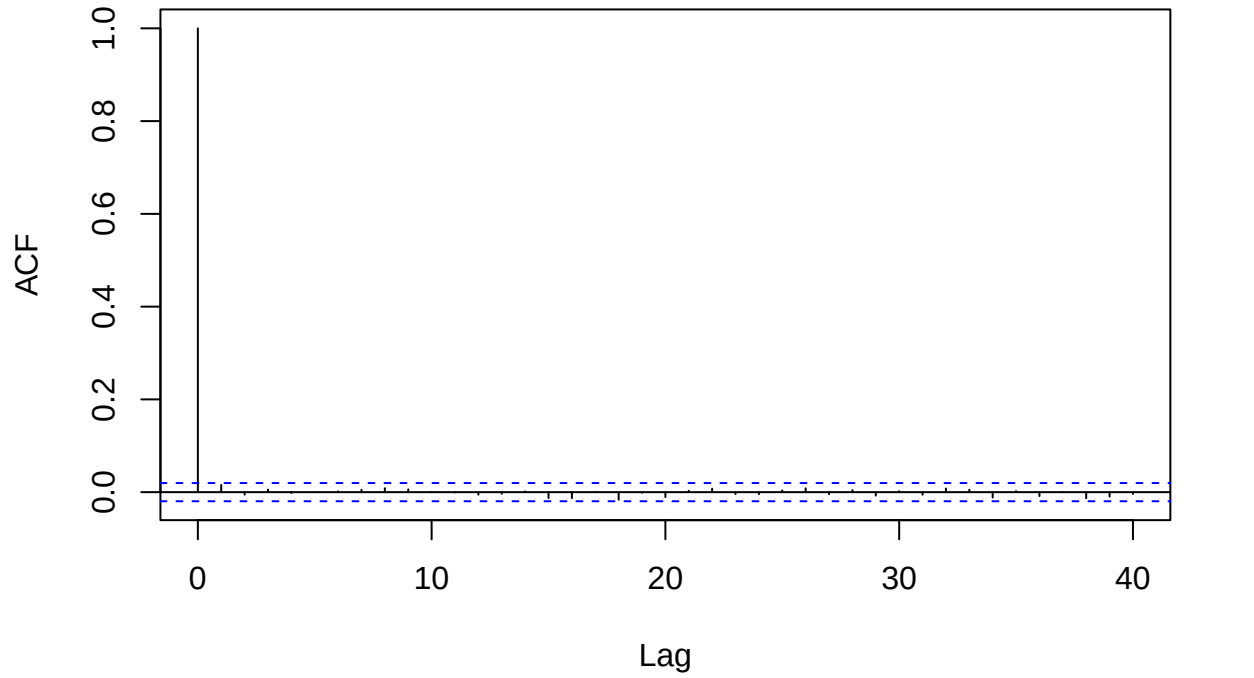
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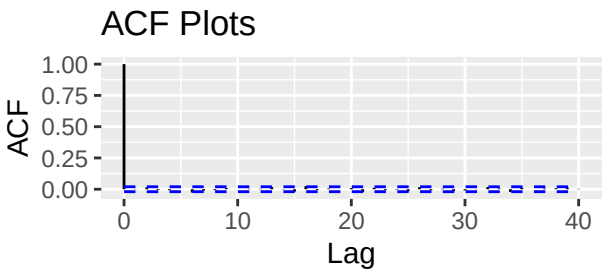
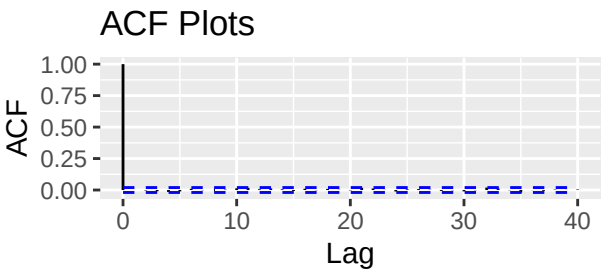
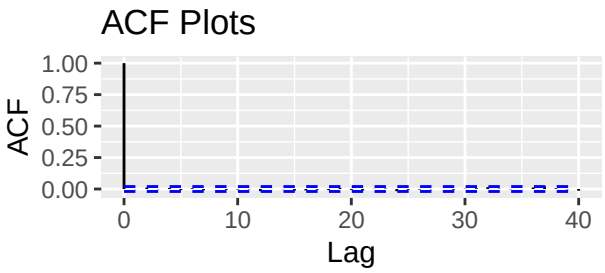
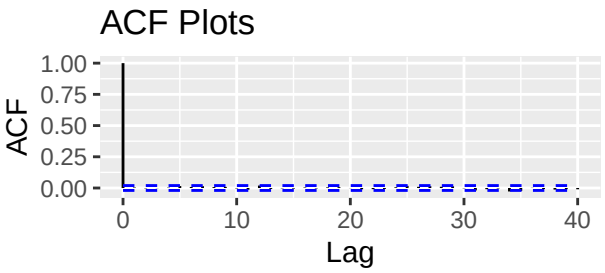
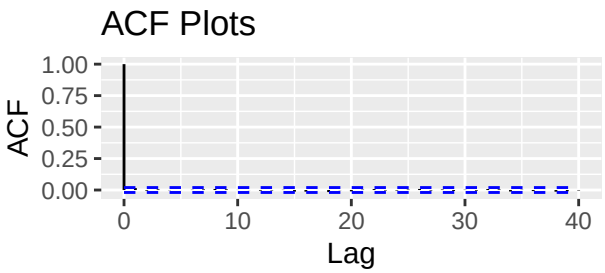


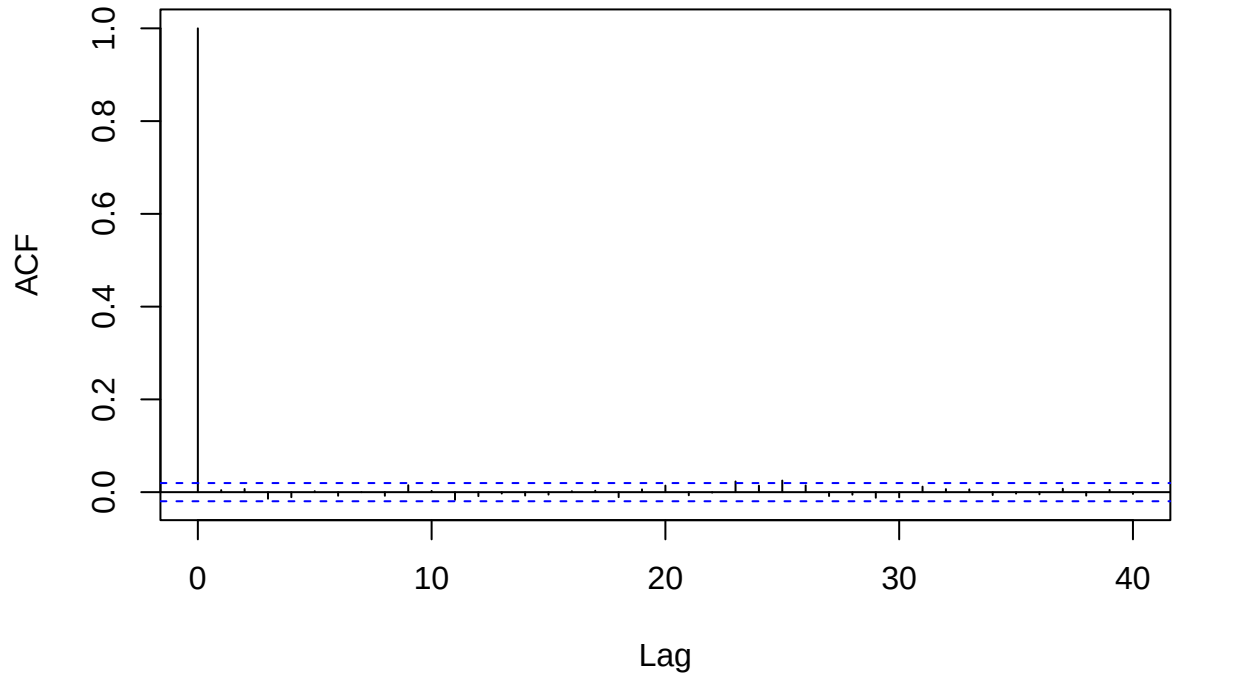









```
acf_plots(post_dist[,6:10])
```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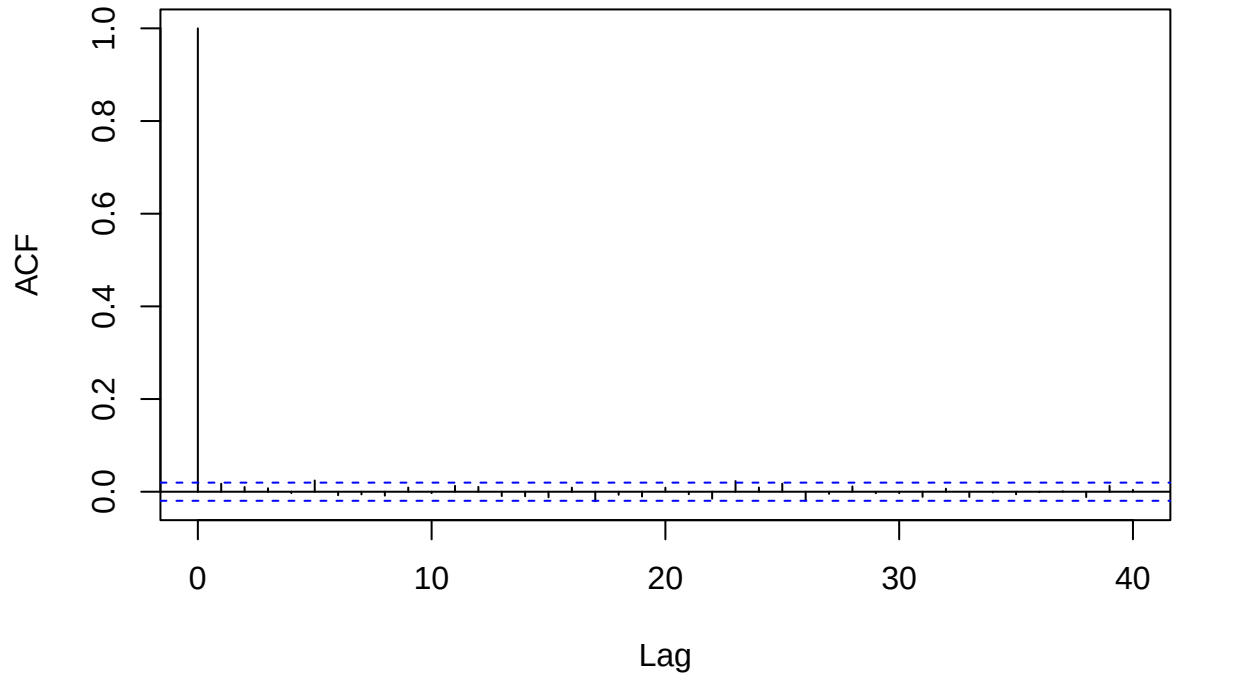
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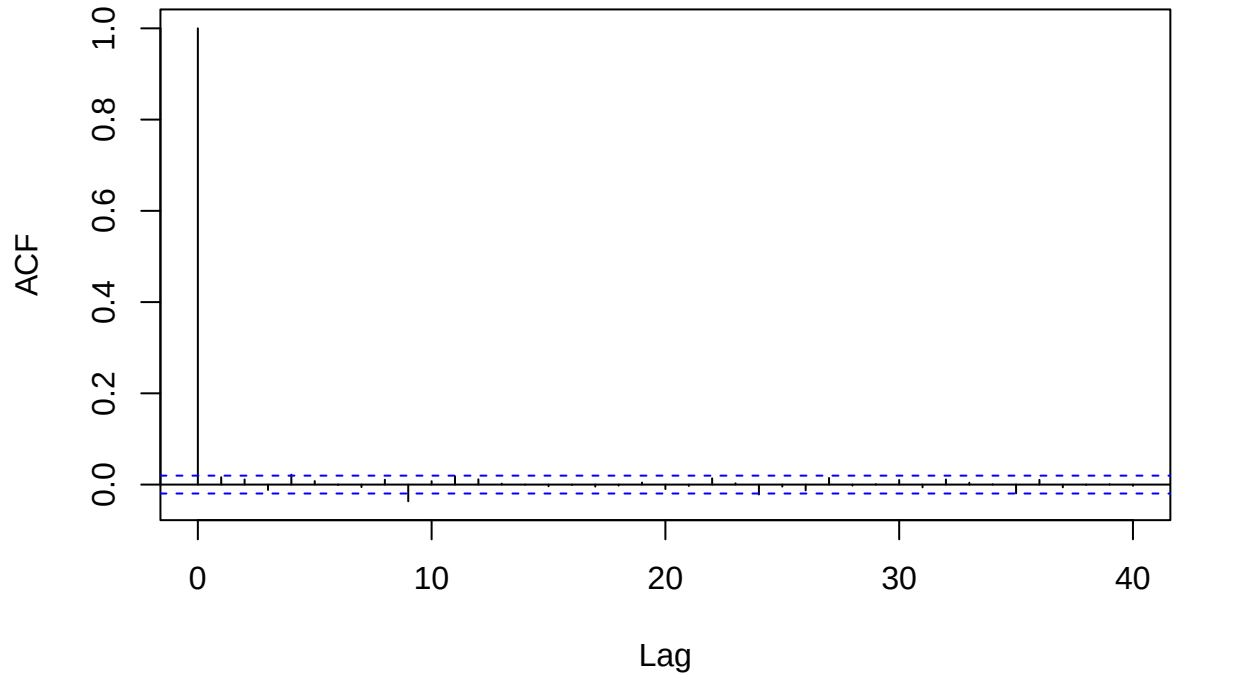
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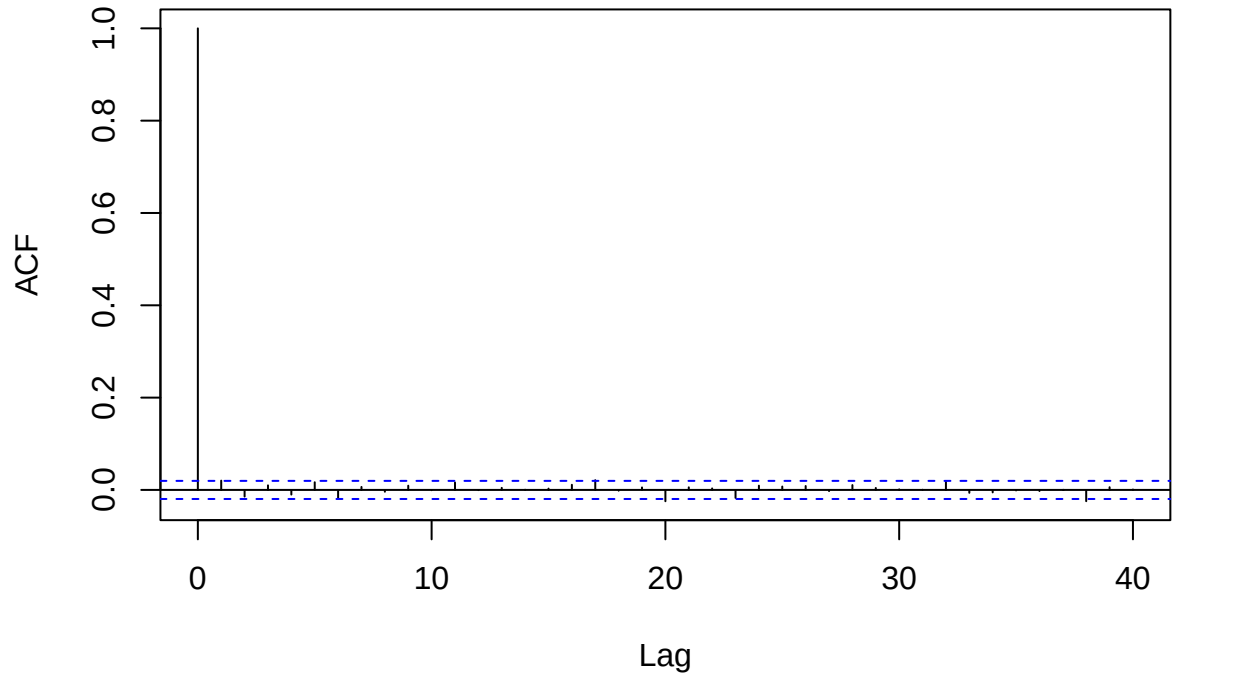
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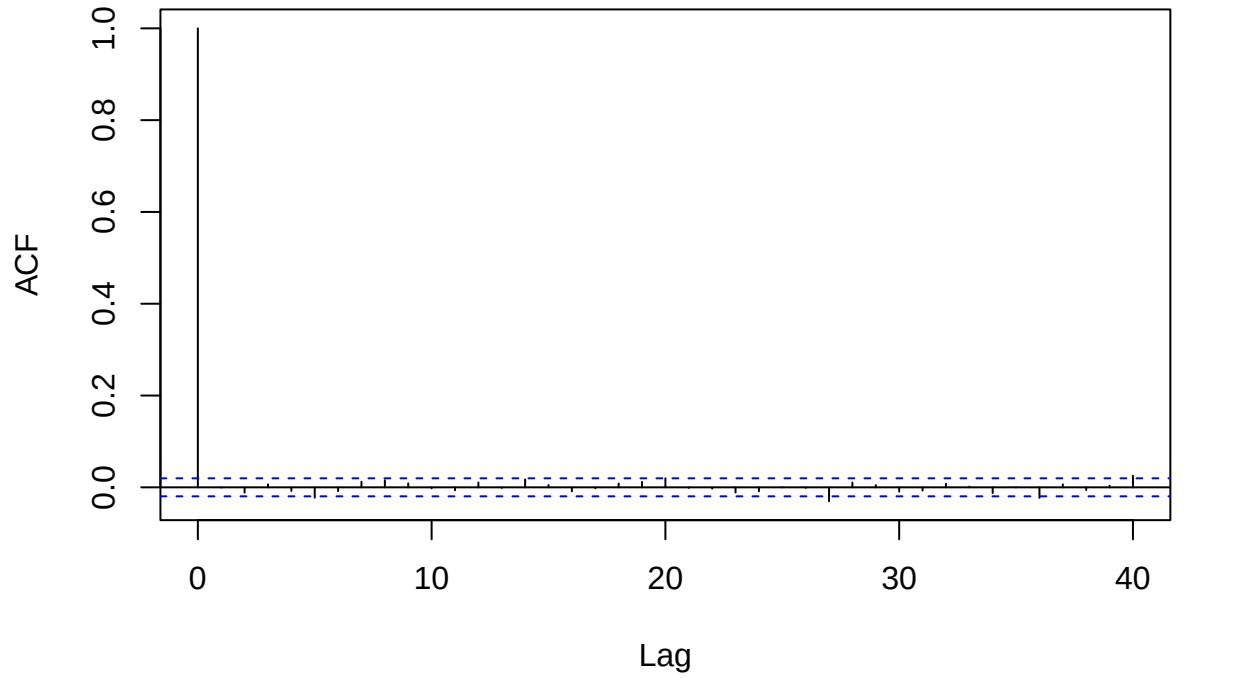
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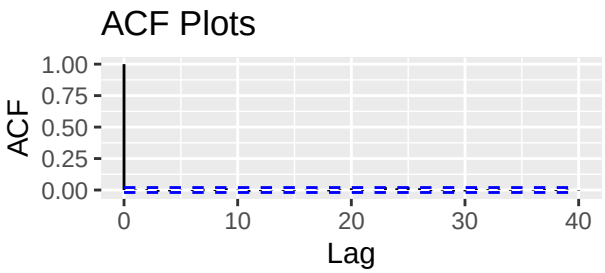

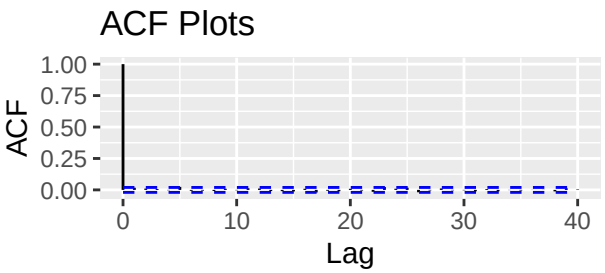

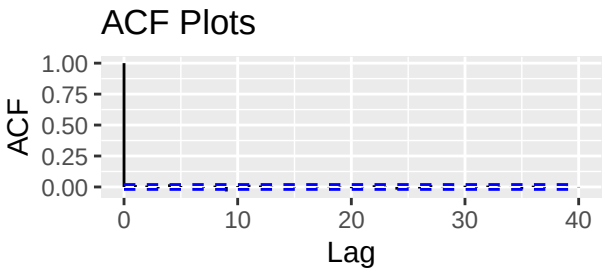

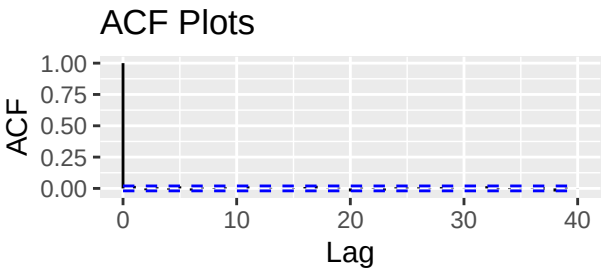

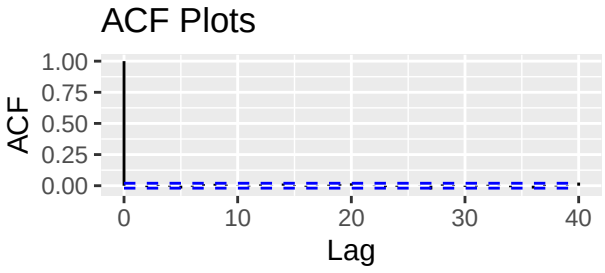


```
acf_plots(post_dist[,11:15])
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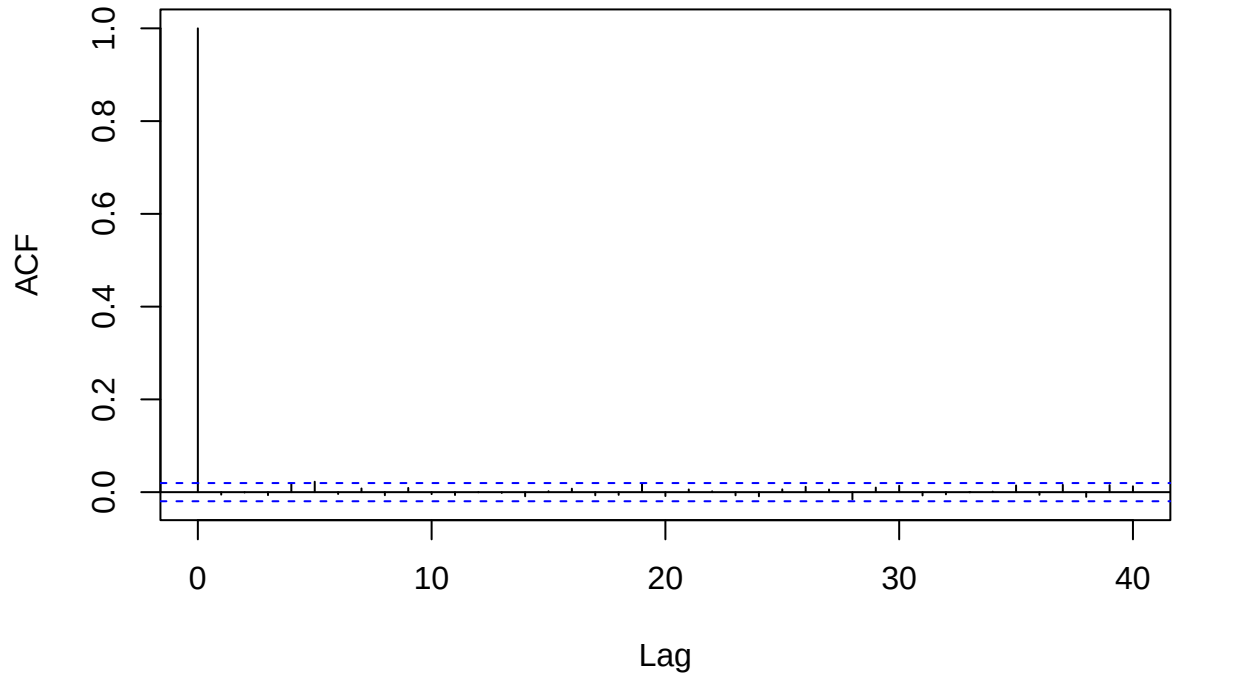
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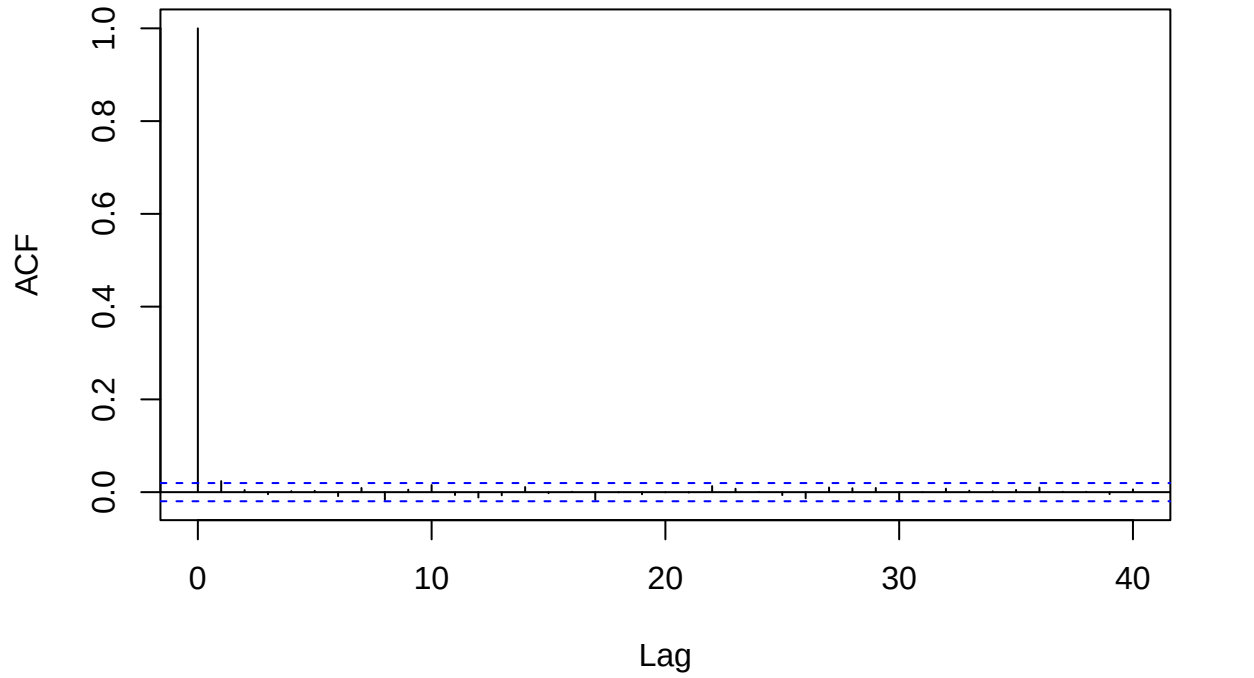
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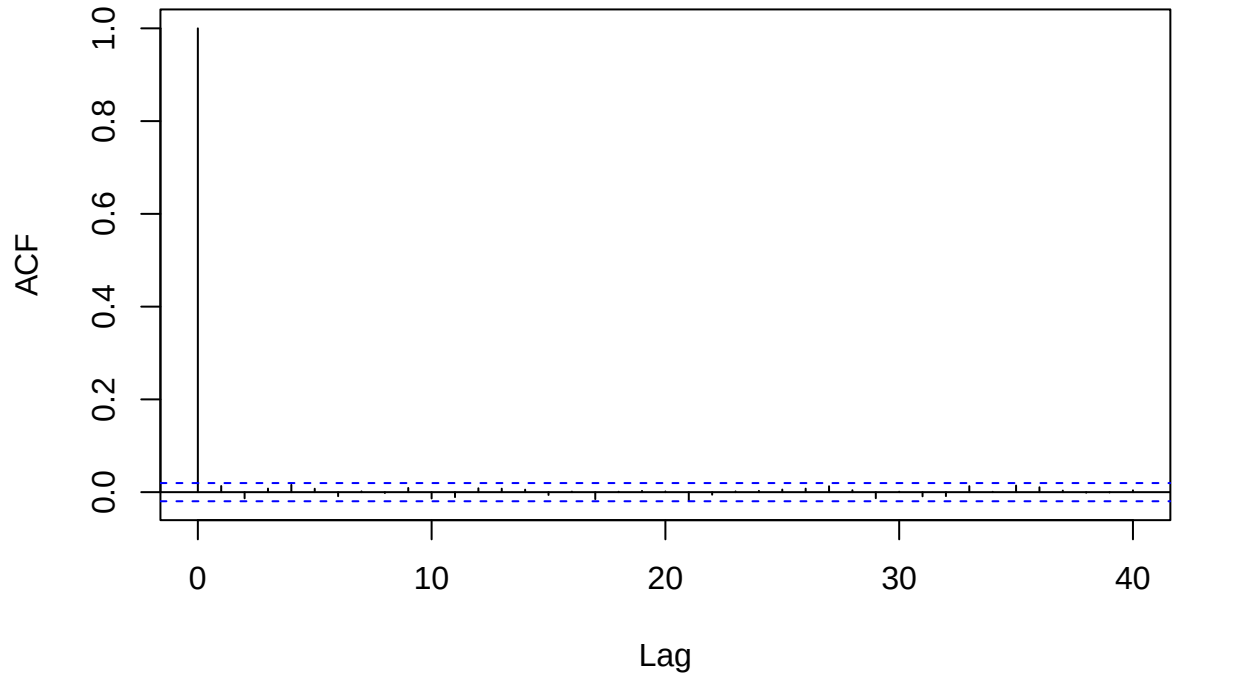
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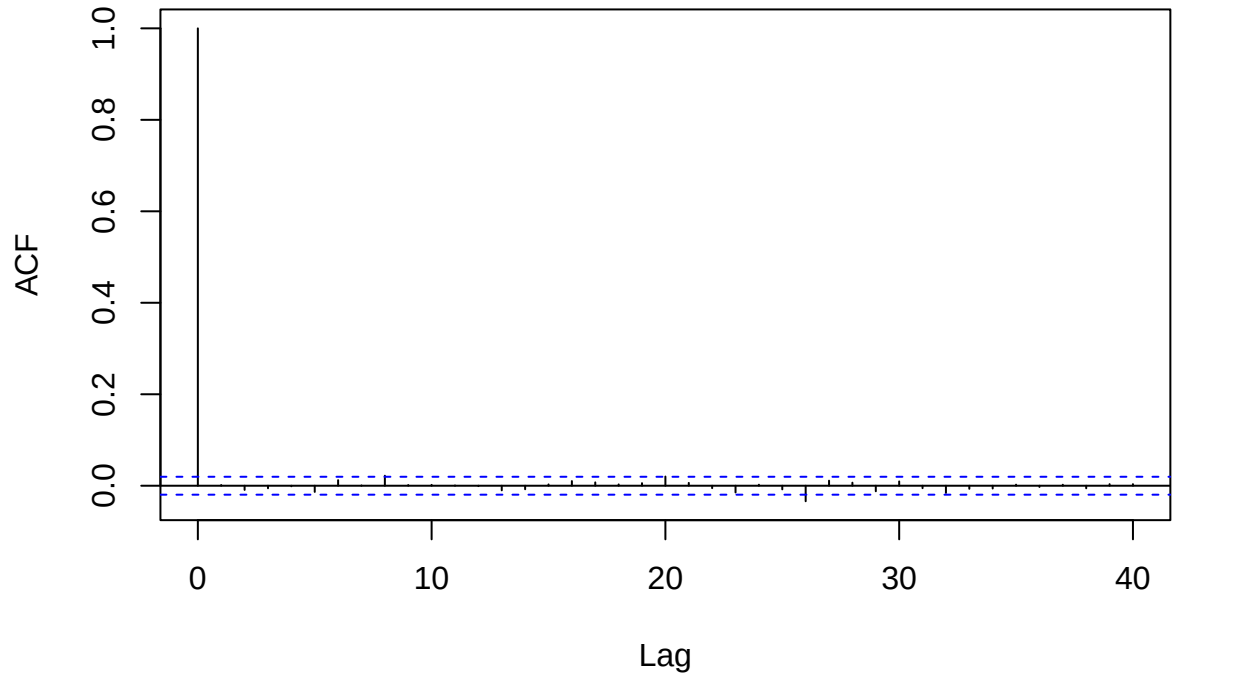
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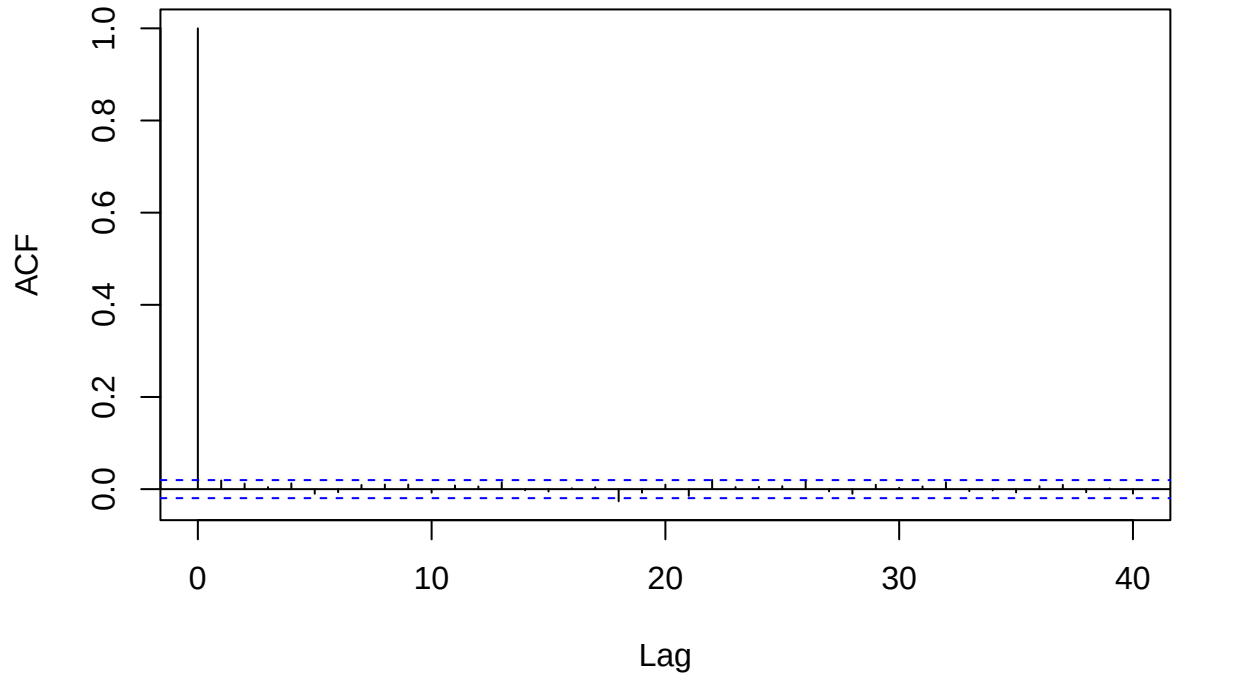
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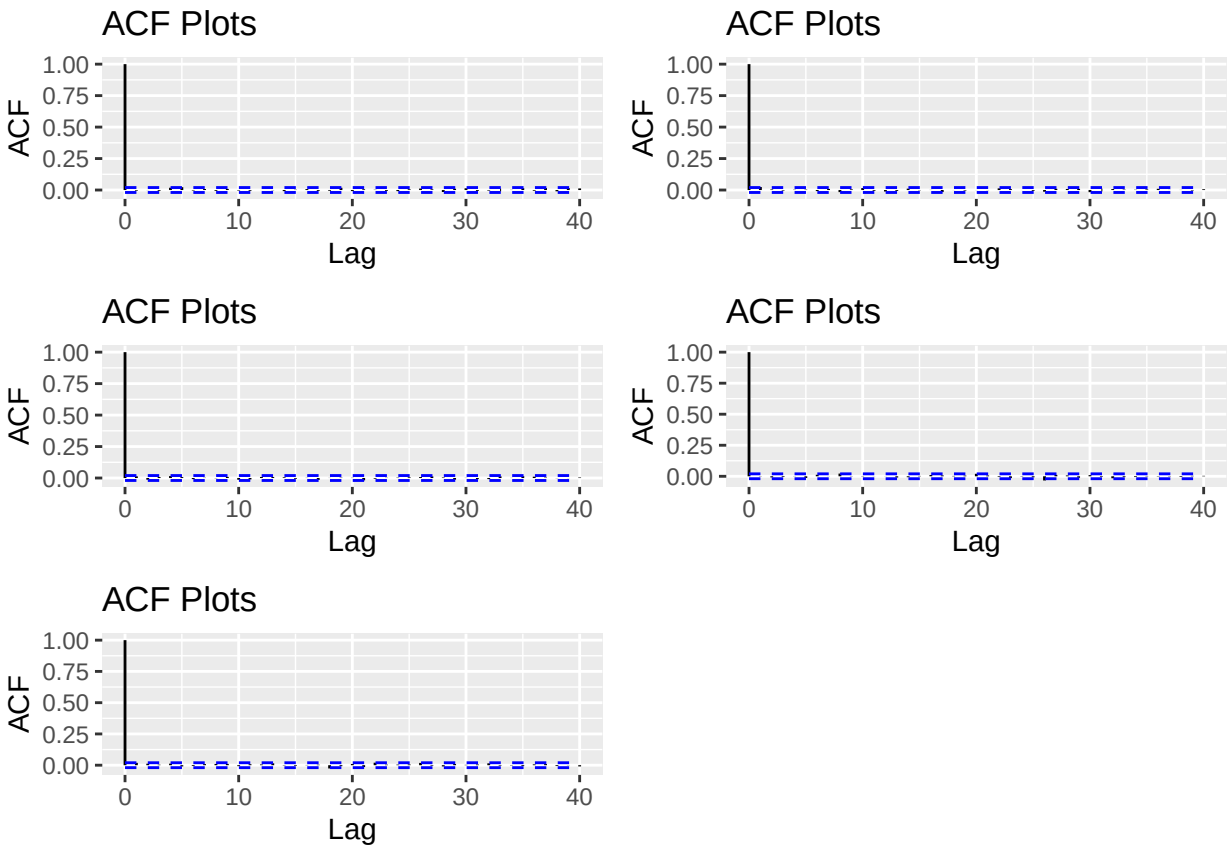
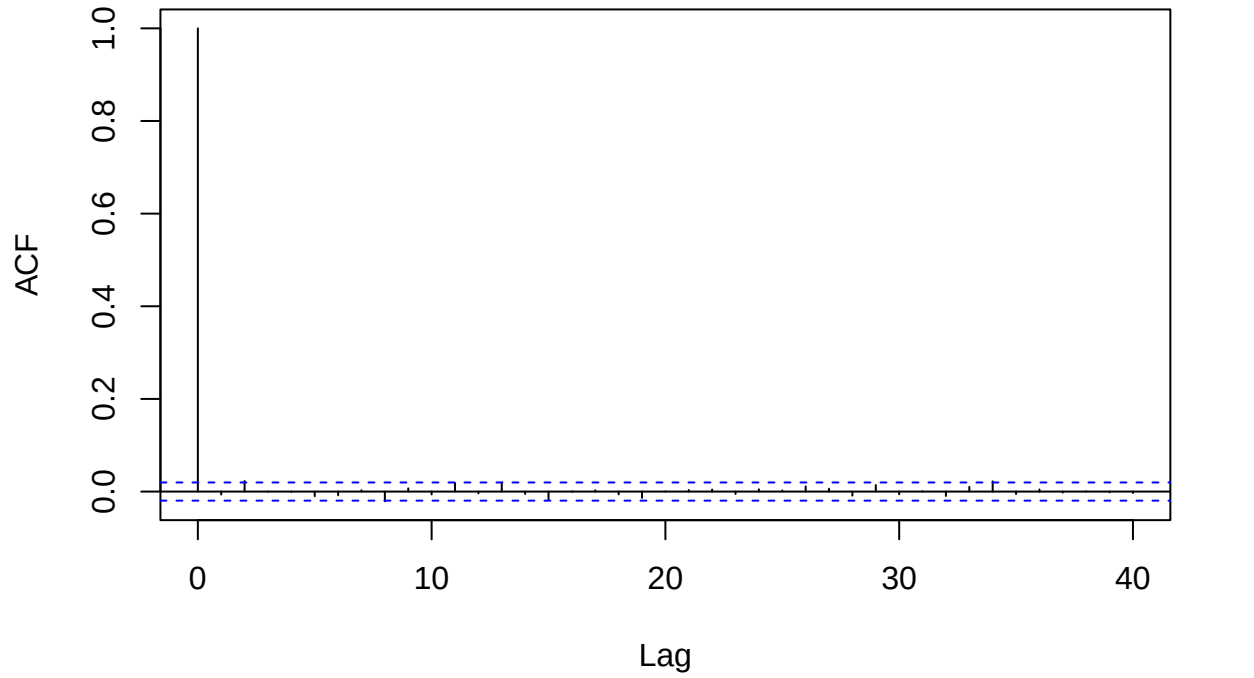



```
acf_plots(post_dist[,16:21])
```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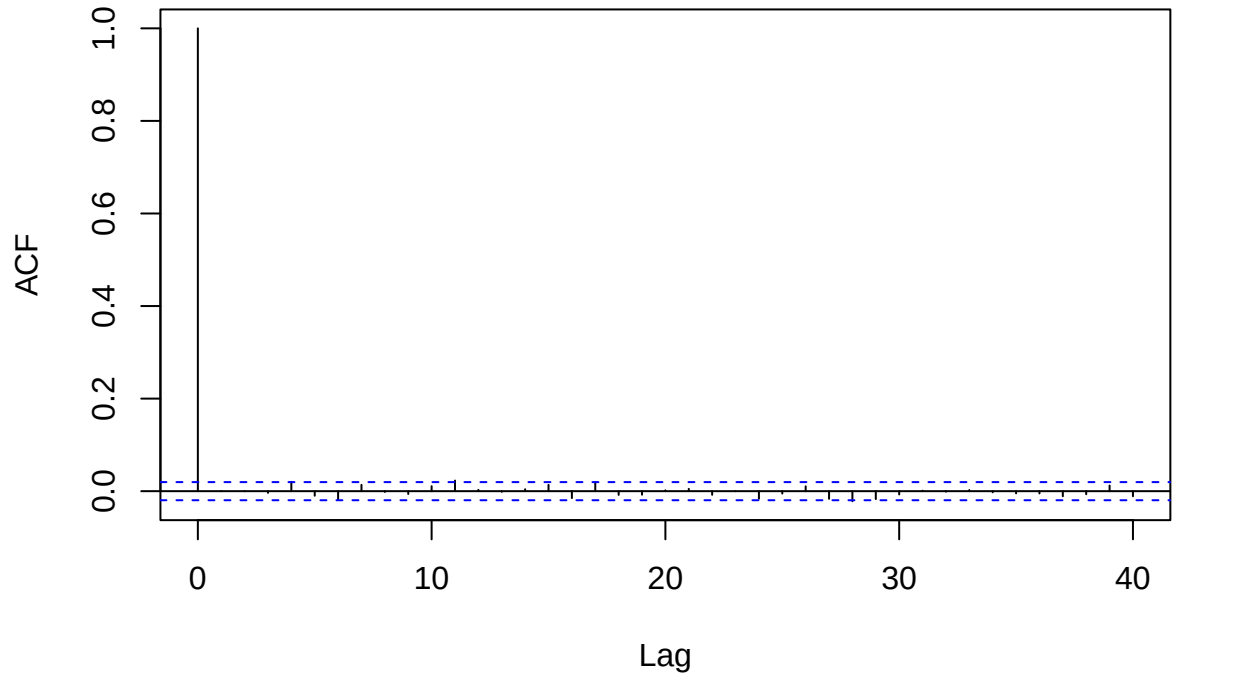
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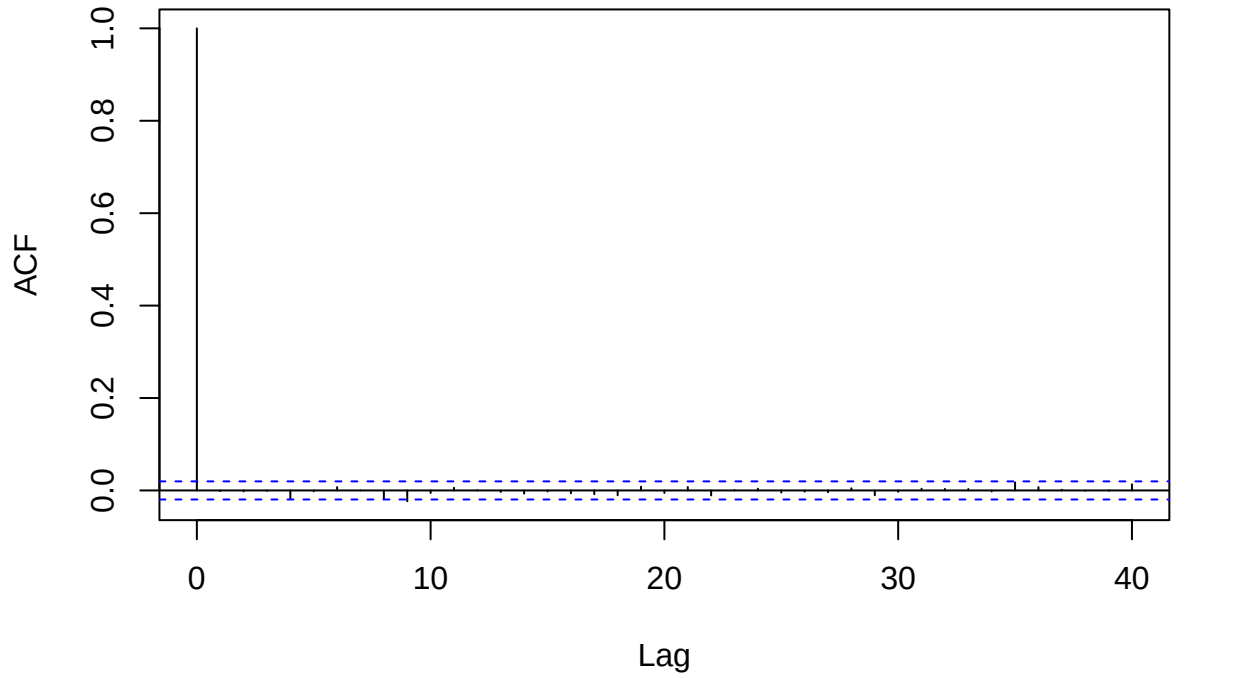
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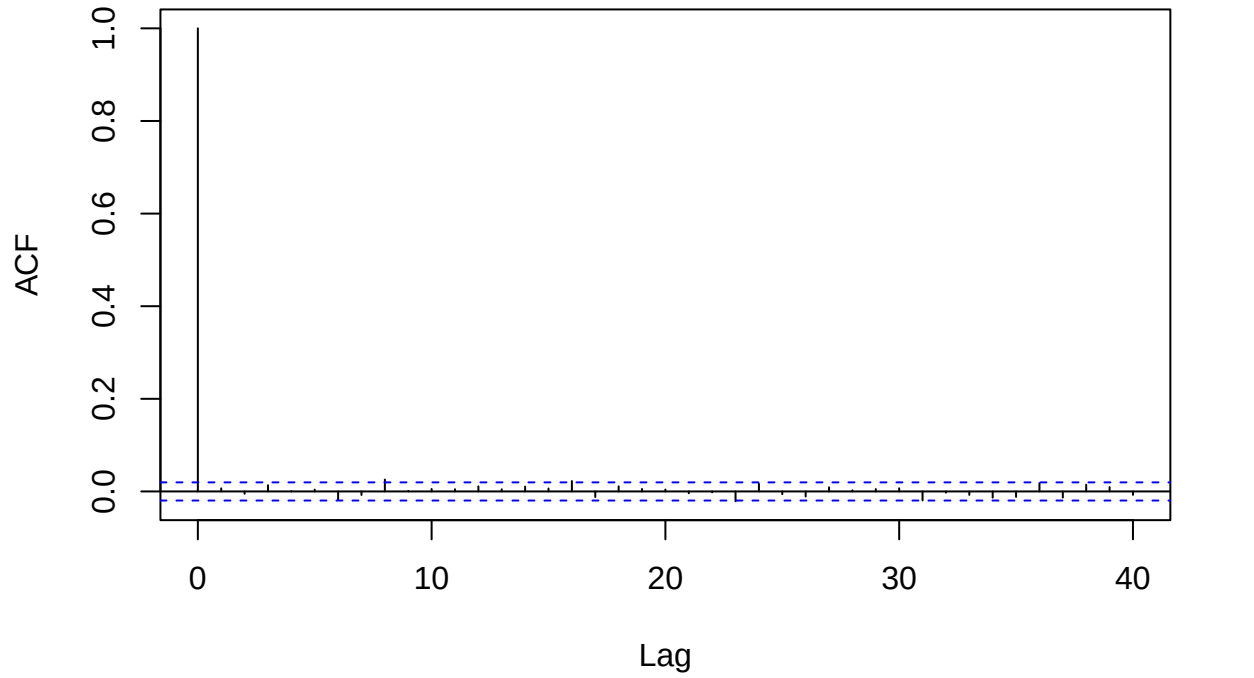
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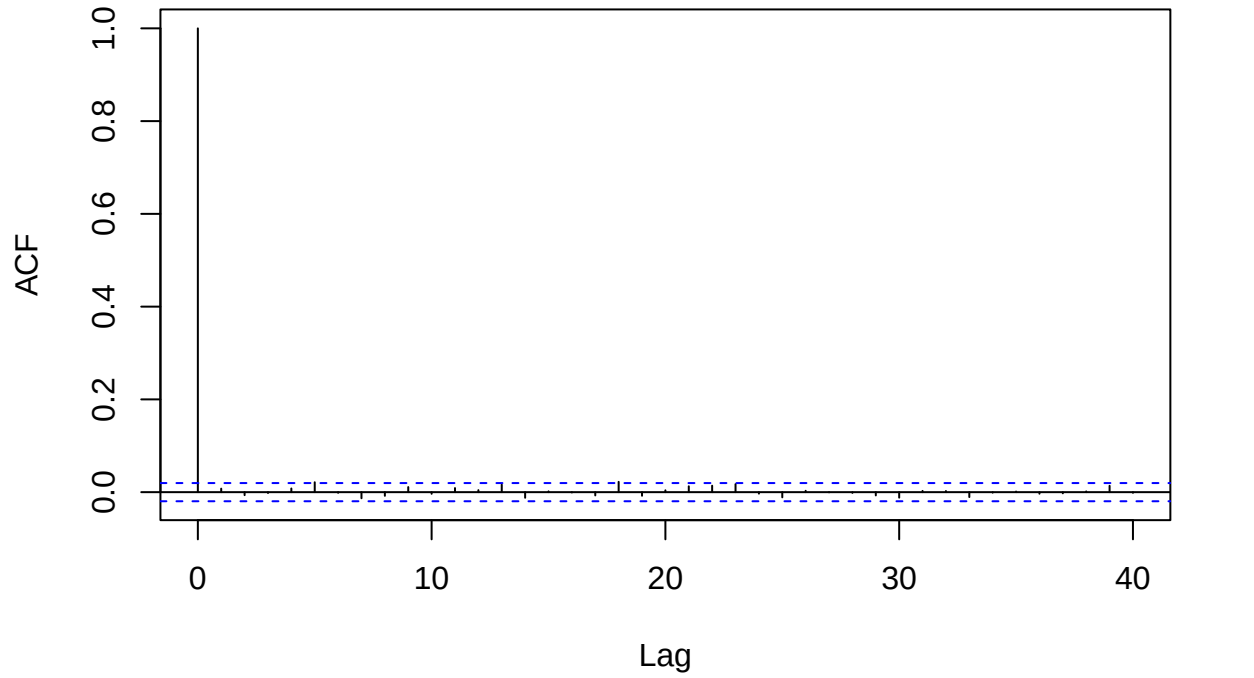
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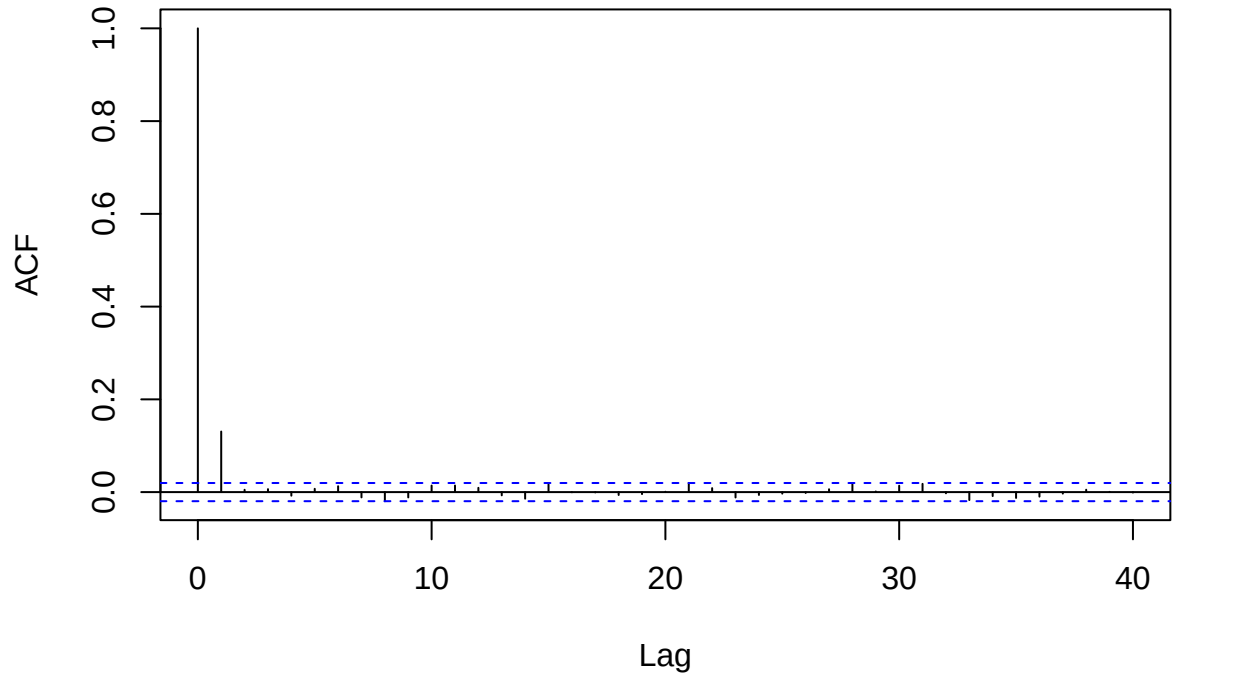
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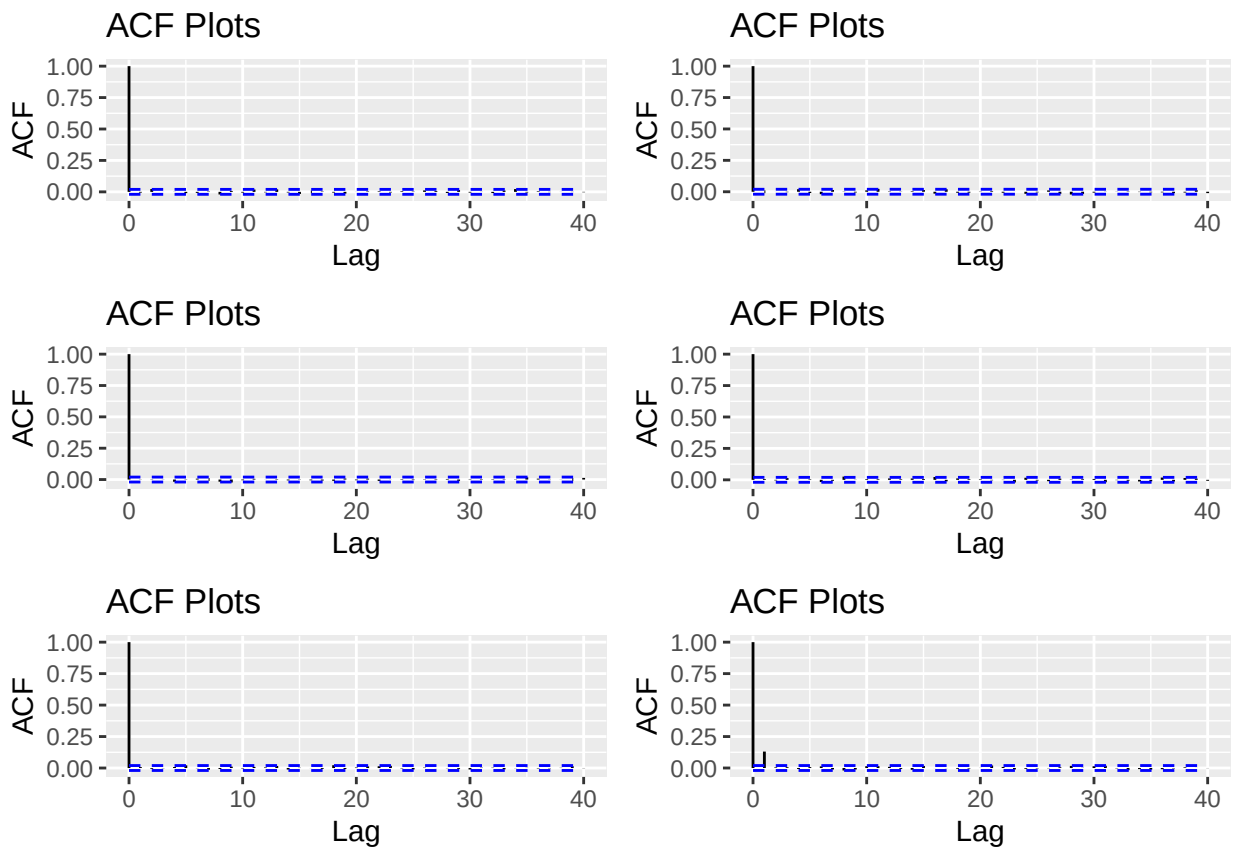


```
summarize_dist(post_dist, colnames(post_dist))
```

Parameter	Post. Mean	Post. Sd	95% CI Low	95% CI High
Intercept	6.9384254	0.0836158	6.7774949	7.1018305
Beef	0.1467420	0.1034165	0.0074350	0.3750682
Pico	0.0701941	0.0611169	0.0021260	0.2259818
Guac	0.0605755	0.0544800	0.0017778	0.2050163
Cheese	0.0644904	0.0583735	0.0017353	0.2068430
Fries	0.0686414	0.0615328	0.0021260	0.2269749
Sour_cream	0.0988254	0.0833568	0.0036434	0.3016444
Pork	0.0780965	0.0725174	0.0020381	0.2703739
Chicken	0.3511293	0.2320270	0.0206528	0.8675249
Shrimp	1.1340635	0.3106623	0.5351073	1.7397784
Rice	0.1028829	0.0956329	0.0028997	0.3403850
Beans	0.0586799	0.0576265	0.0016068	0.2098912
Lettuce	0.2548921	0.2075136	0.0085234	0.7688111
Sauce	0.1983581	0.1512499	0.0083824	0.5671443
Cilantro	0.1334005	0.1269877	0.0035472	0.4483252
Onion	0.1090624	0.1011292	0.0027949	0.3736309
Avocado	0.2037211	0.1807818	0.0058027	0.6716200
Vegetable	0.1315577	0.1222590	0.0042953	0.4239743
Breakfast	0.2540476	0.2267183	0.0081052	0.8440439
Other	0.6890109	0.2953385	0.1265037	1.2787882
sigma	1.2853207	0.0661361	1.1646106	1.4212423

Model Interpretations