

# 大作业：案例分析

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## 1 概况

一. 数据集介绍数据集记录了某产品在 200 个不同市场的销售情况及该产品在每个市场中 3 类广告媒体的预算，这 3 类媒体是：TV, radio, newspaper.

因变量：sales，表示销量

自变量：TV, radio, newspaper，表示在不同媒体上的广告预算

目标：分析 sales 与 TV, radio, newspaper 之间的依赖关系。

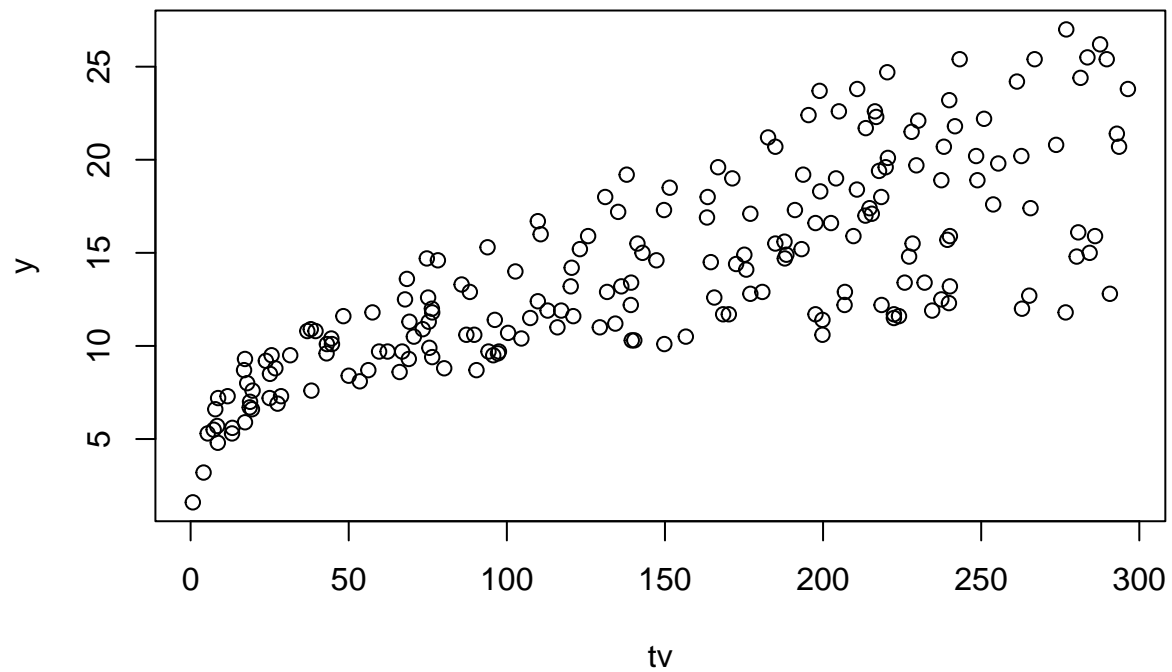
### 二. 实验内容

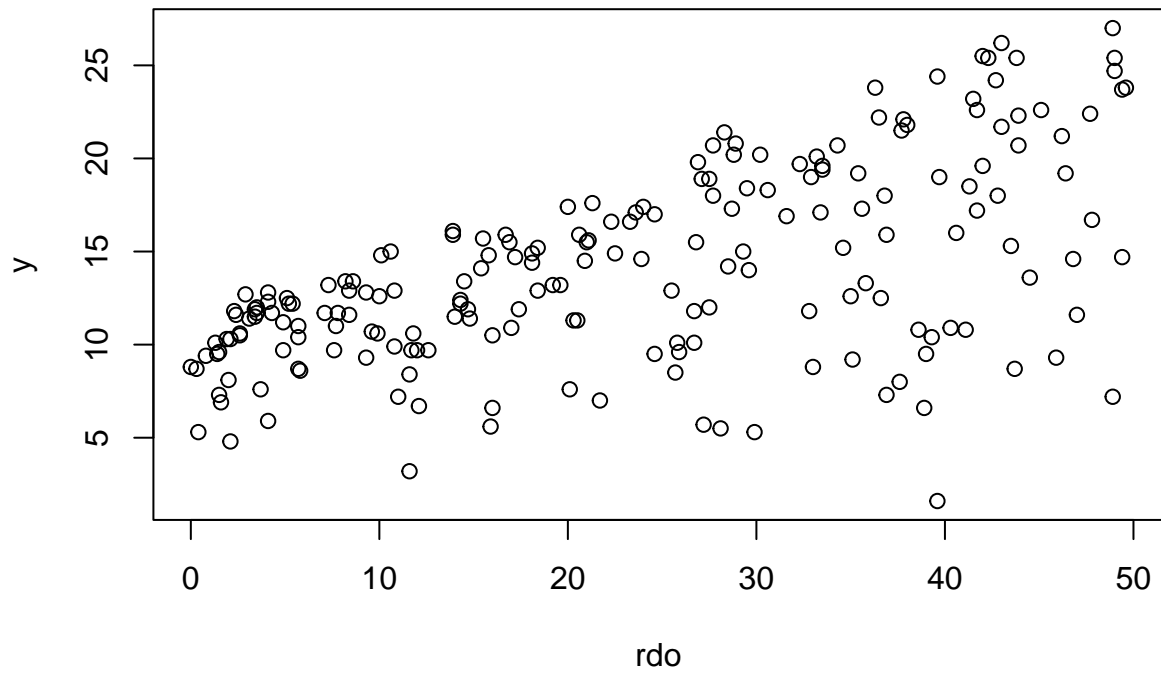
针对因变量 sales(Y), 自变量 TV(tv), radio(rdo), newspaper(nsp),  $X=(1n, tv, rdo, nsp)$  建立线性回归模型  $Y=X\beta + e$ , 假设  $e \sim N(0, \sigma^2 I_n)$

## 2 实验结果

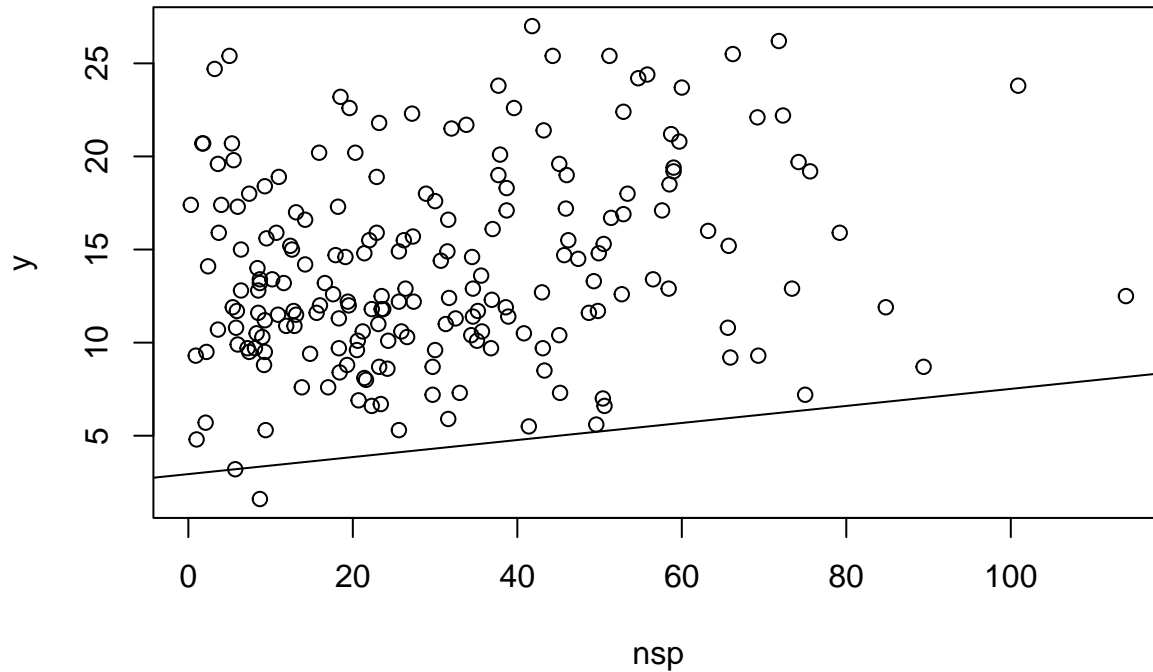
首先应用最小二乘法获得结果

```
adv <- read.csv("Advertising.csv",encoding = "UTF-8",na.strings=c("", " ", "NA"),header=T,row.names = :
y=adv[, 4]
tv=adv[, 1]
rdo=adv[, 2]
nsp=adv[, 3]
mydata=data.frame(y,tv,rdo,nsp)
plot(y~tv+rdo+nsp)
```





```
lm.sol=lm(y~tv+rdo+nsp,data=mydata)
abline(lm.sol)
```



```
summary(lm.sol)
```

```
##
## Call:
## lm(formula = y ~ tv + rdo + nsp, data = mydata)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -8.8277 -0.8908  0.2418  1.1893  2.8292
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.938889   0.311908   9.422  <2e-16 ***
## tv           0.045765   0.001395  32.809  <2e-16 ***
## rdo          0.188530   0.008611  21.893  <2e-16 ***
## nsp         -0.001037   0.005871  -0.177    0.86
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

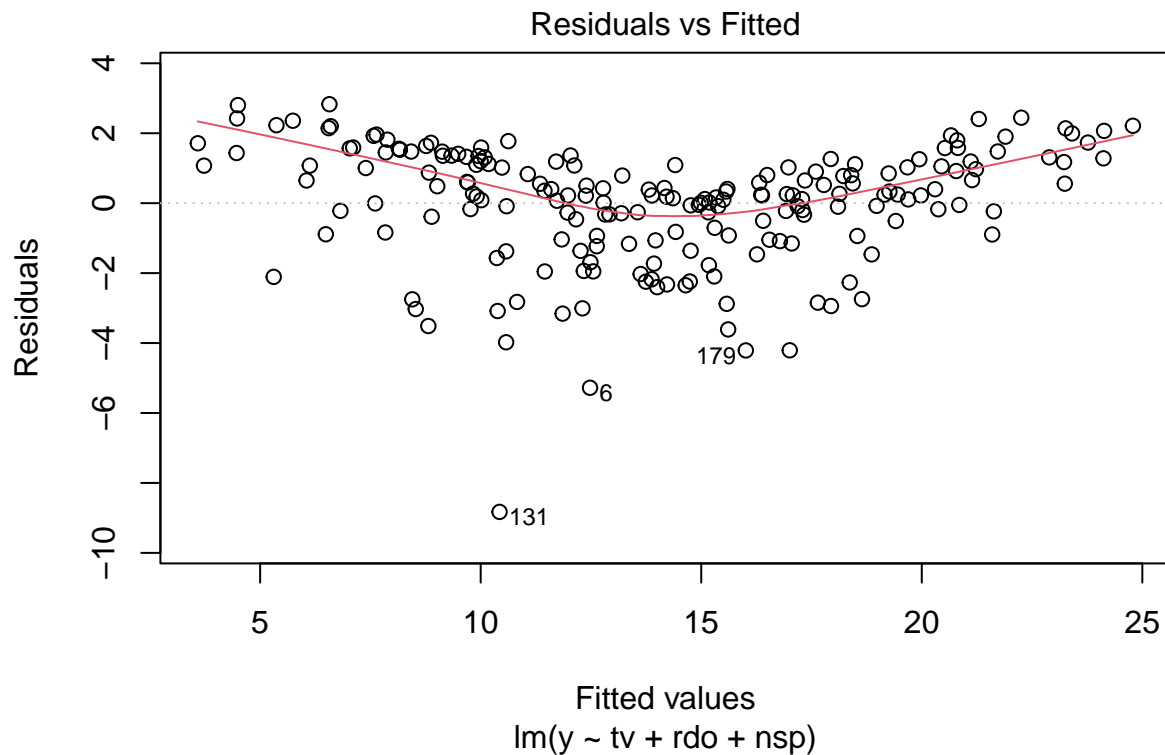
```
##
## Residual standard error: 1.686 on 196 degrees of freedom
## Multiple R-squared:  0.8972, Adjusted R-squared:  0.8956
## F-statistic: 570.3 on 3 and 196 DF,  p-value: < 2.2e-16
```

初步得到的回归方程为  $y=2.938889+0.045765tv+0.188530rdo-0.001037nsp$

## 2.1 回归诊断

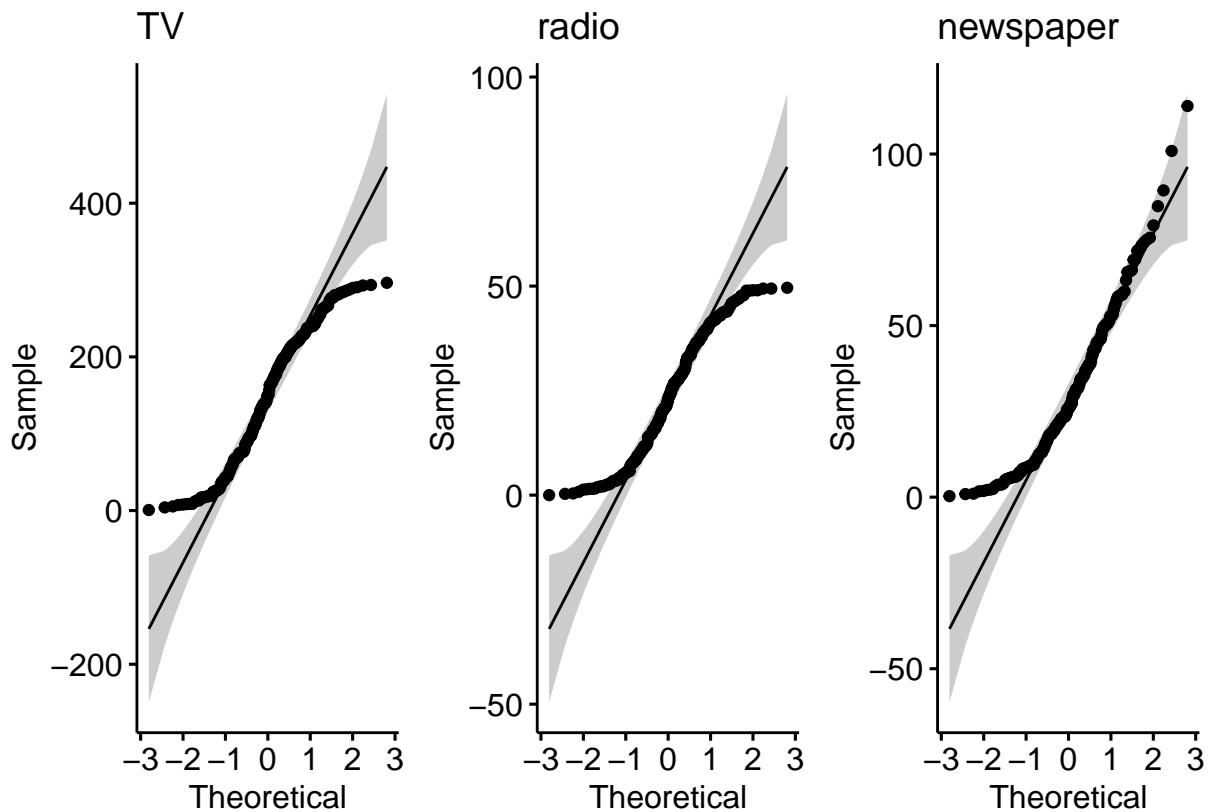
首先模型诊断

```
# 作残差图
y.fit=predict(lm.sol)
plot(lm.sol,which=1)
```



```
#qq 图正态性检验
c1 <- ggqqplot(mydata$tv,main='TV')
c2 <- ggqqplot(mydata$rdo,main='radio')
```

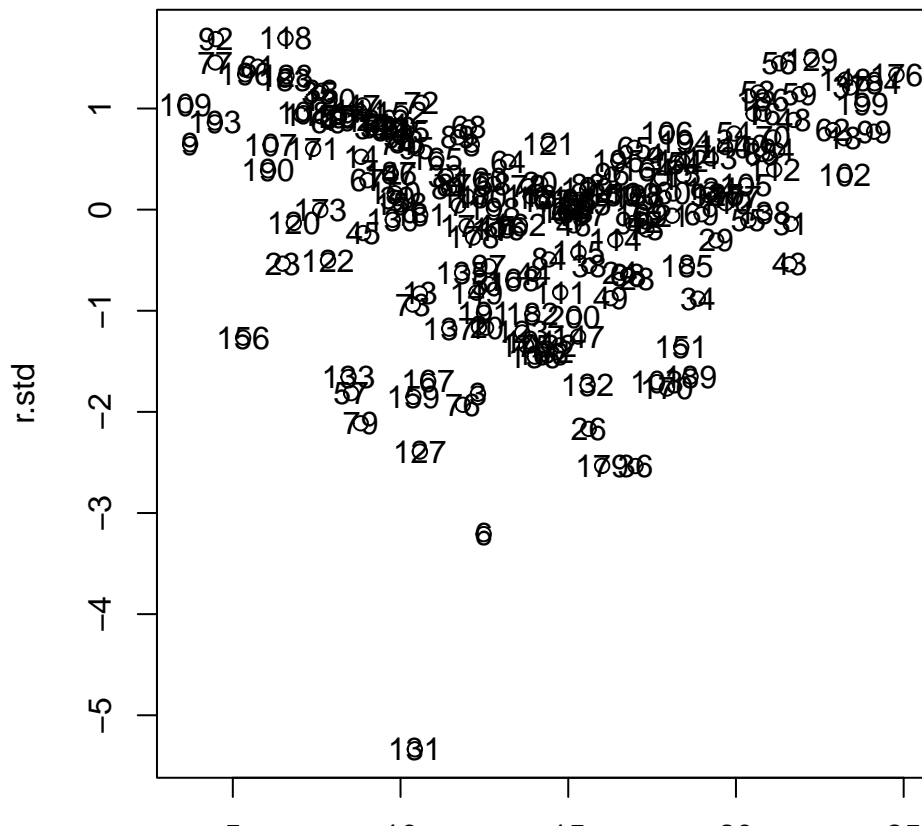
```
c3 <- ggqqplot(mydata$nsp,main='newspaper')
c1+c2+c3
```



如图可以看到：1. 图形没有呈现明显有规则的形状，因此线性假设基本合理 2. 残差呈现一定的“喇叭型”或“倒喇叭型”的形状，可能不符合符合方差齐性 3. 残差图上的点有一定的集团性，可能不相关性不成立。4. 残差大致分布在  $|r_i| \leq 2$  区域内，但集中区域有所不同。从 qq 图可以看出，TV,radio,newspaper 三项基本符合正态分布

接下来进行异常点诊断

```
par(pin=c(4,4))
r.std=rstandard(lm.sol)
plot(r.std~y.fit)
text(y.fit,r.std,label=seq(1,200,1))
```



```
influence.measures(lm.sol)
```

```
## Influence measures of
##   lm(formula = y ~ tv + rdo + nsp, data = mydata) :
##
##          dfb.1_    dfb.tv    dfb.rdo    dfb.nsp    dffit cov.r    cook.d    hat
## 1  -8.56e-02  5.81e-02  2.33e-02  0.101385  0.152240 1.028 5.80e-03 0.02520
## 2  -3.34e-02  1.06e-01 -7.89e-02 -0.029579 -0.163530 1.013 6.67e-03 0.01942
## 3  -1.98e-03  2.19e-01 -1.35e-01 -0.184090 -0.370048 0.992 3.38e-02 0.03923
## 4  -2.44e-02 -1.97e-03  3.14e-02  0.035180  0.070020 1.032 1.23e-03 0.01661
## 5  -8.92e-04 -4.63e-03  1.73e-02 -0.020697 -0.026825 1.045 1.81e-04 0.02351
## 6   2.50e-02  4.23e-01 -2.72e-01 -0.381593 -0.734107 0.864 1.28e-01 0.04748
## 7   2.53e-03 -3.16e-03  2.54e-03 -0.001635  0.005067 1.036 6.45e-06 0.01444
## 8   4.49e-02 -1.22e-02  3.45e-03 -0.037700  0.061714 1.021 9.55e-04 0.00918
## 9   1.15e-01 -6.98e-02 -4.43e-02 -0.039534  0.114895 1.044 3.31e-03 0.03071
## 10 -6.45e-02 -5.76e-02  1.13e-01 -0.003357 -0.154351 1.010 5.95e-03 0.01715
## 11  1.06e-01 -5.93e-02 -7.46e-02  0.011295  0.119465 1.019 3.57e-03 0.01598
## 12  1.46e-03  4.12e-03  2.37e-03 -0.006645  0.009111 1.039 2.09e-05 0.01735
```

```
## 13 -2.06e-02  9.19e-02 -1.76e-02 -0.089164 -0.146895  1.038 5.40e-03 0.03044
## 14  5.86e-02 -1.83e-02 -2.62e-02 -0.027059  0.063462  1.030 1.01e-03 0.01461
## 15 -1.34e-02  1.46e-02  9.65e-03  0.011701  0.034347  1.029 2.96e-04 0.01031
## 16 -7.12e-02  3.09e-02  9.19e-02  0.030911  0.138031  1.023 4.77e-03 0.02078
## 17  1.15e-02  1.67e-02  6.66e-03 -0.056457 -0.061601  1.116 9.53e-04 0.08633
## 18 -7.43e-02  7.47e-02  3.45e-02  0.038662  0.113911  1.037 3.25e-03 0.02542
## 19  6.95e-02 -5.02e-02  2.67e-03 -0.028383  0.082603  1.018 1.71e-03 0.01046
## 20  9.93e-03  4.35e-04  4.47e-03 -0.010614  0.021155  1.026 1.12e-04 0.00669
## 21  2.67e-03 -3.33e-03  4.57e-04 -0.004186 -0.007047  1.035 1.25e-05 0.01359
## 22 -3.78e-02 -1.08e-01  1.18e-01 -0.006953 -0.186471  1.003 8.66e-03 0.01886
## 23 -4.80e-02  6.05e-02  3.07e-02 -0.045374 -0.085605  1.041 1.84e-03 0.02512
## 24 -2.72e-03 -4.33e-02  1.86e-02  0.004008 -0.064802  1.024 1.05e-03 0.01071
## 25  9.91e-02 -6.20e-02 -3.44e-02 -0.019318  0.104517  1.016 2.73e-03 0.01255
## 26 -5.06e-02 -2.24e-01  2.02e-01  0.015013 -0.344354  0.949 2.91e-02 0.02415
## 27  2.29e-04 -1.31e-05  3.33e-04 -0.000460  0.000665  1.032 1.11e-07 0.01122
## 28 -1.74e-03 -5.48e-02  1.87e-02  0.012386 -0.077233  1.024 1.50e-03 0.01249
## 29  7.34e-03 -2.59e-02 -7.92e-03  0.011311 -0.035742  1.033 3.21e-04 0.01361
## 30  5.66e-02 -5.15e-02 -3.85e-02  0.041742  0.091342  1.020 2.09e-03 0.01259
## 31  1.01e-02 -1.67e-02 -8.10e-04 -0.004266 -0.020350  1.042 1.04e-04 0.02072
## 32  1.58e-02 -9.34e-03 -1.28e-02  0.013123  0.029699  1.027 2.22e-04 0.00807
## 33  1.17e-01 -4.39e-02 -1.29e-01  0.046121  0.161712  1.011 6.52e-03 0.01857
## 34 -7.16e-03 -9.17e-02 -1.50e-02  0.092166 -0.142916  1.031 5.11e-03 0.02572
## 35  1.46e-01 -4.09e-02 -9.52e-02 -0.046168  0.159819  1.012 6.37e-03 0.01882
## 36 -5.19e-02 -3.28e-01  1.97e-01  0.122998 -0.459319  0.922 5.13e-02 0.03092
## 37 -5.97e-02  1.22e-01  1.64e-01 -0.160329  0.247685  1.032 1.53e-02 0.04028
## 38  4.99e-03  3.76e-02 -6.57e-02 -0.004561 -0.088849  1.040 1.98e-03 0.02508
## 39  7.70e-03 -1.00e-02  1.74e-03  0.001501  0.013071  1.034 4.29e-05 0.01298
## 40 -2.92e-02  4.05e-02  4.39e-02 -0.014928  0.075623  1.027 1.43e-03 0.01430
## 41 -1.88e-05  6.09e-03 -1.05e-03  0.000470  0.011214  1.028 3.16e-05 0.00716
## 42  2.20e-03 -2.54e-03 -4.78e-03 -0.001070 -0.010401  1.029 2.72e-05 0.00792
## 43  1.32e-02 -6.82e-02 -2.93e-02  0.061954 -0.099044  1.049 2.46e-03 0.03262
## 44 -2.11e-02 -3.38e-02  4.64e-02 -0.006572 -0.072783  1.026 1.33e-03 0.01299
## 45 -1.62e-02  2.41e-02 -1.33e-04 -0.010289 -0.030793  1.038 2.38e-04 0.01737
## 46 -2.08e-03 -3.62e-03  9.23e-04 -0.000583 -0.011621  1.026 3.39e-05 0.00557
## 47  8.16e-02 -4.74e-02 -7.56e-02  0.045522  0.117997  1.012 3.48e-03 0.01292
## 48 -4.04e-02  6.74e-02  9.43e-02 -0.069868  0.138527  1.029 4.80e-03 0.02383
## 49  1.71e-02 -5.74e-02  5.68e-02 -0.069012 -0.115238  1.022 3.32e-03 0.01704
## 50  7.84e-02 -5.99e-02 -5.92e-02  0.041651  0.109380  1.018 2.99e-03 0.01409
## 51 -2.87e-02 -3.49e-02  8.15e-02 -0.036165 -0.102590  1.029 2.64e-03 0.01903
```



## 52	9.00e-02	-2.64e-02	-2.89e-02	-0.055477	0.100505	1.022	2.53e-03	0.01507
## 53	-6.70e-02	6.15e-02	9.46e-02	-0.004607	0.145566	1.009	5.29e-03	0.01552
## 54	-5.41e-02	1.61e-02	6.20e-02	0.042240	0.109109	1.030	2.98e-03	0.02063
## 55	2.81e-03	-1.02e-02	-4.49e-03	0.006819	-0.014414	1.040	5.22e-05	0.01877
## 56	-1.29e-01	4.97e-02	1.41e-01	0.079075	0.231147	1.003	1.33e-02	0.02477
## 57	-1.39e-01	2.18e-01	-2.90e-02	-0.062143	-0.262898	0.974	1.71e-02	0.02032
## 58	1.44e-02	-1.59e-03	-8.41e-04	-0.010381	0.021390	1.027	1.15e-04	0.00711
## 59	-7.99e-02	5.41e-02	1.43e-01	-0.028435	0.177346	1.018	7.85e-03	0.02352
## 60	8.83e-04	8.73e-03	8.97e-03	-0.014003	0.020353	1.037	1.04e-04	0.01612
## 61	1.86e-01	-1.03e-01	-1.35e-01	0.013535	0.205266	1.000	1.05e-02	0.02055
## 62	-7.88e-02	6.96e-02	5.26e-02	0.036065	0.122266	1.032	3.74e-03	0.02366
## 63	-3.38e-04	-5.09e-02	2.51e-02	0.000269	-0.072751	1.025	1.33e-03	0.01251
## 64	2.89e-02	-1.65e-02	2.89e-02	-0.041326	0.058053	1.031	8.46e-04	0.01497
## 65	-2.78e-03	-1.03e-02	6.29e-02	-0.024839	0.076997	1.029	1.49e-03	0.01567
## 66	1.13e-01	-5.07e-02	-2.86e-02	-0.066287	0.120437	1.024	3.63e-03	0.01887
## 67	3.36e-02	-2.70e-02	1.33e-02	-0.028565	0.045185	1.044	5.13e-04	0.02371
## 68	5.91e-02	-1.56e-03	-1.60e-02	-0.044776	0.080688	1.017	1.63e-03	0.00978
## 69	2.61e-04	-3.54e-03	-1.98e-03	0.003629	-0.006015	1.038	9.09e-06	0.01702
## 70	-3.48e-02	3.91e-02	7.73e-02	-0.036807	0.101988	1.031	2.61e-03	0.02005
## 71	-7.46e-03	1.26e-02	8.04e-03	0.004181	0.027954	1.027	1.96e-04	0.00810
## 72	6.74e-02	-3.11e-02	-4.89e-02	0.022644	0.095457	1.006	2.28e-03	0.00810
## 73	-7.57e-02	9.47e-02	-6.38e-02	0.050035	-0.135302	1.023	4.58e-03	0.02034
## 74	4.77e-02	-7.49e-03	-5.94e-02	0.022906	0.076083	1.025	1.45e-03	0.01334
## 75	-2.03e-03	-1.13e-02	-5.17e-03	0.012903	-0.021875	1.033	1.20e-04	0.01229
## 76	3.35e-02	2.40e-01	-7.25e-02	-0.345220	-0.477956	1.002	5.63e-02	0.05704
## 77	2.13e-01	-1.38e-01	-1.40e-01	0.012694	0.231046	1.002	1.33e-02	0.02445
## 78	1.11e-02	-4.80e-03	1.11e-02	-0.015206	0.023741	1.030	1.42e-04	0.01046
## 79	-2.34e-01	2.50e-01	-1.39e-01	0.174913	-0.352990	0.956	3.06e-02	0.02669
## 80	6.68e-02	-1.72e-02	-5.51e-02	0.002427	0.083258	1.019	1.74e-03	0.01100
## 81	1.37e-02	-1.23e-02	6.32e-03	-0.006900	0.021005	1.030	1.11e-04	0.00985
## 82	-1.95e-02	-1.14e-01	1.55e-01	-0.076491	-0.216366	1.003	1.16e-02	0.02292
## 83	4.52e-02	-3.96e-02	-1.03e-02	0.009706	0.063026	1.020	9.96e-04	0.00884
## 84	-7.97e-03	3.47e-02	-5.20e-02	0.008958	-0.071298	1.037	1.28e-03	0.02059
## 85	-2.88e-02	2.81e-02	5.25e-02	-0.014606	0.072281	1.032	1.31e-03	0.01705
## 86	-2.87e-04	3.86e-04	-7.82e-04	0.001461	0.001743	1.046	7.63e-07	0.02390
## 87	1.69e-02	-1.38e-02	1.00e-02	-0.013459	0.026442	1.032	1.76e-04	0.01210
## 88	-6.89e-03	-9.30e-03	1.22e-02	0.020542	0.034748	1.040	3.03e-04	0.02006
## 89	2.76e-03	-3.99e-02	-2.85e-02	0.106772	0.123955	1.040	3.85e-03	0.02919
## 90	3.98e-03	5.16e-03	-1.36e-02	-0.003991	-0.019466	1.042	9.52e-05	0.02099

## 91	6.95e-02	-2.96e-03	-4.86e-02	-0.029293	0.086529	1.025	1.88e-03	0.01437
## 92	2.24e-01	-1.62e-01	-1.90e-01	0.088594	0.282064	0.989	1.97e-02	0.02697
## 93	-9.15e-03	7.71e-03	2.23e-03	0.011485	0.018908	1.037	8.98e-05	0.01663
## 94	-5.97e-02	4.61e-02	7.85e-03	0.070151	0.102391	1.045	2.63e-03	0.02975
## 95	5.41e-02	-1.73e-02	-1.34e-02	-0.030760	0.062214	1.024	9.71e-04	0.01043
## 96	-8.40e-03	3.07e-03	5.14e-03	0.021810	0.036028	1.029	3.26e-04	0.01059
## 97	-4.02e-02	-2.77e-02	4.08e-02	0.029365	-0.077475	1.034	1.51e-03	0.01882
## 98	2.17e-03	3.20e-03	-2.18e-04	-0.002619	0.008042	1.028	1.63e-05	0.00686
## 99	-8.48e-02	8.71e-02	5.27e-02	0.025732	0.128533	1.036	4.14e-03	0.02711
## 100	-3.64e-03	-2.40e-03	1.18e-02	0.003221	0.018023	1.034	8.16e-05	0.01339
## 101	-1.00e-02	-8.42e-02	1.63e-01	-0.131210	-0.220375	1.013	1.21e-02	0.02746
## 102	-5.51e-02	3.95e-02	-8.62e-03	0.076901	0.094068	1.095	2.22e-03	0.07023
## 103	3.58e-03	-1.98e-01	1.04e-01	0.021847	-0.257205	0.983	1.64e-02	0.02201
## 104	-1.24e-03	-1.36e-03	6.21e-04	0.001281	-0.003378	1.029	2.87e-06	0.00828
## 105	-3.41e-03	1.86e-02	2.05e-02	-0.026844	0.038538	1.046	3.73e-04	0.02531
## 106	-3.78e-02	-1.22e-02	6.39e-02	0.044175	0.110090	1.030	3.04e-03	0.02073
## 107	7.50e-02	-6.39e-02	-3.75e-02	0.014983	0.088191	1.031	1.95e-03	0.01851
## 108	1.08e-01	-3.99e-02	-1.03e-01	0.016900	0.132630	1.021	4.40e-03	0.01900
## 109	1.56e-01	-1.11e-01	-1.12e-01	0.029605	0.177244	1.028	7.85e-03	0.02869
## 110	-4.73e-04	5.99e-03	2.98e-03	-0.006313	0.009756	1.044	2.39e-05	0.02264
## 111	8.29e-03	-5.34e-02	9.22e-02	-0.095284	-0.139143	1.036	4.85e-03	0.02814
## 112	-1.74e-02	3.05e-02	3.24e-02	-0.021985	0.054184	1.037	7.37e-04	0.01854
## 113	8.02e-03	3.84e-03	-8.60e-04	-0.011178	0.015738	1.035	6.22e-05	0.01428
## 114	-7.06e-03	-1.66e-02	-2.66e-03	0.020056	-0.033515	1.031	2.82e-04	0.01232
## 115	-3.18e-03	2.65e-02	-5.02e-02	0.011238	-0.063764	1.040	1.02e-03	0.02230
## 116	-2.61e-03	1.25e-02	-6.73e-03	-0.011223	-0.023899	1.036	1.43e-04	0.01547
## 117	7.33e-03	-5.40e-04	-5.21e-03	-0.000115	0.010912	1.027	2.99e-05	0.00685
## 118	2.20e-01	-8.94e-02	-1.60e-01	-0.020872	0.239643	0.981	1.42e-02	0.01941
## 119	-9.34e-03	-5.51e-03	2.17e-03	0.029695	0.035842	1.052	3.23e-04	0.03089
## 120	-1.54e-02	1.37e-02	3.06e-03	0.001520	-0.017315	1.038	7.53e-05	0.01708
## 121	3.14e-03	-4.94e-03	-6.16e-04	0.031444	0.056919	1.020	8.12e-04	0.00765
## 122	-3.70e-02	5.51e-02	1.44e-02	-0.038654	-0.075296	1.038	1.42e-03	0.02202
## 123	-6.04e-02	-8.57e-02	1.11e-01	0.021001	-0.173672	1.010	7.52e-03	0.01999
## 124	2.50e-03	-1.37e-03	5.70e-03	-0.005835	0.008716	1.036	1.91e-05	0.01531
## 125	-1.24e-02	9.05e-03	-1.48e-03	0.019913	0.025442	1.051	1.63e-04	0.02890
## 126	7.66e-02	-4.12e-02	-4.50e-02	0.005634	0.089086	1.015	1.99e-03	0.01020
## 127	-1.02e-01	2.97e-01	-1.46e-01	-0.113644	-0.402887	0.932	3.96e-02	0.02694
## 128	1.79e-01	-6.40e-02	-1.21e-01	-0.040502	0.192040	1.006	9.18e-03	0.02068
## 129	-5.15e-02	9.06e-02	2.48e-01	-0.219059	0.318139	1.020	2.51e-02	0.04373

```
## 130 8.88e-02 -7.89e-02 -7.70e-02 0.073312 0.143710 1.014 5.16e-03 0.01717
## 131 -5.33e-01 7.11e-01 -6.73e-01 0.590710 -1.127360 0.566 2.73e-01 0.03692
## 132 6.17e-03 -1.77e-01 2.18e-01 -0.134736 -0.311095 0.990 2.39e-02 0.03086
## 133 -2.04e-01 1.88e-01 -1.00e-01 0.171468 -0.287655 0.994 2.05e-02 0.02906
## 134 -9.54e-03 1.12e-02 6.42e-03 0.005954 0.021465 1.032 1.16e-04 0.01158
## 135 -6.80e-03 6.26e-02 -2.45e-02 -0.062065 -0.107778 1.043 2.91e-03 0.02903
## 136 -7.64e-02 1.24e-01 -2.25e-01 0.172867 -0.293952 1.017 2.15e-02 0.03908
## 137 -9.45e-02 1.20e-01 -1.32e-01 0.117757 -0.211680 1.024 1.12e-02 0.03124
## 138 2.54e-03 -3.10e-03 3.37e-04 -0.002710 -0.004813 1.046 5.82e-06 0.02399
## 139 -8.62e-03 8.61e-03 -2.93e-03 0.003672 -0.011961 1.035 3.59e-05 0.01400
## 140 -2.18e-03 1.97e-02 8.78e-02 -0.087307 0.117050 1.049 3.44e-03 0.03466
## 141 8.24e-02 -4.85e-02 -6.84e-03 -0.040435 0.091472 1.018 2.09e-03 0.01169
## 142 -3.56e-02 1.47e-02 2.59e-03 0.065119 0.080784 1.045 1.64e-03 0.02744
## 143 -2.01e-02 2.95e-02 2.01e-02 0.002692 0.052534 1.026 6.93e-04 0.01066
## 144 8.02e-02 -3.18e-02 -9.17e-02 0.045693 0.121089 1.016 3.67e-03 0.01511
## 145 4.80e-02 -3.26e-02 -4.07e-02 0.036032 0.079668 1.019 1.59e-03 0.01033
## 146 3.56e-02 5.26e-04 -2.94e-02 -0.012970 0.046060 1.035 5.33e-04 0.01673
## 147 -4.88e-02 -1.05e-01 7.32e-02 0.064088 -0.179288 1.008 8.01e-03 0.01994
## 148 -1.20e-01 9.49e-02 1.46e-01 -0.002071 0.207876 1.012 1.08e-02 0.02540
## 149 -5.57e-02 7.57e-02 -9.43e-02 0.076596 -0.141845 1.037 5.04e-03 0.02904
## 150 1.38e-02 -1.37e-02 4.63e-03 -0.005868 0.019160 1.034 9.22e-05 0.01371
## 151 3.84e-02 -1.54e-01 8.24e-02 -0.048036 -0.199443 1.004 9.90e-03 0.02098
## 152 4.93e-02 -2.04e-02 -9.36e-02 0.087286 0.131074 1.021 4.30e-03 0.01859
## 153 2.84e-03 6.33e-03 2.68e-03 -0.008423 0.014487 1.031 5.27e-05 0.01019
## 154 -1.31e-02 7.42e-03 3.46e-02 -0.002545 0.049711 1.028 6.20e-04 0.01144
## 155 2.04e-03 2.18e-03 7.96e-04 -0.004168 0.006258 1.032 9.84e-06 0.01129
## 156 -1.95e-01 1.45e-01 3.17e-02 0.078193 -0.203369 1.013 1.03e-02 0.02507
## 157 5.87e-04 2.59e-03 -4.12e-03 -0.001781 -0.006855 1.039 1.18e-05 0.01797
## 158 4.09e-03 3.78e-04 -5.39e-03 0.000909 0.006597 1.038 1.09e-05 0.01637
## 159 -9.43e-02 2.20e-01 -1.05e-01 -0.058369 -0.289292 0.974 2.07e-02 0.02354
## 160 1.21e-02 -3.68e-03 -8.75e-03 0.006965 0.023517 1.025 1.39e-04 0.00621
## 161 2.77e-03 2.44e-03 -3.03e-03 0.000993 0.008722 1.027 1.91e-05 0.00619
## 162 -1.61e-03 8.67e-03 -6.68e-03 -0.006960 -0.018066 1.034 8.20e-05 0.01350
## 163 -6.31e-04 -1.00e-03 6.02e-04 0.000260 -0.002326 1.028 1.36e-06 0.00696
## 164 6.27e-03 5.59e-03 3.80e-02 -0.041355 0.055989 1.039 7.87e-04 0.02042
## 165 4.42e-02 -9.76e-03 -5.98e-03 -0.035514 0.055182 1.028 7.64e-04 0.01225
## 166 5.35e-02 -1.02e-01 2.54e-01 -0.329393 -0.390670 1.052 3.80e-02 0.06920
## 167 -1.24e-01 1.87e-01 -1.52e-01 0.091009 -0.271249 0.986 1.82e-02 0.02469
## 168 -3.34e-02 -3.81e-02 5.63e-02 0.005831 -0.086987 1.026 1.90e-03 0.01544
```

```

## 169 2.00e-03 -2.73e-03 1.74e-03 -0.004735 -0.006665 1.038 1.12e-05 0.01653
## 170 -2.10e-02 -2.15e-01 7.09e-02 0.118777 -0.294277 0.983 2.14e-02 0.02664
## 171 6.91e-02 -4.61e-02 -2.52e-02 -0.010963 0.072451 1.028 1.32e-03 0.01439
## 172 3.62e-04 1.06e-03 -2.82e-03 0.005279 0.008138 1.030 1.66e-05 0.00924
## 173 -5.25e-04 4.77e-04 -2.03e-05 0.000173 -0.000614 1.039 9.47e-08 0.01755
## 174 -1.14e-02 -3.77e-03 9.98e-03 0.005435 -0.018196 1.033 8.32e-05 0.01256
## 175 -6.90e-02 -9.33e-02 1.12e-01 0.037486 -0.189087 1.003 8.90e-03 0.01931
## 176 -1.43e-01 1.37e-01 1.54e-01 -0.015233 0.235929 1.015 1.39e-02 0.03024
## 177 -3.63e-03 1.11e-02 5.95e-03 -0.006835 0.016499 1.036 6.84e-05 0.01548
## 178 -1.19e-02 -5.95e-03 2.37e-02 -0.011978 -0.031416 1.032 2.48e-04 0.01286
## 179 -3.56e-02 -2.93e-01 2.68e-01 -0.024910 -0.434670 0.919 4.59e-02 0.02781
## 180 7.77e-03 2.53e-03 -6.75e-03 -0.002817 0.012776 1.030 4.10e-05 0.00984
## 181 -4.78e-03 -7.83e-04 4.12e-03 0.002134 -0.006753 1.038 1.15e-05 0.01657
## 182 -3.37e-02 -6.57e-02 9.34e-02 -0.019595 -0.134747 1.016 4.54e-03 0.01669
## 183 1.44e-01 -9.31e-02 -1.12e-01 0.041050 0.174211 1.005 7.56e-03 0.01801
## 184 -1.69e-01 1.36e-01 5.86e-02 0.132013 0.245051 1.026 1.50e-02 0.03693
## 185 1.25e-02 -5.00e-02 7.12e-03 0.001081 -0.064150 1.027 1.03e-03 0.01298
## 186 -3.97e-02 4.95e-02 1.35e-01 -0.086708 0.169103 1.021 7.14e-03 0.02395
## 187 2.94e-02 -6.11e-04 -3.77e-02 0.008986 0.046037 1.034 5.32e-04 0.01581
## 188 9.49e-04 4.96e-03 5.55e-03 -0.007251 0.013257 1.030 4.42e-05 0.00984
## 189 -1.15e-02 -2.03e-01 3.23e-02 0.136670 -0.278226 0.992 1.92e-02 0.02738
## 190 4.83e-02 -4.03e-02 -1.73e-02 -0.000235 0.053181 1.037 7.10e-04 0.01849
## 191 -7.41e-02 9.23e-02 -1.30e-01 0.119089 -0.191866 1.035 9.20e-03 0.03418
## 192 1.04e-01 -4.75e-02 -2.79e-02 -0.053993 0.110143 1.020 3.04e-03 0.01536
## 193 1.15e-01 -9.07e-02 -8.31e-02 0.036994 0.139717 1.032 4.89e-03 0.02565
## 194 5.15e-03 1.12e-02 8.71e-02 -0.087144 0.116869 1.042 3.42e-03 0.02958
## 195 1.32e-02 1.59e-03 4.52e-02 -0.052421 0.068925 1.037 1.19e-03 0.02009
## 196 1.93e-01 -1.14e-01 -1.03e-01 -0.026510 0.197725 1.005 9.73e-03 0.02131
## 197 1.09e-01 -3.43e-02 -5.98e-02 -0.040178 0.117324 1.020 3.44e-03 0.01609
## 198 5.80e-04 2.60e-04 -3.60e-04 -0.000507 0.000994 1.035 2.49e-07 0.01385
## 199 -1.29e-01 1.11e-01 5.08e-02 0.091306 0.190196 1.031 9.04e-03 0.03206
## 200 -4.26e-02 -8.17e-02 5.44e-02 0.056327 -0.144465 1.016 5.21e-03 0.01817
##      inf
## 1
## 2
## 3
## 4
## 5
## 6      *
```

```
## 7
## 8
## 9
## 10
## 11
## 12
## 13
## 14
## 15
## 16
## 17      *
## 18
## 19
## 20
## 21
## 22
## 23
## 24
## 25
## 26
## 27
## 28
## 29
## 30
## 31
## 32
## 33
## 34
## 35
## 36      *
## 37
## 38
## 39
## 40
## 41
## 42
## 43
## 44
## 45
```

```
## 46
## 47
## 48
## 49
## 50
## 51
## 52
## 53
## 54
## 55
## 56
## 57
## 58
## 59
## 60
## 61
## 62
## 63
## 64
## 65
## 66
## 67
## 68
## 69
## 70
## 71
## 72
## 73
## 74
## 75
## 76      *
## 77
## 78
## 79
## 80
## 81
## 82
## 83
## 84
```

```
## 85
## 86
## 87
## 88
## 89
## 90
## 91
## 92
## 93
## 94
## 95
## 96
## 97
## 98
## 99
## 100
## 101
## 102  *
## 103
## 104
## 105
## 106
## 107
## 108
## 109
## 110
## 111
## 112
## 113
## 114
## 115
## 116
## 117
## 118
## 119
## 120
## 121
## 122
## 123
```

```
## 124
## 125
## 126
## 127    *
## 128
## 129
## 130
## 131    *
## 132
## 133
## 134
## 135
## 136
## 137
## 138
## 139
## 140
## 141
## 142
## 143
## 144
## 145
## 146
## 147
## 148
## 149
## 150
## 151
## 152
## 153
## 154
## 155
## 156
## 157
## 158
## 159
## 160
## 161
## 162
```



```
## 163
## 164
## 165
## 166  *
## 167
## 168
## 169
## 170
## 171
## 172
## 173
## 174
## 175
## 176
## 177
## 178
## 179  *
## 180
## 181
## 182
## 183
## 184
## 185
## 186
## 187
## 188
## 189
## 190
## 191
## 192
## 193
## 194
## 195
## 196
## 197
## 198
## 199
## 200
```

```
which(abs(r.std)>2)
```

```
##      6  26  36  79 127 131 179
```

```
##      6  26  36  79 127 131 179
```

```
influence.measures(lm.sol)
```

```
## Influence measures of
```

```
##      lm(formula = y ~ tv + rdo + nsp, data = mydata) :
```

```
##
```

##		dfb.1_	dfb.tv	dfb.rdo	dfb.nsp	dffit	cov.r	cook.d	hat
## 1		-8.56e-02	5.81e-02	2.33e-02	0.101385	0.152240	1.028	5.80e-03	0.02520
## 2		-3.34e-02	1.06e-01	-7.89e-02	-0.029579	-0.163530	1.013	6.67e-03	0.01942
## 3		-1.98e-03	2.19e-01	-1.35e-01	-0.184090	-0.370048	0.992	3.38e-02	0.03923
## 4		-2.44e-02	-1.97e-03	3.14e-02	0.035180	0.070020	1.032	1.23e-03	0.01661
## 5		-8.92e-04	-4.63e-03	1.73e-02	-0.020697	-0.026825	1.045	1.81e-04	0.02351
## 6		2.50e-02	4.23e-01	-2.72e-01	-0.381593	-0.734107	0.864	1.28e-01	0.04748
## 7		2.53e-03	-3.16e-03	2.54e-03	-0.001635	0.005067	1.036	6.45e-06	0.01444
## 8		4.49e-02	-1.22e-02	3.45e-03	-0.037700	0.061714	1.021	9.55e-04	0.00918
## 9		1.15e-01	-6.98e-02	-4.43e-02	-0.039534	0.114895	1.044	3.31e-03	0.03071
## 10		-6.45e-02	-5.76e-02	1.13e-01	-0.003357	-0.154351	1.010	5.95e-03	0.01715
## 11		1.06e-01	-5.93e-02	-7.46e-02	0.011295	0.119465	1.019	3.57e-03	0.01598
## 12		1.46e-03	4.12e-03	2.37e-03	-0.006645	0.009111	1.039	2.09e-05	0.01735
## 13		-2.06e-02	9.19e-02	-1.76e-02	-0.089164	-0.146895	1.038	5.40e-03	0.03044
## 14		5.86e-02	-1.83e-02	-2.62e-02	-0.027059	0.063462	1.030	1.01e-03	0.01461
## 15		-1.34e-02	1.46e-02	9.65e-03	0.011701	0.034347	1.029	2.96e-04	0.01031
## 16		-7.12e-02	3.09e-02	9.19e-02	0.030911	0.138031	1.023	4.77e-03	0.02078
## 17		1.15e-02	1.67e-02	6.66e-03	-0.056457	-0.061601	1.116	9.53e-04	0.08633
## 18		-7.43e-02	7.47e-02	3.45e-02	0.038662	0.113911	1.037	3.25e-03	0.02542
## 19		6.95e-02	-5.02e-02	2.67e-03	-0.028383	0.082603	1.018	1.71e-03	0.01046
## 20		9.93e-03	4.35e-04	4.47e-03	-0.010614	0.021155	1.026	1.12e-04	0.00669
## 21		2.67e-03	-3.33e-03	4.57e-04	-0.004186	-0.007047	1.035	1.25e-05	0.01359
## 22		-3.78e-02	-1.08e-01	1.18e-01	-0.006953	-0.186471	1.003	8.66e-03	0.01886
## 23		-4.80e-02	6.05e-02	3.07e-02	-0.045374	-0.085605	1.041	1.84e-03	0.02512
## 24		-2.72e-03	-4.33e-02	1.86e-02	0.004008	-0.064802	1.024	1.05e-03	0.01071
## 25		9.91e-02	-6.20e-02	-3.44e-02	-0.019318	0.104517	1.016	2.73e-03	0.01255
## 26		-5.06e-02	-2.24e-01	2.02e-01	0.015013	-0.344354	0.949	2.91e-02	0.02415
## 27		2.29e-04	-1.31e-05	3.33e-04	-0.000460	0.000665	1.032	1.11e-07	0.01122
## 28		-1.74e-03	-5.48e-02	1.87e-02	0.012386	-0.077233	1.024	1.50e-03	0.01249

## 29	7.34e-03	-2.59e-02	-7.92e-03	0.011311	-0.035742	1.033	3.21e-04	0.01361
## 30	5.66e-02	-5.15e-02	-3.85e-02	0.041742	0.091342	1.020	2.09e-03	0.01259
## 31	1.01e-02	-1.67e-02	-8.10e-04	-0.004266	-0.020350	1.042	1.04e-04	0.02072
## 32	1.58e-02	-9.34e-03	-1.28e-02	0.013123	0.029699	1.027	2.22e-04	0.00807
## 33	1.17e-01	-4.39e-02	-1.29e-01	0.046121	0.161712	1.011	6.52e-03	0.01857
## 34	-7.16e-03	-9.17e-02	-1.50e-02	0.092166	-0.142916	1.031	5.11e-03	0.02572
## 35	1.46e-01	-4.09e-02	-9.52e-02	-0.046168	0.159819	1.012	6.37e-03	0.01882
## 36	-5.19e-02	-3.28e-01	1.97e-01	0.122998	-0.459319	0.922	5.13e-02	0.03092
## 37	-5.97e-02	1.22e-01	1.64e-01	-0.160329	0.247685	1.032	1.53e-02	0.04028
## 38	4.99e-03	3.76e-02	-6.57e-02	-0.004561	-0.088849	1.040	1.98e-03	0.02508
## 39	7.70e-03	-1.00e-02	1.74e-03	0.001501	0.013071	1.034	4.29e-05	0.01298
## 40	-2.92e-02	4.05e-02	4.39e-02	-0.014928	0.075623	1.027	1.43e-03	0.01430
## 41	-1.88e-05	6.09e-03	-1.05e-03	0.000470	0.011214	1.028	3.16e-05	0.00716
## 42	2.20e-03	-2.54e-03	-4.78e-03	-0.001070	-0.010401	1.029	2.72e-05	0.00792
## 43	1.32e-02	-6.82e-02	-2.93e-02	0.061954	-0.099044	1.049	2.46e-03	0.03262
## 44	-2.11e-02	-3.38e-02	4.64e-02	-0.006572	-0.072783	1.026	1.33e-03	0.01299
## 45	-1.62e-02	2.41e-02	-1.33e-04	-0.010289	-0.030793	1.038	2.38e-04	0.01737
## 46	-2.08e-03	-3.62e-03	9.23e-04	-0.000583	-0.011621	1.026	3.39e-05	0.00557
## 47	8.16e-02	-4.74e-02	-7.56e-02	0.045522	0.117997	1.012	3.48e-03	0.01292
## 48	-4.04e-02	6.74e-02	9.43e-02	-0.069868	0.138527	1.029	4.80e-03	0.02383
## 49	1.71e-02	-5.74e-02	5.68e-02	-0.069012	-0.115238	1.022	3.32e-03	0.01704
## 50	7.84e-02	-5.99e-02	-5.92e-02	0.041651	0.109380	1.018	2.99e-03	0.01409
## 51	-2.87e-02	-3.49e-02	8.15e-02	-0.036165	-0.102590	1.029	2.64e-03	0.01903
## 52	9.00e-02	-2.64e-02	-2.89e-02	-0.055477	0.100505	1.022	2.53e-03	0.01507
## 53	-6.70e-02	6.15e-02	9.46e-02	-0.004607	0.145566	1.009	5.29e-03	0.01552
## 54	-5.41e-02	1.61e-02	6.20e-02	0.042240	0.109109	1.030	2.98e-03	0.02063
## 55	2.81e-03	-1.02e-02	-4.49e-03	0.006819	-0.014414	1.040	5.22e-05	0.01877
## 56	-1.29e-01	4.97e-02	1.41e-01	0.079075	0.231147	1.003	1.33e-02	0.02477
## 57	-1.39e-01	2.18e-01	-2.90e-02	-0.062143	-0.262898	0.974	1.71e-02	0.02032
## 58	1.44e-02	-1.59e-03	-8.41e-04	-0.010381	0.021390	1.027	1.15e-04	0.00711
## 59	-7.99e-02	5.41e-02	1.43e-01	-0.028435	0.177346	1.018	7.85e-03	0.02352
## 60	8.83e-04	8.73e-03	8.97e-03	-0.014003	0.020353	1.037	1.04e-04	0.01612
## 61	1.86e-01	-1.03e-01	-1.35e-01	0.013535	0.205266	1.000	1.05e-02	0.02055
## 62	-7.88e-02	6.96e-02	5.26e-02	0.036065	0.122266	1.032	3.74e-03	0.02366
## 63	-3.38e-04	-5.09e-02	2.51e-02	0.000269	-0.072751	1.025	1.33e-03	0.01251
## 64	2.89e-02	-1.65e-02	2.89e-02	-0.041326	0.058053	1.031	8.46e-04	0.01497
## 65	-2.78e-03	-1.03e-02	6.29e-02	-0.024839	0.076997	1.029	1.49e-03	0.01567
## 66	1.13e-01	-5.07e-02	-2.86e-02	-0.066287	0.120437	1.024	3.63e-03	0.01887
## 67	3.36e-02	-2.70e-02	1.33e-02	-0.028565	0.045185	1.044	5.13e-04	0.02371

## 68	5.91e-02	-1.56e-03	-1.60e-02	-0.044776	0.080688	1.017	1.63e-03	0.00978
## 69	2.61e-04	-3.54e-03	-1.98e-03	0.003629	-0.006015	1.038	9.09e-06	0.01702
## 70	-3.48e-02	3.91e-02	7.73e-02	-0.036807	0.101988	1.031	2.61e-03	0.02005
## 71	-7.46e-03	1.26e-02	8.04e-03	0.004181	0.027954	1.027	1.96e-04	0.00810
## 72	6.74e-02	-3.11e-02	-4.89e-02	0.022644	0.095457	1.006	2.28e-03	0.00810
## 73	-7.57e-02	9.47e-02	-6.38e-02	0.050035	-0.135302	1.023	4.58e-03	0.02034
## 74	4.77e-02	-7.49e-03	-5.94e-02	0.022906	0.076083	1.025	1.45e-03	0.01334
## 75	-2.03e-03	-1.13e-02	-5.17e-03	0.012903	-0.021875	1.033	1.20e-04	0.01229
## 76	3.35e-02	2.40e-01	-7.25e-02	-0.345220	-0.477956	1.002	5.63e-02	0.05704
## 77	2.13e-01	-1.38e-01	-1.40e-01	0.012694	0.231046	1.002	1.33e-02	0.02445
## 78	1.11e-02	-4.80e-03	1.11e-02	-0.015206	0.023741	1.030	1.42e-04	0.01046
## 79	-2.34e-01	2.50e-01	-1.39e-01	0.174913	-0.352990	0.956	3.06e-02	0.02669
## 80	6.68e-02	-1.72e-02	-5.51e-02	0.002427	0.083258	1.019	1.74e-03	0.01100
## 81	1.37e-02	-1.23e-02	6.32e-03	-0.006900	0.021005	1.030	1.11e-04	0.00985
## 82	-1.95e-02	-1.14e-01	1.55e-01	-0.076491	-0.216366	1.003	1.16e-02	0.02292
## 83	4.52e-02	-3.96e-02	-1.03e-02	0.009706	0.063026	1.020	9.96e-04	0.00884
## 84	-7.97e-03	3.47e-02	-5.20e-02	0.008958	-0.071298	1.037	1.28e-03	0.02059
## 85	-2.88e-02	2.81e-02	5.25e-02	-0.014606	0.072281	1.032	1.31e-03	0.01705
## 86	-2.87e-04	3.86e-04	-7.82e-04	0.001461	0.001743	1.046	7.63e-07	0.02390
## 87	1.69e-02	-1.38e-02	1.00e-02	-0.013459	0.026442	1.032	1.76e-04	0.01210
## 88	-6.89e-03	-9.30e-03	1.22e-02	0.020542	0.034748	1.040	3.03e-04	0.02006
## 89	2.76e-03	-3.99e-02	-2.85e-02	0.106772	0.123955	1.040	3.85e-03	0.02919
## 90	3.98e-03	5.16e-03	-1.36e-02	-0.003991	-0.019466	1.042	9.52e-05	0.02099
## 91	6.95e-02	-2.96e-03	-4.86e-02	-0.029293	0.086529	1.025	1.88e-03	0.01437
## 92	2.24e-01	-1.62e-01	-1.90e-01	0.088594	0.282064	0.989	1.97e-02	0.02697
## 93	-9.15e-03	7.71e-03	2.23e-03	0.011485	0.018908	1.037	8.98e-05	0.01663
## 94	-5.97e-02	4.61e-02	7.85e-03	0.070151	0.102391	1.045	2.63e-03	0.02975
## 95	5.41e-02	-1.73e-02	-1.34e-02	-0.030760	0.062214	1.024	9.71e-04	0.01043
## 96	-8.40e-03	3.07e-03	5.14e-03	0.021810	0.036028	1.029	3.26e-04	0.01059
## 97	-4.02e-02	-2.77e-02	4.08e-02	0.029365	-0.077475	1.034	1.51e-03	0.01882
## 98	2.17e-03	3.20e-03	-2.18e-04	-0.002619	0.008042	1.028	1.63e-05	0.00686
## 99	-8.48e-02	8.71e-02	5.27e-02	0.025732	0.128533	1.036	4.14e-03	0.02711
## 100	-3.64e-03	-2.40e-03	1.18e-02	0.003221	0.018023	1.034	8.16e-05	0.01339
## 101	-1.00e-02	-8.42e-02	1.63e-01	-0.131210	-0.220375	1.013	1.21e-02	0.02746
## 102	-5.51e-02	3.95e-02	-8.62e-03	0.076901	0.094068	1.095	2.22e-03	0.07023
## 103	3.58e-03	-1.98e-01	1.04e-01	0.021847	-0.257205	0.983	1.64e-02	0.02201
## 104	-1.24e-03	-1.36e-03	6.21e-04	0.001281	-0.003378	1.029	2.87e-06	0.00828
## 105	-3.41e-03	1.86e-02	2.05e-02	-0.026844	0.038538	1.046	3.73e-04	0.02531
## 106	-3.78e-02	-1.22e-02	6.39e-02	0.044175	0.110090	1.030	3.04e-03	0.02073

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## 107 7.50e-02 -6.39e-02 -3.75e-02 0.014983 0.088191 1.031 1.95e-03 0.01851
## 108 1.08e-01 -3.99e-02 -1.03e-01 0.016900 0.132630 1.021 4.40e-03 0.01900
## 109 1.56e-01 -1.11e-01 -1.12e-01 0.029605 0.177244 1.028 7.85e-03 0.02869
## 110 -4.73e-04 5.99e-03 2.98e-03 -0.006313 0.009756 1.044 2.39e-05 0.02264
## 111 8.29e-03 -5.34e-02 9.22e-02 -0.095284 -0.139143 1.036 4.85e-03 0.02814
## 112 -1.74e-02 3.05e-02 3.24e-02 -0.021985 0.054184 1.037 7.37e-04 0.01854
## 113 8.02e-03 3.84e-03 -8.60e-04 -0.011178 0.015738 1.035 6.22e-05 0.01428
## 114 -7.06e-03 -1.66e-02 -2.66e-03 0.020056 -0.033515 1.031 2.82e-04 0.01232
## 115 -3.18e-03 2.65e-02 -5.02e-02 0.011238 -0.063764 1.040 1.02e-03 0.02230
## 116 -2.61e-03 1.25e-02 -6.73e-03 -0.011223 -0.023899 1.036 1.43e-04 0.01547
## 117 7.33e-03 -5.40e-04 -5.21e-03 -0.000115 0.010912 1.027 2.99e-05 0.00685
## 118 2.20e-01 -8.94e-02 -1.60e-01 -0.020872 0.239643 0.981 1.42e-02 0.01941
## 119 -9.34e-03 -5.51e-03 2.17e-03 0.029695 0.035842 1.052 3.23e-04 0.03089
## 120 -1.54e-02 1.37e-02 3.06e-03 0.001520 -0.017315 1.038 7.53e-05 0.01708
## 121 3.14e-03 -4.94e-03 -6.16e-04 0.031444 0.056919 1.020 8.12e-04 0.00765
## 122 -3.70e-02 5.51e-02 1.44e-02 -0.038654 -0.075296 1.038 1.42e-03 0.02202
## 123 -6.04e-02 -8.57e-02 1.11e-01 0.021001 -0.173672 1.010 7.52e-03 0.01999
## 124 2.50e-03 -1.37e-03 5.70e-03 -0.005835 0.008716 1.036 1.91e-05 0.01531
## 125 -1.24e-02 9.05e-03 -1.48e-03 0.019913 0.025442 1.051 1.63e-04 0.02890
## 126 7.66e-02 -4.12e-02 -4.50e-02 0.005634 0.089086 1.015 1.99e-03 0.01020
## 127 -1.02e-01 2.97e-01 -1.46e-01 -0.113644 -0.402887 0.932 3.96e-02 0.02694
## 128 1.79e-01 -6.40e-02 -1.21e-01 -0.040502 0.192040 1.006 9.18e-03 0.02068
## 129 -5.15e-02 9.06e-02 2.48e-01 -0.219059 0.318139 1.020 2.51e-02 0.04373
## 130 8.88e-02 -7.89e-02 -7.70e-02 0.073312 0.143710 1.014 5.16e-03 0.01717
## 131 -5.33e-01 7.11e-01 -6.73e-01 0.590710 -1.127360 0.566 2.73e-01 0.03692
## 132 6.17e-03 -1.77e-01 2.18e-01 -0.134736 -0.311095 0.990 2.39e-02 0.03086
## 133 -2.04e-01 1.88e-01 -1.00e-01 0.171468 -0.287655 0.994 2.05e-02 0.02906
## 134 -9.54e-03 1.12e-02 6.42e-03 0.005954 0.021465 1.032 1.16e-04 0.01158
## 135 -6.80e-03 6.26e-02 -2.45e-02 -0.062065 -0.107778 1.043 2.91e-03 0.02903
## 136 -7.64e-02 1.24e-01 -2.25e-01 0.172867 -0.293952 1.017 2.15e-02 0.03908
## 137 -9.45e-02 1.20e-01 -1.32e-01 0.117757 -0.211680 1.024 1.12e-02 0.03124
## 138 2.54e-03 -3.10e-03 3.37e-04 -0.002710 -0.004813 1.046 5.82e-06 0.02399
## 139 -8.62e-03 8.61e-03 -2.93e-03 0.003672 -0.011961 1.035 3.59e-05 0.01400
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## 141 8.24e-02 -4.85e-02 -6.84e-03 -0.040435 0.091472 1.018 2.09e-03 0.01169
## 142 -3.56e-02 1.47e-02 2.59e-03 0.065119 0.080784 1.045 1.64e-03 0.02744
## 143 -2.01e-02 2.95e-02 2.01e-02 0.002692 0.052534 1.026 6.93e-04 0.01066
## 144 8.02e-02 -3.18e-02 -9.17e-02 0.045693 0.121089 1.016 3.67e-03 0.01511
## 145 4.80e-02 -3.26e-02 -4.07e-02 0.036032 0.079668 1.019 1.59e-03 0.01033
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## 146 3.56e-02 5.26e-04 -2.94e-02 -0.012970 0.046060 1.035 5.33e-04 0.01673
## 147 -4.88e-02 -1.05e-01 7.32e-02 0.064088 -0.179288 1.008 8.01e-03 0.01994
## 148 -1.20e-01 9.49e-02 1.46e-01 -0.002071 0.207876 1.012 1.08e-02 0.02540
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## 150 1.38e-02 -1.37e-02 4.63e-03 -0.005868 0.019160 1.034 9.22e-05 0.01371
## 151 3.84e-02 -1.54e-01 8.24e-02 -0.048036 -0.199443 1.004 9.90e-03 0.02098
## 152 4.93e-02 -2.04e-02 -9.36e-02 0.087286 0.131074 1.021 4.30e-03 0.01859
## 153 2.84e-03 6.33e-03 2.68e-03 -0.008423 0.014487 1.031 5.27e-05 0.01019
## 154 -1.31e-02 7.42e-03 3.46e-02 -0.002545 0.049711 1.028 6.20e-04 0.01144
## 155 2.04e-03 2.18e-03 7.96e-04 -0.004168 0.006258 1.032 9.84e-06 0.01129
## 156 -1.95e-01 1.45e-01 3.17e-02 0.078193 -0.203369 1.013 1.03e-02 0.02507
## 157 5.87e-04 2.59e-03 -4.12e-03 -0.001781 -0.006855 1.039 1.18e-05 0.01797
## 158 4.09e-03 3.78e-04 -5.39e-03 0.000909 0.006597 1.038 1.09e-05 0.01637
## 159 -9.43e-02 2.20e-01 -1.05e-01 -0.058369 -0.289292 0.974 2.07e-02 0.02354
## 160 1.21e-02 -3.68e-03 -8.75e-03 0.006965 0.023517 1.025 1.39e-04 0.00621
## 161 2.77e-03 2.44e-03 -3.03e-03 0.000993 0.008722 1.027 1.91e-05 0.00619
## 162 -1.61e-03 8.67e-03 -6.68e-03 -0.006960 -0.018066 1.034 8.20e-05 0.01350
## 163 -6.31e-04 -1.00e-03 6.02e-04 0.000260 -0.002326 1.028 1.36e-06 0.00696
## 164 6.27e-03 5.59e-03 3.80e-02 -0.041355 0.055989 1.039 7.87e-04 0.02042
## 165 4.42e-02 -9.76e-03 -5.98e-03 -0.035514 0.055182 1.028 7.64e-04 0.01225
## 166 5.35e-02 -1.02e-01 2.54e-01 -0.329393 -0.390670 1.052 3.80e-02 0.06920
## 167 -1.24e-01 1.87e-01 -1.52e-01 0.091009 -0.271249 0.986 1.82e-02 0.02469
## 168 -3.34e-02 -3.81e-02 5.63e-02 0.005831 -0.086987 1.026 1.90e-03 0.01544
## 169 2.00e-03 -2.73e-03 1.74e-03 -0.004735 -0.006665 1.038 1.12e-05 0.01653
## 170 -2.10e-02 -2.15e-01 7.09e-02 0.118777 -0.294277 0.983 2.14e-02 0.02664
## 171 6.91e-02 -4.61e-02 -2.52e-02 -0.010963 0.072451 1.028 1.32e-03 0.01439
## 172 3.62e-04 1.06e-03 -2.82e-03 0.005279 0.008138 1.030 1.66e-05 0.00924
## 173 -5.25e-04 4.77e-04 -2.03e-05 0.000173 -0.000614 1.039 9.47e-08 0.01755
## 174 -1.14e-02 -3.77e-03 9.98e-03 0.005435 -0.018196 1.033 8.32e-05 0.01256
## 175 -6.90e-02 -9.33e-02 1.12e-01 0.037486 -0.189087 1.003 8.90e-03 0.01931
## 176 -1.43e-01 1.37e-01 1.54e-01 -0.015233 0.235929 1.015 1.39e-02 0.03024
## 177 -3.63e-03 1.11e-02 5.95e-03 -0.006835 0.016499 1.036 6.84e-05 0.01548
## 178 -1.19e-02 -5.95e-03 2.37e-02 -0.011978 -0.031416 1.032 2.48e-04 0.01286
## 179 -3.56e-02 -2.93e-01 2.68e-01 -0.024910 -0.434670 0.919 4.59e-02 0.02781
## 180 7.77e-03 2.53e-03 -6.75e-03 -0.002817 0.012776 1.030 4.10e-05 0.00984
## 181 -4.78e-03 -7.83e-04 4.12e-03 0.002134 -0.006753 1.038 1.15e-05 0.01657
## 182 -3.37e-02 -6.57e-02 9.34e-02 -0.019595 -0.134747 1.016 4.54e-03 0.01669
## 183 1.44e-01 -9.31e-02 -1.12e-01 0.041050 0.174211 1.005 7.56e-03 0.01801
## 184 -1.69e-01 1.36e-01 5.86e-02 0.132013 0.245051 1.026 1.50e-02 0.03693
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## 185 1.25e-02 -5.00e-02 7.12e-03 0.001081 -0.064150 1.027 1.03e-03 0.01298
## 186 -3.97e-02 4.95e-02 1.35e-01 -0.086708 0.169103 1.021 7.14e-03 0.02395
## 187 2.94e-02 -6.11e-04 -3.77e-02 0.008986 0.046037 1.034 5.32e-04 0.01581
## 188 9.49e-04 4.96e-03 5.55e-03 -0.007251 0.013257 1.030 4.42e-05 0.00984
## 189 -1.15e-02 -2.03e-01 3.23e-02 0.136670 -0.278226 0.992 1.92e-02 0.02738
## 190 4.83e-02 -4.03e-02 -1.73e-02 -0.000235 0.053181 1.037 7.10e-04 0.01849
## 191 -7.41e-02 9.23e-02 -1.30e-01 0.119089 -0.191866 1.035 9.20e-03 0.03418
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## 193 1.15e-01 -9.07e-02 -8.31e-02 0.036994 0.139717 1.032 4.89e-03 0.02565
## 194 5.15e-03 1.12e-02 8.71e-02 -0.087144 0.116869 1.042 3.42e-03 0.02958
## 195 1.32e-02 1.59e-03 4.52e-02 -0.052421 0.068925 1.037 1.19e-03 0.02009
## 196 1.93e-01 -1.14e-01 -1.03e-01 -0.026510 0.197725 1.005 9.73e-03 0.02131
## 197 1.09e-01 -3.43e-02 -5.98e-02 -0.040178 0.117324 1.020 3.44e-03 0.01609
## 198 5.80e-04 2.60e-04 -3.60e-04 -0.000507 0.000994 1.035 2.49e-07 0.01385
## 199 -1.29e-01 1.11e-01 5.08e-02 0.091306 0.190196 1.031 9.04e-03 0.03206
## 200 -4.26e-02 -8.17e-02 5.44e-02 0.056327 -0.144465 1.016 5.21e-03 0.01817
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## 127  *
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## 131  *
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```

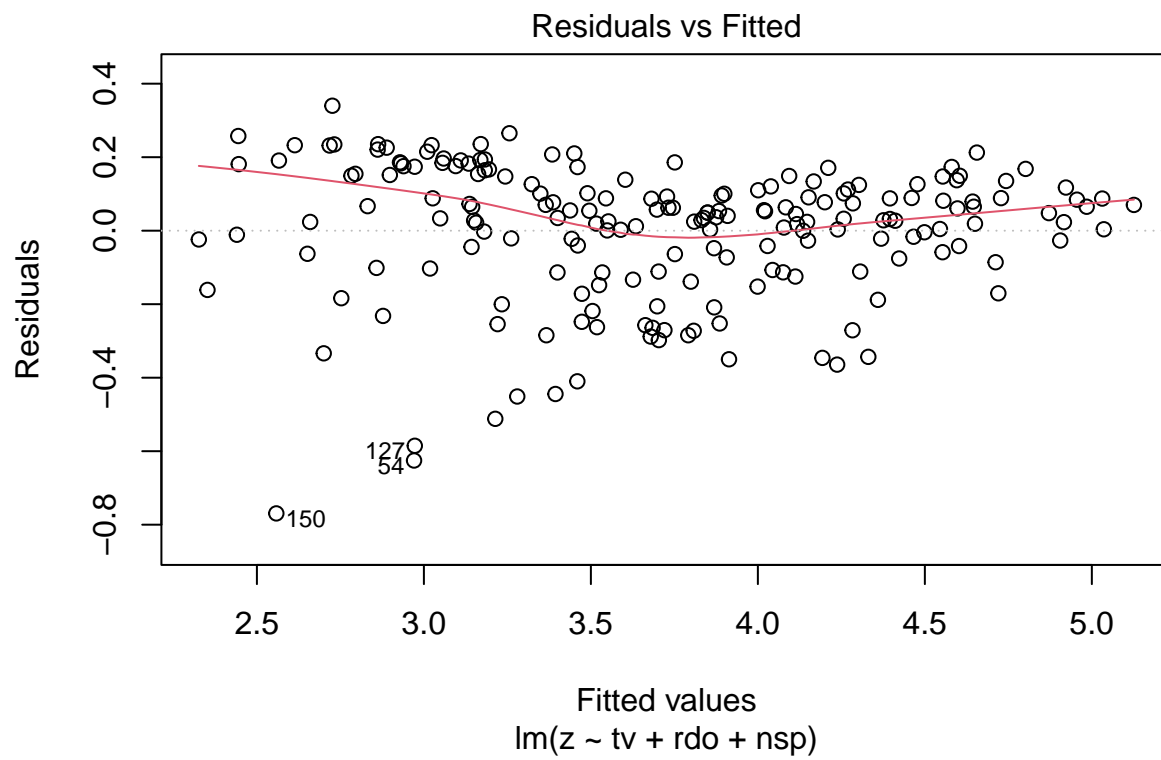
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## 200
```

根据残差判定异常点有 6 26 36 79 127 131 179

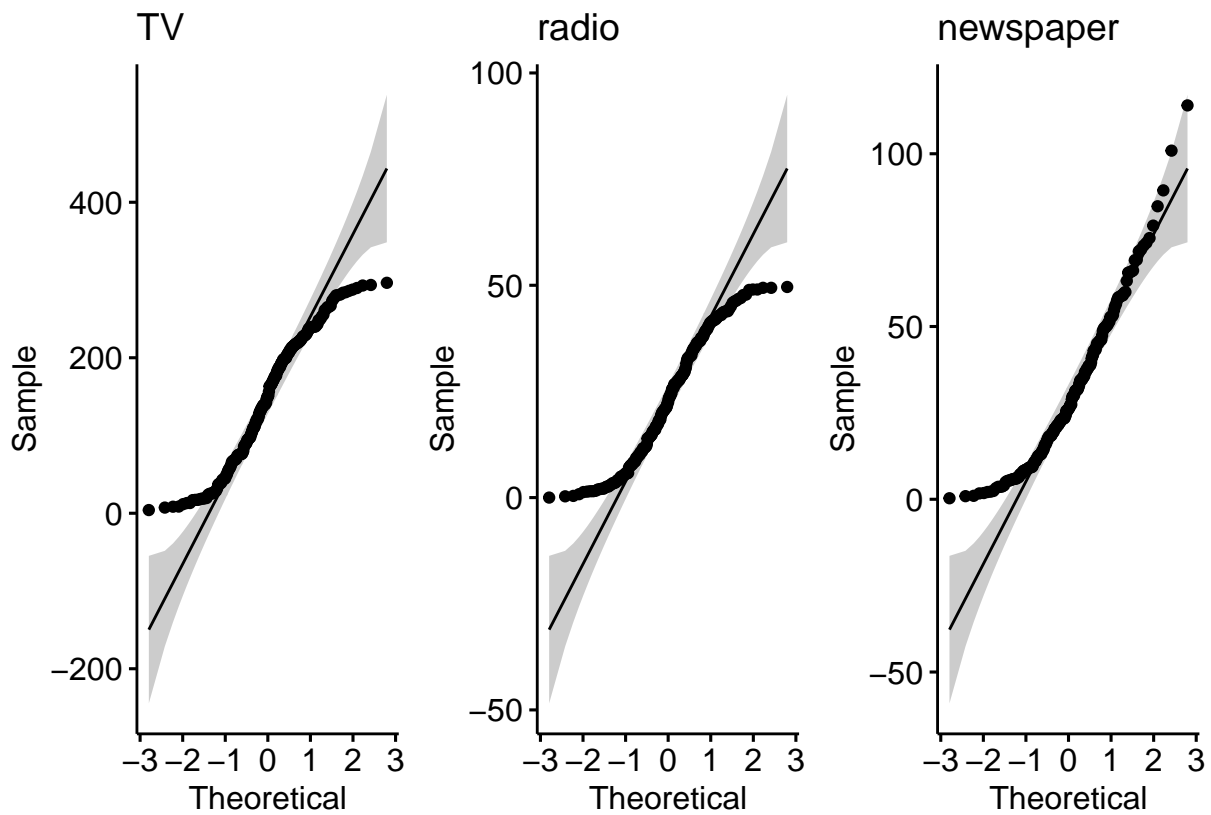
强影响点有 6,17,36,76,102,127,131,166,179,

对数据作删去异常点的处理，并作方差稳定性变换

```
d <- c(6,26,36,79,127,131,179)  
adv <- adv[-d,]  
y <- adv[,4]  
tv <- adv[,1]  
rdo <- adv[,2]  
nsp <- adv[,3]  
z=sqrt(y)  
mydata2=data.frame(z,tv,rdo,nsp)  
lm.sol2=lm(z~tv+rdo+nsp,data=mydata2)  
plot(lm.sol2,which=1)
```



```
c1 <- ggqqplot(mydata2$tv,main='TV')
c2 <- ggqqplot(mydata2$rdo,main='radio')
c3 <- ggqqplot(mydata2$nsp,main='newspaper')
c1+c2+c3
```



由本次结果可见模型基本满足线性，方差齐性，正态性和不相关性。

## 2.2 多重共线性检验

*#VIF 诊断*

```
vif(lm.sol2)
```

```
##      tv      rdo      nsp
## 1.0191 1.1475 1.1360
```

*# 特征根与条件数诊断*

```
X=cbind(tv,rdo,nsp)
rho=cor(X)
eigen(rho)
```

```
## eigen() decomposition
## $values
```

```
## [1] 1.4012238 0.9459739 0.6528023
##
## $vectors
##          [,1]      [,2]      [,3]
## [1,] -0.3545657  0.9291641  0.1045813
## [2,] -0.6721868 -0.1755473 -0.7192691
## [3,] -0.6499601 -0.3253263  0.6868149
```

```
kappa(rho,exact=TRUE)
```

```
## [1] 2.146475
```

根据结果认为并不存在严重的多重共线性。

## 2.3 回归方程和回归系数的显著性检验

最终可以得到的回归方程为

```
summary(lm.sol2)
```

```
##
## Call:
## lm(formula = z ~ tv + rdo + nsp, data = mydata2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.76927 -0.08587  0.03648  0.12654  0.34000
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.2481149  0.0345862  65.000   <2e-16 ***
## tv           0.0060827  0.0001613  37.710   <2e-16 ***
## rdo          0.0247984  0.0009716  25.523   <2e-16 ***
## nsp         -0.0004547  0.0006545  -0.695    0.488
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1847 on 189 degrees of freedom
## Multiple R-squared:  0.9284, Adjusted R-squared:  0.9273
## F-statistic: 816.8 on 3 and 189 DF,  p-value: < 2.2e-16
```

$$\sqrt{y} = 2.2676843 + 0.0060511tv + 0.0249715rdo - 0.0008940nsp$$

p-value:  $< 2.2e-16$  , 所以认为回归自变量整体对因变量有显著的线性影响。

因为  $p_1 < 2e-16, p_2 < 2e-16, p_3 > 0.05$ , 因此我们拒绝  $H_1: \beta_1 = 0$   $H_2: \beta_2 = 0$ ,  $H_3: \beta_3 = 0$ , 剔除 nsp 后重新进行回归分析

```
lm.sol3=lm(z~tv+rdo,data=mydata2)
summary(lm.sol3)
```

```
##
## Call:
## lm(formula = z ~ tv + rdo, data = mydata2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.76125 -0.08975  0.04389  0.13303  0.34177
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.2401560   0.0325895   68.74  <2e-16 ***
## tv           0.0060780   0.0001609   37.77  <2e-16 ***
## rdo          0.0245710   0.0009136   26.89  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1844 on 190 degrees of freedom
## Multiple R-squared:  0.9282, Adjusted R-squared:  0.9275
## F-statistic: 1228 on 2 and 190 DF, p-value: < 2.2e-16
```

得回归模型为  $\sqrt{y} = 0.0060462tv + 0.244878rdo$

验证: 利用逐步回归法

```
min.model=lm(z~1,data=mydata2)
step.model=step(min.model,direction="both",
scope=(~tv+rdo+nsp))
```

```
## Start:  AIC=-145.21
## z ~ 1
##
```



```
##          Df Sum of Sq   RSS   AIC
## + tv      1    58.949 31.063 -348.55
## + rdo      1    35.045 54.967 -238.40
## + nsp      1     4.788 85.224 -153.76
## <none>                90.012 -145.21
##
## Step: AIC=-348.55
## z ~ tv
##
##          Df Sum of Sq   RSS   AIC
## + rdo      1    24.601  6.462 -649.57
## + nsp      1     2.402 28.661 -362.08
## <none>                31.063 -348.55
## - tv       1    58.949 90.012 -145.21
##
## Step: AIC=-649.57
## z ~ tv + rdo
##
##          Df Sum of Sq   RSS   AIC
## <none>                6.462 -649.57
## + nsp      1     0.016  6.445 -648.07
## - rdo      1    24.601 31.063 -348.55
## - tv       1    48.505 54.967 -238.40
```

```
summary(step.model)
```

```
##
## Call:
## lm(formula = z ~ tv + rdo, data = mydata2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.76125 -0.08975  0.04389  0.13303  0.34177
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.2401560  0.0325895   68.74  <2e-16 ***
## tv           0.0060780  0.0001609   37.77  <2e-16 ***
## rdo          0.0245710  0.0009136   26.89  <2e-16 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1844 on 190 degrees of freedom
## Multiple R-squared:  0.9282, Adjusted R-squared:  0.9275
## F-statistic: 1228 on 2 and 190 DF,  p-value: < 2.2e-16
```

得到结果类似，因此可以确定结论销量主要与  $tv$  和  $radio$  有关，且满足  $\sqrt{y} = 0.0060462tv + 0.244878rdo$