Analysis of the GPD department-level racial pattern in initiating vehicle stops during the years 2008-2013

Prepared for GPD by

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Summary:

We have replicated the procedures from the RAND report and did not find any indication of a GPD department-level racial pattern in initiating vehicle stops during the years 2008-2013.

Methods:

We analyzed the data provided by the GPD according to the method provided by the RAND report. The summary of the method is as follows.

1) Cleaning and preparing the data set
    a. We removed all duplicate stopID records
    b. We matched the stopIDs with the race
    c. We removed purpose 5 Vehicle Equipment Violation to avoid non-moving violations
    d. We removed all races besides black and white (too few data points for other races)
    e. We separated the data by year

2) We considered only traffic stops during the two 60 days periods (one in Spring, one in the Fall) that starts 30 days prior a daylight savings time change and ends 30 days after the change. Consider only stops that occur during the twilight times.

Daylight saving change dates as found at
https://en.wikipedia.org/wiki/History_of_time_in_the_United_States

2002	April 7	October 27
2003	April 6	October 26
2004	April 4	October 31
2005	April 3	October 30
2006	April 2	October 29
2007	March 11	November 4
2008	March 9	November 2
2009	March 8	November 1
2010	March 14	November 7
2011	March13	November 6
2012	March 11	November 4
2013	March 10	November 3

30 days prior the change and 30 days after the change.

Year	Start day	End day	Start day	End day
2002	March 8	May 7	September 27	November 26
2003	March 7	May 6	September 25	November 25

2004	March 5	May 4	October 1	November 30
2005	March 4	May 3	September 30	November 29
2006	March 3	May 2	September 29	November 28
2007	February 9	April 10	October 5	December 4
2008	February 7	April 8	October 3	December 2
2009	February 6	April 7	October 1	December 1
2010	February 12	April 13	October 8	December 7
2011	February 11	April 12	October 7	December 6
2012	February 9	April 10	October 5	December 4
2013	February 8	April 9	October 4	December 3

From http://www.timeanddate.com/sun/usa/greensboro we got the civil twilight times. For years 2008-2013, the ends of civil twilights ranged from 5:33pm to 8:14pm.

3) We created 11 bins of 15 minutes increment and grouped the stops in the appropriate bins.

4) To each a traffic stop, we assigned an indicator whether the stop was during the light (0) or during the dark (1). Light means before the end of civil twilight, dark means after the end of civil twilight. The twilight times had to be manually copied and paste from http://www.timeanddate.com/sun/usa/greensboro

5) We run the generalized linear regression using an R function glm (see for example http://www.ats.ucla.edu/stat/r/dae/logit.htm) to see whether there is any bias towards stopping black drivers, specifically to determine if any of the following is a predictor of a stopped driver being black: Bin (i.e. time of the day), Day of the week, Darkness.

6) We run Wald test to see if any of the predictors is significant

Summary of Results:

R1) There was no significant predictor (i.e. no indication of departmental level racial profiling) for years 2011 and 2013

R2) There was a slight indication that time of the day may be significant in 2008, but Wald test ruled out the possibility. Consequently, there was no significant finding in 2008 (i.e. no indication of departmental level racial profiling).

R3) Day of the week was found to be a significant predictor in year 2012. In particular, drivers stopped on Tuesday, Wednesday or Friday were white with greater probability than those stopped on Sunday. However, this does not imply that GPD racially profiles.

R4) Darkness was found to be a significant predictor in 2009 and 2010. Specifically, a driver stopped in darkness is more likely black (compared to drivers stopped during the daylight). However, as pointed out in the RAND report, police officers cannot determine the race in darkness, and so this is no indication of racial profiling.

Detailed results can be found in the log file below.

2008 Results (1010 data points):

```
> a<-read.csv("GPD_STOPS_EVENINGS_springfall2008_load.csv",header=T, as.is=T)
> fit <- glm(Race~factor(DayoftheWeek)+factor(BINS)+factor(Darkness),data=a,family=binomial())
> summary(fit)
Call:
glm(formula = Race ~ factor(DayoftheWeek) + factor(BINS) + factor(Darkness),
    family = binomial(), data = a)
Deviance Residuals:
   Min      1Q  Median      3Q     Max
-1.5758  -1.2273   0.9164   1.0872   1.3679

Coefficients:
                    Estimate Std. Error z value Pr(>|z|)
(Intercept)         -0.37685    0.26627  -1.415  0.15698
factor(DayoftheWeek)2  0.12116    0.25005   0.485  0.62800
factor(DayoftheWeek)3  0.05153    0.22263   0.231  0.81696
factor(DayoftheWeek)4  0.14167    0.24153   0.587  0.55750
factor(DayoftheWeek)5 -0.06059    0.24451  -0.248  0.80427
factor(DayoftheWeek)6  0.39053    0.23006   1.698  0.08960 .
factor(DayoftheWeek)7  0.31590    0.21537   1.467  0.14243
factor(BINS)2          0.07201    0.30109   0.239  0.81099
factor(BINS)3          0.49712    0.31204   1.593  0.11113
factor(BINS)4          0.59985    0.32347   1.854  0.06368 .
factor(BINS)5          0.74988    0.31977   2.345  0.01902 *
factor(BINS)6          0.59334    0.31821   1.865  0.06224 .
factor(BINS)7          0.34775    0.30516   1.140  0.25448
factor(BINS)8          0.24059    0.30825   0.781  0.43509
factor(BINS)9          0.92542    0.32791   2.822  0.00477 **
factor(BINS)10         0.59252    0.32181   1.841  0.06559 .
factor(BINS)11         0.41030    0.31711   1.294  0.19570
factor(Darkness)1     -0.03844    0.15816  -0.243  0.80799
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)
    Null deviance: 1391.0  on 1009  degrees of freedom
Residual deviance: 1368.5  on  992  degrees of freedom
AIC: 1404.5
Number of Fisher Scoring iterations: 4
```

The results say that bins 5 & 9 are significant compared to bin 1.

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WE CAN EXPONENTIATE THE RESULTS TO GET ODDS RATIOS INSTEAD OF COEFFICIENTS:

```
> exp(cbind(OR = coef(fit), confint(fit)))
Waiting for profiling to be done...
                          OR     2.5 %   97.5 %
(Intercept)          0.6860187 0.4054885 1.154130
factor(DayoftheWeek)2 1.1288033 0.6917660 1.846020
factor(DayoftheWeek)3 1.0528787 0.6804590 1.629954
factor(DayoftheWeek)4 1.1521968 0.7180326 1.852825
factor(DayoftheWeek)5 0.9412048 0.5823637 1.520541
factor(DayoftheWeek)6 1.4777695 0.9429040 2.325772
factor(DayoftheWeek)7 1.3714939 0.8998688 2.094912
factor(BINS)2         1.0746612 0.5954855 1.942641
factor(BINS)3         1.6439807 0.8941377 3.045466
factor(BINS)4         1.8218459 0.9701621 3.457016
factor(BINS)5         2.1167367 1.1364062 3.990251
factor(BINS)6         1.8100167 0.9732984 3.396137
factor(BINS)7         1.4158748 0.7797432 2.584334
factor(BINS)8         1.2720046 0.6958570 2.334296
factor(BINS)9         2.5229316 1.3337064 4.833403
factor(BINS)10        1.8085468 0.9652792 3.414809
factor(BINS)11        1.5072745 0.8110840 2.816484
factor(Darkness)1     0.9622925 0.7052861 1.311731
```

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THE THREE WALD TESTS SHOW THAT THE INDICATOR VARIABLES (BINS, DARKNESS, DAY OF THE WEEK) ARE NOT STATISTICALLY SIGNIFICANT WHEN CONSIDERED OVERALL:

```
> wald.test(b = coef(fit), Sigma = vcov(fit), Terms = 2:7)
Wald test:
----------
Chi-squared test:
```

```
X2 = 5.7, df = 6, P(> X2) = 0.45

> wald.test(b = coef(fit), Sigma = vcov(fit), Terms = 8:17)
Wald test:
----------
Chi-squared test:
X2 = 16.1, df = 10, P(> X2) = 0.097

> wald.test(b = coef(fit), Sigma = vcov(fit), Terms = 18)
Wald test:
----------
Chi-squared test:
X2 = 0.059, df = 1, P(> X2) = 0.81
```

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2009 Results (1091 data points):

```
> b <- read.csv("GPD_STOPS_EVENINGS_springfall2009_load.csv",header=T, as.is=T)
> fitb <- glm(Race~factor(DayoftheWeek)+factor(BINS)+factor(Darkness),data=b,family=binomial())
> summary(fitb)

Call:
glm(formula = Race ~ factor(DayoftheWeek) + factor(BINS) + factor(Darkness),
    family = binomial(), data = b)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.6386  -1.2581   0.9135   1.0676   1.2863

Coefficients:
                      Estimate Std. Error z value Pr(>|z|)
(Intercept)           0.255696   0.244232   1.047   0.2951
factor(DayoftheWeek)2  0.236454   0.238216   0.993   0.3209
factor(DayoftheWeek)3 -0.158916   0.223254  -0.712   0.4766
factor(DayoftheWeek)4 -0.129515   0.235123  -0.551   0.5817
factor(DayoftheWeek)5  0.536332   0.241561   2.220   0.0264 *
factor(DayoftheWeek)6  0.008061   0.217781   0.037   0.9705
factor(DayoftheWeek)7 -0.008841   0.210041  -0.042   0.9664
factor(BINS)2         -0.349194   0.283656  -1.231   0.2183
```

```
factor(BINS)3         0.157232   0.294138   0.535   0.5930
factor(BINS)4        -0.187032   0.288643  -0.648   0.5170
factor(BINS)5        -0.091457   0.291702  -0.314   0.7539
factor(BINS)6        -0.398300   0.295877  -1.346   0.1782
factor(BINS)7        -0.262955   0.310738  -0.846   0.3974
factor(BINS)8        -0.210076   0.289343  -0.726   0.4678
factor(BINS)9        -0.301401   0.299857  -1.005   0.3148
factor(BINS)10       -0.306209   0.306870  -0.998   0.3184
factor(BINS)11       -0.173017   0.306100  -0.565   0.5719
factor(Darkness)1     0.339186   0.144322   2.350   0.0188 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1490.4  on 1090  degrees of freedom
Residual deviance: 1469.5  on 1073  degrees of freedom
AIC: 1505.5

Number of Fisher Scoring iterations: 4
```

%%

WE CAN EXPONENTIATE THE RESULTS TO GET ODDS RATIOS INSTEAD OF COEFFICIENTS:

```
> exp(cbind(OR = coef(fitb), confint(fitb)))
Waiting for profiling to be done...
                          OR     2.5 %   97.5 %
(Intercept)           1.2913600 0.8020913 2.093766
factor(DayoftheWeek)2 1.2667490 0.7954401 2.026242
factor(DayoftheWeek)3 0.8530679 0.5502382 1.321307
factor(DayoftheWeek)4 0.8785216 0.5538036 1.393487
factor(DayoftheWeek)5 1.7097246 1.0684891 2.758175
factor(DayoftheWeek)6 1.0080936 0.6576273 1.545574
factor(DayoftheWeek)7 0.9911975 0.6563163 1.496284
factor(BINS)2         0.7052561 0.4032316 1.228091
factor(BINS)3         1.1702667 0.6578262 2.088387
factor(BINS)4         0.8294171 0.4701655 1.460388
factor(BINS)5         0.9126007 0.5145670 1.617721
factor(BINS)6         0.6714609 0.3748801 1.197902
```

```
factor(BINS)7        0.7687765 0.4174492 1.414410
factor(BINS)8        0.8105223 0.4587435 1.428575
factor(BINS)9        0.7397814 0.4101554 1.331170
factor(BINS)10       0.7362325 0.4026870 1.343382
factor(BINS)11       0.8411235 0.4610645 1.533349
factor(Darkness)1    1.4038037 1.0587045 1.864811
```

%%

THE THREE WALD TESTS SHOW THAT THE INDICATOR VARIABLES (BINS, DAY OF THE WEEK) ARE NOT STATISTICALLY SIGNIFICANT WHEN CONSIDERED OVERALL, BUT DARKNESS IS SIGNIFICANT:

```
> wald.test(b = coef(fitb), Sigma = vcov(fitb), Terms = 2:7)
Wald test:
----------
Chi-squared test:
X2 = 10.8, df = 6, P(> X2) = 0.096

> wald.test(b = coef(fitb), Sigma = vcov(fitb), Terms = 8:17)
Wald test:
----------
Chi-squared test:
X2 = 5.8, df = 10, P(> X2) = 0.83

> wald.test(b = coef(fitb), Sigma = vcov(fitb), Terms = 18)
Wald test:
----------
Chi-squared test:
X2 = 5.5, df = 1, P(> X2) = 0.019
```

%%

2010 Results (1557 data points):

```
> c <- read.csv("GPD_STOPS_EVENINGS_springfall2010_load.csv",header=T, as.is=T)
> fitc <- glm(Race~factor(DayoftheWeek)+factor(BINS)+factor(Darkness),data=c,family=binomial())
> summary(fitc)
```

```
Call:
glm(formula = Race ~ factor(DayoftheWeek) + factor(BINS) + factor(Darkness),
    family = binomial(), data = c)

Deviance Residuals:
    Min      1Q  Median      3Q     Max
-1.4941  -1.1831   0.9412   1.1337   1.4094

Coefficients:
                    Estimate Std. Error z value Pr(>|z|)
(Intercept)         -0.257167   0.208434  -1.234   0.2173
factor(DayoftheWeek)2 -0.150473   0.187430  -0.803   0.4221
factor(DayoftheWeek)3 -0.123740   0.189053  -0.655   0.5128
factor(DayoftheWeek)4 -0.195519   0.194404  -1.006   0.3145
factor(DayoftheWeek)5  0.055416   0.192617   0.288   0.7736
factor(DayoftheWeek)6  0.009989   0.183069   0.055   0.9565
factor(DayoftheWeek)7  0.134574   0.180752   0.745   0.4566
factor(BINS)2          0.031881   0.231497   0.138   0.8905
factor(BINS)3          0.024550   0.248300   0.099   0.9212
factor(BINS)4          0.360790   0.240483   1.500   0.1335
factor(BINS)5          0.430769   0.244539   1.762   0.0781 .
factor(BINS)6          0.554126   0.250376   2.213   0.0269 *
factor(BINS)7          0.355823   0.247394   1.438   0.1504
factor(BINS)8          0.133348   0.260634   0.512   0.6089
factor(BINS)9         -0.077840   0.260829  -0.298   0.7654
factor(BINS)10         0.173364   0.258842   0.670   0.5030
factor(BINS)11         0.260027   0.273002   0.952   0.3409
factor(BINS)12         0.119099   0.391813   0.304   0.7612
factor(Darkness)1      0.287724   0.127354   2.259   0.0239 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 2156.9  on 1556  degrees of freedom
Residual deviance: 2129.8  on 1538  degrees of freedom
AIC: 2167.8

Number of Fisher Scoring iterations: 4
```

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WE CAN EXPONENTIATE THE RESULTS TO GET ODDS RATIOS INSTEAD OF COEFFICIENTS:

```
> exp(cbind(OR = coef(fitc), confint(fitc)))
Waiting for profiling to be done...
                        OR     2.5 %   97.5 %
(Intercept)           0.7732393 0.5127643 1.162227
factor(DayoftheWeek)2 0.8603010 0.5954190 1.242018
factor(DayoftheWeek)3 0.8836098 0.6096571 1.279858
factor(DayoftheWeek)4 0.8224079 0.5613307 1.203461
factor(DayoftheWeek)5 1.0569805 0.7246863 1.542812
factor(DayoftheWeek)6 1.0100393 0.7053850 1.446407
factor(DayoftheWeek)7 1.1440497 0.8028489 1.631342
factor(BINS)2         1.0323946 0.6558701 1.626909
factor(BINS)3         1.0248535 0.6295517 1.668298
factor(BINS)4         1.4344627 0.8964055 2.303416
factor(BINS)5         1.5384409 0.9541190 2.491098
factor(BINS)6         1.7404191 1.0678745 2.852767
factor(BINS)7         1.4273554 0.8800104 2.323232
factor(BINS)8         1.1426473 0.6857991 1.907224
factor(BINS)9         0.9251120 0.5545087 1.543250
factor(BINS)10        1.1892993 0.7165456 1.978633
factor(BINS)11        1.2969648 0.7604080 2.219732
factor(BINS)12        1.1264818 0.5223874 2.445003
factor(Darkness)1     1.3333891 1.0391775 1.712475
```

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THE THREE WALD TESTS SHOW THAT THE INDICATOR VARIABLES (BINS, DAY OF THE WEEK)
ARE NOT STATISTICALLY SIGNIFICANT WHEN CONSIDERED OVERALL, BUT DARKNESS IS SIGNIFICANT:

```
> wald.test(b = coef(fitc), Sigma = vcov(fitc), Terms = 2:7)
Wald test:
----------
Chi-squared test:
X2 = 4.6, df = 6, P(> X2) = 0.6
```

```
> wald.test(b = coef(fitc), Sigma = vcov(fitc), Terms = 8:18)
Wald test:
----------
Chi-squared test:
X2 = 13.9, df = 11, P(> X2) = 0.24

> wald.test(b = coef(fitc), Sigma = vcov(fitc), Terms = 19)
Wald test:
----------
Chi-squared test:
X2 = 5.1, df = 1, P(> X2) = 0.024
```

%%

2011 Results (1098 data points):

```
> d <- read.csv("GPD_STOPS_EVENINGS_springfall2011_load.csv",header=T, as.is=T)
> fitd <- glm(Race~factor(DayoftheWeek)+factor(BINS)+factor(Darkness),data=d,family=binomial())
> summary(fitd)

Call:
glm(formula = Race ~ factor(DayoftheWeek) + factor(BINS) + factor(Darkness),
    family = binomial(), data = d)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.5770  -1.2280   0.9206   1.0576   1.4343

Coefficients:
                      Estimate Std. Error z value Pr(>|z|)
(Intercept)           0.306371   0.275818   1.111   0.2667
factor(DayoftheWeek)2  0.112529   0.218790   0.514   0.6070
factor(DayoftheWeek)3 -0.261099   0.214158  -1.219   0.2228
factor(DayoftheWeek)4 -0.601589   0.250515  -2.401   0.0163 *
factor(DayoftheWeek)5 -0.296995   0.229124  -1.296   0.1949
factor(DayoftheWeek)6  0.009359   0.215736   0.043   0.9654
factor(DayoftheWeek)7 -0.070496   0.218343  -0.323   0.7468
factor(BINS)2          0.007776   0.328518   0.024   0.9811
factor(BINS)3         -0.195130   0.300572  -0.649   0.5162
factor(BINS)4          0.002232   0.322885   0.007   0.9945
```

```
factor(BINS)5        -0.290910   0.314844  -0.924   0.3555
factor(BINS)6        -0.231861   0.325325  -0.713   0.4760
factor(BINS)7         0.117227   0.335865   0.349   0.7271
factor(BINS)8        -0.109824   0.321489  -0.342   0.7326
factor(BINS)9         0.208179   0.344601   0.604   0.5458
factor(BINS)10        0.047324   0.330592   0.143   0.8862
factor(BINS)11       -0.223549   0.330905  -0.676   0.4993
factor(BINS)12       -0.498623   0.510185  -0.977   0.3284
factor(Darkness)1     0.276159   0.147671   1.870   0.0615 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1506.2  on 1097  degrees of freedom
Residual deviance: 1484.0  on 1079  degrees of freedom
AIC: 1522

Number of Fisher Scoring iterations: 4
```

%%

WE CAN EXPONENTIATE THE RESULTS TO GET ODDS RATIOS INSTEAD OF COEFFICIENTS:

```
> exp(cbind(OR = coef(fitd), confint(fitd)))
Waiting for profiling to be done...
                          OR     2.5 %    97.5 %
(Intercept)           1.3584864 0.7928565 2.3451026
factor(DayoftheWeek)2 1.1191052 0.7291836 1.7207087
factor(DayoftheWeek)3 0.7702050 0.5055945 1.1714661
factor(DayoftheWeek)4 0.5479402 0.3342461 0.8937186
factor(DayoftheWeek)5 0.7430477 0.4736466 1.1640222
factor(DayoftheWeek)6 1.0094027 0.6612737 1.5417832
factor(DayoftheWeek)7 0.9319311 0.6072948 1.4305042
factor(BINS)2         1.0078068 0.5284943 1.9210572
factor(BINS)3         0.8227274 0.4548512 1.4814301
factor(BINS)4         1.0022342 0.5312986 1.8888682
factor(BINS)5         0.7475827 0.4018730 1.3841197
factor(BINS)6         0.7930564 0.4178736 1.4996589
factor(BINS)7         1.1243746 0.5817054 2.1757830
```

```
factor(BINS)8        0.8959922 0.4759518 1.6824052
factor(BINS)9        1.2314341 0.6268992 2.4270126
factor(BINS)10       1.0484621 0.5476640 2.0063386
factor(BINS)11       0.7996757 0.4169409 1.5288281
factor(BINS)12       0.6073665 0.2215457 1.6615420
factor(Darkness)1    1.3180580 0.9870590 1.7616181
```

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%%%%%%

THE THREE WALD TESTS SHOW THAT THE INDICATOR VARIABLES (BINS, DARKNESS, DAY OF THE WEEK) ARE NOT STATISTICALLY SIGNIFICANT WHEN CONSIDERED OVERALL:

```
> wald.test(b = coef(fitd), Sigma = vcov(fitd), Terms = 2:7)
Wald test:
----------
Chi-squared test:
X2 = 11.0, df = 6, P(> X2) = 0.088

> wald.test(b = coef(fitd), Sigma = vcov(fitd), Terms = 8:18)
Wald test:
----------
Chi-squared test:
X2 = 6.9, df = 11, P(> X2) = 0.81

> wald.test(b = coef(fitd), Sigma = vcov(fitd), Terms = 19)
Wald test:
----------
Chi-squared test:
X2 = 3.5, df = 1, P(> X2) = 0.061
```

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%%%%%%

2012 Results (1320 data points):

```
> e <- read.csv("GPD_STOPS_EVENINGS_springfall2012_load.csv",header=T, as.is=T)
> fite <- glm(Race~factor(DayoftheWeek)+factor(BINS)+factor(Darkness),data=e,family=binomial())
> summary(fite)
```

```
Call:
glm(formula = Race ~ factor(DayoftheWeek) + factor(BINS) + factor(Darkness),
    family = binomial(), data = e)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.5993  -1.2414   0.8809   1.0636   1.3690

Coefficients:
                    Estimate Std. Error z value Pr(>|z|)
(Intercept)           0.2737     0.2331   1.174  0.24039
factor(DayoftheWeek)2  -0.2371     0.2033  -1.167  0.24334
factor(DayoftheWeek)3  -0.6160     0.2147  -2.869  0.00412 **
factor(DayoftheWeek)4  -0.5348     0.2102  -2.544  0.01094 *
factor(DayoftheWeek)5  -0.2114     0.2128  -0.994  0.32045
factor(DayoftheWeek)6  -0.6103     0.1982  -3.079  0.00208 **
factor(DayoftheWeek)7  -0.0185     0.2038  -0.091  0.92767
factor(BINS)2          0.4914     0.2691   1.826  0.06783 .
factor(BINS)3         -0.0975     0.2615  -0.373  0.70929
factor(BINS)4          0.1747     0.2798   0.624  0.53235
factor(BINS)5          0.1032     0.2840   0.363  0.71647
factor(BINS)6          0.2697     0.2835   0.951  0.34151
factor(BINS)7          0.5660     0.2840   1.993  0.04631 *
factor(BINS)8          0.3978     0.2824   1.409  0.15891
factor(BINS)9          0.5182     0.2810   1.844  0.06515 .
factor(BINS)10         0.1149     0.2866   0.401  0.68857
factor(BINS)11         0.2299     0.2825   0.814  0.41582
factor(BINS)12         0.5852     0.4387   1.334  0.18225
factor(Darkness)1      0.0938     0.1380   0.680  0.49675
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1804.2  on 1319  degrees of freedom
Residual deviance: 1766.0  on 1301  degrees of freedom
AIC: 1804

Number of Fisher Scoring iterations: 4
```

%%%

WE CAN EXPONENTIATE THE RESULTS TO GET ODDS RATIOS INSTEAD OF COEFFICIENTS:

```
> exp(cbind(OR = coef(fite), confint(fite)))
Waiting for profiling to be done...
                          OR     2.5 %    97.5 %
(Intercept)           1.3148426 0.8328692 2.0806256
factor(DayoftheWeek)2 0.7888703 0.5292043 1.1748815
factor(DayoftheWeek)3 0.5400882 0.3538229 0.8216212
factor(DayoftheWeek)4 0.5858045 0.3873457 0.8835557
factor(DayoftheWeek)5 0.8094554 0.5332826 1.2290218
factor(DayoftheWeek)6 0.5431777 0.3675182 0.7998656
factor(DayoftheWeek)7 0.9816735 0.6584023 1.4646083
factor(BINS)2         1.6346221 0.9665023 2.7795366
factor(BINS)3         0.9070997 0.5427553 1.5150822
factor(BINS)4         1.1908761 0.6886172 2.0652357
factor(BINS)5         1.1086532 0.6354661 1.9377669
factor(BINS)6         1.3095609 0.7519994 2.2886770
factor(BINS)7         1.7611377 1.0120875 3.0863335
factor(BINS)8         1.4886025 0.8572605 2.5972663
factor(BINS)9         1.6790567 0.9700102 2.9226168
factor(BINS)10        1.1217121 0.6397947 1.9701983
factor(BINS)11        1.2584511 0.7237763 2.1932981
factor(BINS)12        1.7953668 0.7711150 4.3544837
factor(Darkness)1     1.0983443 0.8377125 1.4395594
```

%%%

THE THREE WALD TESTS SHOW THAT THE INDICATOR VARIABLES (BINS, DARKNESS)
ARE NOT STATISTICALLY SIGNIFICANT WHEN CONSIDERED OVERALL, BUT DAY OF THE WEEK IS SIGNIFICANT:

```
> wald.test(b = coef(fite), Sigma = vcov(fite), Terms = 2:7)
Wald test:
----------
Chi-squared test:
X2 = 19.7, df = 6, P(> X2) = 0.0032
```

```
> wald.test(b = coef(fite), Sigma = vcov(fite), Terms = 8:18)
Wald test:
----------
Chi-squared test:
X2 = 13.6, df = 11, P(> X2) = 0.26

> wald.test(b = coef(fite), Sigma = vcov(fite), Terms = 19)
Wald test:
----------
Chi-squared test:
X2 = 0.46, df = 1, P(> X2) = 0.5
```

%%

2013 Results (1306 data points):

```
> f <- read.csv("GPD_STOPS_EVENINGS_springfall2013_load.csv",header=T, as.is=T)
> fitf <- glm(Race~factor(DayoftheWeek)+factor(BINS)+factor(Darkness),data=f,family=binomial())
> summary(fitf)

Call:
glm(formula = Race ~ factor(DayoftheWeek) + factor(BINS) + factor(Darkness),
    family = binomial(), data = f)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.5556  -1.2659   0.9282   1.0546   1.3455

Coefficients:
                      Estimate Std. Error z value Pr(>|z|)
(Intercept)           -0.21860    0.26384  -0.829   0.4074
factor(DayoftheWeek)2  0.03220    0.22061   0.146   0.8840
factor(DayoftheWeek)3  0.07192    0.20444   0.352   0.7250
factor(DayoftheWeek)4  0.25669    0.21845   1.175   0.2400
factor(DayoftheWeek)5 -0.11561    0.21719  -0.532   0.5945
factor(DayoftheWeek)6 -0.16830    0.20365  -0.826   0.4086
factor(DayoftheWeek)7  0.36066    0.21198   1.701   0.0889 .
factor(BINS)2          0.14335    0.29223   0.491   0.6238
factor(BINS)3          0.67216    0.29545   2.275   0.0229 *
factor(BINS)4          0.71381    0.29711   2.402   0.0163 *
```

```
factor(BINS)5         0.20638    0.29054   0.710   0.4775
factor(BINS)6         0.49415    0.29944   1.650   0.0989 .
factor(BINS)7         0.43588    0.29191   1.493   0.1354
factor(BINS)8         0.52609    0.30468   1.727   0.0842 .
factor(BINS)9         0.39206    0.28396   1.381   0.1674
factor(BINS)10        0.71569    0.29270   2.445   0.0145 *
factor(BINS)11        0.61199    0.29822   2.052   0.0402 *
factor(Darkness)1    -0.03089    0.13252  -0.233   0.8157
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1784.5  on 1305  degrees of freedom
Residual deviance: 1760.7  on 1288  degrees of freedom
AIC: 1796.7

Number of Fisher Scoring iterations: 4
```

%%

WE CAN EXPONENTIATE THE RESULTS TO GET ODDS RATIOS INSTEAD OF COEFFICIENTS:

```
> exp(cbind(OR = coef(fitf), confint(fitf)))
Waiting for profiling to be done...
                          OR     2.5 %   97.5 %
(Intercept)            0.8036432 0.4777107 1.347091
factor(DayoftheWeek)2 1.0327195 0.6701814 1.592749
factor(DayoftheWeek)3 1.0745689 0.7195296 1.604684
factor(DayoftheWeek)4 1.2926450 0.8431130 1.986814
factor(DayoftheWeek)5 0.8908269 0.5815787 1.363634
factor(DayoftheWeek)6 0.8451025 0.5663705 1.259191
factor(DayoftheWeek)7 1.4342725 0.9473810 2.176506
factor(BINS)2          1.1541341 0.6511288 2.051436
factor(BINS)3          1.9584556 1.1009308 3.512815
factor(BINS)4          2.0417555 1.1442615 3.674999
factor(BINS)5          1.2292168 0.6960349 2.178375
factor(BINS)6          1.6391039 0.9133784 2.960133
factor(BINS)7          1.5463265 0.8739792 2.749838
factor(BINS)8          1.6923069 0.9334923 3.087975
```

factor(BINS)9 1.4800215 0.8494617 2.590680
factor(BINS)10 2.0456003 1.1554395 3.646521
factor(BINS)11 1.8440969 1.0300643 3.321847
factor(Darkness)1 0.9695811 0.7474607 1.256961

%%%
%%%
%%%%%%%

THE THREE WALD TESTS SHOW THAT THE INDICATOR VARIABLES (BINS, DARKNESS, DAY OF THE WEEK) ARE NOT STATISTICALLY SIGNIFICANT WHEN CONSIDERED OVERALL:

```
> wald.test(b = coef(fitf), Sigma = vcov(fitf), Terms = 2:7)
Wald test:
----------
Chi-squared test:
X2 = 9.6, df = 6, P(> X2) = 0.14

> wald.test(b = coef(fitf), Sigma = vcov(fitf), Terms = 8:17)
Wald test:
----------
Chi-squared test:
X2 = 14.2, df = 10, P(> X2) = 0.17

> wald.test(b = coef(fitf), Sigma = vcov(fitf), Terms = 18)
Wald test:
----------
Chi-squared test:
X2 = 0.054, df = 1, P(> X2) = 0.82
```