Homework 10
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STAT 659-700

7.3

```
Call:
glm(formula = Count ~ . * ., family = poisson, data = dta)

Deviance Residuals:
       1         2         3         4         5         6         7
-0.10448   0.08372   0.07952  -0.05078   0.54271  -0.21886  -0.31912
       8
 0.09107

Coefficients:
                 Estimate Std. Error z value Pr(>|z|)
(Intercept)        8.9452     1.2340   7.249 4.20e-13 ***
President         -5.7197     1.0457  -5.470 4.51e-08 ***
Busing            -0.6509     0.5216  -1.248 0.212074
Home              -1.5850     0.6084  -2.605 0.009178 **
President:Busing   0.7211     0.3539   2.038 0.041571 *
President:Home     1.5520     0.4436   3.499 0.000468 ***
Busing:Home        0.4672     0.2371   1.971 0.048744 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 408.04858  on 7  degrees of freedom
Residual deviance:   0.47939  on 1  degrees of freedom
AIC: 54.952

Number of Fisher Scoring iterations: 4
```

a) $G^2 = 408.04 - .479 = 407.561 > 12.59 = qchisq(.95, 6)$ Conclude that there is significant evidence that the model fits the data well.
b) President:Housing `OR: exp(.7211) = 2.05`
   President:Home `OR: exp(1.55) = 4.71`
   Busing:Home `OR: exp(.4672) = 1.59`

c) $Ho : BP = 0, Ha : BP > 0, 95CI : .7211 + c(-1, 1) * 1.96 * (.3539) = (.027, 1.414)$ Reject H_o
d) exp(.027, 1.414) = (1.027, 4.11), The odds of someone supporting busing and a black president are 1.02 to 4.11 times more than someone not supporting busing and a black president.

7.4

```
Call:
glm(formula = Count ~ . * ., family = poisson, data = dta)

Deviance Residuals:
       1         2         3         4         5         6         7
-0.10362   0.07183   0.39073  -0.17923   0.08516  -0.06730  -0.26626
       8
 0.13173

Coefficients:
                          Estimate Std. Error z value Pr(>|z|)
(Intercept)                 3.8521     0.1415  27.219  < 2e-16 ***
GenderMale                 -0.5976     0.2242  -2.666  0.00768 **
InfoSupport                 1.3514     0.1575   8.578  < 2e-16 ***
HealthSupport              -1.3750     0.2750  -5.001 5.71e-07 ***
GenderMale:InfoSupport      0.4636     0.2406   1.927  0.05401 .
GenderMale:HealthSupport   -0.2516     0.1749  -1.438  0.15035
InfoSupport:HealthSupport   0.8997     0.2852   3.155  0.00160 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 445.82335  on 7  degrees of freedom
Residual deviance:   0.30072  on 1  degrees of freedom
AIC: 59.683

Number of Fisher Scoring iterations: 4
```

a) $G^2 = 445.8 - .3 = 445.5 > 12.59 = qchisq(.95, 6)$ Conclude that there is significant evidence that the model fits the data well

b) The conditional odds that a Male Supports the Health opinion is exp(.4636) = 1.58 times that of a Female Opposing the Health opinion.

c) Based on an $\alpha = .04$, the pvalue of GI is greater than .05 so we would conclude that there is no conditional dependence between Gender and Info and the interaction term is not needed in the model.

7.6

```
Call:  glm(formula = Count ~ ., family = poisson, data = dta)

Coefficients:
(Intercept)          EII          SNS          JPP          TFT
     3.7926       0.2644       0.8701      -0.1297      -0.4855

Degrees of Freedom: 15 Total (i.e. Null);  11 Residual
Null Deviance:      399.9
Residual Deviance: 135.9    AIC: 238.7
```

a) $G^2 = 399.94 - 135.87 = 264.07 > 9.48 = qchisq(.95, 4)$ Conclude that there is significant evidence that the model fits the data well

```
Call:
glm(formula = Count ~ . * ., family = poisson, data = dta)

Deviance Residuals:
      1        2        3        4        5        6        7        8        9       10
-0.72826  0.05168  1.00215 -0.01429  1.49947 -0.07596 -1.29325  0.00231  0.56850 -0.04948
     11       12       13       14       15       16
-0.82975  0.01728 -1.57051  0.08587  1.09960 -0.00804

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  3.44760    0.13793  24.994  < 2e-16 ***
EII         -0.02907    0.15266  -0.190 0.848952
SNS          1.21082    0.14552   8.320  < 2e-16 ***
JPP          0.93417    0.14594   6.401 1.54e-10 ***
TFT         -0.64194    0.16768  -3.828 0.000129 ***
EII:SNS      0.30212    0.14233   2.123 0.033780 *
EII:JPP      0.01766    0.13160   0.134 0.893261
EII:TFT      0.19449    0.13121   1.482 0.138258
SNS:JPP     -1.22153    0.14547  -8.397  < 2e-16 ***
SNS:TFT      0.40920    0.15243   2.684 0.007265 **
JPP:TFT     -0.55936    0.13512  -4.140 3.48e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 399.944  on 15  degrees of freedom
Residual deviance:  10.162  on  5  degrees of freedom
AIC: 125

Number of Fisher Scoring iterations: 4
```

b) Based on the interaction variable with the largest absolute coefficient, SN:JP has the strongest association

c) Both EI/JP and EI/TF have coefficients near 0 and they both are statistically insignificant so there is not strong evidence of an assocation.

7.7

a) $G^2 = 12.36 - 10.16 = 2.2 < 5.99 = qchisq(.95, 2)$ Conclude that there is no significant difference between the two models.
b) $OR : (exp(-1.5075), exp(-.9382)) = (.2214, .3913)$
c) The odds of SJ is exp(1.22) = 3.387 times that of NP

7.8

a) Mutual Independence: $log(\mu_{ijkl}) = \lambda + \lambda_i^{EI} + \lambda_j^{SN} + \lambda_k^{JP} + \lambda_l^{TF}$
Homogeneous Association: $log(\mu_{ijkl}) = \lambda + \lambda_i^{EI} + \lambda_j^{SN} + \lambda_k^{JP} + \lambda_l^{TF} + \lambda_{ij}^{EI:SN} + \lambda_{ik}^{EI:JP} + \lambda_{il}^{EI:TF} + \lambda_{jk}^{SN:JP} + \lambda_{jl}^{SN:TF} + \lambda_{kl}^{JP:TF}$
Saturated Model: $log(\mu_{ijkl}) = \lambda + \lambda_i^{EI} + \lambda_j^{SN} + \lambda_k^{JP} + \lambda_l^{TF} + \lambda_{ij}^{EI:SN} + \lambda_{ik}^{EI:JP} + \lambda_{il}^{EI:TF} + \lambda_{jk}^{SN:JP} + \lambda_{jl}^{SN:TF} + \lambda_{kl}^{JP:TF} + \lambda_{ijk}^{EI:SN:JP} + \lambda_{ijl}^{EI:SN:TF} + \lambda_{ikl}^{EI:JP:TF} + \lambda_{jkl}^{SN:JP:TF}$

b) Mutual Independence: 238.7
Homogeneous Association: 125
Saturated Model: 129.9

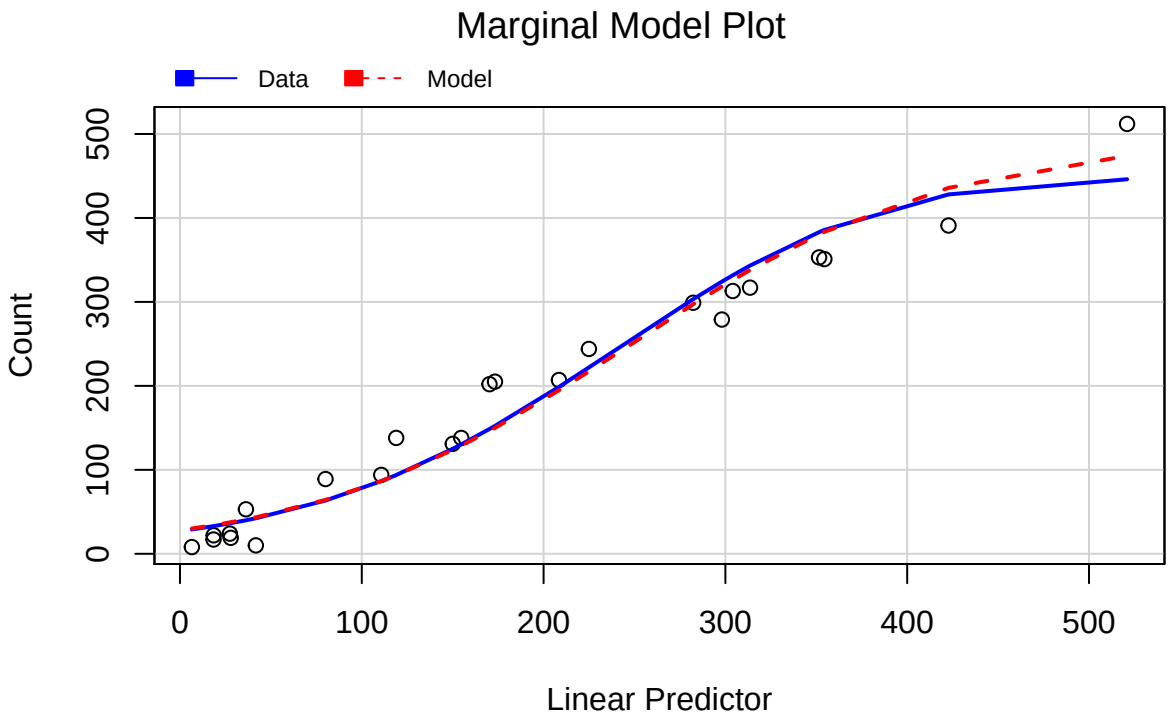
The Homogenous Association model would be the best model because it has the lowest AIC. This makes sense because the saturated model with the 3way interaction terms are all insignificant.

```
Call:  glm(formula = Count ~ .^3, family = poisson, data = dta)

Coefficients:
(Intercept)          EII          SNS          JPP          TFT      EII:SNS      EII:JPP
    3.56370     -0.27880      1.05839      0.76316     -0.63483      0.61460      0.37430
    EII:TFT      SNS:JPP      SNS:TFT      JPP:TFT  EII:SNS:JPP  EII:SNS:TFT  EII:JPP:TFT
    0.20026     -0.96288      0.41081     -0.58773     -0.51039     -0.02364      0.02440
SNS:JPP:TFT
    0.01922

Degrees of Freedom: 15 Total (i.e. Null);  1 Residual
Null Deviance:      399.9
Residual Deviance: 7.096    AIC: 129.9
```

7.9

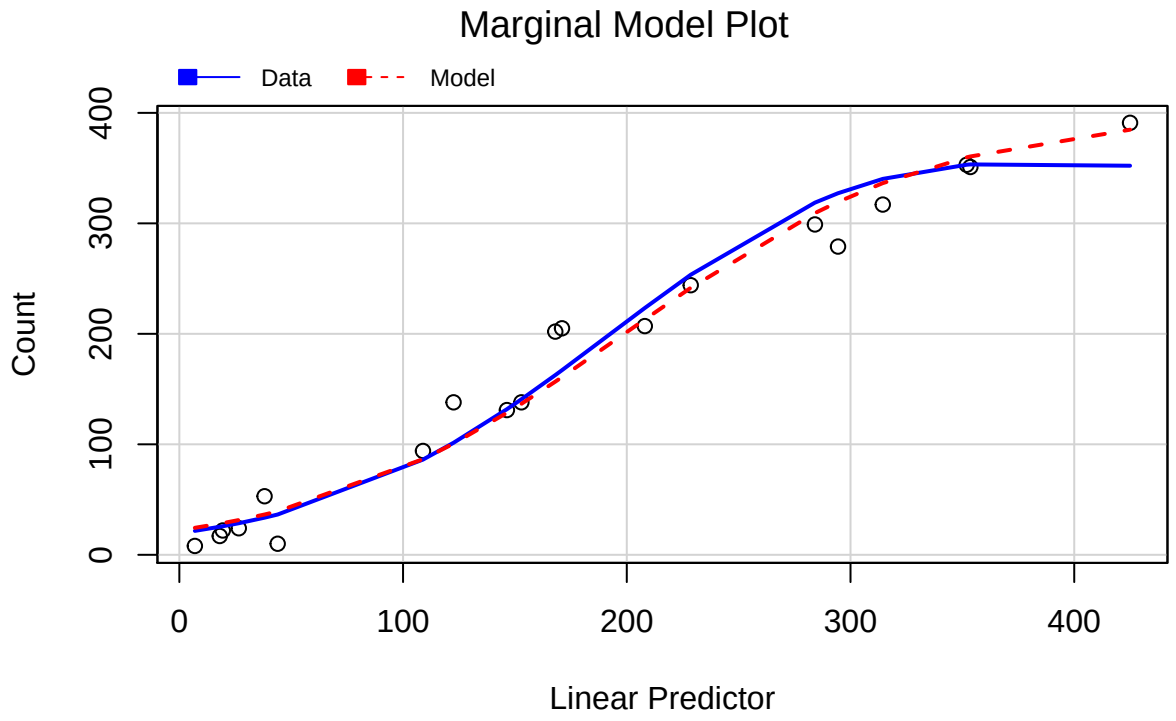
```
Call:
glm(formula = Count ~ . * ., family = poisson, data = dta)

Deviance Residuals:
     1       2       3       4       5       6       7       8       9      10      11
-0.3930  0.0776 -5.9073  1.7046  2.5940  0.7768  0.5105 -0.1009  2.3425 -1.1166 -1.3689
    12      13      14      15      16      17      18      19      20      21      22
-0.1833  0.9819 -0.3433  2.3619 -1.5914 -1.6310 -0.6722 -1.7970  0.5495 -1.5635  1.2540
    23      24
 0.9851  0.1942

Coefficients:
                        Estimate Std. Error z value Pr(>|z|)
(Intercept)              3.33022    0.12416  26.821  < 2e-16 ***
Department2             -1.45155    0.23638  -6.141 8.21e-10 ***
Department3              2.71652    0.13038  20.835  < 2e-16 ***
Department4              2.08557    0.13124  15.892  < 2e-16 ***
Department5              2.31271    0.13388  17.275  < 2e-16 ***
Department6              2.41775    0.13474  17.944  < 2e-16 ***
AdmittedYes              1.05250    0.10586   9.943  < 2e-16 ***
GenderMale               2.38699    0.12161  19.628  < 2e-16 ***
Department2:AdmittedYes -0.01582    0.11001  -0.144    0.886
Department3:AdmittedYes -1.96189    0.12209 -16.069  < 2e-16 ***
Department4:AdmittedYes -1.45720    0.10864 -13.413  < 2e-16 ***
Department5:AdmittedYes -1.98850    0.13069 -15.216  < 2e-16 ***
Department6:AdmittedYes -3.48827    0.17308 -20.154  < 2e-16 ***
Department2:GenderMale   1.07407    0.22892   4.692 2.71e-06 ***
Department3:GenderMale  -3.27892    0.13802 -23.757  < 2e-16 ***
Department4:GenderMale  -2.10546    0.12992 -16.206  < 2e-16 ***
Department5:GenderMale  -2.98835    0.14321 -20.867  < 2e-16 ***
Department6:GenderMale  -2.26441    0.14046 -16.122  < 2e-16 ***
AdmittedYes:GenderMale  -0.51406    0.08935  -5.753 8.76e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 2917.152  on 23  degrees of freedom
Residual deviance:   75.068  on  5  degrees of freedom
AIC: 269.66

Number of Fisher Scoring iterations: 5
```

a) $OR : exp(-.029)$
b) $G^2 = 2917.15 - 75.06 = 2842 > 28.8 = qchisq(.95, 18)$ Based on the Likelihood ratio test and the marginal model plot, I would conclude that the model is a reasonable fit to the data. One cause for concern is the Residual Deviance/DF is high




```
Call:
glm(formula = Count ~ . * ., family = poisson, data = dta)

Deviance Residuals:
     2       3       4       5       6       8       9      10      11      12      14
0.0565  -6.1892  1.3650  2.2784  0.5722  -0.0736  2.5171  -0.9067  -1.2257  -0.1372  -0.2520
    15      16      17      18      20      21      22      23      24
2.5382  -1.2977  -1.4627  -0.5081  0.3929  -1.6701  1.0088  0.8766  0.1451

Coefficients:
                        Estimate Std. Error z value Pr(>|z|)
(Intercept)              1.93725    0.21980   8.814  < 2e-16 ***
Department3              4.11474    0.22301  18.451  < 2e-16 ***
Department4              3.49463    0.22297  15.673  < 2e-16 ***
Department5              3.71206    0.22499  16.499  < 2e-16 ***
Department6              3.81349    0.22576  16.892  < 2e-16 ***
AdmittedYes              0.95647    0.12619   7.579 3.47e-14 ***
GenderMale               3.40058    0.21592  15.749  < 2e-16 ***
Department3:AdmittedYes -1.88426    0.13721 -13.733  < 2e-16 ***
Department4:AdmittedYes -1.40187    0.12288 -11.409  < 2e-16 ***
Department5:AdmittedYes -1.91532    0.14435 -13.269  < 2e-16 ***
Department6:AdmittedYes -3.42721    0.18248 -18.782  < 2e-16 ***
Department3:GenderMale  -4.31067    0.22473 -19.181  < 2e-16 ***
Department4:GenderMale  -3.14746    0.21973 -14.324  < 2e-16 ***
Department5:GenderMale  -4.02008    0.22798 -17.634  < 2e-16 ***
Department6:GenderMale  -3.28322    0.22682 -14.475  < 2e-16 ***
AdmittedYes:GenderMale  -0.43084    0.09606  -4.485 7.29e-06 ***
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 2135.450  on 19  degrees of freedom
Residual deviance:   69.713  on  4  degrees of freedom
AIC: 231.52

Number of Fisher Scoring iterations: 5
```



c) $G^2 = 2135.45 - 69.713 = 2065 > 24.9 = qchisq(.95, 15)$ Since the models are not using the same dataset we cannot compare AIC, but the 2nd model shows every factor level is significant compared to one that was not significant in the first model. The likelihood ratio test and marginal model plots help us to conclude that the model fits the data well.

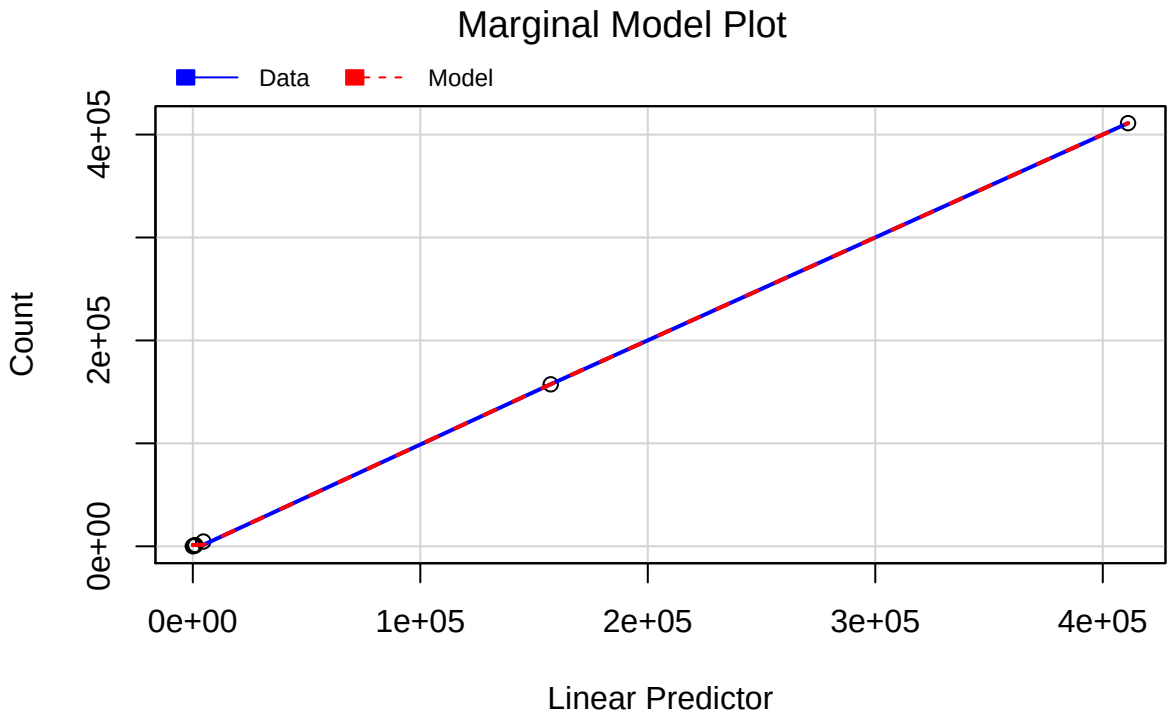
```
Call:
glm(formula = Admitted ~ Department * Gender, family = binomial,
    data = dta, weights = Count)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-20.2983  -10.2999   -0.3243   12.8427   20.8585

Coefficients:
                     Estimate Std. Error z value Pr(>|z|)
(Intercept)           0.75377    0.42875   1.758 0.078733 .
Department3          -1.41421    0.43741  -3.233 0.001224 **
```

```
Department4            -1.37574    0.44222  -3.111 0.001864 **
Department5            -1.91092    0.44475  -4.297 1.73e-05 ***
Department6            -3.33462    0.47817  -6.974 3.09e-12 ***
GenderMale             -0.22002    0.43759  -0.503 0.615103
Department3:GenderMale -2.13996    0.55125  -3.882 0.000104 ***
Department4:GenderMale  0.13804    0.46266   0.298 0.765432
Department5:GenderMale  0.42021    0.48123   0.873 0.382557
Department6:GenderMale  0.03113    0.53349   0.058 0.953474
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 4253.8  on 19  degrees of freedom
Residual deviance: 3624.4  on 10  degrees of freedom
AIC: 3644.4

Number of Fisher Scoring iterations: 6
```

d) Conditional on Department 2: OR = exp(-.22) = .80
Conditional on Department 3: OR = exp(-.22 - 2.1399) = .094
Conditional on Department 4: OR = exp(-.22 + .138) = .921
Conditional on Department 5: OR = exp(-.22 + .4202) = 1.22
Conditional on Department 6: OR = exp(-.22 + .031) = .827

7.10

```
Call:
glm(formula = Count ~ . * ., family = poisson, data = dta)

Deviance Residuals:
       1         2         3         4         5         6         7         8
 0.20704  -1.59987  -0.01071   0.31400  -0.10095   0.30951   0.01731  -0.21583

Coefficients:
                             Estimate Std. Error z value Pr(>|z|)
(Intercept)                   6.92251    0.03110  222.56   <2e-16 ***
SafetySeat Belt              -0.75682    0.05394  -14.03   <2e-16 ***
EjectedYes                   -0.72784    0.05345  -13.62   <2e-16 ***
InjuryNon Fatal               5.04362    0.03120  161.65   <2e-16 ***
SafetySeat Belt:EjectedYes   -2.39964    0.03334  -71.97   <2e-16 ***
SafetySeat Belt:InjuryNon Fatal  1.71732    0.05402   31.79   <2e-16 ***
EjectedYes:InjuryNon Fatal   -2.79779    0.05526  -50.63   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 1.6249e+06  on 7  degrees of freedom
Residual deviance: 2.8540e+00  on 1  degrees of freedom
AIC: 93.853

Number of Fisher Scoring iterations: 3
```



a) The odds of an injury for someone wearing a seatbelt who was ejected is exp(-.756 -.727 - 2.399) = .02 times that of a person not wearing a seatbelt and was not ejected.
The odds of injury for someone wearing a seatbelt enduring a nonfatal injury is exp(-.756 + 5.043 + 1.717) = 405 times that of someone who is not wearing a seatbelt and endures a fatal injury.
The odds of an injury for someone who is ejected and nonfatally injured is exp(-.727 + 5.043 - 2.797) = 4.56 times that of someone who was non ejected and endured a fatal injury.

```
Call:
glm(formula = Injury ~ Safety * Ejected, family = binomial, data = dta,
    weights = Count)

Deviance Residuals:
       1         2         3         4         5         6         7         8
   5.275   -11.076    31.071   -80.736    30.727   -48.151    44.828  -100.968

Coefficients:
                           Estimate Std. Error z value Pr(>|z|)
(Intercept)                 5.05045    0.03160 159.836   <2e-16 ***
SafetySeat Belt             1.69615    0.05542  30.607   <2e-16 ***
EjectedYes                 -2.82003    0.05680 -49.644   <2e-16 ***
SafetySeat Belt:EjectedYes  0.44197    0.27863   1.586    0.113
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 26669  on 7  degrees of freedom
Residual deviance: 23101  on 4  degrees of freedom
AIC: 23109

Number of Fisher Scoring iterations: 8
```

b) The odds of a non fatal injury from someone who is wearing a seatbelt is exp(1.69) = 5.41 times that of someone who is not wearing a seatbelt
The odds of a non fatal injury from someone who is ejected is exp(-2.82) = .0596 times that of someone who is not ejected
The odds of a non fatal injury from someone who was ejected while wearing a seatbelt is exp(1.69 - 2.82 + .441) = .5 times that of someone who is not ejected while not wearing a seatbelt

c) `with(dta, 1/(2*576184) * sum(abs(Count - mean(Count)))) = .736`

7.14

a)

```
Call:
glm(formula = count ~ . * ., family = poisson, data = dta)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-1.25008  -0.34687  -0.06744   0.37143   1.07662

Coefficients:
                       Estimate Std. Error z value Pr(>|z|)
(Intercept)              4.5650     0.0950  48.054  < 2e-16 ***
political2              -0.1729     0.1335  -1.295 0.195261
political3              -0.7375     0.1522  -4.845 1.27e-06 ***
premarital2             -2.3672     0.2029 -11.668  < 2e-16 ***
religious2              -0.2290     0.1327  -1.726 0.084379 .
birth2                  -1.7824     0.1802  -9.892  < 2e-16 ***
political2:premarital2   0.7199     0.1952   3.688 0.000226 ***
political3:premarital2   0.8018     0.2031   3.948 7.87e-05 ***
political2:religious2    0.2583     0.1729   1.494 0.135261
political3:religious2    0.3441     0.1883   1.827 0.067658 .
political2:birth2        0.3048     0.1893   1.610 0.107377
political3:birth2        0.9288     0.1936   4.797 1.61e-06 ***
premarital2:religious2   1.1459     0.1698   6.749 1.49e-11 ***
premarital2:birth2       1.1468     0.1532   7.488 6.99e-14 ***
religious2:birth2        0.5979     0.1626   3.678 0.000235 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 477.7846  on 23  degrees of freedom
Residual deviance:   6.9631  on  9  degrees of freedom
AIC: 161.4

Number of Fisher Scoring iterations: 4
```

b) Political(Moderate):Premarital(Wrong): The odds of a moderate who thinks premarital sex is wrong is exp(.7199) = 2.054 times that of a liberal who thinks premarital sex is okay

Political(Conservative):Premarital(Wrong): The odds of a conservative who thinks premarital sex is wrong is exp(.8018) = 2.3 times that of a liberal who thinks premarital sex is okay

Political(Moderate):Religous(frequent): The odds of political moderate who attends church frequently is exp(.258) = 1.29 times that of liberal who attends church infrequently

Political(Conservative):Religous(frequent): The odds of conservative who attends church frequently is exp(.344) = 1.41 times that of a liberal who attends church infrequently

Political(Moderate):BirthControl(disagree): The odds of moderate disagreeing with birth control is exp(.3048) = 1.356 times that of liberal who agrees with birth control

Political(Conservative):BirthControl(disagree): The odds of conservative who disagrees with birth control is exp(.9288) = 2.53 times that of a liberal who aggrees with birth control

Premarital(Wrong):Religous(frequent): The odds of someone who thinks premarital sex is wrong and attends church frequently is exp(1.145) = 3.14 times that of a person who thinks premarital sex is okay and attends church infrequently

Premarital(Wrong):BirthControl(disagree): The odds of someone who thinks premarital sex is wrong and disagrees with birth control is exp(1.146) = 3.14 times that of someone who thinks premarital sex is okay and agrees with birth control

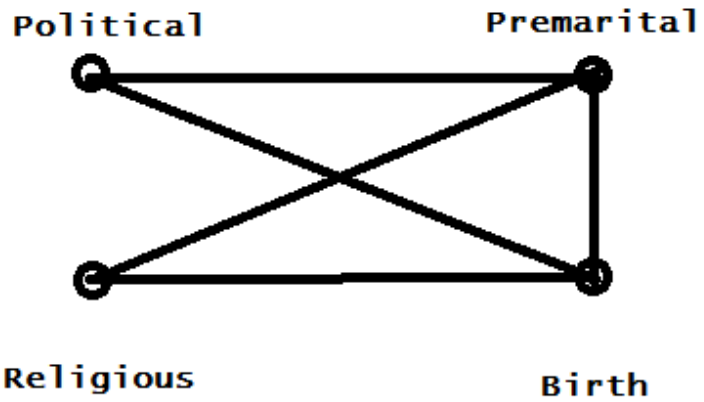
Relgious(frequent):BirthControl(disagree): The odds of someone who attends church frequently and disagrees with birth control is exp(.597) times that of someone who attends church infrequently and agrees with birth control

```
Call:
glm(formula = premarital ~ political + religious + birth, family = binomial,
    data = dta, weights = count)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-9.0882  -5.2338   0.3338   6.4840   9.8644

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -2.3753     0.2043 -11.628  < 2e-16 ***
political2    0.7280     0.1955   3.725 0.000196 ***
political3    0.8054     0.2035   3.957 7.59e-05 ***
religious2    1.1489     0.1699   6.761 1.37e-11 ***
birth2        1.1487     0.1531   7.502 6.29e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 1217.6  on 23  degrees of freedom
Residual deviance: 1047.3  on 19  degrees of freedom
AIC: 1057.3

Number of Fisher Scoring iterations: 5


Call:
glm(formula = count ~ . * ., family = poisson, data = dta)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-1.25008  -0.34687  -0.06744   0.37143   1.07662

Coefficients:
                     Estimate Std. Error z value Pr(>|z|)
(Intercept)             4.5650     0.0950  48.054  < 2e-16 ***
political2             -0.1729     0.1335  -1.295 0.195261
political3             -0.7375     0.1522  -4.845 1.27e-06 ***
premarital2            -2.3672     0.2029 -11.668  < 2e-16 ***
religious2             -0.2290     0.1327  -1.726 0.084379 .
birth2                 -1.7824     0.1802  -9.892  < 2e-16 ***
```

```
political2:premarital2   0.7199     0.1952   3.688 0.000226 ***
political3:premarital2   0.8018     0.2031   3.948 7.87e-05 ***
political2:religious2    0.2583     0.1729   1.494 0.135261
political3:religious2    0.3441     0.1883   1.827 0.067658 .
political2:birth2        0.3048     0.1893   1.610 0.107377
political3:birth2        0.9288     0.1936   4.797 1.61e-06 ***
premarital2:religious2   1.1459     0.1698   6.749 1.49e-11 ***
premarital2:birth2       1.1468     0.1532   7.488 6.99e-14 ***
religious2:birth2        0.5979     0.1626   3.678 0.000235 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 477.7846  on 23  degrees of freedom
Residual deviance:   6.9631  on  9  degrees of freedom
AIC: 161.4

Number of Fisher Scoring iterations: 4
```

c) The odds of a moderate aggreeing that premarital sex is wrong is exp(.728) = 2.07 times that of a liberal
The odds of a conservative aggreeing that premarital sex is wrong is exp(.805) = 2.23 times that of a liberal
The odds of a frequent church goer agreeing that premarital sex is wrong is exp(1.14) = 3.12 that of an infrequent church goer
The odds of a someone against birth control agrreeing that premarital sex is wrong is exp(1.1487) = 3.15 times that of who supports birth control

d) Only religious and political are independent

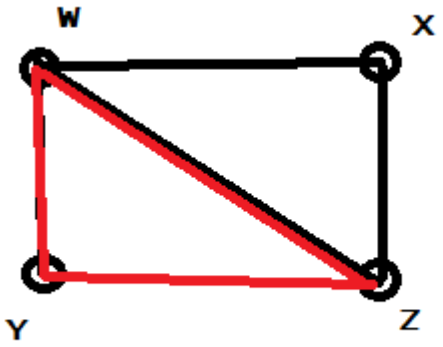


7.16

a)

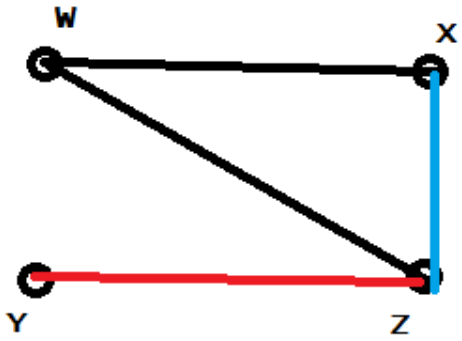
```
Call:
glm(formula = Count ~ .^3, family = poisson, data = dta)

Deviance Residuals:
      1        2        3        4        5        6        7        8        9       10
 0.12027 -0.32405 -0.09531  0.37418 -0.17993  0.33015  0.13110 -0.37131 -0.10069  0.36166
     11       12       13       14       15       16
 0.09801 -0.52177  0.13122 -0.31071 -0.12537  0.45614

Coefficients:
                                  Estimate Std. Error z value Pr(>|z|)
(Intercept)                        8.08834    0.01731 467.290  < 2e-16 ***
GenderMale                         0.62979    0.02129  29.588  < 2e-16 ***
LocationUrban                      0.80410    0.02071  38.831  < 2e-16 ***
SeatbeltYes                        0.63159    0.02128  29.681  < 2e-16 ***
InjuryYes                         -1.21855    0.03467 -35.150  < 2e-16 ***
GenderMale:LocationUrban          -0.27351    0.02579 -10.607  < 2e-16 ***
GenderMale:SeatbeltYes            -0.53937    0.02710 -19.903  < 2e-16 ***
GenderMale:InjuryYes              -0.50174    0.04423 -11.344  < 2e-16 ***
LocationUrban:SeatbeltYes         -0.16551    0.02561  -6.463 1.03e-10 ***
LocationUrban:InjuryYes           -0.75989    0.04460 -17.038  < 2e-16 ***
SeatbeltYes:InjuryYes             -0.85855    0.04673 -18.373  < 2e-16 ***
GenderMale:LocationUrban:SeatbeltYes  0.12646    0.03288   3.846  0.00012 ***
GenderMale:LocationUrban:InjuryYes   -0.08176    0.05469  -1.495  0.13491
GenderMale:SeatbeltYes:InjuryYes     -0.01144    0.05603  -0.204  0.83821
LocationUrban:SeatbeltYes:InjuryYes   0.09685    0.05547   1.746  0.08080 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 61709.5207  on 15  degrees of freedom
Residual deviance:     1.3253  on  1  degrees of freedom
AIC: 184.78

Number of Fisher Scoring iterations: 3
```

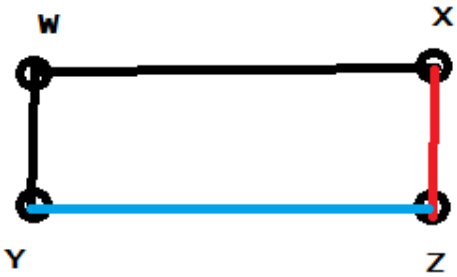
7.19



a) Variables x and y are conditionally indepenent
b) X and Y are not directly related, but are partially related through by W and Z

7.20



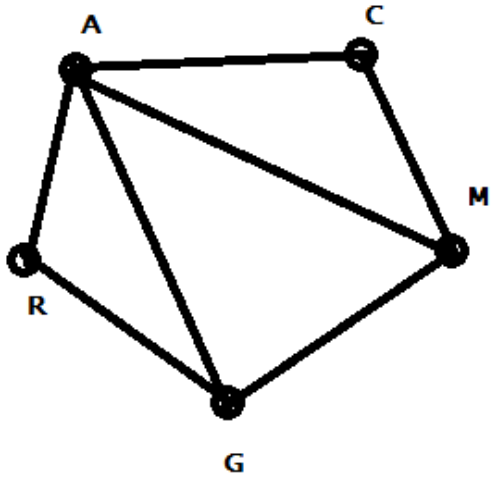


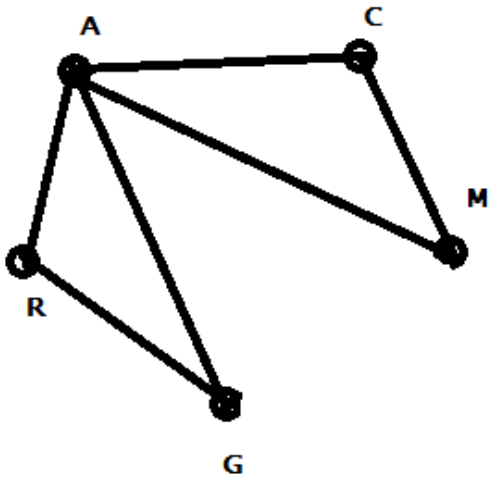
Both X and Y are independent in both cases

7.22

a) M is not connected to R, but both A and M are connected to G.

b) GR only connection to CM is through A





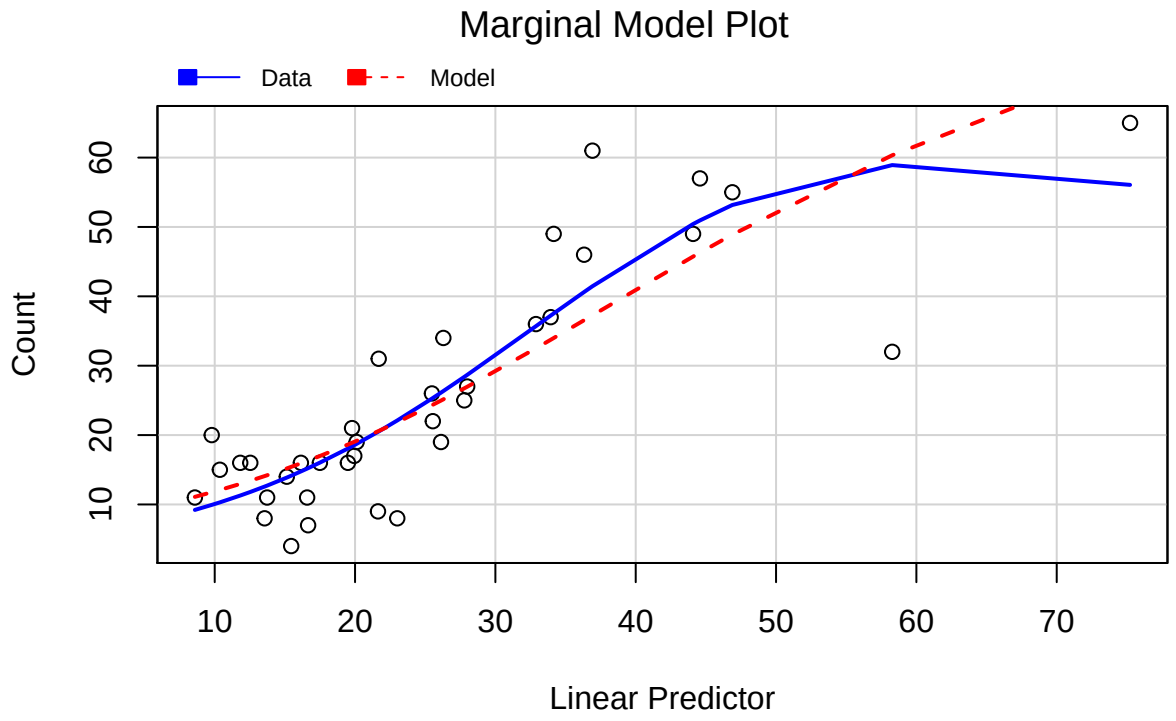
c) Because the linkage between A, C, M to G, R all go through A.

7.24

a) There are some high leverage, high residual points that are heavily influencing the model, but the residuals look random the overall the model appears to be a good fit.

```
Call:
glm(formula = Count ~ Religion.Attend + Teenage.BC, family = poisson,
    data = dta)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.7667  -0.9140  -0.1117   1.1532   3.6198

Coefficients:
                                  Estimate Std. Error z value Pr(>|z|)
(Intercept)                        3.53086    0.10412  33.912  < 2e-16 ***
Religion.Attend2-3 Times per Year -0.29299    0.13629  -2.150 0.031576 *
Religion.AttendAbout Once a Month -0.54582    0.14709  -3.711 0.000207 ***
Religion.AttendEvery Week          0.53436    0.11219   4.763 1.91e-06 ***
Religion.AttendLess Than Once a Year -0.45426    0.14296  -3.178 0.001485 **
Religion.AttendNearly Every Week  -0.92426    0.16714  -5.530 3.21e-08 ***
Religion.AttendOnce or Twice a Year  0.06156    0.12409   0.496 0.619852
Religion.AttendSeveral Times a Week -0.79323    0.15963  -4.969 6.72e-07 ***
Religion.AttendSeveral Times a Year -0.26157    0.13508  -1.936 0.052812 .
Teenage.BCAgree                    0.25529    0.08409   3.036 0.002397 **
Teenage.BCDisagree                -0.26796    0.09588  -2.795 0.005193 **
Teenage.BCStrongly Disagree       -0.45655    0.10136  -4.504 6.66e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

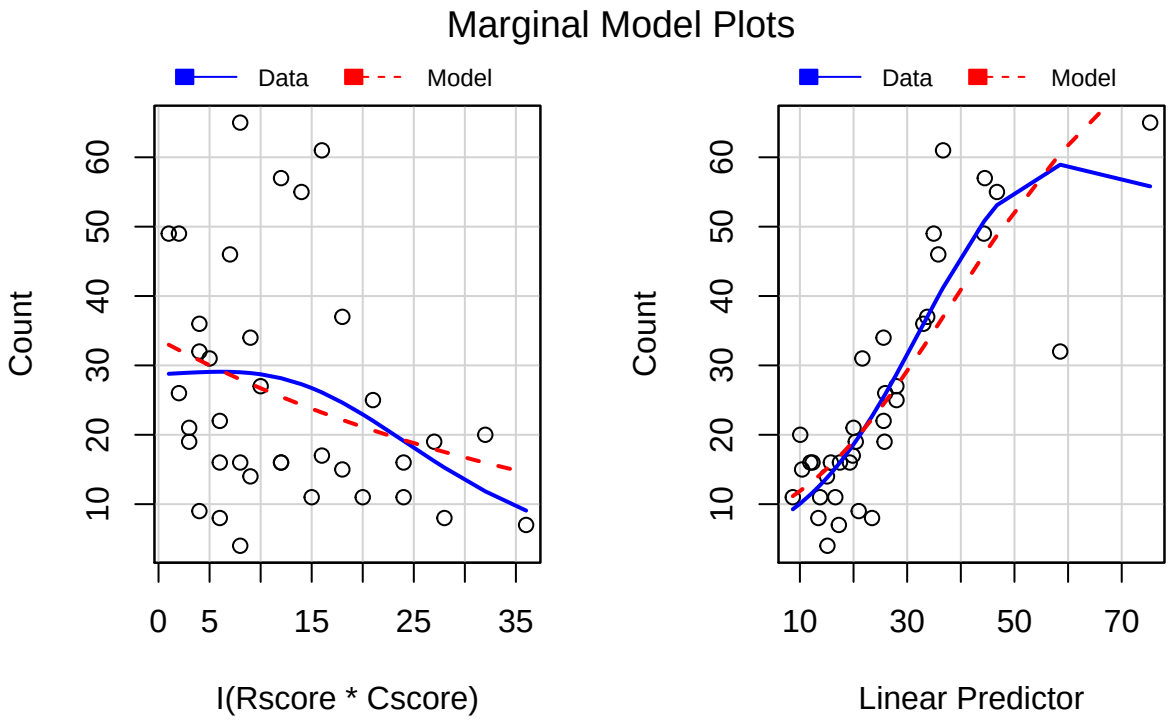
```
(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 360.16  on 35  degrees of freedom
Residual deviance: 112.54  on 24  degrees of freedom
AIC: 312.35

Number of Fisher Scoring iterations: 5
```



b) There is a strong association between Religious Attendance and supporting teenage birth control. The odds of someone supporting teen birth control increases by exp(0.004) = 1.004 for each increased level of religeous attendance. The result is insiginicant.

```
Call:
glm(formula = Count ~ Religion.Attend + Teenage.BC + I(Rscore *
    Cscore), family = poisson, data = dta)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.7973  -0.8855  -0.0846   1.1276   3.6603

Coefficients:
                                 Estimate Std. Error z value Pr(>|z|)
(Intercept)                      3.548916   0.113399  31.296  < 2e-16 ***
Religion.Attend2-3 Times per Year -0.304027   0.139124  -2.185 0.028867 *
Religion.AttendAbout Once a Month -0.567929   0.157393  -3.608 0.000308 ***
Religion.AttendEvery Week         0.501158   0.140285   3.572 0.000354 ***
```

```
Religion.AttendLess Than Once a Year -0.498571   0.181944  -2.740 0.006140 **
Religion.AttendNearly Every Week     -0.979718   0.218682  -4.480 7.46e-06 ***
Religion.AttendOnce or Twice a Year  -0.005070   0.210162  -0.024 0.980752
Religion.AttendSeveral Times a Week  -0.871054   0.254601  -3.421 0.000623 ***
Religion.AttendSeveral Times a Year  -0.350616   0.264330  -1.326 0.184697
Teenage.BCAgree                       0.232436   0.102134   2.276 0.022858 *
Teenage.BCDisagree                   -0.313819   0.151052  -2.078 0.037751 *
Teenage.BCStrongly Disagree          -0.525570   0.203321  -2.585 0.009740 **
I(Rscore * Cscore)                    0.004879   0.012441   0.392 0.694928
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 360.16  on 35  degrees of freedom
Residual deviance: 112.38  on 23  degrees of freedom
AIC: 314.19

Number of Fisher Scoring iterations: 5
```

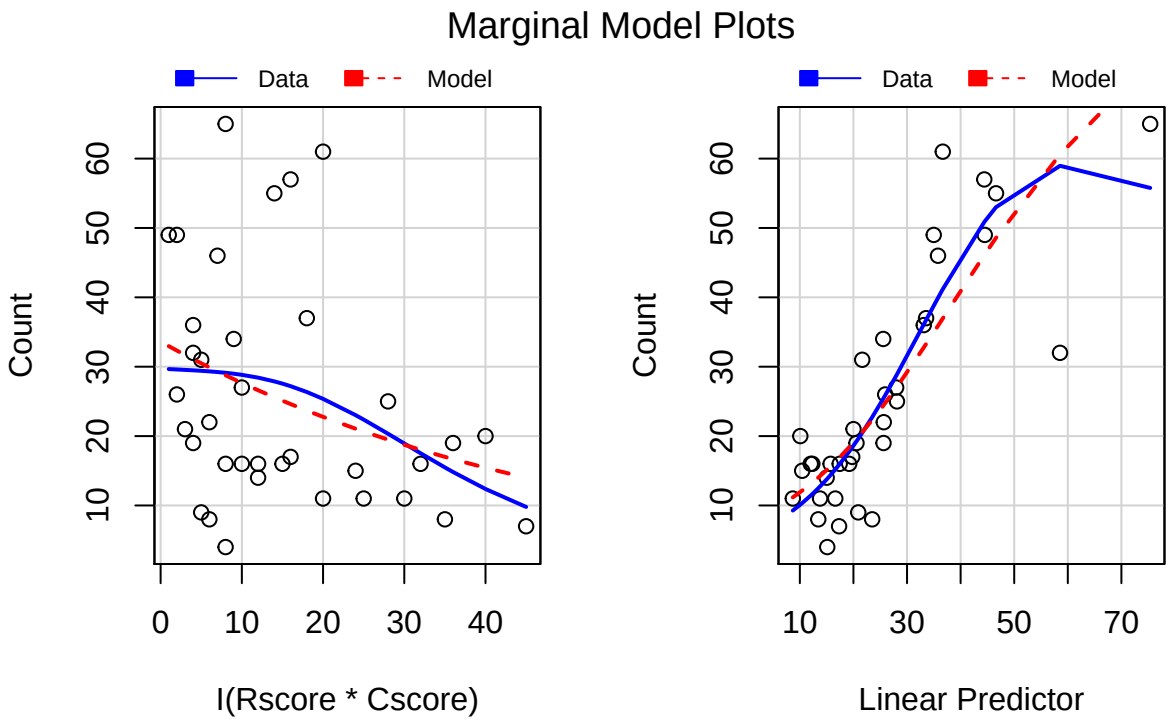


c) $G^2 = 360.16 - 107.6 = 252.56 > 21 = qchisq(.95, 12)$

d) The fit seemed to improve slightly, but the results are not very different

```
Call:
glm(formula = Count ~ Religion.Attend + Teenage.BC + I(Rscore *
    Cscore), family = poisson, data = dta)
```

```
Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.7989  -0.8866  -0.0857   1.1168   3.6644

Coefficients:
                                    Estimate Std. Error z value Pr(>|z|)
(Intercept)                         3.550919   0.112710  31.505  < 2e-16 ***
Religion.Attend2-3 Times per Year  -0.303366   0.138167  -2.196 0.028117 *
Religion.AttendAbout Once a Month  -0.566614   0.153980  -3.680 0.000233 ***
Religion.AttendEvery Week           0.503118   0.131480   3.827 0.000130 ***
Religion.AttendLess Than Once a Year -0.495975   0.169842  -2.920 0.003498 **
Religion.AttendNearly Every Week   -0.976494   0.202890  -4.813 1.49e-06 ***
Religion.AttendOnce or Twice a Year  -0.001228   0.185939  -0.007 0.994732
Religion.AttendSeveral Times a Week  -0.866601   0.227489  -3.809 0.000139 ***
Religion.AttendSeveral Times a Year  -0.345561   0.229751  -1.504 0.132564
Teenage.BCAgree                     0.236832   0.093353   2.537 0.011183 *
Teenage.BCDisagree                 -0.323634   0.155932  -2.075 0.037943 *
Teenage.BCStrongly Disagree        -0.530984   0.193516  -2.744 0.006072 **
I(Rscore * Cscore)                  0.003945   0.008721   0.452 0.651002
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for poisson family taken to be 1)

    Null deviance: 360.16  on 35  degrees of freedom
Residual deviance: 112.33  on 23  degrees of freedom
AIC: 314.14

Number of Fisher Scoring iterations: 5
```



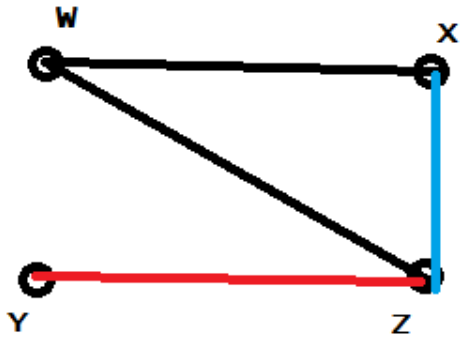
e) Agree and Disagree have opposite effects in terms of their association with Religious attendance. The relationship of someone who supports birth control increases the liklihood that they go to church more often.

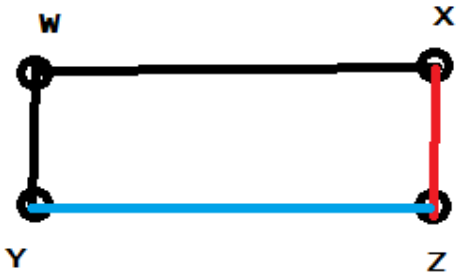
Additional I

Model 2 is the best model with the lowest deviance and 1 degree of freedom.

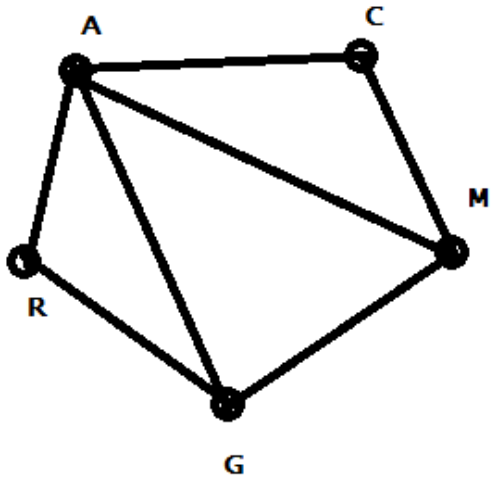
```
Analysis of Deviance Table

Model 1: count ~ gender + country + switch
Model 2: count ~ (gender + country + switch) * (gender + country + switch)
Model 3: count ~ (gender + country + switch)^3
  Resid. Df Resid. Dev Df Deviance  Pr(>Chi)
1         4     29.427
2         1     10.138  3   19.289 0.0002383 ***
3         0      0.000  1   10.138 0.0014525 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

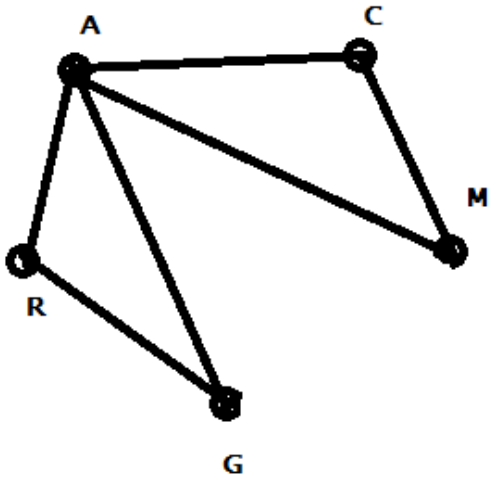
Additional II





a and b)





c)

7.25

a)

b) You can test the Wald Z value for significane, if the $Ho : \beta = 0$ is not rejected then X and Y are independent

c) β is a linear combination of the ordered factors so the relationship is fixed for the different levels.

d) This is equivalent to setting an interaction term which is equivalent to homogenous association

7.26