HW 10

1. Hierarchical Logistic Regression (20 points)

a. Data Viz (5 points)

Create a set of data visualizations that show the success climbing probability as a function of month and route.

b. Data Analysis (5 points)

Fit a hierarchical logistic regression model where the intercept varies by Route.

Discuss any differences in the point estimates of the model estimate success probability with the empirical success probabilities below.

```
climbing %>% group_by(Route) %>% summarise(success_prob = sum(succeeded)/sum(attempted), total_attempts
```

```
## # A tibble: 10 x 3
##    Route                          success_prob total_attempts
##    <chr>                                 <dbl>          <dbl>
##  1 Disappointment Cleaver                0.573           9722
##  2 Emmons-Winthrop                       0.572           2521
##  3 Fuhrers Finger                        0.364            231
##  4 Kautz Cleaver                         0.314             51
##  5 Kautz Glacier                         0.597            772
##  6 Liberty RIngraham Directge            0.497            165
##  7 Little Tahoma                         0.477            262
##  8 Ptarmigan RIngraham Directge          0.491             55
##  9 Success Cleaver                       0.438             16
## 10 Tahoma Glacier                        0.478             23
```

c. Data Analysis (10 points)

Compare and contrast the following two models. In particular, comment on the terms in the GLM model with extremely large variance; what is happening with those sitations and why does the hierarchical model not have huge standard errors too?

```
glm_fit <- glm(cbind(succeeded, failed) ~ month *  Route, data = climbing, family = binomial)
display(glm_fit)
```

```
## glm(formula = cbind(succeeded, failed) ~ month * Route, family = binomial,
##     data = climbing)
##                                          coef.est  coef.se
## (Intercept)                                 -0.05      0.05
## month6                                       0.30      0.06
## month7                                       0.51      0.06
## RouteEmmons-Winthrop                        -1.10      0.26
## RouteFuhrers Finger                         -1.14      0.24
## RouteKautz Cleaver                         -25.11 101766.65
## RouteKautz Glacier                           0.13      0.39
## RouteLiberty RIngraham Directge             -1.05      0.28
## RouteLittle Tahoma                          -2.13      0.40
## RoutePtarmigan RIngraham Directge          -25.11 101766.65
```

```
## RouteSuccess Cleaver                          0.46      0.91
## RouteTahoma Glacier                          -0.24      0.77
## month6:RouteEmmons-Winthrop                   1.23      0.27
## month7:RouteEmmons-Winthrop                   0.94      0.27
## month6:RouteFuhrers Finger                    0.22      0.33
## month7:RouteFuhrers Finger                    1.89      0.45
## month6:RouteKautz Cleaver                    24.01 101766.65
## month7:RouteKautz Cleaver                    24.65 101766.65
## month6:RouteKautz Glacier                    -0.14      0.40
## month7:RouteKautz Glacier                    -0.01      0.40
## month6:RouteLiberty RIngraham Directge        1.74      0.38
## month7:RouteLiberty RIngraham Directge        0.81      0.55
## month6:RouteLittle Tahoma                     1.97      0.44
## month7:RouteLittle Tahoma                     2.81      0.49
## month6:RoutePtarmigan RIngraham Directge     24.67 101766.65
## month7:RoutePtarmigan RIngraham Directge     26.04 101766.65
## month6:RouteSuccess Cleaver                  24.66  97685.95
## month7:RouteSuccess Cleaver                 -26.72  92261.04
## month6:RouteTahoma Glacier                    0.68      1.16
## month7:RouteTahoma Glacier                   -0.63      1.00
## ---
##   n = 30, k = 30
##   residual deviance = 0.0, null deviance = 360.3 (difference = 360.3)
```

```
glmer_fit <- glmer(cbind(succeeded, failed) ~ -1 + (month | Route), data = climbing, family = binomial)
coef(glmer_fit)
```

```
## $Route
##                               (Intercept)     month6     month7
## Disappointment Cleaver       -0.05679190  0.3025014  0.5093205
## Emmons-Winthrop              -1.05176518  1.4272479  1.3582701
## Fuhrers Finger               -1.17846128  0.5865367  2.2504138
## Kautz Cleaver                -0.69048251  0.1208654  1.1821407
## Kautz Glacier                -0.19421796  0.4052719  0.7244749
## Liberty RIngraham Directge   -1.02572191  1.7826907  1.2957830
## Little Tahoma                -1.96604803  2.0318207  3.0999686
## Ptarmigan RIngraham Directge -1.38798460  1.2139151  2.3801000
## Success Cleaver               0.86971229 -0.2696023 -1.8967421
## Tahoma Glacier               -0.04354708  0.2768707 -0.1143504
##
## attr(,"class")
## [1] "coef.mer"
```

```
se.ranef(glmer_fit)
```

```
## $Route
##                               (Intercept)     month6     month7
## Disappointment Cleaver        0.05065288 0.06046241 0.05938422
## Emmons-Winthrop               0.22967647 0.23971827 0.23809382
## Fuhrers Finger                0.22092431 0.30314852 0.38929271
## Kautz Cleaver                 0.72090910 0.78160277 1.10654771
## Kautz Glacier                 0.32292175 0.34349717 0.35101114
## Liberty RIngraham Directge    0.25277717 0.34005046 0.45714610
## Little Tahoma                 0.32073078 0.37100960 0.44225217
## Ptarmigan RIngraham Directge  0.75484324 0.80983737 1.14936077
```

```
## Success Cleaver               0.67742154 0.82806617 1.07426820
## Tahoma Glacier                0.56670328 0.73057188 0.87595549
```