Denis Ostroushko - PUBH 7440 - HW3

Problem 1

Problem 2

In this version of the Gamma distribution parametrization, the mean is given by $\frac{\alpha}{\beta}$, or $\frac{Y_{0\alpha}}{n_{0\alpha}}$, which is the death rate we want to analyze. Therefore, the whole estimated Gamma distribution is 'centered' at the estimate death rate, and the distribution provides expected variation around the point estimate $\frac{Y_{0\alpha}}{n_{0\alpha}}$.

Problem 3

This makes sense because we will preserve the distribution of age groups within a county which was observed in the data. Death rate will be based on a proportional population for age group α, according to values of parameter $\lambda_{0\alpha}$. This way we can control the value of total country population, and though $\pi_{0\alpha}$ we control the number of people in each age group.

Problem 4

Problem 5

We want to learn about the death rates in each county in each age group. Recall that $\lambda_{i\alpha}$ represents mortality rate associated with stroke in each county $i = 1, 2, ..., 67$ in each age group $\alpha = 1, 2, 3$. In the Bayesian data analysis framework, we want to obtain a posterior distribution of each parameter $\lambda_{i\alpha}$ given observed death rates, or death counts (the data) $Y_{i\alpha}$ and population size corresponding to an age group in the county i.

In the framework of our analysis, we treat population size for age group α in county i as a constant value.

According to the *Problem 1* statement, the likelihood for observed data is $Y_{i\alpha}$~$Pois(n_{i\alpha}\lambda_{i\alpha})$, and the prior distribution of the parameter of interest is $\lambda_{i\alpha}$~$Gamma(n_{0\alpha}, Y_{0\alpha})$.

So, $p(\lambda_{i\alpha}|Y_{i\alpha}, n_{i\alpha}, Y_{0\alpha}, n_{0\alpha}) \propto$

Problem 6

```
[1] 1000
[1] 2000
[1] 3000
[1] 4000
[1] 5000
[1] 6000
[1] 7000
[1] 8000
[1] 9000
[1] 10000
```

Problem 7

```
                county   age.group deaths population crude.rate.100k
1     Adams County, PA 65-74 years     NA      11402              NA
2     Adams County, PA 75-84 years     15       5763           260.3
3     Adams County, PA   85+ years     27       2694          1002.2
4 Allegheny County, PA 65-74 years     80     119039            67.2
5 Allegheny County, PA 75-84 years    170      64600           263.2
6 Allegheny County, PA   85+ years    329      36872           892.3
         ratio lambda_0       p_0      n_0 from_sim_mean from_sim_median
1           NA  0.00075 0.5562775 5562.775  0.0005944583    0.0005746002
2 0.0026028110  0.00250 0.2933133 2933.133  0.0025693046    0.0025327448
3 0.0100222717  0.01000 0.1504092 1504.092  0.0100057041    0.0099138560
4 0.0006720487  0.00075 0.5562775 5562.775  0.0006753003    0.0006736465
5 0.0026315789  0.00250 0.2933133 2933.133  0.0026268011    0.0026232005
6 0.0089227598  0.01000 0.1504092 1504.092  0.0089680024    0.0089610082
```

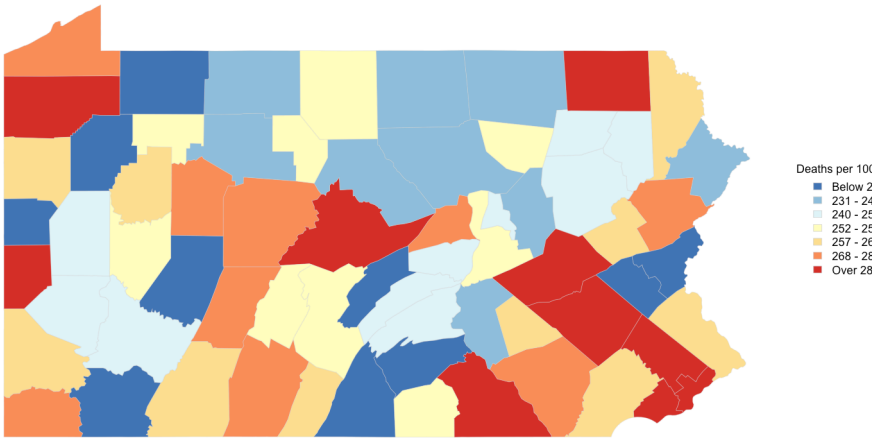

Figure 1: Final Map of Rates