## Lab Assignment # 3: Bootstrapping and Maximum likelihood

## Question 1.

Generate a data set os size 5,000 from a Gamma distribution with parameters  $\alpha = 2$  and  $\lambda = 2$ .

- (15 marks) Find the maximum likelihood estimates of  $\alpha$  and  $\lambda$ . Finding the maximum explicitly in this case is not possible. To get the maximum use the Newton method. Write your own function in R for Newton method. Use the methods of moments estimate as your initial value for the Newton method.
- (15 marks) Evaluate the approximate 95% confidence intervals (CIs) for the parameters  $\alpha$  and  $\lambda$  using parametric bootstrap. Obviously, there are various ways to do the bootstrap. Use the method described on page 284 of the book to do the bootstrap. This method involves sampling from the distribution using the obtained estimate  $\hat{\theta}$  and then obtain new estimates  $\theta_j^*$  and then approximate  $\hat{\theta} \theta_0$  by  $\theta^* \hat{\theta}$ , quantiles of which are used to make the confidence interval.

## Question 2. (10 marks)

Use the height-weight data set from lab 1. Find the standard deviation of the estimate for median of the height variable using non-parametric bootstrapping. Write your own function to bootstrap and do not use the functions available in R for bootstrapping. Use different number of iterations for bootstrapping:  $10, 20, \dots, 1000$  and plot the obtained standard deviation against the number of iterations. You can use the "sample" function in R to draw samples with replacement.

Note: You can only submit your lab assignment printed with appropriate graphs produced by R. Emails are not accepted. The way you present your solutions is considered as a part of your skills and a portion of the mark is devoted to that. Label the axes for your graphs and put explanations when necessary.