1. (10) Write your own code and find solution to the equation $x^3 + x - 4 = 0$ using Newton's method and the secant method. Compare the number of iterations needed for different starting values for the two methods.

2. (20) Poisson regression. The Ache hunting data set has $n = 47$ observations recording is the number of monkeys killed over a period of days with each hunter along with hunter's age. It is of interest to estimate and quantify the monkey kill rate as a function of hunter's age. Hunting prowess confers elevated status among the group, so a natural question is whether hunting ability improves with age, and at which age hunting ability is best. I have a sample code set up for you.

```
d=read.table("ache.txt",header=T)
n=length(d$age)
X=cbind(rep(1,n),d$age,(d$age)^2)
ll=function(theta){
sum(dpois(d$monkeys,exp(log(d$days)+X%*%theta),log=T))
}
```

Hand-code Newton-Raphson in R to fit the Poisson regression model

$$monkeys_i \sim Pois\{exp(\log days_i + \theta_1 + \theta_2 age_i + \theta_3 age_i^2)\}.$$

Feel free to use jacobian and hessian in the numDeriv R package. You may need a sets of crude starting values. I run a linear regression for the "empirical log- rates" and get starting values $(-5.99, 0.167, -0.001)$. Feel free to use those. Compare your result with glm() function in R using

```
glm(monkeys~age+I(age^2),family="poisson",offset=log(days),data=d)
```

3. (20) Logistic and Cauchy distributions are well-suited to the inverse transform method. For each of the following, generate 10,000 random variables using the inverse transform. Compare your program with the built-in R functions rlogis() and rcauchy(), respectively:

(a)Standard Logistic Distribution:

$$F(x) = \frac{1}{1 + e^{-x}}$$

(b)Standard Cauchy Distribution:

$$F(x) = \frac{1}{2} + \frac{1}{\pi} arctan(x)$$

4. (10) Generating 10,000 random variables from $Geometric(p)$ distribution based off Bernoulli trials.

5. (20) Generate random values from a Standard Half Normal distribution with pdf,

$$f(x) = \frac{2}{\sqrt{2\pi}} e^{-x^2/2}, x > 0$$

For the candidate pdf, choose the exponential density with rate 1. Verify that your method works via a plot of the true density, and a histogram of the generated values.

6. (20) Use accept-reject to sample from this bimodal density:

$$f(x) \propto 3e^{-0.5(x+2)^2} + 7e^{-0.5(x-2)^2}.$$

The normalizing constant is 25.066. For your proposal g(·), use a $N(0, 2^2)$ distribution. Verify that your method works via a plot of the true normalized density, and a histogram of the generated values.