SCRIPT `MOD3S1D`: DELTA METHOD AND KRINSKY-ROBB SIMULATION

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1. Introduction and Data

This is an example for deriving the estimated asymptotic variance and standard error for a nonlinear function of original MLE estimates using the DELTA method and Krinsky-Robb simulation.

We will build on the results from `module2s1b`. There, MLE produced a point estimate and the standard error for the standard deviation of the regression error, σ. Here we are interested in the estimate and standard error for the variance σ^2. See our lecture notes for the analytical details.

First, we will load the estimation results from the MLE model with analytical gradient and Hessian, using the wage data.

```
R> load("c:/Klaus/AAEC5126/R/data/wage1000.rda")#load data
R> load("c:/Klaus/AAEC5126/R/data/mod2s1b.rda") #load MLE results
R> names(data)[1]<-"wage"
R> names(data)[2]<-"gender"
R> names(data)[3]<-"race"
R> names(data)[4]<-"unionmember"
R> names(data)[5]<-"education"
R> names(data)[6]<-"experience"
R> names(data)[7]<-"age"
R> attach(data)
R> n<-nrow(data)
R> X<-cbind(rep(1,n),gender,race,unionmember,education,experience)
R> k<-ncol(X)
R> y<-matrix(log(wage))
```

2. Inference via Delta Method

```
R> sig<-b[k+1]
R> H1<-solve(-H)
R> Vsig<-H1[k+1,k+1]
R> sig2<-sig^2
R> Vsig2<-4*sig^2*Vsig
R> sesig2<-sqrt(Vsig2)
R> #Confidence interval:
R> lo<-sig2-1.96*sesig2
R> hi<-sig2+1.96*sesig2
R> ttDELTA<-data.frame(col1="error variance",
                col2=sig2,
                col3=sesig2,
```

```
               col4=lo,
               col5=hi)
R> colnames(ttDELTA)<-c("variable","estimate","s.e.","lower","upper")

R> ttDELTAx<- xtable(ttDELTA,
 caption="MLE results for error variance using DELTA method")
R> digits(ttDELTAx)<-3   #decimals to be shown for each column
R> print(ttDELTAx,include.rownames=FALSE,
 latex.environment="center", caption.placement="top",table.placement="!h")
```

Table 1. MLE results for error variance using DELTA method

variable	estimate	s.e.	lower	upper
error variance	0.224	0.009	0.205	0.243

3. Inference via Krinsky-Robb method

The MLE estimate for σ, call it $\hat{\sigma}$, will be asymptotically normally distributed, with mean σ, and variance the $(k+1)^{th}$ element of the inverted information matrix. We'll approximate the former by the estimate itself, and the latter by the $(k+1)^{th}$ element of the inverted negative Hessian.

We then take R draws from this asymptotic distribution. We square each draw to obtain the asymptotic distribution of σ^2.

```
R> R<-10000; #number of repetitions
R> #Step 1: Draw R sig's from empirical density
R> sigvec<-rnorm(R,sig,sqrt(Vsig))
R> #Step2: For each draw, compute function of interest
R> sig2vec<-sigvec^2
R> #Examine statistics of interest
R> sig2<-mean(sig2vec)
R> sesig2<-sd(sig2vec)
R> lo<-quantile(sig2vec,0.025)
R> hi<-quantile(sig2vec,0.975)
R> ttKR<-data.frame(col1="error variance",
               col2=sig2,
               col3=sesig2,
               col4=lo,
               col5=hi)
R> colnames(ttKR)<-c("variable","estimate","s.e.","lower","upper")

R> ttKRx<- xtable(ttKR,
 caption="MLE results for error variance using Krinsky-Robb method")
R> digits(ttKRx)<-3   #decimals to be shown for each column
R> print(ttKRx,include.rownames=FALSE,
 latex.environment="center", caption.placement="top",table.placement="!h")

R> proc.time()-tic
   user  system elapsed
   0.12    0.02    0.17
```

Table 2. MLE results for error variance using Krinsky-Robb method

variable	estimate	s.e.	lower	upper
error variance	0.224	0.010	0.205	0.243