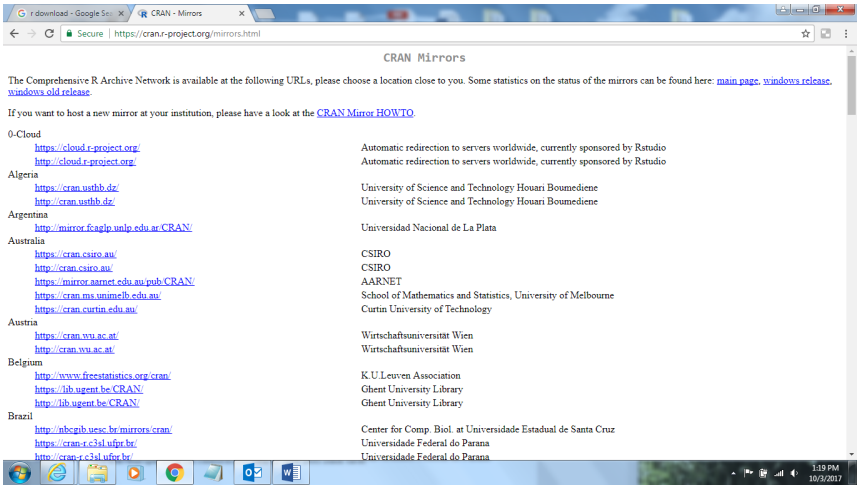
Computer code for calculation of the L factors

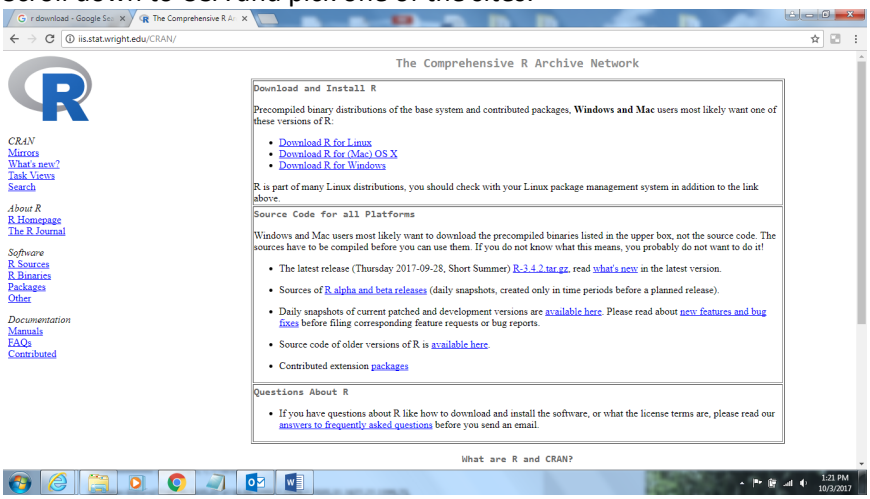
The code requires that both R and OpenBUGS be installed, both are free to download.

R can be obtained at http://www.R-project.org/

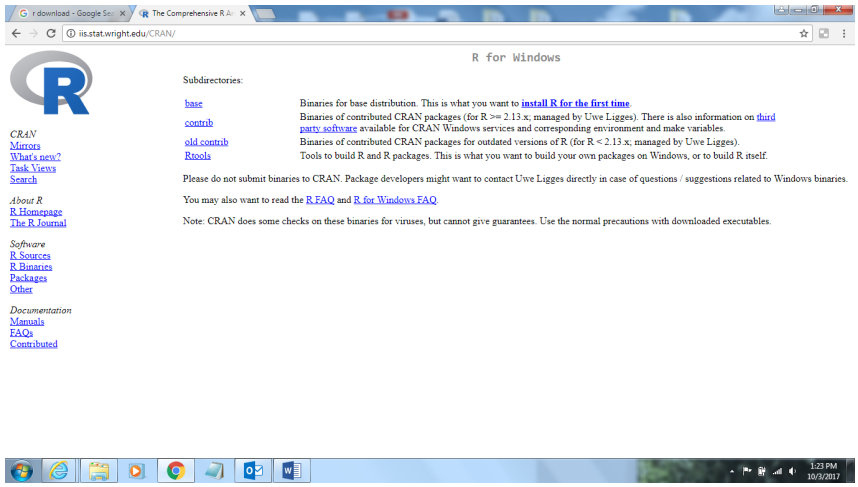
1. Click on “download R” this will appear:



2. Scroll down to USA and pick one of the sites:



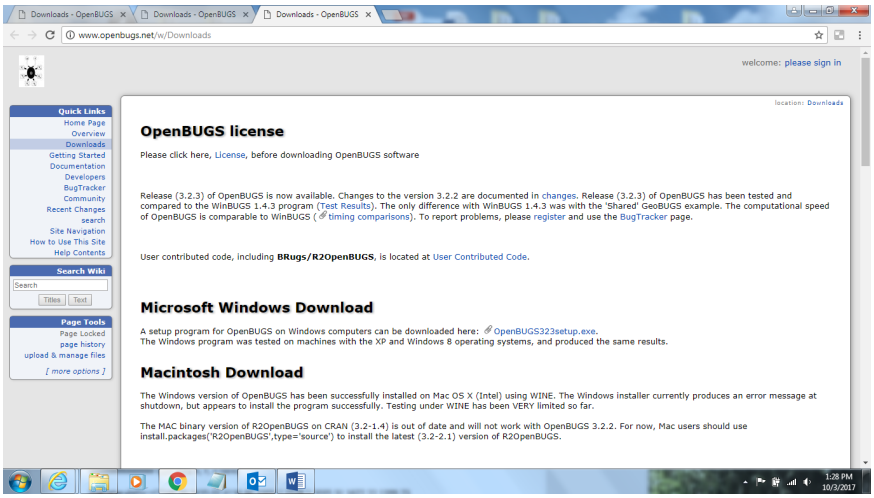
3. Download the R version appropriate for your system.



4. Click “install R for the first time and follow instructions.

OpenBUGS can be obtained at http://www.openbugs.net/w/Downloads .

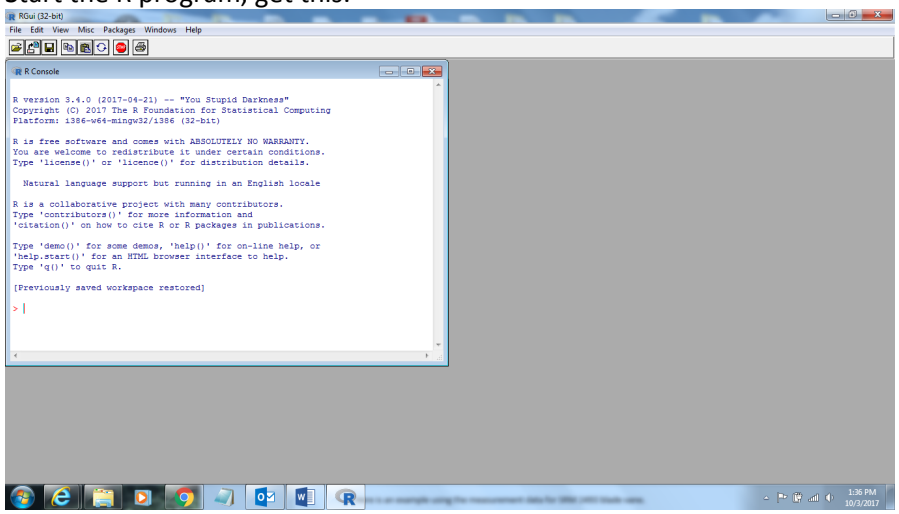
1.



2. Click on the download for your system
3. Run the installer.

To run the program:

1. Start the R program, get this:



2. The only input to the program that is needed are the values *N* and *Γ*, and the sample size n. In the program below *x* = *N* in rad/s, and *y* = *Γ* in μNm.

For example, SRM 2493 with six-blade vane configuration:

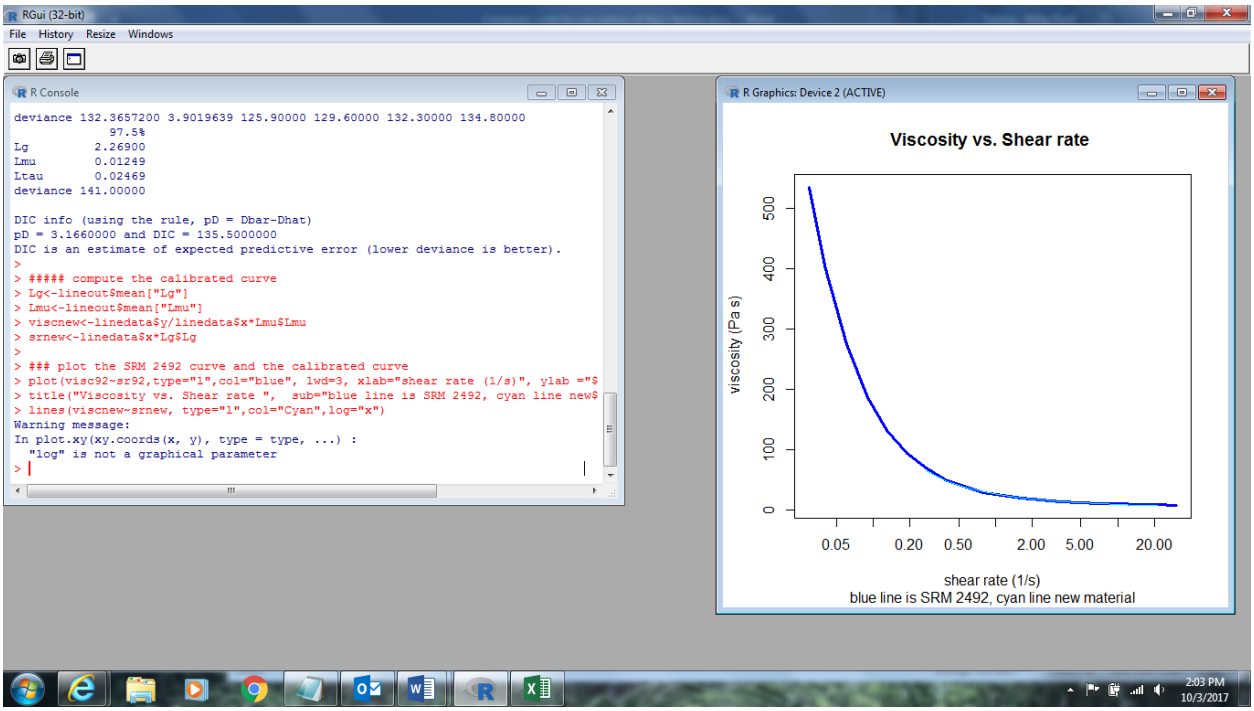
N (x)	*Γ* (y)
10.472	7246.99
7.278	5435.07
5.058	4136.84
3.519	3203.2
2.45	2528.2
1.696	2035.31
1.183	1672.22
0.822	1399.73
0.571	1190
0.397	1031.01
0.276	907.89
0.192	812.84
0.133	740.87
0.093	683.41
0.065	636.65
0.045	601.52
0.031	574.89
0.022	551.14
0.015	533.65
0.01	519.51

3. Paste the entire program below into a notepad window:

```
##################################################################################
library(R2OpenBUGS)

############## type data X (in rad/s), Y (in µNm) , n here:

linedata<-list(y=c(7246.99,5435.07,4136.84,3203.2,2528.2,2035.31,1672.22,1399.73,
1190,1031.01,907.89,812.84,740.87),
x=c(10.472,7.278,5.058,3.519,2.45,1.696,1.183,0.822,0.571,0.397,0.276,0.192,0.133), n=13)

###############

####SRM 2492 curve (from table 8) for comparison to see the fit
visc92<-c(8.72,9.21,9.84,10.66,11.73,13.15,14.94,17.33,20.44,24.44,30.1,
39.27,51.25,69.47,94.31,132.83, 186.79,274.08,404.37,534.13)

sr92<-c(30.32,21.07,14.64,10.19,7.09,4.91,3.43,2.38,1.65,1.15,0.8,
0.55,0.39,0.27,0.19,0.13,0.09,0.06,0.04,0.03)
#####
##### OpenBUGS code and inits

lineinits<-function(){list(sig=1)}
linemodel <- function() {sig~dgamma(1.0E-5,1.0E-5)
Lg~dunif(1,8)
Lm~dunif(10,10000)
Lmu<-1/Lm
Ltau<-Lg/Lm

a1n<-16.411
a1sig<-1/(0.64*0.64)
b1n<-0.988
b1sig<-1/(0.018*0.018)
c1n<-9.641
c1sig<-1/(0.98*0.98)
a2n<-19.178
a2sig<-1/(0.61*0.61)
b2n<-0.727
b2sig<-1/(0.09*0.09)
c2n<-7.116
c2sig<-1/(0.78*0.78)

a1~dnorm(a1n,a1sig)
b1 ~dnorm(b1n,b1sig)
```

```
c1 ~dnorm(c1n,c1sig)
a2 ~dnorm(a2n,a2sig)
b2 ~dnorm(b2n,b2sig)
c2 ~dnorm(c2n,c2sig)
a<-8
    for (i in 1:n){ srd[i]<-x[i]*Lg
                num[i]<-a*srd[i]
                top[i]<-a*(srd[i]-1)
    mu[i]<-
Lm*(c1*exp(a)+c2*exp(num[i])+a2*exp(num[i])/pow(srd[i],b2)+a1*exp(a)/pow(srd[i],b1))/(exp(
a)+exp(num[i]))
                gon[i]<-y[i]/x[i]
                gon[i]~dnorm(mu[i],sig)
               }
}
######
###### run the OpenBUGS

lineout<-bugs(data=linedata,inits=lineinits,parameters=c("Lg","Lmu","Ltau"),
model.file=linemodel,n.chains=1,n.iter=10000,n.burnin=5000,n.thin=10)

#####print the values of the L factors
print(lineout, digits=7)

##### compute the calibrated curve
Lg<-lineout$mean["Lg"]
Lmu<-lineout$mean["Lmu"]
viscnew<-linedata$y/linedata$x*Lmu$Lmu
srnew<-linedata$x*Lg$Lg

### plot the SRM 2492 curve and the calibrated curve
plot(visc92~sr92,type="l",col="blue", lwd=3, xlab="shear rate (1/s)", ylab =" viscosity (Pa s)",
log="x")
title("Viscosity vs. Shear rate ",  sub="blue line is SRM 2492, cyan line new material")
lines(viscnew~srnew, type="l",col="Cyan",log="x")
```

4. Edit the X and Y lists to input your own data. (numbers in blue in the program above)
5. Paste the entire edited file into the R window.
6. This will run the code and produce the estimates of the *L* factors as well as a plot which shows the fit to the SRM 2492 function.



7. Read the L factors as: L_γ (Lg in the output)

   L_μ in Pa s / N m s (1000000 Lmu in output),

   L_τ Pa/N m (1000000 Ltau in output).