GLMM

To start we will look at a simple data set of a medical experiment, with treatment
of a drug on populations and the number of live or dead after treatment
called mortality.txt
this is a text file so use read.table or read.delim

take a look at the data using the hist() plot what you think will be interesting

Ok so say we are interested in how much treatment is affecting the number of dead animals
in each population?

but is the population really of scientific interest to us?
while it might make a difference we don't actually care which one they are in if it's
about the drug.

so lets do a GLMM but for this we are going to need to load in another package

```
install.packages('lme4')


library(lme4)
```

Like with linear models mixed effect models can be linear or general linear
there are two different commands lmer and glmer

lets start with doing a linear mixed effects model

```
lme1<- lmer(Dead ~ Treatment + (1|Population), data = )
```

the (1|) Denotes to use that as a random factor, there are several ways to take random

factors into account, this is the simplest.

```
summary(lme1)
```

that gives us some low t values, (p values are not happy in lmer but the t is low so it is not significant) but it compares factor levels not the overall factor

```
anova(lme1, test = 'F')
```

if we try plot we can see that it doesn't give us the same diagnostic plots for an lme

```
plot(lme1)
```

However the number dead is not really that useful it should be the proportion dead or proportion alive

```
mort$size <-(mort$Alive + mort$Dead)
mort$prop <- mort$Dead/ mort$size
```

this nor gives us a proportion that died

```
glmm1 <- glmer(prop ~ Treatment + (1|Population), weights = size, data = mort, family = binomial())

summary(glmm1)
```

here still nothing is significant. This is just how science is, sucks to be the researcher

Ok lets look at the data called RIKZ, this is data on fossils found on beaches with the number of different fossils, the height of sealevel (NAP) and the sun exposure they recieved on the beach.

ok so some of the data here is obviously not going to be normal and is count data. So we should use a glmm

we're interested in what impacts the richness of fossils on each beach, whether it is NAP or exposure or both. But do we care about the actual beach it was on?
Nope? so lets use a GLMM

first of all exposure is between 1 and 10 so it can be thought of as a factor
we can make it a factor!

```
RIKZ$Exposure <- as.factor(RIKZ$Exposure)
```

```
glmm2<- glmer(Richness ~ Exposure * NAP + (1|Beach), data = RIKZ , family = poisson())

summary(glmm2)

anova(glmm2)
```

so it looks like both are significant, good job, but the interactions are not, so lets drop that

```
glmm3 <- glmer(Richness ~ Exposure + NAP + (1|Beach), data = RIKZ , family = poisson())
summary(glmm3)
```

lets take a look directly at the effect NAP on Richness then

```
plot(Richness ~ NAP, data = RIKZ)
```

lets do just an glmer with these two

```
glmm4 <-glmer(Richness ~ NAP + (1|Beach), data = RIKZ , family = poisson())
```

so we can see that there is a negative trend of richness with higher NAP

lets do what we did before and get a line

```
pred2<- expand.grid(NAP = seq(-2,3, by = 0.1))
```

we need to add re.form = ~0 to this to include the random effect of beach

```
pred2$fit <- predict(glmm4, newdata= pred2, type = 'response',re.form = ~0)
lines(fit ~ NAP, data=pred2)
```

cool we have a plot now tell me about it in words.

I want you to work out the equation of the line

```
summary(glmm4)
```

ok so y = -6.7x + 9.569

so in words lets describe this what does an increase in 0.1 NAP do?

go from 0 to 0.1

y = -6.7*0 + 9.569, y = 9.569

y = -6.7*0.1 + 9.569

y = -0.67 + 9.569, y = 8.899

9.569 - 8.899 = 0.67

so an increase of 0.1 NAP decreases fossil richness by 0.67

now add your stastistics

an increase of 0.1 NAP decreases fossil richness by 0.67(glmm, z = -6.687, p = >0.001)

This is what I want when I see statistics!

OK now that you've done it open up the tundra.csv dataset

this is real data from a meta analysis of carbon sequestration rates of tundras all around the world

I want you to tell me what effect the increase of year is having on carbon sequestration

GS.NEE in the data

hint you need to control for site.