

# MLM Nested Main Section

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## Question 0: read data and process missingness

```
dat <- read.dta("classroom.dta")

# construct new outcome math1st
dat <- dat %>%
  mutate(math1st = mathkind + mathgain)

# remove missing data
dat <- dat %>%
  filter(complete.cases(dat))
```

## Question 1

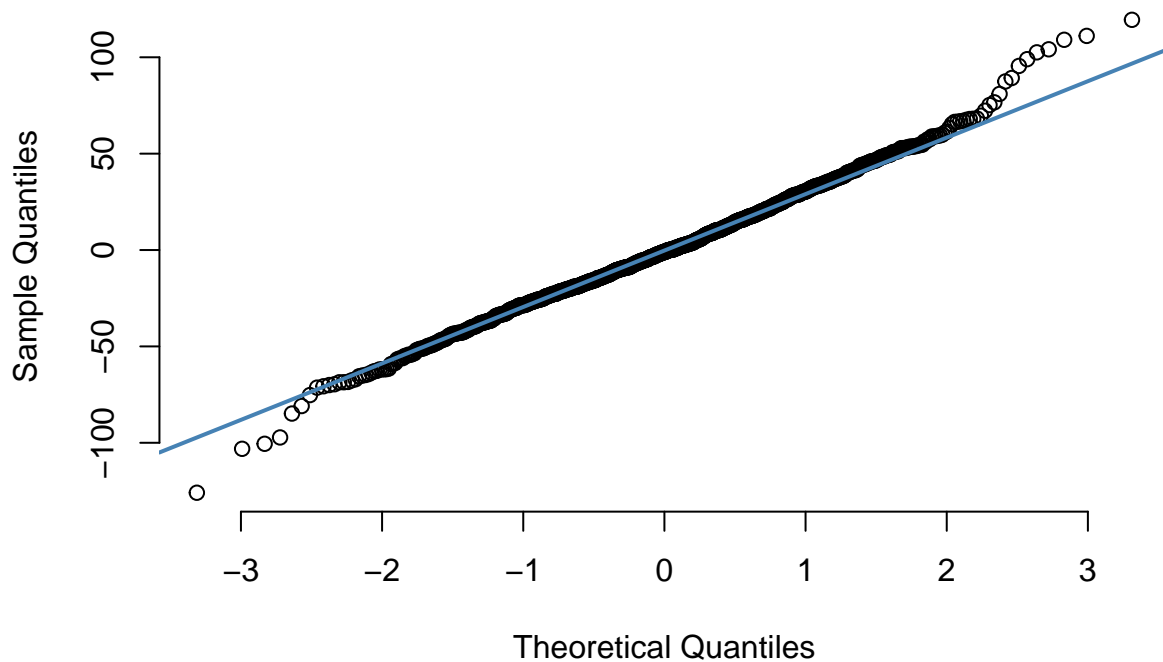
```
# fit a model
fit1 <- lmer(math1st ~ housepov + yearstea + mathprep + mathknow + ses + sex + minority +
  (1 | schoolid/classid), data = dat)
summary(fit1)

## Linear mixed model fit by REML. t-tests use Satterthwaite's method [
## lmerModLmerTest]
## Formula: math1st ~ housepov + yearstea + mathprep + mathknow + ses + sex +
## minority + (1 | schoolid/classid)
## Data: dat
##
## REML criterion at convergence: 10729.5
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -3.8581 -0.6134 -0.0321  0.5971  3.6598
##
## Random effects:
## Groups           Name             Variance Std.Dev.
## classid:schoolid (Intercept)    93.89   9.689
## schoolid         (Intercept)   169.45  13.017
## Residual                        1064.96  32.634
## Number of obs: 1081, groups: classid:schoolid, 285; schoolid, 105
##
## Fixed effects:
##              Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)  539.63041    5.31209  275.39009 101.585 < 2e-16 ***
## housepov     -17.64850   13.21755  113.87814  -1.335  0.184
```

```
## yearstea      0.01129      0.14141  226.80861   0.080   0.936
## mathprep     -0.27705      1.37583  205.27111  -0.201   0.841
## mathknow      1.35004      1.39168  234.49768   0.970   0.333
## ses           10.05076      1.54485 1066.56211   6.506 1.18e-10 ***
## sex           -1.21419      2.09483 1022.42110  -0.580   0.562
## minority     -16.18676      3.02605  704.47787  -5.349 1.20e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##      (Intr) houspv yearst mthprp mthknw ses      sex
## housepv -0.451
## yearstea -0.259  0.071
## mathprep -0.631  0.038 -0.172
## mathknow -0.083  0.058  0.029  0.004
## ses      -0.121  0.082 -0.028  0.053 -0.007
## sex      -0.190 -0.007  0.016 -0.006  0.007  0.020
## minority -0.320 -0.178  0.024  0.001  0.115  0.162 -0.011
```

```
# plot residuals to test normality assumption
res1 <- residuals(fit1)
qqnorm(res1, pch = 1, frame = FALSE)
qqline(res1, col = "steelblue", lwd = 2)
```

**Normal Q-Q Plot**



QQ plot shows that points are around the line, and thus we believe the normality assumption holds.

## Question 2

```
blups_fit1 <- ranef(fit1)
```

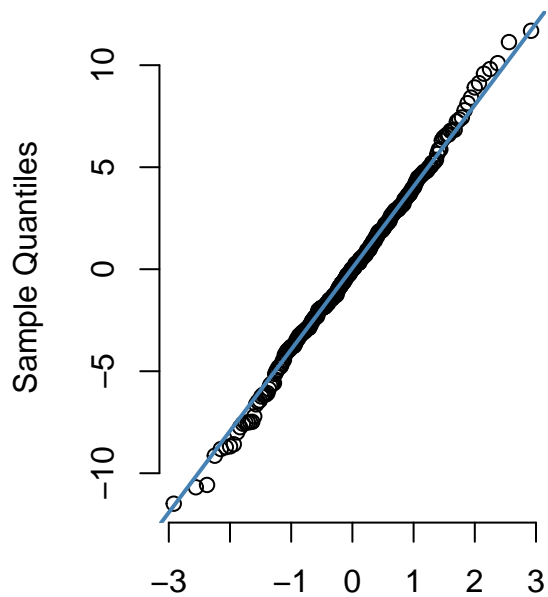
```

par(mfrow = c(1, 2))
# examine normality for eta0 (class-level)
eta0_fit1 <- blups_fit1$classid:schoolid`$(Intercept)`
qqnorm(eta0_fit1, pch = 1, frame = FALSE, main = "Normal Q-Q plot for eta0")
qqline(eta0_fit1, col = "steelblue", lwd = 2)

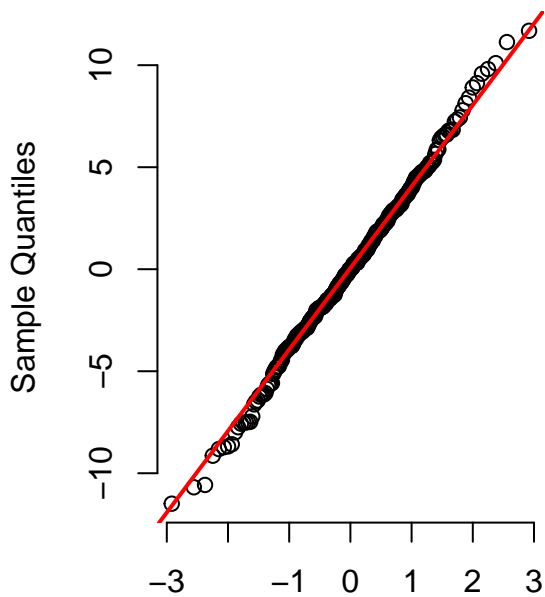
# examine normality for zeta0 (school-level)
zeta0_fit1 <- blups_fit1$classid:schoolid`$(Intercept)`
qqnorm(zeta0_fit1, pch = 1, frame = FALSE, main = "Normal Q-Q plot for zeta0")
qqline(zeta0_fit1, col = "red", lwd = 2)

```

**Normal Q-Q plot for eta0**



**Normal Q-Q plot for zeta0**



```

par(mfrow = c(1, 1))

```

QQ plot shows that both sets of BLUPs of zeta0 and eta0 are around the line, and thus we believe the normality assumption holds.

### Question 3