2015 Q1

codename

```
library(nlme)
library(car)
library(gmodels)
library(cfcdae)
library(dplyr)
library(mgcv)
```

(a)

```
### Data Preprocessing
d <- read.table('fev1.txt', header = T)
d <- within(d, {
  grp <- as.factor(grp)
  gender <- as.factor(gender)
  fev1.chg <- fev1 - fev1.0
})
d <- d %>% filter(year != 0)

### Simple estimate of treatment effect without adjustment to other covariates
ma.lme <- lme(fev1.chg ~ grp, random = ~ 1|ID, data = d)
Anova(ma.lme)
```

```
## Analysis of Deviance Table (Type II tests)
##
## Response: fev1.chg
##      Chisq Df Pr(>Chisq)
## grp 17.764  3   0.000492 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
coeff.matrix <- rbind("1 vs 2" = c(1, -1, 0, 0),
                      "1 vs 3" = c(1, 0, -1, 0),
                      "1 vs 4" = c(1, 0, 0, -1))
fit.contrast(ma.lme, "grp", coeff = coeff.matrix, conf.int = 1 - (0.05/3))
```

```
##             Estimate Std. Error   t-value     Pr(>|t|)     lower CI  upper CI
## grp1 vs 2 0.51448507  0.1389639 3.7022917 0.0002421447  0.180470170 0.8485000
## grp1 vs 3 0.32508532  0.1385313 2.3466566 0.0194065343 -0.007889595 0.6580602
## grp1 vs 4 0.05572438  0.1403292 0.3970976 0.6914972345 -0.281572038 0.3930208
## attr(,"class")
## [1] "fit_contrast"
```

(b)

```
getVarCov(ma.lme, type = "random.effects")
```

```
## Random effects variance covariance matrix
##             (Intercept)
## (Intercept)      0.7912
##   Standard Deviations: 0.88949
```

```
getVarCov(ma.lme, individuals = "1", type = "conditional")
```

```
## ID 1
## Conditional variance covariance matrix
##         1       2       3
## 1 0.83885 0.00000 0.00000
## 2 0.00000 0.83885 0.00000
## 3 0.00000 0.00000 0.83885
##   Standard Deviations: 0.91589 0.91589 0.91589
```

(c)

```
mc.lme1 <- lme(fev1.chg ~ (grp + I(age - 60) + I((age - 60)^2) +
                           gender + smoking + bpmeds + fev1.0)^2 + year,
               random = ~ year|ID, data = d)
Anova(mc.lme1)
```

```
...
##                                Chisq Df Pr(>Chisq)
## grp                          57.6134  3  1.901e-12 ***
## I(age - 60)                   1.5030  1    0.22022
## I((age - 60)^2)               0.0368  1    0.84797
## gender                        0.0774  1    0.78089
## smoking                       0.0053  1    0.94213
## bpmeds                        0.1743  1    0.67636
## fev1.0                     1202.5442  1  < 2.2e-16 ***
## year                          6.4525  1    0.01108 *
## grp:I(age - 60)              10.1911  3    0.01701 *
## gender:fev1.0                 0.4030  1    0.52552
## smoking:bpmeds                4.4114  1    0.03570 *
## smoking:fev1.0                1.7426  1    0.18681
...
```

```
mc.lme2 <- update(mc.lme1, method = "ML")
mc.lme3 <- update(mc.lme2, fixed = fev1.chg ~ grp * I(age - 60) + fev1.0 +
                    year + smoking * bpmeds)
anova(mc.lme2, mc.lme3)
```

```
##         Model df      AIC      BIC    logLik   Test L.Ratio p-value
## mc.lme2     1 48 3992.080 4246.632 -1948.040
## mc.lme3     2 17 3959.192 4049.346 -1962.596 1 vs 2 29.1121  0.5634
```

```
mc.lme4 <- update(mc.lme3, method = "REML")
mc.lme5 <- update(mc.lme4, random = ~ 1|ID)
anova(mc.lme4, mc.lme5)
```

```
##         Model df      AIC      BIC    logLik   Test      L.Ratio p-value
## mc.lme4     1 17 4036.132 4126.137 -2001.066
## mc.lme5     2 15 4032.132 4111.548 -2001.066 1 vs 2 1.897006e-07       1
```

```
Anova(mc.lme5)
```

```
## Analysis of Deviance Table (Type II tests)
##
## Response: fev1.chg
##                     Chisq Df Pr(>Chisq)
```

```
## grp               65.3512  3  4.219e-14 ***
## I(age - 60)        2.4778  1   0.115463
## fev1.0          1322.7572  1  < 2.2e-16 ***
## year               6.5178  1   0.010680 *
## smoking            0.1656  1   0.684057
## bpmeds             0.5744  1   0.448530
## grp:I(age - 60)    9.3300  3   0.025210 *
## smoking:bpmeds    10.4865  1   0.001202 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
d <- within(d, {
  dose <- as.ordered(dose)
})
mc.lme6 <- lme(fev1.chg ~ dose * I(age - 60) + fev1.0 + year +
                smoking * bpmeds, random = ~ 1|ID, data = d)
```

```
summary(mc.lme6)
```

```
...
## Fixed effects: fev1.chg ~ dose * I(age - 60) + fev1.0 + year + smoking * bpmeds
##                          Value  Std.Error   DF   t-value p-value
## (Intercept)          2.7685307 0.10771155 1060  25.70319  0.0000
## dose.L               0.1183948 0.04850057  412   2.44110  0.0151
## dose.Q               0.1900586 0.04932388  412   3.85328  0.0001
## dose.C              -0.3125340 0.04938725  412  -6.32823  0.0000
## I(age - 60)         -0.0071003 0.00420450  412  -1.68875  0.0920
## fev1.0              -1.0062925 0.02766841  412 -36.36973  0.0000
## year                -0.0586302 0.02296525 1060  -2.55300  0.0108
## smoking              0.1420019 0.06898850  412   2.05834  0.0402
## bpmeds               0.2007069 0.07271454  412   2.76020  0.0060
## dose.L:I(age - 60) -0.0182902 0.00737097  412  -2.48138  0.0135
## dose.Q:I(age - 60)  0.0108024 0.00725328  412   1.48931  0.1372
## dose.C:I(age - 60)  0.0045118 0.00708608  412   0.63671  0.5247
## smoking:bpmeds      -0.3138557 0.09692011  412  -3.23829  0.0013
...
```

```
d <- within(d, {
  dose <- as.numeric(dose)
})
mc.lme7 <- lme(fev1.chg ~ dose + I(dose^2) + I(dose^3) + smoking * bpmeds +
                 fev1.0 + year, random = ~ 1|ID, data = d)
Anova(mc.lme7)
```

```
## Analysis of Deviance Table (Type II tests)
##
## Response: fev1.chg
##                     Chisq Df Pr(>Chisq)
## dose              51.9470  1  5.702e-13 ***
## I(dose^2)         47.5565  1  5.344e-12 ***
## I(dose^3)         42.4957  1  7.084e-11 ***
## smoking            0.3056  1   0.580406
## bpmeds             0.0636  1   0.800886
## fev1.0          1362.3180  1  < 2.2e-16 ***
## year               6.7056  1   0.009611 **
## smoking:bpmeds     8.4462  1   0.003658 **
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary(mc.lme7)
```

```
...
## Linear mixed-effects model fit by REML
##  Data: d
##        AIC      BIC    logLik
##   4003.555 4061.823 -1990.778
##
## Random effects:
##  Formula: ~1 | ID
##          (Intercept)  Residual
## StdDev: 0.0002173172 0.9136655
##
## Fixed effects: fev1.chg ~ dose + I(dose^2) + I(dose^3) + smoking * bpmeds +      fev1.0 + year
##                    Value Std.Error   DF   t-value p-value
## (Intercept)     5.613466 0.4111610 1060  13.65272  0.0000
## dose           -4.357695 0.6046119  416  -7.20742  0.0000
## I(dose^2)       1.844808 0.2675138  416   6.89612  0.0000
## I(dose^3)      -0.231858 0.0355672  416  -6.51887  0.0000
## smoking         0.116237 0.0684375  416   1.69845  0.0902
## bpmeds          0.143028 0.0657693  416   2.17469  0.0302
## fev1.0         -0.992214 0.0268823  416 -36.90959  0.0000
## year           -0.059612 0.0230206 1060  -2.58953  0.0097
## smoking:bpmeds -0.277222 0.0953889  416  -2.90623  0.0039
...
```

The effect of drug doesn't differ by age, gender, smoking status, use of blood pressure medication, or baseline level of FEV1. The effect of the drug does is cubic, not linear. ...

(d)

```
d2 <- d %>% filter(year == 1, grp %in% c(2, 4))
m.lm <- lm(fev1.chg ~ grp, data = d2)
summary(m.lm)$sigma
```

```
## [1] 1.31876
```

```
power.t.test(n = NULL, delta = 0.2, sd = 1.32, sig.level = 0.05, power = 0.8,
             type = "two.sample", alternative = "two.sided")
```

```
##
##      Two-sample t test power calculation
##
##               n = 684.7561
##           delta = 0.2
##              sd = 1.32
##       sig.level = 0.05
##           power = 0.8
##     alternative = two.sided
##
## NOTE: n is number in *each* group
```

Appendix

Figures

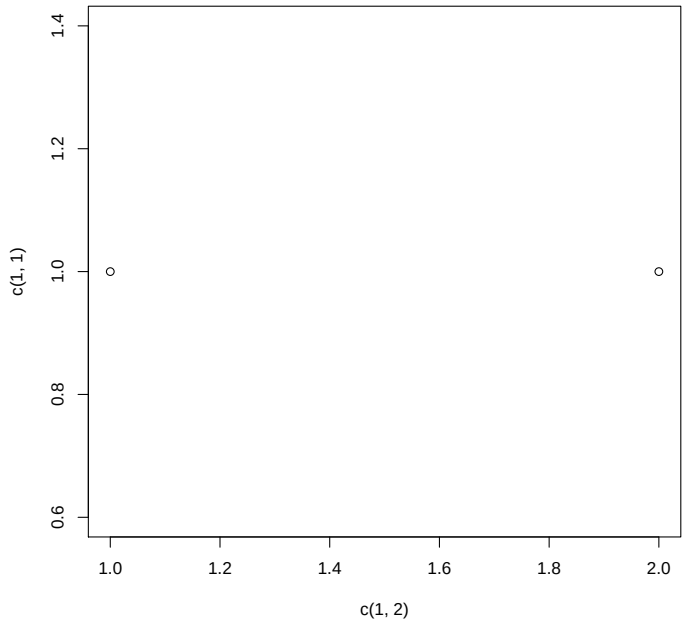

Figure 1: Scatter Plot Age vs. np.chg