P8131 HW7

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4/4/2022

Load packages

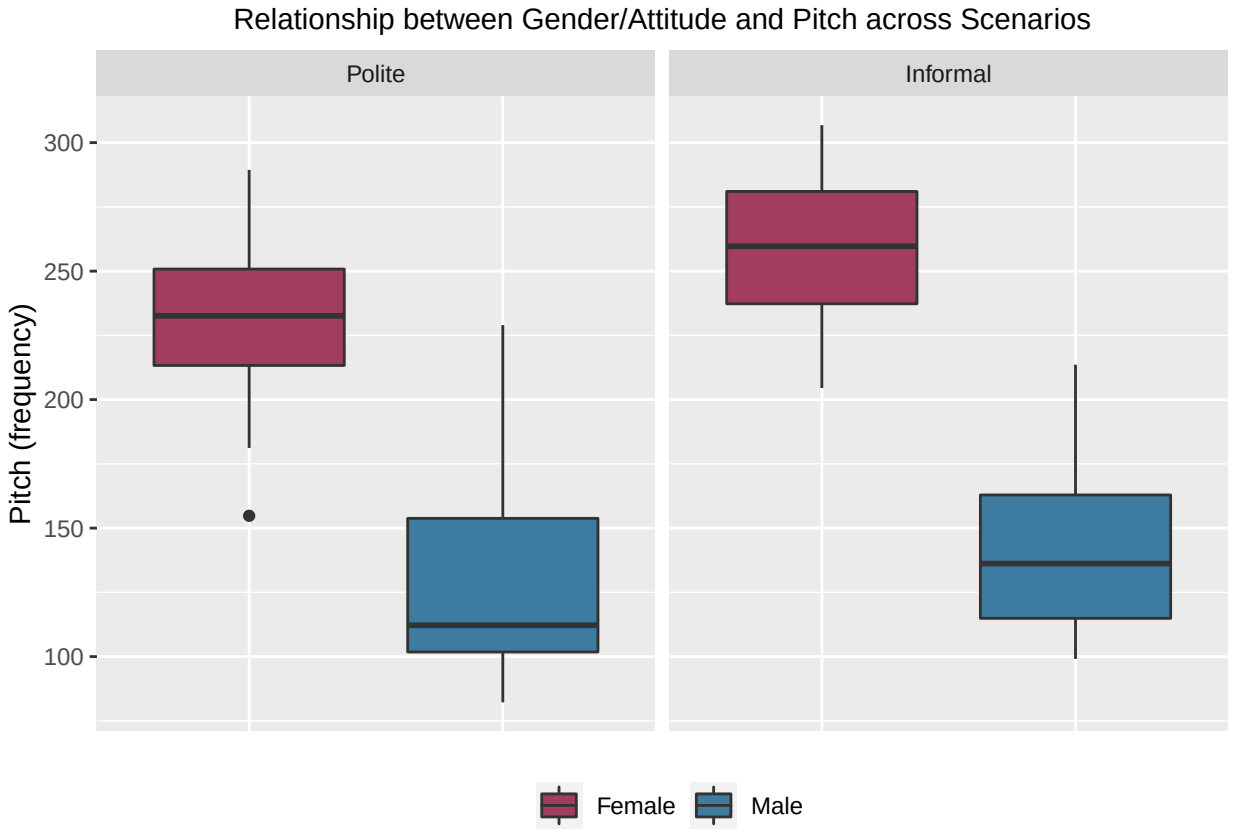
```
library(tidyverse)
library(knitr)
library(nlme)
library(lme4)
```

Import data

```
data = read_csv("HW7-politeness_data.csv", col_types = "ffffd")
```

a) **EDA**

```
data %>%
  mutate(
    attitude = factor(attitude, labels = c("Polite", "Informal"))
  ) %>%
  ggplot(aes(x = gender, y = frequency, fill = gender)) +
  geom_boxplot() +
  facet_grid(cols = vars(attitude)) +
  scale_fill_manual(labels = c("Female", "Male"), values = c("#A13E60", "#3E7BA1")) +
  labs(
    title = "Relationship between Gender/Attitude and Pitch across Scenarios",
    y = "Pitch (frequency)"
  ) +
  theme(
    plot.title = element_text(size = 11, hjust = 0.5),
    axis.title.x = element_blank(),
    axis.text.x = element_blank(),
    axis.ticks.x = element_blank(),
    legend.position = "bottom",
    legend.title = element_blank()
  )
```


Relationship between Gender/Attitude and Pitch across Scenarios
Polite
Informal
Pitch (frequency)
300
250
200
150
100
Female
Male

b) **Fit and interpret a random intercept model for the different subjects**

```
# fit a mixed effect model with random intercepts for different subjects
lmm1 = lme (frequency ~ gender + attitude, random = ~1 | subject, data = data, method ='ML')

# covariance matrix for a subject
rand_eff_var = as.double(VarCorr(lmm1)[1,1])
res_var = as.double(VarCorr(lmm1)[2,1])
cov_y =
  data.frame(
    cov = c("genderM", "attitudeinf"),
    genderM = c(rand_eff_var + res_var, rand_eff_var),
    attitudeinf = c(rand_eff_var, rand_eff_var + res_var)
  )

kable(cov_y, "simple")
```

cov	genderM	attitudeinf
genderM	1216.2266	379.3897
attitudeinf	379.3897	1216.2266

```
# covariance matrix for the estimates of fixed effects
kable(vcov(lmm1), "simple")
```

	(Intercept)	genderM	attitudeinf
(Intercept)	156.35027	-146.3879	-19.92469
genderM	-146.38793	292.7759	0.00000
attitudeinf	-19.92469	0.0000	39.84938

```
# # or alternatively ...
# lmm1$varFix

# BLUPs for subject-specific intercepts, which are the random effect coefficients
kable(random.effects(lmm1), "simple")
```

	(Intercept)
F1	-12.915173
F3	3.239592
M4	4.508689
M7	-31.108310
F2	9.675581
M3	26.599621

```
# residuals. do we show residuals in this way?
data$frequency-fitted(lmm1)
```

```
##           F1           F1           F1           F1           F1           F1
## -10.76935066 -39.57173161  61.03064934  15.62826839 -20.16935066  42.82826839
##           F1           F1           F1           F1           F1           F1
##  26.73064934  32.72826839   7.83064934   8.32826839 -42.86935066 -13.37173161
```

```
##           F1           F1           F3           F3           F3           F3
## -27.57173161 -69.26935066 -10.52411574 -22.92649669  -3.42411574  -9.22649669
##           F3           F3           F3           F3           F3           F3
##  26.77588426   5.77350331  35.17588426  46.57350331  -7.62411574  -7.72649669
##           F3           F3           F3           F3           M4           M4
## -13.72411574  18.57350331   4.17350331 -54.72411574 -21.99559397 -29.09797492
##           M4           M4           M4           M4           M4           M4
##  96.30440603 -37.79797492 -20.49559397  60.90202508  60.70440603  10.20202508
##           M4           M4           M4           M4           M4           M4
## -30.89559397 -25.79797492 -22.69559397 -16.49797492  -6.69797492  -6.19559397
##           M7           M7           M7           M7           M7           M7
## -10.97859473 -17.98097568 -14.87859473 -12.78097568 -11.17859473  -6.88097568
##           M7           M7           M7           M7           M7           M7
##   0.02140527   2.91902432  -3.37859473 -14.18097568  11.72140527  -8.88097568
##           M7           M7           F2           F2           F2           F2
##   7.31902432  10.52140527 -13.96010503 -35.36248598  -0.36010503  -6.96248598
##           F2           F2           F2           F2           F2           F2
##  42.73989497  35.13751402  -3.46010503  29.53751402  31.03989497  27.53751402
##           F2           F2           F2           F2           M3           M3
## -38.66010503 -40.76248598  14.33751402 -19.46010503  -0.98652558  14.01109346
##           M3           M3           M3           M3           M3           M3
## -12.38652558  24.91109346   5.41347442  11.31109346  52.71347442  16.11109346
##           M3           M3           M3           M3           M3           M3
##   5.91347442 -18.28890654  -8.08652558 -16.78890654 -13.68890654  -1.48652558
## attr(,"label")
## [1] "Fitted values"
```

c) **Fit a similar random intercept model - but with an interaction term - and compare it with the first model**

```
# fit a mixed effect model with random intercepts for different subjects with the first model
lmm2 = lme (frequency ~ gender * attitude, random = ~1 | subject, data = data, method ='ML')
lmm1_lmm2_pval = anova(lmm2,lmm1)[2, 9]
ifelse(lmm1_lmm2_pval < 0.05,
       "Reject the null hypothesis and suggest the new model with the interaction term has a better fit
       "Fail to reject the null hypothesis and suggest the inclusion of the interaction term does not i
```

```
## [1] "Fail to reject the null hypothesis and suggest the inclusion of the interaction term does not i
```

After comparing the 2 models using the likelihood ratio test, it is concluded that the interaction term for gender and attitude does not create a better fit for modeling pitch, and therefore it is not significantly associated with pitch.

d) **Fit and interpret a random intercept model for the different subjects and scenarios**

```
lmm3 = lmer(frequency ~ gender + attitude + (1 | subject) + (1 | scenario), data = data, REML = T)
VarCorr(lmm3)
```

```
##  Groups   Name        Std.Dev.
##  scenario (Intercept) 14.983
##  subject  (Intercept) 24.763
##  Residual             25.254
```