HW 07 Emalee Schuler

Objective

- 7.1 Differentiate between longitudinal non-longitudinal experiment design.
- 7.2 Evaluate the time dependency in the data by constructing a trajectory plot.
- 7.3 Interpret the time-dependancy using the a suitable mixed effect model.
- 7.4 Determine the relation of variables, time dependancy and predict an outcome by performing simple longitudinal data analysis in R.

Tasks

Perform the following analyses in R.

- Plot the trajectories of the subjects. Color each line according to the group variable.
- Fit a mixed effect model with a random intercept to examine whether the new agent is effective in reducing the blood lead level.
- Fit a mixed effect model with a random intercept and a random time variable to examine whether the new agent is effective in reducing the blood lead level.

Plotting Subject Trajectories

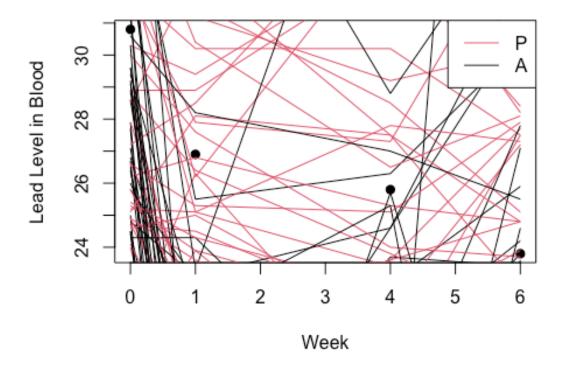
```
tlc.data <- read.table("~/Downloads/tlc-data.txt", quote="\"",
comment.char="")
head(tlc.data)
              ٧4
                   V5
 V1 V2
         V3
                        V6
1 1 P 30.8 26.9 25.8 23.8
2 2 A 26.5 14.8 19.5 21.0
3 3 A 25.8 23.0 19.1 23.2
4 4 P 24.7 24.5 22.0 22.5
5 5 A 20.4 2.8 3.2 9.4
6 6 A 20.4 5.4 4.5 11.9
colnames(tlc.data)<- c("ID", "Group","W0", "W1","W4", "W6")</pre>
head(tlc.data)
 ID Group
                 W1
            WØ
                      W4
                           W6
        P 30.8 26.9 25.8 23.8
1 1
2 2
        A 26.5 14.8 19.5 21.0
3 3
        A 25.8 23.0 19.1 23.2
4 4
        P 24.7 24.5 22.0 22.5
5 5
        A 20.4 2.8 3.2 9.4
        A 20.4 5.4 4.5 11.9
```

```
time <- c(0,1,4,6)
n<- dim(tlc.data)[1]

plot(time, as.numeric(tlc.data[1, -(1:2)]), type = 'p', pch=19, xlab= "Week",
ylab= "Lead Level in Blood")

for (i in 2:n) { lines(time, as.numeric(tlc.data[i, -(1:2)]), pch= 19,
col=as.factor(tlc.data$Group)[i])}

legend("topright", legend = unique(tlc.data$Group), col =
unique(as.factor(tlc.data$Group)), lty = 1)</pre>
```



Mixed Effect Model to Determine Efficacy (Random Intercept)

3 3 A W0 25.8 4 4 P W0 20.4 5 5 A W0 20.4 6 6 A W W0 20.4 7 7 P W0 28.6 8 8 P W0 33.7 9 9 P W0 31.1 11 11 P W0 19.8 12 12 A W0 24.8 13 13 P W0 21.4 14 14 A W0 27.9 15 15 P W0 21.1 16 16 P W0 20.6 17 17 P W0 24.0 18 18 P W0 35.3 19 19 A W0 35.3 19 19 A W0 35.3 20 20 A W0 25.8 21 21 P W0 31.9 22 22 A W0 29.6 23 23 A W0 21.5 24 24 P W0 26.2 25 25 A W0 21.8 26 26 A W0 22.0 27 27 A W0 22.2 28 28 P W0 20.5 29 29 A W0 25.0 30 30 P W0 33.3 31 31 A W0 25.0 30 30 P W0 33.3 31 31 A W0 26.0 32 32 A W0 19.7 33 33 P W0 24.7 35 35 P W0 28.8 39 39 A W0 24.7 35 35 P W0 28.8 39 39 A W0 24.7 35 35 P W0 24.4 40 40 A W0 33.7 41 41 P W0 24.9 42 42 P W0 26.8 43 43 A P W0 26.8 44 44 A W0 26.8 45 45 A W0 29.6 46 66 A W0 29.6 47 37 7 P W0 33.3 38 8 P W0 24.7 35 35 P W0 33.3 38 9 W0 24.7 35 35 P W0 28.8 39 39 A W0 24.7 35 35 P W0 28.8 39 39 A W0 24.7 35 35 P W0 28.8 39 39 A W0 24.4 40 40 A W0 33.7 41 41 P W0 24.9 42 42 P W0 26.8 43 43 A W0 26.8 44 44 A W0 26.8 45 45 A W0 26.8 46 66 P W0 26.8 47 47 P W0 26.8 48 48 A W0 26.8 49 49 A W0 26.5 50 50 P W0 26.1						
5 5 A W0 20.4 7 7 P W0 28.6 8 8 P W0 33.7 10 10 P W0 19.7 10 10 P W0 31.1 11 11 P W0 24.8 13 13 P W0 21.4 14 14 A W0 22.1 16 16 P W0 20.6 17 17 P W0 23.6 19 19 A W0 28.6 21 21 P W0 35.3 20 20 A W0 22.6 21 21 P W0 31.9 22 22 A W0 22.5 24 24 P W0 23.0 27 27 A W0 25.0						
6 6 A W0 20.4 7 P W0 33.7 9 9 P P W0 33.7 10 10 P W0 31.1 11 11 P W0 19.8 12 12 A W0 24.8 13 13 P W0 21.4 14 14 A W0 27.9 15 15 P W0 20.6 17 17 P W0 24.0 18 18 P W0 35.3 20 20 A W0 35.3 20 20 A W0 28.6 21 21 P W0 31.9 22 22 A W0 29.6 23 23 A W0 21.5 24 24 P W0 26.2 25 25 A W0 21.8 26 26 A W0 23.0 27 27 A W0 22.2 28 28 P W0 33.3 31 3 A W0 25.0 33 33 P W0 25.0 33 33 P W0 25.0 34 34 P W0 33.3 35 37 P W0 33.3 36 36 A W0 25.0 37 37 P W0 32.0 38 38 P W0 27.9 38 38 P W0 27.9 38 38 P W0 21.8 39 39 A W0 24.4 40 40 A W0 33.7 41 41 P W0 24.9 43 43 A W0 26.7 44 44 A W0 26.7 45 A W0 26.2 46 46 P W0 35.4 47 47 P W0 26.2 49 49 A W0 26.2 49 49 A W0 26.2 49 49 A W0 26.2 40 26.8 51 51 P W0 20.3 51 51 P W0 20.3						
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50 50 P W0 20.3 51 51 P W0 20.4						
51 51 P W0 20.4						
			Р			
52 52 P W0 24.1						
	52	52	Р	W0	24.1	

53	53	Α	WØ	27.1	
54	54	Α	W0	34.7	
55	55	Р	W0	28.5	
56	56	Р	W0	26.6	
57	57	Α	W0	24.5	
58	58	Р	W0	20.5	
59	59	Р	WØ	25.2	
60	60	Р	WØ	34.7	
61	61	Р	W0	30.3	
62	62	Р	WØ	26.6	
63	63	Р	W0	20.7	
64	64	Α	W0	27.7	
65	65	Α	W0	24.3	
66	66	Α	W0	36.6	
67	67	Р	WØ	28.9	
68	68	Α	WØ	34.0	
69	69	Α	WØ	32.6	
70	70	Α	WØ	29.2	
71	71	Α	WØ	26.4	
72	72	Α	WØ	21.8	
73	73	Р	WØ	27.2	
74	74	Р	WØ	22.4	
75	75	Р	WØ	32.5	
76	76	Р	WØ	24.9	
77	77	Р	WØ	24.6	
78	78	Р	WØ	23.1	
79	79	Α	WØ	21.1	
80	80	Р	WØ	25.8	
81	81	Р	WØ	30.0	
82	82	Α	WØ	22.1	
83	83	Р	WØ	20.0	
84	84	Р	WØ	38.1	
85	85	Α	WØ	28.9	
86	86	Р	WØ	25.1	
87	87	Α	WØ	19.8	
88	88	Р	WØ	22.1	
89	89	Α	WØ	23.5	
90	90	Α	WØ	29.1	
91	91	Α	WØ	30.3	
92	92	Р	WØ	25.4	
93	93	Α	WØ	30.6	
94	94	Α	WØ	22.4	
95	95	Α	WØ	31.2	
96	96	Α	WØ	31.4	
97	97	Α	WØ	41.1	
98	98	Α	WØ	29.4	
99	99	Α	WØ	21.9	
	100	Α	WØ	20.7	
lib	rary(1	me4)			

```
Loading required package: Matrix
Attaching package: 'Matrix'
The following objects are masked from 'package:tidyr':
    expand, pack, unpack
long.tlc.data2 <- separate(long.tlc.data, Week, sep = "(?<=[a-</pre>
zA=Z])\W^*(?=[0-9])", into = c("No use", "time"), fill = "left")
library(dplyr)
Attaching package: 'dplyr'
The following objects are masked from 'package:stats':
    filter, lag
The following objects are masked from 'package:base':
    intersect, setdiff, setequal, union
long.tlc.data3 <- long.tlc.data2 %>%
  mutate(time = case_when(time == 'W0' ~ 0, time == 'W1' ~ 1, time == 'W4' ~
4, time == 'W6' ~ 6, TRUE ~ as.numeric(time) ))
Warning: There was 1 warning in `mutate()`.
In argument: `time = case_when(...)`.
Caused by warning:
! NAs introduced by coercion
model1 = lmer(as.numeric(Blood_Level) ~ Group + as.numeric(time) + (1 | ID),
data= long.tlc.data3)
summary(model1)
Linear mixed model fit by REML ['lmerMod']
Formula: as.numeric(Blood Level) ~ Group + as.numeric(time) + (1 | ID)
   Data: long.tlc.data3
REML criterion at convergence: 2670.2
Scaled residuals:
            1Q Median
                            3Q
                                    Max
-2.4885 -0.3686 -0.0176 0.4514 6.3428
Random effects:
                     Variance Std.Dev.
Groups Name
```

```
(Intercept) 22.09
 ID
                               4.700
 Residual
                      33.98
                               5.829
Number of obs: 400, groups: ID, 100
Fixed effects:
                 Estimate Std. Error t value
(Intercept)
                  20.1872
                              0.8512 23.716
GroupP
                   5.5775
                              1.1060
                                       5.043
as.numeric(time) -0.4010
                              0.1222 -3.281
Correlation of Fixed Effects:
            (Intr) GroupP
GroupP
            -0.650
as.nmrc(tm) -0.395 0.000
confint(model1)
Computing profile confidence intervals ...
                      2.5 %
                                97.5 %
.sig01
                  3.7900871
                             5.6286877
.sigma
                  5.3828709 6.3177692
(Intercept)
                 18.5219859 21.8525141
GroupP
                  3.4108260 7.7441740
as.numeric(time) -0.6408891 -0.1611109
```

Mixed Effect Model to Determine Efficacy (Random Intercept & Random Time)

```
model2= lmer(as.numeric(Blood Level) ~ Group + as.numeric(time) + (1+
as.numeric(time) | ID), data = long.tlc.data3)
summary(model2)
Linear mixed model fit by REML ['lmerMod']
Formula:
as.numeric(Blood_Level) ~ Group + as.numeric(time) + (1 + as.numeric(time) |
    ID)
   Data: long.tlc.data3
REML criterion at convergence: 2664.4
Scaled residuals:
    Min
             1Q Median
                             3Q
                                    Max
-2.6833 -0.3869 -0.0118 0.4731 5.8022
Random effects:
 Groups
          Name
                           Variance Std.Dev. Corr
          (Intercept)
 ID
                           14.93750 3.8649
          as.numeric(time) 0.09966 0.3157
                                             1.00
 Residual
                           33.08488 5.7519
Number of obs: 400, groups: ID, 100
```

```
Fixed effects:
                Estimate Std. Error t value
                           0.7965 25.379
(Intercept)
                 20.2150
GroupP
                  5.5220
                             1.0814 5.106
as.numeric(time) -0.4010
                           0.1247 -3.217
Correlation of Fixed Effects:
           (Intr) GroupP
GroupP
           -0.679
as.nmrc(tm) -0.280 0.000
optimizer (nloptwrap) convergence code: 0 (OK)
boundary (singular) fit: see help('isSingular')
confint(model2)
                     2.5 %
                             97.5 %
.sig01
                        NA
                                   NA
.sig02
                        NA
                                   NA
                                   NA
.sig03
                        NA
.sigma
                        NA
                                   NA
(Intercept)
                18.6538462 21.7746958
GroupP
                 3.4027686 7.6413828
as.numeric(time) -0.6458739 -0.1561261
```