

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)
```

	V1	V2	V3	V4	V5	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")
```

```
head(tlc.data)
```

	ID	Group	W0	W1	W4	W6
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

```

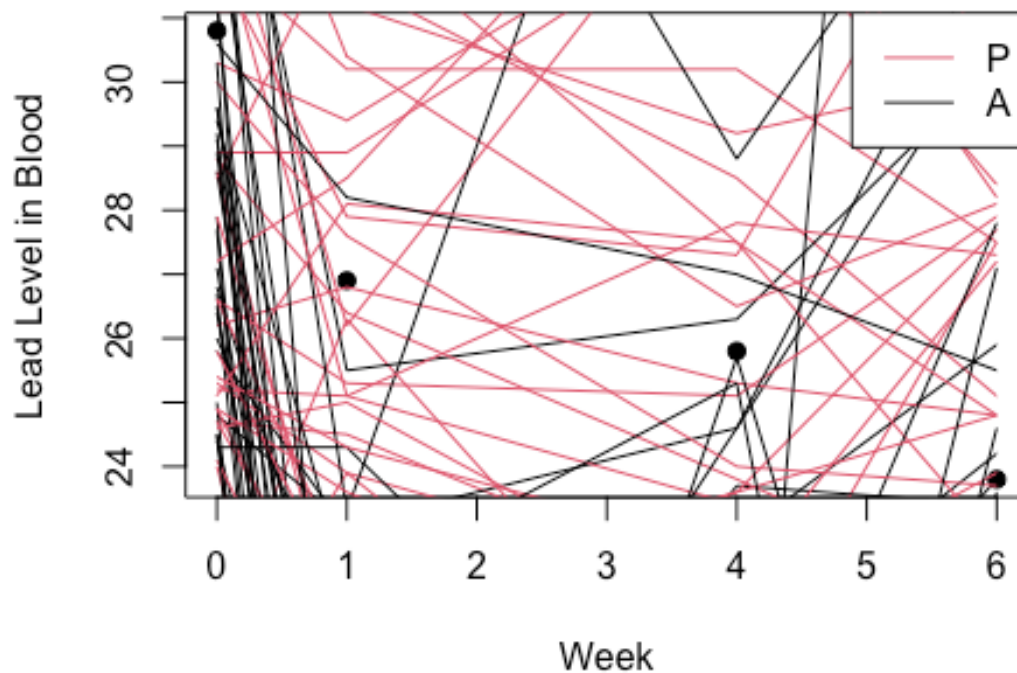
time <- c(0,1,4,6)
n<- dim(tlc.data)[1]

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)

```



Mixed Effect Model to Determine Efficacy (Random Intercept)

```

library(tidyr)

long.tlc.data <- tlc.data %>% gather(Week, Blood_Level, W0, W1, W4, W6)

head(long.tlc.data,100)

```

	ID	Group	Week	Blood_Level
1	1	P	W0	30.8
2	2	A	W0	26.5

3	3	A	W0	25.8
4	4	P	W0	24.7
5	5	A	W0	20.4
6	6	A	W0	20.4
7	7	P	W0	28.6
8	8	P	W0	33.7
9	9	P	W0	19.7
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	21.1
16	16	P	W0	20.6
17	17	P	W0	24.0
18	18	P	W0	37.6
19	19	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	20.5
29	29	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	27.9
34	34	P	W0	24.7
35	35	P	W0	28.8
36	36	A	W0	29.6
37	37	P	W0	32.0
38	38	P	W0	21.8
39	39	A	W0	24.4
40	40	A	W0	33.7
41	41	P	W0	24.9
42	42	P	W0	19.8
43	43	A	W0	26.7
44	44	A	W0	26.8
45	45	A	W0	20.2
46	46	P	W0	35.4
47	47	P	W0	25.3
48	48	A	W0	20.2
49	49	A	W0	24.5
50	50	P	W0	20.3
51	51	P	W0	20.4
52	52	P	W0	24.1

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

`library(lme4)`

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-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:

Min	1Q	Median	3Q	Max
-2.4885	-0.3686	-0.0176	0.4514	6.3428

Random effects:

Groups	Name	Variance	Std.Dev.
--------	------	----------	----------

```
ID      (Intercept) 22.09    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
ID	(Intercept)	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
(Intercept)	20.2150	0.7965	25.379
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
.sig03	NA	NA
.sigma	NA	NA
(Intercept)	18.6538462	21.7746958
GroupP	3.4027686	7.6413828
as.numeric(time)	-0.6458739	-0.1561261