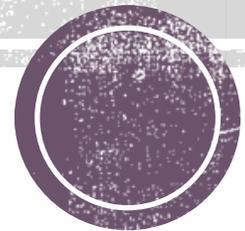


Face Description and CMC

- Mixed Effects Logistic Regression

Guanghao You



Fixed Effects

- Deletes
- Typing Time
- Number of Turns
- ~~Number of Total Trials~~



Random Effects

- Variability
 - **Subject** – Participants
 - Language capacity – **Intercept**
 - Deletes (typing behavior) – **Random slope**
 - **Item** - Faces (Images)
 - Easy/difficult – **Intercept**
 - Salient/Neutral (number of turns) – **Random slope**



Pre-processing

- Centering
 - Subtracted by mean
 - Avoid a spurious correlation (between slope and intercept)
- Rescaling
 - Typing Time in unit (ms) – WARNING: huge!



Basic Model – Trial I

```
Formula: my.data.SuccessofTrial ~ my.data.DeletesPerTrial + my.data.TypingTimePerTrial +  
my.data.NumberOfTextTurnsPerTrial + (1 | my.data.DyadID) + (1 | my.data.TrialNo)  
Data: face.data
```

AIC	BIC	logLik	deviance	df.resid
225.5	245.4	-106.8	213.5	196

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.3368	-0.5691	0.3302	0.5274	3.2988

Random effects:

Groups	Name	Variance	Std.Dev.
my.data.DyadID	(Intercept)	0.759	0.8712
my.data.TrialNo	(Intercept)	1.003	1.0015

Number of obs: 202, groups: my.data.DyadID, 16; my.data.TrialNo, 13

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)	
(Intercept)	1.2899	0.4198	3.073	0.00212	**
my.data.DeletesPerTrial	0.6897	0.2964	2.327	0.01995	*
my.data.TypingTimePerTrial	-0.1132	0.3018	-0.375	0.70747	
my.data.NumberOfTextTurnsPerTrial	-0.4954	0.3122	-1.587	0.11252	



Basic Model – Trial II

```
Formula: my.data.SuccessOfTrial ~ my.data.DeletesPerTrial + my.data.NumberOfTextTurnsPerTrial +  
  (1 | my.data.DyadID) + (1 | my.data.TrialNo)  
Data: face.data
```

AIC	BIC	logLik	deviance	df.resid
223.7	240.2	-106.8	213.7	197

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.3371	-0.5934	0.3246	0.5154	2.7007

Random effects:

Groups	Name	Variance	Std.Dev.
my.data.DyadID	(Intercept)	0.7796	0.8829
my.data.TrialNo	(Intercept)	1.0950	1.0464

Number of obs: 202, groups: my.data.DyadID, 16; my.data.TrialNo, 13

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)	
(Intercept)	1.3017	0.4221	3.084	0.00204	**
my.data.DeletesPerTrial	0.6596	0.2812	2.345	0.01900	*
my.data.NumberOfTextTurnsPerTrial	-0.5335	0.2888	-1.847	0.06469	.



Add Random Slope – Trial I

```
Formula: my.data.SuccessofTrial ~ my.data.DeletesPerTrial + my.data.NumberOfTextTurnsPerTrial +  
  (1 | my.data.DyadID) + (0 + my.data.DeletesPerTrial | my.data.DyadID) +  
  (1 | my.data.TrialNo)  
Data: face.data
```

AIC	BIC	logLik	deviance	df.resid
223.2	243.1	-105.6	211.2	196

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.3784	-0.5723	0.3019	0.5000	2.9131

Random effects:

Groups	Name	Variance	Std.Dev.
my.data.DyadID	(Intercept)	0.6492	0.8057
my.data.DyadID.1	my.data.DeletesPerTrial	0.5685	0.7540
my.data.TrialNo	(Intercept)	1.1711	1.0822

Number of obs: 202, groups: my.data.DyadID, 16; my.data.TrialNo, 13

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	1.3839	0.4429	3.125	0.00178 **
my.data.DeletesPerTrial	0.9316	0.4098	2.273	0.02300 *
my.data.NumberOfTextTurnsPerTrial	-0.5510	0.2999	-1.837	0.06621 .



Add Random Slope – Trial II

```
Formula: my.data.SuccessOfTrial ~ my.data.DeletesPerTrial + my.data.NumberOfTextTurnsPerTrial +  
  (1 | my.data.DyadID) + (0 + my.data.NumberOfTextTurnsPerTrial |  
  my.data.DyadID) + (1 | my.data.TrialNo)  
Data: face.data
```

AIC	BIC	logLik	deviance	df.resid
222.3	242.1	-105.1	210.3	196

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.4306	-0.5646	0.3346	0.5151	1.5950

Random effects:

Groups	Name	Variance	Std.Dev.
my.data.DyadID	(Intercept)	0.313	0.5595
my.data.DyadID.1	my.data.NumberOfTextTurnsPerTrial	0.676	0.8222
my.data.TrialNo	(Intercept)	1.158	1.0761

Number of obs: 202, groups: my.data.DyadID, 16; my.data.TrialNo, 13

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)	
(Intercept)	1.3513	0.4164	3.245	0.00117	**
my.data.DeletesPerTrial	0.8096	0.3265	2.479	0.01316	*
my.data.NumberOfTextTurnsPerTrial	-0.5436	0.3901	-1.393	0.16352	



Correlation?

```
Formula: my.data.SuccessOfTrial ~ my.data.DeletesPerTrial + my.data.NumberOfTextTurnsPerTrial +  
  (1 + my.data.NumberOfTextTurnsPerTrial | my.data.DyadID) +      (1 | my.data.TrialNo)  
Data: face.data
```

```
      AIC      BIC  logLik deviance df.resid  
224.0    247.1  -105.0   210.0     195
```

Scaled residuals:

```
      Min      1Q  Median      3Q      Max  
-2.4796 -0.5614  0.3407  0.5021  1.6533
```

Random effects:

```
Groups          Name              Variance Std.Dev. Corr  
my.data.DyadID  (Intercept)              0.3455  0.5878  
                my.data.NumberOfTextTurnsPerTrial 0.6029  0.7764  0.39  
my.data.TrialNo (Intercept)              1.1461  1.0706  
Number of obs: 202, groups: my.data.DyadID, 16; my.data.TrialNo, 13
```

Fixed effects:

```
              Estimate Std. Error z value Pr(>|z|)  
(Intercept)      1.3298    0.4180   3.181  0.00147 **  
my.data.DeletesPerTrial  0.8324    0.3290   2.530  0.01140 *  
my.data.NumberOfTextTurnsPerTrial -0.5226    0.3907  -1.338  0.18104
```



Correlation?

```
Formula: my.data.SuccessofTrial ~ my.data.DeletesPerTrial + my.data.NumberOfTextTurnsPerTrial +  
  (1 + my.data.DeletesPerTrial | my.data.DyadID) + (1 | my.data.TrialNo)  
Data: face.data
```

```
      AIC      BIC   logLik deviance df.resid  
222.1    245.2   -104.0    208.1     195
```

Scaled residuals:

```
      Min       1Q   Median       3Q      Max  
-2.4650 -0.5665  0.3151  0.5060  2.2756
```

Random effects:

```
Groups          Name                Variance Std.Dev. Corr  
my.data.DyadID  (Intercept)                0.6562   0.8101  
                my.data.DeletesPerTrial 0.8450   0.9193  0.92  
my.data.TrialNo (Intercept)                1.1294   1.0627
```

Number of obs: 202, groups: my.data.DyadID, 16; my.data.TrialNo, 13

Fixed effects:

```
                Estimate Std. Error z value Pr(>|z|)  
(Intercept)      1.3824    0.4454   3.104  0.00191 **  
my.data.DeletesPerTrial  1.0401    0.4578   2.272  0.02310 *  
my.data.NumberOfTextTurnsPerTrial -0.4149    0.3010  -1.378  0.16812
```



Does centering help?

```
Formula: my.data.SuccessofTrial ~ my.data.DeletesPerTrial + my.data.NumberOfTextTurnsPerTrial +  
  (1 + my.data.DeletesPerTrial | my.data.DyadID) + (1 | my.data.TrialNo)  
Data: comp.data
```

```
      AIC      BIC    logLik deviance df.resid  
222.1    245.2   -104.0    208.1     195
```

Scaled residuals:

```
      Min      1Q   Median      3Q      Max  
-2.4650 -0.5665  0.3151  0.5060  2.2756
```

Correlation is different though...

Random effects:

```
Groups          Name              Variance Std.Dev. Corr  
my.data.DyadID (Intercept)         0.1261  0.3551  
                my.data.DeletesPerTrial 1.6792  1.2958  -0.46  
my.data.TrialNo (Intercept)         1.1294  1.0627
```

Number of obs: 202, groups: my.data.DyadID, 16; my.data.TrialNo, 13

Fixed effects:

```
                Estimate Std. Error z value Pr(>|z|)  
(Intercept)         0.9115    0.4993   1.825   0.0679 .  
my.data.DeletesPerTrial  1.4661    0.6453   2.272   0.0231 *  
my.data.NumberOfTextTurnsPerTrial -0.6980    0.5064  -1.378   0.1681
```



More Correlation

```
Formula: my.data.SuccessOfTrial ~ my.data.DeletesPerTrial + my.data.NumberOfTextTurnsPerTrial +
(1 + my.data.DeletesPerTrial | my.data.DyadID) + (1 + my.data.NumberOfTextTurnsPerTrial |
my.data.TrialNo)
Data: face.data
```

```
      AIC      BIC  logLik deviance df.resid
 222.2   252.0  -102.1   204.2     193
```

Scaled residuals:

```
      Min      1Q  Median      3Q      Max
-2.6110 -0.4944  0.2841  0.4963  1.9207
```

Random effects:

Groups	Name	Variance	Std.Dev.	Corr
my.data.DyadID	(Intercept)	0.6987	0.8359	
	my.data.DeletesPerTrial	0.6436	0.8022	0.83
my.data.TrialNo	(Intercept)	1.1884	1.0901	
	my.data.NumberOfTextTurnsPerTrial	0.2725	0.5221	-1.00

Number of obs: 202, groups: my.data.DyadID, 16; my.data.TrialNo, 13

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	1.3632	0.4547	2.998	0.00272 **
my.data.DeletesPerTrial	0.9869	0.4651	2.122	0.03386 *
my.data.NumberOfTextTurnsPerTrial	-0.6695	0.3550	-1.886	0.05930 .



More Trials...

- ... (0 + Deletes + Turns | Dyad) + (1 | Dyad) ...
- ... (0 + Deletes * Turns | Dyad) + (1 | Dyad) ...
- ... (1 + Deletes * Turns | Dyad) ...
- ... (1 + Deletes | Dyad) + (0 + Turns | Dyad) ...
- ...
- ...
- All AICs were higher than previous ones

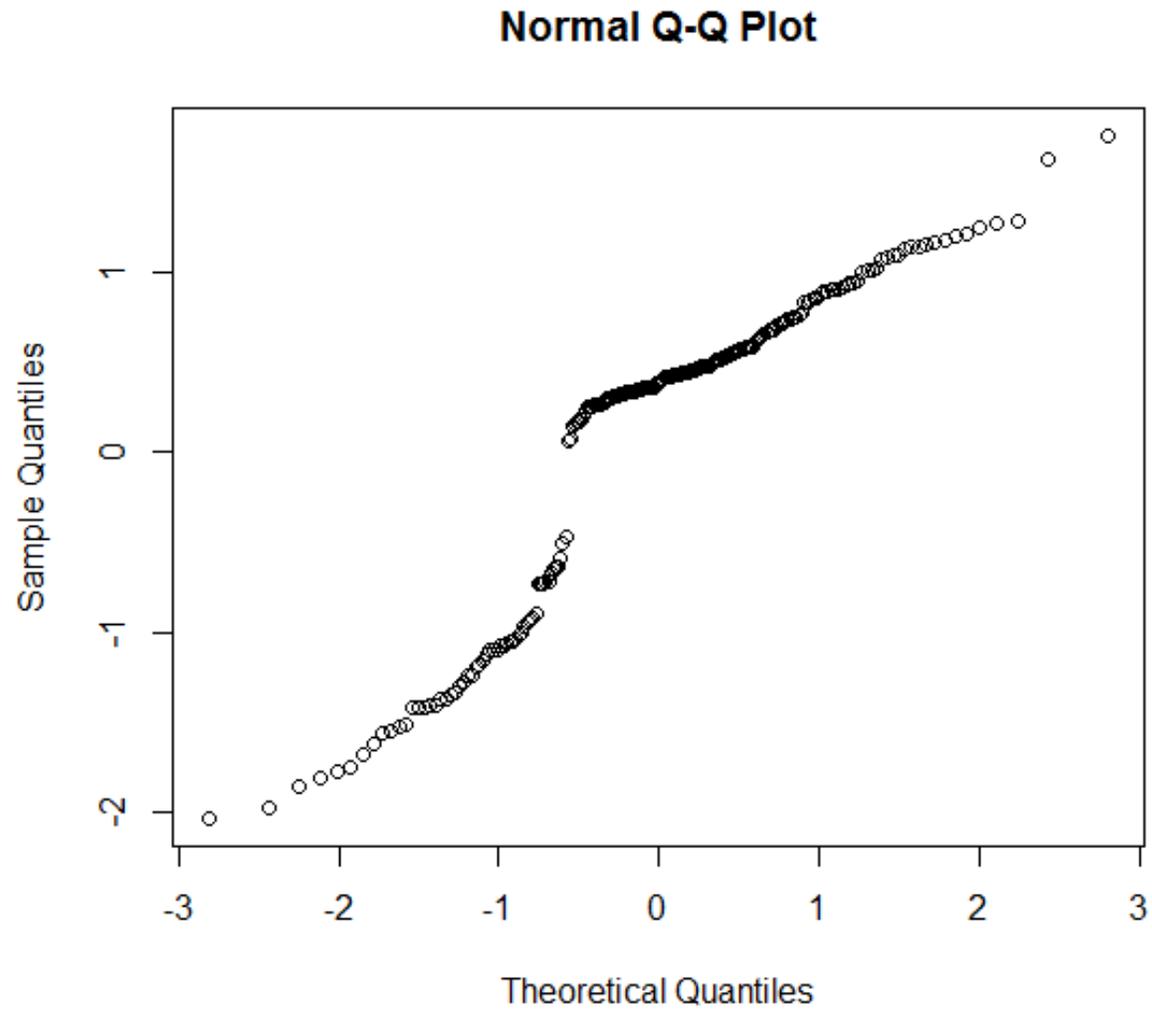


Best Model (?)

- Success \sim Deletes + Turns + (1 + Deletes | Dyad) + (1 + Turns| Face)
- Not quite yet – model criticism
 - Trim!



Trim!



The Trimmed Model

- 6 ‘outliers’ were discarded (3%)

Formula:

```
my.data.SuccessOfTrial ~ my.data.DeletesPerTrial + my.data.NumberOfTextTurnsPerTrial +  
  (1 + my.data.DeletesPerTrial | my.data.DyadID) + (1 + my.data.NumberOfTextTurnsPerTrial |  
  my.data.TrialNo)  
Data: trimmed.data
```

AIC	BIC	logLik	deviance	df.resid
191.4	220.9	-86.7	173.4	187

Scaled residuals:

Min	1Q	Median	3Q	Max
-1.8844	-0.3008	0.1733	0.3818	2.5741

Random effects:

Groups	Name	Variance	Std.Dev.	Corr
my.data.DyadID	(Intercept)	1.1978	1.0945	
	my.data.DeletesPerTrial	1.4297	1.1957	0.91
my.data.TrialNo	(Intercept)	2.6837	1.6382	
	my.data.NumberOfTextTurnsPerTrial	0.5869	0.7661	-1.00

Number of obs: 196, groups: my.data.DyadID, 16; my.data.TrialNo, 13

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	2.0277	0.6849	2.961	0.00307 **
my.data.DeletesPerTrial	1.3831	0.6526	2.119	0.03406 *
my.data.NumberOfTextTurnsPerTrial	-0.8501	0.4724	-1.800	0.07192 .



The Trimmed Model

- Comparison

- AIC

- The original model: 225.5
 - With random slope: 222.2
 - The trimmed: 191.4

- Improved fit

- The original model: 0.36970128
 - With random slope: 0.41799971
 - The trimmed: 0.51134736



Bootstrapping Sampling

```
bs.logr = confint(trimmed.model, method="boot", nsim=100, level =0.95)
```

	2.5 %	97.5 %
.sig01	0.08290903	2.48616337
.sig02	-0.80104389	1.00000000
.sig03	0.12422096	2.77711940
.sig04	0.36206041	3.32814093
.sig05	-1.00000000	0.09084085
.sig06	0.14430470	2.32085977
(Intercept)	0.73748654	5.51388810
my.data.DeletesPerTrial	0.36178490	3.67961122
my.data.NumberOfTextTurnsPerTrial	-2.50949160	-0.01031134



Conclusions

- More repairs (deletes) could significantly enhance game performance, namely the coordination in CMC.
- Coordination could also benefit from fewer turns, but less significantly.



Problem encountered

- Failed to converge?
 - Supervised learning
 - Optimizer: minimize the loss function
 - Might fail to find a meaningful minimization
 - Fail to build a model to depict the training data
 - Solution?
 - Default setting: 'Bobyqa' and 'Nelder_Mead' - one for preliminary optimization, and one for finalizing the work
 - Alternatively, try either one of them (or package 'optimx')



Thank you!

- Questions?

