

Functional ANOVA: Analyze Simulated Data Using JAGS

November 08, 2018

Simulate Three-Group One-Way Functional ANOVA Data

Three-group one-way functional ANOVA data were simulated using methods described in the paper “Fast Function-on-Scalar Regression with Penalized Basis Expansions” from Reiss et al:

$$\begin{aligned}y_i(t) &= \mu(t) + \beta_{gp(i)}(t) + \epsilon_i(t) \\ \mu(t) &= 0.4 \arctan(10t - 5) + 0.6 \\ \beta_1(t) &= -0.5e^{-10t} - 0.04 \sin(8t) - 0.3t + 0.5 \\ \beta_2(t) &= -(t - 0.5)^2 - 0.15 \sin(13t) \\ \beta_3(t) &= -\beta_1(t) - \beta_2(t)\end{aligned}$$

where $t = m/200$ for $m = 0, \dots, 200$ and the error functions, $\epsilon_i(t)$, were simulated from a mean-zero Gaussian process with covariance $V(s, t) = \sigma_1 0.15^{|s-t|} + \sigma_2 \delta_{st}$ where $\delta_{st} = 1$ if $s = t$ and 0 otherwise. For the simulations, $N=10$ curves were simulated for each of the 3 groups, $\sigma_1 = 0.15$, and $\sigma_2 = 0.05$. So, we have 6030 observations from 30 curves with 10 curves per group.

Figure 1: The true effect functions along with the simulated data.

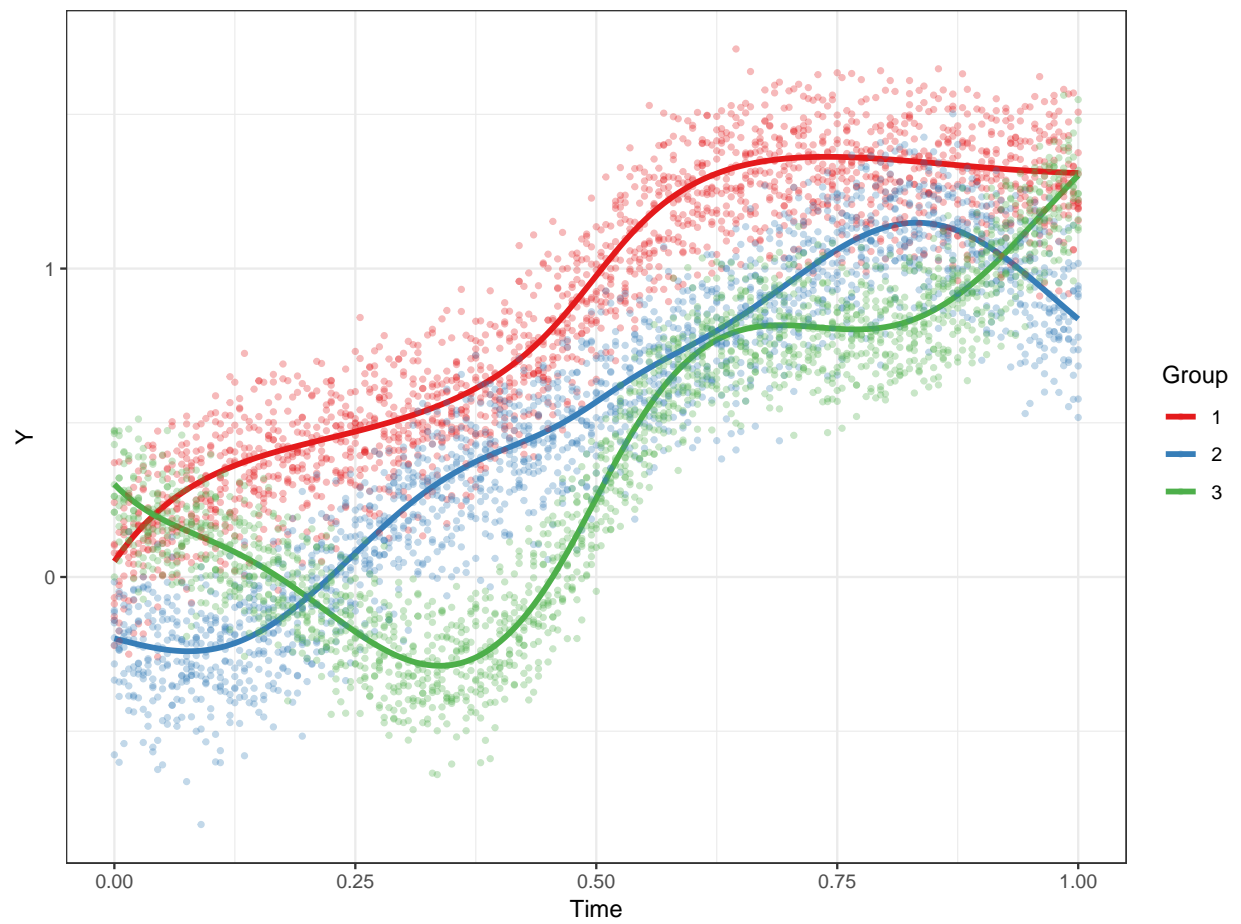


Figure 2: The smoothed subject-specific curves from the simulated data.

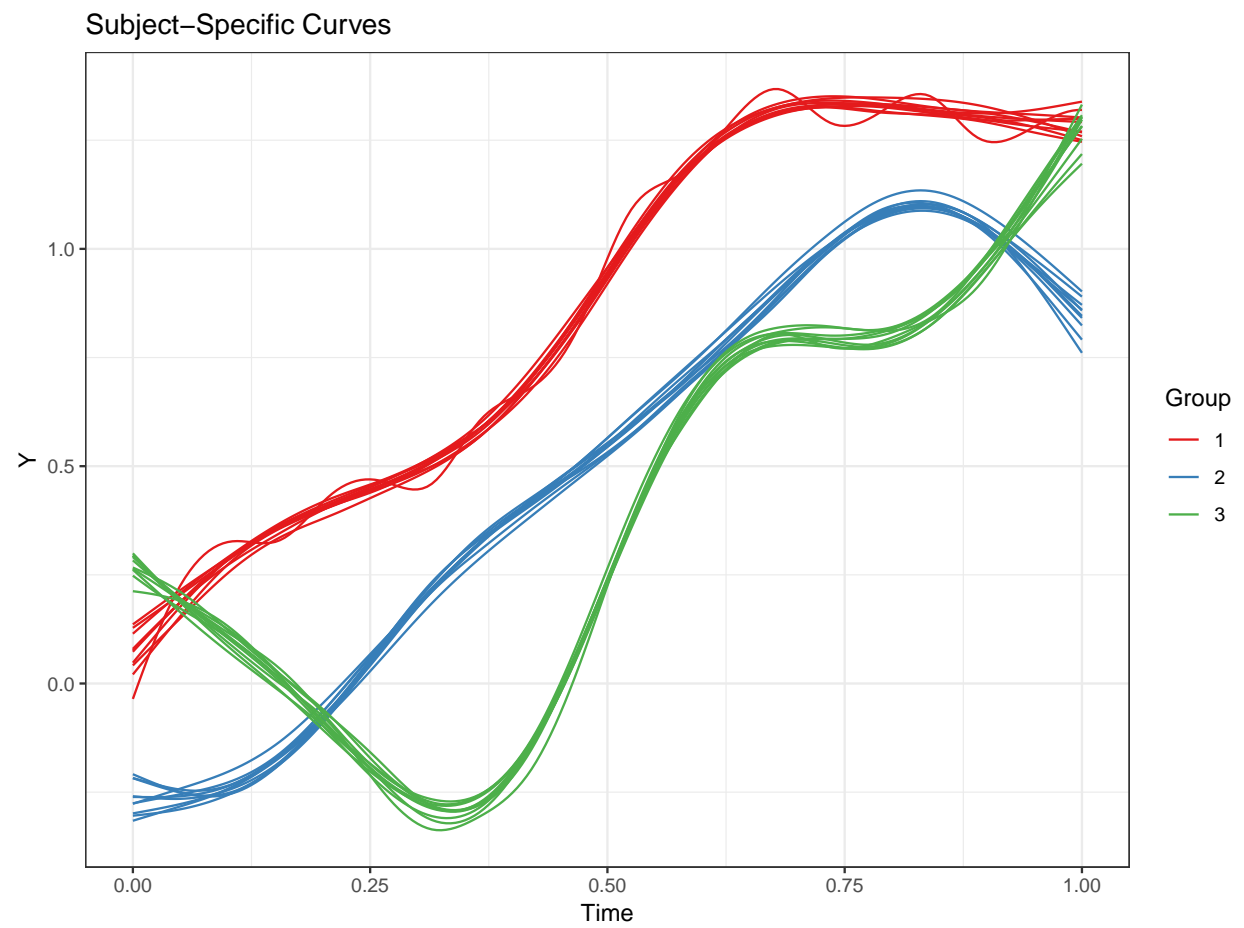
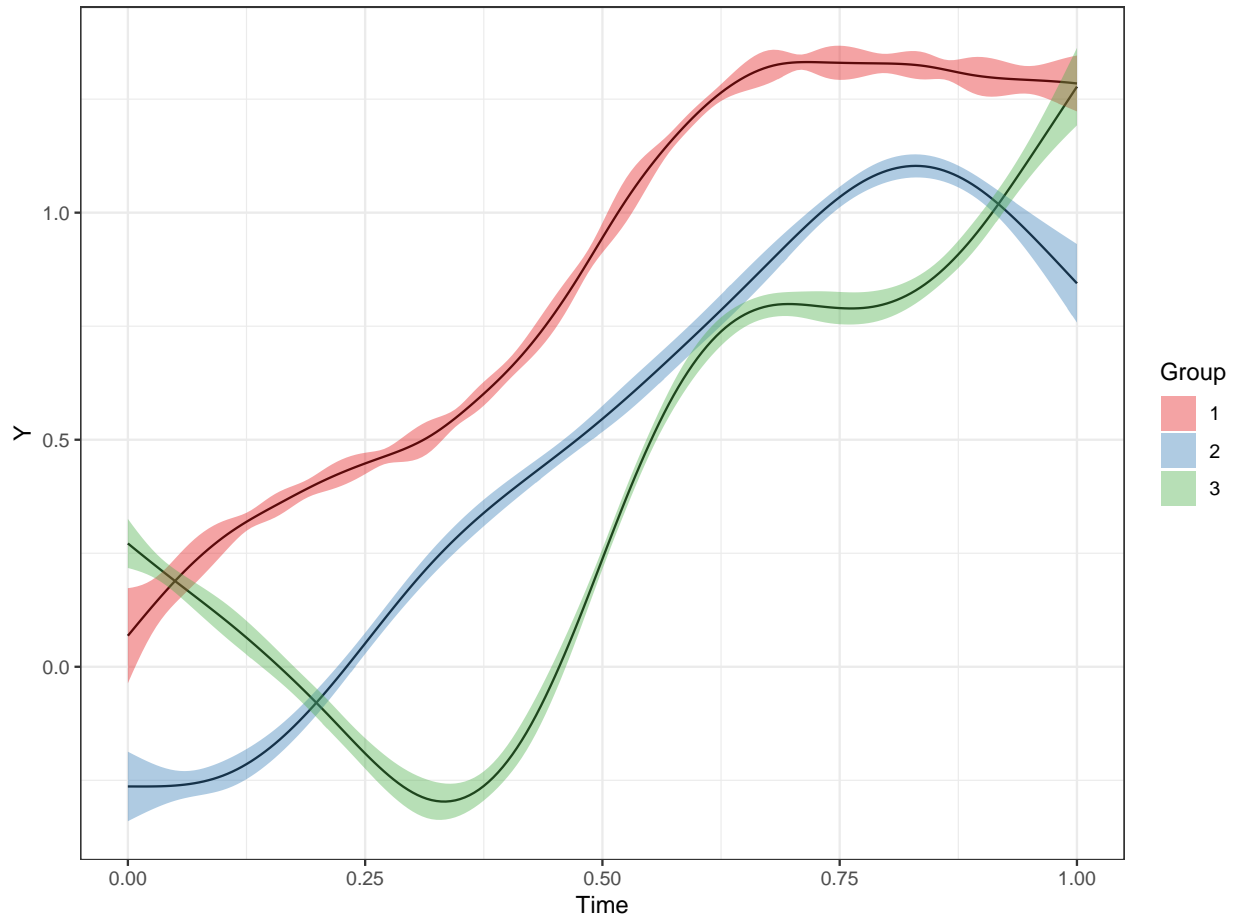
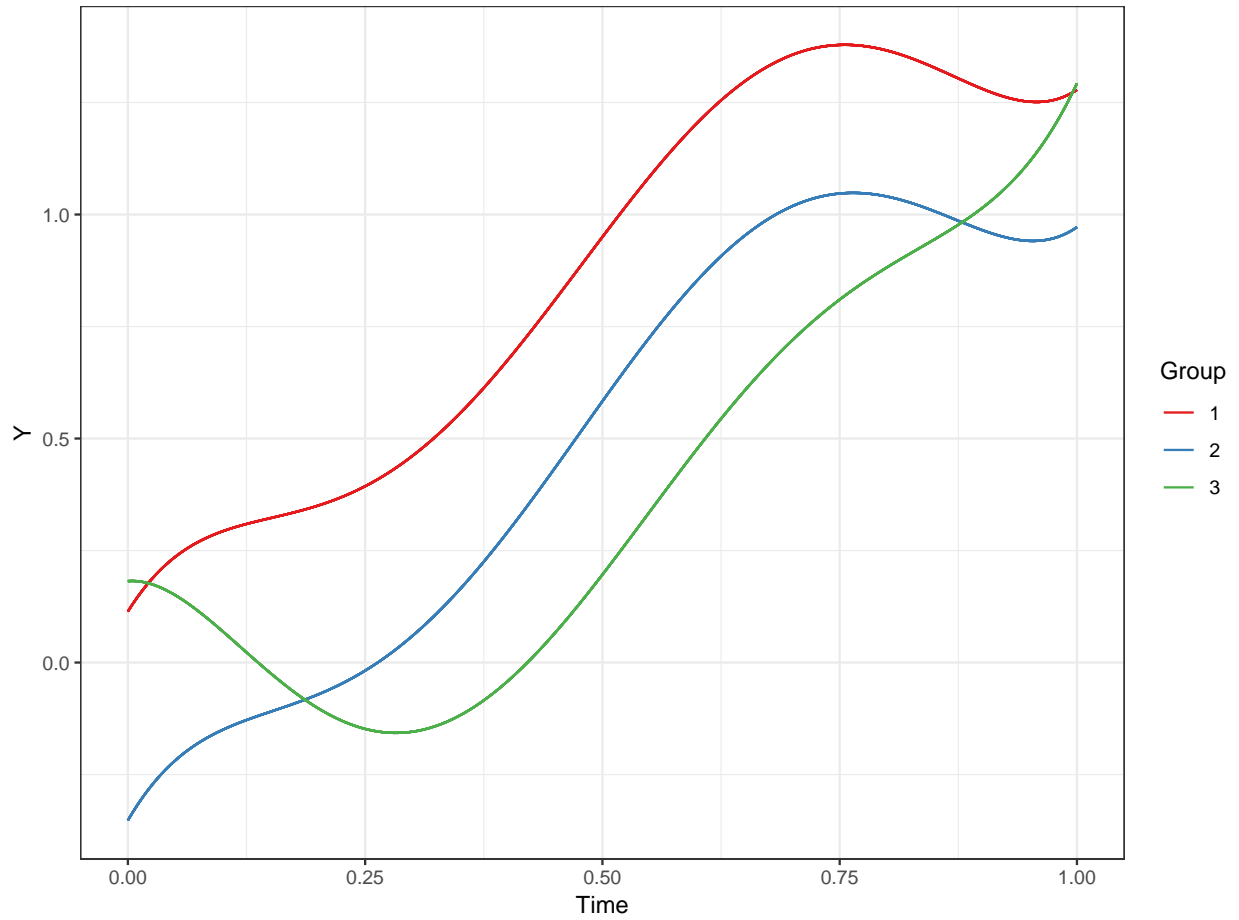


Figure 3: The group-level mean functions for the smoothed simulated data ± 2 point-wise standard deviations.



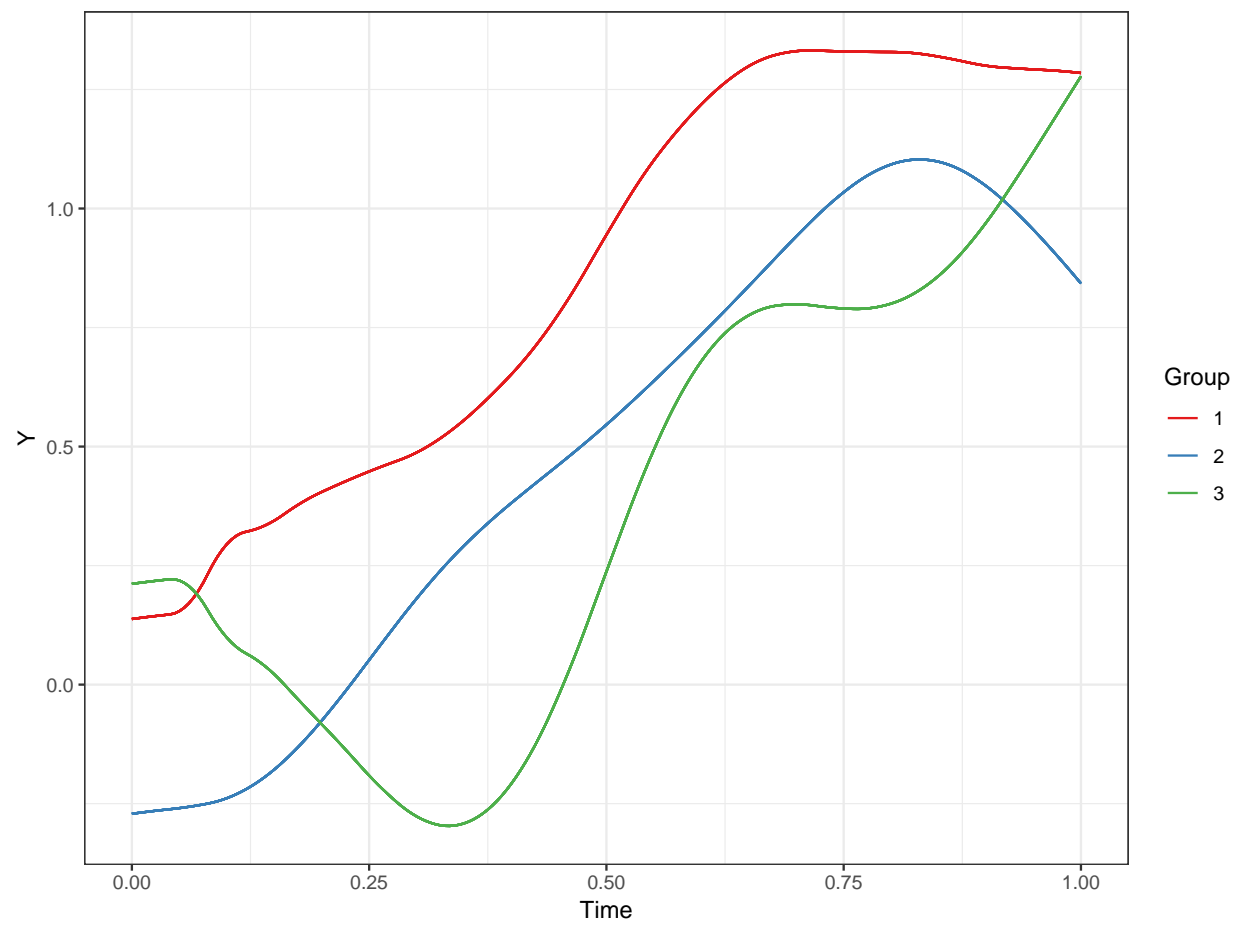
Analyze Using `lm()`

Figure 4: The group-level mean functions from `lm()` using a 5th-order linear model with time-by-group and Time^2 -by-group interactions.



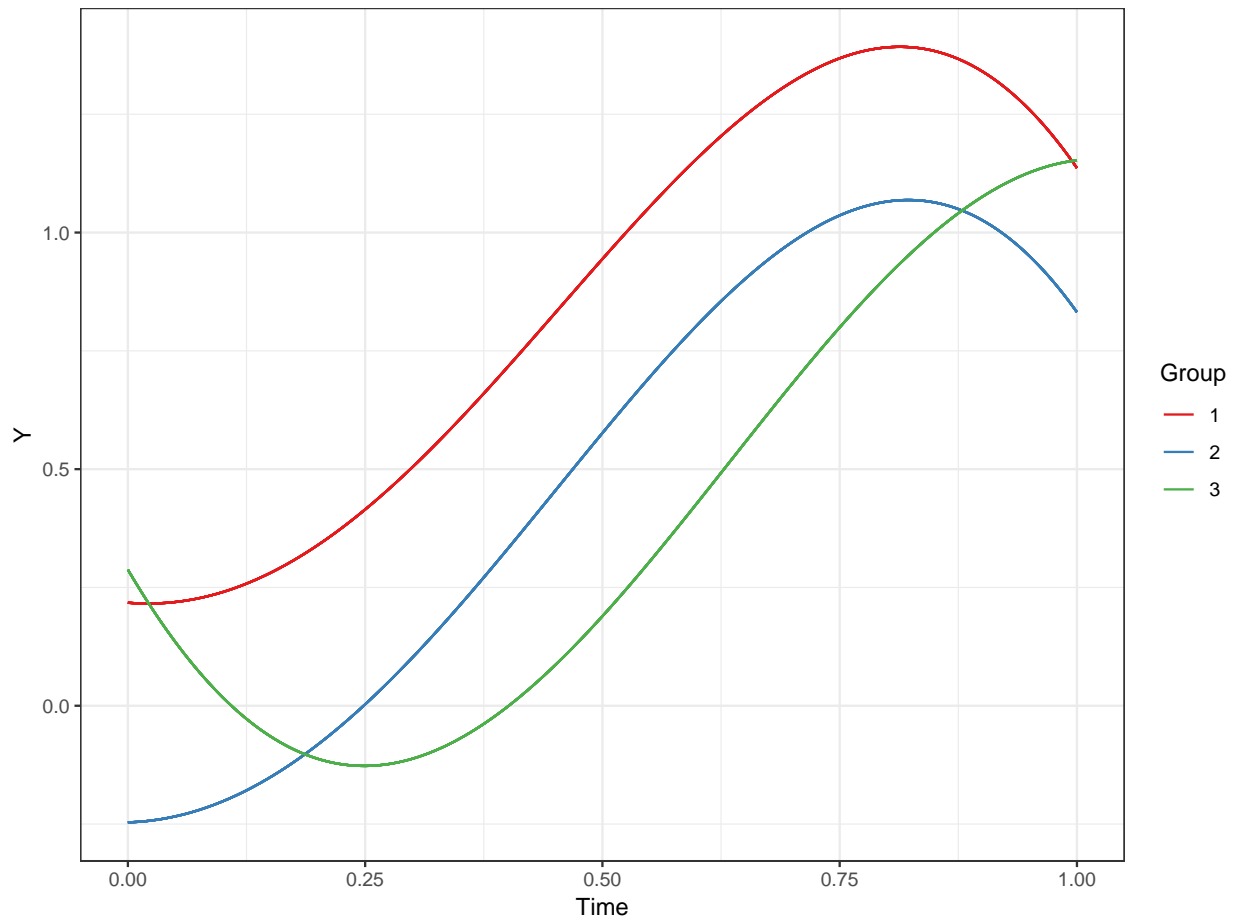
Analyze Using Penalized Splines and lme()

Figure 5: The group-level mean functions using penalized splines and lme().



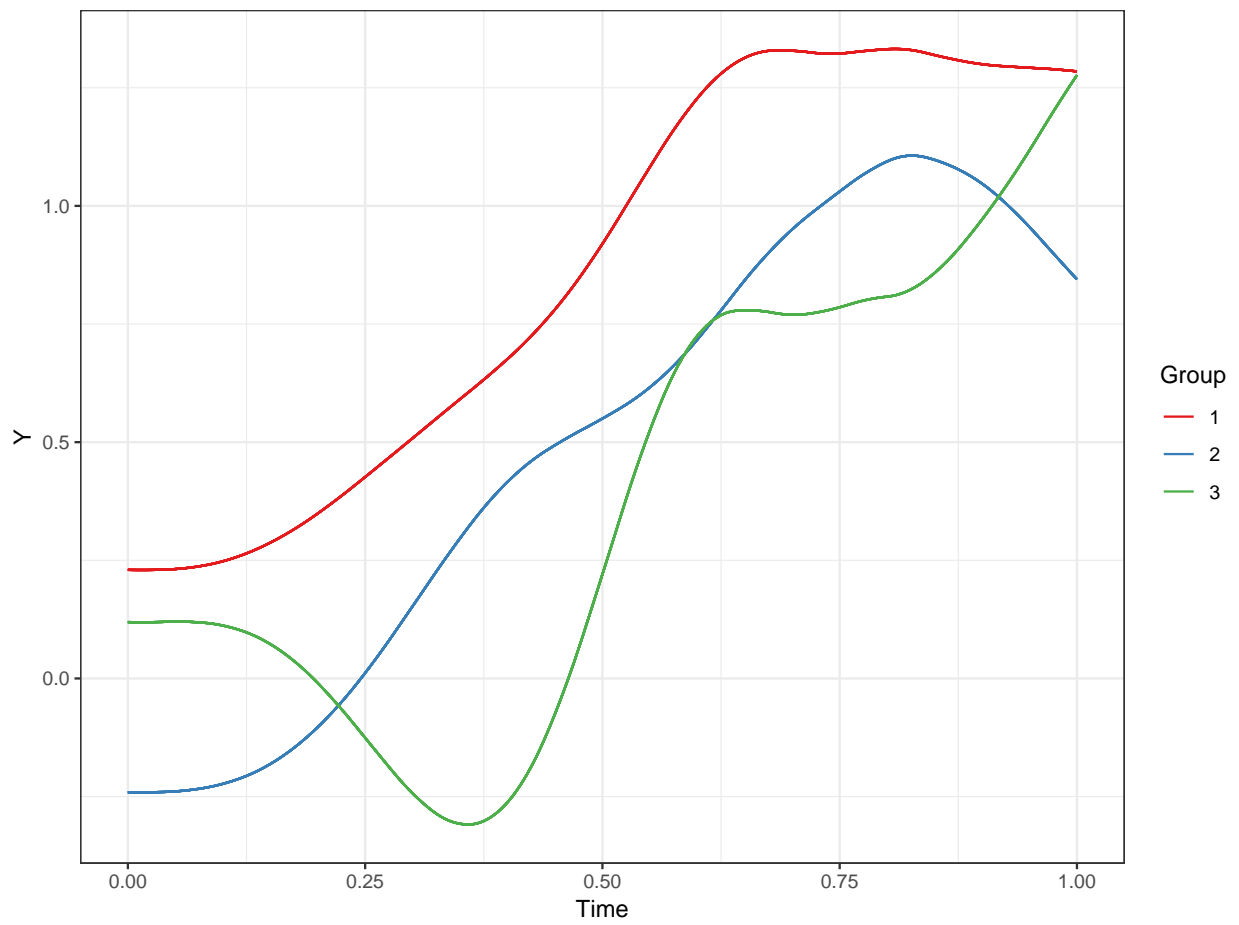
Analyze Using JAGS

Figure 6: The group-level mean functions from JAGS using a 5th-order linear model with time-by-group and Time^2 -by-group interactions.



Analyze Using Penalized Splines and JAGS

Figure 7: The group-level mean functions using penalized splines and JAGS.



Session Info

A summary of the R session used for the analysis.

```
## R version 3.5.1 (2018-07-02)
## Platform: x86_64-w64-mingw32/x64 (64-bit)
## Running under: Windows 7 x64 (build 7601) Service Pack 1
##
## Matrix products: default
##
## attached base packages:
## [1] stats      graphics  grDevices utils      datasets  methods   base
##
## other attached packages:
## [1] rjags_4-8          coda_0.19-2        lme4_1.1-18-1
## [4] Matrix_1.2-14      nlme_3.1-137       RColorBrewer_1.1-2
## [7] ggplot2_3.1.0      knitr_1.20
##
## loaded via a namespace (and not attached):
## [1] Rcpp_0.12.19      nloptr_1.2.1      pillar_1.3.0      compiler_3.5.1
## [5] plyr_1.8.4        bindr_0.1.1       tools_3.5.1       digest_0.6.18
## [9] lattice_0.20-35   evaluate_0.12     tibble_1.4.2      gtable_0.2.0
## [13] pkgconfig_2.0.2   rlang_0.3.0.1     rstudioapi_0.8    yaml_2.2.0
## [17] xfun_0.4          bindrcpp_0.2.2    withr_2.1.2       dplyr_0.7.7
## [21] stringr_1.3.1     rprojroot_1.3-2   grid_3.5.1        tidyselect_0.2.5
## [25] glue_1.3.0        R6_2.3.0          rmarkdown_1.10    minqa_1.2.4
## [29] purrr_0.2.5       magrittr_1.5      MASS_7.3-51       splines_3.5.1
## [33] scales_1.0.0      backports_1.1.2   htmltools_0.3.6   rsconnect_0.8.8
## [37] assertthat_0.2.0  colorspace_1.3-2  labeling_0.3       tinytex_0.9
## [41] stringi_1.2.4     lazyeval_0.2.1    munsell_0.5.0     crayon_1.3.4
```