Web-based Supporting Materials for “A Bayesian Approach to Joint Analysis of Multivariate Longitudinal Data and Parametric Accelerated Failure Time” by Sheng Luo

OpenBUGS program to fit model (6)

```
model {
  for (i in 1:obs) {
    Y.conti[i] ~ dnorm(mu.conti[subject[i], time[i]], tau.conti)
    # K.ordi: number of ordinal outcomes; n[k]: number of categories of the kth outcome
    for (k in 1:K.ordi) { Y.ordi[i, k] ~ dcat(prob.y[subject[i], time[i], k, 1:n[k]]) }
  }

  # construct the means for the continuous variables
  for (i in 1:N) {
    for (j in 1:T) {
      # a.conti, b.conti: the difficulty and discriminating parameters for a continuous outcome
      mu.conti[i, j] <- a.conti + b.conti * theta[i, j]
    }
  }

  # construct the probability vector for the remaining ordinal variables
  for (i in 1:N) {
    for (j in 1:T) {
      for (k in 1:K.ordi) {
        a.ordi[k,l], b.ordi[k]: the difficulty and discriminating parameters of ordinal outcome k
        for (l in 1:(n[k]-1)) { logit(psi[i, j, k, l]) <- a.ordi[k,l] - b.ordi[k]*theta[i, j] }
        psi[i, j, k, n[k]] <- 1

        prob.y[i, j, k, 1] <- psi[i, j, k, 1]
        for (l in 2:n[k]) { prob.y[i, j, k, l] <- psi[i, j, k, l] - psi[i, j, k, l-1] }
      }  # end of "for (k in 1:K.ordi)"
    }  # end of "for (j in 1:T)"
  } # end of "for (i in 1:N)"

  ##################################################################
  # construct the likelihood contribution from the survival portion
  ##################################################################
  pi <- 3.1415926
  for (i in 1:N) {
    temp[i] <- (log(t.obv[i]) - gam[1] - gam[2]*treat[i] - nu[1]*u[i, 1]-nu[2]*u[i,2])/sigma.surv

    #survival distribution and density function of logistic distribution, which gives log-logistic distribution of T
#   s0[i] <- 1/(1+exp(temp[i]))
```

```
#    f0[i] <- exp(temp[i])*pow(s0[i],2)

    #survival distribution and density function of standard normal, , which gives log-normal distribution of T
   s0[i] <- 1-phi(temp[i])
   f0[i] <- pow(2*pi, -0.5)*exp(-0.5*pow(temp[i], 2))

    #survival distribution and density function of extreme value distribution, which gives Weibull distribution of T
#   s0[i] <- exp(-exp(temp[i]))
#   f0[i] <- s0[i]*exp(temp[i])

    #Loglikelihood Function
    L[i] <- cens[i]*log(f0[i]/(sigma.surv*t.obv[i]))+(1-cens[i])*log(s0[i]) - log(1.0E+10)

    #poisson zero trick
    zeros[i] <- 0.0
    phi[i] <- -L[i]
    zeros[i] ~ dpois(phi[i])
  } # end of "for (i in 1:N)"

  # construct theta[i,j], the latent variable of subject i at time j
  for (i in 1:N) { u[i, 1:2] ~ dmnorm(zero[], precision[,]) }

  # construct the variance-covariance matrix
  precision[1:2, 1:2] <- inverse(Sigma[,])
  Sigma[1, 1] <- 1
  Sigma[1, 2] <- rho*sig
  Sigma[2, 1] <- Sigma[1, 2]
  Sigma[2, 2] <- sig*sig

  for (i in 1:N) {
    for (j in 1:T) { theta[i, j] <- u[i, 1] + (beta[1] + beta[2]*treat[i] + u[i, 2])*t[j]}
  }

  # prior for regression coefficients
  for (i in 1:2) { beta[i] ~ dnorm(0, 0.01) }

  # specify prior distributions from here
  rho ~ dunif(-1, 1)
  sig ~  dgamma(0.01, 0.01)

  # prior for continuous variable's parameters
  b.conti ~ dgamma(0.01, 0.01)
  a.conti ~ dnorm(0, 0.0005)
  tau.conti ~ dgamma(0.01, 0.01)
  sd.conti <- 1/sqrt(tau.conti)

  #prior for ordinal variables' parameters
  for (k in 1:K.ordi) {
    b.ordi[k] ~ dgamma(0.01, 0.01)
    a.ordi[k, 1] ~ dnorm(0,0.01)
    for (l in 2:(n[k]-1)) { a.ordi[k, l] <- a.ordi[k, l-1] + delta[k, l-1] }
    for (i in 1:(n[k]-2)) {delta[k, i] ~ dnorm(0,0.01)I(0,) }
  }

  # priors for the parameters in survival portion
  for (i in 1:2) { gam[i] ~ dnorm(0, 0.01) }
  for (i in 1:2) { nu[i] ~ dnorm(0, 0.01) }
  inversesigma ~ dgamma(0.01, 0.01)
  sigma.surv <- 1/inversesigma
}
```

Table 1: Results of fitting the reduced log-logistic ($\mathrm{RM}_{\mathrm{LL}}$) and Weibull ($\mathrm{RM}_{\mathrm{W}}$) models and the joint log-logistic ($\mathrm{JM}_{\mathrm{LL}}$) and Weibull ($\mathrm{JM}_{\mathrm{W}}$) models in the DATATOP study.

	$\mathrm{RM}_{\mathrm{LL}}$				$\mathrm{JM}_{\mathrm{LL}}$			
	Mean	SD	95% CI		Mean	SD	95% CI	
For longitudinal outcomes								
β_{10}	0.785	0.049	0.690	0.885	0.953	0.057	0.846	1.071
β_{11}	−0.380	0.058	−0.498	−0.272	−0.461	0.062	−0.582	−0.339
ρ	0.343	0.072	0.202	0.478	0.408	0.060	0.287	0.522
σ_u	0.451	0.036	0.380	0.522	0.517	0.038	0.448	0.593
For survival								
γ_0	0.114	0.041	0.035	0.196	0.136	0.046	0.050	0.229
γ_1	0.440	0.061	0.315	0.559	0.445	0.059	0.330	0.564
σ_ϵ	0.446	0.019	0.410	0.485	0.337	0.022	0.293	0.381
η_0					−0.197	0.045	−0.287	−0.107
η_1					−0.810	0.126	−1.058	−0.563
	RM_{W}				JM_{W}			
	Mean	SD	95% CI		Mean	SD	95% CI	
For longitudinal outcomes								
β_{10}	0.786	0.049	0.699	0.886	0.941	0.056	0.831	1.052
β_{11}	−0.378	0.058	−0.493	−0.266	−0.464	0.060	−0.581	−0.351
ρ	0.338	0.070	0.194	0.477	0.431	0.061	0.314	0.547
σ_u	0.456	0.036	0.386	0.524	0.508	0.039	0.433	0.587
For survival								
γ_0	0.347	0.036	0.280	0.417	0.342	0.039	0.264	0.420
γ_1	0.357	0.057	0.249	0.467	0.411	0.057	0.303	0.526
σ_ϵ	0.527	0.023	0.486	0.573	0.449	0.024	0.405	0.496
η_0					−0.189	0.041	−0.271	−0.107
η_1					−0.667	0.126	−0.926	−0.428

Table 2: Additional results of fitting the reduced log-normal model ($\mathrm{RM_{LN}}$) and the joint log-normal model ($\mathrm{JM_{LN}}$) in the DATATOP study.

	$\mathrm{RM_{LN}}$				$\mathrm{JM_{LN}}$			
	Mean	SD	95% CI		Mean	SD	95% CI	
For UPDRS								
a_1	24.547	0.404	23.720	25.300	24.407	0.394	23.670	25.190
b_1	10.821	0.282	10.300	11.410	10.806	0.287	10.240	11.370
σ_1	5.033	0.106	4.832	5.248	5.043	0.104	4.849	5.250
For SEADL								
a_{21}	−2.629	0.098	−2.820	−2.437	−2.614	0.096	−2.803	−2.443
a_{22}	−0.600	0.082	−0.751	−0.432	−0.577	0.080	−0.734	−0.427
a_{23}	1.942	0.092	1.769	2.122	1.978	0.094	1.793	2.166
a_{24}	2.729	0.101	2.543	2.931	2.767	0.101	2.570	2.969
a_{25}	4.893	0.143	4.620	5.189	4.933	0.146	4.663	5.227
a_{26}	5.880	0.182	5.530	6.232	5.920	0.181	5.572	6.270
b_2	1.897	0.075	1.759	2.047	1.906	0.074	1.768	2.054
For MMSE								
a_{31}	−0.101	0.039	−0.175	−0.023	−0.095	0.039	−0.174	−0.020
a_{32}	0.960	0.043	0.880	1.051	0.964	0.043	0.878	1.044
a_{33}	1.795	0.051	1.695	1.897	1.800	0.053	1.698	1.910
a_{34}	2.637	0.070	2.506	2.772	2.639	0.072	2.499	2.783
a_{35}	3.343	0.091	3.162	3.520	3.343	0.096	3.161	3.530
a_{36}	4.074	0.128	3.827	4.331	4.069	0.134	3.812	4.330
b_3	0.394	0.036	0.329	0.467	0.392	0.035	0.324	0.460
For HRSD								
a_{41}	−0.895	0.045	−0.989	−0.809	−0.890	0.046	−0.982	−0.800
a_{42}	−0.044	0.042	−0.129	0.037	−0.037	0.043	−0.118	0.047
a_{43}	0.514	0.045	0.428	0.603	0.521	0.044	0.435	0.608
a_{44}	1.034	0.049	0.940	1.133	1.041	0.047	0.951	1.134
a_{45}	1.493	0.052	1.394	1.597	1.501	0.052	1.399	1.608
a_{46}	1.926	0.057	1.819	2.037	1.933	0.057	1.819	2.045
a_{47}	2.368	0.065	2.246	2.497	2.375	0.066	2.246	2.508
a_{48}	2.837	0.075	2.696	2.985	2.844	0.075	2.695	3.001
a_{49}	3.270	0.088	3.097	3.444	3.278	0.089	3.102	3.454
b_4	0.656	0.037	0.584	0.729	0.659	0.038	0.586	0.734