```
$PROBLEM
$INPUT     ID ITEM NDAY TIME DV GRP MDV RESV
$DATA      ….csv IGNORE=@
$PRED
;Covariates ----------------------------------------------------------------------------------------------------------------------
;;; BASERESV-DEFINITION START
IF(RESV.EQ.-99) THEN
  BASERESV = 0
ELSE
  BASERESV = ( 0 + THETA(71)*(RESV - 48.3))
ENDIF
;;; BASERESV-DEFINITION END
;;; BASE-RELATION START
BASECOV=BASERESV
;;; BASE-RELATION END
;Longitudinal parameters ----------------------------------------------------------------------------------------------------------
TVBASE = THETA(66)
TVBASE = BASECOV+TVBASE
BASE = TVBASE + ETA(1) ; baseline latent disability
TVASY = THETA(67)
ASY=TVASY*(1+ETA(2)) ; Asymptote Maximum decrease in disease Status
TPROG = THETA(68)*EXP(ETA(4)) ; T1/2 describing disease progression rate
SLPREL=ETA(3) ; no theta associated with this parameter (i.e. fixed to 0)
TVDRUG=0
IF(TIME.GT.0.AND.GRP.GT.0) TVDRUG=THETA(70)
PSI = BASE + ASY*(1-EXP(-(LOG(2)/TPROG*TIME)**WEI)) + SLPREL*TIME + TVDRUG  ; longitudinal trajectory of latent disability
;--------------assignment of item parameters----------------------------------------
;Constants to select the model type
GR5=1
GR6=2
GR13=3
MODEL=0
;Define ICCs for IPSS items (ITEM=1 to ITEM=7)
IF(ITEM.EQ.1) THEN
              MODEL=GR5
              DIS=THETA(3) ; I1DISGR
```

```
        DIF1=THETA(4) ; I1DIF1GR
        DIF2=THETA(5) ; I1DIF2GR
        DIF3=THETA(6) ; I1DIF3GR
        DIF4=THETA(7) ; I1DIF4GR
        DIF5=THETA(8) ; I1DIF5GR
ENDIF
; excluded code for IPSS items 2 to 6 for brevity
IF(ITEM.EQ.7) THEN
        MODEL=GR5
        DIS=THETA(39) ; I7DISGR
        DIF1=THETA(40) ; I7DIF1GR
        DIF2=THETA(41) ; I7DIF2GR
        DIF3=THETA(42) ; I7DIF3GR
        DIF4=THETA(43) ; I7DIF4GR
        DIF5=THETA(44) ; I7DIF5GR
ENDIF
; Define QoL item
IF(ITEM.EQ.8) THEN
        MODEL=GR6
        DIS=THETA(45)  ; QoLDISGR
        DIF1=THETA(46) ; QoLDIF1GR
        DIF2=THETA(47) ; QoLDIF2GR
        DIF3=THETA(48) ; QoLDIF3GR
        DIF4=THETA(49) ; QoLDIF4GR
        DIF5=THETA(50) ; QoLDIF5GR
        DIF6=THETA(51) ; QoLDIF5GR
ENDIF
; Define BII summary score
IF(ITEM.EQ.9) THEN
        MODEL=GR13
        DIS=THETA(52)  ; BIIDISGR
        DIF1=THETA(53) ; BIIDIF1GR
        DIF2=THETA(54) ; BIIDIF2GR
        DIF3=THETA(55) ; BIIDIF3GR
        DIF4=THETA(56) ; BIIDIF4GR
        DIF5=THETA(57) ; BIIDIF5GR
```

```
            DIF6=THETA(58) ; BIIDIF6GR
            DIF7=THETA(59) ; BIIDIF7GR
            DIF8=THETA(60) ; BIIDIF8GR
            DIF9=THETA(61) ; BIIDIF9GR
            DIF10=THETA(62) ; BIIDIF10GR
            DIF11=THETA(63) ; BIIDIF11GR
            DIF12=THETA(64) ; BIIDIF12GR
            DIF13=THETA(65) ; BIIDIF13GR
ENDIF
;----------------------------IPSS Graded response model implementation (0-5) ----------------------------
IF(MODEL.EQ.GR5) THEN
DIFG1=DIF1
DIFG2=DIFG1+DIF2
DIFG3=DIFG2+DIF3
DIFG4=DIFG3+DIF4
DIFG5=DIFG4+DIF5
PGE1=EXP(DIS*(PSI-DIFG1))/(1+EXP(DIS*(PSI-DIFG1)))
PGE2=EXP(DIS*(PSI-DIFG2))/(1+EXP(DIS*(PSI-DIFG2)))
PGE3=EXP(DIS*(PSI-DIFG3))/(1+EXP(DIS*(PSI-DIFG3)))
PGE4=EXP(DIS*(PSI-DIFG4))/(1+EXP(DIS*(PSI-DIFG4)))
PGE5=EXP(DIS*(PSI-DIFG5))/(1+EXP(DIS*(PSI-DIFG5)))
P0=1-PGE1
P1=PGE1-PGE2
P2=PGE2-PGE3
P3=PGE3-PGE4
P4=PGE4-PGE5
P5=PGE5
ENDIF
;Select appropriate P(Y=k)
IF(MODEL.EQ.GR5.AND.DV.EQ.0) P=P0
IF(MODEL.EQ.GR5.AND.DV.EQ.1) P=P1
IF(MODEL.EQ.GR5.AND.DV.EQ.2) P=P2
IF(MODEL.EQ.GR5.AND.DV.EQ.3) P=P3
IF(MODEL.EQ.GR5.AND.DV.EQ.4) P=P4
IF(MODEL.EQ.GR5.AND.DV.EQ.5) P=P5
```

```
;IPRED = (P1*1) + (P2*2) + (P3*3) + (P4*4) + (P5*5)
;RES = DV - IPRED
;----------QoL Graded response model implementation (0-6) ----------
IF(MODEL.EQ.GR6) THEN
DIFG1=DIF1
DIFG2=DIFG1+DIF2
DIFG3=DIFG2+DIF3
DIFG4=DIFG3+DIF4
DIFG5=DIFG4+DIF5
DIFG6=DIFG5+DIF6
PGE1=EXP(DIS*(PSI-DIFG1))/(1+EXP(DIS*(PSI-DIFG1)))
;excluded PGE2 to PGE5 for brevity
PGE6=EXP(DIS*(PSI-DIFG6))/(1+EXP(DIS*(PSI-DIFG6)))
P0=1-PGE1
P1=PGE1-PGE2
,excluded P2 to P5 for brevity
P6=PGE6
ENDIF
;Select appropriate P(Y=k)
IF(MODEL.EQ.GR6.AND.DV.EQ.0) P=P0
;excluded P for DV=1 to DV=5 for brevity
IF(MODEL.EQ.GR6.AND.DV.EQ.6) P=P6
;---------- BII Graded response model implementation (0-13) ----------
IF(MODEL.EQ.GR13) THEN
DIFG1=DIF1
DIFG2=DIFG1+DIF2
;excluded DIFG3 TO DIFG12 for brevity
DIFG13=DIFG12+DIF13
PGE1=EXP(DIS*(PSI-DIFG1))/(1+EXP(DIS*(PSI-DIFG1)))
PGE2=EXP(DIS*(PSI-DIFG2))/(1+EXP(DIS*(PSI-DIFG2)))
;excluded PGE3 to PGE12 for brevity
PGE13=EXP(DIS*(PSI-DIFG13))/(1+EXP(DIS*(PSI-DIFG13)))
P0=1-PGE1
P1=PGE1-PGE2
;excluded P2 to P12 for brevity
P13=PGE13
```

```
ENDIF
Select appropriate P(Y=k)
IF(MODEL.EQ.GR13.AND.DV.EQ.0) P=P0
IF(MODEL.EQ.GR13.AND.DV.EQ.1) P=P1
;excluded definintion of P for DV=2 to DV=12
IF(MODEL.EQ.GR13.AND.DV.EQ.13) P=P13
;IPRED = (P1*1) + (P2*2) + (P3*3) + (P4*4) + (P5*5) + (P6*6) +(P7*7) + (P8*8) + (P9*9) + (P10*10) + (P11*11) + (P12*12) + (P13*13)
;RES = DV - IPRED
;-----------------------Response probability prediction-------------------------
IF(P.LT.1E-16)     P = 1E-16     ; protection for P->0
IF(P.GT.(1-1E-16)) P = 1-1E-16   ; protection for P->1
Y=-2*LOG(P)
;---------------------------------Simulation code---------------------------------
;REP=IREP
;IF(ICALL.EQ.4) THEN
;               IF(MODEL.EQ.GR5) THEN
;               CALL RANDOM (2,R)
;               SDV=0
;               IF(R.LT.PGE1) SDV=1
;               IF(R.LT.PGE2) SDV=2
;               IF(R.LT.PGE3) SDV=3
;               IF(R.LT.PGE4) SDV=4
;               IF(R.LT.PGE5) SDV=5
;               ENDIF
;               IF(MODEL.EQ.GR6) THEN
;               CALL RANDOM (2,R)
;               SDV=0
;               IF(R.LT.PGE1) SDV=1
;               IF(R.LT.PGE2) SDV=2
;               IF(R.LT.PGE3) SDV=3
;               IF(R.LT.PGE4) SDV=4
;               IF(R.LT.PGE5) SDV=5
;               IF(R.LT.PGE6) SDV=6
;               ENDIF
;;              IF(MODEL.EQ.GR13) THEN
;               CALL RANDOM (2,R)
```

```
;               SDV=0
;               IF(R.LT.PGE1) SDV=1
;               IF(R.LT.PGE2) SDV=2
;               IF(R.LT.PGE3) SDV=3
;               IF(R.LT.PGE4) SDV=4
;               IF(R.LT.PGE5) SDV=5
;               IF(R.LT.PGE6) SDV=6
;               IF(R.LT.PGE7) SDV=7
;               IF(R.LT.PGE8) SDV=8
;               IF(R.LT.PGE9) SDV=9
;               IF(R.LT.PGE10) SDV=10
;               IF(R.LT.PGE11) SDV=11
;               IF(R.LT.PGE12) SDV=12
;               IF(R.LT.PGE13) SDV=13
;               ENDIF
;       DV=SDV
;ENDIF
;----------------------------estimation task ------------------------------------------

$ESTIMATION MAXEVAL=99999 METHOD=COND LAPLACE -2LL PRINT=1
$COVARIANCE PRINT=E
$THETA
(0) FIX ; theta not used
(0) FIX ; theta not used
; ICC parameters
(0, 1.19) FIX ; 3 I1DISGR
(-4.56) FIX ; 4 I1DIF1GR
(0, 2.02) FIX ; 5 I1DIF2GR
(0, 1.86) FIX ; 6 I1DIF3GR
(0, 1.57) FIX ; 7 I1DIF4GR
(0, 1.4) FIX ; 8 I1DIF5GR
(0, 1.04) FIX ; 9 I2DISGR
(-5.55) FIX ; 10 I2DIF1GR
(0, 2.65) FIX ; 11 I2DIF2GR
(0, 2.06) FIX ; 12 I2DIF3GR
(0, 1.49) FIX ; 13 I2DIF4GR
```

(0, 1.53) FIX ; 14 I2DIF5GR

;exlcluded thetas for items 3 to 9 for brevity

;longitudinal parameters

(-0.0372) ; 66 TVBASE

(-1.22) ; 67 TVASY

(0, 16.2) ; 68 TPROG

(0) FIX ; theta not used

(-0.567) ; 70 TVDRUG

(-20, 0.0025,20) ; 71 BASERESV1

$OMEGA BLOCK(3)

 1.14

 0.205 1.78

 0 0.00495 0.000072

$OMEGA

 0.251