

```

$SIZES          LIM6=2892 LTH=300
$PROBLEM        IRT simulation model for MDS-UPDRS motor
$INPUT          ID TIME ITEM DV OCC
; ID           = ID number
; TIME         = Time in years since start of study
; ITEM         = Item of the MDS-UPDRS scale
; DV          = Patient's response to MDS-UPDRS assessment item
;              rater assessed items: 0 - 4 = category
;              (no impairment - severely impaired)
; OCC          = Occasion number

```

```

$DATA data.csv IGNORE=@
IGNORE(ITEM.LT.14)
IGNORE(ITEM.EQ.23)
IGNORE(ITEM.EQ.46)
IGNORE(ITEM.GT.49)

```

```

$ABBR DECLARE INTEGER IOCC
$ABBR DECLARE UPDRSARRM(12)

```

```

$PRED
;-----Latent variable-----
BSLMOTOR = THETA(1)+ETA(1)
SLPMOTOR = THETA(2)+ETA(2)
PSI = BSLMOTOR+TIME*(SLPMOTOR)

```

```

;-----Constants to select model type---
MODEL=0
OC2=2
OC3=3
OC4=4
OC5=5

```

```

;-----Assignment of item parameters----
IF(ITEM.EQ.14) THEN
MODEL=OC3
DIS=(1.14)
DIF1=(1.26)
DIF2=(1.18)
ENDIF

```

```

IF(ITEM.EQ.15) THEN
MODEL=OC4
DIS=(1.11)
DIF1=(1.22)
DIF2=(0.724)

```

```
DIF3=(1.11)  
ENDIF
```

```
IF (ITEM.EQ.16) THEN  
MODEL=0C2  
DIS=(1.04)  
DIF1=(2.46)  
ENDIF
```

```
IF (ITEM.EQ.17) THEN  
MODEL=0C3  
DIS=(1.42)  
DIF1=(1.16)  
DIF2=(1.95)  
ENDIF
```

```
IF (ITEM.EQ.18) THEN  
MODEL=0C3  
DIS=(2.01)  
DIF1=(0.867)  
DIF2=(1.53)  
ENDIF
```

```
IF (ITEM.EQ.19) THEN  
MODEL=0C2  
DIS=(1.65)  
DIF1=(1.36)  
ENDIF
```

```
IF (ITEM.EQ.20) THEN  
MODEL=0C4  
DIS=(1.18)  
DIF1=(0.263)  
DIF2=(1.46)  
DIF3=(1.34)  
ENDIF
```

```
IF (ITEM.EQ.21) THEN  
MODEL=0C3  
DIS=(1.39)  
DIF1=(1)  
DIF2=(1.46)
```

```
ENDIF  
IF (ITEM.EQ.22) THEN  
MODEL=0C3
```

DIS=(1.24)
DIF1=(1.43)
DIF2=(2.78)
ENDIF

IF (ITEM.EQ.24) THEN
MODEL=0C3
DIS=(1.35)
DIF1=(0.82)
DIF2=(1.95)
ENDIF

IF (ITEM.EQ.25) THEN
MODEL=0C3
DIS=(1.38)
DIF1=(0.945)
DIF2=(2.32)
ENDIF

IF (ITEM.EQ.26) THEN
MODEL=0C2
DIS=(1.67)
DIF1=(2.53)
ENDIF

IF (ITEM.EQ.27) THEN
MODEL=0C3
DIS=(1.69)
DIF1=(0.758)
DIF2=(1.88)
ENDIF

IF (ITEM.EQ.28) THEN
MODEL=0C4
DIS=(2.18)
DIF1=(-0.206)
DIF2=(1.48)
DIF3=(1.52)
ENDIF

IF (ITEM.EQ.29) THEN
MODEL=0C4
DIS=(1.97)
DIF1=(0.741)
DIF2=(0.869)
DIF3=(1.64)

ENDIF

```
IF (ITEM.EQ.30) THEN
MODEL=0C4
DIS=(1.83)
DIF1=(-0.483)
DIF2=(1.15)
DIF3=(1.86)
ENDIF
```

```
IF (ITEM.EQ.31) THEN
MODEL=0C3
DIS=(1.66)
DIF1=(0.881)
DIF2=(1.26)
ENDIF
```

```
IF (ITEM.EQ.32) THEN
MODEL=0C4
DIS=(1.62)
DIF1=(0.54)
DIF2=(0.978)
DIF3=(1.59)
ENDIF
```

```
IF (ITEM.EQ.33) THEN
MODEL=0C3
DIS=(1.83)
DIF1=(1.42)
DIF2=(0.916)
ENDIF
```

```
IF (ITEM.EQ.34) THEN
MODEL=0C4
DIS=(2.25)
DIF1=(-0.65)
DIF2=(1.31)
DIF3=(1.1)
ENDIF
```

```
IF (ITEM.EQ.35) THEN
MODEL=0C4
DIS=(1.89)
DIF1=(0.718)
DIF2=(1.2)
DIF3=(1.28)
```

ENDIF

```
IF (ITEM.EQ.36) THEN
MODEL=0C4
DIS=(2.37)
DIF1=(-0.215)
DIF2=(1.18)
DIF3=(1.08)
ENDIF
```

```
IF (ITEM.EQ.37) THEN
MODEL=0C3
DIS=(2.05)
DIF1=(0.98)
DIF2=(1.15)
ENDIF
```

```
IF (ITEM.EQ.38) THEN
MODEL=0C4
DIS=(1.98)
DIF1=(-0.251)
DIF2=(1.22)
DIF3=(1.21)
ENDIF
```

```
IF (ITEM.EQ.39) THEN
MODEL=0C3
DIS=(2.01)
DIF1=(1.09)
DIF2=(1.19)
ENDIF
```

```
IF (ITEM.EQ.40) THEN
MODEL=0C4
DIS=(1.99)
DIF1=(-0.334)
DIF2=(1.35)
DIF3= (1.24)
ENDIF
```

```
IF (ITEM.EQ.41) THEN
MODEL=0C4
DIS=(1.45)
DIF1=(0.89)
DIF2=(1.53)
DIF3=(1.67)
```

ENDIF

```
IF (ITEM.EQ.42) THEN
MODEL=0C4
DIS=(1.96)
DIF1=(0.364)
DIF2=(1.31)
DIF3= (1.4)
ENDIF
```

```
IF (ITEM.EQ.43) THEN
MODEL=0C3
DIS=(1.79)
DIF1=(1.37)
DIF2=(1.32)
ENDIF
```

```
IF (ITEM.EQ.44) THEN
MODEL=0C3
DIS=(1.36)
DIF1=(2.02)
DIF2=(1.68)
ENDIF
```

```
IF (ITEM.EQ.45) THEN
MODEL=0C3
DIS=(1.42)
DIF1=(0.437)
DIF2=(2.44)
ENDIF
```

```
IF (ITEM.EQ.47) THEN
MODEL=0C3
DIS=(0.902)
DIF1=(3.28)
DIF2=(1.38)
ENDIF
```

```
IF (ITEM.EQ.48) THEN
MODEL=0C3
DIS=(1.29)
DIF1=(0.447)
DIF2=(2.05)
ENDIF
```

```
IF (ITEM.EQ.49) THEN
```

```

MODEL=0C4
DIS=(2.76)
DIF1=(-0.172)
DIF2=(1.1)
DIF3=(1.22)
ENDIF

;-----Ordered categorical data model-----
IF(MODEL.EQ.0C2) THEN
DIFG1=DIF1

PGE1=EXP(DIS*(PSI-DIFG1))/(1+EXP(DIS*(PSI-DIFG1)))

P0=1-PGE1
P1=PGE1

ENDIF

IF(MODEL.EQ.0C2.AND.DV.EQ.0) P=P0
IF(MODEL.EQ.0C2.AND.DV.GE.1) P=P1

IF(P.LT.1E-16) P=1E-16
IF(P.GT.(1-1E-16)) P=1-1E-16
IF(MODEL.EQ.0C2) Y=-2*LOG(P)

;-----Ordered categorical data model-----
IF(MODEL.EQ.0C3) THEN
DIFG1=DIF1
DIFG2=DIFG1+DIF2

PGE1=EXP(DIS*(PSI-DIFG1))/(1+EXP(DIS*(PSI-DIFG1)))
PGE2=EXP(DIS*(PSI-DIFG2))/(1+EXP(DIS*(PSI-DIFG2)))

P0=1-PGE1
P1=PGE1-PGE2
P2=PGE2
ENDIF

IF(MODEL.EQ.0C3.AND.DV.EQ.0) P=P0
IF(MODEL.EQ.0C3.AND.DV.EQ.1) P=P1
IF(MODEL.EQ.0C3.AND.DV.GE.2) P=P2

IF(P.LT.1E-16) P=1E-16
IF(P.GT.(1-1E-16)) P=1-1E-16

```

```
IF (MODEL.EQ.0C3) Y=-2*LOG(P)
```

```
;-----Ordered categorical data model-----
```

```
IF (MODEL.EQ.0C4) THEN
```

```
DIFG1=DIF1
```

```
DIFG2=DIFG1+DIF2
```

```
DIFG3=DIFG2+DIF3
```

```
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)))
```

```
P0=1-PGE1
```

```
P1=PGE1-PGE2
```

```
P2=PGE2-PGE3
```

```
P3=PGE3
```

```
ENDIF
```

```
IF (MODEL.EQ.0C4.AND.DV.EQ.0) P=P0
```

```
IF (MODEL.EQ.0C4.AND.DV.EQ.1) P=P1
```

```
IF (MODEL.EQ.0C4.AND.DV.EQ.2) P=P2
```

```
IF (MODEL.EQ.0C4.AND.DV.GE.3) P=P3
```

```
IF (P.LT.1E-16) P=1E-16
```

```
IF (P.GT.(1-1E-16)) P=1-1E-16
```

```
IF (MODEL.EQ.0C4) Y=-2*LOG(P)
```

```
;-----Ordered categorical data model-----
```

```
IF (MODEL.EQ.0C5) THEN
```

```
DIFG1=DIF1
```

```
DIFG2=DIFG1+DIF2
```

```
DIFG3=DIFG2+DIF3
```

```
DIFG4=DIFG3+DIF4
```

```
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)))
```

```
P0=1-PGE1
```

```
P1=PGE1-PGE2
```

```
P2=PGE2-PGE3
```

```
P3=PGE3-PGE4
```

```
P4=PGE4
```

```
ENDIF
```

```
IF (MODEL.EQ.0C5.AND.DV.EQ.0) P=P0
IF (MODEL.EQ.0C5.AND.DV.EQ.1) P=P1
IF (MODEL.EQ.0C5.AND.DV.EQ.2) P=P2
IF (MODEL.EQ.0C5.AND.DV.EQ.3) P=P3
IF (MODEL.EQ.0C5.AND.DV.EQ.4) P=P4
```

```
IF (P.LT.1E-16) P=1E-16
IF (P.GT.(1-1E-16)) P=1-1E-16
IF (MODEL.EQ.0C5) Y=-2*LOG(P)
```

```
;-----Simulation code-----
```

```
IF(ICALL.EQ.4) THEN
ISIM=IREP
```

```
IF (MODEL.EQ.0C2) THEN
CALL RANDOM (2,R)
SDV=0
IF(R.LT.PGE1) SDV=1
ENDIF
```

```
IF (MODEL.EQ.0C3) THEN
CALL RANDOM (2,R)
SDV=0
IF(R.LT.PGE1) SDV=1
IF(R.LT.PGE2) SDV=2
ENDIF
```

```
IF (MODEL.EQ.0C4) 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
ENDIF
```

```
IF (MODEL.EQ.0C5) 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
ENDIF
DV=SDV
```

```
ENDIF
```

```

;-----Calculation of MDS-UPDRS motor score-----
IF(NEWIND.NE.2) THEN
UPDRSARRM(1)=0
UPDRSARRM(2)=0
UPDRSARRM(3)=0
UPDRSARRM(4)=0
UPDRSARRM(5)=0
UPDRSARRM(6)=0
UPDRSARRM(7)=0
UPDRSARRM(8)=0
UPDRSARRM(9)=0
UPDRSARRM(10)=0
UPDRSARRM(11)=0
UPDRSARRM(12)=0
ENDIF

IOCC=0
"IOCC=INT(OCC)

IF(ITEM.GT.13.AND.ITEM.NE.46.AND.ITEM.NE.23.AND.ITEM.LT.50) THEN
UPDRSARRM(IOCC)=UPDRSARRM(IOCC) + DV
ENDIF

UPDRSMOTOR=UPDRSARRM(IOCC)

;-----Baseline and slope-----
$THETA
... ; 1 BSLMOTOR
... ; 2 SLPMOTOR

;-----Random effects for baseline and slope---
$OMEGA
... ; 1 BSLMOTOR_IIV
... ; 2 SLPMOTOR_IIV

$SIMULATION (...) (...) UNIFORM) NOPREDICTION
ONLYSIMULATION SUBPROBLEMS=1
$TABLE ID TIME ITEM DV UPDRSMOTOR
NOAPPEND NOHEADER NOPRINT FILE=... FORMAT=,1PE11.4

```