

APPENDIX A

Mplus Syntax for the 2-class fully unconstrained model

TITLE: Fitting 2-class unconstrained model;

DATA: FILE IS EPIA_1.txt;

VARIABLE: NAMES = y1-y5;
USEVARIABLES = x1-x5;
CLASSES = c(2);

! Below is transforming the observed variables to logits

! Maximum score for this dataset was 112

DEFINE: z1 = y1/112;
z2 = y2/112;
z3 = y3/112;
z4 = y4/112;
z5 = y5/112;
x1 = log(z1/(1-z1));
x2 = log(z2/(1-z2));
x3 = log(z3/(1-z3));
x4 = log(z4/(1-z4));
x5 = log(z5/(1-z5));

ANALYSIS: TYPE = MIXTURE;
ALGORITHM = INTEGRATION;
ESTIMATOR = MLR;
STARTS 500 30;
PROCESS = 8 (STARTS);
ITERATIONS = 10000;
MITERATIONS = 10000;
H1ITERATIONS = 10000;
SDITERATIONS = 10;
CONVERGENCE = .0001;
MCONVERGENCE = .0001;
H1CONVERGENCE = .0001;
LOGCRITERION = .0001;

MODEL:

%OVERALL%
f1 BY x1* x2 - x5;
f1@1;

%c#1%
f1 BY x1* x2 - x5 (lam1-lam5);
[f1@0];
f1@1;
[x1-x5];
x1-x5 (res1-res5);
[x1-x5] (int1-int5);

```
%c#2%
f1 BY x1*x2 - x5 (lam6-lam10);
[f1@0];
f1@1;
[x1-x5];
x1-x5 (res6-res10);
[x1-x5] (int6-int10);
```

MODEL CONSTRAINT:

```
lam1>0;lam2>0;lam3>0;lam4>0;lam5>0;lam6>0;lam7>0;lam8>0;lam9>0;lam10>0;
res1>0;res2>0;res3>0; res4>0; res5>0; res6>0; res7>0; res8>0;res9>0; res10>0;
```

! Below, we transform the model parameters back to the IRT metric

```
NEW (a1_1 a1_2 a1_3 a1_4 a1_5
     a2_1 a2_2 a2_3 a2_4 a2_5
     b1_1 b1_2 b1_3 b1_4 b1_5
     b2_1 b2_2 b2_3 b2_4 b2_5);
```

```
a1_1 = lam1/sqrt(res1);
a1_2 = lam2/sqrt(res2);
a1_3 = lam3/sqrt(res3);
a1_4 = lam4/sqrt(res4);
a1_5 = lam5/sqrt(res5);
a2_1 = lam6/sqrt(res6);
a2_2 = lam7/sqrt(res7);
a2_3 = lam8/sqrt(res8);
a2_4 = lam9/sqrt(res9);
a2_5 = lam10/sqrt(res10);
b1_1 = -int1/lam1;
b1_2 = -int2/lam2;
b1_3 = -int3/lam3;
b1_4 = -int4/lam4;
b1_5 = -int5/lam5;
b2_1 = -int6/lam6;
b2_2 = -int7/lam7;
b2_3 = -int8/lam8;
b2_4 = -int9/lam9;
b2_5 = -int10/lam10;
```

SAVEDATA:

```
FILE = '2-class_unconstrained.dat';
FORMAT IS F8.2;
SAVE = CPROBABILITIES;
SAVE = CPROBABILITIES;
```

Mplus Syntax for the 2-class with class-invariant Item 2

```
TITLE: Fitting 2-class unconstrained model;
DATA: FILE IS EPIA_1.txt;
VARIABLE: NAMES = y1-y5;
          USEVARIABLES = x1-x5;
          CLASSES = c(2);

DEFINE: z1 = y1/112;
        z2 = y2/112;
        z3 = y3/112;
        z4 = y4/112;
        z5 = y5/112;
        x1 = log(z1/(1-z1));
        x2 = log(z2/(1-z2));
        x3 = log(z3/(1-z3));
        x4 = log(z4/(1-z4));
        x5 = log(z5/(1-z5));

ANALYSIS: TYPE = MIXTURE;
          ALGORITHM = INTEGRATION;
          ESTIMATOR = MLR;
          STARTS 500 30;
          PROCESS = 8 (STARTS);
          ITERATIONS = 10000;
          MITERATIONS = 10000;
          H1ITERATIONS = 10000;
          SDITERATIONS = 10;
          CONVERGENCE = .0001;
          MCONVERGENCE = .0001;
          H1CONVERGENCE = .0001;
          LOGCRITERION = .0001;

MODEL:
%OVERALL%
  f1 BY x1*x2-x5;

  %c#1%
  f1 BY x1*x2-x5 (lam1 lam2 lam3 lam4 lam5);
  [f1@0];
  f1@1
  [x1-x5];
  x1-x5 (res1 res2 res3 res4 res5);
  [x1-x5] (int1 int2 int3 int4 int5);

  %c#2%
  f1 BY x1*x2-x5 (lam6 lam2 lam7 lam8 lam9);
  [x1-x5];
  x1-x5 (res6 res2 res7 res8 res9);
  [x1-x5] (int6 int2 int7 int8 int9);
  [f1](1);
```

MODEL CONSTRAINT:
lam1>0;lam2>0;lam3>0;lam4>0;lam5>0;lam6>0;lam7>0;lam8>0;lam9>0;
res1>0;res2>0;res3>0;res4>0;res5>0;res6>0;res7>0;res8>0;res9>0;

NEW (a1_1 a1_2 a1_3 a1_4 a1_5

 a2_1 a2_2 a2_3 a2_4 a2_5
 b1_1 b1_2 b1_3 b1_4 b1_5
 b2_1 b2_2 b2_3 b2_4 b2_5);

a1_1 = lam1/sqrt(res1);
a1_2 = lam2/sqrt(res2);
a1_3 = lam3/sqrt(res3);
a1_4 = lam4/sqrt(res4);
a1_5 = lam5/sqrt(res5);
a2_1 = lam6/sqrt(res6);
a2_2 = lam2/sqrt(res2);
a2_3 = lam7/sqrt(res7);
a2_4 = lam8/sqrt(res8);
a2_5 = lam9/sqrt(res9);
b1_1 = -int1/lam1;
b1_2 = -int2/lam2;
b1_3 = -int3/lam3;
b1_4 = -int4/lam4;
b1_5 = -int5/lam5;
b2_1 = -int6/lam6;
b2_2 = -int2/lam2;
b2_3 = -int7/lam7;
b2_4 = -int8/lam8;
b2_5 = -int9/lam9;

SAVEDATA:
FILE = '2-class_Item2 anchor.dat';
FORMAT IS F8.2;
SAVE = CPROBABILITIES;
SAVE = FScores;