Mplus syntax files for three-level mediation models, to accompany:

Preacher, K. J. (2011). Multilevel SEM strategies for evaluating mediation in three-level data. *Multivariate Behavioral Research*, *46*, 691-731.

This file contains:

- **Appendix A**: **Mplus syntax for the Variance Components Model (VCM) in Example 1**
- **Appendix B**: **Mplus syntax for the Contextual Effect Model (CEM) model in Example 1**
- **Appendix C**: **Mplus syntax for the VCM/CEM in Example 2**
- **Appendix D**: **Mplus syntax for the Conflated Coefficients Model (CCM) in Example 3**
- **Bonus Appendix**: **Method 4: Centered Manifest Predictor (CMP) model**

Appendix A
Mplus syntax for the Variance Components Model (VCM) in Example 1

```
TITLE: test msem;
DATA: FILE IS datawide.out;
VARIABLE:
NAMES ARE !tx, tm, and ty are group mean centered
          !variables not used in this analysis
k j x1-x10 m1-m10 y1-y10 tx1-tx10 tm1-tm10 ty1-ty10;
USEVARIABLES ARE
k   x1-x10 m1-m10 y1-y10;
CLUSTER=k;
MISSING ARE ALL (-999);
ANALYSIS:
TYPE=TWOLEVEL RANDOM;
ALGORITHM=INTEGRATION;
INTEGRATION=MONTECARLO;
MODEL:

%WITHIN%

fx1 WITH fm2-fm10@0; fx2 WITH fm3-fm10@0; fx3 WITH fm4-fm10@0;
fx4 WITH fm5-fm10@0; fx5 WITH fm6-fm10@0; fx6 WITH fm7-fm10@0;
fx7 WITH fm8-fm10@0; fx8 WITH fm9-fm10@0; fx9 WITH fm10@0;

fm1 WITH fy2-fy10@0; fm2 WITH fy3-fy10@0; fm3 WITH fy4-fy10@0;
fm4 WITH fy5-fy10@0; fm5 WITH fy6-fy10@0; fm6 WITH fy7-fy10@0;
fm7 WITH fy8-fy10@0; fm8 WITH fy9-fy10@0; fm9 WITH fy10@0;

fx1 WITH fy2-fy10@0; fx2 WITH fy3-fy10@0; fx3 WITH fy4-fy10@0;
fx4 WITH fy5-fy10@0; fx5 WITH fy6-fy10@0; fx6 WITH fy7-fy10@0;
fx7 WITH fy8-fy10@0; fx8 WITH fy9-fy10@0; fx9 WITH fy10@0;

fm1 WITH fx2-fx10@0; fm2 WITH fx3-fx10@0; fm3 WITH fx4-fx10@0;
fm4 WITH fx5-fx10@0; fm5 WITH fx6-fx10@0; fm6 WITH fx7-fx10@0;
fm7 WITH fx8-fx10@0; fm8 WITH fx9-fx10@0; fm9 WITH fx10@0;

fy1 WITH fm2-fm10@0; fy2 WITH fm3-fm10@0; fy3 WITH fm4-fm10@0;
fy4 WITH fm5-fm10@0; fy5 WITH fm6-fm10@0; fy6 WITH fm7-fm10@0;
fy7 WITH fm8-fm10@0; fy8 WITH fm9-fm10@0; fy9 WITH fm10@0;

fy1 WITH fx2-fx10@0; fy2 WITH fx3-fx10@0; fy3 WITH fx4-fx10@0;
fy4 WITH fx5-fx10@0; fy5 WITH fx6-fx10@0; fy6 WITH fx7-fx10@0;
fy7 WITH fx8-fx10@0; fy8 WITH fx9-fx10@0; fy9 WITH fx10@0;

xiw WITH fm1-fm10@0; miw WITH fm1-fm10@0; miw WITH fx1-fx10@0;
xiw BY x1-x10@1; miw BY m1-m10@1; yiw BY y1-y10@1;

fx1 BY x1@1; fx2 BY x2@1; fx3 BY x3@1;
fx4 BY x4@1; fx5 BY x5@1; fx6 BY x6@1;
fx7 BY x7@1; fx8 BY x8@1; fx9 BY x9@1; fx10 BY x10@1;

fm1 BY m1@1; fm2 BY m2@1; fm3 BY m3@1;
fm4 BY m4@1; fm5 BY m5@1; fm6 BY m6@1;
fm7 BY m7@1; fm8 BY m8@1; fm9 BY m9@1; fm10 BY m10@1;

fy1 BY y1@1; fy2 BY y2@1; fy3 BY y3@1;
fy4 BY y4@1; fy5 BY y5@1; fy6 BY y6@1;
```

```
fy7 BY y7@1; fy8 BY y8@1; fy9 BY y9@1; fy10 BY y10@1;

fm1-fm10 PON fx1-fx10*.067(aw);
fy1-fy10 PON fm1-fm10*.1(bw);
fy1-fy10 PON fx1-fx10*.1(cw);

fx1 WITH fx2-fx10@0; fx2 WITH fx3-fx10@0; fx3 WITH fx4-fx10@0;
fx4 WITH fx5-fx10@0; fx5 WITH fx6-fx10@0; fx6 WITH fx7-fx10@0;
fx7 WITH fx8-fx10@0; fx8 WITH fx9-fx10@0; fx9 WITH fx10@0;

fm1 WITH fm2-fm10@0; fm2 WITH fm3-fm10@0; fm3 WITH fm4-fm10@0;
fm4 WITH fm5-fm10@0; fm5 WITH fm6-fm10@0; fm6 WITH fm7-fm10@0;
fm7 WITH fm8-fm10@0; fm8 WITH fm9-fm10@0; fm9 WITH fm10@0;

fy1 WITH fy2-fy10@0; fy2 WITH fy3-fy10@0; fy3 WITH fy4-fy10@0;
fy4 WITH fy5-fy10@0; fy5 WITH fy6-fy10@0; fy6 WITH fy7-fy10@0;
fy7 WITH fy8-fy10@0; fy8 WITH fy9-fy10@0; fy9 WITH fy10@0;

xiw WITH fx1-fx10@0; yiw WITH fy1-fy10@0;
fx1-fx10*.34(exw); fm1-fm10*.35(emw); fy1-fy10*.30(eyw);
x1-x10@0; m1-m10@0; y1-y10@0;
xiw*.33; miw*.28; yiw*.29;
miw ON xiw*.031(ab2); yiw ON miw*.5(bb2); yiw ON xiw*.1(cb2);
[fx1-fx10@0]; [fm1-fm10@0]; [fy1-fy10@0];

%BETWEEN%

[x1-x10@0]; [m1-m10@0]; [y1-y10@0];
xib BY x1-x10@1; mib BY m1-m10@1; yib BY y1-y10@1;
x1-x10@0; m1-m10@0; y1-y10@0;
[xib*0]; [mib*0]; [yib*0];
xib*.33; mib*.28; yib*.29;
mib ON xib*.4(ab3); yib ON mib*.2(bb3); yib ON xib*.3(cb3);

MODEL CONSTRAINT:
NEW(indw indb2 indb3);
indw=aw*bw;
indb2=ab2*bb2;
indb3=ab3*bb3;
```

Appendix B
Mplus syntax for the Contextual Effects Model (CEM) in Example 1

```
TITLE: test msem;
DATA: FILE IS datawide.out;
VARIABLE:
NAMES ARE !tx, tm, and ty are group mean centered
          !variables not used in this analysis
k j x1-x10 m1-m10 y1-y10 tx1-tx10 tm1-tm10 ty1-ty10;
USEVARIABLES ARE
k   x1-x10 m1-m10 y1-y10;
CLUSTER=k;
MISSING ARE ALL (-999);
ANALYSIS:
TYPE=TWOLEVEL RANDOM;
ALGORITHM=INTEGRATION;
INTEGRATION=MONTECARLO;
MODEL:

%WITHIN%

xiw BY x1-x10@1; miw BY m1-m10@1; yiw BY y1-y10@1;
m1-m10 PON x1-x10*.3(aw); y1-y10 PON m1-m10*.1(bw); y1-y10 PON x1-x10*.1(cw);
x1-x10*.34(exw); m1-m10*.35(emw); y1-y10*.30(eyw);
xiw*.33; miw*.28; yiw*.29;
miw ON xiw*.1(ab2); yiw ON miw*.5(bb2); yiw ON xiw*.1(cb2);

%BETWEEN%

[x1-x10@0]; [m1-m10@0]; [y1-y10@0];
xib BY x1-x10@1; mib BY m1-m10@1; yib BY y1-y10@1;
x1-x10@0; m1-m10@0; y1-y10@0;
[xib*0]; [mib*0]; [yib*0];
xib*.33; mib*.28; yib*.29;
mib ON xib*.4(ab3); yib ON mib*.2(bb3); yib ON xib*.3(cb3);

MODEL CONSTRAINT:
NEW(indw indb2 indb3);
indw=aw*bw;
indb2=(aw+ab2)*(bw+bb2);
indb3=ab3*bb3;
```

Appendix C
Mplus syntax for the VCM/CEM in Example 2

```
TITLE: test msem (1-2-3);
DATA: FILE IS datawide.123b.out;
VARIABLE:
NAMES ARE !tx, tm, and ty are group mean centered
          !variables not used in this analysis
k j x1-x14 m1-m14 y1-y14 tx1-tx14 tm1-tm14 ty1-ty14;
USEVARIABLES ARE
k   x1-x14 m1 y1;
CLUSTER IS k;
BETWEEN IS y1;
MISSING ARE ALL (-999);
ANALYSIS:
TYPE IS TWOLEVEL RANDOM;
ALGORITHM IS INTEGRATION;
INTEGRATION IS 7;
MODEL:

%WITHIN%

xiw BY x1-x14@1;
miw BY m1@1;
sa2 | miw ON xiw;
x1-x14*.34(exw); m1@0;
xiw*.33; miw*.28;

%BETWEEN%

[sa2*.0](a2); sa2*.3;
sa2 WITH xib@0; sa2 WITH mib@0; sa2 WITH yib@0;
[x1-x14@0]; [m1@0]; [y1@0];
xib BY x1-x14@1;
mib BY m1@1;
yib BY y1@1;
x1-x14@0; m1@0; y1@0;
[xib*0]; [mib*0]; [yib*0];
xib*.33; mib*.28; yib*.29;
mib ON xib*.2(a3);
yib ON mib*.2(b3);
yib ON xib*-.1;

MODEL CONSTRAINT:
NEW(indb3);
indb3=a3*b3;
```

Appendix D
Mplus syntax for the Conflated Coefficients Model (CCM) in Example 3

```
TITLE: 3-level mlm; ! MLM SPECIFICATION WITH a RANDOM AT L2 AND b RANDOM AT L3
DATA: FILE IS datawide2.11.11.out; ! assumes uncentered t variables
VARIABLE: !tx, tm, and ty are group mean centered
          !variables not used in this analysis
NAMES ARE k
mAo1-mAo11 yAo1-yAo11 txAo1-txAo11 tmAo1-tmAo11  ! 1st L2 unit
mBo1-mBo11 yBo1-yBo11 txBo1-txBo11 tmBo1-tmBo11  ! 2nd L2 unit
mCo1-mCo11 yCo1-yCo11 txCo1-txCo11 tmCo1-tmCo11  ! 3rd L2 unit
mDo1-mDo11 yDo1-yDo11 txDo1-txDo11 tmDo1-tmDo11  ! 4th L2 unit
mEo1-mEo11 yEo1-yEo11 txEo1-txEo11 tmEo1-tmEo11  ! 5th L2 unit
mFo1-mFo11 yFo1-yFo11 txFo1-txFo11 tmFo1-tmFo11  ! 6th L2 unit
mGo1-mGo11 yGo1-yGo11 txGo1-txGo11 tmGo1-tmGo11  ! 7th L2 unit
mHo1-mHo11 yHo1-yHo11 txHo1-txHo11 tmHo1-tmHo11  ! 8th L2 unit
mIo1-mIo11 yIo1-yIo11 txIo1-txIo11 tmIo1-tmIo11  ! 9th L2 unit
mJo1-mJo11 yJo1-yJo11 txJo1-txJo11 tmJo1-tmJo11  !10th L2 unit
mKo1-mKo11 yKo1-yKo11 txKo1-txKo11 tmKo1-tmKo11; !11th L2 unit
USEVARIABLES ARE
mAo1-mAo11 yAo1-yAo11  ! 1st L2 unit
mBo1-mBo11 yBo1-yBo11  ! 2nd L2 unit
mCo1-mCo11 yCo1-yCo11  ! 3rd L2 unit
mDo1-mDo11 yDo1-yDo11  ! 4th L2 unit
mEo1-mEo11 yEo1-yEo11  ! 5th L2 unit
mFo1-mFo11 yFo1-yFo11  ! 6th L2 unit
mGo1-mGo11 yGo1-yGo11  ! 7th L2 unit
mHo1-mHo11 yHo1-yHo11  ! 8th L2 unit
mIo1-mIo11 yIo1-yIo11  ! 9th L2 unit
mJo1-mJo11 yJo1-yJo11  !10th L2 unit
mKo1-mKo11 yKo1-yKo11; !11th L2 unit
CONSTRAINT ARE
txAo1-txAo11 tmAo1-tmAo11  ! 1st L2 unit
txBo1-txBo11 tmBo1-tmBo11  ! 2nd L2 unit
txCo1-txCo11 tmCo1-tmCo11  ! 3rd L2 unit
txDo1-txDo11 tmDo1-tmDo11  ! 4th L2 unit
txEo1-txEo11 tmEo1-tmEo11  ! 5th L2 unit
txFo1-txFo11 tmFo1-tmFo11  ! 6th L2 unit
txGo1-txGo11 tmGo1-tmGo11  ! 7th L2 unit
txHo1-txHo11 tmHo1-tmHo11  ! 8th L2 unit
txIo1-txIo11 tmIo1-tmIo11  ! 9th L2 unit
txJo1-txJo11 tmJo1-tmJo11  !10th L2 unit
txKo1-txKo11 tmKo1-tmKo11; !11th L2 unit
MISSING ARE ALL (-999);
ANALYSIS:
PROCESSORS = 12;
!ALGORITHM = INTEGRATION;
!INTEGRATION = MONTECARLO;
MODEL:
  miA BY mAo1-mAo11@1; mxsA BY mAo1-mAo11*(mxA1-mxA11);
  miB BY mBo1-mBo11@1; mxsB BY mBo1-mBo11*(mxB1-mxB11);
  miC BY mCo1-mCo11@1; mxsC BY mCo1-mCo11*(mxC1-mxC11);
  miD BY mDo1-mDo11@1; mxsD BY mDo1-mDo11*(mxD1-mxD11);
  miE BY mEo1-mEo11@1; mxsE BY mEo1-mEo11*(mxE1-mxE11);
  miF BY mFo1-mFo11@1; mxsF BY mFo1-mFo11*(mxF1-mxF11);
  miG BY mGo1-mGo11@1; mxsG BY mGo1-mGo11*(mxG1-mxG11);
  miH BY mHo1-mHo11@1; mxsH BY mHo1-mHo11*(mxH1-mxH11);
  miI BY mIo1-mIo11@1; mxsI BY mIo1-mIo11*(mxI1-mxI11);
  miJ BY mJo1-mJo11@1; mxsJ BY mJo1-mJo11*(mxJ1-mxJ11);
  miK BY mKo1-mKo11@1; mxsK BY mKo1-mKo11*(mxK1-mxK11);
  yiA BY yAo1-yAo11@1; ymsA BY yAo1-yAo11*(ymA1-ymA11); yxsA BY yAo1-yAo11*(yxA1-yxA11);
```

```
  yiB BY yBo1-yBo11@1; ymsB BY yBo1-yBo11*(ymB1-ymB11); yxsB BY yBo1-yBo11*(yxB1-yxB11);
  yiC BY yCo1-yCo11@1; ymsC BY yCo1-yCo11*(ymC1-ymC11); yxsC BY yCo1-yCo11*(yxC1-yxC11);
  yiD BY yDo1-yDo11@1; ymsD BY yDo1-yDo11*(ymD1-ymD11); yxsD BY yDo1-yDo11*(yxD1-yxD11);
  yiE BY yEo1-yEo11@1; ymsE BY yEo1-yEo11*(ymE1-ymE11); yxsE BY yEo1-yEo11*(yxE1-yxE11);
  yiF BY yFo1-yFo11@1; ymsF BY yFo1-yFo11*(ymF1-ymF11); yxsF BY yFo1-yFo11*(yxF1-yxF11);
  yiG BY yGo1-yGo11@1; ymsG BY yGo1-yGo11*(ymG1-ymG11); yxsG BY yGo1-yGo11*(yxG1-yxG11);
  yiH BY yHo1-yHo11@1; ymsH BY yHo1-yHo11*(ymH1-ymH11); yxsH BY yHo1-yHo11*(yxH1-yxH11);
  yiI BY yIo1-yIo11@1; ymsI BY yIo1-yIo11*(ymI1-ymI11); yxsI BY yIo1-yIo11*(yxI1-yxI11);
  yiJ BY yJo1-yJo11@1; ymsJ BY yJo1-yJo11*(ymJ1-ymJ11); yxsJ BY yJo1-yJo11*(yxJ1-yxJ11);
  yiK BY yKo1-yKo11@1; ymsK BY yKo1-yKo11*(ymK1-ymK11); yxsK BY yKo1-yKo11*(yxK1-yxK11);
 miA*.3(a);  miB*.3(a);  miC*.3(a);  miD*.3(a);  miE*.3(a);  miF*.3(a);  miG*.3(a);
mxsA*.3(b); mxsB*.3(b); mxsC*.3(b); mxsD*.3(b); mxsE*.3(b); mxsF*.3(b); mxsG*.3(b);
 yiA*.3(f);  yiB*.3(f);  yiC*.3(f);  yiD*.3(f);  yiE*.3(f);  yiF*.3(f);  yiG*.3(f);
  miH*.3(a);  miI*.3(a);  miJ*.3(a);  miK*.3(a);
 mxsH*.3(b); mxsI*.3(b); mxsJ*.3(b); mxsK*.3(b);
  yiH*.3(f);  yiI*.3(f);  yiJ*.3(f);  yiK*.3(f);
yxsA@0; yxsB@0; yxsC@0; yxsD@0; yxsE@0; yxsF@0; yxsG@0; yxsH@0; yxsI@0; yxsJ@0; yxsK@0;
ymsA@0; ymsB@0; ymsC@0; ymsD@0; ymsE@0; ymsF@0; ymsG@0; ymsH@0; ymsI@0; ymsJ@0; ymsK@0;
miA ON mi@1; mxsA ON mxs@1; yiA ON yi@1; yxsA ON yxs@1; ymsA ON yms@1;
miB ON mi@1; mxsB ON mxs@1; yiB ON yi@1; yxsB ON yxs@1; ymsB ON yms@1;
miC ON mi@1; mxsC ON mxs@1; yiC ON yi@1; yxsC ON yxs@1; ymsC ON yms@1;
miD ON mi@1; mxsD ON mxs@1; yiD ON yi@1; yxsD ON yxs@1; ymsD ON yms@1;
miE ON mi@1; mxsE ON mxs@1; yiE ON yi@1; yxsE ON yxs@1; ymsE ON yms@1;
miF ON mi@1; mxsF ON mxs@1; yiF ON yi@1; yxsF ON yxs@1; ymsF ON yms@1;
miG ON mi@1; mxsG ON mxs@1; yiG ON yi@1; yxsG ON yxs@1; ymsG ON yms@1;
miH ON mi@1; mxsH ON mxs@1; yiH ON yi@1; yxsH ON yxs@1; ymsH ON yms@1;
miI ON mi@1; mxsI ON mxs@1; yiI ON yi@1; yxsI ON yxs@1; ymsI ON yms@1;
miJ ON mi@1; mxsJ ON mxs@1; yiJ ON yi@1; yxsJ ON yxs@1; ymsJ ON yms@1;
miK ON mi@1; mxsK ON mxs@1; yiK ON yi@1; yxsK ON yxs@1; ymsK ON yms@1;
miA WITH mxsA*.08(c); miA WITH yiA*.08(i); miA WITH yxsA@0; miA WITH ymsA@0;
miB WITH mxsB*.08(c); miB WITH yiB*.08(i); miB WITH yxsB@0; miB WITH ymsB@0;
miC WITH mxsC*.08(c); miC WITH yiC*.08(i); miC WITH yxsC@0; miC WITH ymsC@0;
miD WITH mxsD*.08(c); miD WITH yiD*.08(i); miD WITH yxsD@0; miD WITH ymsD@0;
miE WITH mxsE*.08(c); miE WITH yiE*.08(i); miE WITH yxsE@0; miE WITH ymsE@0;
miF WITH mxsF*.08(c); miF WITH yiF*.08(i); miF WITH yxsF@0; miF WITH ymsF@0;
miG WITH mxsG*.08(c); miG WITH yiG*.08(i); miG WITH yxsG@0; miG WITH ymsG@0;
miH WITH mxsH*.08(c); miH WITH yiH*.08(i); miH WITH yxsH@0; miH WITH ymsH@0;
miI WITH mxsI*.08(c); miI WITH yiI*.08(i); miI WITH yxsI@0; miI WITH ymsI@0;
miJ WITH mxsJ*.08(c); miJ WITH yiJ*.08(i); miJ WITH yxsJ@0; miJ WITH ymsJ@0;
miK WITH mxsK*.08(c); miK WITH yiK*.08(i); miK WITH yxsK@0; miK WITH ymsK@0;
mxsA WITH yiA*.08(l); mxsA WITH yxsA@0; mxsA WITH ymsA@0;
mxsB WITH yiB*.08(l); mxsB WITH yxsB@0; mxsB WITH ymsB@0;
mxsC WITH yiC*.08(l); mxsC WITH yxsC@0; mxsC WITH ymsC@0;
mxsD WITH yiD*.08(l); mxsD WITH yxsD@0; mxsD WITH ymsD@0;
mxsE WITH yiE*.08(l); mxsE WITH yxsE@0; mxsE WITH ymsE@0;
mxsF WITH yiF*.08(l); mxsF WITH yxsF@0; mxsF WITH ymsF@0;
mxsG WITH yiG*.08(l); mxsG WITH yxsG@0; mxsG WITH ymsG@0;
mxsH WITH yiH*.08(l); mxsH WITH yxsH@0; mxsH WITH ymsH@0;
mxsI WITH yiI*.08(l); mxsI WITH yxsI@0; mxsI WITH ymsI@0;
mxsJ WITH yiJ*.08(l); mxsJ WITH yxsJ@0; mxsJ WITH ymsJ@0;
mxsK WITH yiK*.08(l); mxsK WITH yxsK@0; mxsK WITH ymsK@0;
yiA WITH yxsA@0; yiA WITH ymsA@0; yxsA WITH ymsA@0;
yiB WITH yxsB@0; yiB WITH ymsB@0; yxsB WITH ymsB@0;
yiC WITH yxsC@0; yiC WITH ymsC@0; yxsC WITH ymsC@0;
yiD WITH yxsD@0; yiD WITH ymsD@0; yxsD WITH ymsD@0;
yiE WITH yxsE@0; yiE WITH ymsE@0; yxsE WITH ymsE@0;
yiF WITH yxsF@0; yiF WITH ymsF@0; yxsF WITH ymsF@0;
yiG WITH yxsG@0; yiG WITH ymsG@0; yxsG WITH ymsG@0;
yiH WITH yxsH@0; yiH WITH ymsH@0; yxsH WITH ymsH@0;
yiI WITH yxsI@0; yiI WITH ymsI@0; yxsI WITH ymsI@0;
yiJ WITH yxsJ@0; yiJ WITH ymsJ@0; yxsJ WITH ymsJ@0;
yiK WITH yxsK@0; yiK WITH ymsK@0; yxsK WITH ymsK@0;
```

```
mi*.35; mxs@0; yi*.35; yxs@0; yms*.35; mi WITH mxs@0; mi WITH yi*.06;
mi WITH yxs@0; mi WITH yms*.06; mxs WITH yi@0; mxs WITH yxs@0;
mxs WITH yms@0; yi WITH yxs@0; yi WITH yms*.06; yxs WITH yms@0;
[mi*.0](mi); [mxs*.3](mxs); [yi*.0](yi); [yxs*.1](yxs); [yms*.3](yms);
mi BY mAo1@0; mxs BY mAo1@0; yi BY mAo1@0; yxs BY mAo1@0; yms BY mAo1@0;
[miA@0];  [miB@0];  [miC@0];  [miD@0];  [miE@0];  [miF@0];
[mxsA@0]; [mxsB@0]; [mxsC@0]; [mxsD@0]; [mxsE@0]; [mxsF@0];
[yiA@0];  [yiB@0];  [yiC@0];  [yiD@0];  [yiE@0];  [yiF@0];
[yxsA@0]; [yxsB@0]; [yxsC@0]; [yxsD@0]; [yxsE@0]; [yxsF@0];
[ymsA@0]; [ymsB@0]; [ymsC@0]; [ymsD@0]; [ymsE@0]; [ymsF@0];
[miG@0];  [miH@0];  [miI@0];  [miJ@0];  [miK@0];
[mxsG@0]; [mxsH@0]; [mxsI@0]; [mxsJ@0]; [mxsK@0];
[yiG@0];  [yiH@0];  [yiI@0];  [yiJ@0];  [yiK@0];
[yxsG@0]; [yxsH@0]; [yxsI@0]; [yxsJ@0]; [yxsK@0];
[ymsG@0]; [ymsH@0]; [ymsI@0]; [ymsJ@0]; [ymsK@0];
[mAo1-mAo11@0]; [mBo1-mBo11@0]; [mCo1-mCo11@0];
[mDo1-mDo11@0]; [mEo1-mEo11@0]; [mFo1-mFo11@0];
[mGo1-mGo11@0]; [mHo1-mHo11@0]; [mIo1-mIo11@0];
[mJo1-mJo11@0]; [mKo1-mKo11@0];
[yAo1-yAo11@0]; [yBo1-yBo11@0]; [yCo1-yCo11@0];
[yDo1-yDo11@0]; [yEo1-yEo11@0]; [yFo1-yFo11@0];
[yGo1-yGo11@0]; [yHo1-yHo11@0]; [yIo1-yIo11@0];
[yJo1-yJo11@0]; [yKo1-yKo11@0];
mAo1-mAo11*.34(e); mBo1-mBo11*.34(e); mCo1-mCo11*.34(e);
mDo1-mDo11*.34(e); mEo1-mEo11*.34(e); mFo1-mFo11*.34(e);
mGo1-mGo11*.34(e); mHo1-mHo11*.34(e); mIo1-mIo11*.34(e);
mJo1-mJo11*.34(e); mKo1-mKo11*.34(e);
yAo1-yAo11*.30(r); yBo1-yBo11*.30(r); yCo1-yCo11*.30(r);
yDo1-yDo11*.30(r); yEo1-yEo11*.30(r); yFo1-yFo11*.30(r);
yGo1-yGo11*.30(r); yHo1-yHo11*.30(r); yIo1-yIo11*.30(r);
yJo1-yJo11*.30(r); yKo1-yKo11*.30(r);
miA WITH miB@0; miA WITH miC@0; miA WITH miD@0; miA WITH miE@0; miA WITH miF@0;
miB WITH miC@0; miB WITH miD@0; miB WITH miE@0; miB WITH miF@0; miB WITH miG@0;
miC WITH miD@0; miC WITH miE@0; miC WITH miF@0; miC WITH miG@0; miC WITH miH@0;
miD WITH miE@0; miD WITH miF@0; miD WITH miG@0; miD WITH miH@0; miD WITH miI@0;
miE WITH miF@0; miE WITH miG@0; miE WITH miH@0; miE WITH miI@0; miE WITH miJ@0;
miF WITH miG@0; miF WITH miH@0; miF WITH miI@0; miF WITH miJ@0; miF WITH miK@0;
miG WITH miH@0; miG WITH miI@0; miG WITH miJ@0; miG WITH miK@0;
miH WITH miI@0; miH WITH miJ@0; miH WITH miK@0;
miI WITH miJ@0; miI WITH miK@0;
miJ WITH miK@0;
 miA WITH miG@0; miA WITH miH@0; miA WITH miI@0; miA WITH miJ@0; miA WITH miK@0;
 miB WITH miH@0; miB WITH miI@0; miB WITH miJ@0; miB WITH miK@0;
 miC WITH miI@0; miC WITH miJ@0; miC WITH miK@0;
 miD WITH miJ@0; miD WITH miK@0;
 miE WITH miK@0;
mxsA WITH mxsB@0; mxsA WITH mxsC@0; mxsA WITH mxsD@0; mxsA WITH mxsE@0; mxsA WITH mxsF@0;
mxsB WITH mxsC@0; mxsB WITH mxsD@0; mxsB WITH mxsE@0; mxsB WITH mxsF@0; mxsB WITH mxsG@0;
mxsC WITH mxsD@0; mxsC WITH mxsE@0; mxsC WITH mxsF@0; mxsC WITH mxsG@0; mxsC WITH mxsH@0;
mxsD WITH mxsE@0; mxsD WITH mxsF@0; mxsD WITH mxsG@0; mxsD WITH mxsH@0; mxsD WITH mxsI@0;
mxsE WITH mxsF@0; mxsE WITH mxsG@0; mxsE WITH mxsH@0; mxsE WITH mxsI@0; mxsE WITH mxsJ@0;
mxsF WITH mxsG@0; mxsF WITH mxsH@0; mxsF WITH mxsI@0; mxsF WITH mxsJ@0; mxsF WITH mxsK@0;
mxsG WITH mxsH@0; mxsG WITH mxsI@0; mxsG WITH mxsJ@0; mxsG WITH mxsK@0;
mxsH WITH mxsI@0; mxsH WITH mxsJ@0; mxsH WITH mxsK@0;
mxsI WITH mxsJ@0; mxsI WITH mxsK@0;
mxsJ WITH mxsK@0;
 mxsA WITH mxsG@0; mxsA WITH mxsH@0; mxsA WITH mxsI@0; mxsA WITH mxsJ@0; mxsA WITH mxsK@0;
 mxsB WITH mxsH@0; mxsB WITH mxsI@0; mxsB WITH mxsJ@0; mxsB WITH mxsK@0;
 mxsC WITH mxsI@0; mxsC WITH mxsJ@0; mxsC WITH mxsK@0;
 mxsD WITH mxsJ@0; mxsD WITH mxsK@0;
 mxsE WITH mxsK@0;
yiA WITH yiB@0; yiA WITH yiC@0; yiA WITH yiD@0; yiA WITH yiE@0; yiA WITH yiF@0;
```

```
yiB WITH yiC@0; yiB WITH yiD@0; yiB WITH yiE@0; yiB WITH yiF@0; yiB WITH yiG@0;
yiC WITH yiD@0; yiC WITH yiE@0; yiC WITH yiF@0; yiC WITH yiG@0; yiC WITH yiH@0;
yiD WITH yiE@0; yiD WITH yiF@0; yiD WITH yiG@0; yiD WITH yiH@0; yiD WITH yiI@0;
yiE WITH yiF@0; yiE WITH yiG@0; yiE WITH yiH@0; yiE WITH yiI@0; yiE WITH yiJ@0;
yiF WITH yiG@0; yiF WITH yiH@0; yiF WITH yiI@0; yiF WITH yiJ@0; yiF WITH yiK@0;
yiG WITH yiH@0; yiG WITH yiI@0; yiG WITH yiJ@0; yiG WITH yiK@0;
yiH WITH yiI@0; yiH WITH yiJ@0; yiH WITH yiK@0;
yiI WITH yiJ@0; yiI WITH yiK@0;
yiJ WITH yiK@0;
 yiA WITH yiG@0; yiA WITH yiH@0; yiA WITH yiI@0; yiA WITH yiJ@0; yiA WITH yiK@0;
 yiB WITH yiH@0; yiB WITH yiI@0; yiB WITH yiJ@0; yiB WITH yiK@0;
 yiC WITH yiI@0; yiC WITH yiJ@0; yiC WITH yiK@0;
 yiD WITH yiJ@0; yiD WITH yiK@0;
 yiE WITH yiK@0;
yxsA WITH yxsB@0; yxsA WITH yxsC@0; yxsA WITH yxsD@0; yxsA WITH yxsE@0; yxsA WITH yxsF@0;
yxsB WITH yxsC@0; yxsB WITH yxsD@0; yxsB WITH yxsE@0; yxsB WITH yxsF@0; yxsB WITH yxsG@0;
yxsC WITH yxsD@0; yxsC WITH yxsE@0; yxsC WITH yxsF@0; yxsC WITH yxsG@0; yxsC WITH yxsH@0;
yxsD WITH yxsE@0; yxsD WITH yxsF@0; yxsD WITH yxsG@0; yxsD WITH yxsH@0; yxsD WITH yxsI@0;
yxsE WITH yxsF@0; yxsE WITH yxsG@0; yxsE WITH yxsH@0; yxsE WITH yxsI@0; yxsE WITH yxsJ@0;
yxsF WITH yxsG@0; yxsF WITH yxsH@0; yxsF WITH yxsI@0; yxsF WITH yxsJ@0; yxsF WITH yxsK@0;
yxsG WITH yxsH@0; yxsG WITH yxsI@0; yxsG WITH yxsJ@0; yxsG WITH yxsK@0;
yxsH WITH yxsI@0; yxsH WITH yxsJ@0; yxsH WITH yxsK@0;
yxsI WITH yxsJ@0; yxsI WITH yxsK@0;
yxsJ WITH yxsK@0;
 yxsA WITH yxsG@0; yxsA WITH yxsH@0; yxsA WITH yxsI@0; yxsA WITH yxsJ@0; yxsA WITH yxsK@0;
 yxsB WITH yxsH@0; yxsB WITH yxsI@0; yxsB WITH yxsJ@0; yxsB WITH yxsK@0;
 yxsC WITH yxsI@0; yxsC WITH yxsJ@0; yxsC WITH yxsK@0;
 yxsD WITH yxsJ@0; yxsD WITH yxsK@0;
 yxsE WITH yxsK@0;
ymsA WITH ymsB@0; ymsA WITH ymsC@0; ymsA WITH ymsD@0; ymsA WITH ymsE@0; ymsA WITH ymsF@0;
ymsB WITH ymsC@0; ymsB WITH ymsD@0; ymsB WITH ymsE@0; ymsB WITH ymsF@0; ymsB WITH ymsG@0;
ymsC WITH ymsD@0; ymsC WITH ymsE@0; ymsC WITH ymsF@0; ymsC WITH ymsG@0; ymsC WITH ymsH@0;
ymsD WITH ymsE@0; ymsD WITH ymsF@0; ymsD WITH ymsG@0; ymsD WITH ymsH@0; ymsD WITH ymsI@0;
ymsE WITH ymsF@0; ymsE WITH ymsG@0; ymsE WITH ymsH@0; ymsE WITH ymsI@0; ymsE WITH ymsJ@0;
ymsF WITH ymsG@0; ymsF WITH ymsH@0; ymsF WITH ymsI@0; ymsF WITH ymsJ@0; ymsF WITH ymsK@0;
ymsG WITH ymsH@0; ymsG WITH ymsI@0; ymsG WITH ymsJ@0; ymsG WITH ymsK@0;
ymsH WITH ymsI@0; ymsH WITH ymsJ@0; ymsH WITH ymsK@0;
ymsI WITH ymsJ@0; ymsI WITH ymsK@0;
ymsJ WITH ymsK@0;
 ymsA WITH ymsG@0; ymsA WITH ymsH@0; ymsA WITH ymsI@0; ymsA WITH ymsJ@0; ymsA WITH ymsK@0;
 ymsB WITH ymsH@0; ymsB WITH ymsI@0; ymsB WITH ymsJ@0; ymsB WITH ymsK@0;
 ymsC WITH ymsI@0; ymsC WITH ymsJ@0; ymsC WITH ymsK@0;
 ymsD WITH ymsJ@0; ymsD WITH ymsK@0;
 ymsE WITH ymsK@0;

miA WITH mxsB@0; miA WITH mxsC@0; miA WITH mxsD@0; miA WITH mxsE@0; miA WITH mxsF@0;
miB WITH mxsA@0; miB WITH mxsC@0; miB WITH mxsD@0; miB WITH mxsE@0; miB WITH mxsF@0;
miC WITH mxsA@0; miC WITH mxsB@0; miC WITH mxsD@0; miC WITH mxsE@0; miC WITH mxsF@0;
miD WITH mxsA@0; miD WITH mxsB@0; miD WITH mxsC@0; miD WITH mxsE@0; miD WITH mxsF@0;
miE WITH mxsA@0; miE WITH mxsB@0; miE WITH mxsC@0; miE WITH mxsD@0; miE WITH mxsF@0;
miF WITH mxsA@0; miF WITH mxsB@0; miF WITH mxsC@0; miF WITH mxsD@0; miF WITH mxsE@0;
miG WITH mxsA@0; miG WITH mxsB@0; miG WITH mxsC@0; miG WITH mxsD@0; miG WITH mxsE@0;
miH WITH mxsA@0; miH WITH mxsB@0; miH WITH mxsC@0; miH WITH mxsD@0; miH WITH mxsE@0;
miI WITH mxsA@0; miI WITH mxsB@0; miI WITH mxsC@0; miI WITH mxsD@0; miI WITH mxsE@0;
miJ WITH mxsA@0; miJ WITH mxsB@0; miJ WITH mxsC@0; miJ WITH mxsD@0; miJ WITH mxsE@0;
miK WITH mxsA@0; miK WITH mxsB@0; miK WITH mxsC@0; miK WITH mxsD@0; miK WITH mxsE@0;

 miA WITH mxsG@0; miA WITH mxsH@0; miA WITH mxsI@0; miA WITH mxsJ@0; miA WITH mxsK@0;
 miB WITH mxsG@0; miB WITH mxsH@0; miB WITH mxsI@0; miB WITH mxsJ@0; miB WITH mxsK@0;
 miC WITH mxsG@0; miC WITH mxsH@0; miC WITH mxsI@0; miC WITH mxsJ@0; miC WITH mxsK@0;
 miD WITH mxsG@0; miD WITH mxsH@0; miD WITH mxsI@0; miD WITH mxsJ@0; miD WITH mxsK@0;
 miE WITH mxsG@0; miE WITH mxsH@0; miE WITH mxsI@0; miE WITH mxsJ@0; miE WITH mxsK@0;
```

```
 miF WITH mxsG@0; miF WITH mxsH@0; miF WITH mxsI@0; miF WITH mxsJ@0; miF WITH mxsK@0;
 miG WITH mxsF@0; miG WITH mxsH@0; miG WITH mxsI@0; miG WITH mxsJ@0; miG WITH mxsK@0;
 miH WITH mxsF@0; miH WITH mxsG@0; miH WITH mxsI@0; miH WITH mxsJ@0; miH WITH mxsK@0;
 miI WITH mxsF@0; miI WITH mxsG@0; miI WITH mxsH@0; miI WITH mxsJ@0; miI WITH mxsK@0;
 miJ WITH mxsF@0; miJ WITH mxsG@0; miJ WITH mxsH@0; miJ WITH mxsI@0; miJ WITH mxsK@0;
 miK WITH mxsF@0; miK WITH mxsG@0; miK WITH mxsH@0; miK WITH mxsI@0; miK WITH mxsJ@0;

miA WITH yiB@0; miA WITH yiC@0; miA WITH yiD@0; miA WITH yiE@0; miA WITH yiF@0;
miB WITH yiA@0; miB WITH yiC@0; miB WITH yiD@0; miB WITH yiE@0; miB WITH yiF@0;
miC WITH yiA@0; miC WITH yiB@0; miC WITH yiD@0; miC WITH yiE@0; miC WITH yiF@0;
miD WITH yiA@0; miD WITH yiB@0; miD WITH yiC@0; miD WITH yiE@0; miD WITH yiF@0;
miE WITH yiA@0; miE WITH yiB@0; miE WITH yiC@0; miE WITH yiD@0; miE WITH yiF@0;
miF WITH yiA@0; miF WITH yiB@0; miF WITH yiC@0; miF WITH yiD@0; miF WITH yiE@0;
miG WITH yiA@0; miG WITH yiB@0; miG WITH yiC@0; miG WITH yiD@0; miG WITH yiE@0;
miH WITH yiA@0; miH WITH yiB@0; miH WITH yiC@0; miH WITH yiD@0; miH WITH yiE@0;
miI WITH yiA@0; miI WITH yiB@0; miI WITH yiC@0; miI WITH yiD@0; miI WITH yiE@0;
miJ WITH yiA@0; miJ WITH yiB@0; miJ WITH yiC@0; miJ WITH yiD@0; miJ WITH yiE@0;
miK WITH yiA@0; miK WITH yiB@0; miK WITH yiC@0; miK WITH yiD@0; miK WITH yiE@0;

 miA WITH yiG@0; miA WITH yiH@0; miA WITH yiI@0; miA WITH yiJ@0; miA WITH yiK@0;
 miB WITH yiG@0; miB WITH yiH@0; miB WITH yiI@0; miB WITH yiJ@0; miB WITH yiK@0;
 miC WITH yiG@0; miC WITH yiH@0; miC WITH yiI@0; miC WITH yiJ@0; miC WITH yiK@0;
 miD WITH yiG@0; miD WITH yiH@0; miD WITH yiI@0; miD WITH yiJ@0; miD WITH yiK@0;
 miE WITH yiG@0; miE WITH yiH@0; miE WITH yiI@0; miE WITH yiJ@0; miE WITH yiK@0;
 miF WITH yiG@0; miF WITH yiH@0; miF WITH yiI@0; miF WITH yiJ@0; miF WITH yiK@0;
 miG WITH yiF@0; miG WITH yiH@0; miG WITH yiI@0; miG WITH yiJ@0; miG WITH yiK@0;
 miH WITH yiF@0; miH WITH yiG@0; miH WITH yiI@0; miH WITH yiJ@0; miH WITH yiK@0;
 miI WITH yiF@0; miI WITH yiG@0; miI WITH yiH@0; miI WITH yiJ@0; miI WITH yiK@0;
 miJ WITH yiF@0; miJ WITH yiG@0; miJ WITH yiH@0; miJ WITH yiI@0; miJ WITH yiK@0;
 miK WITH yiF@0; miK WITH yiG@0; miK WITH yiH@0; miK WITH yiI@0; miK WITH yiJ@0;

miA WITH yxsB@0; miA WITH yxsC@0; miA WITH yxsD@0; miA WITH yxsE@0; miA WITH yxsF@0;
miB WITH yxsA@0; miB WITH yxsC@0; miB WITH yxsD@0; miB WITH yxsE@0; miB WITH yxsF@0;
miC WITH yxsA@0; miC WITH yxsB@0; miC WITH yxsD@0; miC WITH yxsE@0; miC WITH yxsF@0;
miD WITH yxsA@0; miD WITH yxsB@0; miD WITH yxsC@0; miD WITH yxsE@0; miD WITH yxsF@0;
miE WITH yxsA@0; miE WITH yxsB@0; miE WITH yxsC@0; miE WITH yxsD@0; miE WITH yxsF@0;
miF WITH yxsA@0; miF WITH yxsB@0; miF WITH yxsC@0; miF WITH yxsD@0; miF WITH yxsE@0;
miG WITH yxsA@0; miG WITH yxsB@0; miG WITH yxsC@0; miG WITH yxsD@0; miG WITH yxsE@0;
miH WITH yxsA@0; miH WITH yxsB@0; miH WITH yxsC@0; miH WITH yxsD@0; miH WITH yxsE@0;
miI WITH yxsA@0; miI WITH yxsB@0; miI WITH yxsC@0; miI WITH yxsD@0; miI WITH yxsE@0;
miJ WITH yxsA@0; miJ WITH yxsB@0; miJ WITH yxsC@0; miJ WITH yxsD@0; miJ WITH yxsE@0;
miK WITH yxsA@0; miK WITH yxsB@0; miK WITH yxsC@0; miK WITH yxsD@0; miK WITH yxsE@0;

 miA WITH yxsG@0; miA WITH yxsH@0; miA WITH yxsI@0; miA WITH yxsJ@0; miA WITH yxsK@0;
 miB WITH yxsG@0; miB WITH yxsH@0; miB WITH yxsI@0; miB WITH yxsJ@0; miB WITH yxsK@0;
 miC WITH yxsG@0; miC WITH yxsH@0; miC WITH yxsI@0; miC WITH yxsJ@0; miC WITH yxsK@0;
 miD WITH yxsG@0; miD WITH yxsH@0; miD WITH yxsI@0; miD WITH yxsJ@0; miD WITH yxsK@0;
 miE WITH yxsG@0; miE WITH yxsH@0; miE WITH yxsI@0; miE WITH yxsJ@0; miE WITH yxsK@0;
 miF WITH yxsG@0; miF WITH yxsH@0; miF WITH yxsI@0; miF WITH yxsJ@0; miF WITH yxsK@0;
 miG WITH yxsF@0; miG WITH yxsH@0; miG WITH yxsI@0; miG WITH yxsJ@0; miG WITH yxsK@0;
 miH WITH yxsF@0; miH WITH yxsG@0; miH WITH yxsI@0; miH WITH yxsJ@0; miH WITH yxsK@0;
 miI WITH yxsF@0; miI WITH yxsG@0; miI WITH yxsH@0; miI WITH yxsJ@0; miI WITH yxsK@0;
 miJ WITH yxsF@0; miJ WITH yxsG@0; miJ WITH yxsH@0; miJ WITH yxsI@0; miJ WITH yxsK@0;
 miK WITH yxsF@0; miK WITH yxsG@0; miK WITH yxsH@0; miK WITH yxsI@0; miK WITH yxsJ@0;

miA WITH ymsB@0; miA WITH ymsC@0; miA WITH ymsD@0; miA WITH ymsE@0; miA WITH ymsF@0;
miB WITH ymsA@0; miB WITH ymsC@0; miB WITH ymsD@0; miB WITH ymsE@0; miB WITH ymsF@0;
miC WITH ymsA@0; miC WITH ymsB@0; miC WITH ymsD@0; miC WITH ymsE@0; miC WITH ymsF@0;
miD WITH ymsA@0; miD WITH ymsB@0; miD WITH ymsC@0; miD WITH ymsE@0; miD WITH ymsF@0;
miE WITH ymsA@0; miE WITH ymsB@0; miE WITH ymsC@0; miE WITH ymsD@0; miE WITH ymsF@0;
miF WITH ymsA@0; miF WITH ymsB@0; miF WITH ymsC@0; miF WITH ymsD@0; miF WITH ymsE@0;
miG WITH ymsA@0; miG WITH ymsB@0; miG WITH ymsC@0; miG WITH ymsD@0; miG WITH ymsE@0;
```

```
miH WITH ymsA@0; miH WITH ymsB@0; miH WITH ymsC@0; miH WITH ymsD@0; miH WITH ymsE@0;
miI WITH ymsA@0; miI WITH ymsB@0; miI WITH ymsC@0; miI WITH ymsD@0; miI WITH ymsE@0;
miJ WITH ymsA@0; miJ WITH ymsB@0; miJ WITH ymsC@0; miJ WITH ymsD@0; miJ WITH ymsE@0;
miK WITH ymsA@0; miK WITH ymsB@0; miK WITH ymsC@0; miK WITH ymsD@0; miK WITH ymsE@0;

 miA WITH ymsG@0; miA WITH ymsH@0; miA WITH ymsI@0; miA WITH ymsJ@0; miA WITH ymsK@0;
 miB WITH ymsG@0; miB WITH ymsH@0; miB WITH ymsI@0; miB WITH ymsJ@0; miB WITH ymsK@0;
 miC WITH ymsG@0; miC WITH ymsH@0; miC WITH ymsI@0; miC WITH ymsJ@0; miC WITH ymsK@0;
 miD WITH ymsG@0; miD WITH ymsH@0; miD WITH ymsI@0; miD WITH ymsJ@0; miD WITH ymsK@0;
 miE WITH ymsG@0; miE WITH ymsH@0; miE WITH ymsI@0; miE WITH ymsJ@0; miE WITH ymsK@0;
 miF WITH ymsG@0; miF WITH ymsH@0; miF WITH ymsI@0; miF WITH ymsJ@0; miF WITH ymsK@0;
 miG WITH ymsF@0; miG WITH ymsH@0; miG WITH ymsI@0; miG WITH ymsJ@0; miG WITH ymsK@0;
 miH WITH ymsF@0; miH WITH ymsG@0; miH WITH ymsI@0; miH WITH ymsJ@0; miH WITH ymsK@0;
 miI WITH ymsF@0; miI WITH ymsG@0; miI WITH ymsH@0; miI WITH ymsJ@0; miI WITH ymsK@0;
 miJ WITH ymsF@0; miJ WITH ymsG@0; miJ WITH ymsH@0; miJ WITH ymsI@0; miJ WITH ymsK@0;
 miK WITH ymsF@0; miK WITH ymsG@0; miK WITH ymsH@0; miK WITH ymsI@0; miK WITH ymsJ@0;

mxsA WITH yiB@0; mxsA WITH yiC@0; mxsA WITH yiD@0; mxsA WITH yiE@0; mxsA WITH yiF@0;
mxsB WITH yiA@0; mxsB WITH yiC@0; mxsB WITH yiD@0; mxsB WITH yiE@0; mxsB WITH yiF@0;
mxsC WITH yiA@0; mxsC WITH yiB@0; mxsC WITH yiD@0; mxsC WITH yiE@0; mxsC WITH yiF@0;
mxsD WITH yiA@0; mxsD WITH yiB@0; mxsD WITH yiC@0; mxsD WITH yiE@0; mxsD WITH yiF@0;
mxsE WITH yiA@0; mxsE WITH yiB@0; mxsE WITH yiC@0; mxsE WITH yiD@0; mxsE WITH yiF@0;
mxsF WITH yiA@0; mxsF WITH yiB@0; mxsF WITH yiC@0; mxsF WITH yiD@0; mxsF WITH yiE@0;
mxsG WITH yiA@0; mxsG WITH yiB@0; mxsG WITH yiC@0; mxsG WITH yiD@0; mxsG WITH yiE@0;
mxsH WITH yiA@0; mxsH WITH yiB@0; mxsH WITH yiC@0; mxsH WITH yiD@0; mxsH WITH yiE@0;
mxsI WITH yiA@0; mxsI WITH yiB@0; mxsI WITH yiC@0; mxsI WITH yiD@0; mxsI WITH yiE@0;
mxsJ WITH yiA@0; mxsJ WITH yiB@0; mxsJ WITH yiC@0; mxsJ WITH yiD@0; mxsJ WITH yiE@0;
mxsK WITH yiA@0; mxsK WITH yiB@0; mxsK WITH yiC@0; mxsK WITH yiD@0; mxsK WITH yiE@0;

 mxsA WITH yiG@0; mxsA WITH yiH@0; mxsA WITH yiI@0; mxsA WITH yiJ@0; mxsA WITH yiK@0;
 mxsB WITH yiG@0; mxsB WITH yiH@0; mxsB WITH yiI@0; mxsB WITH yiJ@0; mxsB WITH yiK@0;
 mxsC WITH yiG@0; mxsC WITH yiH@0; mxsC WITH yiI@0; mxsC WITH yiJ@0; mxsC WITH yiK@0;
 mxsD WITH yiG@0; mxsD WITH yiH@0; mxsD WITH yiI@0; mxsD WITH yiJ@0; mxsD WITH yiK@0;
 mxsE WITH yiG@0; mxsE WITH yiH@0; mxsE WITH yiI@0; mxsE WITH yiJ@0; mxsE WITH yiK@0;
 mxsF WITH yiG@0; mxsF WITH yiH@0; mxsF WITH yiI@0; mxsF WITH yiJ@0; mxsF WITH yiK@0;
 mxsG WITH yiF@0; mxsG WITH yiH@0; mxsG WITH yiI@0; mxsG WITH yiJ@0; mxsG WITH yiK@0;
 mxsH WITH yiF@0; mxsH WITH yiG@0; mxsH WITH yiI@0; mxsH WITH yiJ@0; mxsH WITH yiK@0;
 mxsI WITH yiF@0; mxsI WITH yiG@0; mxsI WITH yiH@0; mxsI WITH yiJ@0; mxsI WITH yiK@0;
 mxsJ WITH yiF@0; mxsJ WITH yiG@0; mxsJ WITH yiH@0; mxsJ WITH yiI@0; mxsJ WITH yiK@0;
 mxsK WITH yiF@0; mxsK WITH yiG@0; mxsK WITH yiH@0; mxsK WITH yiI@0; mxsK WITH yiJ@0;

mxsA WITH yxsB@0; mxsA WITH yxsC@0; mxsA WITH yxsD@0; mxsA WITH yxsE@0; mxsA WITH yxsF@0;
mxsB WITH yxsA@0; mxsB WITH yxsC@0; mxsB WITH yxsD@0; mxsB WITH yxsE@0; mxsB WITH yxsF@0;
mxsC WITH yxsA@0; mxsC WITH yxsB@0; mxsC WITH yxsD@0; mxsC WITH yxsE@0; mxsC WITH yxsF@0;
mxsD WITH yxsA@0; mxsD WITH yxsB@0; mxsD WITH yxsC@0; mxsD WITH yxsE@0; mxsD WITH yxsF@0;
mxsE WITH yxsA@0; mxsE WITH yxsB@0; mxsE WITH yxsC@0; mxsE WITH yxsD@0; mxsE WITH yxsF@0;
mxsF WITH yxsA@0; mxsF WITH yxsB@0; mxsF WITH yxsC@0; mxsF WITH yxsD@0; mxsF WITH yxsE@0;
mxsG WITH yxsA@0; mxsG WITH yxsB@0; mxsG WITH yxsC@0; mxsG WITH yxsD@0; mxsG WITH yxsE@0;
mxsH WITH yxsA@0; mxsH WITH yxsB@0; mxsH WITH yxsC@0; mxsH WITH yxsD@0; mxsH WITH yxsE@0;
mxsI WITH yxsA@0; mxsI WITH yxsB@0; mxsI WITH yxsC@0; mxsI WITH yxsD@0; mxsI WITH yxsE@0;
mxsJ WITH yxsA@0; mxsJ WITH yxsB@0; mxsJ WITH yxsC@0; mxsJ WITH yxsD@0; mxsJ WITH yxsE@0;
mxsK WITH yxsA@0; mxsK WITH yxsB@0; mxsK WITH yxsC@0; mxsK WITH yxsD@0; mxsK WITH yxsE@0;

 mxsA WITH yxsG@0; mxsA WITH yxsH@0; mxsA WITH yxsI@0; mxsA WITH yxsJ@0; mxsA WITH yxsK@0;
 mxsB WITH yxsG@0; mxsB WITH yxsH@0; mxsB WITH yxsI@0; mxsB WITH yxsJ@0; mxsB WITH yxsK@0;
 mxsC WITH yxsG@0; mxsC WITH yxsH@0; mxsC WITH yxsI@0; mxsC WITH yxsJ@0; mxsC WITH yxsK@0;
 mxsD WITH yxsG@0; mxsD WITH yxsH@0; mxsD WITH yxsI@0; mxsD WITH yxsJ@0; mxsD WITH yxsK@0;
 mxsE WITH yxsG@0; mxsE WITH yxsH@0; mxsE WITH yxsI@0; mxsE WITH yxsJ@0; mxsE WITH yxsK@0;
 mxsF WITH yxsG@0; mxsF WITH yxsH@0; mxsF WITH yxsI@0; mxsF WITH yxsJ@0; mxsF WITH yxsK@0;
 mxsG WITH yxsF@0; mxsG WITH yxsH@0; mxsG WITH yxsI@0; mxsG WITH yxsJ@0; mxsG WITH yxsK@0;
 mxsH WITH yxsF@0; mxsH WITH yxsG@0; mxsH WITH yxsI@0; mxsH WITH yxsJ@0; mxsH WITH yxsK@0;
 mxsI WITH yxsF@0; mxsI WITH yxsG@0; mxsI WITH yxsH@0; mxsI WITH yxsJ@0; mxsI WITH yxsK@0;
```

```
 mxsJ WITH yxsF@0; mxsJ WITH yxsG@0; mxsJ WITH yxsH@0; mxsJ WITH yxsI@0; mxsJ WITH yxsK@0;
 mxsK WITH yxsF@0; mxsK WITH yxsG@0; mxsK WITH yxsH@0; mxsK WITH yxsI@0; mxsK WITH yxsJ@0;

mxsA WITH ymsB@0; mxsA WITH ymsC@0; mxsA WITH ymsD@0; mxsA WITH ymsE@0; mxsA WITH ymsF@0;
mxsB WITH ymsA@0; mxsB WITH ymsC@0; mxsB WITH ymsD@0; mxsB WITH ymsE@0; mxsB WITH ymsF@0;
mxsC WITH ymsA@0; mxsC WITH ymsB@0; mxsC WITH ymsD@0; mxsC WITH ymsE@0; mxsC WITH ymsF@0;
mxsD WITH ymsA@0; mxsD WITH ymsB@0; mxsD WITH ymsC@0; mxsD WITH ymsE@0; mxsD WITH ymsF@0;
mxsE WITH ymsA@0; mxsE WITH ymsB@0; mxsE WITH ymsC@0; mxsE WITH ymsD@0; mxsE WITH ymsF@0;
mxsF WITH ymsA@0; mxsF WITH ymsB@0; mxsF WITH ymsC@0; mxsF WITH ymsD@0; mxsF WITH ymsE@0;
mxsG WITH ymsA@0; mxsG WITH ymsB@0; mxsG WITH ymsC@0; mxsG WITH ymsD@0; mxsG WITH ymsE@0;
mxsH WITH ymsA@0; mxsH WITH ymsB@0; mxsH WITH ymsC@0; mxsH WITH ymsD@0; mxsH WITH ymsE@0;
mxsI WITH ymsA@0; mxsI WITH ymsB@0; mxsI WITH ymsC@0; mxsI WITH ymsD@0; mxsI WITH ymsE@0;
mxsJ WITH ymsA@0; mxsJ WITH ymsB@0; mxsJ WITH ymsC@0; mxsJ WITH ymsD@0; mxsJ WITH ymsE@0;
mxsK WITH ymsA@0; mxsK WITH ymsB@0; mxsK WITH ymsC@0; mxsK WITH ymsD@0; mxsK WITH ymsE@0;

 mxsA WITH ymsG@0; mxsA WITH ymsH@0; mxsA WITH ymsI@0; mxsA WITH ymsJ@0; mxsA WITH ymsK@0;
 mxsB WITH ymsG@0; mxsB WITH ymsH@0; mxsB WITH ymsI@0; mxsB WITH ymsJ@0; mxsB WITH ymsK@0;
 mxsC WITH ymsG@0; mxsC WITH ymsH@0; mxsC WITH ymsI@0; mxsC WITH ymsJ@0; mxsC WITH ymsK@0;
 mxsD WITH ymsG@0; mxsD WITH ymsH@0; mxsD WITH ymsI@0; mxsD WITH ymsJ@0; mxsD WITH ymsK@0;
 mxsE WITH ymsG@0; mxsE WITH ymsH@0; mxsE WITH ymsI@0; mxsE WITH ymsJ@0; mxsE WITH ymsK@0;
 mxsF WITH ymsG@0; mxsF WITH ymsH@0; mxsF WITH ymsI@0; mxsF WITH ymsJ@0; mxsF WITH ymsK@0;
 mxsG WITH ymsF@0; mxsG WITH ymsH@0; mxsG WITH ymsI@0; mxsG WITH ymsJ@0; mxsG WITH ymsK@0;
 mxsH WITH ymsF@0; mxsH WITH ymsG@0; mxsH WITH ymsI@0; mxsH WITH ymsJ@0; mxsH WITH ymsK@0;
 mxsI WITH ymsF@0; mxsI WITH ymsG@0; mxsI WITH ymsH@0; mxsI WITH ymsJ@0; mxsI WITH ymsK@0;
 mxsJ WITH ymsF@0; mxsJ WITH ymsG@0; mxsJ WITH ymsH@0; mxsJ WITH ymsI@0; mxsJ WITH ymsK@0;
 mxsK WITH ymsF@0; mxsK WITH ymsG@0; mxsK WITH ymsH@0; mxsK WITH ymsI@0; mxsK WITH ymsJ@0;

yiA WITH yxsB@0; yiA WITH yxsC@0; yiA WITH yxsD@0; yiA WITH yxsE@0; yiA WITH yxsF@0;
yiB WITH yxsA@0; yiB WITH yxsC@0; yiB WITH yxsD@0; yiB WITH yxsE@0; yiB WITH yxsF@0;
yiC WITH yxsA@0; yiC WITH yxsB@0; yiC WITH yxsD@0; yiC WITH yxsE@0; yiC WITH yxsF@0;
yiD WITH yxsA@0; yiD WITH yxsB@0; yiD WITH yxsC@0; yiD WITH yxsE@0; yiD WITH yxsF@0;
yiE WITH yxsA@0; yiE WITH yxsB@0; yiE WITH yxsC@0; yiE WITH yxsD@0; yiE WITH yxsF@0;
yiF WITH yxsA@0; yiF WITH yxsB@0; yiF WITH yxsC@0; yiF WITH yxsD@0; yiF WITH yxsE@0;
yiG WITH yxsA@0; yiG WITH yxsB@0; yiG WITH yxsC@0; yiG WITH yxsD@0; yiG WITH yxsE@0;
yiH WITH yxsA@0; yiH WITH yxsB@0; yiH WITH yxsC@0; yiH WITH yxsD@0; yiH WITH yxsE@0;
yiI WITH yxsA@0; yiI WITH yxsB@0; yiI WITH yxsC@0; yiI WITH yxsD@0; yiI WITH yxsE@0;
yiJ WITH yxsA@0; yiJ WITH yxsB@0; yiJ WITH yxsC@0; yiJ WITH yxsD@0; yiJ WITH yxsE@0;
yiK WITH yxsA@0; yiK WITH yxsB@0; yiK WITH yxsC@0; yiK WITH yxsD@0; yiK WITH yxsE@0;

 yiA WITH yxsG@0; yiA WITH yxsH@0; yiA WITH yxsI@0; yiA WITH yxsJ@0; yiA WITH yxsK@0;
 yiB WITH yxsG@0; yiB WITH yxsH@0; yiB WITH yxsI@0; yiB WITH yxsJ@0; yiB WITH yxsK@0;
 yiC WITH yxsG@0; yiC WITH yxsH@0; yiC WITH yxsI@0; yiC WITH yxsJ@0; yiC WITH yxsK@0;
 yiD WITH yxsG@0; yiD WITH yxsH@0; yiD WITH yxsI@0; yiD WITH yxsJ@0; yiD WITH yxsK@0;
 yiE WITH yxsG@0; yiE WITH yxsH@0; yiE WITH yxsI@0; yiE WITH yxsJ@0; yiE WITH yxsK@0;
 yiF WITH yxsG@0; yiF WITH yxsH@0; yiF WITH yxsI@0; yiF WITH yxsJ@0; yiF WITH yxsK@0;
 yiG WITH yxsF@0; yiG WITH yxsH@0; yiG WITH yxsI@0; yiG WITH yxsJ@0; yiG WITH yxsK@0;
 yiH WITH yxsF@0; yiH WITH yxsG@0; yiH WITH yxsI@0; yiH WITH yxsJ@0; yiH WITH yxsK@0;
 yiI WITH yxsF@0; yiI WITH yxsG@0; yiI WITH yxsH@0; yiI WITH yxsJ@0; yiI WITH yxsK@0;
 yiJ WITH yxsF@0; yiJ WITH yxsG@0; yiJ WITH yxsH@0; yiJ WITH yxsI@0; yiJ WITH yxsK@0;
 yiK WITH yxsF@0; yiK WITH yxsG@0; yiK WITH yxsH@0; yiK WITH yxsI@0; yiK WITH yxsJ@0;

yiA WITH ymsB@0; yiA WITH ymsC@0; yiA WITH ymsD@0; yiA WITH ymsE@0; yiA WITH ymsF@0;
yiB WITH ymsA@0; yiB WITH ymsC@0; yiB WITH ymsD@0; yiB WITH ymsE@0; yiB WITH ymsF@0;
yiC WITH ymsA@0; yiC WITH ymsB@0; yiC WITH ymsD@0; yiC WITH ymsE@0; yiC WITH ymsF@0;
yiD WITH ymsA@0; yiD WITH ymsB@0; yiD WITH ymsC@0; yiD WITH ymsE@0; yiD WITH ymsF@0;
yiE WITH ymsA@0; yiE WITH ymsB@0; yiE WITH ymsC@0; yiE WITH ymsD@0; yiE WITH ymsF@0;
yiF WITH ymsA@0; yiF WITH ymsB@0; yiF WITH ymsC@0; yiF WITH ymsD@0; yiF WITH ymsE@0;
yiG WITH ymsA@0; yiG WITH ymsB@0; yiG WITH ymsC@0; yiG WITH ymsD@0; yiG WITH ymsE@0;
yiH WITH ymsA@0; yiH WITH ymsB@0; yiH WITH ymsC@0; yiH WITH ymsD@0; yiH WITH ymsE@0;
yiI WITH ymsA@0; yiI WITH ymsB@0; yiI WITH ymsC@0; yiI WITH ymsD@0; yiI WITH ymsE@0;
yiJ WITH ymsA@0; yiJ WITH ymsB@0; yiJ WITH ymsC@0; yiJ WITH ymsD@0; yiJ WITH ymsE@0;
yiK WITH ymsA@0; yiK WITH ymsB@0; yiK WITH ymsC@0; yiK WITH ymsD@0; yiK WITH ymsE@0;
```

```
 yiA WITH ymsG@0; yiA WITH ymsH@0; yiA WITH ymsI@0; yiA WITH ymsJ@0; yiA WITH ymsK@0;
 yiB WITH ymsG@0; yiB WITH ymsH@0; yiB WITH ymsI@0; yiB WITH ymsJ@0; yiB WITH ymsK@0;
 yiC WITH ymsG@0; yiC WITH ymsH@0; yiC WITH ymsI@0; yiC WITH ymsJ@0; yiC WITH ymsK@0;
 yiD WITH ymsG@0; yiD WITH ymsH@0; yiD WITH ymsI@0; yiD WITH ymsJ@0; yiD WITH ymsK@0;
 yiE WITH ymsG@0; yiE WITH ymsH@0; yiE WITH ymsI@0; yiE WITH ymsJ@0; yiE WITH ymsK@0;
 yiF WITH ymsG@0; yiF WITH ymsH@0; yiF WITH ymsI@0; yiF WITH ymsJ@0; yiF WITH ymsK@0;
 yiG WITH ymsF@0; yiG WITH ymsH@0; yiG WITH ymsI@0; yiG WITH ymsJ@0; yiG WITH ymsK@0;
 yiH WITH ymsF@0; yiH WITH ymsG@0; yiH WITH ymsI@0; yiH WITH ymsJ@0; yiH WITH ymsK@0;
 yiI WITH ymsF@0; yiI WITH ymsG@0; yiI WITH ymsH@0; yiI WITH ymsJ@0; yiI WITH ymsK@0;
 yiJ WITH ymsF@0; yiJ WITH ymsG@0; yiJ WITH ymsH@0; yiJ WITH ymsI@0; yiJ WITH ymsK@0;
 yiK WITH ymsF@0; yiK WITH ymsG@0; yiK WITH ymsH@0; yiK WITH ymsI@0; yiK WITH ymsJ@0;

yxsA WITH ymsB@0; yxsA WITH ymsC@0; yxsA WITH ymsD@0; yxsA WITH ymsE@0; yxsA WITH ymsF@0;
yxsB WITH ymsA@0; yxsB WITH ymsC@0; yxsB WITH ymsD@0; yxsB WITH ymsE@0; yxsB WITH ymsF@0;
yxsC WITH ymsA@0; yxsC WITH ymsB@0; yxsC WITH ymsD@0; yxsC WITH ymsE@0; yxsC WITH ymsF@0;
yxsD WITH ymsA@0; yxsD WITH ymsB@0; yxsD WITH ymsC@0; yxsD WITH ymsE@0; yxsD WITH ymsF@0;
yxsE WITH ymsA@0; yxsE WITH ymsB@0; yxsE WITH ymsC@0; yxsE WITH ymsD@0; yxsE WITH ymsF@0;
yxsF WITH ymsA@0; yxsF WITH ymsB@0; yxsF WITH ymsC@0; yxsF WITH ymsD@0; yxsF WITH ymsE@0;
yxsG WITH ymsA@0; yxsG WITH ymsB@0; yxsG WITH ymsC@0; yxsG WITH ymsD@0; yxsG WITH ymsE@0;
yxsH WITH ymsA@0; yxsH WITH ymsB@0; yxsH WITH ymsC@0; yxsH WITH ymsD@0; yxsH WITH ymsE@0;
yxsI WITH ymsA@0; yxsI WITH ymsB@0; yxsI WITH ymsC@0; yxsI WITH ymsD@0; yxsI WITH ymsE@0;
yxsJ WITH ymsA@0; yxsJ WITH ymsB@0; yxsJ WITH ymsC@0; yxsJ WITH ymsD@0; yxsJ WITH ymsE@0;
yxsK WITH ymsA@0; yxsK WITH ymsB@0; yxsK WITH ymsC@0; yxsK WITH ymsD@0; yxsK WITH ymsE@0;

 yxsA WITH ymsG@0; yxsA WITH ymsH@0; yxsA WITH ymsI@0; yxsA WITH ymsJ@0; yxsA WITH ymsK@0;
 yxsB WITH ymsG@0; yxsB WITH ymsH@0; yxsB WITH ymsI@0; yxsB WITH ymsJ@0; yxsB WITH ymsK@0;
 yxsC WITH ymsG@0; yxsC WITH ymsH@0; yxsC WITH ymsI@0; yxsC WITH ymsJ@0; yxsC WITH ymsK@0;
 yxsD WITH ymsG@0; yxsD WITH ymsH@0; yxsD WITH ymsI@0; yxsD WITH ymsJ@0; yxsD WITH ymsK@0;
 yxsE WITH ymsG@0; yxsE WITH ymsH@0; yxsE WITH ymsI@0; yxsE WITH ymsJ@0; yxsE WITH ymsK@0;
 yxsF WITH ymsG@0; yxsF WITH ymsH@0; yxsF WITH ymsI@0; yxsF WITH ymsJ@0; yxsF WITH ymsK@0;
 yxsG WITH ymsF@0; yxsG WITH ymsH@0; yxsG WITH ymsI@0; yxsG WITH ymsJ@0; yxsG WITH ymsK@0;
 yxsH WITH ymsF@0; yxsH WITH ymsG@0; yxsH WITH ymsI@0; yxsH WITH ymsJ@0; yxsH WITH ymsK@0;
 yxsI WITH ymsF@0; yxsI WITH ymsG@0; yxsI WITH ymsH@0; yxsI WITH ymsJ@0; yxsI WITH ymsK@0;
 yxsJ WITH ymsF@0; yxsJ WITH ymsG@0; yxsJ WITH ymsH@0; yxsJ WITH ymsI@0; yxsJ WITH ymsK@0;
 yxsK WITH ymsF@0; yxsK WITH ymsG@0; yxsK WITH ymsH@0; yxsK WITH ymsI@0; yxsK WITH ymsJ@0;

MODEL CONSTRAINT:

mxA1=txAo1; mxA2=txAo2; mxA3=txAo3; mxA4=txAo4; mxA5=txAo5; mxA6=txAo6;
mxB1=txBo1; mxB2=txBo2; mxB3=txBo3; mxB4=txBo4; mxB5=txBo5; mxB6=txBo6;
mxC1=txCo1; mxC2=txCo2; mxC3=txCo3; mxC4=txCo4; mxC5=txCo5; mxC6=txCo6;
mxD1=txDo1; mxD2=txDo2; mxD3=txDo3; mxD4=txDo4; mxD5=txDo5; mxD6=txDo6;
mxE1=txEo1; mxE2=txEo2; mxE3=txEo3; mxE4=txEo4; mxE5=txEo5; mxE6=txEo6;
mxF1=txFo1; mxF2=txFo2; mxF3=txFo3; mxF4=txFo4; mxF5=txFo5; mxF6=txFo6;
mxG1=txGo1; mxG2=txGo2; mxG3=txGo3; mxG4=txGo4; mxG5=txGo5; mxG6=txGo6;
mxH1=txHo1; mxH2=txHo2; mxH3=txHo3; mxH4=txHo4; mxH5=txHo5; mxH6=txHo6;
mxI1=txIo1; mxI2=txIo2; mxI3=txIo3; mxI4=txIo4; mxI5=txIo5; mxI6=txIo6;
mxJ1=txJo1; mxJ2=txJo2; mxJ3=txJo3; mxJ4=txJo4; mxJ5=txJo5; mxJ6=txJo6;
mxK1=txKo1; mxK2=txKo2; mxK3=txKo3; mxK4=txKo4; mxK5=txKo5; mxK6=txKo6;

ymA1=tmAo1; ymA2=tmAo2; ymA3=tmAo3; ymA4=tmAo4; ymA5=tmAo5; ymA6=tmAo6;
ymB1=tmBo1; ymB2=tmBo2; ymB3=tmBo3; ymB4=tmBo4; ymB5=tmBo5; ymB6=tmBo6;
ymC1=tmCo1; ymC2=tmCo2; ymC3=tmCo3; ymC4=tmCo4; ymC5=tmCo5; ymC6=tmCo6;
ymD1=tmDo1; ymD2=tmDo2; ymD3=tmDo3; ymD4=tmDo4; ymD5=tmDo5; ymD6=tmDo6;
ymE1=tmEo1; ymE2=tmEo2; ymE3=tmEo3; ymE4=tmEo4; ymE5=tmEo5; ymE6=tmEo6;
ymF1=tmFo1; ymF2=tmFo2; ymF3=tmFo3; ymF4=tmFo4; ymF5=tmFo5; ymF6=tmFo6;
ymG1=tmGo1; ymG2=tmGo2; ymG3=tmGo3; ymG4=tmGo4; ymG5=tmGo5; ymG6=tmGo6;
ymH1=tmHo1; ymH2=tmHo2; ymH3=tmHo3; ymH4=tmHo4; ymH5=tmHo5; ymH6=tmHo6;
ymI1=tmIo1; ymI2=tmIo2; ymI3=tmIo3; ymI4=tmIo4; ymI5=tmIo5; ymI6=tmIo6;
ymJ1=tmJo1; ymJ2=tmJo2; ymJ3=tmJo3; ymJ4=tmJo4; ymJ5=tmJo5; ymJ6=tmJo6;
ymK1=tmKo1; ymK2=tmKo2; ymK3=tmKo3; ymK4=tmKo4; ymK5=tmKo5; ymK6=tmKo6;
```

```
yxA1=txAo1; yxA2=txAo2; yxA3=txAo3; yxA4=txAo4; yxA5=txAo5; yxA6=txAo6;
yxB1=txBo1; yxB2=txBo2; yxB3=txBo3; yxB4=txBo4; yxB5=txBo5; yxB6=txBo6;
yxC1=txCo1; yxC2=txCo2; yxC3=txCo3; yxC4=txCo4; yxC5=txCo5; yxC6=txCo6;
yxD1=txDo1; yxD2=txDo2; yxD3=txDo3; yxD4=txDo4; yxD5=txDo5; yxD6=txDo6;
yxE1=txEo1; yxE2=txEo2; yxE3=txEo3; yxE4=txEo4; yxE5=txEo5; yxE6=txEo6;
yxF1=txFo1; yxF2=txFo2; yxF3=txFo3; yxF4=txFo4; yxF5=txFo5; yxF6=txFo6;
yxG1=txGo1; yxG2=txGo2; yxG3=txGo3; yxG4=txGo4; yxG5=txGo5; yxG6=txGo6;
yxH1=txHo1; yxH2=txHo2; yxH3=txHo3; yxH4=txHo4; yxH5=txHo5; yxH6=txHo6;
yxI1=txIo1; yxI2=txIo2; yxI3=txIo3; yxI4=txIo4; yxI5=txIo5; yxI6=txIo6;
yxJ1=txJo1; yxJ2=txJo2; yxJ3=txJo3; yxJ4=txJo4; yxJ5=txJo5; yxJ6=txJo6;
yxK1=txKo1; yxK2=txKo2; yxK3=txKo3; yxK4=txKo4; yxK5=txKo5; yxK6=txKo6;

mxA7=txAo7; mxA8=txAo8; mxA9=txAo9; mxA10=txAo10; mxA11=txAo11;
mxB7=txBo7; mxB8=txBo8; mxB9=txBo9; mxB10=txBo10; mxB11=txBo11;
mxC7=txCo7; mxC8=txCo8; mxC9=txCo9; mxC10=txCo10; mxC11=txCo11;
mxD7=txDo7; mxD8=txDo8; mxD9=txDo9; mxD10=txDo10; mxD11=txDo11;
mxE7=txEo7; mxE8=txEo8; mxE9=txEo9; mxE10=txEo10; mxE11=txEo11;
mxF7=txFo7; mxF8=txFo8; mxF9=txFo9; mxF10=txFo10; mxF11=txFo11;
mxG7=txGo7; mxG8=txGo8; mxG9=txGo9; mxG10=txGo10; mxG11=txGo11;
mxH7=txHo7; mxH8=txHo8; mxH9=txHo9; mxH10=txHo10; mxH11=txHo11;
mxI7=txIo7; mxI8=txIo8; mxI9=txIo9; mxI10=txIo10; mxI11=txIo11;
mxJ7=txJo7; mxJ8=txJo8; mxJ9=txJo9; mxJ10=txJo10; mxJ11=txJo11;
mxK7=txKo7; mxK8=txKo8; mxK9=txKo9; mxK10=txKo10; mxK11=txKo11;

ymA7=tmAo7; ymA8=tmAo8; ymA9=tmAo9; ymA10=tmAo10; ymA11=tmAo11;
ymB7=tmBo7; ymB8=tmBo8; ymB9=tmBo9; ymB10=tmBo10; ymB11=tmBo11;
ymC7=tmCo7; ymC8=tmCo8; ymC9=tmCo9; ymC10=tmCo10; ymC11=tmCo11;
ymD7=tmDo7; ymD8=tmDo8; ymD9=tmDo9; ymD10=tmDo10; ymD11=tmDo11;
ymE7=tmEo7; ymE8=tmEo8; ymE9=tmEo9; ymE10=tmEo10; ymE11=tmEo11;
ymF7=tmFo7; ymF8=tmFo8; ymF9=tmFo9; ymF10=tmFo10; ymF11=tmFo11;
ymG7=tmGo7; ymG8=tmGo8; ymG9=tmGo9; ymG10=tmGo10; ymG11=tmGo11;
ymH7=tmHo7; ymH8=tmHo8; ymH9=tmHo9; ymH10=tmHo10; ymH11=tmHo11;
ymI7=tmIo7; ymI8=tmIo8; ymI9=tmIo9; ymI10=tmIo10; ymI11=tmIo11;
ymJ7=tmJo7; ymJ8=tmJo8; ymJ9=tmJo9; ymJ10=tmJo10; ymJ11=tmJo11;
ymK7=tmKo7; ymK8=tmKo8; ymK9=tmKo9; ymK10=tmKo10; ymK11=tmKo11;

yxA7=txAo7; yxA8=txAo8; yxA9=txAo9; yxA10=txAo10; yxA11=txAo11;
yxB7=txBo7; yxB8=txBo8; yxB9=txBo9; yxB10=txBo10; yxB11=txBo11;
yxC7=txCo7; yxC8=txCo8; yxC9=txCo9; yxC10=txCo10; yxC11=txCo11;
yxD7=txDo7; yxD8=txDo8; yxD9=txDo9; yxD10=txDo10; yxD11=txDo11;
yxE7=txEo7; yxE8=txEo8; yxE9=txEo9; yxE10=txEo10; yxE11=txEo11;
yxF7=txFo7; yxF8=txFo8; yxF9=txFo9; yxF10=txFo10; yxF11=txFo11;
yxG7=txGo7; yxG8=txGo8; yxG9=txGo9; yxG10=txGo10; yxG11=txGo11;
yxH7=txHo7; yxH8=txHo8; yxH9=txHo9; yxH10=txHo10; yxH11=txHo11;
yxI7=txIo7; yxI8=txIo8; yxI9=txIo9; yxI10=txIo10; yxI11=txIo11;
yxJ7=txJo7; yxJ8=txJo8; yxJ9=txJo9; yxJ10=txJo10; yxJ11=txJo11;
yxK7=txKo7; yxK8=txKo8; yxK9=txKo9; yxK10=txKo10; yxK11=txKo11;

OUTPUT: TECH1;
```

Bonus Appendix
Method 4: Centered Manifest Predictor (CMP) model

In the published paper I describe three methods for tackling mediation in three-level data: VCM, CEM, and CCM. This appendix contains a fourth method, termed the *Centered Manifest Predictor* (CMP) model. The data management is a little more cumbersome because it involves creating centered versions of level-1 variables, but may work if the other methods fail to converge properly.

Method 4: Centered Manifest Predictor (CMP)

This model is termed the *Centered Manifest Predictor* (CMP) model. The main idea behind this method is to partition variability of the observed variables into components that vary strictly within vs. between level-3 units. The strictly level-3 variability is modeled in the Between model of MSEM. The level-1 and level-2 variance components are further separated in the Within model by incorporating alternate versions of the predictor variables centered at level-2 cluster means. The CMP model is characterized by "unconflated" slope estimates at each level, allowing the researcher to estimate indirect effects separately within each level of the data hierarchy. The level-1 and level-2 slopes may vary randomly across level-3 units. Figure A1 contains a compact path diagram illustrating the CMP model.

The first step in implementing the CMP model is to create level-2 group mean centered versions of *X* and *M* in addition to their uncentered counterparts. That is, level-2 cluster means of *X* and *M* are subtracted from *X* and *M*, respectively, leaving $X_{i..}$ and $M_{i..}$. These centered level-1 predictors are incorporated into the model in much the same way that time-varying covariates are often incorporated into latent growth curve models (e.g., Muthén, 1993; Muthén & Curran, 1997) for data that are balanced on time. Because $X_{i..}$ and $M_{i..}$ have been centered using level-2 cluster means, they vary only within level-2 units, and not across level-2 or level-3 units, and therefore can explain only level-1 variance in dependent variables.

The CMP model takes advantage of the isomorphism between a random-intercepts multilevel model and a restricted confirmatory factor analysis (CFA) model with unit factor loadings. Level-1 units are modeled as exchangeable with other level-1 units within the same level-2 unit in precisely the same way that items are exchangeable with other items that load on the same factor in CFA (Bauer, 2003; Curran, 2003; Mehta & Neale, 2005). It is possible to represent the CMP model in terms of Muthén and Asparouhov's (2008) MSEM in the following manner. The measurement model serves only to link the measured variables—including X_{ijk}, M_{ijk}, Y_{ijk}, and the level-2 cluster mean centered variables $X_{i..}$ and $M_{i..}$—to latent Within and Between components. Eq. A1 is an expansion of Eq. 2a (in the article) in which observed variables are linked to latent level-1, level-2, and level-3 components. In Eq. A1, *i* = 1 or 2 to index only two level-1 units for compactness. For example, Y_{1jk} and Y_{2jk} represent the values of *Y* for the two level-1 units within level-2 unit *j* and level-3 unit *k*.

$$\mathbf{Y}_{ijk} = \mathbf{\Lambda}_{jk}\mathbf{\eta}_{jk} = \left[X_{1jk} \;\; X_{2jk} \;\; M_{1jk} \;\; M_{2jk} \;\; Y_{1jk} \;\; Y_{2jk} \;\; X_{1..} \;\; X_{2..} \;\; M_{1..} \;\; M_{2..} \right]' \qquad \text{(A1)}$$

where

$$\mathbf{\Lambda}_{jk} = \left[\begin{array}{ccccccccccccc|ccccccccc}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{array} \right] \qquad \text{(A2)}$$

$$\mathbf{\eta}'_{jk} = \left[\eta_{X1jk} \;\; \eta_{X2jk} \;\; \eta_{M1jk} \;\; \eta_{M2jk} \;\; \eta_{Y1jk} \;\; \eta_{Y2jk} \;\; \eta_{X1} \;\; \eta_{X2} \;\; \eta_{M1} \;\; \eta_{M2} \;\; \eta_{Xjk} \;\; \eta_{Mjk} \;\; \eta_{Yjk} \,\middle|\, \eta_{X1k} \;\; \eta_{X2k} \;\; \eta_{M1k} \;\; \eta_{M2k} \;\; \eta_{Y1k} \;\; \eta_{Y2k} \;\; \eta_{Xk} \;\; \eta_{Mk} \;\; \eta_{jk} \right] \qquad \text{(A3)}$$

Elements before the partition in $\mathbf{\Lambda}_{jk}$ and $\mathbf{\eta}_{jk}$ correspond to the Within model (where level-1 and level-2 relationships will be modeled) and elements after the partition correspond to the Between model (where level-3 effects will be modeled). The vector $\mathbf{\varepsilon}_{ijk}$ is not used here, but is available if the researcher wishes to use latent variables with multiple indicators rather than measured variables. X_{1jk} through Y_{2jk} represent the observed variables, and $X_{1..}$ through $M_{2..}$ represent the level-2 cluster mean centered versions of X_{ijk} and M_{ijk}. Only the first subscript is varied for $X_{1..}$, $X_{2..}$, $M_{1..}$, and $M_{2..}$ because these centered variables have no variance components at level-2 or level-3.

The measurement model in Eqs. A1 – A3 is used to assign measured variables to latent components that vary only at levels 1, 2, and 3. The Within structural model in Eq. A4 will be used to model the relationships among level-1 and level-2 components; these relationships potentially vary randomly across level-3 units. It is also used to link the Between components of the observed variables to latent components that vary strictly at level-3.

$$\boldsymbol{\eta}_{jk} = \boldsymbol{\alpha}_k + \mathbf{B}_k \boldsymbol{\eta}_{jk} + \boldsymbol{\zeta}_{jk}$$

$$= \begin{bmatrix} \eta_{X1jk} \\ \eta_{X2jk} \\ \eta_{M1jk} \\ \eta_{M2jk} \\ \eta_{Y1jk} \\ \eta_{Y2jk} \\ \eta_{X1} \\ \eta_{X2} \\ \eta_{M1} \\ \eta_{M2} \\ \eta_{Xjk} \\ \eta_{Mjk} \\ \eta_{Yjk} \\ \hline \eta_{X1k} \\ \eta_{X2k} \\ \eta_{M1k} \\ \eta_{M2k} \\ \eta_{Y1k} \\ \eta_{Y2k} \\ \eta_{Xk} \\ \eta_{Mk} \\ \eta_{Yk} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \hline 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \alpha_{\eta Xk} \\ \alpha_{\eta Mk} \\ \alpha_{\eta Yk} \end{bmatrix} + \left[\begin{array}{ccccccccccccc|ccccccccc}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & B_{MXjk} & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & B_{MXjk} & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & B_{YXjk} & 0 & B_{YMjk} & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & B_{YXjk} & 0 & B_{YMjk} & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & B_{MXk} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & B_{YXk} & B_{YMk} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
\hline
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{array} \right] \begin{bmatrix} \eta_{X1jk} \\ \eta_{X2jk} \\ \eta_{M1jk} \\ \eta_{M2jk} \\ \eta_{Y1jk} \\ \eta_{Y2jk} \\ \eta_{X1} \\ \eta_{X2} \\ \eta_{M1} \\ \eta_{M2} \\ \eta_{Xjk} \\ \eta_{Mjk} \\ \eta_{Yjk} \\ \hline \eta_{X1k} \\ \eta_{X2k} \\ \eta_{M1k} \\ \eta_{M2k} \\ \eta_{Y1k} \\ \eta_{Y2k} \\ \eta_{Xk} \\ \eta_{Mk} \\ \eta_{Yk} \end{bmatrix} + \begin{bmatrix} \zeta_{X1jk} \\ \zeta_{X2jk} \\ \zeta_{M1jk} \\ \zeta_{M2jk} \\ \zeta_{Y1jk} \\ \zeta_{Y2jk} \\ \zeta_{X1} \\ \zeta_{X2} \\ \zeta_{M1} \\ \zeta_{M2} \\ \zeta_{Xjk} \\ \zeta_{Mjk} \\ \zeta_{Yjk} \\ \hline 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} \quad \text{(A4)}$$

In Eq. A4, the Within latent components of the observed variables M_{ijk} and Y_{ijk} are regressed on $X_{i..}$ and $M_{i..}$. These slopes—B_{MXjk}, B_{YXjk}, and B_{YMjk}—represent the strictly level-1 effects that may vary randomly across level-3 units (but not across level-2 units). The residuals associated with these regressions—ζ_{X1jk} through ζ_{Y2jk} for the level-1 components and ζ_{Xjk}, ζ_{Mjk}, and ζ_{Yjk} for the level-2 components—vary according to:

$$\boldsymbol{\zeta}_{jk} \sim MVN\left(\begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \hline \underset{9\times 1}{\mathbf{0}} \end{bmatrix}, \left[\begin{array}{ccccccccccccc|c}
\sigma^2_{Xjk} & & & & & & & & & & & & & \\
0 & \sigma^2_{Xjk} & & & & & & & & & & & & \\
0 & 0 & \sigma^2_{Mjk} & & & & & & & & & & & \\
0 & 0 & 0 & \sigma^2_{Mjk} & & & & & & & & & & \\
0 & 0 & 0 & 0 & \sigma^2_{Yjk} & & & & & & & & & \\
0 & 0 & 0 & 0 & 0 & \sigma^2_{Yjk} & & & & & & & & \\
0 & 0 & 0 & 0 & 0 & 0 & \sigma^2_{Xjk} & & & & & & & \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma^2_{Xjk} & & & & & & \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma^2_{Mjk} & & & & & \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma^2_{Mjk} & & & & \\
 & & & & & & & & & & \Psi_{Xk} & & & \\
 & & & & & \underset{3\times 10}{\mathbf{0}} & & & & & 0 & \Psi_{Mk} & & \\
 & & & & & & & & & & 0 & 0 & \Psi_{Yk} & \\
\hline
 & & & & & \underset{9\times 10}{\mathbf{0}} & & & & & & \underset{9\times 3}{\mathbf{0}} & & \underset{9\times 9}{\mathbf{0}}
\end{array} \right] \right). \quad \text{(A5)}$$

In Eq. A5, σ^2_{Xjk}, σ^2_{Mjk}, and σ^2_{Yjk} are level-1 (residual) variances for the subscripted variables, and Ψ_{Xk}, Ψ_{Mk}, and Ψ_{Yk} are level-2 (residual) variances. These variances cannot themselves vary at higher levels in Muthén and Asparouhov's MSEM framework. Residuals from level-1 cannot covary with residuals from level-2. It is also important to note that X_{ijk} and $X_{i..}$ share the same level-1 residual variance, as do M_{ijk} and $M_{i..}$, so these equality constraints must be applied.

Finally, the Between structural model in Eq. A6 is used to model the relationships among the level-1 and level-2 random effects. All of the random elements from parameter matrices at levels 1 and 2 (random intercepts and slopes from $\boldsymbol{\alpha}_k$ and $\mathbf{B}_k$ in Eq. A4) are stacked into the vector $\boldsymbol{\eta}_k$. Means and intercepts of these random effects populate the mean vector $\boldsymbol{\mu}$, and the random intercepts $\alpha_{\eta Xk}$, $\alpha_{\eta Mk}$, and $\alpha_{\eta Yk}$ (representing strictly level-3 variability in *X*, *M*, and *Y*, respectively), are regressed on one another in matrix $\boldsymbol{\beta}$. The vector $\boldsymbol{\mu}$ also contains the means of level-1 slopes in $\mu_{BMX(1)}$, $\mu_{BYX(1)}$, and $\mu_{BYM(1)}$. Thus, the Between structural model contains the strictly level-1 slopes (e.g., $\mu_{BMX(1)}$), the strictly level-2 slopes (e.g., $\mu_{BMX(2)}$), and the strictly level-3 slopes (e.g., β_{MX}).

$$\boldsymbol{\eta}_k = \boldsymbol{\mu} + \boldsymbol{\beta}\boldsymbol{\eta}_k + \boldsymbol{\zeta}_k$$

$$= \begin{bmatrix} B_{MXjk} \\ B_{YXjk} \\ B_{YMjk} \\ B_{MXk} \\ B_{YXk} \\ B_{YMk} \\ \alpha_{\eta Xk} \\ \alpha_{\eta Mk} \\ \alpha_{\eta Yk} \end{bmatrix} = \begin{bmatrix} \mu_{BMX(1)} \\ \mu_{BYX(1)} \\ \mu_{BYM(1)} \\ \mu_{BMX(2)} \\ \mu_{BYX(2)} \\ \mu_{BYM(2)} \\ \mu_{\alpha\eta X} \\ \mu_{\alpha\eta M} \\ \mu_{\alpha\eta Y} \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \beta_{MX} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \beta_{YX} & \beta_{YM} & 0 \end{bmatrix} \begin{bmatrix} B_{MXjk} \\ B_{YXjk} \\ B_{YMjk} \\ B_{MXk} \\ B_{YXk} \\ B_{YMk} \\ \alpha_{\eta Xk} \\ \alpha_{\eta Mk} \\ \alpha_{\eta Yk} \end{bmatrix} + \begin{bmatrix} \zeta_{BMXjk} \\ \zeta_{BYXjk} \\ \zeta_{BYMjk} \\ \zeta_{BMXk} \\ \zeta_{BYXk} \\ \zeta_{BYMk} \\ \zeta_{\alpha\eta Xk} \\ \zeta_{\alpha\eta Mk} \\ \zeta_{\alpha\eta Yk} \end{bmatrix} \quad \text{(A6)}$$

The Between model residuals vary and covary according to:

$$\zeta_k \sim MVN\left(\begin{bmatrix}0\\0\\0\\0\\0\\0\\0\\0\\0\end{bmatrix},\begin{bmatrix}
\psi_{11} & & & & & & & & \\
\psi_{21} & \psi_{22} & & & & & & & \\
\psi_{31} & \psi_{32} & \psi_{33} & & & & & & \\
\psi_{41} & \psi_{42} & \psi_{43} & \psi_{44} & & & & & \\
\psi_{51} & \psi_{52} & \psi_{53} & \psi_{54} & \psi_{55} & & & & \\
\psi_{61} & \psi_{62} & \psi_{63} & \psi_{64} & \psi_{65} & \psi_{66} & & & \\
\psi_{71} & \psi_{72} & \psi_{73} & \psi_{74} & \psi_{75} & \psi_{76} & \psi_{77} & & \\
\psi_{81} & \psi_{82} & \psi_{83} & \psi_{84} & \psi_{85} & \psi_{86} & 0 & \psi_{88} & \\
\psi_{91} & \psi_{92} & \psi_{93} & \psi_{94} & \psi_{95} & \psi_{96} & 0 & 0 & \psi_{99}
\end{bmatrix}\right) \qquad \text{(A7)}$$

where ψ_{11} through ψ_{33} are the Level-3 (co)variances of level-1 random slopes; ψ_{44} through ψ_{66} are the Level-3 (co)variances of level-2 random slopes; ψ_{77}, ψ_{88}, ψ_{99} are the Variances of level-3 intercepts.

The residual variances in the Between model may vary freely for random coefficients, or may be constrained to zero for fixed coefficients, as the situation dictates.

Fitting the CMP model requires software capable of fitting multilevel SEM with random coefficients. Currently the only software in which this is practical is Mplus (Muthén & Muthén, 1998-2010). The steps involved in specifying the CMP model are as follows:

1. Create a data set in which every row corresponds to a different level-2 unit. Identify the maximum level-2 cluster size (max(n_j)) and create that many repeated measure variables each for X_{ijk}, M_{ijk}, Y_{ijk}, and the centered $X_{i..}$ and $M_{i..}$. Thus, assuming there are no covariates, there will be five times as many columns as there are level-1 units in the largest level-2 cluster. For level-2 units containing fewer than max(n_j) level-1 units, any observations short of max(n_j) will be treated as missing data. Include an additional column denoting level-3 cluster membership.
2. Allow X_{ijk}, M_{ijk}, Y_{ijk}, $X_{i..}$, and $M_{i..}$ to load on latent variables in the Within model with unit loadings, and allow X_{ijk}, M_{ijk}, and Y_{ijk} to load on latent variables in the Between model with unit loadings. This partitions the observed variables into latent components that vary strictly within and strictly between level-3 units.
3. Specify the Within model
   a. Allow the latent components of X_{ijk}, M_{ijk}, and Y_{ijk} to load on level-2 intercept factors with unit loadings.
   b. Allow each latent component of $X_{i..}$ and $M_{i..}$ to load on its own level-1 latent variable in the Within model with unit loadings.
   c. Regress the intercept factor for *M* onto the intercept factor for *X*, and regress the intercept factor for *Y* onto the intercept factors for both *X* and *M*.

d. Regress the level-1 latent components of *M* onto corresponding level-1 latent components of $X_{i..}$, constraining these slopes equal. Regress the level-1 latent components of *Y* onto corresponding level-1 latent components of $X_{i..}$ and $M_{i..}$, constraining the $X_{i..}$ slopes equal and constraining the $M_{i..}$ slopes equal.

4. Specify the Between model
   a. Allow the latent components of X_{ijk}, M_{ijk}, and Y_{ijk} to load on intercept factors with unit loadings.
   b. Regress the intercept factor for M onto the intercept factor for X, and regress the intercept factor for Y onto the intercept factors for both X and M.

There are potentially three indirect effects in the CMP model, which can be labeled the *level-1*, *level-2*, and *level-3 indirect effects*. The level-1 and level-2 indirect effects may involve slopes that vary at level-3. If both component slopes of either the level-1 or level-2 indirect effect vary at level-3, then the indirect effect involves a level-3 covariance term in addition to the usual product of coefficients (Goodman, 1960). The level-1 indirect effect is quantified as $\omega_{CMP1} = \mu_{BMX(1)}\mu_{BYM(1)} + \psi_{31}$, and is interpreted as the indirect effect of X_{ijk} on Y_{ijk} via M_{ijk} after controlling for level-2 and level-3 cluster membership. Its estimation assumes that there is no level-2 covariance between the Within slopes B_{MXjk} and B_{YMjk}. The level-2 indirect effect is quantified as $\omega_{CMP2} = \mu_{BMX(2)}\mu_{BYM(2)} + \psi_{64}$, and is interpreted as the indirect effect of level-2 cluster mean X_{ijk} on level-2 cluster mean Y_{ijk} via level-2 cluster mean M_{ijk} after controlling for level-3 cluster membership. The level-3 indirect effect is quantified as $\omega_{CMP3} = \beta_{MX}\beta_{YM}$, and is interpreted as the indirect effect of level-3 cluster mean X_{ijk} on level-3 cluster mean Y_{ijk} via level-3 cluster mean M_{ijk}.

Advantages. The CMP model has several advantages over existing methods for assessing mediation in three-level data. First, it can estimate separate effects at each level rather than a single conflated effect (as in MLM). Second, it accommodates dependence due to nesting within both level-2 and level-3 clusters. Third, it can accommodate level-1 and level-2 slopes that may be random at level-3. Fourth, because ω_{CMP1}, ω_{CMP2}, and ω_{CMP3} are estimated using latent components of X_{ijk}, M_{ijk}, and Y_{ijk} that vary strictly within levels 1, 2, and 3, these slopes are not conflated across levels, nor are they biased due to using observed cluster means. Fifth, it can accommodate a variety of level-1 residual covariance structures (independence was assumed here). Sixth, it can be estimated using existing software intended for two-level models. Seventh, because FIML estimation is used, it can accommodate clusters of different sizes simply by considering clusters with fewer than the maximum observed number of cases as containing missing data. Eighth, it can be extended to accommodate latent variables with multiple indicators. Finally, it can be expanded to accommodate other mediation models, such as longitudinal or multiple-mediator models.

Disadvantages. A disadvantage of the CMP model is that level-1 slopes may not be specified as random across level-2 units (only across level-3 units). If the level-1 slopes really do vary across level-2 units, the model is misspecified and bias likely will result. Another disadvantage is that, even though adding centered versions of *X* and *M* permits the estimation of strictly W slopes, doing so adds more variables to the Within model, which in turn alters the degrees of freedom. Thus, the interpretation of model fit and selection indices is compromised. However, nested model comparisons are still legitimate because only the log-likelihoods are used, and differences in *df* will still be accurate despite the addition of several centered variables.

```
TITLE: test msem;
DATA: FILE IS datawide.out;
VARIABLE:
NAMES ARE !tx, tm, and ty are group mean centered
          !variables not used in this analysis
k j x1-x10 m1-m10 y1-y10 tx1-tx10 tm1-tm10 ty1-ty10;
USEVARIABLES ARE
k   x1-x10 m1-m10 y1-y10 tx1-tx10 tm1-tm10;
WITHIN=tx1-tx10 tm1-tm10;
CLUSTER=k;
MISSING ARE ALL (-999);
ANALYSIS:
TYPE=TWOLEVEL RANDOM;
ALGORITHM=INTEGRATION;
INTEGRATION=MONTECARLO;
MODEL:

%WITHIN%

xiw BY x1-x10@1; miw BY m1-m10@1; yiw BY y1-y10@1;
m1-m10 PON tx1-tx10*.3(aw);
y1-y10 PON tm1-tm10*.1(bw);
y1-y10 PON tx1-tx10*.1(cw);
x1-x10*.34 (exw); m1-m10*.35 (emw); y1-y10*.30 (eyw);
xiw*.33; miw*.28; yiw*.29;
miw ON xiw*.1(ab2); yiw ON miw*.5(bb2); yiw ON xiw*.1(cb2);
tx1-tx10*.34 (exw); tm1-tm10*.35 (emw);
[tx1-tx10@0]; [tm1-tm10@0];

%BETWEEN%

[x1-x10@0]; [m1-m10@0]; [y1-y10@0];
xib BY x1-x10@1; mib BY m1-m10@1; yib BY y1-y10@1;
x1-x10@0; m1-m10@0; y1-y10@0;
[xib*0]; [mib*0]; [yib*0];
xib*.33; mib*.28; yib*.29;
mib ON xib*.4(ab3); yib ON mib*.2(bb3); yib ON xib*.3(cb3);

MODEL CONSTRAINT:
NEW(indw indb2 indb3);
indw=aw*bw;
indb2=ab2*bb2;
indb3=ab3*bb3;
```

References

Bauer, D. J. (2003). Estimating multilevel linear models as structural equation models. *Journal of Educational and Behavioral Statistics, 28,* 135-167.

Goodman, L. A. (1960). On the exact variance of products. *Journal of the American Statistical Association, 55*, 708-713.

Mehta, P. D., & Neale, M. C. (2005). People are variables too: Multilevel structural equation modeling. *Psychological Methods*, *10*, 259-284.

Muthén, B. (1993). Latent variable modeling of growth with missing data and multilevel data. In C. M. Cuadras, & C. R. Rao (Eds.), *Multivariate analysis: Future directions 2* (pp. 199-210). Amsterdam: North Holland.

Muthén, B. O., & Asparouhov, T. (2008). Growth mixture modeling: Analysis with non-Gaussian random effects. In G. Fitzmaurice, M. Davidian, G. Verbeke, & G. Molenberghs (Eds.), *Longitudinal data analysis* (pp. 143-165). Boca Raton, FL: Chapman & Hall/CCM.

Muthén, B. O., & Curran, P. J. (1997). General longitudinal modeling of individual differences in experimental designs: A latent variable framework for analysis and power estimation. *Psychological Methods*, *2,* 371-402.

Muthén, L. K., & Muthén, B. O. (1998-2010). *Mplus user's guide: Statistical analysis with latent variables* (6th ed.). Los Angeles, CA: Muthén & Muthén.

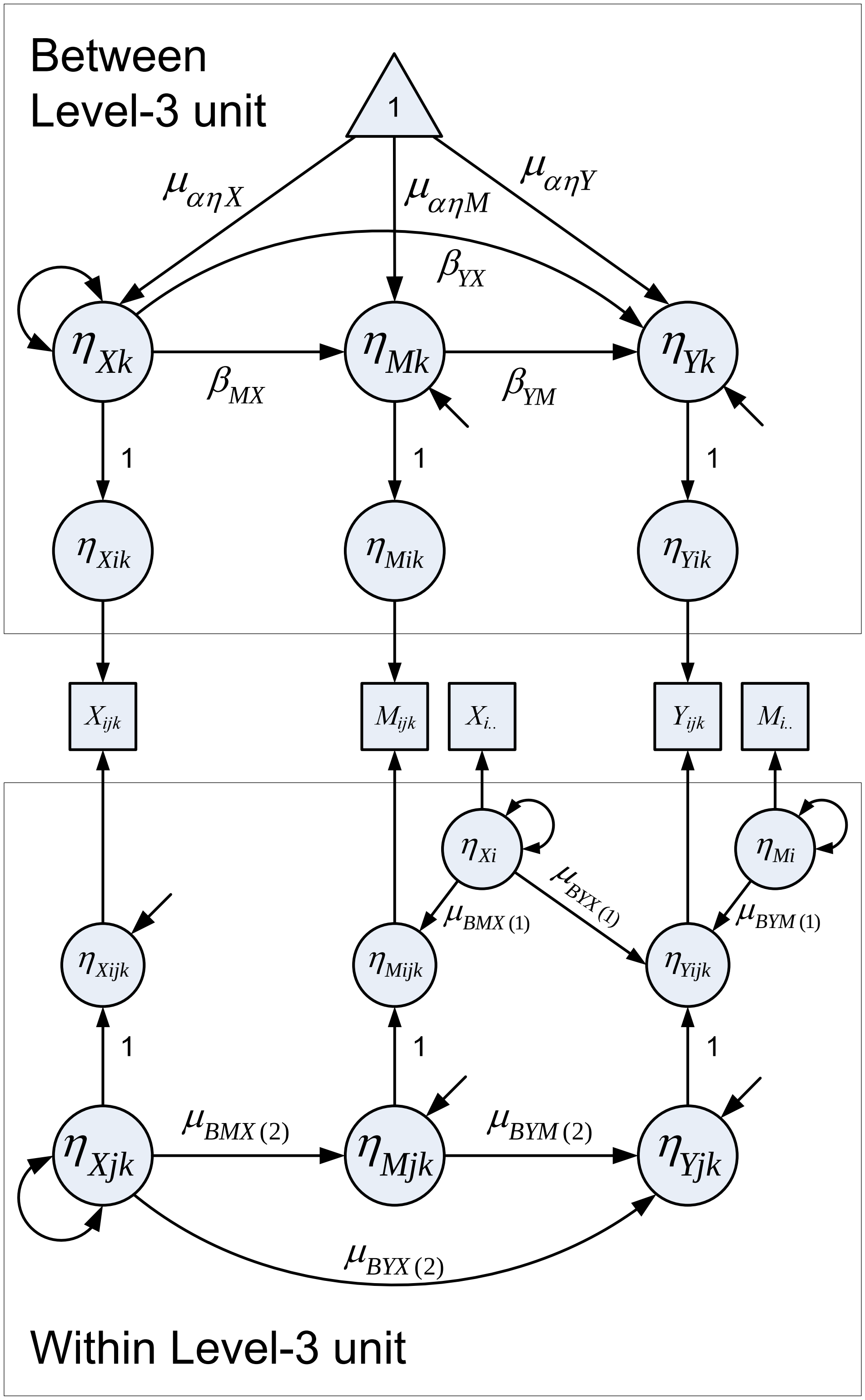

Figure A1. The CMP model in compact path diagram notation advocated by Mehta and Neale (2005).