MIC function additions

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Table of contents

Objectives

- Illustrates use of the MIC functions - namely, simdat, mic_iapm and mic_lcfa

Load MIC package and new R functions

```
rm(list=ls())
suppressPackageStartupMessages(library(MIC))
library(mirt)
```

```
Loading required package: stats4
```

```
Loading required package: lattice
```

Model Specification

These models, described using the lavaan model syntax, will be used in MIC::tr_reliability and mic_lcfa.

```
model_cfa <- '
   # Factors
   F1 =~ a1*Item_1+a2*Item_2+a3*Item_3+a4*Item_4+a5*Item_5+a6*Item_6+
         a7*Item_7+a8*Item_8+a9*Item_9+a10*Item_10+f1*trat
   F2 =~ a1*Item_1.1+a2*Item_2.1+a3*Item_3.1+a4*Item_4.1+a5*Item_5.1+
         a6*Item_6.1+a7*Item_7.1+a8*Item_8.1+a9*Item_9.1+a10*Item_10.1+f2*trat

   # Correlated errors over time
   Item_1 ~~ Item_1.1
   Item_2 ~~ Item_2.1
   Item_3 ~~ Item_3.1
   Item_4 ~~ Item_4.1
   Item_5 ~~ Item_5.1
   Item_6 ~~ Item_6.1
   Item_7 ~~ Item_7.1
   Item_8 ~~ Item_8.1
   Item_9 ~~ Item_9.1
   Item_10 ~~ Item_10.1

   # Thresholds
   Item_1 + Item_1.1 | b11*t1+b12*t2+b13*t3
   Item_2 + Item_2.1 | b21*t1+b22*t2+b23*t3
   Item_3 + Item_3.1 | b31*t1+b32*t2+b33*t3
   Item_4 + Item_4.1 | b41*t1+b42*t2+b43*t3
   Item_5 + Item_5.1 | b51*t1+b52*t2+b53*t3
   Item_6 + Item_6.1 | b61*t1+b62*t2+b63*t3
   Item_7 + Item_7.1 | b71*t1+b72*t2+b73*t3
   Item_8 + Item_8.1 | b81*t1+b82*t2+b83*t3
   Item_9 + Item_9.1 | b91*t1+b92*t2+b93*t3
 Item_10 + Item_10.1 | b101*t1+b102*t2+b103*t3


   # Variances/covariances
   F1 ~~ 1*F1
   F2 ~~ NA*F2
   F1 ~~ NA*F2

   Item_1.1 ~~ NA*Item_1.1
   Item_2.1 ~~ NA*Item_2.1
   Item_3.1 ~~ NA*Item_3.1
   Item_4.1 ~~ NA*Item_4.1
```

```
   Item_5.1 ~~ NA*Item_5.1
   Item_6.1 ~~ NA*Item_6.1
   Item_7.1 ~~ NA*Item_7.1
   Item_8.1 ~~ NA*Item_8.1
   Item_9.1 ~~ NA*Item_9.1
   Item_10.1 ~~ NA*Item_10.1

   # Means/intercepts
   F1 ~  0*1
   F2 ~ NA*1

   # Equal-but-opposite constrained factor loadings TR
   # remove this for psb assessment
   # f1 == -f2

   # b_param for trt
   trat | thr.trt*t1
   psb := (f1/f2) +1
   b_param := thr.trt/f2
   '



model_tr <- 'F1 = ~ Item_1 + Item_2 + Item_3 + Item_4 + Item_5 + Item_6 + Item_7 + Item_8
F2 = ~ Item_1.1 + Item_2.1 + Item_3.1 + Item_4.1 + Item_5.1 + Item_6.1 + Item_7.1 + Item_8
Item_1 ~~ Item_1.1
Item_2 ~~ Item_2.1
Item_3 ~~ Item_3.1
Item_4 ~~ Item_4.1
Item_5 ~~ Item_5.1
Item_6 ~~ Item_6.1
Item_7 ~~ Item_7.1
Item_8 ~~ Item_8.1
Item_9 ~~ Item_9.1
Item_10 ~~ Item_10.1
'
```

simdat

```
mydat <- simdat()$datw
head(mydat)
```

```
  Item_1 Item_2 Item_3 Item_4 Item_5 Item_6 Item_7 Item_8 Item_9 Item_10
1      0      1      1      1      0      0      0      0      3       0
2      1      1      1      3      1      1      0      1      0       1
3      1      1      2      3      1      0      1      0      0       2
4      2      2      1      2      1      2      1      2      0       0
5      3      1      1      1      2      0      0      1      0       0
6      3      2      1      2      0      0      1      0      2       1
  Item_1.1 Item_2.1 Item_3.1 Item_4.1 Item_5.1 Item_6.1 Item_7.1 Item_8.1
1        3        1        1        0        2        1        3        1
2        2        0        2        2        1        0        1        1
3        3        3        3        1        2        3        1        2
4        3        3        3        2        3        2        2        1
5        3        2        3        3        3        1        3        2
6        2        1        0        0        2        0        1        0
  Item_9.1 Item_10.1 trat xoc
1        0         1    0   7
2        3         0    0   2
3        0         0    1   7
4        3         1    1  10
5        3         3    1  17
6        0         0    0  -6
```

mic_lcfa

`mic_lcfa` estimates (i) present state bias in transition ratings[1] and (ii) anchor-based minimal important change using longitudinal confirmatory factor analysis[2]

```
mydat_cfa <- mydat[, !names(mydat) %in% "xoc"]
mic_lcfa (mydat = mydat_cfa, model = model_cfa, B = 50) ## should actually do more bootstr
```

```
$psb
[1] -0.03030116

$MIC.theta
[1] 0.3782999
```

```
$MIC.ets
[1] 2.50483

$MIC_CI
             Lower Upper
MIC.ets_boot 2.097 2.849
```

mic_iapm

`mic_iapm` computes the (i) predictive modeling-based, (ii) adjusted predictive modeling-based, and (iii) "improved" adjusted predictive modeling-based[3] MICs and their attendant bootstrapped 95% CIs.

Specifically, to compute the "improved" APM-based MIC, `mic_iapm` requires information about the reliability of the transition ratings (estimated using `MIC::tr_reliability`).

```
(mytr_rel <- tr_reliability(data = mydat_cfa, model = model_tr)$reliability)
```

```
Warning: lavaan->ldw_parse_step1():
   splitting of '=~' deprecated at line 1, pos 4
F1 = ~ Item_1 + Item_2 + Item_3 + Item_4 + Item_5 + Item_6 + Item_7 + Item_8 + Item_9 + Item
   ^

[1] 0.7065266
```

```
mic_iapm(mypred= "xoc", anchor = "trat", mydata= mydat, tr_rel = mytr_rel, nboot = 500)
```

```
Successfully simulated 100 bootstrapped MICs

Successfully simulated 200 bootstrapped MICs

Successfully simulated 300 bootstrapped MICs

Successfully simulated 400 bootstrapped MICs

Successfully simulated 500 bootstrapped MICs
```

```
$mic_pm
[1] 2.082743

$mic_apm
[1] 2.274713

$mic_iapm
[1] 2.461029

$boot_CI
   lower    upper
2.069670 2.852271

$mic_ci
     mic    lower    upper
2.461029 2.069670 2.852271
```

References

1. Griffiths P, Terluin B, Trigg A, Schuller W, Bjorner JB. A confirmatory factor analysis approach was found to accurately estimate the reliability of transition ratings. J Clin Epidemiol. 2022;141:36–45.
2. Terluin B, Trigg A, Fromy P, Schuller W, Terwee CB, Bjorner JB. Estimating anchor-based minimal important change using longitudinal confirmatory factor analysis. Qual Life Res. 2024;33:963–73.
3. Terluin B, Eekhout I, Terwee CB. Improved adjusted minimal important change took reliability of transition ratings into account. J Clin Epidemiol. 2022;148:48–53.