**Lab 2: Using R for Binary IRT Models**

**Feb 15, 2023**

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| Outline   * ‘irtoys’ R package * Example |

* Estimation and plotting of IRT models for binary responses using **‘irtoys’ R package**

**1. Installation of R package ‘irtoys’**

Packages > Install package(s) > USA(TN) > irtoys

**2. Functions in the R package ‘irtoys’**

See the following pages of the ‘irtoys’ manual downloaded from http://cran.r-project.org/web/packages/irtoys/irtoys.pdf.

* ‘est’ function [Estimate item parameters]: pages 7-9
* ‘eap’ function [EAP estimation of ability]: page 6
* ‘irf’ function [Item response function]: pages 10-11
* ‘plot.irf’ function [A plot method for item response functions]: page 18
* ‘plot.iif’ function [A plot method for item information functions]: page 17
* ‘plot.tif’ function [A plot method for test information functions]: page 29
* ‘scp’ function [Plot observed and predicted scores against ability]: pages 27-28
* Example

**1. Dataset**

binary.txt

25-item, 250-person

Codes as 0 or 1

Data description: see handout

Note: Missing responses can be coded as **NA**

**2. R Script**

**Data**

**Rasch (1PL)**

**2PL**

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| update.packages(ask='irtoys',checkBuilt=TRUE)  packageVersion("irtoys")  ## Call libraries irtoys and ltem  library(irtoys)  library(ltm)  ## Import binary data (binary.txt)  binary <- read.table("C:/Teaching/IRT I\_2023 Spring/Labs/Lab 2/binary.txt",header=TRUE)  binary[1:10,]  ## Fit a Rasch model or 1PL model  # Item parameter estimates  #"rasch"=T, the common value for discriminations is forced to 1  Rasch <- est(binary,model="1PL",engine="ltm",rasch=TRUE)  Rasch  Rasch <- est(binary, model="1PL", engine="ltm")  Rasch  # Person scores  Rasch.th <- eap(resp=binary,ip=Rasch$est,qu=normal.qu())  Rasch.th  write.table(Rasch.th,file="C:/Teaching/ IRT I\_2022 Spring /Labs/Lab 2/Rasch\_Score.txt",sep="\t")  # Wright Map with a "ltm" library  fsc <- factor.scores(rasch(binary))  plot(fsc,include.items=TRUE)  # Item response function: P\_ji  irf(Rasch$est[1,]) # For Item 1  irf(Rasch$est[,]) # For all items  # Item characteristic curves  plot(irf(Rasch$est[c(1),]),label=TRUE) # Plot item response function for item 1  plot(irf(Rasch$est),label=TRUE) # Plot item response function for all items  # Test charactersitic curves (IRT true scores)  scp(binary,Rasch$est) #The observed sum scores are shown in red.  # Item information curve  Rasch\_iif <- iif(Rasch$est)  plot(iif(Rasch$est[c(1),]),label=TRUE) # Plot item information function for item 1  plot(iif(Rasch$est),label=TRUE) # Plot item information function for all items  # Test information curve  plot(tif(Rasch$est),label=TRUE) # Plot test information function  ## Fit a 2PL model  # Item parameter estimates  Two <- est(binary,model="2PL",engine="ltm")  Two  # 2PL person scores  Th <- eap(resp=binary, ip=Two$est, qu=normal.qu())  write.table(Th,file="C:/Teaching/ IRT I\_2023 Spring /Labs/Lab 2/2PL\_Score.txt",sep="\t")  # Item response function: P\_ji  irf(Two$est[1,]) # For Item 1  irf(Two$est[,]) # For all items  # Item characteristic curves  plot(irf(Two$est[c(1),]),label=TRUE) # Plot item response function for item 1  plot(irf(Two$est),label=TRUE) # Plot item response function for all items  # Test charactersitic curves (IRT true scores)  scp(binary,Two$est) #The observed sum scores are shown in red.  # Item information curve  Two\_iif <- iif(Two$est)  plot(iif(Two$est[c(1),]),label=TRUE) # Plot item information function for item 1  plot(iif(Two$est),label=TRUE) # Plot item information function for all items  # Test information curve  plot(tif(Two$est),label=TRUE) # Plot test information function  ## Fit a 3PL model  # Item parameter estimates: There is a covergence problem for the 3PL.  Three <- est(binary,model="3PL",engine="ltm")  Three |

**3. Result interpretations**

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| > # Item parameter estimates  > #"rasch"=T, the common value for discriminations is forced to 1  >  > Rasch <- est(binary,model="1PL",engine="ltm",rasch=TRUE)  > Rasch  $est  Item parameter estimates   * [,1]: Item discrimination * [,2]: Item difficulty   Values on the left side in Wright Map   * [,3]: Item guessing   [,1] [,2] [,3]  item1 1 0.33090051 0  …  item25 1 0.79985547 0  $se  Standard errors of item parameter estimates   * [,1]: Item discrimination * [,2]: Item difficulty   Values on the left side in Wright Map   * [,3]: Item guessing   [,1] [,2] [,3]  [1,] NA 0.1650808 0  …  [25,] NA 0.1682570 0 |

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| * est: Person parameter estimate   Values on the right side of Wight Map   * sem: Standard errors of person parameter estimates * n: Number of items for person scoring   > Rasch.th  est sem n  [1,] -2.094335823 0.5397264 25  [2,] 0.611504864 0.3974595 25  [3,] 1.498102177 0.4543139 25  [4,] 0.148352147 0.3893718 25  …. |

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| > # Item response function: P\_ji  values  > irf(Rasch[1,]) # For Item 1  $x  [1] -4.00 -3.92 -3.84 -3.76 -3.68 -3.60 -3.52 -3.44 -3.36 -3.28 -3.20 -3.12  [13] -3.04 -2.96 -2.88 -2.80 -2.72 -2.64 -2.56 -2.48 -2.40 -2.32 -2.24 -2.16  [25] -2.08 -2.00 -1.92 -1.84 -1.76 -1.68 -1.60 -1.52 -1.44 -1.36 -1.28 -1.20  [37] -1.12 -1.04 -0.96 -0.88 -0.80 -0.72 -0.64 -0.56 -0.48 -0.40 -0.32 -0.24  [49] -0.16 -0.08 0.00 0.08 0.16 0.24 0.32 0.40 0.48 0.56 0.64 0.72  [61] 0.80 0.88 0.96 1.04 1.12 1.20 1.28 1.36 1.44 1.52 1.60 1.68  [73] 1.76 1.84 1.92 2.00 2.08 2.16 2.24 2.32 2.40 2.48 2.56 2.64  [85] 2.72 2.80 2.88 2.96 3.04 3.12 3.20 3.28 3.36 3.44 3.52 3.60  [97] 3.68 3.76 3.84 3.92 4.00  $f  [,1]  [1,] 0.01298487  Probability of a correct response for a person 1 on an item 1;    [2,] 0.01405115  [3,] 0.01520363  [4,] 0.01644907  [5,] 0.01779469  [6,] 0.01924823  … |

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| > # Item characteristic curves  > plot(irf(Rasch$est[c(1),]),label=TRUE) # Plot item response function for item 1 |

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| > # Test charactersitic curves (IRT true scores)  > scp(binary,Rasch$est)     * Score on the y-axis = true scores * True score with a confidence band (plus/minus standard error) * Observed sum scores are shown in red. |

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| > # Item information curve  > plot(iif(Rasch$est[c(1),]),label=TRUE) # Plot item information function for item 1    An item measures ability with greater precision at the ability level corresponding to the item difficulty parameter. |

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| > # Test information curve  > plot(tif(Rasch$est),label=TRUE) # Plot test information function |