

Basic mirt Commands: A Reference Guide

Derek Briggs

EDUC 8720

Contents

Introduction	1
Part 1: Classical Item Analysis	2
Part 2: Fitting IRT Models with <code>mirt</code>	3
Part 3: Plotting with <code>mirt</code>	6
Part 4: Test Characteristic Curve and Information Functions	9
Quick Reference Summary	13

Introduction

This document is a reference guide for using the `mirt` package in R to fit IRT models to dichotomously scored item response data. It covers the essential workflow from classical item analysis through model fitting, parameter extraction, and plotting. Use this as a resource when working with different data sets to complete class assignments.

Required Packages

```
library(mirt)
```

Loading Data

For this guide we use a 15-item data set (`pset1_formA.csv`). When working with your own data, update the file path accordingly.

```
data_path <- "../IRT Models for Dichotomously Scored Items/Data/"
forma <- read.csv(paste0(data_path, "pset1_formA.csv"))
forma <- forma[, 1:15] # Use first 15 items
head(forma)
```

```
##   V1 V2 V3 V4 V5 V6 V7 V8 V9 V10 V11 V12 V13 V14 V15
## 1  0  0  0  0  1  1  0  0  1  0  0  0  0  0  1
## 2  0  0  0  1  1  1  1  1  1  1  0  0  1  0  0
## 3  0  0  0  0  0  0  0  0  1  0  0  0  0  0  1
```

```
## 4 0 0 0 1 1 1 1 0 0 0 0 0 0 1 0
## 5 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## 6 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0
```

Part 1: Classical Item Analysis

Always start with descriptive statistics before doing anything fancy. In this context, descriptive stats are classical item statistics.

Item Statistics using `mirt:itemstats`

```
itemstats(forma)
```

```
## $overall
##      N mean_total.score sd_total.score ave.r  sd.r alpha SEM.alpha
## 1958      5.652      4.061 0.304 0.112 0.866      1.487
##
## $itemstats
##      N K  mean    sd total.r total.r_if_rm alpha_if_rm
## V1 1958 2 0.278 0.448  0.608      0.531      0.857
## V2 1958 2 0.261 0.440  0.606      0.530      0.857
## V3 1958 2 0.208 0.406  0.584      0.513      0.858
## V4 1958 2 0.601 0.490  0.606      0.520      0.857
## V5 1958 2 0.554 0.497  0.651      0.572      0.854
## V6 1958 2 0.380 0.486  0.600      0.515      0.857
## V7 1958 2 0.630 0.483  0.594      0.508      0.858
## V8 1958 2 0.202 0.402  0.577      0.505      0.858
## V9 1958 2 0.455 0.498  0.613      0.527      0.857
## V10 1958 2 0.368 0.482  0.672      0.598      0.853
## V11 1958 2 0.138 0.345  0.532      0.467      0.860
## V12 1958 2 0.172 0.378  0.542      0.471      0.860
## V13 1958 2 0.448 0.497  0.475      0.372      0.865
## V14 1958 2 0.515 0.500  0.615      0.530      0.857
## V15 1958 2 0.440 0.497  0.591      0.502      0.858
##
## $proportions
##      0      1
## V1 0.722 0.278
## V2 0.739 0.261
## V3 0.792 0.208
## V4 0.399 0.601
## V5 0.446 0.554
## V6 0.620 0.380
## V7 0.370 0.630
## V8 0.798 0.202
## V9 0.545 0.455
## V10 0.632 0.368
## V11 0.862 0.138
## V12 0.828 0.172
```

```
## V13 0.552 0.448
## V14 0.485 0.515
## V15 0.560 0.440
```

Part 2: Fitting IRT Models with mirt

Estimating the 1PL, 2PL, and 3PL Models

The `mirt` function is used to fit unidimensional IRT models. The key arguments are:

- `model = 1` specifies a unidimensional model
- `itemtype` specifies the model type: "Rasch", "2PL", or "3PL"
- `method = "EM"` specifies the EM algorithm for estimation (this is the default)

```
mirt_1pl <- mirt(forma, model = 1, itemtype = "Rasch", method = "EM")
mirt_2pl <- mirt(forma, model = 1, itemtype = "2PL", method = "EM")
mirt_3pl <- mirt(forma, model = 1, itemtype = "3PL", method = "EM")
```

Extracting Item Parameter Estimates

By default, `mirt` parameterizes models in **slope-intercept form**: $a_i(\theta_p + d_i)$. To get the traditional IRT parameterization $a_i(\theta_p - b_i)$, use `IRTpars = TRUE`.

```
# Slope-intercept form (default)
coef(mirt_2pl, simplify = TRUE)
```

```
## $items
##      a1      d g u
## V1  2.223 -1.707 0 1
## V2  2.285 -1.877 0 1
## V3  2.371 -2.413 0 1
## V4  1.833  0.599 0 1
## V5  2.152  0.311 0 1
## V6  1.641 -0.756 0 1
## V7  1.595  0.741 0 1
## V8  2.057 -2.258 0 1
## V9  1.580 -0.299 0 1
## V10 2.338 -1.052 0 1
## V11 2.353 -3.177 0 1
## V12 2.018 -2.520 0 1
## V13 0.956 -0.262 0 1
## V14 1.566  0.052 0 1
## V15 1.468 -0.368 0 1
##
## $means
## F1
##  0
##
## $cov
##      F1
## F1  1
```

```
# Traditional IRT form
coef(mirt_2pl, simplify = TRUE, IRTpars = TRUE)
```

```
## $items
##      a      b g u
## V1  2.223  0.768 0 1
## V2  2.285  0.821 0 1
## V3  2.371  1.018 0 1
## V4  1.833 -0.327 0 1
## V5  2.152 -0.144 0 1
## V6  1.641  0.461 0 1
## V7  1.595 -0.465 0 1
## V8  2.057  1.098 0 1
## V9  1.580  0.189 0 1
## V10 2.338  0.450 0 1
## V11 2.353  1.350 0 1
## V12 2.018  1.249 0 1
## V13 0.956  0.274 0 1
## V14 1.566 -0.033 0 1
## V15 1.468  0.251 0 1
##
## $means
## F1
## 0
##
## $cov
##      F1
## F1  1
```

Note the relationship between the two parameterizations: $b = -d/a$.

Saving and Working with Parameter Estimates

```
coef_1pl <- coef(mirt_1pl, simplify = TRUE, IRTpars = TRUE)
coef_2pl <- coef(mirt_2pl, simplify = TRUE, IRTpars = TRUE)
coef_3pl <- coef(mirt_3pl, simplify = TRUE, IRTpars = TRUE)

# Extract just the a and b columns for the 2PL
coef_2pl$items[, 1:2]
```

```
##      a      b
## V1  2.2229042  0.76796594
## V2  2.2852959  0.82116507
## V3  2.3709157  1.01792382
## V4  1.8331464 -0.32676666
## V5  2.1519449 -0.14432116
## V6  1.6413947  0.46051170
## V7  1.5948384 -0.46481011
## V8  2.0568636  1.09772715
## V9  1.5795863  0.18920500
## V10 2.3383711  0.44967213
```

```
## V11 2.3534503 1.35010342
## V12 2.0179700 1.24898596
## V13 0.9564336 0.27361200
## V14 1.5655666 -0.03331578
## V15 1.4678540 0.25067126
```

The *g* and *u* columns in the output represent the lower asymptote (guessing) and upper asymptote parameters. These are only estimated in the 3PL (and a hypothetical 4PL) model.

Comparing Parameters Across Models

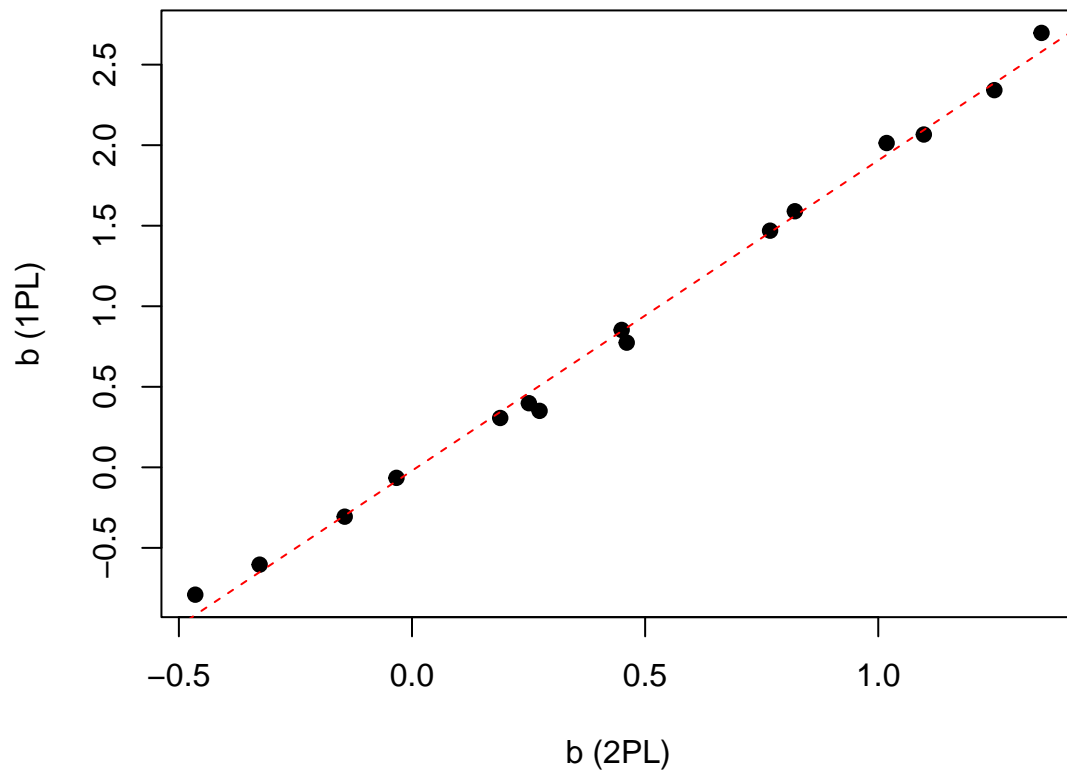
```
round(data.frame(
  coef_1pl$items[, 1:2],
  coef_2pl$items[, 1:2],
  coef_3pl$items[, 1:3]
), 3)
```

```
##      a      b  a.1  b.1  a.2  b.2      g
## V1  1  1.469 2.223 0.768 60.370 0.949 0.081
## V2  1  1.590 2.285 0.821 59.418 0.960 0.064
## V3  1  2.013 2.371 1.018 11.383 1.007 0.044
## V4  1 -0.604 1.833 -0.327 1.747 -0.290 0.000
## V5  1 -0.306 2.152 -0.144 2.048 -0.095 0.000
## V6  1  0.774 1.641 0.461 1.545 0.532 0.000
## V7  1 -0.791 1.595 -0.465 1.537 -0.433 0.000
## V8  1  2.066 2.057 1.098 1.903 1.186 0.000
## V9  1  0.306 1.580 0.189 1.531 0.248 0.000
## V10 1  0.853 2.338 0.450 2.139 0.532 0.000
## V11 1  2.697 2.353 1.350 2.027 1.470 0.000
## V12 1  2.342 2.018 1.249 1.838 1.347 0.000
## V13 1  0.351 0.956 0.274 0.932 0.324 0.000
## V14 1 -0.065 1.566 -0.033 1.476 0.015 0.000
## V15 1  0.398 1.468 0.251 1.412 0.310 0.000
```

Note that the 1PL estimates are on a **different scale** than the 2PL and 3PL estimates (see the companion document on scale constraints for details). But the *b*-values are highly correlated across models—the differences are up to a linear transformation due to scale.

```
plot(coef_2pl$items[, 2], coef_1pl$items[, 2],
     pch = 19, xlab = "b (2PL)", ylab = "b (1PL)",
     main = "Difficulty Estimates: 1PL vs. 2PL")
abline(lm(coef_1pl$items[, 2] ~ coef_2pl$items[, 2]), col = "red", lty = 2)
```

Difficulty Estimates: 1PL vs. 2PL

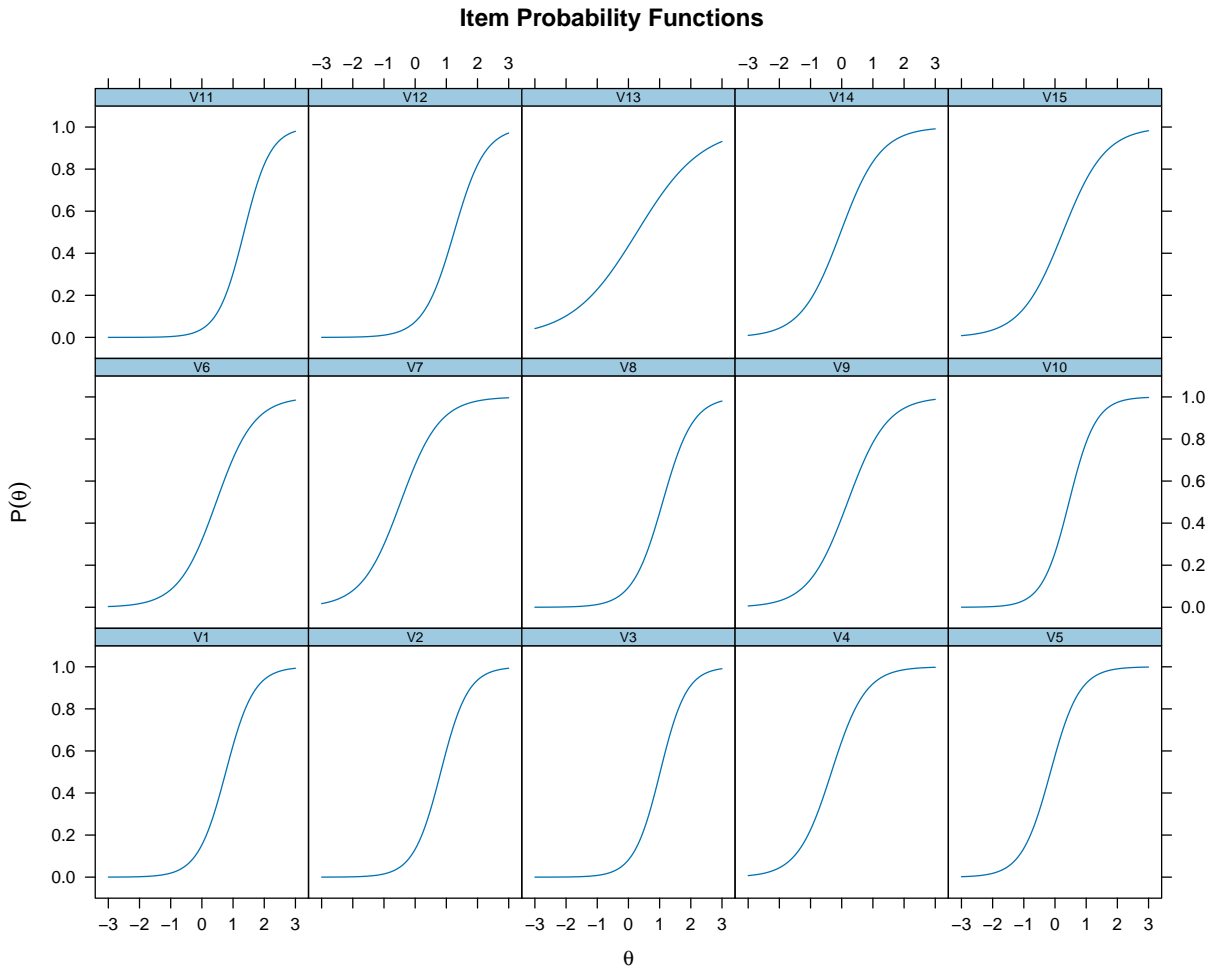


Part 3: Plotting with mirt

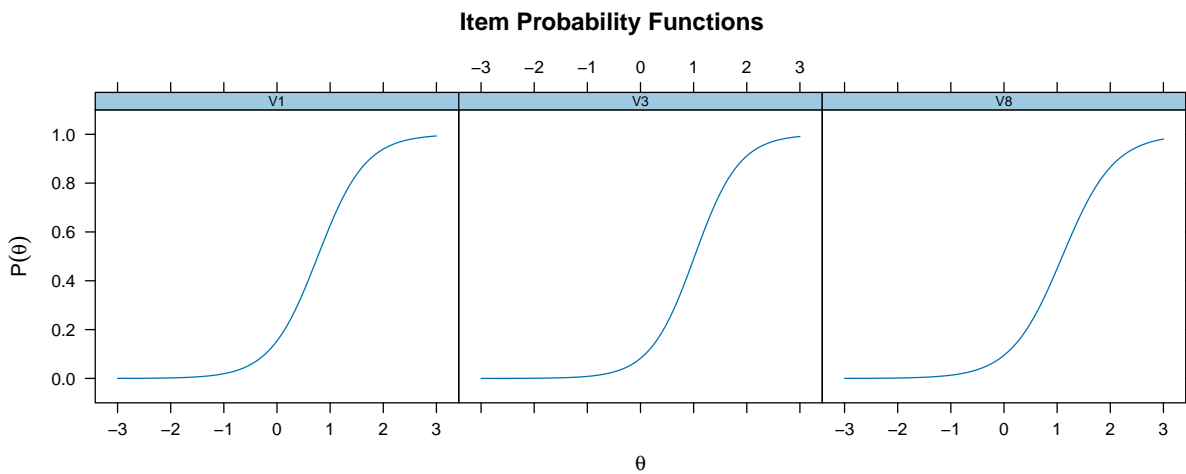
The `mirt` package has a powerful built-in `plot` function with many options. Use `help('plot-method')` to see all available plot types.

Item Response Functions (ICCs)

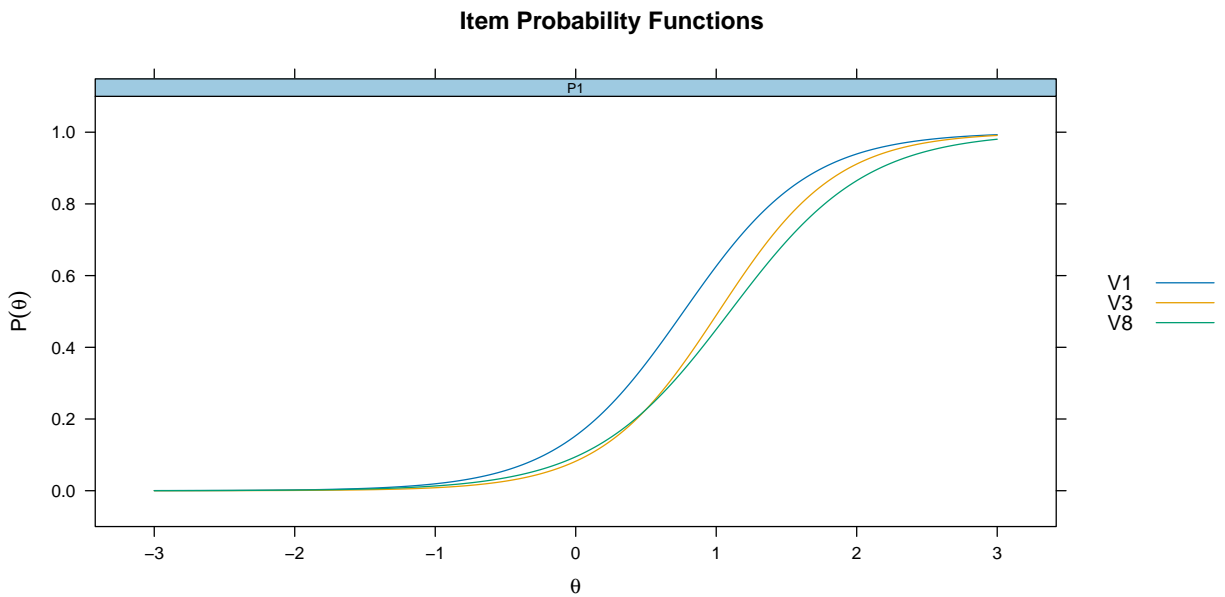
```
# All items
plot(mirt_2pl, type = 'trace', theta_lim = c(-3, 3))
```



```
# Specific items
plot(mirt_2pl, which.items = c(1, 3, 8), type = 'trace', theta_lim = c(-3, 3))
```



```
# Overlay specific ICCs on a single plot
plot(mirt_2pl,
     type = "trace",
     which.items = c(1, 3, 8),
     theta_lim = c(-3, 3),
     facet_items = FALSE)
```

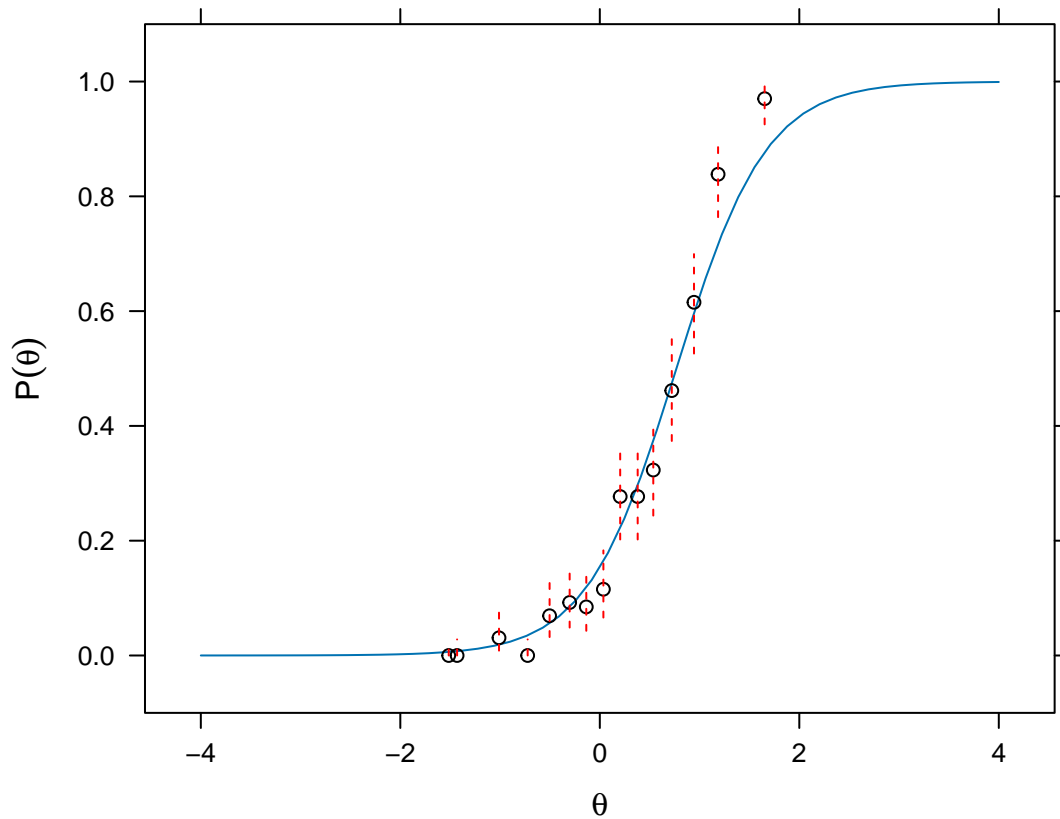


Observed vs. Predicted (Item Fit)

The `itemfit` function with `empirical.plot = 1` overlays observed response proportions on the model-implied ICC. This is useful for diagnosing item misfit.

```
itemfit(mirt_2pl, group.bins = 15, empirical.plot = 1, theta_lim = c(-3, 3))
```


Empirical plot for item 1

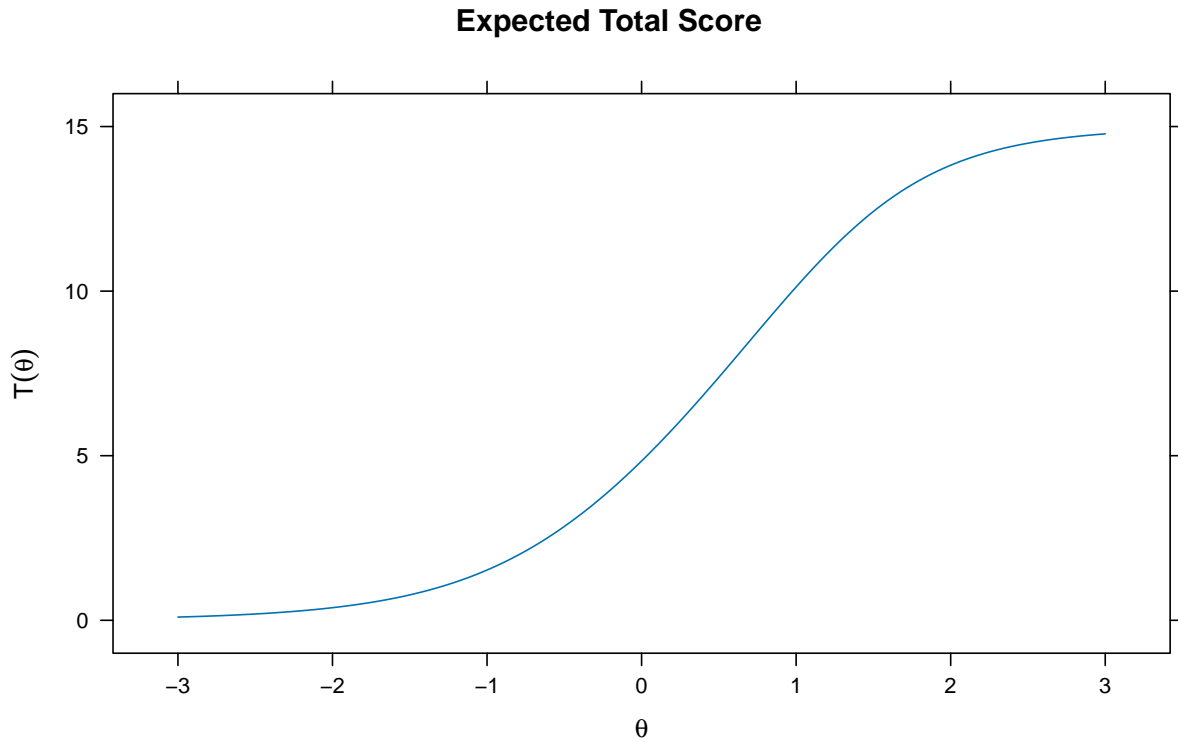


Part 4: Test Characteristic Curve and Information Functions

Test Characteristic Curve (TCC)

The TCC shows the expected number of correct answers (out of 15) at each ability level.

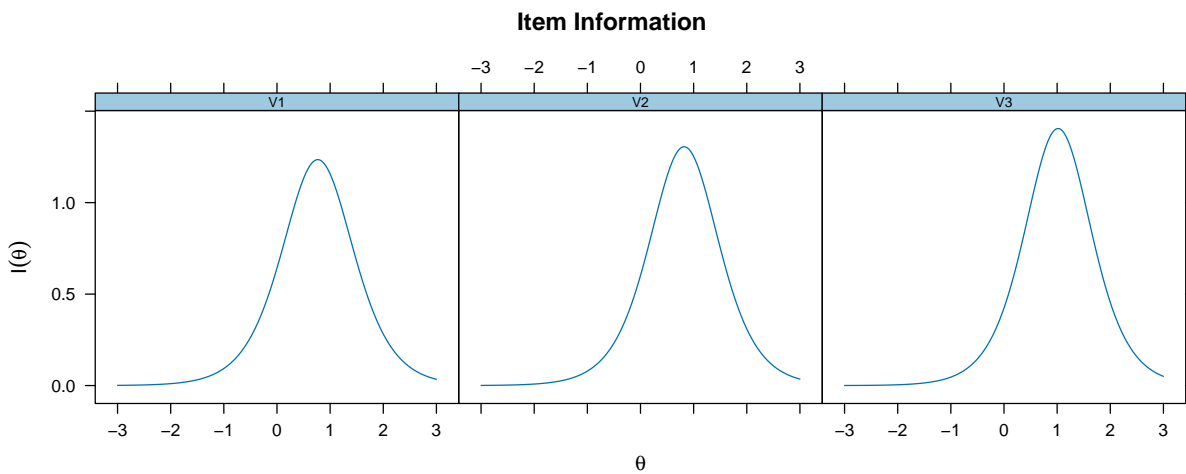
```
plot(mirt_2pl, theta_lim = c(-3, 3))
```



Item Information Functions

Each item provides a certain amount of “information” about ability at different points on the theta scale.

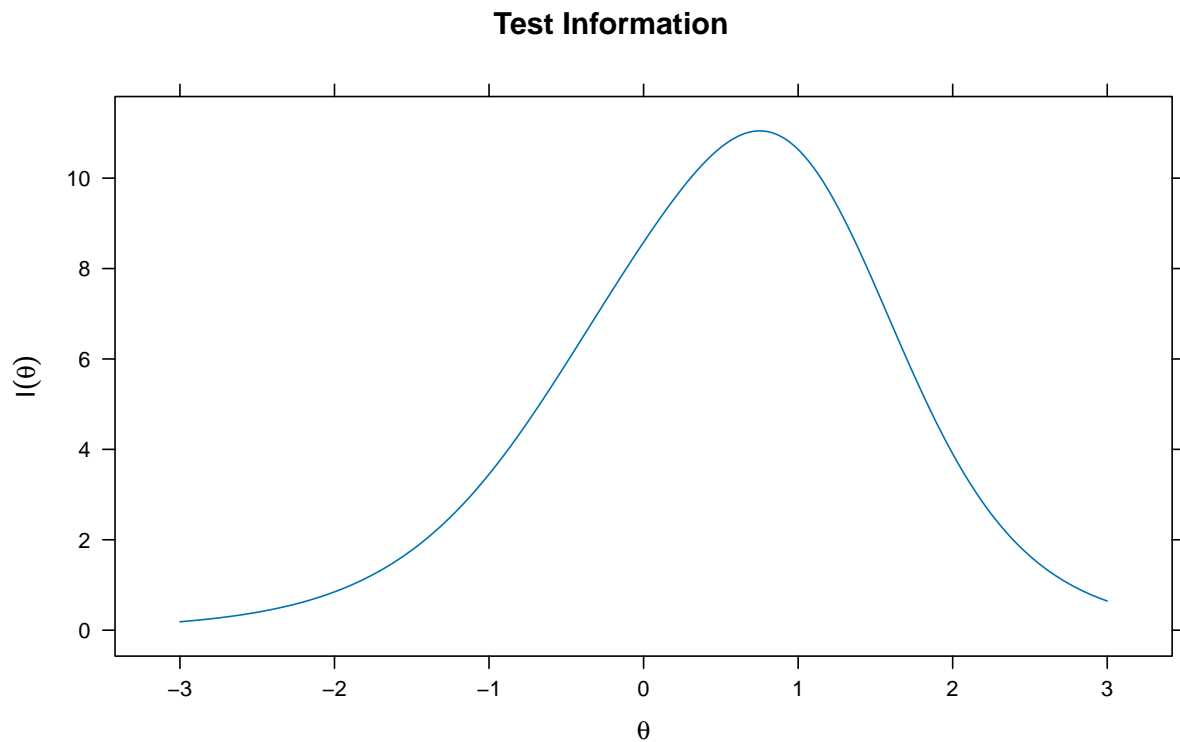
```
plot(mirt_2pl, type = 'infotrace', which.items = c(1:3), theta_lim = c(-3, 3))
```



Test Information Function

The test information function is the sum of all item information functions.

```
plot(mirt_2pl, type = 'info', theta_lim = c(-3, 3))
```

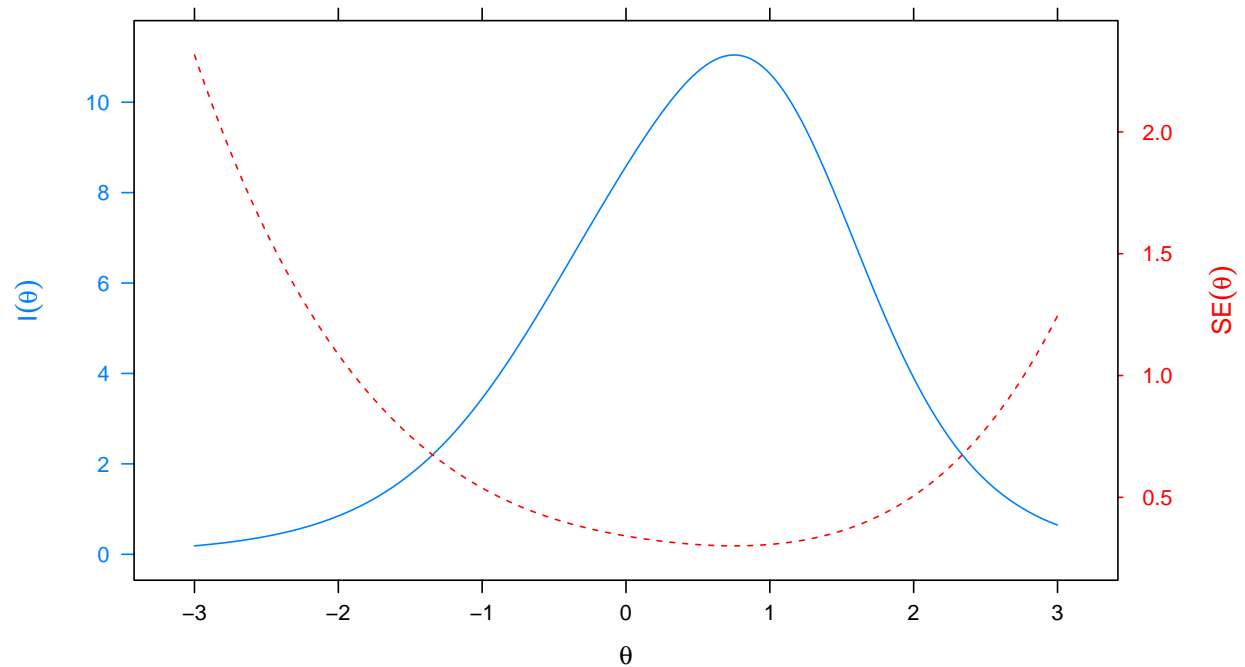


Test Information and Standard Error of Measurement

This combined plot shows both the test information function and the SEM on the same graph. The SEM is the inverse of the square root of the information: $SEM(\theta) = 1/\sqrt{I(\theta)}$.

```
plot(mirt_2pl, type = 'infoSE', theta_lim = c(-3, 3))
```

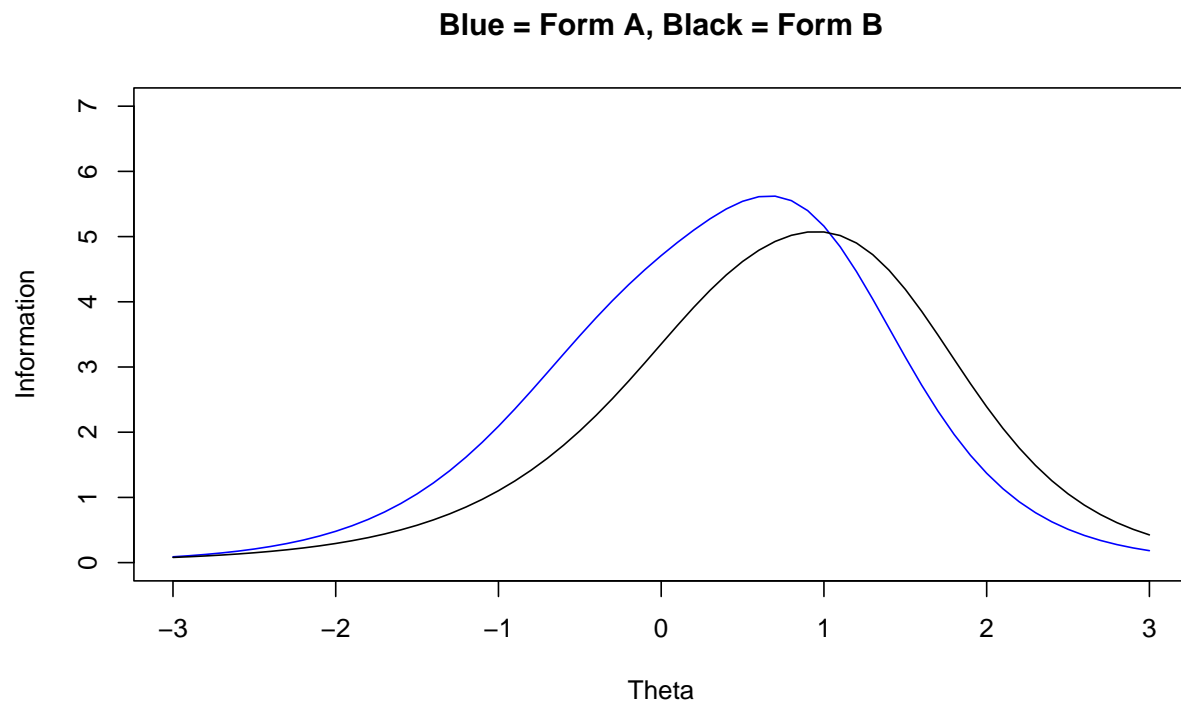
Test Information and Standard Errors



Comparing Custom Test Information Functions

Say we create two test forms, form A with items 1-7, and form B with items 8-14. Let's compare test info by form

```
A<-c(1:7)
B<-c(8:14)
A.info <- testinfo(mirt_2pl, which.items = A, Theta = matrix(seq(-3,3,by=0.1)))
B.info <- testinfo(mirt_2pl, which.items = B, Theta = matrix(seq(-3,3,by=0.1)))
ymax <- round(max(max(A.info), max(B.info)), 0) + 1 # Top end of y-axis
# Plotting information without using the mirt plot function
Theta <- seq(-3, 3, by = 0.1)
plot(Theta, A.info, type = "l", ylim = c(0, ymax), col = "blue",
     ylab = "Information", main = "Blue = Form A, Black = Form B")
lines(Theta, B.info, col = "black")
```



Quick Reference Summary

Classical Item Analysis

Task	Command
Classical item stats	<code>itemstats(data)</code>

Model Fitting

Task	Command
Fit Rasch model	<code>mirt(data, 1, itemtype = "Rasch")</code>
Fit 2PL model	<code>mirt(data, 1, itemtype = "2PL")</code>
Fit 3PL model	<code>mirt(data, 1, itemtype = "3PL")</code>

Extracting Parameters

Task	Command
Get IRT parameters	<code>coef(mod, simplify = TRUE, IRTpars = TRUE)</code>
Get slope-intercept form	<code>coef(mod, simplify = TRUE)</code>

Task	Command
EAP ability estimates	<code>fscores(mod, method = "EAP")</code>

Plotting

Task	Command
Plot all ICCs (faceted)	<code>plot(mod, type = 'trace', theta_lim = c(-3, 3))</code>
Plot specific item ICCs	<code>plot(mod, which.items = c(1, 3), type = 'trace', theta_lim = c(-3, 3))</code>
Overlay ICCs on one plot	<code>plot(mod, which.items = c(1, 3), type = 'trace', facet_items = FALSE)</code>
Plot TCC	<code>plot(mod, theta_lim = c(-3, 3))</code>
Plot item information	<code>plot(mod, type = 'infotrace', which.items = 1:3, theta_lim = c(-3, 3))</code>
Plot test information	<code>plot(mod, type = 'info', theta_lim = c(-3, 3))</code>
Plot info + SEM	<code>plot(mod, type = 'infoSE', theta_lim = c(-3, 3))</code>
Custom test info by form	<code>testinfo(mod, which.items = c(1:7), Theta = matrix(seq(-3, 3, by = 0.1)))</code>
Check item fit	<code>itemfit(mod, group.bins = 15, empirical.plot = 1, theta_lim = c(-3, 3))</code>