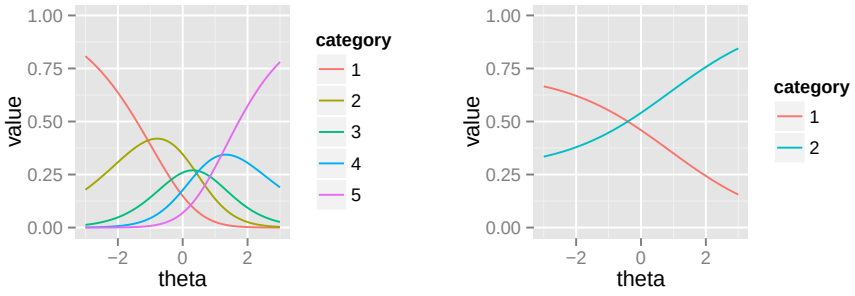
1 How to perform common IRT diagnostics

Here's how to create an item characteristic curve plot for any 1 dimensional item. These are random item parameters so the curves change every time the documentation is recreated.

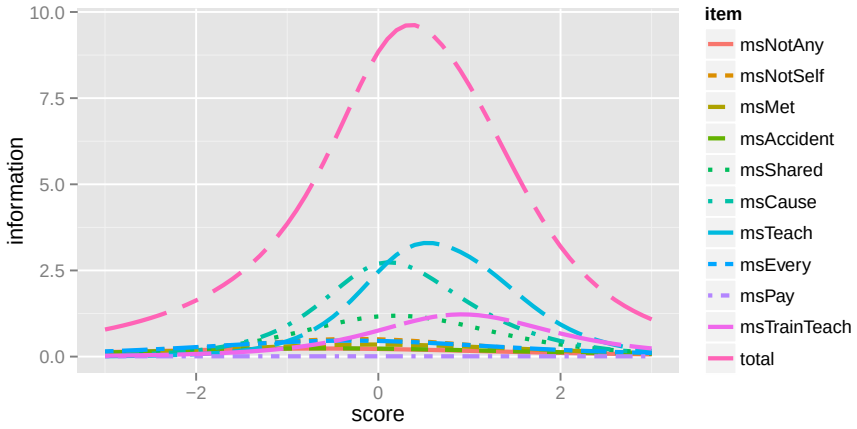
```
plot.icc <- function(item, param, width = 3) {
    pm <- rpf.prob(item, param, seq(-width, width, 0.1))
    icc <- as.data.frame(melt(pm, varnames = c("theta", "category")))
    icc$theta <- seq(-width, width, 0.1)
    icc$category <- as.factor(icc$category)
    ggplot(icc, aes(theta, value)) + geom_line(aes(color = category)) + ylim(0,
        1) + xlim(-width, width)
}

i1 <- rpf.gpcm(5)
i1.p <- rpf.rparam(i1)
i2 <- rpf.drm()
i2.p <- rpf.rparam(i2)
grid.arrange(plot.icc(i1, i1.p), plot.icc(i2, i2.p), ncol = 2)
```



Now let us look at some real data.

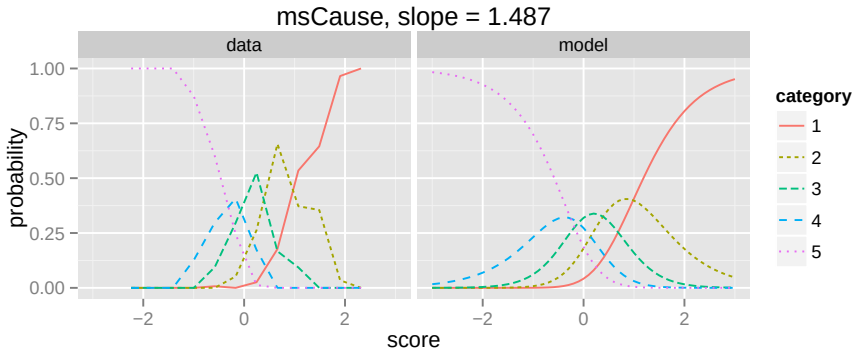
```
data(ms.items)

spec <- list()
for (ix in 1:10) {
    spec[[ix]] <- rpf.gpcm(5)
}

plot.info <- function(spec, param, i.name, width = 3) {
    if (missing(i.name)) {
        i.name <- paste0("i", 1:length(spec))
    }
    grid <- seq(-width, width, 0.1)
```

```
    df <- list(score = grid)
    total <- numeric(length(grid))
    for (ix in 1:length(spec)) {
        id <- i.name[ix]
        s <- spec[[ix]]
        df[[id]] <- rpf.info(s, param[ix, 1:s@numParam], grid)
        total <- total + df[[id]]
    }
    df$total <- total
    df <- as.data.frame(df)
    long <- melt(df, id.vars = c("score"), variable.name = "item")
    long$item <- factor(long$item)
    ggplot(long, aes(score, value, group = item)) + geom_line(size = 1.1, aes(linetype = ite
        color = item)) + ylab("information")
}

param <- ms.items[, c("slope", paste0("b", 1:4))]

plot.info(spec, param, ms.items[, "name"])
```



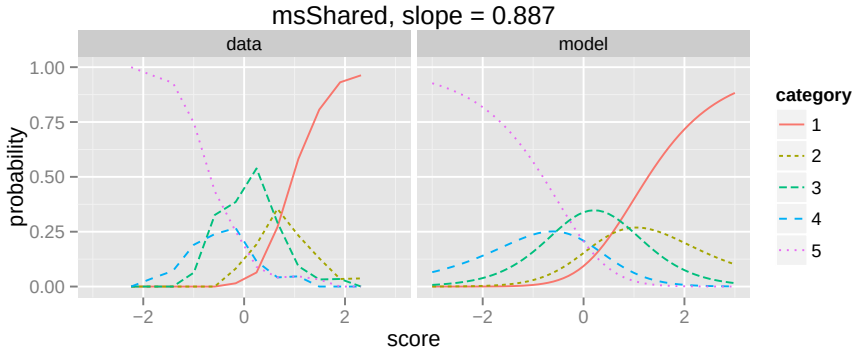

```
data(ms.people)

data.vs.model <- function(spec1, param, espt, item.name, width = 3, data.bins = 10) {
    pm <- rpf.prob(spec1, param[1:spec1@numParam], seq(-width, width, 0.1))
    icc <- as.data.frame(melt(pm, varnames = c("theta", "category")))
    icc$theta <- seq(-width, width, 0.1)
    icc$category <- as.ordered(1 + max(icc$category) - icc$category)  #parscale reverses stu
    icc$type <- "model"

    breaks <- seq(min(espt$score, na.rm = TRUE), max(espt$score, na.rm = TRUE),
```

```
        length.out = data.bins + 1)
    bin <- unclass(cut(espt$score, breaks, include.lowest = TRUE))
    est <- tabulate(bin, length(levels(bin)))
    if (any(est < 10)) {
        warning("Some bins have less than 10 samples; try fewer data.bins")
    }

    eout <- array(dim = c(data.bins, spec1@numOutcomes + 1))
    for (px in 1:data.bins) {
        t <- table(espt[[item.name]][bin == px], useNA = "no")
        eout[px, 2:(spec1@numOutcomes + 1)] <- t/sum(t)
    }
    eout[, 1] <- ((c(breaks, 0) + c(0, breaks))/2)[2:(data.bins + 1)]

    edf <- melt(as.data.frame(eout), id.vars = c("V1"), variable.name = "category")
    edf$category <- ordered(unclass(edf$category))
    edf$theta <- edf$V1
    edf$V1 <- NULL
    edf$type <- "data"

    both <- rbind(edf, icc)
    both$type <- factor(both$type)

    ggplot(both, aes(theta, value)) + geom_line(aes(color = category, linetype = category))
        facet_wrap(~type) + ylim(0, 1) + xlim(-width, width) + labs(y = "probability",
        x = "score")
}

name <- "msCause"
item.x <- match(name, ms.items$name)
param <- ms.items[item.x, c("slope", paste0("b", 1:4))]
data.vs.model(spec[[item.x]], param, ms.people, name, data.bins = 12) + labs(title = paste0(
    ", slope = ", param[1]))
```



Let us plot one more. For msShared, categories 2 and 4 are never the most likely choice. You can see this visually by confirming that the curves for categories 2 and 4 are already beneath the curves for other categories.

```
name <- "msShared"
item.x <- match(name, ms.items$name)
param <- ms.items[item.x, c("slope", paste0("b", 1:4))]
data.vs.model(spec[[item.x]], param, ms.people, name, data.bins = 12) + labs(title = paste0(
    ", slope = ", param[1]))
```



Let's take another dataset and look at item fit. This will show the most overfitting and underfitting items.

```
data(science.items)
data(science.people)

scores <- science.people$trait
params <- cbind(1, science.items[, c(paste0("b", 1:2))])
rownames(params) <- as.character(science.items$name)
items <- list()
items[1:25] <- rpf.gpcm(3)
```

```
responses <- science.people[, as.character(science.items$name)]
rownames(responses) <- science.people$name
fit <- rpf.1dim.fit(items, params, responses, scores, 2)
head(fit[order(-fit$outfit), ])
```

```
##    infit infit.z outfit outfit.z                   name
## 23 2.138  5.1802 3.9615  10.4071             WATCH A RAT
## 5  2.056  4.6570 3.3768   8.5301   FIND BOTTLES AND CANS
## 20 1.229  1.4549 1.5981   3.3955              WATCH BUGS
## 8  1.058  0.4359 1.1041   0.7370 LOOK IN SIDEWALK CRACKS
## 9  1.040  0.3358 1.0534   0.4319        LEARN WEED NAMES
## 16 1.008  0.1063 0.9636  -0.2062              MAKE A MAP
```

```
tail(fit[order(-fit$outfit), ])
```

```
##     infit infit.z outfit outfit.z                    name
## 11 0.6973  -2.053 0.5638   -3.182 FIND WHERE ANIMAL LIVES
## 12 0.7915  -1.162 0.5637   -2.776            GO TO MUSEUM
## 17 0.6234  -3.034 0.5603   -3.664  WATCH WHAT ANIMALS EAT
## 2  0.7020  -1.927 0.5235   -3.403   READ BOOKS ON ANIMALS
## 10 0.7154  -1.452 0.5210   -2.745     LISTEN TO BIRD SING
## 21 0.6816  -1.995 0.5112   -3.372    WATCH BIRD MAKE NEST
```

And we can do the same with people.

```
fit <- rpf.1dim.fit(items, params, responses, scores, 1)
head(fit[order(-fit$outfit), ])
```

```
##    infit infit.z outfit outfit.z              name
## 72 1.800  2.3481  4.721    7.146  JACKSON, SOLOMON
## 71 2.945  4.8233  4.406    7.072     STOLLER, DAVE
## 73 2.624  4.4155  3.960    6.729    SANDBERG, RYNE
## 29 1.188  0.7115  3.767    5.881     LANDMAN, ALAN
## 12 1.566  1.9160  3.270    5.581 LIEBERMAN, DANIEL
## 49 1.293  1.1557  2.137    3.539    BAUDET, GERARD
```

```
tail(fit[order(-fit$outfit), ])
```

```
##      infit  infit.z  outfit outfit.z                 name
## 16 0.61459 -1.14200 0.34774  -2.3793     BUFF, MARGE BABY
## 34 0.82123 -0.04295 0.33696  -1.0822         PASTER, RUTH
## 41 0.64827 -0.23107 0.28871  -0.9914      FATALE, NATASHA
## 22 0.28735 -3.55599 0.27813  -3.6325      HOGAN, KATHLEEN
## 21 0.25194 -4.11624 0.27123  -3.9369       EISEN, NORM L.
## 2  0.09884 -1.48753 0.05025  -1.7980 ROSSNER, LAWRENCE F.
```