i

Info

Some guidelines:

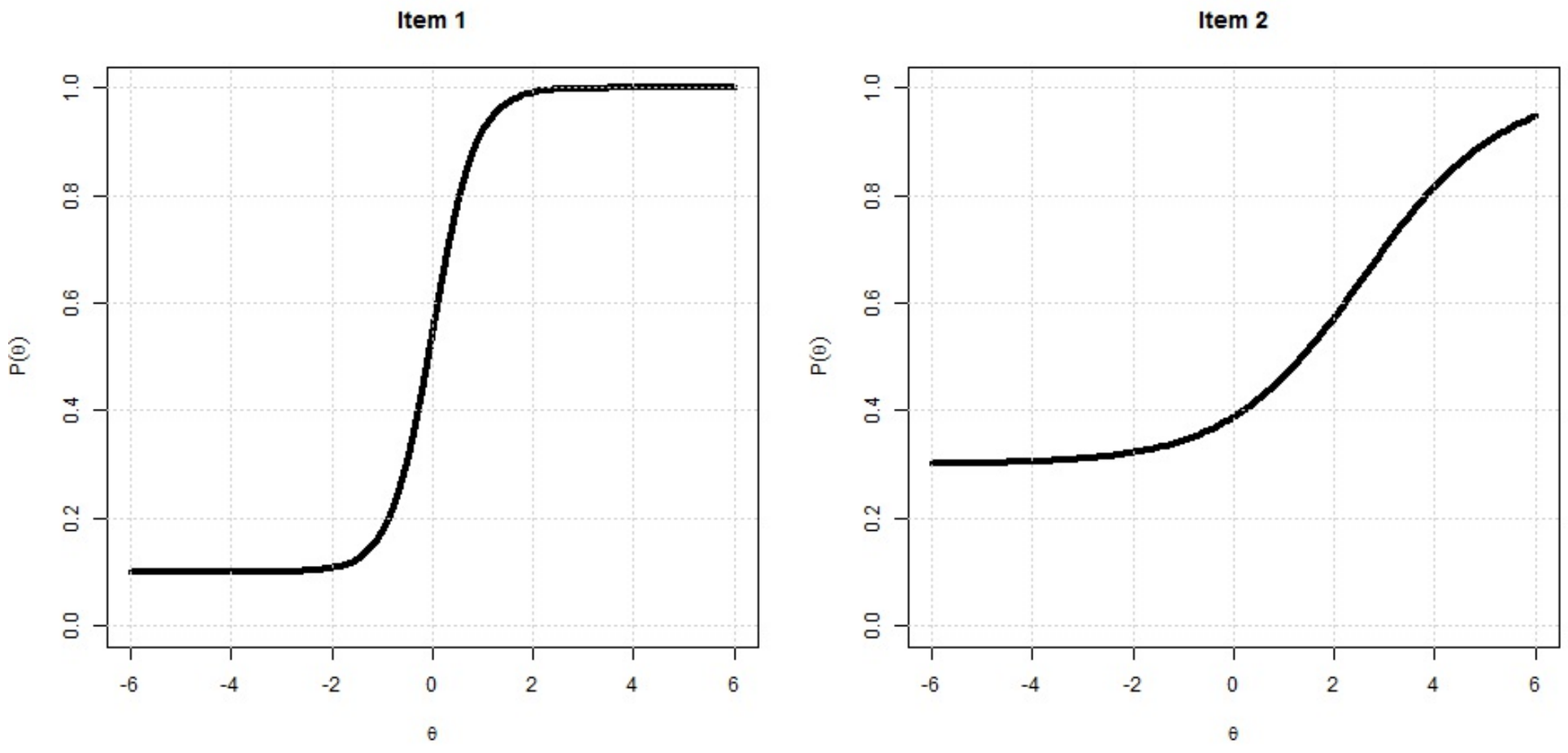
- The exam consists of a combination of multiple choice questions and free-response questions. Note that the multiple choice questions have only one category which is the correct one.
- When answering questions that ask you to interpret the results, you can obtain partial credit even if you did not calculate the quantities correctly. As long as your interpretation is consistent with your calculations you will obtain at least partial credit.
- Read the questions carefully and write down if you do not understand something about a question. The responsible teacher will visit the exam site for a short period during the first two hours of the exam.

Best of luck!

1

IRT model identify 1

The two item characteristic curves in the figure below belong to the same type of item response theory model. Identify the type of model.



Select one alternative:

- The 2-PL model.
- The graded response model.
- The 1-PL model.
- The 3-PL model.

Maximum marks: 2

2 Features of 2PL model 1

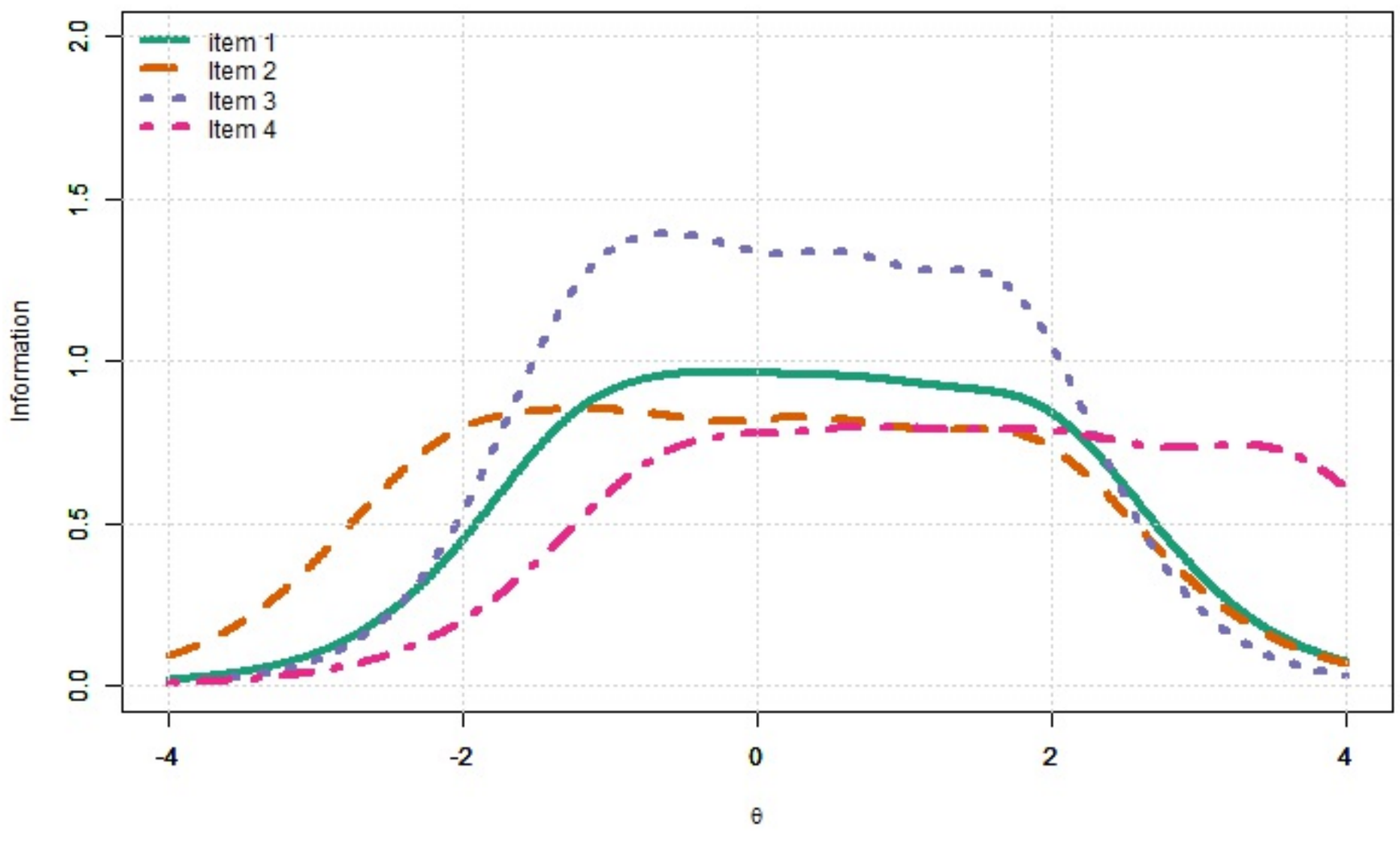
With the 2-PL model, the maximum slope of the item characteristic curve is..
Select one alternative:

- ...always larger than 1.
- ...a function of the item location parameter.
- ...at the maximum of the item characteristic curve.
- ...proportional to the discrimination parameter.

Maximum marks: 2

3 Information function 1

The following four item information functions were obtained from an estimation procedure that assumed a normal latent distribution with mean 0 and variance 1. Which of the items would you most prefer to include for a test with purpose to assess individuals at the 97.5 percentile of the assumed distribution?



Select one alternative:

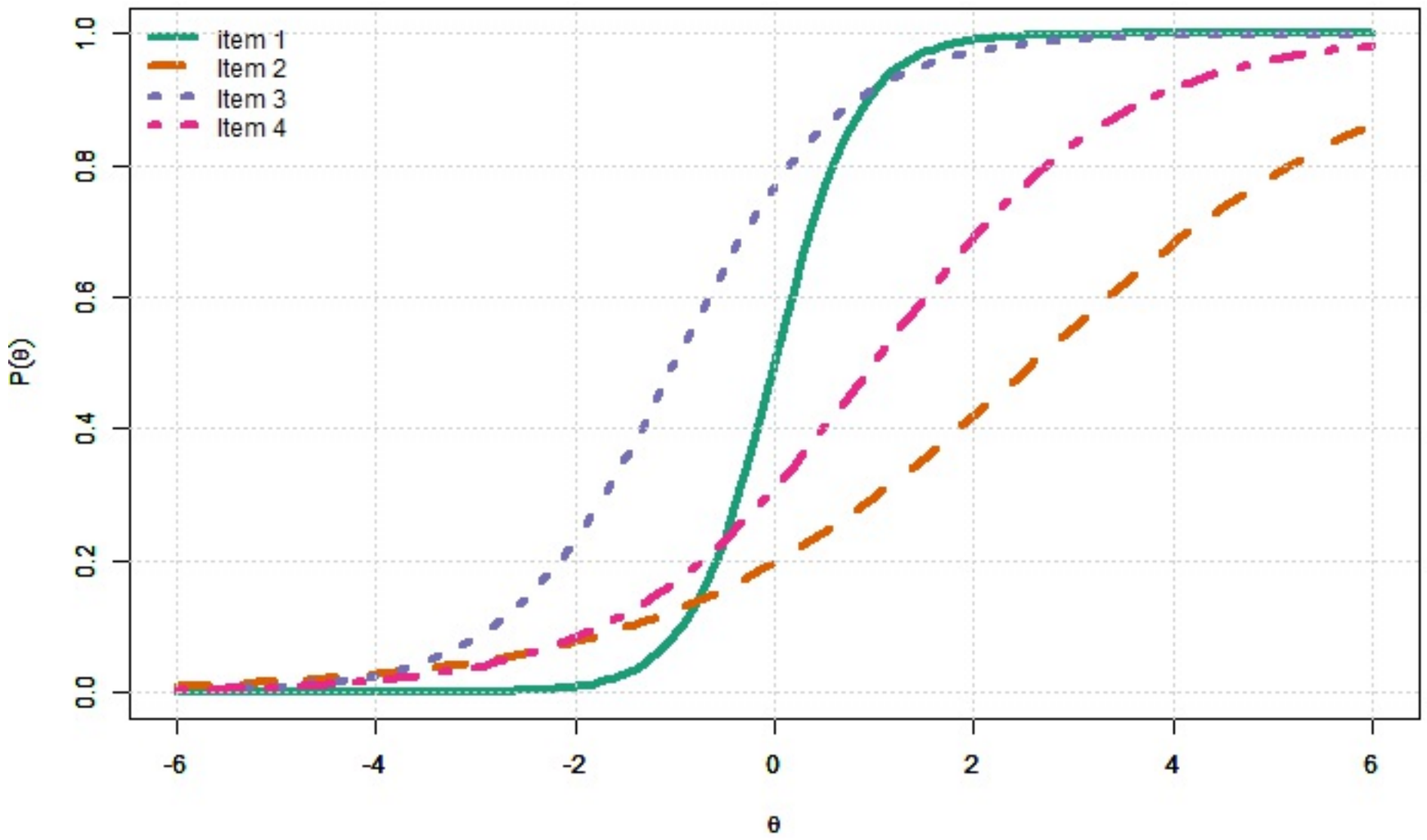
- Item 1
- Item 4
- Item 3
- Item 2

Maximum marks: 2

4

Item characteristic curve

Consider the following 2-PL item characteristic curves. Which item has the highest discrimination parameter?



Select one alternative:

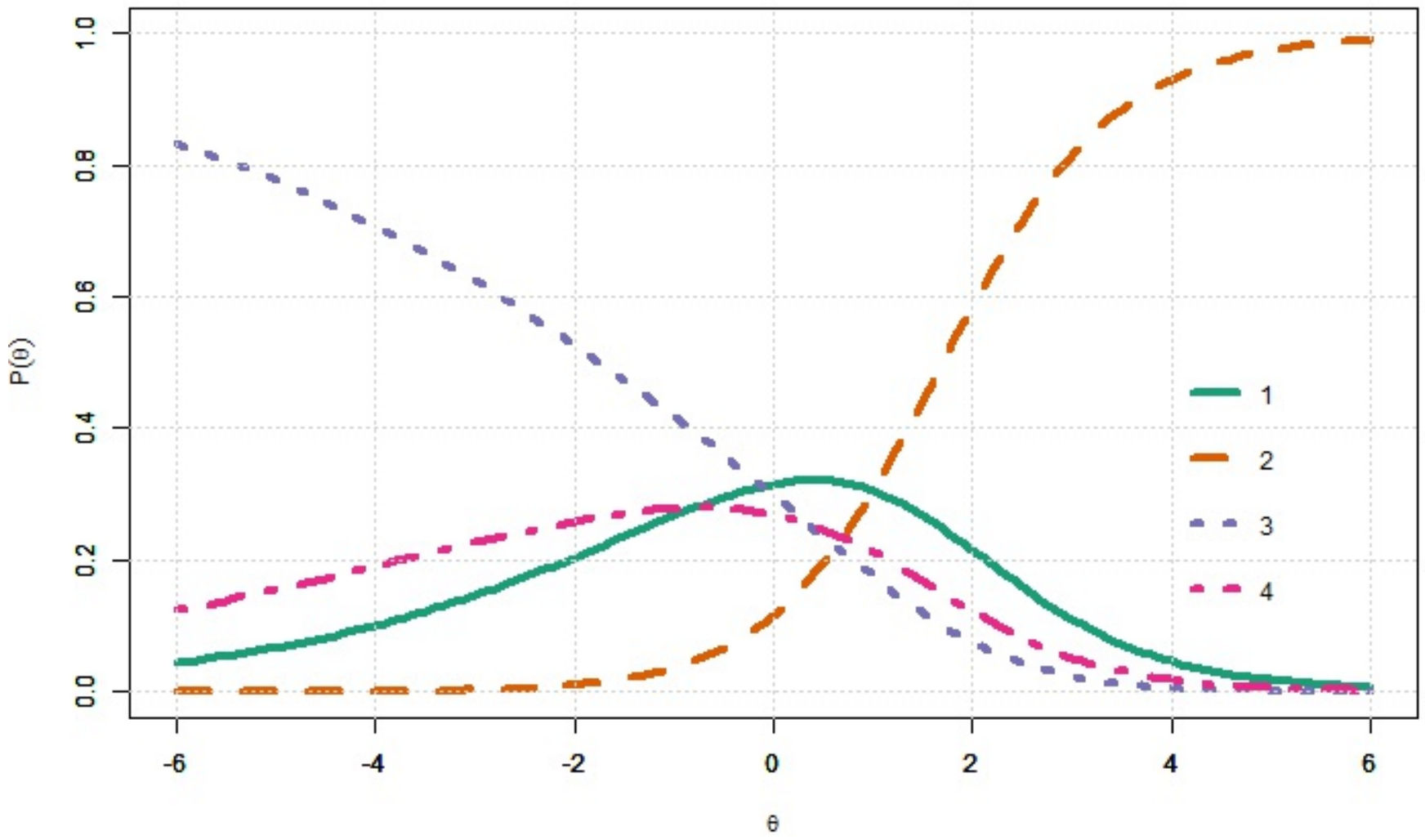
- Item 2
- Item 1
- Item 3
- Item 4

Maximum marks: 2

5

IRT model identify 2

An item was scored as integers from 1 to 4. Which IRT model are the following item category response functions from?



Select one alternative:

- The graded response model.
- The generalized partial credit model.
- A model for nominal responses.
- The partial credit model.

Maximum marks: 2

6

Features of the 2PL model 2

The parameters for a 2-PL item are $\alpha = 1.2$ and $\delta = 0.6$. What is $P(\theta = 0.6)$?

Select one alternative:

- 0.6
- 0.5
- 0.2
- 0.4

Maximum marks: 2

7

Features of the 3PL model

The parameters of a 3-PL item are $\alpha = 1.2$, $\delta = 0.6$ and $\chi = 0.1$. What is $P(\theta = 0.6)$?

Select one alternative:

- 0.5
- 0.45
- 0.4
- 0.55

Maximum marks: 2

8

Ability estimates properties

For a test of 20 items, which of the following distributions has the highest variance?

Select one alternative:

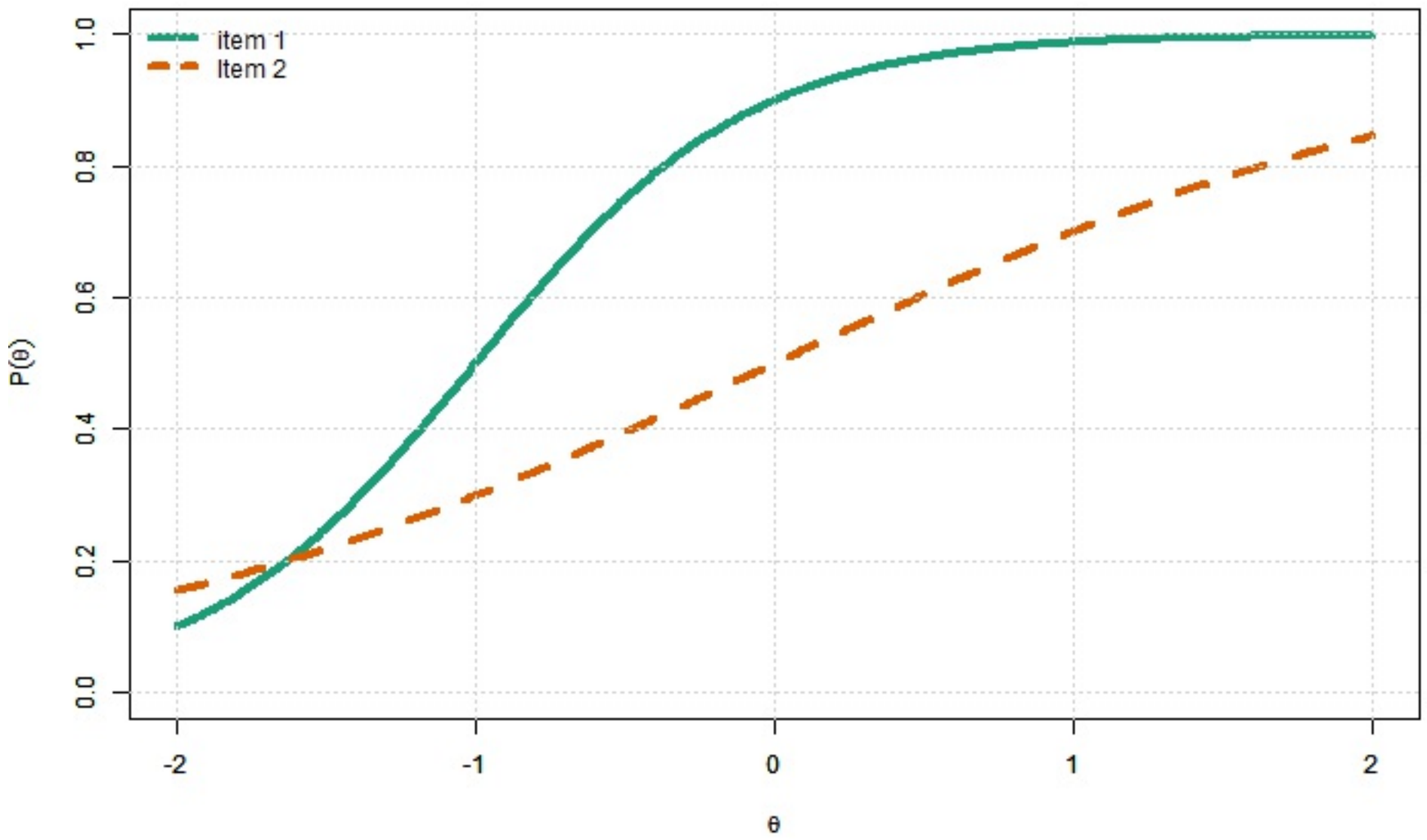
- The distribution of the maximum aposteriori (MAP) ability estimates.
- The true ability distribution.
- The distribution of the expected aposteriori (EAP) ability estimates.
- The distribution of the maximum likelihood (ML) ability estimates.

Maximum marks: 2

9

Local independence

Judging from the two item characteristic curves given below, what is the probability (approximately) of a randomly selected individual with $\theta = 0$ to answer both items correctly? State any assumptions that you make when calculating this probability.



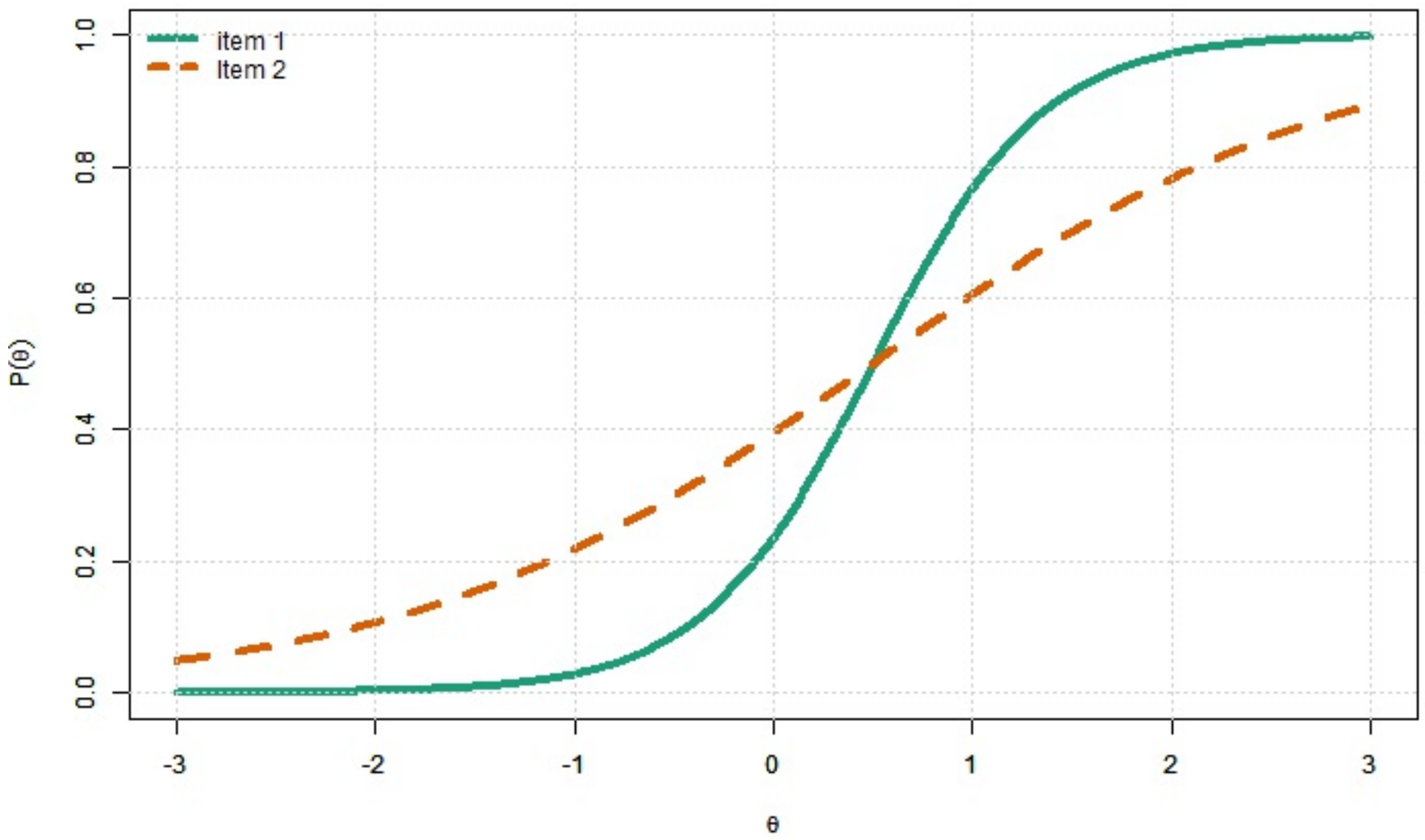
Fill in your answer here

Maximum marks: 2

10

Item difficulty and latent distribution

Assume that the population distribution of the latent variable θ generates observations in the interval (-2, 2). Based on this information, can you infer which of the following two items that is more difficult for individuals from this population? Motivate your answer.



Fill in your answer here

Maximum marks: 2

11 Model choice

Based on the theoretical properties of the item response models we have considered in the course, suggest a model that can be considered appropriate for each of the following cases and motivate your answers.

a) A mathematics test consisting of ten items with similar properties which are scored 0-4 based on the extent to which the item was completed.

Enter text here

b) A questionnaire designed to screen for depression, consisting of Likert scale items.

Enter text here

Maximum marks: 2

12 Confidence interval for ability

An individual obtained the maximum likelihood ability estimate of $\hat{\theta}_{\mathbf{obs}} = 0.4$. The test information function at $\theta = 0.4$ was 4. What is an approximate 95% confidence interval for the ability of the individual? Present and explain how you obtained the answer.

Fill in your answer here

Format

Words: 0

Maximum marks: 2

13

IRT linking coefficients

The estimated parameters for a 3-PL item in a group of students in grade 8 were:

$\hat{\alpha} = 1.2$

$\hat{\delta} = 0.4$

$\hat{\chi} = 0.2$

This item was to be used in grade 9 by using the linking coefficients $\beta_1 = 1.2$ and $\beta_2 = 0.2$ for a transformation from the grade 8 to the grade 9 metric. What is the equated discrimination parameter $\hat{\alpha}$ for grade 9? Demonstrate and explain how you obtained the answer.

Fill in your answer here

Format | B I U x_2 x^2 I_x | Ω | ∑ | ABC

Words: 0

Maximum marks: 2

14 IRT and scale development

Describe two distinct uses of item response theory in the development of a psychological scale.

Fill in your answer here

Format

Words: 0/250

Maximum marks: 2

15 IRT improvement

Detail two ways in which item response theory provides improved analysis techniques compared to classical test theory.

Fill in your answer here

Format

Words: 0/250

Maximum marks: 2

16

Unidimensional or not

Two binary items were observed for a large sample of individuals with a particular level $\theta = -0.6$ of a latent variable. The estimated marginal probabilities were $P(Y_1 = 1|\theta = -0.6) = 0.5$ and $P(Y_2 = 1|\theta = -0.6) = 0.7$. Meanwhile, the joint probabilities were:

$P(Y_1 = 1, Y_2 = 1|\theta = -0.6) = 0.45$

$P(Y_1 = 0, Y_2 = 1|\theta = -0.6) = 0.05$

$P(Y_1 = 1, Y_2 = 0|\theta = -0.6) = 0.25$

$P(Y_1 = 0, Y_2 = 0|\theta = -0.6) = 0.25$

Are these probabilities consistent with a unidimensional assumption? Motivate your answer.

Fill in your answer here

Format

Words: 0

Maximum marks: 2

17

How to DIF

A study was conducted to evaluate a 20-item scale measuring depression in elderly people, where there were two groups: one of individuals with a college degree and one of individuals without a college degree. The groups can not be assumed to have the same latent distribution. The first ten items were included in a pilot study and no differential item functioning (DIF) was detected in these ten items with respect to education level.

a) How would you investigate if the items perform identically in the two groups? (2p)

Fill in your answer here

b) A DIF analysis with respect to college degree/no college degree was done, indicating DIF in three items. In light of this, how would you propose to estimate the latent ability in the two groups? Motivate your answer. (2p)

Enter text here

Maximum marks: 4

18

Model selection and item fit

A test designed to identify students especially gifted in logical reasoning was developed, consisting of ten free-response dichotomous and ten free-response polytomous items. A sample of size 1000 from the population of interest was obtained.

a) Describe which models for which set of items you want to consider and outline the model selection procedure you intend to use. (2p)

Enter text here

b) Describe two methods for item fit evaluation to be conducted after the model selection phase and explain what they serve to evaluate. (2p)

Fill in your answer here

Maximum marks: 4

19

IRT model fit

An item response theory model for a set of dichotomous items was estimated, obtaining the following model fit statistics:
M2: 493.19 (df = 20, p-value = 0.00)
RMSEA: 0.036
SRMSR: 0.032

Identify if the model fits well with specific motivation for each of these statistics. Also summarize the main idea behind the M2 statistic.

Fill in your answer here

Format

Words: 0/500

Maximum marks: 4

20

Explanatory IRT

A mathematics test had items in three different domains: algebra, calculus and statistics. The following item covariate explanatory IRT model was estimated for the item intercept parameters:

$$\gamma_j = \beta_0 + \beta_1 x_{1j} + \beta_2 x_{2j},$$

where $x_{1j} = 1$ indicated that an item belonged to the calculus domain and $x_{2j} = 1$ that an item belonged to the statistics domain. The parameter estimates were

$$\hat{\beta}_0 = 0.5$$

$$\hat{\beta}_1 = -1.5$$

$$\hat{\beta}_2 = 0.6$$

a) Interpret the estimates of the regression coefficients β_0, β_1 and β_2. (2p)

Enter text here

b) The fifth item on the test was in the domain of calculus and had a discrimination parameter estimate equal to $\hat{\alpha}_5 = 2.0$. Calculate the predicted value of the *location parameter* δ_5 for this item based on the above model for the intercept parameter γ_5 and the estimated discrimination parameter. (2p)

Fill in your answer here

c) A separate analysis was done to estimate the relationship between individual characteristics and mathematics proficiency. Individual covariates were a continuous variable indicating socioeconomic status (ses) and a variable indicating gender (coded females : 1/ males: 0). The following model was estimated:

$$\theta_i = \beta_{\text{gen}} \text{gen}_i + \beta_{\text{ses}} \text{ses}_i + \epsilon_i.$$

The parameter estimates with standard errors in parentheses were:

$$\hat{\beta}_{\text{ses}} = 0.4 \quad (0.1)$$

$$\hat{\beta}_{\text{gen}} = 0.01 \quad (0.1)$$

What do the estimated regression coefficients and standard errors tell you about the relationship between socioeconomic status, gender and mathematics proficiency? Explain in words what the model implies for female individuals with a socioeconomic status of 0.5. (2p)

Enter text here

Maximum marks: 6