Package: catSurv (via r-universe)

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Type Package

Title Computerized Adaptive Testing for Survey Research

Version 1.6.0

Description Provides methods of computerized adaptive testing for survey researchers. See Montgomery and Rossiter (2020) <doi:10.1093/jssam/smz027>. Includes functionality for data fit with the classic item response methods including the latent trait model, the Birnbaum three parameter model, the graded response, and the generalized partial credit model. Additionally, includes several ability parameter estimation and item selection routines. During item selection, all calculations are done in compiled C++ code.

Depends ltm(>= 1.1.1), R(>= 3.4)

License GPL-3

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`agree_cat` *Agreeableness Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 20-item Agreeableness dimension of the 100-item IPIP representation of Costa and McCrae's Five Factor Model

Usage

```
data(agree_cat)
```

Format

An object of class `Cat` of length 1.

Details

Cat object containing item parameters for graded response model fit with 774,410 response profiles by myPersonality Poject and 1500 response profiles collected by YouGov in June 2018. The sample from myPersonality Project was a convenience sample, and the respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (.113) and a standard deviation (1.5) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are 1=Very inaccurate; 2=Moderately inaccurate; 3=Neither inaccurate nor accurate; 4=Moderately accurate; 5=Very accurate.

The wording of the question items:

I...

`q86` Have a good word for everyone.

`q6` Believe that others have good intentions.

`q66` Respect others.

`q46` Accept people as they are.

`q36` Make people feel at ease.

`q26` Am concerned about others.

`q56` Trust what people say.

`q76` Sympathize with others' feelings.

`q13` Am easy to satisfy.

`q96` Treat all people equally.

`q82` Have a sharp tongue.

`q9` Cut others to pieces.

`q22` Suspect hidden motives in others.

`q32` Get back at others.

`q92` Insult people.

`q42` Believe that I am better than others.

`q52` Contradict others.

`q62` Make demands on others.

`q2` Hold a grudge.

`q72` Am out for my own personal gain.

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

References

Costa, P. T., Jr., & McCrae, R. R. (1992). Revised NEO Personality Inventory (NEO PI-R) and NEO Five-Factor Inventory (NEO-FFI): Professional manual. Odessa, FL: Psychological Assessment Resources.

Stillwell, David, and Michal Kosinski. 2007. "myPersonality Project." https://sites.google.com/michalkosinski.com/mypersonality

See Also

Cat-class, grmCat

`Cat-class` *Computerized Adaptive Testing Survey (catSurv) Object*

Description

Creates an object of class `Cat`. `Cat` objects are used in administering Computerized Adaptive Testing (CAT) Surveys. These objects contain several pieces of information relevant for CAT surveys, and are used as input in the main functions of the `catSurv` package.

Details

Assume we have a survey battery with `I` questions. An object of the class `Cat` has the following slots:

- `ids` A vector of length `I` of unique question identifiers. Default is the column names of response data frame used to calibrate `Cat` object.
- `guessing` A vector of length `I` of guessing parameters. Guessing parameters are only applicable for `Cat` objects fit with the `"tpm"` model, using the `tpmCat` function.
- `discrimination` A vector of length `I` of discrimination parameters.
- `difficulty` A vector or list of length `I` of difficulty parameters. For `Cat` objects of the `"ltm"` or `"tpm"` model, `difficulty` is a vector that contains a parameter for each item. For `Cat` objects of the `"grm"` or `"gpcm"` model, `difficulty` is a list that contains a vector for each item, and each vector contains parameters for each response option.
- `answers` A vector of length `I` of answers to questions as given by the survey respondent. Unanswered questions have the value `NA`. Questions respondent has skipped or refused to answer have a value of `-1`.
- `priorName` A character vector of length one giving the prior distribution to use for the ability parameter estimates. The options are `"NORMAL"` for the normal distribution, `"STUDENT_T"` for the student's t distribution, and `"UNIFORM"` for the uniform distribution. The default value is `"NORMAL"`.
- `priorParams` A numeric vector of length two of parameters for the distribution specified in the `priorName` slot. When `priorName` is set to `"NORMAL"`, the first element of `priorParams` is the mean, and the second element is the standard deviation. When `priorName` is set to `"STUDENT_T"`, the first element of `priorParams` is the location parameter and the second is

degrees of freedom. When priorName is set to "UNIFORM", the elements of priorParams are lower and upper bound, respectively. Note that the uniform distribution is only applicable for the "EAP" estimation method. The default values are $0, 1$.

- lowerBound A numeric indicating the lower bound of the interval of the latent scale used in estimation. The default value is -5.
- upperBound A numeric indicating the upper bound of the interval of the latent scale used in estimation. The default value is 5.
- model A string indicating the model fit to the data. The options are "ltm" for the latent trait model, "tpm" for Birnbaum's three parameter model, "grm" for the graded response model, and "gpcm" for the generalized partial credit model.
- estimation A string indicating the approach to estimating ability parameters. The options are "EAP" for the expected a posteriori approach, "MAP" for the modal a posteriori approach, "MLE" for the maximum likelihood approach, and "WLE" for the weighted maximum likelihood approach. The default value is "EAP".
- estimationDefault A string indicating the approach to estimating ability parameters when the primary estimation choice indicated in the estimation slot is "MLE" or "WLE" and this estimation fails to converge. The options are "EAP" and "MAP". The default value is "MAP".
- selection A string indicating the approach for selecting the next item. The options are "EPV" for minimum expected posterior variance, "MEI" for maximum expected information, "MFI" for maximum Fisher information, "MPWI" for maximum posterior weighted information, "MLWI" for maximum likelihood weighted information, "KL" for the maximum expected Kullback-Leibler (KL) information, "LKL" maximum likelihood weighted KL information, "PKL" maximum posterior weighted KL information, "MFII" for maximum Fisher interval information, and "RANDOM" where the next item is chosen randomly. The default value is "EPV".
- z A numeric used in calculating δ. δ is used in determining the bounds of integration for some selectItem methods. See selectItem for more information. Default value is 0.9.
- lengthThreshold A numeric. The number of questions answered must be greater than or equal to this threshold to stop administering items. The default value is NA.
- seThreshold A numeric. The standard error estimate of the latent trait must be less than this threshold to stop administering items. The default value is NA.
- infoThreshold A numeric. The Fisher's information for all remaining items must be less than this threshold to stop administering items. The default value is NA.
- gainThreshold A numeric. The absolute value of the difference between the standard error of the latent trait estimate and the square root of the expected posterior variance for each item must be less than this threshold to stop administering items. The default value is NA.
- lengthOverride A numeric. The number of questions answered must be less than this override to continue administering items. The default value is NA.
- gainOverride A numeric. The absolute value of the difference between the standard error of the latent trait estimate and the square root of the expected posterior variance for each item must be less than this override to continue administering items. The default value is NA.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

checkStopRules, estimateTheta, gpcmCat, grmCat, ltmCat, selectItem, tpmCat

---

checkStopRules *Check if Stop and/or Override Rules are Met*

Description

Evaluates the specified stopping and/or override rules to check if respondent should be asked further questions.

Usage

```
checkStopRules(catObj)
```

Arguments

catObj	An object of class Cat

Details

The stopping rule thresholds are stored in the following Cat object slots: lengthThreshold, seThreshold, infoThreshold, and gainThreshold. The override thresholds are stored in the following Cat object slots: lengthOverride, gainOverride. A value of NA indicates the rule will not be used in evaluating if further questions should be administered. A user can specify any combination of stopping rules and/or overrides.

Stopping Rules:

lengthThreshold: Number of question's answered $\geq a$

seThreshold: $SE(\hat{\theta}) < a$

infoThreshold: $FI < a \; \forall$ remaining items

gainThreshold: $SE(\hat{\theta}) - \sqrt{EPV|} < a \; \forall$ remaining items

Overrides:

lengthOverride: Number of question's answered $< a$

gainOverride: $|SE(\hat{\theta}) - \sqrt{EPV|} \geq a \; \forall$ remaining items

Value

The function checkStopRules returns a boolean. TRUE indicates all specified stopping rules are met and no specified overrides are met. No further items should be administered. FALSE indicates at least one specified stopping rule is not met, or if any specified override threshold is met. Additional items should be administered.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled C++ code.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

References

Babcock, Ben, and David J. Weiss. 2009. "Termination Criteria in Computerized Adaptive Tests: Variable-Length CATs are not Biased." Proceedings of the 2009 GMAC Conference on Computerized Adaptive Testing. Vol. 14.

See Also

Cat-class, estimateSE, expectedPV, fisherInf

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1,0,0,0,1,1, rep(NA, 30))

## Stop administering items if standard error of ability
## estimate is low enough
setSeThreshold(ltm_cat) <- .5
checkStopRules(ltm_cat)

## Now stop if standard error is low enough, but only if respondent has
## answered 11 questions
setLengthOverride(ltm_cat) <- 11
checkStopRules(ltm_cat)

## When respondent has answered 11 questions and standard error
## of ability estimate is below .5, stop administering items
setAnswers(ltm_cat) <- c(1,0,1,0,1,0,0,0,1,1,0, rep(NA, 29))
checkStopRules(ltm_cat)
```

---

consc_cat *Conscientiousness Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 20-item Conscientiousness dimension of the 100-item IPIP representation of Costa and McCrae's Five Factor Model

Usage

```
data(consc_cat)
```

Format

An object of class `Cat` of length 1.

Details

Cat object containing item parameters for graded response model fit with 774,410 response profiles by myPersonality Project and 1500 response profiles collected by YouGov in June 2018. The sample from myPersonality Project was a convenience sample, and the respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (.455) and a standard deviation (1.5) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are 1=Very inaccurate; 2=Moderately inaccurate; 3=Neither inaccurate nor accurate; 4=Moderately accurate; 5=Very accurate.

The wording of the question items:

I...

`q15` Am always prepared.

`q85` Pay attention to details.

`q75` Get chores done right away.

`q95` Carry out my plans.

`q55` Make plans and stick to them.

`q5` Complete tasks successfully.

`q25` Do things according to a plan.

`q45` Am exacting in my work.

`q65` Finish what I start.

`q35` Follow through with my plans.

`q28` Waste my time.

`q88` Find it difficult to get down to work.

`q98` Do just enough work to get by.

`q78` Don't see things through.

`q20` Shirk my duties.

`q38` Mess things up.

`q58` Leave things unfinished.

`q48` Don't put my mind on the task at hand.

`q68` Make a mess of things.

`q8` Need a push to get started.

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

References

Costa, P. T., Jr., & McCrae, R. R. (1992). Revised NEO Personality Inventory (NEO PI-R) and NEO Five-Factor Inventory (NEO-FFI): Professional manual. Odessa, FL: Psychological Assessment Resources.

Stillwell, David, and Michal Kosinski. 2007. "myPersonality Project." https://sites.google.com/michalkosinski.com/mypersonality

See Also

`Cat-class`, `grmCat`

`d1LL` *The First Derivative of the Log-Likelihood*

Description

Calculates either the first derivative of the log-likelihood or the first derivative of the log-posterior evaluated at point θ.

Usage

```
d1LL(catObj, theta, use_prior)
```

Arguments

`catObj`	An object of class `Cat`
`theta`	A numeric or an integer indicating the value for θ_j
`use_prior`	A logical indicating whether to calculate based on the log-likelihood or log-posterior

Details

When the `usePrior` argument is `FALSE`, the function `d1LL` evaluates the first derivative of the log-likelihood at point θ.

When the `usePrior` argument is `TRUE`, the function `d1LL` evaluates the first derivative of the log-posterior at point θ.

If the argument `use_prior` is `TRUE`, the function `d1LL` must use the the normal prior distribution.

Value

The function d1LL returns a numeric of the derivative of the log-likelihood (or log-posterior) given a respondent's answer profile.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled C++ code.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

References

Baker, Frank B. and Seock-Ho Kim. 2004. Item Response Theory: Parameter Estimation Techniques. New York: Marcel Dekker.

Choi, Seung W. and Richard J. Swartz. 2009. "Comparison of CAT Item Selection Criteria for Polytomous Items." Applied Psychological Measurement 33(6):419-440.

Muraki, Eiji. 1992. "A generalized partial credit model: Application of an EM algorithm." ETS Research Report Series 1992(1):1-30.

van der Linden, Wim J. 1998. "Bayesian Item Selection Criteria for Adaptive Testing." Psychometrika 63(2):201-216.

See Also

Cat-class, prior

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## d1LL for Cat object of the ltm model
d1LL(ltm_cat, theta = 1, use_prior = FALSE)
```

d2LL *The Second Derivative of the Log-Likelihood*

Description

Calculates either the second derivative of the log-likelihood or the second derivative of the log-posterior evaluated at point θ.

Usage

```
d2LL(catObj, theta, use_prior)
```

Arguments

catObj	An object of class Cat
theta	A numeric or an integer indicating the value for θ
use_prior	A logical indicating whether to calculate based on the log-likelihood or log-posterior

Details

When the usePrior argument is FALSE, the function d2LL evaluates the second derivative of the log-likelihood at point θ.

When the usePrior argument is TRUE, the function d2LL evaluates the second derivative of the log-posterior at point θ.

If the argument use_prior is TRUE, the function d2LL must use the the normal prior distribution.

Value

The function d2LL returns a numeric of the second derivative of the log-likelihood (or log-posterior) given a respondent's answer profile.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled C++ code.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

References

Baker, Frank B. and Seock-Ho Kim. 2004. Item Response Theory: Parameter Estimation Techniques. New York: Marcel Dekker.

Choi, Seung W. and Richard J. Swartz. 2009. “Comparison of CAT Item Selection Criteria for Polytomous Items." Applied Psychological Measurement 33(6):419-440.

Muraki, Eiji. 1992. “A generalized partial credit model: Application of an EM algorithm." ETS Research Report Series 1992(1):1-30.

van der Linden, Wim J. 1998. “Bayesian Item Selection Criteria for Adaptive Testing." Psychometrika 63(2):201-216.

See Also

Cat-class, d1LL, prior

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## d2LL for Cat object of the ltm model
d2LL(ltm_cat, theta = 1, use_prior = FALSE)
```

---

empathy_cat *Empathizing Quotient Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 40-item Empathy Quotient personality inventory

Usage

```
data(empathy_cat)
```

Format

An object of class Cat of length 1.

Details

Cat object containing item parameters for graded response model fit with 13976 response profiles collected by myPersonality Project, 3050 response profiles collected by Qualtrics in June 2018, and 1500 response profiles collected by YouGov in June 2018. The sample from myPersonality Project was a convenience sample, and the respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (-0.363) and a standard deviation (1.5) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are 1=Strongly disagree; 2=Slightly disagree; 3=Slightly agree; 4=Strongly agree

The wording of the question items:

`q1` I can easily tell if someone else wants to enter a conversation.

`q4` I find it difficult to explain to others things that I understand easily, when they don't understand it first time.

`q6` I really enjoy caring for other people.

`q8` I find it hard to know what to do in a social situation.

`q10` People often tell me that I went too far in driving my point home in a discussion.

`q11` It doesn't bother me too much if I am late meeting a friend.

`q12` Friendships and relationships are just too difficult, so I tend not to bother with them.

`q14` I often find it difficult to judge if something is rude or polite.

`q15` In a conversation, I tend to focus on my own thoughts rather than on what my listener might be thinking.

`q18` When I was a child, I enjoyed cutting up worms to see what would happen.

`q19` I can pick up quickly if someone says one thing but means another.

`q21` It is hard for me to see why some things upset people so much.

`q22` I find it easy to put myself in somebody else's shoes.

`q25` I am good at predicting how someone will feel.

`q26` I am quick to spot when someone in a group is feeling awkward or uncomfortable.

`q27` If I say something that someone else is offended by, I think that that's their problem, not mine.

`q28` If anyone asked me if I liked their haircut, I would reply truthfully, even if I didn't like it.

`q29` I can't always see why someone should have felt offended by a remark.

`q32` Seeing people cry doesn't really upset me.

`q34` I am very blunt, which some people take to be rudeness, even though this is unintentional.

`q35` I don't tend to find social situations confusing.

`q36` Other people tell me I am good at understanding how they are feeling and what they are thinking.

`q37` When I talk to people, I tend to talk about their experiences rather than my own.

`q38` It upsets me to see an animal in pain.

`q39` I am able to make decisions without being influenced by people's feelings.

`q41` I can easily tell if someone else is interested or bored with what I am saying.

`q42` I get upset if I see people suffering on news programs.

`q43` Friends usually talk to me about their problems as they say that I am very understanding.

`q44` I can sense if I am intruding, even if the other person doesn't tell me.

`q46` People sometimes tell me that I have gone too far with teasing.

`q48` Other people often say that I am insensitive, though I don't always see why.

`q49` If I see a stranger in a group, I think that it is up to them to make an effort to join in.

`q50` I usually stay emotionally detached when watching a film.

`q52` I can tune into how someone else feels rapidly and intuitively.

`q54` I can easily work out what another person might want to talk about.

`q55` I can tell if someone is masking their true emotion.

`q57` I don't consciously work out the rules of social situations.

`q58` I am good at predicting what someone will do.

`q59` I tend to get emotionally involved with a friend's problems.

`q60` I can usually appreciate the other person's viewpoint, even if I don't agree with it.

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

References

Baron-Cohen, Simon, and Sally Wheelwright. "The empathy quotient: an investigation of adults with Asperger syndrome or high functioning autism, and normal sex differences." Journal of autism and developmental disorders 34, no. 2 (2004): 163-175.

Stillwell, David, and Michal Kosinski. 2007. "myPersonality Project." https://sites.google.com/michalkosinski.com/mypersonality

See Also

`Cat-class`, `grmCat`

`estimateSE` *Standard Error of Ability Parameter Estimate*

Description

Estimates the standard error for a respondent's ability parameter estimate, θ.

Usage

```
estimateSE(catObj)
```

Arguments

`catObj`	An object of class `Cat`

Details

The function `estimateSE` estimates the standard error of the ability estimate given the estimation approach of the `Cat` object, specified in `estimation` slot of `Cat` object.

The expected a posteriori approach is used when `estimation` slot is `"EAP"`. This method involves integration. See **Note** for more information.

The modal a posteriori approach is used when `estimation` slot is `"MAP"`. This method is only available using the normal prior distribution.

The maximum likelihood approach is used when `estimation` slot is `"MLE"`. When the likelihood of the ability estimate is undefined, the MAP or EAP method will be used, determined by what is specified in the `estimationDefault` slot in `Cat` object.

The weighted maximum likelihood approach is used when `estimation` slot is `"WLE"`. Estimating θ requires root finding with the "Brent" method in the GNU Scientific Library (GSL) with initial search interval of `[-5,5]`.

Value

The function `estimateSE` returns a numeric for the standard error for θ.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled `C++` code.

This function uses adaptive quadrature methods from the GNU Scientific Library (GSL) to approximate single-dimensional integrals with high accuracy. The bounds of integration are determined by the `lowerBound` and `upperBound` slots of the `Cat` object.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

estimateTheta

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## Set different estimation procedures and calculate ability estimate and its standard error
setEstimation(ltm_cat) <- "EAP"
estimateTheta(ltm_cat)
estimateSE(ltm_cat)

setEstimation(ltm_cat) <- "MAP"
estimateTheta(ltm_cat)
estimateSE(ltm_cat)

setEstimation(ltm_cat) <- "MLE"
estimateTheta(ltm_cat)
estimateSE(ltm_cat)

setEstimation(ltm_cat) <- "WLE"
estimateTheta(ltm_cat)
estimateSE(ltm_cat)
```

---

estimateTheta *Estimate of the Respondent's Ability Parameter*

Description

Estimates the expected value of the ability parameter θ, conditioned on the observed answers, prior, and the item parameters.

Usage

```
estimateTheta(catObj)
```

Arguments

catObj	An object of class Cat

Details

Estimation approach is specified in `estimation` slot of `Cat` object.

The expected a posteriori approach is used when `estimation` slot is `"EAP"`. This method involves integration. See **Note** for more information.

The modal a posteriori approach is used when `estimation` slot is `"MAP"`. This method is only available using the normal prior distribution.

The maximum likelihood approach is used when `estimation` slot is `"MLE"`. When the likelihood is undefined, the MAP or EAP method will be used, determined by what is specified in the `estimationDefault` slot in `Cat` object.

The weighted maximum likelihood approach is used when `estimation` slot is `"WLE"`. Estimating θ requires root finding with the "Brent" method in the GNU Scientific Library (GSL) with initial search interval of `[-5,5]`.

Value

The function `estimateTheta` returns a numeric consisting of the expected value of the respondent's ability parameter.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled `C++` code.

This function uses adaptive quadrature methods from the GNU Scientific Library (GSL) to approximate single-dimensional integrals with high accuracy. The bounds of integration are determined by the `lowerBound` and `upperBound` slots of the `Cat` object.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

References

van der Linden, Wim J. 1998. "Bayesian Item Selection Criteria for Adaptive Testing." Psychometrika 63(2):201-216.

Van der Linden, Wim J., and Peter J. Pashley. 2009. "Item Selection and Ability Estimation in Adaptive Testing." Elements of Adaptive Testing. Springer New York, 3-30.

See Also

`Cat-class`, `estimateSE`

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
```

```
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## Set different estimation procedures and estimate ability parameter
setEstimation(ltm_cat) <- "EAP"
estimateTheta(ltm_cat)

setEstimation(ltm_cat) <- "MAP"
estimateTheta(ltm_cat)

setEstimation(ltm_cat) <- "MLE"
estimateTheta(ltm_cat)

setEstimation(ltm_cat) <- "WLE"
estimateTheta(ltm_cat)
```

`estimateThetas` *Estimates of Ability Parameters for a Dataset of Response Profiles*

Description

Estimates the expected value of the ability parameter θ, conditioned on the observed answers, prior, and the item parameters for complete response profiles for a dataset of respondents.

Usage

```
## S4 method for signature 'Cat'
estimateThetas(catObj, responses)
```

Arguments

`catObj`	An object of class `Cat`
`responses`	A dataframe of complete response profiles

Details

Estimation approach is specified in `estimation` slot of `Cat` object.

The expected a posteriori approach is used when `estimation` slot is `"EAP"`. This method involves integration. See **Note** for more information.

The modal a posteriori approach is used when `estimation` slot is `"MAP"`. This method is only available using the normal prior distribution.

The maximum likelihood approach is used when `estimation` slot is `"MLE"`. When the likelihood is undefined, the MAP or EAP method will be used, determined by what is specified in the `estimationDefault` slot in `Cat` object.

The weighted maximum likelihood approach is used when `estimation` slot is `"WLE"`. Estimating θ requires root finding with the "Brent" method in the GNU Scientific Library (GSL) with initial search interval of `[-5,5]`.

Value

The function `estimateThetas` returns a vector containing respondents' estimated ability parameters.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled `C++` code.

This function uses adaptive quadrature methods from the GNU Scientific Library (GSL) to approximate single-dimensional integrals with high accuracy. The bounds of integration are determined by the `lowerBound` and `upperBound` slots of the `Cat` object.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

`Cat-class`, `estimateTheta`

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Set different estimation procedures and estimate ability parameter
data(npi)
setEstimation(ltm_cat) <- "EAP"
estimateThetas(ltm_cat, responses = npi[1:25, ])
```

---

ex_qualtrics_results *Example Qualtrics Data for Adaptive Inventory*

Description

Example data when including an adaptive inventory on a Qualtrics survey

Usage

```
data(ex_qualtrics_results)
```

Format

An object of class `data.frame` with 6 rows and 9 columns.

Details

This data set includes four example responses to a length four adaptive inventory for the agreeableness battery.

See agree_cat for details regarding the Cat object structure and battery items.

See readQualtrics for how to clean adaptive inventory response profiles.

See Also

agree_cat, readQualtrics

---

ex_qualtrics_results_multiple

Example Qualtrics Data for Multiple Adaptive Inventories

Description

Example data when including multiple adaptive inventory on a Qualtrics survey

Usage

```
data(ex_qualtrics_results_multiple)
```

Format

An object of class `data.frame` with 6 rows and 17 columns.

Details

This data set includes four example responses to length four adaptive inventories for both the agreeableness and neuroticism batteries.

See agree_cat and neuro_cat for details regarding the Cat object structure and battery items.

See readQualtrics for how to clean adaptive inventory response profiles.

See Also

agree_cat, neuro_cat,readQualtrics

`expectedKL` *Expected Kullback-Leibler Information*

Description

Calculates the expected Kullback-Leibler information for an individual question item.

Usage

```
expectedKL(catObj, item)
```

Arguments

`catObj`	An object of class `Cat`
`item`	An integer indicating the index of the question item

Details

The function `expectedKL` calculates the expected value of the Kullback-Leibler information for a specified item where the bounds of integration are $\hat{\theta} \pm \delta$, where δ is qnorm(z) times the square root of the Fisher test information and z is specified in the `z` slot of the `Cat` object. See **Note** for more information on integration.

Value

The function `expectedKL` returns a numeric indicating the expected Kullback-Leibler information for the specified item, given the current answer profile and ability parameter estimate.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled `C++` code.

This function uses adaptive quadrature methods from the GNU Scientific Library (GSL) to approximate single-dimensional integrals with high accuracy.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

`likelihoodKL`, `posteriorKL`, `selectItem`

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## Estimate KL for different unasked items
expectedKL(ltm_cat, item = 10)
expectedKL(ltm_cat, item = 20)
expectedKL(ltm_cat, item = 30)
```

`expectedObsInf` *Expected Observed Information*

Description

Calculates the expected information, which is the observed information attained from a specific response set times the probability of that profile occurring.

Usage

```
expectedObsInf(catObj, item)
```

Arguments

`catObj`	An object of class `Cat`
`item`	An integer indicating the index of the question item

Value

The function `expectedObsInf` returns a numeric value of the expected information. **Not implemented for three parameter model for binary data.**

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled `C++` code.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

`estimateSE`,`obsInf`, `probability`, `selectItem`

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## Expected observed information for different items
expectedObsInf(ltm_cat, item = 10)
expectedObsInf(ltm_cat, item = 20)
```

`expectedPV` *Expected Posterior Variance*

Description

Estimates the expected posterior variance for a respondent's estimated ability parameter for an item yet to be answered based on a respondent's ability parameter estimate from the already-answered items.

Usage

```
expectedPV(catObj, item)
```

Arguments

`catObj`	An object of class `Cat`
`item`	An integer indicating the index of the question item

Value

The function `expectedPV` returns a numeric value indicating a respondent's expected posterior variance for an unasked item.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled `C++` code.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

`estimateSE`, `probability`, `selectItem`

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## Estimate EPV for different unasked items
expectedPV(ltm_cat, item = 10)
expectedPV(ltm_cat, item = 20)
expectedPV(ltm_cat, item = 30)
```

`extra_cat` *Extraversion Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 20-item Extraversion dimension of the 100-item IPIP representation of Costa and McCrae's Five Factor Model

Usage

```
data(extra_cat)
```

Format

An object of class `Cat` of length 1.

Details

Cat object containing item parameters for graded response model fit with 774,410 response profiles by myPersonality Project and 1500 response profiles collected by YouGov in June 2018. The sample from myPersonality Project was a convenience sample, and the respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (-.367) and a standard deviation (1.3) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are 1=Very inaccurate; 2=Moderately inaccurate; 3=Neither inaccurate nor accurate; 4=Moderately accurate; 5=Very accurate.

The wording of the question items:

I...

`q83` Feel comfortable around people.

`q10` Make friends easily.

`q73` Am skilled in handling social situations.

`q63` Am the life of the party.

`q53` Know how to captivate people.

`q93` Start conversations.

`q33` Warm up quickly to others.

`q43` Talk to a lot of different people at parties.

`q3` Don't mind being the center of attention.

`q23` Cheer people up.

`q39` Have little to say.

`q14` Keep in the background.

`q89` Would describe my experiences as somewhat dull.

`q59` Don't like to draw attention to myself.

`q29` Don't talk a lot.

`q18` Avoid contacts with others.

`q99` Am hard to get to know.

`q79` Retreat from others.

`q69` Find it difficult to approach others.

`q49` Keep others at a distance.

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

References

Costa, P. T., Jr., & McCrae, R. R. (1992). Revised NEO Personality Inventory (NEO PI-R) and NEO Five-Factor Inventory (NEO-FFI): Professional manual. Odessa, FL: Psychological Assessment Resources.

Stillwell, David, and Michal Kosinski. 2007. "myPersonality Project." https://sites.google.com/michalkosinski.com/mypersonality

See Also

`Cat-class`, `grmCat`

`fisherInf` *Fisher's Information*

Description

Calculates the expected value of the observed information of the likelihood evaluated at the input value θ.

Usage

```
fisherInf(catObj, theta, item)
```

Arguments

`catObj`	An object of class `Cat`
`theta`	A numeric or an integer indicating the potential value for θ
`item`	An integer indicating the index of the question item

Details

For the dichotomous case, this Fisher's information is equivalent to the observed information.

Value

The function `fisherInf` returns a numeric of the expected value of the observed information of the likelihood evaluated at the input value θ.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled `C++` code.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

`fisherTestInfo`, `obsInf`, `selectItem`

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## Fisher's information for different items, at ability parameter of 1
fisherInf(ltm_cat, theta = 1, item = 10)
fisherInf(ltm_cat, theta = 1, item = 20)
```

---

fisherTestInfo *Fisher's Test Information*

Description

Calculates the total information gained for a respondent for all answered items, conditioned on θ.

Usage

```
fisherTestInfo(catObj, theta)
```

Arguments

catObj	An object of class Cat
theta	A numeric indicating the position on the latent trait.

Value

The function fisherTestInfo returns a numeric indicating the total information gained for a respondent, given a specific answer set and the current estimate of θ.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled C++ code.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

fisherInf

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## Fisher's test information for answer profile
fisherTestInfo(ltm_cat, theta = 2)
```

`fromJSONCat` *Convert JSON object to Cat object*

Description

This function object of class `Cat`.

Usage

```
## S4 method for signature 'json'
fromJSONCat(jsonObj)

## S4 method for signature 'character'
fromJSONCat(jsonObj)
```

Arguments

`jsonObj`	A `json` object with elements matching Cat object slots

Details

The `jsonObj` argument of the function `fromJSONCat` is an object of class `json` from the `rjson` package. This function simply populates a `Cat` object with the information provided in the `jsonObj`, thus element and slot names must match.

Value

The function `fromJSONCat` returns an object of class `Cat` with slots populated with the corresponding information stored in the `jsonObj`.

See `Cat-class` for required `Cat` object slots.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

Cat-class

---

getters *Methods for Accessing* Cat *Object Slots*

Description

Getter methods to access slots of a Cat object.

Usage

```
## S4 method for signature 'Cat'
getModel(catObj)

## S4 method for signature 'Cat'
getGuessing(catObj)

## S4 method for signature 'Cat'
getDiscrimination(catObj)

## S4 method for signature 'Cat'
getDifficulty(catObj)

## S4 method for signature 'Cat'
getAnswers(catObj)

## S4 method for signature 'Cat'
getIds(catObj)

## S4 method for signature 'Cat'
getPriorName(catObj)

## S4 method for signature 'Cat'
getPriorParams(catObj)

## S4 method for signature 'Cat'
getLowerBound(catObj)

## S4 method for signature 'Cat'
getUpperBound(catObj)

## S4 method for signature 'Cat'
getEstimation(catObj)

## S4 method for signature 'Cat'
```

```
getEstimationDefault(catObj)

## S4 method for signature 'Cat'
getSelection(catObj)

## S4 method for signature 'Cat'
getZ(catObj)

## S4 method for signature 'Cat'
getLengthThreshold(catObj)

## S4 method for signature 'Cat'
getSeThreshold(catObj)

## S4 method for signature 'Cat'
getInfoThreshold(catObj)

## S4 method for signature 'Cat'
getGainThreshold(catObj)

## S4 method for signature 'Cat'
getLengthOverride(catObj)

## S4 method for signature 'Cat'
getGainOverride(catObj)
```

Arguments

`catObj`	An object of class `Cat`

Value

These functions return the respective slot from Cat object.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

References

Montgomery, Jacob M., and Erin L. Rossiter. "So many questions, so little time: Integrating adaptive inventories into public opinion research." Journal of Survey Statistics and Methodology (2019).

See Also

`Cat-class`, `setters`

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Getting estimation slot before and after change
getEstimation(ltm_cat)
setEstimation(ltm_cat) <- "MAP"
getEstimation(ltm_cat)

## Getting discrimination slot before and after change
getDiscrimination(ltm_cat)
setDiscrimination(ltm_cat) <- rep(1, 40)
getDiscrimination(ltm_cat)
```

---

gpcm_cat *gpcm Cat Object*

Description

An object of class `Cat` created using the `gpcmCat` function with the `polknowTAPS` dataset. To have a better fitting model, we first fit an object of class `gpcm` from the `ltm` package which provides for additional control values to be used in fitting. See `gpcmCat`.

Usage

```
data(gpcm_cat)
```

Format

An object of class `Cat`. See `Cat-class` for more details.

See Also

`Cat-class`, `gpcmCat`, `polknowTAPS`

Examples

```
## Not run:
## How this Cat object was created
data(polknowTAPS)
gpcm_fit <- gpcm(polknowTAPS, constraint = "gpcm", control = list(iter.qN = 200, GHk = 100))
gpcm_cat <- gpcmCat(gpcm_fit)

## End(Not run)

## How to load this Cat object for usage
data(gpcm_cat)
```

gpcmCat *Computerized Adaptive Testing Generalized Partial Credit Model*

Description

This function fits the generalized partial credit model for ordinal polytomous data and populates the fitted values for discrimination and difficulty parameters to an object of class Cat.

Usage

```
## S4 method for signature 'data.frame'
gpcmCat(data, quadraturePoints = 21, ...)

## S4 method for signature 'gpcm'
gpcmCat(data, quadraturePoints = NULL, ...)
```

Arguments

data	A data frame of manifest variables or an object of class gpcm.
quadraturePoints	A numeric to be passed into the gpcm function indicating the number of Gauss-Hermite quadrature points. Only applicable when data is a data frame. Default value is 21.
...	arguments to be passed to methods. For more details about the arguments, see gpcm in the ltm package.

Details

The data argument of the function gpcmCat is either a data frame or an object of class gpcm from the ltm package. If it is a data frame each row represents a respondent and each column represents a question item. If it is an object of the class gpcm, it is output from the gpcm function in the ltm package.

The quadraturePoints argument of the function gpcmCat is used only when the data argument is a data frame. quadraturePoints is then passed to the gpcm function from the ltm package when fitting the generalized partial credit model to the data and is used when approximating the value of integrals.

Value

The function gpcmCat returns an object of class Cat with changes to the following slots:

- difficulty A list of difficulty parameters, where each element in the list corresponds to the difficulty parameters for an item.
- discrimination A vector consisting of of discrimination parameters for each item.
- model The string "gpcm", indicating this Cat object corresponds to a generalized partial credit model.

See Cat-class for default values of Cat object slots. See **Examples** and setters for example code to change slot values.

Note

This Cat object should be used for testing package functionality only.

In case the Hessian matrix at convergence is not positive definite try to use start.val = "random".

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

References

Baker, Frank B. and Seock-Ho Kim. 2004. Item Response Theory: Parameter Estimation Techniques. New York: Marcel Dekker.

Muraki, Eiji. 1992. "A generalized partial credit model: Application of an EM algorithm." ETS Research Report Series 1992(1):1-30.

Rizopoulos, Dimitris. 2006. "ltm: An R Package for Latent Variable Modeling and Item Response Theory Analyses." Journal of Statistical Software 17(5):1-25.

See Also

Cat-class, grmCat, polknowTAPS, probability

Examples

```
## Not run:
## Creating Cat object with fitted object of class gpcm
data(polknowTAPS)
gpcm_fit <- gpcm(polknowTAPS, constraint = "gpcm", control = list(iter.qN = 200, GHk = 100))
class(gpcm_fit)
gpcm_cat <- gpcmCat(gpcm_fit)

## End(Not run)

## Creating Cat objects from large datasets is computationally expensive
## Load the Cat object created from the above code
data(gpcm_cat)

## Slots that have changed from default values
getModel(gpcm_cat)
getDifficulty(gpcm_cat)
getDiscrimination(gpcm_cat)

## Changing slots from default values
setEstimation(gpcm_cat) <- "MLE"
setSelection(gpcm_cat) <- "MFI"
```

grm_cat *grm Cat Object*

Description

An object of class `Cat` created using the `grmCat` function with the `nfc` dataset.

Usage

```
data(grm_cat)
```

Format

An object of class `Cat`. See `Cat-class` for more details.

See Also

`Cat-class`, `grmCat`, `nfc`

Examples

```
## Not run:
## How this Cat object was created
data(nfc)
grm_cat <- grmCat(nfc, quadraturePoints = 100)

## End(Not run)

## How to load this Cat object for usage
data(grm_cat)
```

grmCat *Computerized Adaptive Testing Graded Response Model*

Description

This function fits the graded response model for ordinal polytomous data and populates the fitted values for discrimination and difficulty parameters to an object of class `Cat`.

Usage

```
## S4 method for signature 'data.frame'
grmCat(data, quadraturePoints = 21, ...)

## S4 method for signature 'grm'
grmCat(data, quadraturePoints = NULL, ...)
```

Arguments

data	A data frame of manifest variables or an object of class grm.
quadraturePoints	A numeric to be passed into the grm function indicating the number of Gauss-Hermite quadrature points. Only applicable when data is a data frame. Default value is 21.
...	arguments to be passed to methods. For more details about the arguments, see grm in the ltm package.

Details

The data argument of the function grmCat is either a data frame or an object of class grm from the ltm package. If it is a data frame each row represents a respondent and each column represents a question item. If it is an object of the class grm, it is output from the grm function in the ltm package.

The quadraturePoints argument of the function grmCat is used only when the data argument is a data frame. quadraturePoints is then passed to the grm function from the ltm package when fitting the graded response model to the data and is used when approximating the value of integrals.

Value

The function grmCat returns an object of class Cat with changes to the following slots:

- difficulty A list of difficulty parameters, where each element in the list corresponds to the difficulty parameters for an item.
- discrimination A vector consisting of discrimination parameters for each item.
- model The string "grm", indicating this Cat object corresponds to a graded response model.

See Cat-class for default values of Cat object slots. See **Examples** and setters for example code to change slot values.

Note

In case the Hessian matrix at convergence is not positive definite try to use start.val = "random".

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

References

Baker, Frank B. and Seock-Ho Kim. 2004. Item Response Theory: Parameter Estimation Techniques. New York: Marcel Dekker.

Samejima, Fumiko. 1969. "Estimation of Latent Ability Using a Response Pattern of Graded Scores." Psychometrika monograph supplement 34(4):100-114.

Rizopoulos, Dimitris. 2006. "ltm: An R Package for Latent Variable Modeling and Item Response Theory Analyses." Journal of Statistical Software 17(5):1-25.

See Also

Cat-class, gpcmCat, nfc, probability

Examples

```
## Not run:
## Creating Cat object with raw data
data(nfc)
grm_cat1 <- grmCat(nfc, quadraturePoints = 100)

## Creating Cat object with fitted object of class grm
grm_fit <- grm(nfc, control = list(GHk = 100)) ## from ltm package
class(grm_fit)
grm_cat2 <- grmCat(grm_fit)

## Note the two Cat objects are identical
identical(grm_cat1, grm_cat2)

## End(Not run)

## Creating Cat objects from large datasets is computationally expensive
## Load the Cat object created from the above code
data(grm_cat)

## Slots that have changed from default values
getModel(grm_cat)
getDifficulty(grm_cat)
getDiscrimination(grm_cat)

## Changing slots from default values
setEstimation(grm_cat) <- "MLE"
setSelection(grm_cat) <- "MFI"
```

---

likelihood *Likelihood of the Specified Response Set*

Description

Calculates the likelihood of a respondent, with ability parameter θ, having offered the specific set of responses stored in the Cat objects answers slot. All calculations are conditional on the item-level parameters stored in the Cat object.

Usage

```
likelihood(catObj, theta)
```

Arguments

catObj	An object of class Cat
theta	A numeric or an integer indicating the value for θ

Value

The function likelihood returns a numeric value of the likelihood of the respondent having offered the provided response profile. Note that when no questions have been answered, likelihood evaluates to 1.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled C++ code.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

References

Baker, Frank B. and Seock-Ho Kim. 2004. Item Response Theory: Parameter Estimation Techniques. New York: Marcel Dekker.

Choi, Seung W. and Richard J. Swartz. 2009. "Comparison of CAT Item Selection Criteria for Polytomous Items." Applied Psychological Measurement 33(6):419-440.

Muraki, Eiji. 1992. "A generalized partial credit model: Application of an EM algorithm." ETS Research Report Series 1992(1):1-30.

van der Linden, Wim J. 1998. "Bayesian Item Selection Criteria for Adaptive Testing." Psychometrika 63(2):201-216.

See Also

Cat-class, probability

Examples

```
## Loading ltm Cat object
## Likelihood for Cat object of the ltm model
data(ltm_cat)
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))
likelihood(ltm_cat, theta = 1)

## Loading grm Cat object
## Likelihood for Cat object of the grm model
data(grm_cat)
setAnswers(grm_cat) <- c(1,1,5,2,5, rep(NA, 13))
likelihood(grm_cat, theta = 1)
```

`likelihoodKL` *Expected Kullback-Leibler Information, Weighted by Likelihood*

Description

Calculates the expected Kullback-Leibler information, weighted by likelihood, for a specified item.

Usage

```
likelihoodKL(catObj, item)
```

Arguments

`catObj`	An object of class `Cat`
`item`	An integer indicating the index of the question item

Details

The function `likelihoodKL` calculates the expected Kullback-Leibler information for question `item`, where the proposed values of the true ability parameter are weighted by the current likelihood.

This function involves integration. See **Note** for more information.

Value

The function `likelihoodKL` returns a numeric indicating the expected Kullback-Leibler information weighted by the likelihood for the specified item, given the current answer profile and ability parameter estimate.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled `C++` code.

This function uses adaptive quadrature methods from the GNU Scientific Library (GSL) to approximate single-dimensional integrals with high accuracy. The bounds of integration are determined by the `lowerBound` and `upperBound` slots of the `Cat` object.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

`expectedKL`, `posteriorKL`, `selectItem`

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## Estimate EPV for different unasked items
likelihoodKL(ltm_cat, item = 10)
likelihoodKL(ltm_cat, item = 20)
likelihoodKL(ltm_cat, item = 30)
```

`lookAhead` *Look Ahead to Select Next Item*

Description

Selects the next item that would be asked for all possible response options to the question the respondent is currently answering.

Usage

```
lookAhead(catObj, item)
```

Arguments

`catObj`	An object of class `Cat`
`item`	A numeric indicating the question item the respondent is currently answering.

Value

A function `lookAhead` returns a data.frame. The the first column of the data frame is the possible response option to the question the respondent is currently answering and the second column is the next item that should be asked given each response.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled `C++` code.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

selectItem

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## What should be asked next if respondent is currently answering item 6
lookAhead(ltm_cat, 6)

## Loading grm Cat object
data(grm_cat)

## Store example answers
setAnswers(grm_cat) <- c(4,3,5,1,1, rep(NA, 13))

## What should be asked next if respondent is currently answering item 6
lookAhead(grm_cat, 6)
```

---

ltm_cat *ltm Cat Object*

Description

An object of class Cat created using the ltmCat function with the npi dataset.

Usage

```
data(ltm_cat)
```

Format

An object of class Cat. See Cat-class for more details.

See Also

Cat-class, ltmCat, npi

Examples

```
## Not run:
## How this Cat object was created
data(npi)
ltm_cat <- ltmCat(npi, quadraturePoints = 100)

## End(Not run)

## How to load this Cat object for usage
data(ltm_cat)
```

`ltmCat` *Computerized Adaptive Testing Latent Trait Model*

Description

This function fits the latent trait model for binary data and populates the fitted values for discrimination and difficulty parameters to an object of class `Cat`.

Usage

```
## S4 method for signature 'data.frame'
ltmCat(data, quadraturePoints = 21, ...)

## S4 method for signature 'ltm'
ltmCat(data, quadraturePoints = NULL, ...)
```

Arguments

`data`	A data frame of manifest variables or an object of class `ltm`.
`quadraturePoints`	A numeric to be passed into the `ltm` function indicating the number of Gauss-Hermite quadrature points. Only applicable when `data` is a data frame. Default value is 21.
`...`	arguments to be passed to methods. For more details about the arguments, see `ltm` in the `ltm` package.

Details

The `data` argument of the function `ltmCat` is either a data frame or an object of class `ltm` from the `ltm` package. If it is a data frame each row represents a respondent and each column represents a question item. If it is an object of the class `ltm`, it is output from the `ltm` function in the `ltm` package.

The `quadraturePoints` argument of the function `ltmCat` is used only when the `data` argument is a data frame. `quadraturePoints` is then passed to the `ltm` function from the `ltm` package when fitting the latent trait model to the data and is used when approximating the value of integrals.

Value

The function `ltmCat` returns an object of class `Cat` with changes to the following slots:

- `difficulty` A vector consisting of difficulty parameters for each item.
- `discrimination` A vector consisting of discrimination parameters for each item.
- `model` The string `"ltm"`, indicating this `Cat` object corresponds to a latent trait model.

See `Cat-class` for default values of `Cat` object slots. See **Examples** and `setters` for example code to change slot values.

Note

In case the Hessian matrix at convergence is not positive definite try to use `start.val = "random"`.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

References

Baker, Frank B. and Seock-Ho Kim. 2004. Item Response Theory: Parameter Estimation Techniques. New York: Marcel Dekker.

Rizopoulos, Dimitris. 2006. “ltm: An R Package for Latent Variable Modeling and Item Response Theory Analyses." Journal of Statistical Software 17(5):1-25.

See Also

`Cat-class`, `npi`, `probability`, `tpmCat`

Examples

```
## Not run:
## Creating Cat object with raw data
data(npi)
ltm_cat1 <- ltmCat(npi, quadraturePoints = 100)

## Creating Cat object with fitted object of class ltm
ltm_fit <- ltm(npi ~ z1, control = list(GHk = 100)) ## from ltm package
class(ltm_fit)
ltm_cat2 <- ltmCat(ltm_fit)

## Note the two Cat objects are identical
identical(ltm_cat1, ltm_cat2)

## End(Not run)

## Creating Cat objects from large datasets is computationally expensive
## Load the Cat object created from the above code
data(ltm_cat)
```

```
## Slots that have changed from default values
getModel(ltm_cat)
getDifficulty(ltm_cat)
getDiscrimination(ltm_cat)

## Changing slots from default values
setEstimation(ltm_cat) <- "MLE"
setSelection(ltm_cat) <- "MFI"
```

---

mach_cat *Machiavellianism Personality Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 20 item machiavellianism inventory

Usage

```
data(mach_cat)
```

Format

An object of class `Cat` of length 1.

Details

Cat object containing item parameters for graded response model fit with 3020 response profiles collected by Qualtrics in June 2018 and 12299 response profiles collected by the Open Source Psychometrics Project in 2012.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the Qualtrics sample (-0.713) and a standard deviation (1) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are: 5 = Strongly agree, 4 = Somewhat agree, 3 = Neither agree nor disagree, 2 = Somewhat disagree, 1 = Strongly disagree

The wording of the item responses is:

`Q1` Never tell anyone the real reason you did something unless it is useful to do so.

`Q2` The best way to handle people is to tell them what they want to hear.

Q3 One should take action only when sure it is morally right.

Q4 Most people are basically good and kind.

Q5 It is safest to assume that all people have a vicious streak and it will come out when they are given a chance.

Q6 Honesty is the best policy in all cases.

Q7 There is no excuse for lying to someone else.

Q8 Generally speaking, people won't work hard unless they're forced to do so.

Q9 All in all, it is better to be humble and honest than to be important and dishonest.

Q10 When you ask someone to do something for you, it is best to give the real reasons for wanting it rather than giving reasons which carry more weight.

Q11 Most people who get ahead in the world lead clean, moral lives.

Q12 Anyone who completely trusts anyone else is asking for trouble.

Q13 The biggest difference between most criminals and other people is that the criminals are stupid enough to get caught.

Q14 Most people are brave.

Q15 It is wise to flatter important people.

Q16 It is possible to be good in all respects.

Q17 P.T. Barnum was wrong when he said that there's a sucker born every minute.

Q18 It is hard to get ahead without cutting corners here and there.

Q19 People suffering from incurable diseases should have the choice of being put painlessly to death.

Q20 Most people forget more easily the death of their parents than the loss of their property.

Source

See https://dataverse.harvard.edu/dataverse/pdsl for the raw YouGov and/or Qualtrics data.

See https://openpsychometrics.org/_rawdata/, maintained by Eric Jorgenson, for the raw Open Source Psychometrics Project data.

References

Christie, R., F. L. Geis, and D. Berger (1970), Studies in Machiavellianism, New York: Academic Press.

Open Source Psychometrics Project. https://openpsychometrics.org/_rawdata/

See Also

Cat-class, grmCat

makeTree *Make Tree of Possible Question Combinations*

Description

Pre-calculates a complete branching scheme of all possible questions-answer combinations and stores it as a list of lists or a flattened table of values.

Usage

```
makeTree(catObj, flat = FALSE)
```

Arguments

catObj	An object of class Cat
flat	A logical indicating whether to return tree as as a list of lists or a table

Details

The function takes a Cat object and generates a tree of all possible question-answer combinations, conditional on previous answers in the branching scheme and the current θ estimates for the branch. The tree is stored as a list of lists, iteratively generated by filling in a possible answer, calculating the next question via selectItem, filling in a possible answer for that question, and so forth.

The length of each complete branching scheme within the tree is dictated by the lengthThreshold slot within the Cat object.

Value

The function makeTree returns either a list or a table. If the argument flat is FALSE, the default value, the function returns a list of lists.

If the argument flat is TRUE, the function takes the list of lists and configures it into a flattened table where the columns represent the battery items and the rows represent the possible answer profiles.

Note

This function is computationally expensive. If there are k response options and the researcher wants a complete branching scheme to include n items, k^{n-1} complete branching schemes will be calculated. Setting n is done via the lengthThreshold slot in the Cat object. See **Examples**.

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled C++ code.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

Cat-class, checkStopRules, selectItem

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Setting complete branches to include 3 items
setLengthThreshold(ltm_cat) <- 3

## Object returned is list of lists
ltm_list <- makeTree(ltm_cat)

## Object returned is table
ltm_table <- makeTree(ltm_cat, flat = TRUE)
```

---

neuro_cat *Neuroticism Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 20-item Neuroticism dimension of the 100-item IPIP representation of Costa and McCrae's Five Factor Model

Usage

```
data(neuro_cat)
```

Format

An object of class `Cat` of length 1.

Details

Cat object containing item parameters for graded response model fit with 774,410 response profiles by myPersonality Project and 1500 response profiles collected by YouGov in June 2018. The sample from myPersonality Project was a convenience sample, and the respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See Cat-class for details regarding the Cat object structure. See grmCat for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (-.025) and a standard deviation (1.2) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are 1=Very inaccurate; 2=Moderately inaccurate; 3=Neither inaccurate nor accurate; 4=Moderately accurate; 5=Very accurate.

The wording of the question items:

I...

`q12` Often feel blue.

`q30` Dislike myself.

`q80` Am often down in the dumps.

`q70` Have frequent mood swings.

`q50` Panic easily.

`q90` Am filled with doubts about things.

`q100` Feel threatened easily.

`q17` Get stressed out easily.

`q40` Fear for the worst.

`q60` Worry about things.

`q37` Seldom feel blue.

`q11` Feel comfortable with myself.

`q67` Rarely get irritated.

`q19` Am not easily bothered by things.

`q97` Am very pleased with myself.

`q27` Am relaxed most of the time.

`q77` Seldom get mad.

`q47` Am not easily frustrated.

`q87` Remain calm under pressure.

`q57` Rarely lose my composure.

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

References

Costa, P. T., Jr., & McCrae, R. R. (1992). Revised NEO Personality Inventory (NEO PI-R) and NEO Five-Factor Inventory (NEO-FFI): Professional manual. Odessa, FL: Psychological Assessment Resources.

Stillwell, David, and Michal Kosinski. 2007. "myPersonality Project." https://sites.google.com/michalkosinski.com/mypersonality

See Also

Cat-class, grmCat

---

nfa_cat *Need for Affect Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 26 item Need for Affect inventory

Usage

```
data(nfa_cat)
```

Format

An object of class Cat of length 1.

Details

Cat object containing item parameters for graded response model fit with 2507 response profiles from MTurk, 4990 response profiles collected by Qualtrics in June 2018, and 1512 response profiles from The American Panel Survey (TAPS) in December 2014. TAPS is a monthly online panel survey of about 2,000 adults in the United States. The panel was recruited in the fall of 2011 using an address-based sampling frame. TAPS surveys are administered online. Selected panelists who do not have a computer or online service are provided a computer and internet access by TAPS.

See Cat-class for details regarding the Cat object structure. See grmCat for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the TAPS sample (.236) and a standard deviation (1.3) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are:

5 = Strongly agree, 4 = Somewhat agree, 3 = Neither agree nor disagree, 2 = Somewhat disagree, 1 = Strongly disagree

The wording of the question items is:

q1 It is important for me to be in touch with my feelings.

q2 I think that it is very important to explore my feelings.

q3 I am a very emotional person.

q4 It is important for me to know how others are feeling.

q5 Emotions help people get along in life.

`q6` Strong emotions are generally beneficial.

`q7` I feel that I need to experience strong emotions regularly.

`q8` I approach situations in which I expect to experience strong emotions.

`q9` I feel like I need a good cry every now and then.

`q10` I like to dwell on my emotions.

`q11` We should indulge our emotions.

`q12` I like decorating my bedroom with a lot of pictures and posters of things emotionally significant to me.

`q13` The experience of emotions promotes human survival.

`q14` I do not know how to handle my emotion, so I avoid them.

`q15` I find strong emotions overwhelming and therefore try to avoid them.

`q16` Emotions are dangerous—they tend to get me into situations that I would rather avoid.

`q17` I would prefer not to experience either the lows or highs of emotion.

`q18` If I reflect on my past, I see that I tend to be afraid of emotions.

`q19` I would love to be like Mr. Spock, who is totally logical and experiences little emotion.

`q20` I have trouble telling the people close to me that I love them.

`q21` Displays of emotions are embarrassing.

`q22` Acting on ones emotions is always a mistake.

`q23` I am sometimes afraid of how I might act if I become too emotional.

`q24` Avoiding emotional events helps me sleep better at night.

`q25` I wish I could feel less emotion.

`q26` People can function most effectively when they are not experiencing strong emotions.

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

See https://wc.wustl.edu for raw TAPS data.

References

Maio, Gregory R., and Victoria M. Esses. "The need for affect: Individual differences in the motivation to approach or avoid emotions." Journal of personality 69.4 (2001): 583-614.

See Also

`Cat-class`, `grmCat`

nfc *Need For Cognition*

Description

Data of survey respondents' responses to 18 NFC questions, which is a reduced version of NFC (Cacioppo and Petty 1984). For each question, respondents could choose one of five response options: 1 = agree strongly, 2 = agree somewhat, 3 = neither agree nor disagree, 4 = disagree somewhat, 5 = disagree strongly. Missingness is optional. Observations come from one of three administrations of the survey: The American Panel Survey, Amazon's Mechanical Turk in fall of 2014, or Amazon's Mechanical Turk in spring of 2015.

Usage

```
data(nfc)
```

Format

A data frame with 4043 observations on the following 18 variables.

`NFC1` I really enjoy a task that involves coming up with new solutions to problems

`NFC4` I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought

`NFC10` Learning new ways to think doesn't excite me very much

`NFC12` I usually end up deliberating about issues even when they do not affect me personally

`NFC15` The idea of relying on thought to make my way to the top appeals to me

`NFC16` The notion of thinking abstractly is appealing to me

`NFC19` I only think as hard as I have to

`NFC21` I think tasks that require little thought once I've learned them

`NFC22` I prefer to think about small, daily projects to long-term ones

`NFC23` I would rather do something that requires little thought than something that is sure to challenge my thinking abilities

`NFC24` I find satisfaction in deliberating hard and for long hours

`NFC29` I like to have the responsibility of handing a situation that requires a lot of thinkings

`NFC31` I feel relief rather than satisfaction after completing a task that required a lot of mental effort

`NFC32` Thinking is not my idea of fun

`NFC33` I try to anticipate and avoid situations where there is likely a chance I will have to think in depth about something

`NFC39` I prefer my life to be filed with puzzles that I must solve

`NFC40` I would prefer complex to simple problems

`NFC43` Its enough for me that something gets the job done; I don't care how or why it works

References

Cacioppo, John T. and Richard E. Petty. 1984. "The Efficient Assessment of Need for Cognition." Journal of Personality Assessment 48(3):306-307.

`nfc_cat` *Need for Cognition Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 34 item Need for Cognition inventory

Usage

```
data(nfc_cat)
```

Format

An object of class `Cat` of length 1.

Details

Cat object containing item parameters for graded response model fit with 4985 response profiles collected by Qualtrics in June 2018 and 1512 response profiles from The American Panel Survey (TAPS) in December 2014. TAPS is a monthly online panel survey of about 2,000 adults in the United States. The panel was recruited in the fall of 2011 using an address-based sampling frame. TAPS surveys are administered online. Selected panelists who do not have a computer or online service are provided a computer and internet access by TAPS.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the TAPS sample (.003) and a standard deviation (1.6) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are:

5 = Strongly agree, 4 = Somewhat agree, 3 = Neither agree nor disagree, 2 = Somewhat disagree, 1 = Strongly disagree

The wording of the question items is:

`q1` I would prefer complex to simple problems.

`q2` I don't like to have the responsibility for handling a situation that requires a lot of thinking.

`q3` Thinking is not my idea of fun.

q4 I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.

q5 I try to anticipate and avoid situations where there is a likely chance I will have to think in depth about something.

q6 I find little satisfaction in deliberating hard and for long hours.

q7 I only think as hard as I have to.

q8 I prefer to think about small, daily projects more than long-term ones.

q9 I like tasks that require little thought once I've learned them.

q10 The idea of relying on thought to make my way to the top does not appeal to me.

q11 I really enjoy a task that involves coming up with new solutions to problems.

q12 Learning new ways to think doesn't excite me very much.

q13 I prefer my life to be filled with puzzles that I must solve.

q14 The notion of thinking abstractly is not appealing to me.

q15 I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.

q16 I feel relief rather the satisfaction after completing a task that required a lot of mental effort.

q17 Its enough for me that something gets the job done, I don't care how or why it works.

q18 I usually end up deliberating about issues even when they do not affect me personally.

q19 I tend to set goals that can be accomplished only by expending considerable mental effort.

q20 I am usually tempted to put more thought into a task than the job minimally requires.

q21 I am hesitant about making important decisions after thinking about them.

q22 I prefer just to let things happen rather than try to understand why they turned out that way.

q23 I have difficulty thinking in new and unfamiliar situations.

q24 I am an intellectual.

q25 I don't reason well under pressure.

q26 I more often talk with other people about the reasons/possible solutions to international problems than about gossip or tidbits about what famous people are doing.

q27 These days, I see little chance for performing well, even in intellectual jobs, unless one knows the right people.

q28 More often than not, more thinking just leads to more errors.

q29 I appreciate opportunities to discover the strengths and weaknesses of my own reasoning.

q30 I prefer watching educational programs more than entertainment programs.

q31 I think best when those around me are very intelligent.

q32 Simply knowing the answer rather than understanding the reasons for the answer to a problem is fine with me.

q33 Ignorance is bliss.

q34 I enjoy thinking about an issue even when the results of my thought will have no effect on the outcome of the issue.

Source

See https://dataverse.harvard.edu/dataverse/pdsl for the raw YouGov and/or Qualtrics data.

See https://wc.wustl.edu for raw TAPS data.

References

Cacioppo, John T., and Richard E. Petty. "The need for cognition." Journal of personality and social psychology 42.1 (1982): 116.

See Also

Cat-class, grmCat

---

npi *Narcissistic Personality Inventory*

Description

Data from the 40 item Narcissistic Personality Inventory (Raskin and Terry 1988) collected by by the Open Source Psychometrics Project in 2012.

Usage

```
data(npi)
```

Format

A data frame with 11,243 observations on the following 40 variables.

- Q1 0 = I have a natural talent for influencing people. 1 = I am not good at influencing people.
- Q2 0 = Modesty doesn't become me. 1 = I am essentially a modest person.
- Q3 0 = I would do almost anything on a dare. 1 = I tend to be a fairly cautious person.
- Q4 0 = When people compliment me I sometimes get embarrassed. 1 = I know that I am good because everybody keeps telling me so.
- Q5 0 = The thought of ruling the world frightens the hell out of me. 1 = If I ruled the world it would be a better place.
- Q6 0 = I can usually talk my way out of anything. 1 = I try to accept the consequences of my behavior.
- Q7 0 = I prefer to blend in with the crowd. 1 = I like to be the center of attention.
- Q8 0 = I will be a success. 1 = I am not too concerned about success.
- Q9 0 = I am no better or worse than most people. 1 = I think I am a special person.
- Q10 0 = I am not sure if I would make a good leader. 1 = I see myself as a good leader.
- Q11 0 = I am assertive. 1 = I wish I were more assertive.

`Q12` 0 = I like to have authority over other people. 1 = I don't mind following orders.

`Q13` 0 = I find it easy to manipulate people. 1 = I don't like it when I find myself manipulating people.

`Q14` 0 = I insist upon getting the respect that is due me. 1 = I usually get the respect that I deserve.

`Q15` 0 = I don't particularly like to show off my body. 1 = I like to show off my body.

`Q16` 0 = I can read people like a book. 1 = People are sometimes hard to understand.

`Q17` 0 = If I feel competent I am willing to take responsibility for making decisions. 1 = I like to take responsibility for making decisions.

`Q18` 0 = I just want to be reasonably happy. 1 = I want to amount to something in the eyes of the world.

`Q19` 0 = My body is nothing special. 1 = I like to look at my body.

`Q20` 0 = I try not to be a show off. 1 = I will usually show off if I get the chance.

`Q21` 0 = I always know what I am doing. 1 = Sometimes I am not sure of what I am doing.

`Q22` 0 = I sometimes depend on people to get things done. 1 = I rarely depend on anyone else to get things done.

`Q23` 0 = Sometimes I tell good stories. 1 = Everybody likes to hear my stories.

`Q24` 0 = I expect a great deal from other people. 1 = I like to do things for other people.

`Q25` 0 = I will never be satisfied until I get all that I deserve. 1 = I take my satisfactions as they come.

`Q26` 0 = Compliments embarrass me. 1 = I like to be complimented.

`Q27` 0 = I have a strong will to power. 1 = Power for its own sake doesn't interest me.

`Q28` 0 = I don't care about new fads and fashions. 1 = I like to start new fads and fashions.

`Q29` 0 = I like to look at myself in the mirror. 1 = I am not particularly interested in looking at myself in the mirror.

`Q30` 0 = I really like to be the center of attention. 1 = It makes me uncomfortable to be the center of attention.

`Q31` 0 = I can live my life in any way I want to. 1 = People can't always live their lives in terms of what they want.

`Q32` 0 = Being an authority doesn't mean that much to me. 1 = People always seem to recognize my authority.

`Q33` 0 = I would prefer to be a leader. 1 = It makes little difference to me whether I am a leader or not.

`Q34` 0 = I am going to be a great person. 1 = I hope I am going to be successful.

`Q35` 0 = People sometimes believe what I tell them. 1 = I can make anybody believe anything I want them to.

`Q36` 0 = I am a born leader. 1 = Leadership is a quality that takes a long time to develop.

`Q37` 0 = I wish somebody would someday write my biography. 1 = I don't like people to pry into my life for any reason.

`Q38` 0 = I get upset when people don't notice how I look when I go out in public. 1 = I don't mind blending into the crowd when I go out in public.

`Q39` 0 = I am more capable than other people. 1 = There is a lot that I can learn from other people.

`Q40` 0 = I am much like everybody else. 1 = I am an extraordinary person.

Details

Item responses are paired. Respondents had to choose the one that fit them the best.

References

Raskin, Robert and Howard Terry. 1988. "A Principal-Components Analysis of the Narcissistic Personality Inventory and Further Evidence of Its Construct Validity." Journal of Personality and Social Psychology 54(5):890-902.

Open Source Psychometrics Project. https://openpsychometrics.org/_rawdata/

`npi_battery` *Narcissistic personality inventory question items*

Description

A list where each element is a length three vector containin the text of the the question item and the two response options.

Usage

```
data(npi_battery)
```

Format

An object of class `list` of length 40.

References

Raskin, R., and H. Terry (1988), "A Principal-Components Analysis of the Narcissistic Personality Inventory and Further Evidence of Its Construct Validity," Journal of Personality and Social Psychology, 54, 890-902.

See Also

`npi_cat`

Examples

```
data(npi_battery)

# Item 1
npi_battery$Q1[1]

# Response options for item 1
npi_battery$Q1[2:3]
```

`npi_cat` *Narcissistic Personality Cat Object*

Description

Cat object containing item parameters for latent trait model fit with responses to the 40 item Narcissistic Personality inventory

Usage

```
data(npi_cat)
```

Format

An object of class `Cat` of length 1.

Details

Cat object containing item parameters for latent trait model fit with 2945 response profiles collected by Qualtrics in June 2018 and 10440 response profiles collected by the Open Source Psychometrics Project in 2012.

See `Cat-class` for details regarding the Cat object structure. See `ltmCat` for details regarding the latent trait model.

A normal prior was chosen with mean from the theta estimates from the Qualtrics sample (-.069) and a standard deviation (1) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Item responses are paired. Respondents had to choose the one that fit them the best.

The wording of the item responses is:

`Q1*` 0 = I am not good at influencing people. 1 = I have a natural talent for influencing people.

`Q2` 0 = Modesty doesn't become me. 1 = I am essentially a modest person.

`Q3` 0 = I would do almost anything on a dare. 1 = I tend to be a fairly cautious person.

`Q4` 0 = When people compliment me I sometimes get embarrassed. 1 = I know that I am good because everybody keeps telling me so.

`Q5` 0 = The thought of ruling the world frightens the hell out of me. 1 = If I ruled the world it would be a better place.

`Q6` 0 = I can usually talk my way out of anything. 1 = I try to accept the consequences of my behavior.

`Q7` 0 = I prefer to blend in with the crowd. 1 = I like to be the center of attention.

`Q8` 0 = I will be a success. 1 = I am not too concerned about success.

`Q9` 0 = I am no better or worse than most people. 1 = I think I am a special person.

`Q10` 0 = I am not sure if I would make a good leader. 1 = I see myself as a good leader.

`Q11` 0 = I am assertive. 1 = I wish I were more assertive.

`Q12` 0 = I like to have authority over other people. 1 = I don't mind following orders.

`Q13` 0 = I find it easy to manipulate people. 1 = I don't like it when I find myself manipulating people.

`Q14` 0 = I insist upon getting the respect that is due me. 1 = I usually get the respect that I deserve.

`Q15` 0 = I don't particularly like to show off my body. 1 = I like to show off my body.

`Q16` 0 = I can read people like a book. 1 = People are sometimes hard to understand.

`Q17` 0 = If I feel competent I am willing to take responsibility for making decisions. 1 = I like to take responsibility for making decisions.

`Q18` 0 = I just want to be reasonably happy. 1 = I want to amount to something in the eyes of the world.

`Q19` 0 = My body is nothing special. 1 = I like to look at my body.

`Q20` 0 = I try not to be a show off. 1 = I will usually show off if I get the chance.

`Q21` 0 = I always know what I am doing. 1 = Sometimes I am not sure of what I am doing.

`Q22` 0 = I sometimes depend on people to get things done. 1 = I rarely depend on anyone else to get things done.

`Q23` 0 = Sometimes I tell good stories. 1 = Everybody likes to hear my stories.

`Q24` 0 = I expect a great deal from other people. 1 = I like to do things for other people.

`Q25` 0 = I will never be satisfied until I get all that I deserve. 1 = I take my satisfactions as they come.

`Q26` 0 = Compliments embarrass me. 1 = I like to be complimented.

`Q27` 0 = I have a strong will to power. 1 = Power for its own sake doesn't interest me.

`Q28` 0 = I don't care about new fads and fashions. 1 = I like to start new fads and fashions.

`Q29` 0 = I like to look at myself in the mirror. 1 = I am not particularly interested in looking at myself in the mirror.

`Q30` 0 = I really like to be the center of attention. 1 = It makes me uncomfortable to be the center of attention.

`Q31` 0 = I can live my life in any way I want to. 1 = People can't always live their lives in terms of what they want.

`Q32` 0 = Being an authority doesn't mean that much to me. 1 = People always seem to recognize my authority.

`Q33` 0 = I would prefer to be a leader. 1 = It makes little difference to me whether I am a leader or not.

`Q34` 0 = I am going to be a great person. 1 = I hope I am going to be successful.

`Q35` 0 = People sometimes believe what I tell them. 1 = I can make anybody believe anything I want them to.

`Q36` 0 = I am a born leader. 1 = Leadership is a quality that takes a long time to develop.

`Q37` 0 = I wish somebody would someday write my biography. 1 = I don't like people to pry into my life for any reason.

`Q38` 0 = I get upset when people don't notice how I look when I go out in public. 1 = I don't mind blending into the crowd when I go out in public.

`Q39` 0 = I am more capable than other people. 1 = There is a lot that I can learn from other people.

`Q40` 0 = I am much like everybody else. 1 = I am an extraordinary person.

*Note that Item 1 is "reverse coded" from the coding that is typically used. This is because item parameter estimation constrains the first item's discrimination parameter to be positive. So the reverse coding was done for the more intuitive interpretation of item parameters and theta estimates as larger, positive values indicate "more" of the latent trait.

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

See https://openpsychometrics.org/_rawdata/, maintained by Eric Jorgenson, for the raw Open Source Psychometrics Project data.

References

Raskin, R., and H. Terry (1988), "A Principal-Components Analysis of the Narcissistic Personality Inventory and Further Evidence of Its Construct Validity," Journal of Personality and Social Psychology, 54, 890-902.

Open Source Psychometrics Project. https://openpsychometrics.org/_rawdata/

See Also

`Cat-class`, `ltmCat`

`nte` *Need to Evaluate*

Description

4005 full response profiles to 16 Need to Evaluate inventory. Observations come from one of three administrations of the survey: The American Panel Survey, Amazon's Mechanical Turk in fall of 2014, or Amazon's Mechanical Turk in spring of 2015.

Usage

```
data(nte)
```

Format

An object of class `data.frame` with 4005 rows and 16 columns.

Details

See `nte_cat` for detailed information on question wordings and response options.

References

Jarvis, W. Blair G., and Richard E. Petty. "The need to evaluate." Journal of personality and social psychology 70.1 (1996): 172.

See Also

nte_cat

---

nte_cat *Need to Evaluate Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 16 item Need to Evaluate inventory

Usage

```
data(nte_cat)
```

Format

An object of class Cat of length 1.

Details

Cat object containing item parameters for graded response model fit with 2534 response profiles from MTurk, 4993 response profiles collected by Qualtrics in June 2018, and 1512 response profiles from The American Panel Survey (TAPS) in December 2014. TAPS is a monthly online panel survey of about 2,000 adults in the United States. The panel was recruited in the fall of 2011 using an address-based sampling frame. TAPS surveys are administered online. Selected panelists who do not have a computer or online service are provided a computer and internet access by TAPS.

See Cat-class for details regarding the Cat object structure. See grmCat for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the TAPS sample (.002) and a standard deviation (1.3) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are:

5 = Extremely characteristic of me, 4 = Somewhat characteristic of me, 3 = Uncertain, 2 = Somewhat uncharacteristic of me, 1 = Extremely uncharacteristic of me

The wording of the question items is:

q1 I form opinions about everything.

`q2` I prefer to avoid taking extreme positions.

`q3` It is very important to me to hold strong opinions.

`q4` I want to know exactly what is good and bad about everything.

`q5` I often prefer to remain neutral about complex issues.

`q6` If something does not affect me, I do not usually determine if it is good or bad.

`q7` I enjoy strongly liking and disliking things.

`q8` There are many things for which I do not have a preference.

`q9` It bothers me to remain neutral.

`q10` I like to have strong opinions even when I am not personally involved.

`q11` I have many more opinions than the average person.

`q12` I would rather have a strong opinion than no opinion at all.

`q13` I pay a lot of attention to whether things are good or bad.

`q14` I only form strong opinions when I have to.

`q15` I like to decide that new things are really good or really bad.

`q16` I am pretty much indifferent to many important issues.

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

See https://wc.wustl.edu for raw TAPS data.

References

Jarvis, W. Blair G., and Richard E. Petty. "The need to evaluate." Journal of personality and social psychology 70.1 (1996): 172.

See Also

Cat-class, grmCat

---

obsInf *Observed Information*

Description

Calculates the observed information of the likelihood of a respondent's ability θ for a given `item`.

Usage

```
obsInf(catObj, theta, item)
```

Arguments

catObj	An object of class Cat
theta	A numeric or an integer indicating the value for θ
item	An integer indicating the index of the question item

Details

The observed information is equivalent to the negative second derivative of the log-likelihood evaluated at θ. This function should never be called when the respondent has answered no questions as the likelihood is not defined.

Value

The function obsInf returns a numeric value of the observed information of the likelihood, given θ, for a given question item.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled C++ code.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

estimateTheta, expectedObsInf

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## Calculate observed information for different ability parameters and items
obsInf(ltm_cat, theta = 1, item = 10)
obsInf(ltm_cat, theta = 1, item = 11)
obsInf(ltm_cat, theta = 0, item = 10)
obsInf(ltm_cat, theta = 0, item = 11)
```

open_cat *Openness to Experience Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 20-item Openness dimension of the 100-item IPIP representation of Costa and McCrae's Five Factor Model

Usage

```
data(open_cat)
```

Format

An object of class `Cat` of length 1.

Details

Cat object containing item parameters for graded response model fit with 774,410 response profiles by myPersonality Project and 1500 response profiles collected by YouGov in June 2018. The sample from myPersonality Project was a convenience sample, and the respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (-.674) and a standard deviation (1.2) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are 1=Very inaccurate; 2=Moderately inaccurate; 3=Neither inaccurate nor accurate; 4=Moderately accurate; 5=Very accurate.

The wording of the question items:

I...

`q91` Believe in the importance of art.

`q1` Have a vivid imagination.

`q51` Tend to vote for liberal political candidates.

`q41` Carry the conversation to a higher level.

`q61` Enjoy hearing new ideas.

`q31` Enjoy thinking about things.

`q21` Can say things beautifully.

`q16` Enjoy wild flights of fantasy.

`q81` Get excited by new ideas.

q71 Have a rich vocabulary.

q24 Am not interested in abstract ideas.

q74 Do not like art.

q7 Avoid philosophical discussions.

q34 Do not enjoy going to art museums.

q44 Tend to vote for conservative political candidates.

q4 Do not like poetry.

q94 Rarely look for a deeper meaning in things.

q84 Believe that too much tax money goes to support artists.

q54 Am not interested in theoretical discussions.

q64 Have difficulty understanding abstract ideas.

Source

See https://dataverse.harvard.edu/dataverse/pdsl for the raw YouGov and/or Qualtrics data.

References

Costa, P. T., Jr., & McCrae, R. R. (1992). Revised NEO Personality Inventory (NEO PI-R) and NEO Five-Factor Inventory (NEO-FFI): Professional manual. Odessa, FL: Psychological Assessment Resources.

Stillwell, David, and Michal Kosinski. 2007. "myPersonality Project." https://sites.google.com/michalkosinski.com/mypersonality

See Also

Cat-class, grmCat

---

oracle *Find Answer Profile that Minimizes Bias*

Description

Generating all possible combinations of length n from a response profile to determine the possible response profile best able to estimate the true value of theta.

Usage

```
## S4 method for signature 'Cat'
oracle(catObj, theta, responses, approx = FALSE, parallel = FALSE)
```

Arguments

catObj	An object of class Cat
theta	A numeric representing the true position on the latent trait.
responses	A vector representing the respondent's full answer profile.
approx	If TRUE, uses a subset of 1000 potential response profiles
parallel	If TRUE, computes in parallel

Details

lengthThreshold slot should specify how many questions to ask. Note this function uses the estimateTheta method specified in the supplied cat object

Value

A data.frame where the first column is the user-supplied true value of theta, the second column is the best possible theta estimate given n questions are asked, and the remaining columns are the answer profile leading to the best possible theta estimation.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

---

plot.Cat *Plotting function for Cat object*

Description

Function to plot item response functions, item characteristic functions, and item information functions for Cat objects.

Usage

```
## S4 method for signature 'Cat'
plot(x, item, plotType, xlim = c(-5, 5), ...)
```

Arguments

x	Cat object.
item	Numeric. Item index.
plotType	Character. Either "IRF", "ICC", or "IIF" for item response functions, item characteristic functions, and item information functions, respectively.
xlim	Vector. Range of the x-axis.
...	Other arguments passed to plot().

polknowMT *MTurk Political Knowledge*

Description

Data from Amazon Mechanical Turkers in 2012 responding to 64 political knowledge questions. Political knowledge questions had a varying number of response options, noted below. This dataset codes answers as either correct (a value of 0) or incorrect (a value of 1).

Usage

```
data(polknowMT)
```

Format

A data frame with 810 observations on the following 64 questions.

`Q1` How long is one term for the President of the United States?

Eight years; Six years; Four years; Two years

`Q2` The FDA is part of the national government primarily responsible for regulating

Food quality; The national parks; Electricity production and energy; Pollution and the environment

`Q3` Who is the Vice President of the United States?

Leon Panetta; William Daley; Hillary Clinton; Joe Biden

`Q4` The federal debt is

Much smaller than it was 20 years ago; The difference between imports and exports with foreign countries; The annual difference between spending and tax revenues; The accumulated borrowing of the federal government that has not been repaid

`Q5` How many times can an individual be elected President of the United States under current laws?

Any number of terms; Three times; Twice; Once

`Q6` What do we call the first ten amendments to the Constitution?

The Articles of Confederation; The inalienable right; The Bill of Rights; The Declaration of Independence

`Q7` Is the U.S. federal budget deficit, the amount by which the governments spending exceeds the amount of money it collects, now bigger, about the same, or smaller than it was during most of the 1990s?

Smaller; About the same; Bigger

`Q8` Who signs bills to become laws?

The President; The Vice President; The Chief Justice of the Supreme Court; The Secretary of State

`Q9` Which party is generally more supportive of creating a way for immigrants who are in the U.S. illegally to eventually become citizens?

The Republican Party; The Democratic Party

`Q10` In what month do we vote for the President?

November; October; February; January

`Q11` What are the two parts of the U.S. Congress?

The Senate and the Supreme Court; The House of Lords and the House of Commons; The House of Representative and the Supreme Court; The Senate and House of Representatives

`Q12` Which party is generally more supportive of restricting access to abortion?

The Republican Party; The Democratic Party

`Q13` Which of these political parties is considered most conservative?

Green Party; Republican Party; Democratic Party

`Q14` The NRA is an organization that advocates for

Clean elections; A cleaner environment; The rights of gun owners; Women's rights

`Q15` Compared to 30 years ago, is the difference in incomes between the top 20% of households and the bottom 20% of households now bigger, smaller, or the same?

The difference is now the same as 30 years ago; The difference is now smaller than 30 years ago; The difference is now bigger than 30 years ago

`Q16` The EPA is part of the national government primarily responsible for regulating

Food quality; The national parks; Electricity production and energy; Pollution and the environment

`Q17` Which party is generally more supportive of reducing the size of the defense budget?

The Republican Party; The Democratic Party

`Q18` Which party is generally more supportive of increasing taxes on higher income people to reduce the federal budget deficit?

The Republican Party; The Democratic Party

`Q19` Which party is generally more supportive of allowing drilling for oil in the Arctic National Wildlife Refuge?

The Republican Party; The Democratic Party

`Q20` Who is the Commander in Chief of the military?

The Attorney General; The President; The Secretary of Defense; The Vice President

`Q21` The First Amendment to the United States Constitution guarantees all of these rights EXCEPT

Right to remain silent; Right to the free exercise of religion; Right to free speech; Right to peaceably assemble

`Q22` Roe v Wade is a case decided by the Supreme Court that relates to

Executive power; Campaign finance; Birth control; Abortion

`Q23` Social Security is

Funded by the personal income tax; Operated by state government; The responsibility of the Department of Defense; The benefit program for senior citizens

`Q24` What is Medicare?

A private, non-profit organization that runs free health clinic; A private health insurance plan sold to individuals in all 50 states; A program run by state governments to provide health care to poor people; A program run by the U.S. federal government to pay for old people's health care

Q25 How many senators are elected from each state?

It depends on the population of the state; Four; Two; One

Q26 How many votes are required in Congress to override a presidential veto

A simple majority of both houses of Congress; A simple majority of one house of Congress; A two-thirds majority of both houses of Congress; A two-thirds majority of one house of Congress

Q27 The Secretary of State

Serves a two-year term; Serves the state governments; Is nominated by the president; Heads the armed services

Q28 Near the end of an election campaign, a polls shows that an issue that no candidate has mentioned is of great concern to voters. What is most likely to happen?

Some candidates will drop out of the race; Candidates will start talking about the issue; Newspapers will not report the results of the poll; The election will be postponed

Q29 Liberals are generally said to

Support pro-life policies; Oppose all tax increases; Support military spending; Support government programs to give government assistance the needy

Q30 Which party is generally more supportive of reducing the size and scope of the federal government?

The Republican Party; The Democratic Party

Q31 The ability of a minority of senators to prevent a vote on a bill is known as Suspension of the rules; Enrollment; A veto; A filibuster

Q32 conservatives are generally said to

Support pro-choice policies; Support tax cuts; Oppose military spending; Support government programs to give government assistance to the needy

Q33 Which of these regions of the country is generally considered to be most supportive of Republican candidates

Midwest; South; West Coast; New England

Q34 The presiding officer in the House of Representatives is

The Majority Leader; The Sergeant at Arms; The Vice President of the United States; The Speaker

Q35 Which of these countries is NOT a permanent member of the U.N. Security Council

United Kingdom; France; India; China

Q36 Which part has a majority of seats in the U.S. House of Representatives?

Neither; Democrats; Republicans

Q37 What state holds the first primary election in Presidential primaries?

Florida; Nevada; South Carolina; New Hampshire

Q38 Who is the Speaker of the House of Representatives?

Mitt Romney; Eric Holder; Harry Reid; John Boehner

Q39 Most cases are considered by the Supreme Court

In even-numbered years; At the request of the Congress; Upon order of the president; With the approval of at least four justices

`Q40` How many Justices typically serve on the U.S. Supreme Court
Eleven; Nine; Eight; Seven

`Q41` What job or political office is no held by Ben Bernanke?
None of these; Minority Whip of the U.S. House; Chief Justice of the United States Supreme Court; Majority leader of the U.S. Senate, Chairman of the Federal Reserve

`Q42` Whose responsibility is it to nominate judges to the Federal Courts
The state governors; The Supreme Court; Congress; President

`Q43` Who is the Chief Justice of the U.S. Supreme Court?
Larry Thompson; Anthony Kennedy; David Cole; John Roberts

`Q44` The U.S. Senate
Votes to confirm nominees to the U.S. Supreme court chosen by the House of Representatives; Plays no role in choosing the members of the U.S. Supreme Court; Chooses members of the U.S. Supreme Court; Votes to confirm nominees to the U.S. Supreme Court chosen by the President

`Q45` Which party has a majority of seats in the U.S. Senate
Neither; Democrats; Republicans

`Q46` Which of the states listed below has the greatest number of electoral college votes in the U.S. Presidential Elections?
Puerto Rico; Nevada; North Dakota; Washington, D.C.

`Q47` Citizens United v the FEC is a case decided by the Supreme Court that relates to
Executive power; Campaign finance; Birth control; Abortion

`Q48` For how many years is a United States Senator elected that is, how many years are there in one full term of office for a U.S. Senator?
None of these; Eight years; Six years; Four years; Two years

`Q49` Who is the Prime Minister of the United Kingdom?
Richard Branson; Tony Hayward; Nick Clegg; David Cameron

`Q50` The president of Afghanistan is named
Bashar al-Assad; Hosni Mubarak; Hamid Karzai; Nouri al-Maliki

`Q51` The House of Representatives has how many voting members?
Four hundred and forty-one; Four hundred and thirty-five; Two hundred; One hundred

`Q52` The President of the Senate is
The Majority Leader; The Sergeant at Arms; The Vice President of the United States; The senior senator of the majority party

`Q53` On which of the following federal programs is the most money spent each year?
Medicare; Education; Subsidies to farmers; Aid to foreign countries

`Q54` What do all constitutional governments have?
Separation of church and state; A bill of rights; A President as the head of government; Limits on political power

`Q55` One which of the following does the U.S. federal government spend the least money?
Social Security; National defense; Medicare; Foreign aid

`Q56` The head of the Department of Justice is
Kathleen Sebelius; Eric Holder; Timothy Geithner; Hillary Clinton

`Q57` The president may NOT

Declare war; Pardon criminals without justification; Appoint federal officials when Congress is in recess; Refuse to sign legislation passed by Congress

`Q58` Which of these is NOT primarily the responsibility of the Federal government in Washington?

Interstate commerce; Negotiating treaties with foreign countries; Education; National defense

`Q59` Who is the current president of Mexico?

Vincente Fox; Hugo Chavez; Dilma Rousseff; Felipe Calderon

`Q60` Which of the following actions does the United States federal government commonly take to finance a budget deficit?

Expanding public-works projects; Borrowing from the public; Imposing import quotas; Printing more money

`Q61` Common Cause is an organization that advocates for

Women's rights; Clean elections; A cleaner environment; The right of gun owners

`Q62` The Byrd Rule is relevant

During the confirmation of cabinet members; For national party conventions; During Congressional debates over non-budgetary policies; For the Reconciliation process

`Q63` The Majority Leader of the House of Representative is

Nancy Pelosi; Kevin McCarthy; Eric Cantor; John Boehner

`Q64` On which of the following does the U.S. federal government spend the most money each year?

Education; Medicare; Interest on the national debt; National defense

Source

`https://dataverse.harvard.edu/dataset.xhtml?persistentId=hdl:1902.1/19381`

References

Jacob M. Montgomery and Joshua Cutler. 2013. "Computerized Adaptive Testing for Public Opinion Surveys." Political Analysis (Spring 2013) 21 (2): 172-192.

`polknowOrdered` *TAPS Political Knowledge (Ordered Response Options)*

Description

Data of responses to a political knowledge battery from the May 2013 wave of The American Panel Survey (TAPS) out of Washington University in St. Louis.

Usage

```
data(polknowOrdered)
```

Format

A data frame with 1340 observations (only complete cases) of the following 10 questions.

`Q1` Members of the U.S. Supreme Court serve

3 = two-year terms. 4 = ten-year terms. 5 = life terms. 2 = terms determined by the president. 1 = Don't know.

`Q2` Who is the Chief Justice of the U.S. Supreme Court?

5 = John Roberts. 4 = Antonin Scalia. 3 = Mitt Romney. 2 = Hillary Clinton. 1 = Don't know.

`Q3` Social Security is

5 = the benefit program for senior citizens. 2 = the responsibility of the Department of Defense. 3 = operated by state governments. 4 = funded by the personal income tax. 1 = Don't know.

`Q4` On which of the following programs is the most money spent each year?

4 = aid to foreign countries. 5 = Medicare. 2 = subsidies to farmers. 3 = education. 1 = Don't know.

`Q5` Which party holds a majority of seats in the U.S. House of Representatives in Washington?

4 = Democrats. 3 = Republicans. 2 = Independents. 1 = Don't know.

`Q6` How many votes are required in Congress to override a presidential veto?

2 = a simple majority of one house of Congress. 3 = a simple majority of both houses of Congress. 4 = a two-thirds majority of one house of Congress. 5 = a two-thirds majority of both houses of Congress. 1 = Don't know.

`Q7` How long is one term for a member of the U.S. Senate?

3 = two years. 4 = four years. 5 = six years. 2 = eight years. 1 = Don't know.

`Q8` The ability of a minority of senators to prevent a vote on a bill is known as

4 = a veto. 5 = a filibuster. 3 = enrollment. 2 = suspension of the rules. 1 = Don't know.

`Q9` Who is the Vice President of the United States?

4 = Nancy Pelosi. 3 = John Boehner. 5 = Joseph Biden. 2 = Harry Reid. 1 = Don't know.

`Q10` A president may serve

3 = one term. 5 = two terms. 4 = three terms. 2 = any number of terms. 1 = Don't know.

Details

TAPS is a monthly online panel survey of about 2,000 adults in the United States. The panel was recruited in the fall of 2011 using an address-based sampling frame. TAPS surveys are administered online. Selected panelists who do not have a computer or online service are provided a computer and internet access by TAPS.

Source

https://wc.wustl.edu/

polknowTAPS *TAPS Political Knowledge*

Description

Data of responses to a political knowledge battery from the May 2013 wave of The American Panel Survey (TAPS) out of Washington University in St. Louis.

Usage

```
data(polknowTAPS)
```

Format

A data frame with 1496 observations on the following 10 questions.

`Q1` Members of the U.S. Supreme Court serve

1 = two-year terms. 2 = ten-year terms. 3 = life terms. 4 = terms determined by the president. 5 = Don't know.

`Q2` Who is the Chief Justice of the U.S. Supreme Court?

1 = John Roberts. 2 = Antonin Scalia. 3 = Mitt Romney. 4 = Hillary Clinton. 5 = Don't know.

`Q3` Social Security is

1 = the benefit program for senior citizens. 2 = the responsibility of the Department of Defense. 3 = operated by state governments. 4 = funded by the personal income tax. 5 = Don't know.

`Q4` On which of the following programs is the most money spent each year?

1 = aid to foreign countries. 2 = Medicare. 3 = subsidies to farmers. 4 = education. 5 = Don't know.

`Q5` Which party holds a majority of seats in the U.S. House of Representatives in Washington?

1 = Democrats. 2 = Republicans. 3 = Independents. 4 = Don't know.

`Q6` How many votes are required in Congress to override a presidential veto?

1 = a simple majority of one house of Congress. 2 = a simple majority of both houses of Congress. 3 = a two-thirds majority of one house of Congress. 4 = a two-thirds majority of both houses of Congress. 5 = Don't know.

`Q7` How long is one term for a member of the U.S. Senate?

1 = two years. 2 = four years. 3 = six years. 4 = eight years. 5 = Don't know.

`Q8` The ability of a minority of senators to prevent a vote on a bill is known as

1 = a veto. 2 = a filibuster. 3 = enrollment. 4 = suspension of the rules. 5 = Don't know.

`Q9` Who is the Vice President of the United States?

1 = Nancy Pelosi. 2 = John Boehner. 3 = Joseph Biden. 4 = Harry Reid. 5 = Don't know.

`Q10` A president may serve

1 = one term. 2 = two terms. 3 = three terms. 4 = any number of terms. 5 = Don't know.

Details

TAPS is a monthly online panel survey of about 2,000 adults in the United States. The panel was recruited in the fall of 2011 using an address-based sampling frame. TAPS surveys are administered online. Selected panelists who do not have a computer or online service are provided a computer and internet access by TAPS.

Source

https://wc.wustl.edu/

---

posteriorKL *Expected Kullback-Leibler Information, Weighted by the Prior*

Description

Calculates the expected Kullback-Leibler information, weighted by likelihood and prior beliefs, for a specified item.

Usage

```
posteriorKL(catObj, item)
```

Arguments

catObj	An object of class Cat
item	An integer indicating the index of the question item

Details

The function posteriorKL calculates the expected Kullback-Leibler information for question item, where the proposed values of the true ability parameter are weighted by the prior.

This function involves integration. See **Note** for more information.

Value

The function posteriorKL returns a numeric indicating the expected Kullback-Leibler information weighted by the likelihood for the specified item, given the current answer profile and ability parameter estimate.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled C++ code.

This function uses adaptive quadrature methods from the GNU Scientific Library (GSL) to approximate single-dimensional integrals with high accuracy. The bounds of integration are determined by the lowerBound and upperBound slots of the Cat object.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

expectedKL, likelihoodKL, selectItem

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## Estimate EPV for different unasked items
posteriorKL(ltm_cat, item = 10)
posteriorKL(ltm_cat, item = 20)
posteriorKL(ltm_cat, item = 30)
```

---

prior *Evaluate the Prior Density Distribution at Position theta*

Description

Calculates the density at theta of either the normal, Student's t, or uniform distribution.

Usage

```
prior(catObj, theta)
```

Arguments

catObj	An object of class Cat.
theta	A numeric value at which to evaluate the prior

Details

The priorName slot of Cat object needs to be either "UNIFORM", "NORMAL", or "STUDENT_T".

When priorName slot is "NORMAL", the first element of priorParams slot is the mean, the second element is the standard deviation.

When priorName slot is "STUDENT_T", the first element of priorParams slot is the non-centrality parameters and the second is degrees of freedom.

When priorName slot is "UNIFORM", the elements of the priorParams slot are the lower and upper bounds, of the interval, respectively. Note that the "UNIFORM" is only applicable for the expected a posteriori (EAP) estimation method.

Value

The function `prior` returns a numeric consisting of prior value, $\pi(\theta)$, given the value θ.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled `C++` code.

This function uses Boost `C++` source libraries for the uniform and Student's t distributions and calls `dnorm4` written in `C` which is identical to that of `dnorm` in `R`.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

`Cat-class`

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Prior calculation for different distributions
ltm_cat@priorName <- "NORMAL"
ltm_cat@priorParams <- c(0, 1) ## Parameters are mean and standard deviation
prior(ltm_cat, theta = 1)

ltm_cat@priorName <- "STUDENT_T"
ltm_cat@priorParams <- c(1, 3) ## Parameters are non-centrality param and degrees of freedom
prior(ltm_cat, theta = 1)

ltm_cat@priorName <- "UNIFORM"
ltm_cat@priorParams <- c(-1, 1) ## Parameters are lower bound and upper bound of interval
prior(ltm_cat, theta = 1)
```

---

probability *Probability of Responses to a Question Item or the Left-Cumulative Probability of Responses*

Description

Calculates the probability of specific responses or the left-cumulative probability of responses to `item` conditioned on a respondent's ability (θ).

Usage

```
probability(catObj, theta, item)
```

Arguments

`catObj`	An object of class `Cat`
`theta`	A numeric or an integer indicating the value for θ_j
`item`	An integer indicating the index of the question item

Details

For the `ltm` model, the probability of non-zero response for respondent j on item i is

$$Pr(y_{ij} = 1|\theta_j) = \frac{\exp(a_i + b_i\theta_j)}{1 + \exp(a_i + b_i\theta_j)}$$

where θ_j is respondent j 's position on the latent scale of interest, a_i is item i 's discrimination parameter, and b_i is item i 's difficulty parameter.

For the `tpm` model, the probability of non-zero response for respondent j on item i is

$$Pr(y_{ij} = 1|\theta_j) = c_i + (1 - c_i)\frac{\exp(a_i + b_i\theta_j)}{1 + \exp(a_i + b_i\theta_j)}$$

where θ_j is respondent j 's position on the latent scale of interest, a_i is item i 's discrimination parameter, b_i is item i 's difficulty parameter, and c_i is item i 's guessing parameter.

For the `grm` model, the probability of a response in category k **or lower** for respondent j on item i is

$$Pr(y_{ij} < k|\theta_j) = \frac{\exp(\alpha_{ik} - \beta_i\theta_{ij})}{1 + \exp(\alpha_{ik} - \beta_i\theta_{ij})}$$

where θ_j is respondent j 's position on the latent scale of interest, $\alpha_i k$ the k-th element of item i 's difficulty parameter, β_i is discrimination parameter vector for item i. Notice the inequality on the left side and the absence of guessing parameters.

For the `gpcm` model, the probability of a response in category k for respondent j on item i is

$$Pr(y_{ij} = k|\theta_j) = \frac{\exp(\sum_{t=1}^{k} \alpha_i[\theta_j - (\beta_i - \tau_{it})])}{\sum_{r=1}^{K_i} \exp(\sum_{t=1}^{r} \alpha_i[\theta_j - (\beta_i - \tau_{it}))}$$

where θ_j is respondent j 's position on the latent scale of interest, α_i is the discrimination parameter for item i, β_i is the difficulty parameter for item i, and τ_{it} is the category t threshold parameter for item i, with $k = 1, ..., K_i$ response options for item i. For identification purposes $\tau_{i0} = 0$ and $\sum_{t=1}^{1} \alpha_i[\theta_j - (\beta_i - \tau_{it})] = 0$. Note that when fitting the model, the β_i and τ_{it} are not distinct, but rather, the difficulty parameters are β_{it} = β_i - τ_{it}.

Value

When the model slot of the catObj is "ltm", the function probability returns a numeric vector of length one representing the probability of observing a non-zero response.

When the model slot of the catObj is "tpm", the function probability returns a numeric vector of length one representing the probability of observing a non-zero response.

When the model slot of the catObj is "grm", the function probability returns a numeric vector of length k+1, where k is the number of possible responses. The first element will always be zero and the (k+1)th element will always be one. The middle elements are the cumulative probability of observing response k or lower.

When the model slot of the catObj is "gpcm", the function probability returns a numeric vector of length k, where k is the number of possible responses. Each number represents the probability of observing response k.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled C++ code.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

References

Baker, Frank B. and Seock-Ho Kim. 2004. Item Response Theory: Parameter Estimation Techniques. New York: Marcel Dekker.

Choi, Seung W. and Richard J. Swartz. 2009. “Comparison of CAT Item Selection Criteria for Polytomous Items." Applied Psychological Measurement 33(6):419-440.

Muraki, Eiji. 1992. “A generalized partial credit model: Application of an EM algorithm." ETS Research Report Series 1992(1):1-30.

van der Linden, Wim J. 1998. “Bayesian Item Selection Criteria for Adaptive Testing." Psychometrika 63(2):201-216.

See Also

Cat-class

Examples

```
## Loading ltm Cat object
## Probability for Cat object of the ltm model
data(ltm_cat)
probability(ltm_cat, theta = 1, item = 1)

## Loading tpm Cat object
## Probability for Cat object of the tpm model
probability(tpm_cat, theta = 1, item = 1)
```

```
## Loading grm Cat object
## Probability for Cat object of the grm model
probability(grm_cat, theta = 1, item = 1)

## Loading gpcm Cat object
## Probability for Cat object of the gpcm model
probability(gpcm_cat, theta = -3, item = 2)
```

`processAJAX` *Qualtrics AJAX Handler*

Description

Qualtrics AJAX Handler used to implement catSurv functionality in a Qualtrics survey

Usage

```
## S4 method for signature 'character'
processAJAX(catObj, item)
```

Arguments

`catObj`	An object of class `Cat`.
`item`	An integer indicating the index of the question item

Details

This function is not intended for researcher use, rather it is a public facing function of the package because it is used by catSurv to integrate computerized adaptive testing into a Qualtrics survey.

Author(s)

Joshua Landman

`readQualtrics` *Clean adaptive inventory responses from Qualtrics*

Description

This function cleans the adaptive inventory responses stored as embedded data in Qualtrics

Usage

```
## S4 method for signature 'character'
readQualtrics(catObj, responseID)
```

Arguments

catObj	Vector containing JSON character representations of the completed Cat objects from Qualtrics survey
responseID	Vector containing unique character identifiers for the respondents in the Qualtrics survey

Details

This function cleans the adaptive inventory responses contained in the Qualtrics survey results. Because different respondents recieve different adaptive inventories, their answers to the battery are not stored as usual as separate columns in the Data & Analysis tab in the Qualtrics toolbar. Rather, the respondents' answers to the adaptive battery are saved in the catObj embedded data object. To access the answers, click "Export & Import", and then "Export Data." In the window that appears, we recommend downloading the data as a .csv file. Then, feed this function the catObj column and the responseID column.

Value

This function returns a data frame containing cleaned adaptive inventory responses.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

Cat-class, ex_qualtrics_results, ex_qualtrics_results_multiple

Examples

```
data(ex_qualtrics_results) # loads example results
cat_vect <- ex_qualtrics_results$catObj[-c(1,2)] # vector of Cat embedded data objects
ids <- ex_qualtrics_results$ResponseId[-c(1,2)] # vector of respondent identifiers

# clean answer profiles
clean_df <- readQualtrics(catObj = cat_vect, responseID = ids)

# estimate respondents' positions
setEstimation(agree_cat) <- "MAP"
estimateThetas(catObj = agree_cat, responses = clean_df)
```

`rwa_cat` *Right Wing Authoritarianism Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 20 item Right Wing Authoritarianism inventory

Usage

```
data(rwa_cat)
```

Format

An object of class `Cat` of length 1.

Details

Cat object containing item parameters for graded response model fit with 2056 response profiles from Lucid, 2519 response profiles from MTurk, and 1423 response profiles collected by YouGov in June 2018. The sample from MTurk was a convenience sample The respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (.241) and a standard deviation (1) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are:

5 = Strongly agree, 4 = Somewhat agree, 3 = Neither agree nor disagree, 2 = Somewhat disagree, 1 = Strongly disagree

The wording of the question items is:

`q1` Our country desperately needs a mighty leader who will do what has to be done to destroy the radical new ways and sinfulness that are ruining us.

`q2` Gays and lesbians are just as healthy and moral as anybody else.

`q3` It is always better to trust the judgment of the proper authorities in government and religion than to listen to the noisy rabble-rousers in our society who are trying to create doubt in people's minds.

`q4` Atheists and others who have rebelled against the established religions are no doubt every bit as good and virtuous as those who attend church regularly.

`q5` The only way our country can get through the crisis ahead is to get back to our traditional values, put some tough leaders in power, and silence the troublemakers spreading bad ideas.

`q6` There is absolutely nothing wrong with nudist camps.

`q7` Our country needs free thinkers who have the courage to defy traditional ways, even if this upsets many people.

`q8` Our country will be destroyed someday if we do not smash the perversions eating away at our moral fiber and traditional beliefs.

`q9` Everyone should have their own lifestyle, religious beliefs, and sexual preferences, even if it makes them different from everyone else.

`q10` The "old-fashioned ways" and the "old-fashioned values" still show the best way to live.

`q11` You have to admire those who challenged the law and the majority's view by protesting for women's abortion rights, for animal rights, or to abolish school prayer.

`q12` What our country really needs is a strong, determined leader who will crush evil, and take us back to our true path.

`q13` Some of the best people in our country are those who are challenging our government, criticizing religion, and ignoring the "normal way things are supposed to be done."

`q14` God's laws about abortion, pornography and marriage must be strictly followed before it is too late, and those who break them must be strongly punished.

`q15` There are many radical, immoral people in our country today, who are trying to ruin it for their own godless purposes, whom the authorities should put out of action.

`q16` A "woman's place" should be wherever she wants to be. The days when women are submissive to their husbands and social conventions belong strictly in the past.

`q17` Our country will be great if we honor the ways of our forefathers, do what the authorities tell us to do, and get rid of the "rotten apples" who are ruining everything.

`q18` There is no "ONE right way" to live life; everybody has to create their own way.

`q19` Homosexuals and feminists should be praised for being brave enough to defy "traditional family values."

`q20` This country would work a lot better if certain groups of troublemakers would just shut up and accept their group's traditional place in society.

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

References

Altemeyer, Bob. Enemies of freedom: Understanding right-wing authoritarianism. Jossey-Bass, 1988.

See Also

`Cat-class`, `grmCat`

sdo_cat *Social Dominance Orientation Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 15 item Social Dominance Orientation inventory

Usage

```
data(sdo_cat)
```

Format

An object of class `Cat` of length 1.

Details

Cat object containing item parameters for graded response model fit with 2042 response profiles from Lucid, 1192 response profiles from MTurk, and 1482 response profiles collected by YouGov in June 2018. The sample from MTurk was a convenience sample The respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (.19) and a standard deviation (1) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are:

5 = Strongly agree, 4 = Somewhat agree, 3 = Neither agree nor disagree, 2 = Somewhat disagree, 1 = Strongly disagree

The wording of the question items is:

`q1` Some groups of people are simply inferior to other groups.

`q2` In getting what you want, it is sometimes necessary to use force against other groups.

`q3` It's OK if some groups have more of a chance in life than others.

`q4` To get ahead in life, it is sometimes necessary to step on other groups.

`q5` If certain groups stayed in their place, we would have fewer problems.

`q6` It's probably a good thing that certain groups are at the top and other groups are at the bottom.

`q7` Inferior groups should stay in their place.

`q8` Sometimes other groups must be kept in their place.

`q9` It would be good if groups could be equal.

`q10` Group equality should be our ideal.

`q11` All groups should be given an equal chance in life.

`q12` We should do what we can to equalize conditions for different groups.

`q13` Increased social equality is beneficial to society.

`q14` We would have fewer problems if we treated people more equally.

`q15` We should strive to make incomes as equal as possible.

`q16` No group should dominate in society.

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

References

Pratto, F., J. Sidanius, L. M. Stallworth, and B. F. Malle (1994), "Social Dominance Orientation: A Personality Variable Predicting Social and Political Attitudes," Journal of Personality and Social Psychology, 67, 741.

See Also

`Cat-class`, `grmCat`

`selectItem` *Select Next Item*

Description

Selects the next item in the question set to be administered to respondent based on the specified selection method.

Usage

```
selectItem(catObj)
```

Arguments

`catObj`	An object of class `Cat`

Details

Selection approach is specified in the `selection` slot of the `Cat` object.

The minimum expected posterior variance criterion is used when the `selection` slot is `"EPV"`. This method calls `expectedPV` for each unasked item.

The maximum Fisher's information criterion is used when the `selection` slot is `"MFI"`. This method calls `fisherInf` for each unasked item.

The maximum likelihood weighted information criterion is used when the `selection` slot is `"MLWI"`. Note that when no questions have been answered, likelihood evaluates to 1. This method involves integration. See **Note** for more information.

The maximum posterior weighted information criterion is used when the `selection` slot is `"MPWI"`. Note that when no questions have been answered, likelihood evaluates to 1. This method involves integration. See **Note** for more information.

The maximum expected information criterion is used when the `selection` slot is `"MEI"`. This method calls `expectedObsInf` for each unasked item. **Not implemented for three parameter model for binary data.**

The maximum Kullback-Leibler information criterion is used when the `selection` slot is `"KL"`. This method calls `expectedKL` for each unasked item. See `expectedKL` for more information.

The maximum likelihood weighted Kullback-Leibler information criterion is used when the `selection` slot is `"LKL"`. This method calls `likelihoodKL` for each unasked item.

The maximum posterior weighted Kullback-Leibler information criterion is used when the `selection` slot is `"PKL"`. This method calls `posteriorKL` for each unasked item.

The maximum Fisher interval information criterion is used when the `selection` slot is `"MFII"`. This method involves integration. See **Note** for more information. The bounds of integration are $\hat{\theta} \pm \delta$, where δ is qnorm(z) times the square root of the Fisher test information and z is specified in the `z` slot of the `Cat` object.

A random number generator is used when the `selection` slot is `"RANDOM"`.

Value

The function `selectItem` returns a list with three elements:

`estimates`: a data frame with a row for each unasked question and three columns representing the item index number, the item name, and the item value (calculated by the specified selection method), and

`next_item`: a numeric representing the index of the item that should be asked next.

`next_item_name`: a string representing the unique identifier of the item that should be asked next.

Note

This function is to allow users to access the internal functions of the package. During item selection, all calculations are done in compiled `C++` code.

This function uses adaptive quadrature methods from the GNU Scientific Library (GSL) to approximate single-dimensional integrals with high accuracy. The bounds of integration are determined by the `lowerBound` and `upperBound` slots of the `Cat` object unless otherwise noted.

The "RANDOM" item selection criterion uses the package RcppArmadillo to randomly choose the next item among unasked questions. RcppArmadillo provides an exact reproduction of R's sample function that can be called from C++.

In the rare instance that item parameters are identical, it may be that that selectItem must choose between two items with the same value calculated by the selection criterion. In such an instance, selectItem will choose the item with the lower question index.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

References

van der Linden, Wim J. 1998. "Bayesian Item Selection Criteria for Adaptive Testing." Psychometrika 63(2):201-216.

Van der Linden, Wim J., and Peter J. Pashley. 2009. "Item Selection and Ability Estimation in Adaptive Testing." Elements of Adaptive Testing. Springer New York, 3-30.

Veldkamp, B.P., 2003. Item Selection in Polytomous CAT. In New Developments in Psychometrics (pp. 207-214). Springer Japan.

See Also

estimateTheta, expectedPV, fisherInf

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Store example answers
setAnswers(ltm_cat) <- c(1,0,1,0,1, rep(NA, 35))

## Set different selection criterion and choose next item
setSelection(ltm_cat) <- "EPV"
selectItem(ltm_cat)

setSelection(ltm_cat) <- "MFI"
selectItem(ltm_cat)

setSelection(ltm_cat) <- "MLWI"
selectItem(ltm_cat)

setSelection(ltm_cat) <- "MPWI"
selectItem(ltm_cat)

setSelection(ltm_cat) <- "MEI"
selectItem(ltm_cat)

setSelection(ltm_cat) <- "KL"
```

```
selectItem(ltm_cat)

setSelection(ltm_cat) <- "LKL"
selectItem(ltm_cat)

setSelection(ltm_cat) <- "PKL"
selectItem(ltm_cat)

setSelection(ltm_cat) <- "MFII"
selectItem(ltm_cat)

setSelection(ltm_cat) <- "RANDOM"
selectItem(ltm_cat)
```

---

setters *Methods for Setting Value(s) to* Cat *Object Slots*

Description

Setter methods to control changes to the slots of a Cat object.

Usage

```
## S4 replacement method for signature 'Cat'
setGuessing(catObj) <- value

## S4 replacement method for signature 'Cat'
setDiscrimination(catObj) <- value

## S4 replacement method for signature 'Cat'
setDifficulty(catObj) <- value

## S4 replacement method for signature 'Cat'
setAnswers(catObj) <- value

## S4 replacement method for signature 'Cat'
setIds(catObj) <- value

## S4 replacement method for signature 'Cat'
setModel(catObj) <- value

## S4 replacement method for signature 'Cat'
setPriorName(catObj) <- value

## S4 replacement method for signature 'Cat'
setPriorParams(catObj) <- value
```

```
## S4 replacement method for signature 'Cat'
setLowerBound(catObj) <- value

## S4 replacement method for signature 'Cat'
setUpperBound(catObj) <- value

## S4 replacement method for signature 'Cat'
setEstimation(catObj) <- value

## S4 replacement method for signature 'Cat'
setEstimationDefault(catObj) <- value

## S4 replacement method for signature 'Cat'
setSelection(catObj) <- value

## S4 replacement method for signature 'Cat'
setZ(catObj) <- value

## S4 replacement method for signature 'Cat'
setLengthThreshold(catObj) <- value

## S4 replacement method for signature 'Cat'
setSeThreshold(catObj) <- value

## S4 replacement method for signature 'Cat'
setGainThreshold(catObj) <- value

## S4 replacement method for signature 'Cat'
setInfoThreshold(catObj) <- value

## S4 replacement method for signature 'Cat'
setLengthOverride(catObj) <- value

## S4 replacement method for signature 'Cat'
setGainOverride(catObj) <- value
```

Arguments

`catObj`	An object of class `Cat`
`value`	The new value(s)

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

Cat-class, getters

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Setting estimation slot
getEstimation(ltm_cat)
setEstimation(ltm_cat) <- "MAP"
getEstimation(ltm_cat)

## Setting distrimination slot
getDiscrimination(ltm_cat)
setDiscrimination(ltm_cat) <- rep(1, 40)
getDiscrimination(ltm_cat)
```

---

simulateFisherInfo *Calculates Fisher Information under different adaptive battery specifications*

Description

Takes in a a Cat object, a set of respondents, and their corresponding theta values, and calculates the amount of information given an adaptive battery.

Usage

```
simulateFisherInfo(catObjs = list(), theta, responses)
```

Arguments

catObjs	A list of Cat objects of the same class.
theta	A vector of numerics representing the true value of theta.
responses	A dataframe of answer profiles corresponding to the true values of theta.

Details

The function takes a Cat object, theta, and response profiles. The user defines the selection type, estimation type, etc. so that the questions can be applied adaptively These adaptive profiles are then used to calculate the total inforamtion gained for a respondent for all answered items, conditioned on theta.

Value

The function simulateFisherInfo returns a dataframe where each Cat object corresponds to a column and each respondent corresponds to a row.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil, Jaerin Kim, Dominique Lockett

See Also

Cat-class, fisherTestInfo, selectItem

Examples

```
## Not run:
# Example takes > 2.5 min to run
# Load Cat object
data(grm_cat)

# Simulate respondents
respondents <- plyr::adply(.data = matrix(c(-1, 0, 1)),
                           .margins = 1,
                           .id = NULL,
                           .fun = simulateRespondents, cat = grm_cat, n = 10)

# A stopping rule (here, a common one) is required
grm_cat@lengthThreshold <- 3

# Specify different adaptive inventory procedures
grm_MAP <- grm_EAP <- grm_cat
grm_MAP@estimation <- "MAP"
grm_EAP@estimation <- "EAP"

# List of Cat objects
grmList <- list(grm_MAP, grm_EAP)

# Results
fisher_inf_results <- simulateFisherInfo(catObjs = grmList,
                              theta = rep(c(-1, 0, 1),
                              each = 10),
                              responses = respondents)

## End(Not run)
```

---

simulateRespondents *Simulate answer profiles given some true value of theta*

Description

The function simulates n answer profiles given a true value of theta and a battery's item parameters stored in a Cat object.

Usage

```
## S4 method for signature 'Cat'
simulateRespondents(catObj, theta, n)
```

Arguments

catObj	An object of class Cat
theta	A numeric representing the true position on the latent trait.
n	A numeric indicating the number of answer profiles to simulate.

Value

Function returns a dataframe where each row is a possible answer profile simulated given the provided value of theta

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

Examples

```
# Load Cat object
data(grm_cat)

# Simulate 5 response profiles given a theta of 2
sim_resp <- simulateRespondents(catObj = grm_cat, theta = 2, n = 5)
```

---

simulateThetas *Estimates theta under different adaptive battery specifications*

Description

Takes in response profiles from multiple respondents and multiple Cat object (i.e., adaptive battery) specifications and returns a set of theta estimates

Usage

```
simulateThetas(catObjs = list(), responses, return_adaptive = FALSE)
```

Arguments

catObjs	A list of Cat objects of the same model with different adaptive battery specifications
responses	A matrix of response profiles
return_adaptive	Boolean indicating if user wants dataframe containing only answers chosen via the adaptive design for each Cat object in catObjs list.

Details

The function takes multiple Cat objects, stored in a list, and generates an estimation for theta.

Value

The function simulateThetas returns a dataframe where each Cat object corresponds to a column and each respondent corresponds to a row if return_adaptive is FALSE, the default. Optionally, simulateThetas returns a list containing that dataframe plus dataframes for the answer profiles simulated via each adaptive design if return_adaptive is TRUE.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil, Jaerin Kim, Dominique Lockett

See Also

Cat-class, apply, selectItem

Examples

```
## Not run:
# Example takes > 2.5 min to run
# Load Cat object
data(grm_cat)

# Simulate respondents
respondents <- plyr::adply(.data = matrix(c(-1, 0, 1)),
                           .margins = 1,
                           .id = NULL,
                           .fun = simulateRespondents, cat = grm_cat, n = 10)

# A stopping rule (here, a common one) is required
grm_cat@lengthThreshold <- 3

# Specify different adaptive inventory procedures
grm_MAP <- grm_EAP <- grm_cat
grm_MAP@estimation <- "MAP"
grm_EAP@estimation <- "EAP"

# List of Cat objects
```

```
grmList <- list(cat1 = grm_MAP, cat2 = grm_EAP)

# Results
theta_est_results <- simulateThetas(catObjs = grmList, responses = respondents)

## End(Not run)
```

`storeAnswer` *Update Answer to Single Item*

Description

Stores answer to item k to the `Cat` object's `answers` slot.

Usage

```
## S4 method for signature 'Cat'
storeAnswer(catObj, item, answer, returnJSON = FALSE)

## S4 method for signature 'character'
storeAnswer(catObj, item, answer, returnJSON = FALSE)
```

Arguments

`catObj`	An object of class `Cat` or class `json`.
`item`	An integer indicating the index of the question item
`answer`	The answer to the `item` to be updated
`returnJSON`	Boolean indicating whether the updated `Cat` object should be returned as a JSON object. Defaults to FALSE.

Details

The function `storeAnswer` updates the `Cat` object, but the updated object must be assigned to an object for the changes to be stored. See **Examples**.

Value

The function `storeAnswer` returns an updated object of class `Cat` with the `answers` slot reflecting the newly stored `answer` to the indicated `item`. All previously stored answers remain the same, and all unanswered questions remain `NA`.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

Examples

```
## Loading ltm Cat object
data(ltm_cat)

## Printing current answers slot
getAnswers(ltm_cat)

## Storing answer of 0 to item 1
ltm_cat <- storeAnswer(ltm_cat, item = 1, answer = 0)

## Now object reflects answer to item 1
getAnswers(ltm_cat)
```

---

sv_conservation_cat *Conservation (Schwartz Values) Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the Conservation (Schwartz Values) inventory

Usage

```
data(sv_conservation_cat)
```

Format

An object of class `Cat` of length 1.

Details

Cat object containing item parameters for graded response model fit with 8,173 response profiles by the myPersonality Project and 718 response profiles collected by YouGov in June 2018. The sample from myPersonality Project was a convenience sample, and the respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (.480) and a standard deviation (1.4) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options for the Schwartz Values survey are:

0 - means the value is not at all important, it is not relevant as a guiding principle for you. 3 - means the value is important. 6 - means the value is very important.

-1 is for rating any values opposed to the principles that guide you. 7 is for rating a value of supreme importance as a guiding principle in your life; ordinarily there are no more than two such values.

However, for computerized adaptive testing methods, the 0-7 response option range as been shifted to a 1-9 range.

The wording of the question items:

`q11` POLITENESS (courtesy, good manners)

`q20` SELF-DISCIPLINE (self-restraint, resistance to temptation)

`q40` HONORING OF PARENTS AND ELDERS (showing respect)

`q47` OBEDIENT (dutiful, meeting obligations)

`q18` RESPECT FOR TRADITION (preservation of time-honored customs)

`q32` MODERATE (avoiding extremes of feeling & action)

`q36` HUMBLE (modest, self-effacing)

`q44` ACCEPTING MY PORTION IN LIFE (submitting to life's circumstances)

`q51` DEVOUT (holding to religious faith & belief)

`q8` SOCIAL ORDER (stability of society)

`q13` NATIONAL SECURITY (protection of my nation from enemies)

`q15` RECIPROCATION OF FAVORS (avoidance of indebtedness)

`q22` FAMILY SECURITY (safety for loved ones)

`q56` CLEAN (neat, tidy)

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

References

Stillwell, David, and Michal Kosinski. 2007. "myPersonality Project." https://sites.google.com/michalkosinski.com/mypersonality

Schwartz, Shalom H. "Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries." Advances in experimental social psychology. Vol. 25. Academic Press, 1992. 1-65.

See Also

`Cat-class`, `grmCat`

sv_open_cat *Openness to Change (Schwartz Values) Cat Object*

Description

Cat model created for the Openness to Change (Schwartz Values) inventory

Usage

```
data(sv_open_cat)
```

Format

An object of class `Cat` of length 1.

Details

Cat object containing item parameters for graded response model fit with 8,448 response profiles by myPersonality Project and 718 response profiles collected by YouGov in June 2018. The sample from myPersonality Project was a convenience sample, and the respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (-3.54) and a standard deviation (1.2) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options for the Schwartz Values survey are:

0 - means the value is not at all important, it is not relevant as a guiding principle for you. 3 - means the value is important. 6 - means the value is very important.

-1 is for rating any values opposed to the principles that guide you. 7 is for rating a value of supreme importance as a guiding principle in your life; ordinarily there are no more than two such values.

However, for computerized adaptive testing methods, the 0-7 response option range as been shifted to a 1-9 range.

The wording of the question items:

`q5` FREEDOM (freedom of action and thought)

`q15` RECIPROCATION OF FAVORS (avoidance of indebtedness)

`q31` INDEPENDENT (self-reliant, self-sufficient)

`q41` CHOOSING OWN GOALS (selecting own purposes)

`q53` CURIOUS (interested in everything, exploring)

`q9` AN EXCITING LIFE (stimulating experiences)

q25 A VARIED LIFE (filled with challenge, novelty and change)

q37 DARING (seeking adventure, risk)

q4 PLEASURE (gratification of desires)

q50 ENJOYING LIFE (enjoying food, sex, leisure, etc.)

q57 SELF-INDULGENT (doing pleasant things)

Source

See https://dataverse.harvard.edu/dataverse/pdsl for the raw YouGov and/or Qualtrics data.

References

Stillwell, David, and Michal Kosinski. 2007. "myPersonality Project." https://sites.google.com/michalkosinski.com/mypersonality

Schwartz, Shalom H. "Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries." Advances in experimental social psychology. Vol. 25. Academic Press, 1992. 1-65.

See Also

Cat-class, grmCat

---

sv_selfenhance_cat *Self-Enhancement (Schwartz Values) Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the Self-Enhancement(Schwartz Values) inventory

Usage

```
data(sv_selfenhance_cat)
```

Format

An object of class Cat of length 1.

Details

Cat object containing item parameters for graded response model fit with 8,497 response profiles by myPersonality Project and 718 response profiles collected by YouGov in June 2018. The sample from myPersonality Project was a convenience sample, and the respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (-.09) and a standard deviation (1.2) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options for the Schwartz Values survey are:

0 - means the value is not at all important, it is not relevant as a guiding principle for you. 3 - means the value is important. 6 - means the value is very important.

-1 is for rating any values opposed to the principles that guide you. 7 is for rating a value of supreme importance as a guiding principle in your life; ordinarily there are no more than two such values.

However, for computerized adaptive testing methods, the 0-7 response option range as been shifted to a 1-9 range.

The wording of the question items:

`q4` PLEASURE (gratification of desires)

`q50` ENJOYING LIFE (enjoying food, sex, leisure, etc.)

`q57` SELF-INDULGENT (doing pleasant things)

`q34` AMBITIOUS (hard-working, aspiring)

`q39` INFLUENTIAL (having an impact on people and events)

`q43` CAPABLE (competent, effective, efficient)

`q55` SUCCESSFUL (achieving goals)

`q3` SOCIAL POWER (control over others, dominance)

`q12` WEALTH (material possessions, money)

`q27` AUTHORITY (the right to lead or command)

`q46` PRESERVING MY PUBLIC IMAGE (protecting my "face")

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

References

Stillwell, David, and Michal Kosinski. 2007. "myPersonality Project." https://sites.google.com/michalkosinski.com/mypersonality

Schwartz, Shalom H. "Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries." Advances in experimental social psychology. Vol. 25. Academic Press, 1992. 1-65.

See Also

Cat-class, grmCat

---

sv_selftransc_cat *Self-Transcendence (Schwartz Values) Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the Self-Transcendence (Schwartz Values) inventory

Usage

```
data(sv_selftransc_cat)
```

Format

An object of class Cat of length 1.

Details

Cat object containing item parameters for graded response model fit with 8,415 response profiles by myPersonalit Project and 718 response profiles collected by YouGov in June 2018. The sample from myPersonality Project was a convenience sample, and the respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See Cat-class for details regarding the Cat object structure. See grmCat for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (.004) and a standard deviation (1.2) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options for the Schwartz Values survey are:

0 - means the value is not at all important, it is not relevant as a guiding principle for you. 3 - means the value is important. 6 - means the value is very important.

-1 is for rating any values opposed to the principles that guide you. 7 is for rating a value of supreme importance as a guiding principle in your life; ordinarily there are no more than two such values.

However, for computerized adaptive testing methods, the 0-7 response option range as been shifted to a 1-9 range.

The wording of the question items:

q1 EQUALITY (equal opportunity for all)

q17 A WORLD AT PEACE (free of war and conflict)

q24 UNITY WITH NATURE (fitting into nature)

q26 WISDOM (a mature understanding of life)

q29 A WORLD OF BEAUTY (beauty of nature and the arts)

q30 SOCIAL JUSTICE (correcting injustice, care for the weak)

q35 BROADMINDED (tolerant of different ideas and beliefs)

q38 PROTECTING THE ENVIRONMENT (preserving nature)

q33 LOYAL (faithful to my friends, group)

q45 HONEST (genuine, sincere)

q49 HELPFUL (working for the welfare of others)

q52 RESPONSIBLE (dependable, reliable)

q54 FORGIVING (willing to pardon others)

Source

See https://dataverse.harvard.edu/dataverse/pdsl for the raw YouGov and/or Qualtrics data.

References

Stillwell, David, and Michal Kosinski. 2007. "myPersonality Project." https://sites.google.com/michalkosinski.com/mypersonality

Schwartz, Shalom H. "Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries." Advances in experimental social psychology. Vol. 25. Academic Press, 1992. 1-65.

See Also

Cat-class, grmCat

---

systemizing_cat *Systemizing Quotient Cat Object*

Description

Cat object containing item parameters for graded response model fit with responses to the 40-item Systemizing Quotient personality inventory

Usage

```
data(systemizing_cat)
```

Format

An object of class Cat of length 1.

Details

Cat object containing item parameters for graded response model fit with 13,256 response profiles collected by the Open Source Psychometrics Project in 2012, 3050 response profiles collected by Qualtrics in June 2018, and 1500 response profiles collected by YouGov in June 2018. The sample from the Open Source Psychometrics Project was a convenience sample, and the respondents from YouGov were matched to a sampling frame on gender, age, race, and education.

See `Cat-class` for details regarding the Cat object structure. See `grmCat` for details regarding the graded response model.

A normal prior was chosen with mean from the theta estimates from the YouGov sample (.033) and a standard deviation (1.4) wide enough to envelope the range of estimated theta values across both samples.

Note that due to how the item parameters were estimated, large, positive values indicate "more" of the latent trait.

Response options are 1=Strongly disagree; 2=Slightly disagree; 3=Slightly agree; 4=Strongly agree

The wording of the question items:

`q1` When I listen to a piece of music, I always notice the way it's structured.

`q4` I prefer to read non-fiction than fiction.

`q5` If I were buying a car, I would want to obtain specific information about its engine capacity.

`q6` When I look at a painting, I do not usually think about the technique involved in making it.

`q7` If there was a problem with the electrical wiring in my home, I'd be able to fix it myself.

`q11` I rarely read articles or webpages about new technology.

`q12` I do not enjoy games that involve a high degree of strategy.

`q13` I am fascinated by how machines work.

`q15` In math, I am intrigued by the rules and patterns governing numbers.

`q18` I find it difficult to understand instruction manuals for putting appliances together.

`q19` When I look at an animal, I like to know the precise species it belongs to.

`q20` If I were buying a computer, I would want to know exact details about its hard drive capacity and processor speed.

`q23` When I cook, I do not think about exactly how different methods and ingredients contribute to the final product.

`q24` I find it difficult to read and understand maps.

`q25` If I had a collection (e.g. CDs, coins, stamps), it would be highly organized.

`q26` When I look at a piece of furniture, I do not notice the details of how it was constructed.

`q28` When I learn about historical events, I do not focus on exact dates.

`q29` When I read the newspaper, I am drawn to tables of information, such as football league scores or stock market indices.

`q30` When I learn a language, I become intrigued by its grammatical rules.

`q31` I find it difficult to learn my way around a new city.

`q32` I do not tend to watch science documentaries on television or read articles about science and nature.

`q33` If I were buying a stereo, I would want to know about its precise technical features.

`q34` I find it easy to grasp exactly how odds work in betting.

`q35` I am not very meticulous when I carry out D.I.Y.

`q37` When I look at a building, I am curious about the precise way it was constructed.

`q38` When an election is being held, I am not interested in the results for each constituency.

`q40` I find it difficult to understand information the bank sends me on different investment and saving systems.

`q41` When traveling by train, I often wonder exactly how the rail networks are coordinated.

`q42` When I buy a new appliance, I do not read the instruction manual very thoroughly.

`q43` If I were buying a camera, I would not look carefully into the quality of the lens.

`q44` When I read something, I always notice whether it is grammatically correct.

`q45` When I hear the weather forecast, I am not very interested in the meteorological patterns.

`q48` When I look at a mountain, I think about how precisely it was formed.

`q49` I can easily visualize how the highways in my region link up.

`q51` When I'm in a plane, I do not think about the aerodynamics.

`q53` When I am walking in the country, I am curious about how the various kinds of trees differ.

`q55` I am interested in knowing the path a river takes from its source to the sea.

`q56` I do not read legal documents very carefully.

`q57` I am not interested in understanding how wireless communication works.

`q60` I do not care to know the names of the plants I see.

Source

See `https://dataverse.harvard.edu/dataverse/pdsl` for the raw YouGov and/or Qualtrics data.

See https://openpsychometrics.org/_rawdata/, maintained by Eric Jorgenson, for the raw Open Source Psychometrics Project site data.

References

Baron-Cohen, Simon, Jennifer Richler, Dheraj Bisarya, Nhishanth Gurunathan, and Sally Wheelwright. "The systemizing quotient: an investigation of adults with Asperger syndrome or high-functioning autism, and normal sex differences." Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences 358, no. 1430 (2003): 361-374.

Open Source Psychometrics Project. https://openpsychometrics.org/_rawdata/

See Also

`Cat-class`, `grmCat`

toJSONCat *Convert Cat object to JSON*

Description

This function object of class Cat.

Usage

```
## S4 method for signature 'Cat'
toJSONCat(catObj)
```

Arguments

catObj	A Cat object

Value

The function toJSONCat returns a JSON object with list elements corresponding to information stored in the catObj.

See Cat-class for required Cat object slots.

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

See Also

Cat-class

tpm_cat *tpm Cat Object*

Description

An object of class Cat created using the tpmCat function with the first twenty questions of the polknowMT dataset.

Usage

```
data(tpm_cat)
```

Format

An object of class Cat. See Cat-class for more details.

See Also

Cat-class, tpmCat, polknowMT

Examples

```
## Not run:
## How this Cat object was created
data(polknowMT)
tpm_cat <- tpmCat(polknowMT[,1:20], quadraturePoints = 100, start.val = "random")

## End(Not run)

## How to load this Cat object for usage
data(tpm_cat)
```

---

tpmCat *Computerized Adaptive Testing Birnbaum's Three Parameter Model*

Description

This function fits Birnbaum's three parameter model for binary data and populates the fitted values for discrimination, difficulty, and guessing parameters to an object of class Cat.

Usage

```
## S4 method for signature 'data.frame'
tpmCat(data, quadraturePoints = 21, ...)

## S4 method for signature 'tpm'
tpmCat(data, quadraturePoints = NULL, ...)
```

Arguments

data	A data frame of manifest variables or an object of class tpm.
quadraturePoints	A numeric to be passed into the tpm function indicating the number of Gauss-Hermite quadrature points. Only applicable when data is a data frame. Default value is 21.
...	arguments to be passed to methods. For more details about the arguments, see tpm in the ltm package.

Details

The data argument of the function tpmCat is either a data frame or an object of class tpm from the ltm package. If it is a data frame each row represents a respondent and each column represents a question item. If it is an object of the class tpm, it is output from the tpm function in the ltm package.

The quadraturePoints argument of the function tpmCat is used only when the data argument is a data frame. quadraturePoints is then passed to the tpm function from the ltm package when fitting Birnbaum's three parameter model to the data and is used when approximating the value of integrals.

Value

The function tpmCat returns an object of class Cat with changes to the following slots:

- difficulty A vector consisting of difficulty parameters for each item.
- discrimination A vector consisting of discrimination parameters for each item.
- model The string "tpm", indicating this Cat object corresponds to Birnbaum's three parameter model.

See Cat-class for default values of Cat object slots. See **Examples** and setters for example code to change slot values.

Note

In case the Hessian matrix at convergence is not positive definite try to use start.val = "random".

Author(s)

Haley Acevedo, Ryden Butler, Josh W. Cutler, Matt Malis, Jacob M. Montgomery, Tom Wilkinson, Erin Rossiter, Min Hee Seo, Alex Weil

References

Baker, Frank B. and Seock-Ho Kim. 2004. Item Response Theory: Parameter Estimation Techniques. New York: Marcel Dekker.

Birnbaum, Allan. 1968. Some Latent Trait Models and their Use in Inferring an Examinee's Ability. In F. M. Lord and M. R. Novick (Eds.), Statistical Theories of Mental Test Scores, 397-479. Reading, MA: Addison-Wesley.

Rizopoulos, Dimitris. 2006. "ltm: An R Package for Latent Variable Modeling and Item Response Theory Analyses." Journal of Statistical Software 17(5):1-25.

See Also

Cat-class, ltmCat, polknowMT, probability

Examples

```
## Creating Cat objects from large datasets is computationally expensive
## Load the Cat object created from the above code
data(tpm_cat)

## Slots that have changed from default values
getModel(tpm_cat)
getDifficulty(tpm_cat)
getDiscrimination(tpm_cat)

## Changing slots from default values
setEstimation(tpm_cat) <- "MLE"
setSelection(tpm_cat) <- "MFI"
```

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