Package 'AccSamplingDesign'

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Title Acceptance Sampling Plans Design

Version 0.0.1

Description Provides tools for designing and analyzing acceptance sampling plans.
Supports both attribute-based (Binomial and Poisson) and variable-based (Normal and Beta) sampling, enabling quality control for fractional and compositional data.
Uses nonlinear programming (NLP) for sampling plan optimization, minimizing sample size while balancing producer's and consumer's risks. Operating Characteristic (OC) curves are available for plan visualization.

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Encoding UTF-8

Imports stats, methods

Suggests knitr, rmarkdown

VignetteBuilder knitr

URL https://github.com/vietha/AccSamplingDesign

BugReports https://github.com/vietha/AccSamplingDesign/issues

NeedsCompilation no

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Contents

`accProb` *Acceptance Probability*

Description

Calculate the probability of acceptance for a given quality level.

Usage

```
accProb(plan, p)
```

Arguments

`plan`	Acceptance plan object (`AttrPlan`/`VarPlan`).
`p`	True quality level (proportion of nonconforming).

Value

Numeric probability between 0 and 1.

Author(s)

Ha Truong

Examples

```
# Example for attribute plan
attr_plan <- optAttrPlan(PRQ = 0.01, CRQ = 0.1)
accProb(attr_plan, 0.05)

# Example for variable plan (normal distribution)
var_plan <- optVarPlan(
  PRQ = 0.025,        # Acceptable quality level (% nonconforming)
  CRQ = 0.1,         # Rejectable quality level (% nonconforming)
  alpha = 0.05,      # Producer's risk
  beta = 0.1,        # Consumer's risk
  distribution = "normal"
)
accProb(var_plan, 0.05)
```

muEst *Estimate Mean μ Based on Specification Limits and Probability*

Description

Computes the estimated mean μ for a given level of quality and specification limit under either a normal or beta distribution.

Usage

```
muEst(p, USL = NULL, LSL = NULL,
       sigma = NULL, theta = NULL,
       dist = c("normal", "beta"))
```

Arguments

p	Level of quality (numeric, between 0 and 1).
USL	Upper specification limit (numeric). Only one of USL or LSL should be provided.
LSL	Lower specification limit (numeric). Only one of USL or LSL should be provided.
sigma	Standard deviation (numeric) for the normal distribution. Must be provided if dist = "normal".
theta	Theta parameter (numeric) for the beta distribution. Must be provided if dist = "beta".
dist	Distribution type. Either "normal" or "beta".

Details

The function estimates the mean μ corresponding to a given tail probability p, assuming that the process output follows either a normal or beta distribution, and that the probability of being beyond the provided specification limit equals 1 - p.

- For the normal distribution, the mean is calculated using the inverse cumulative distribution function (quantile function) of the normal distribution.
- For the beta distribution, the mean is solved numerically such that the CDF at the specified limit equals p, given the shape determined by theta.

Exactly one of USL or LSL must be provided to define whether the probability refers to the upper or lower tail.

Value

Returns the estimated mean μ as a numeric value.

Author(s)

Ha Truong

Examples

```
# Example for normal distribution with lower specification limit (LSL)
muEst(p = 0.95, LSL = 10, sigma = 2, dist = "normal")

# Example for beta distribution with upper specification limit (USL)
muEst(p = 0.95, USL = 0.7, theta = 500, dist = "beta")
```

`OCdata` *Generate OC Curve Data*

Description

Computes and returns an object of class `"OCdata"`, which contains the operating characteristic (OC) curve data. This includes the proportion of nonconforming items and the corresponding probability of acceptance, along with plan-related metadata. This function supports both pre-defined plan objects and ad-hoc parameter inputs.

Usage

```
OCdata(plan = NULL, pd = NULL,
       distribution = c("binomial", "normal", "beta"),
       PRQ = NULL, CRQ = NULL, alpha = NULL, beta = NULL,
       USL = NULL, LSL = NULL,
       n = NULL, c = NULL, k = NULL,
       sigma_type = c("known", "unknown"),
       theta_type = c("known", "unknown"),
       sigma = NULL, theta = NULL)
```

Arguments

`plan`	An optional acceptance plan object of class `AttrPlan` or `VarPlan`. If supplied, this overrides other individual parameter inputs.
`pd`	An optional vector of proportions of nonconforming items. If `NULL`, the function generates a default sequence based on `CRQ`.
`distribution`	Distribution type used for the plan. Options are `"binomial"`, `"normal"`, or `"beta"`. Required if `plan` is not provided.
`PRQ`	Producer's Risk Quality level (used to define OC curve range when `pd` is not provided).
`CRQ`	Consumer's Risk Quality level (used to define OC curve range when `pd` is not provided).
`alpha`	Producer's risk (Type I error, numeric between 0 and 1).
`beta`	Consumer's risk (Type II error, numeric between 0 and 1).
`USL`	Upper Specification Limit (used for variable sampling plans). Only one of `USL` or `LSL` should be provided.

LSL	Lower Specification Limit (used for variable sampling plans). Only one of USL or LSL should be provided.
n	Sample size.
c	Acceptance number (for attribute plans).
k	Acceptance constant (for variable plans).
sigma_type	Whether sigma is "known" or "unknown" (for normal distribution).
theta_type	Whether theta is "known" or "unknown" (for beta distribution).
sigma	Standard deviation (if sigma_type = "known").
theta	Precision or shape parameter (if theta_type = "known", for beta distribution).

Details

The function evaluates the Operating Characteristic (OC) curve by computing the probability of acceptance across a range of proportions nonconforming (pd). This can be either directly specified or derived based on the plan inputs.

If a plan object is supplied, it overrides the other input parameters and uses stored plan details. If no plan is provided, a new one will be constructed from the inputs.

For:

- binomial distribution: n and c must be provided.
- normal or beta distribution: n (or m) and k are required. Either USL or LSL must be specified to compute process mean values using muEst.

The resulting OC curve data includes acceptance probabilities at various quality levels and, for variable plans, optionally maps these probabilities to corresponding mean levels.

Value

An S4 object of class "OCdata" with the following slots:

pd	Vector of proportions nonconforming.
paccept	Probability of acceptance at each level of nonconformance.
type	Distribution type ("binomial", "normal", or "beta").
n	Sample size used in the plan.
k	Acceptance constant (if applicable).
c	Acceptance number (if applicable).
process_means	Estimated mean values (only for variable plans with specification limits).

Author(s)

Ha Truong

Examples

```
# Example 1: Variable plan (normal distribution)
plan <- optVarPlan(
  PRQ = 0.025,
  CRQ = 0.1,
  alpha = 0.05,
  beta = 0.1,
  distribution = "normal"
)

# Generate OC data
oc_data <- OCdata(plan)

# Plot the OC curve
plot(oc_data)

# Example 2: Attribute plan using direct input
oc_data2 <- OCdata(n = 132, c = 5, PRQ = 0.01, CRQ = 0.05,
                   distribution = "binomial")
oc_data2
plot(oc_data2)
```

`optAttrPlan` *Attribute Acceptance Sampling Plan*

Description

Designs binomial-based acceptance sampling plans using producer/consumer risk criteria.

Usage

```
optAttrPlan(PRQ, CRQ, alpha = 0.05, beta = 0.10,
            distribution = c("binomial", "poisson"))
```

Arguments

`PRQ`	Producer Risk Quality ($0 < PRQ < 1$)
`CRQ`	Consumer Risk Quality ($PRQ < CRQ < 1$)
`alpha`	Producer's risk (0.05 default)
`beta`	Consumer's risk (0.10 default)
`distribution`	Support binomial and poisson distribution

Value

AttrPlan object containing:

n	Sample size
c	Acceptance number
PRQ	Input PRQ value
CRQ	Input CRQ value
distribution	Selected distribution

Author(s)

Ha Truong

References

ISO 2859-1:1999 - Sampling procedures for inspection by attributes

Schilling, E.G., & Neubauer, D.V. (2017). Acceptance Sampling in Quality Control (3rd ed.). Chapman and Hall/CRC. https://doi.org/10.4324/9781315120744

Examples

```
plan <- optAttrPlan(PRQ = 0.01, CRQ = 0.1, alpha = 0.05, beta = 0.1,
                    distribution = "binomial")
```

---

optPlan *Optimal Acceptance Sampling Plan*

Description

Design optimal variable acceptance sampling plans based on specified parameters. Supports different distributions (binomial, normal, beta) and accommodates known or unknown standard deviation and process parameters.

Usage

```
optPlan(PRQ, CRQ, alpha = 0.05, beta = 0.10, USL = NULL, LSL = NULL,
        distribution = c("binomial", "poisson", "normal", "beta"),
        sigma_type = c("known", "unknown"),
        theta_type = c("known", "unknown"),
        sigma = NULL, theta = NULL)
```

Arguments

PRQ	Producer's risk quality level (e.g., acceptable quality level).
CRQ	Consumer's risk quality level (e.g., rejectable quality level).
alpha	Producer's risk (Type I error), default is 0.05.
beta	Consumer's risk (Type II error), default is 0.10.
USL	Upper Specification Limit. Required for variable sampling plans.
LSL	Lower Specification Limit. Required for variable sampling plans.
distribution	Distribution type used in the plan. Can be "binomial", "normal", or "beta".
sigma_type	Indicates if the standard deviation (sigma) is known or unknown.
theta_type	Indicates if the process parameter (theta) is known or unknown.
sigma	Known standard deviation of the process, if applicable.
theta	Known process parameter (e.g., mean), if applicable.

Details

This function designs optimal acceptance sampling plans by balancing producer's and consumer's risks under specified quality levels. It supports plans for attributes (binomial) and variables (normal or beta distributions), including cases with unknown standard deviation or distributional parameters.

Value

Returns a list or data frame with optimal sample size(s) and critical value(s) based on the specified parameters and distribution.

Author(s)

Ha Truong

Examples

```
# Example usage (normal distribution, known sigma):
optPlan(PRQ = 0.005, CRQ = 0.03, alpha = 0.05, beta = 0.10,
        distribution = "normal", sigma_type = "known")

# Example usage (beta distribution, unknown theta):
optPlan(PRQ = 0.025, CRQ = 0.10, alpha = 0.05, beta = 0.10,
        distribution = "beta", theta = 6.6e8,
        theta_type = "unknown", LSL = 5.65e-6)
```

optVarPlan *Variable Acceptance Sampling Plan*

Description

Creates variable sampling plans for normal or beta distributed measurements.

Usage

```
optVarPlan(PRQ, CRQ, alpha = 0.05, beta = 0.10, USL = NULL, LSL = NULL,
         distribution = c("normal", "beta"), sigma_type = c("known", "unknown"),
           theta_type = c("known", "unknown"), sigma = NULL, theta = NULL)
```

Arguments

PRQ	Producer Risk Quality (must be within valid range for the chosen distribution).
CRQ	Consumer Risk Quality (must be greater than PRQ and within valid range).
alpha	Producer's risk (numeric between 0 and 1).
beta	Consumer's risk (numeric between 0 and 1).
USL	Upper Specification Limit (numeric). Only one of USL or LSL should be provided.
LSL	Lower Specification Limit (numeric). Only one of USL or LSL should be provided.
distribution	Measurement distribution: "normal" or "beta".
sigma_type	Indicates whether sigma (population standard deviation) is "known" or "unknown".
theta_type	Indicates whether theta (population precision parameter for beta) is "known" or "unknown".
sigma	Known standard deviation (used for normal distribution). Required if sigma_type = "known".
theta	Dispersion parameter (used for beta distribution). Required if theta_type = "known".

Details

The function generates variable acceptance sampling plans based on specified producer and consumer risks and either a normal or beta distribution model.

The specification limit must be defined via either USL (upper specification limit) or LSL (lower specification limit), depending on whether the one-sided quality criterion concerns the upper or lower tail. Only one limit should be provided.

The plan design accounts for known or unknown standard deviation in the normal case, and known or unknown dispersion parameter (theta) in the beta case. Measurement error, if any, can be incorporated via the measurement_error argument.

Value

A `VarPlan` object containing:

`distribution`	Distribution used ("normal" or "beta").
`sample_size`	Final sample size after rounding (integer).
`k`	Acceptance constant.
`n`	Unrounded sample size.

Author(s)

Ha Truong

References

ISO 3951-1:2013 - Sampling procedures for inspection by variables.

Wilrich, PT. (2004). Single Sampling Plans for Inspection by Variables under a Variance Component Situation. In: Lenz, HJ., Wilrich, PT. (eds) Frontiers in Statistical Quality Control 7. Physica, Heidelberg. doi:10.1007/9783790826746_4

K. Govindaraju and R. Kissling (2015). Sampling plans for Beta-distributed compositional fractions.

Examples

```
# Example for normal distribution plan
norm_plan <- optVarPlan(
  PRQ = 0.025,        # Acceptable quality level (% nonconforming)
  CRQ = 0.1,          # Rejectable quality level (% nonconforming)
  alpha = 0.05,       # Producer's risk
  beta = 0.1,         # Consumer's risk
  distribution = "normal",
  USL = 10
)
summary(norm_plan)

# Example for beta distribution plan
beta_plan <- optVarPlan(
  PRQ = 0.025,        # Target quality level (% nonconforming)
  CRQ = 0.1,          # Minimum quality level (% nonconforming)
  alpha = 0.05,       # Producer's risk
  beta = 0.1,         # Consumer's risk
  distribution = "beta",
  theta = 44000000,   # Beta distribution parameter
  LSL = 0.00001
)
summary(beta_plan)
```

`plot.AttrPlan` *Plot the OC Curve for Attribute Sampling Plans*

Description

Plots the Operating Characteristic (OC) curve for an attribute sampling plan object of class `AttrPlan`.

Usage

```
## S3 method for class 'AttrPlan'
plot(x, pd = NULL, ...)
```

Arguments

`x`	An object of class `AttrPlan` representing an attribute acceptance sampling plan.
`pd`	Optional vector of proportions of nonconforming items. If `NULL` (default), a range is automatically generated.
`...`	Additional graphical parameters passed to `plot()`.

Details

This method computes and visualizes the probability of acceptance (`P(accept)`) as a function of the proportion of nonconforming items in the population, based on the attribute sampling plan.

The plot also includes reference lines at the plan's producer and consumer quality levels (`PRQ`, `CRQ`) and their corresponding acceptance probabilities.

Value

A plot showing the OC curve for the given attribute sampling plan.

Author(s)

Ha Truong

See Also

`optAttrPlan`, `accProb`, `OCdata`

Examples

```
# Create attribute plan
plan <- optAttrPlan(PRQ = 0.01, CRQ = 0.1)

# Plot OC curve
plot(plan)

# With custom pd
plot(plan, pd = seq(0, 0.15, by = 0.001))
```

`plot.OCdata` *Plot Method for OCdata Objects*

Description

Plots the Operating Characteristic (OC) curve from an object of class `"OCdata"`, either by proportion nonconforming or process mean levels.

Usage

```
## S3 method for class 'OCdata'
plot(x, by = c("pd", "mean"), ...)
```

Arguments

`x`	An object of class `"OCdata"`, typically generated using `OCdata()`.
`by`	A character string indicating the type of OC curve to plot. Options are:
	`"pd"` (Default) Plot the OC curve by proportion nonconforming.
	`"mean"` Plot the OC curve by estimated process mean levels (only available for variable sampling plans).
`...`	Additional graphical parameters passed to the `plot()` function.

Details

This method visualizes the OC curve based on the content of the `"OCdata"` object.

By default, the curve is plotted against the proportion of nonconforming items (`@pd`). If `by = "mean"` is specified and the plan includes valid mean-level estimates (`@process_means`), the curve is plotted against mean levels.

If `by = "mean"` is requested but no mean estimates are available (e.g., for attribute plans), a message will be shown and no plot will be drawn.

Value

A plot showing the OC curve for the given attribute/variable sampling plan.

Author(s)

Ha Truong

See Also

`OCdata`, `optAttrPlan`, `optVarPlan`

Examples

```
# Attribute plan
plan_attr <- optAttrPlan(PRQ = 0.01, CRQ = 0.05)
oc_attr <- OCdata(plan_attr)
plot(oc_attr)               # OC curve by pd (default)
plot(oc_attr, by = "mean")  # Will show message if not available

# Variable plan
plan_var <- optVarPlan(PRQ = 0.025, CRQ = 0.1, USL = 0.1,
                       distribution = "normal", sigma=0.01)
oc_var <- OCdata(plan_var)
plot(oc_var)                # OC curve by pd
plot(oc_var, by = "mean")   # OC curve by mean levels
```

---

plot.VarPlan *Plot the OC Curve for Variable Sampling Plans*

Description

Plots the Operating Characteristic (OC) curve for an object of class `VarPlan`. Supports plotting against either the proportion of nonconforming items or the corresponding process mean levels, depending on availability.

Usage

```
## S3 method for class 'VarPlan'
plot(x, pd = NULL, by = c("pd", "mean"), ...)
```

Arguments

`x`	An object of class `VarPlan` representing a variable acceptance sampling plan.
`pd`	Optional numeric vector of proportions of nonconforming items to evaluate. If `NULL` (default), a suitable range is generated automatically.
`by`	Character string indicating which x-axis to use for plotting. Either `"pd"` for proportion nonconforming (default) or `"mean"` for process mean levels. If `"mean"` is selected but the plan lacks specification limits, an error is raised.
`...`	Additional graphical parameters passed to `plot()`.

Details

This plotting method visualizes the probability of acceptance (`P(accept)`) against the desired metric, based on the parameters of a variable sampling plan.

If `by = "pd"`, the x-axis represents the proportion of nonconforming items. If `by = "mean"` and the plan defines `limit_type` and `spec_limit`, the function estimates corresponding process means using `muEst` and plots the OC curve by those mean values.

Reference lines for the Producer's Risk Quality (PRQ) and Consumer's Risk Quality (CRQ), along with their respective acceptance probabilities, are shown when plotting by proportion.

Value

A plot showing the OC curve for the given variable sampling plan, either by nonconforming proportion or mean level.

Author(s)

Ha Truong

See Also

optVarPlan, accProb, muEst, OCdata, plot.OCdata

Examples

```
# Variable sampling plan with specification limits
plan <- optVarPlan(
  PRQ = 0.025, CRQ = 0.1,
  alpha = 0.05, beta = 0.1,
  distribution = "normal",
  USL = 3, sigma = 0.1
)

# Plot by proportion nonconforming
plot(plan, by = "pd")

# Plot by estimated mean level (requires spec_limit and limit_type)
plot(plan, by = "mean")

# Custom pd vector
plot(plan, pd = seq(0.01, 0.15, by = 0.001))
```

---

summary.AttrPlan *Summarize Attribute Acceptance Plan*

Description

Detailed summaries for attribute acceptance plans.

Usage

```
## S3 method for class 'AttrPlan'
summary(object, ...)
```

Arguments

object	Plan object to summarize
...	Additional parameters (ignored)

Value

No return value. This function is called for its side effect of printing a formatted summary of the attribute sampling plan to the console.

Author(s)

Ha Truong

Examples

```
attr_plan <- optAttrPlan(PRQ = 0.01, CRQ = 0.1)
summary(attr_plan)
```

`summary.VarPlan` *Summarize Variable Acceptance Plan*

Description

Detailed summaries for variable acceptance plans.

Usage

```
## S3 method for class 'VarPlan'
summary(object, ...)
```

Arguments

`object`	Plan object to summarize
`...`	Additional parameters (ignored)

Value

No return value. This function is called for its side effect of printing a formatted summary of the variable sampling plan to the console.

Author(s)

Ha Truong

Examples

```
var_plan <- optVarPlan(
  PRQ = 0.025,       # Acceptable quality level (% nonconforming)
  CRQ = 0.1,         # Rejectable quality level (% nonconforming)
  alpha = 0.05,      # Producer's risk
  beta = 0.1,        # Consumer's risk
  distribution = "normal"
)
summary(var_plan)
```

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