

# Package ‘DiagTestKit’

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**Type** Package

**Title** Functions used in evaluating sensitivity and specificity at CVB Statistics

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**Description** A package written by CVB Statistics to estimate the sensitivity and specificity of an experimental diagnostic test kit in accordance with CVB STATWI0002 supporting the 2018 revision to VSM 800.73.

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**URL** [https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/veterinary-biologics/biologics-regulations-and-guidance/ct\\_vb\\_statwi](https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/veterinary-biologics/biologics-regulations-and-guidance/ct_vb_statwi), <https://github.com/ABS-dev/DiagTestKit/blob/master/README.md>

**BugReports** <https://github.com/ABS-dev/DiagTestKit/issues>

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## R topics documented:

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.beta_parm	<i>Convert Beta Parameterizations</i>
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---

**Description**

Convert between the paramaterizations of a beta distribution.

**Usage**

.beta\_parm(b, to = "alpha.beta")

**Arguments**

- |    |   |
|----|---|
| b  | vector A named vector specifying non-NULL values for 2 parameters. e.g. c(alpha=NA, beta=NA, mu=.6, theta=NA, phi=1.6, sigma2=NA) or just c(mu=.6, phi=1.6) |
| to | Specification of desired parameters, options are one of "alpha.beta", "mu.phi", "mu.theta" or "mu.sigma2".  |

**Value**

vector A named vector with values for the parameters specified in the "to" argument of the input.

**Author(s)**

[DiagTestKit-package](#)

---

.cell_counts	<i>Obtain cell counts</i>
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---

## Description

This function creates expected cell counts (and probabilities) for a specific test pattern based on the diagnostic characteristics of the reference test(s) and experimental test.

## Usage

```
.cell_counts(
  SnR,
  SpR,
  Prev,
  SnE,
  SpE,
  sus.perc,
  N_mat,
  nstates,
  suspect2staterows,
  X,
  Xpos,
  Xsus,
  Xneg,
  ncells,
  ntests
)
```

## Arguments

SnR	data.frame Each column corresponds to one reference test. Row 1 contains the sensitivity for the reference test(s). Row 2 contains the probability of a suspect result as a fraction of the non-correct test result. This is a value between 0 and 1 (inclusive). Namely, $P(T?   D+) = \psi = \delta * (1 - \pi)$ where $\delta$ is the second row for a given column (reference test). $\delta = \frac{\psi}{(1-\pi)}$ . Use a zero for a 2-state test (i.e. no suspect region).
SpR	data.frame Each column corresponds to one reference test. Row 1 contains the specificity for each reference test. Row 2 contains the probability of a suspect result as a fraction of the non-correct test result. This is a value between 0 and 1 (inclusive). Namely, $P(T?   D-) = \phi = \gamma * (1 - \theta)$ where $\gamma$ is the second row for a given column (reference test). $\gamma = \frac{\phi}{(1-\theta)}$ . Use a zero for a 2-state test (i.e. no suspect region).
Prev	vector A named vector containing the prevalence for each population sampled.
SnE	Sensitivity of the experimental test kit.
SpE	Specificity of the experimental test kit.
sus.perc	vector A vector containing 2 elements, $c(\delta, \gamma)$ for the experimental test kit. A vector of zeros for a 2-state experimental kit. $\delta$ and $\gamma$ are values between 0 and 1 (inclusive) corresponding to the proportion of the remaining probability (i.e. $1 - \pi$ or $1 - \theta$ ) that is suspect ( $\psi$ or $\phi$ ). $\delta = \frac{\psi}{(1-\pi)}$ and $\gamma = \frac{\phi}{(1-\theta)}$ .

N_mat	matrix Needs to be filled out
nstates	vector A vector with length one greater than the number of reference tests. The first element is the number of states of the experimental test and the remaining entries are the number of states of each reference test (using the same ordering as SnR and SpR).
suspect2staterows	Needs to be filled out.
X	Needs to be filled out.
Xpos	Needs to be filled out.
Xsus	Needs to be filled out.
Xneg	Needs to be filled out.
ncells	Needs to be filled out.
ntests	Needs to be filled out.

**Value**

vector A vector of expected counts corresponding to the properties of the reference and experimental tests. The expected counts are obtained based on a conditional independence assumption of all test methods.

**Author(s)**

[DiagTestKit-package](#)

---

.create\_triangle\_dist *Create Triangular Distribution*

---

**Description**

Creates a discrete step/triangular distribution that can be used to sample values for sensitivity or specificity of a reference test or prevalence of a population.

**Usage**

```
.create_triangle_dist(
  m,
  w,
  h,
  threestate = FALSE,
  suspect = 2/3,
  step_size = 0.005,
  p_proportion = TRUE
)
```

**Arguments**

<code>m</code>	This is a point estimate for the parameter in which you are obtaining the distribution, e.g. sensitivity, specificity, or prevalence.
<code>w</code>	vector A vector that provides the half widths of the 3 regions, (w1 closest, w3 farthest).
<code>h</code>	vector A vector of "y" (pseudo-value until scaled to be a probability) corresponding to the height of the shoulder and the height of the plateau.
<code>threestate</code>	logical (TRUE/FALSE) Indicates whether or not there is a "suspect" region (i.e. positive/suspect/negative).
<code>suspect</code>	A fraction that indicates what percentage of the remaining probability would be assigned to the suspect region. For instance, if the function gives sensitivity and then the probability of "suspect" is (1 - sensitivity) * suspect.
<code>step_size</code>	distance between the 'x' in the discrete distribution, resolution of possible observations of the created distribution.
<code>p_proportion</code>	whether to express 'p' as a proportion of its sum.

**Value**

data.frame of 'x', 'y', and 'p'.

**Author(s)**

[DiagTestKit-package](#)

---

`.emp_hpd`*Calculate the empirical hpd.*

---

**Description**

Empirical highest posterior density by shortest length interval.

**Usage**

```
.emp_hpd(X, alpha)
```

**Arguments**

<code>X</code>	vector of values
<code>alpha</code>	1 - confidence

**Value**

highest posterior density (1-alpha) interval

**Note**

Uses type 7 [quantile](#). Also used in package MF

**Author(s)**

[DiagTestKit-package](#)

---

`.get_simulated_values` *Get Simulated Values*

---

### Description

Simulate values for use in optimization. This function is used to obtain draws from a distribution for the sensitivity and specificity for each reference test and for the prevalence of each population tested.

### Usage

```
.get_simulated_values(means, distn, spread, nsim, step_size, prevalence)
```

### Arguments

<code>means</code>	vector A named vector containing point estimates for the prevalence of each population (when <code>prevalence = TRUE</code> , see below) or a data frame where each column corresponds to a reference test and the rows are sensitivity ( $\pi$ ) and $\psi$ (or specificity ( $\theta$ ) and $\phi$ ).
<code>distn</code>	vector A vector of same length as <code>means</code> . Values may be one of <code>NULL</code> , <code>'beta'</code> , or <code>'triangular'</code> . <code>NULL</code> will be treated as <code>'beta'</code>
<code>spread</code>	vector A vector of same length as <code>means</code> . Values may be one of <code>NULL</code> , <code>'wide'</code> , <code>'medium'</code> , or <code>'narrow'</code> . <code>NULL</code> will be treated as <code>'wide'</code> .
<code>nsim</code>	The number of simulations to draw from the sensitivity and specificity distribution(s) for each reference test or the prevalence distribution from each population.
<code>step_size</code>	Provides the level of resolution in values simulated from a triangular distribution.
<code>prevalence</code>	logical (TRUE/FALSE) TRUE indicates that the function is simulating values of prevalence. This will determine the structure of the output.

### Value

`final_mat` A matrix of simulated values. If `prevalence` is `TRUE`, `final_mat` will have the number of columns corresponding to the number of populations sampled else if `prevalence` is `FALSE`, `final_mat` will have number of columns twice the number of reference tests. The columns are sensitivity (or specificity) of the first reference test, the probability of a suspect result as a fraction of the non-correct test result (i.e. either  $\delta$  or  $\gamma$ ) for the first reference and continues in the same pattern for all reference tests.

### Author(s)

[DiagTestKit-package](#)

## Description

Determine final optimized values for the sensitivity and specificity of an experimental test kit (and probability of suspect given disease positive and given disease negative for a 3-state kit).

## Usage

```
.get_values(
  dat,
  SnR.vec,
  SpR.vec,
  prev.vec,
  N.vec,
  nstates,
  tolerance,
  rep.iter,
  iter.n,
  parm = NULL
)
```

## Arguments

dat	vector A vector of counts ordered in a manner consistent with output from the .cell_counts function.
SnR.vec	data.frame Each column corresponds to one reference test. Row 1 contains the sensitivity for the reference test(s). Row 2 contains the probability of a suspect result as a fraction of the non-correct test result. This is a value between 0 and 1 (inclusive). Namely, $P(T?   D+) = \psi = \delta * (1 - \pi)$ where $\delta$ is the second row for a given column (reference test). $\delta = \frac{\psi}{(1-\pi)}$ . Use a zero for a 2-state test (i.e. no suspect region).
SpR.vec	data.frame Each column corresponds to one reference test. Row 1 contains the specificity for each reference test. Row 2 contains the probability of a suspect result as a fraction of the non-correct test result. This is a value between 0 and 1 (inclusive). Namely, $P(T?   D-) = \phi = \gamma * (1 - \theta)$ where $\gamma$ is the second row for a given column (reference test). $\gamma = \frac{\phi}{(1-\theta)}$ . Use a zero for a 2-state test (i.e. no suspect region).
prev.vec	vector A named vector containing the prevalence for each population sampled.
N.vec	vector A named vector containing the sample size for each population sampled.
nstates	vector A vector with length one more than the number of reference tests. The first element is the number of states of the experimental test and the remaining entries are the number of states of each reference test (using the same ordering as SnR.vec and SpR.vec).
tolerance	Setting a limit on the pgtol used in the optim function with the 'L-BFGS-B' method. See also <a href="#">optim</a> .
rep.iter	logical (TRUE/FALSE) Indicates if updates should be printed regarding the number of iterations completed.

<code>iter.n</code>	integer indicating the frequency of updates for the number of iterations completed.
<code>parm</code>	vector A vector of starting values to be used for the optimization that is passed to <code>.minimize_cell</code> . For a 2-state experimental test, this is a vector of length 2 with entries $(\pi, \theta)$ . For a 3-state experimental test, this is a vector of length 4 with entries $(\pi, \delta, \theta, \gamma)$ . See also <a href="#">estimateSnSp</a> .

## Value

A list:

The following will be returned for both 2 and 3-state experimental tests –

- `sens.final` vector The optimized values for the sensitivity of the experimental test kit.
- `spec.final` vector The optimized values for the specificity of the experimental test kit.
- `converge` vector Each entry is an integer code detailing the convergence of the optimization for each iteration. 0 indicates successful completion. See also [optim](#).
- `message` vector Each entry includes a character string giving any additional information returned by the optimizer or NULL. See also [optim](#).

If three states –

- $\delta$  vector The optimized values for the probability of a suspect result as a fraction of the non-correct test result for diseased samples.
- $\gamma$  vector The optimized value for the probability of a suspect result as a fraction of the non-correct test result for non-diseased samples.

## Author(s)

[DiagTestKit-package](#)

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<code>.minimize_cell</code>	<i>minimize cell</i>
-----------------------------	----------------------

---

## Description

A function used for optimizing the values of sensitivity and specificity (and  $\delta$  and  $\gamma$  for a 3-state kit). The objective function minimizes the sum of the squared deviations (expected - observed cell counts).

## Usage

```
.minimize_cell(
  parm,
  SnR,
  SpR,
  Prev,
  xdat,
  N_mat,
```



```
nstates,
suspect2staterows,
X,
Xpos,
Xsus,
Xneg,
ncells,
ntests
)
```

### Arguments

<code>parm</code>	vector A vector of starting values to be used for the optimization that is passed to <code>.minimize_cell</code> . For a 2-state experimental test, this is a vector of length 2 with entries $(\pi, \theta)$ For a 3-state experimental test, this is a vector of length 4 with entries $(\pi, \delta, \theta, \gamma)$ . See also <a href="#">estimateSnSp</a> .
<code>SnR</code>	<code>data.frame</code> Each column corresponds to one reference test. Row 1 contains the sensitivity for the reference test(s). Row 2 contains the probability of a suspect result as a fraction of the non-correct test result. This is a value between 0 and 1 (inclusive). Namely, $P(T?   D+) = \psi = \delta * (1 - \pi)$ where $\delta$ is the second row for a given column (reference test). $\delta = \frac{\psi}{(1-\pi)}$ . Use a zero for a 2-state test (i.e. no suspect region).
<code>SpR</code>	<code>data.frame</code> Each column corresponds to one reference test. Row 1 contains the specificity for each reference test. Row 2 contains the probability of a suspect result as a fraction of the non-correct test result. This is a value between 0 and 1 (inclusive). Namely, $P(T?   D-) = \phi = \gamma * (1 - \theta)$ where $\gamma$ is the second row for a given column (reference test). $\gamma = \frac{\phi}{(1-\theta)}$ . Use a zero for a 2-state test (i.e. no suspect region).
<code>Prev</code>	vector A named vector containing the prevalence for each population sampled.
<code>xdat</code>	vector A vector of the observed cell counts.
<code>N_mat</code>	matrix Needs to be filled out
<code>nstates</code>	vector A vector with length one more than the number of reference tests. The first element is the number of states of the experimental test and the remaining entries are the number of states of each reference test (using the same ordering as <code>SnR</code> and <code>SpR</code> ).
<code>suspect2staterows</code>	Needs to be filled out.
<code>X</code>	Needs to be filled out.
<code>Xpos</code>	Needs to be filled out.
<code>Xsus</code>	Needs to be filled out.
<code>Xneg</code>	Needs to be filled out.
<code>ncells</code>	Needs to be filled out.
<code>ntests</code>	Needs to be filled out.

### Value

The sum of the squared deviations between the expected and observed cell counts.

### Author(s)

[DiagTestKit-package](#)

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cloppearSnSp

*Binomial confidence interval, Clopper-Pearson method.*


---

### Description

Evaluate binomial confidence interval using Clopper-Pearson method. A function written by CVB Statistics to estimate the sensitivity and specificity of an experimental diagnostic test kit in accordance with **CVB STATWI0002**.

### Usage

```
cloppearSnSp(dat, alpha = 0.05, est.Sn = TRUE)
```

### Arguments

dat	data.frame A data frame with a column for the experimental test results, a column for the infallible reference test results, and a column for the corresponding count. The column name for the experimental test results must contain 'exp' and the column name for the infallible reference test results must include 'ref'. The counts should be the last column.
alpha	Complement of confidence level.
est.Sn	logical (TRUE/FALSE) Indicating if the sensitivity and its confidence interval should be supplied (TRUE) or if the specificity and its confidence interval should be supplied (FALSE).

### Value

An object of type cp that extends list.

**calcVal** Named vector of point estimates and estimated simulated intervals. See below.

**data** Test and Total values of the data. See below.

**alpha** Complement of the confidence interval as provided above.

**If** est.Sn == TRUE

calcVal is a list with the following elements

- **Sn** Sensitivity estimate.
- **Sn.LL** Lower confidence limit for sensitivity.
- **Sn.UL** Upper confidence limit for sensitivity.

data is a list with the following elements

- **Test.Positive** Number of experimental test positives.
- **Total.Positive** Total number of positive samples.

If `est.Sn == FALSE`

`calcVal` is a list with the following elements

- **Sp** Specificity estimate.
- **Sp.LL** Lower confidence limit for specificity.
- **Sp.UL** Upper confidence limit for specificity.

`data` is a list with the following elements

- **Test.Negative** Number of experimental test negatives.
- **Total.Negative** Total number of negative samples.

A matrix with a single row. If `est.Sn = T` the columns correspond to the number of experimental test positives, the total number of positive samples, sensitivity, the lower confidence limit for sensitivity and the upper confidence limit for sensitivity. If `est.Sn=F`, the columns correspond to the number of experimental test negatives, the total number of negative samples, specificity, the lower confidence limit for specificity and the upper confidence limit for specificity.

#### Author(s)

[DiagTestKit-package](#)

#### References

Clopper CJ, Pearson ES, 1934. The use of confidence or fiducial limits illustrated in the case of the binomial. *Biometrika* 26:404-413.

#### Examples

```
CP.Sn <- cloppearSnSp(dat = dat_infal, est.Sn = TRUE)
CP.Sn
# Sn = P(T+|D+): 0.987013 (95% CI: 0.953876, 0.998423)
CP.Sp <- cloppearSnSp(dat = dat_infal, est.Sn = FALSE)
CP.Sp
# Sp = P(T-|D-): 0.970297 (95% CI: 0.915643, 0.915643)
```

---

cp-class

*cp-class*

---

#### Description

cp-class

data1

*Data set for Example 1 in vignette "DiagTestKit Examples"***Description**

Samples randomly selected from a single population are tested by one 2–state fallible reference test and a 2–state experimental test.

**Usage**

data1

**Format**

A data frame with four rows and three variables:

**exp\_result** result of experimental test (positive, negative).

**refl\_result** result of reference test (positive, negative).

**count** number of samples with the unique testing combination.

data2

*Data set for Example 2 in vignette "DiagTestKit Examples"***Description**

Samples randomly selected from 3 populations are tested by one 2–state fallible reference test and a 2–state experimental test.

**Usage**

data2

**Format**

A data frame with 12 rows and four variables:

**population** population identifier (A, B, C).

**exp\_result** result of experimental test (positive, negative).

**ref\_result** result of reference test (positive, negative).

**count** number of samples with the unique testing combination for the specific population.

---

data3*Data set for Example 3 in vignette "DiagTestKit Examples"*

---

**Description**

Samples randomly selected from single population tested by one 3–state fallible reference test and a 2–state experimental test.

**Usage**

data3

**Format**

A data frame with six rows and three variables:

**exp\_result** result of experimental test (positive, negative).

**ref\_result** result of reference test (positive, negative, suspect).

**count** number of samples with the unique testing combination.

---

data4*Data set for Example 4 in vignette "DiagTestKit Examples"*

---

**Description**

Samples randomly selected from 3 populations tested by one fallible 3–state reference test and a 2–state experimental test.

**Usage**

data4

**Format**

A data frame with 18 rows and four variables:

**population** population identifier (A, B, C).

**exp\_result** result of experimental test (positive, negative).

**ref\_result** result of reference test (positive, negative, suspect).

**count** number of samples with the unique testing combination for the specific population.

---

data5

*Data set for Example 5 in vignette "DiagTestKit Examples"*

---

### Description

Samples randomly selected from 2 populations tested by one 2–state reference test and a 3–state experimental test.

### Usage

data5

### Format

A data frame with 11 rows and four variables:

**Population** population identifier (A, B).

**exp\_result** result of experimental test (positive, negative, suspect).

**ref\_result** result of reference test (positive, negative).

**count** number of samples with the unique testing combination for the specific population.

---

data6

*Data set for Example 6 in vignette "DiagTestKit Examples"*

---

### Description

Samples randomly selected from a single population tested with two 2–state reference test and a 2–state experimental test.

### Usage

data6

### Format

A data frame with 8 rows and four variables:

**exp\_result** result of experimental test (positive, negative).

**ref1\_result** result of first reference test (positive, negative).

**ref2\_result** result of second reference test (positive, negative).

**count** number of samples with the unique testing combination.

---

data7*Data set for Example 7 in vignette "DiagTestKit Examples"*

---

**Description**

Samples randomly selected from 2 populations tested with two 3–state reference test and a 2–state experimental test.

**Usage**

```
data7
```

**Format**

A data frame with 39 rows and five variables:

**Population** population identifier (A, B).

**exp\_result** result of experimental test (positive, negative).

**ref1\_result** result of first reference test (positive, negative, suspect).

**ref2\_result** result of second reference test (positive, negative, suspect).

**count** number of samples with the unique testing combination for the specific population.

---

data8*Data set for Example 8 in vignette "DiagTestKit Examples"*

---

**Description**

Samples randomly selected from 3 populations tested by three 2–state reference tests and a 3–state experimental test.

**Usage**

```
data8
```

**Format**

A data frame with 72 rows and six variables:

**Population** population identifier (A, B, C).

**exp\_result** result of experimental test (positive, negative, suspect).

**ref1\_result** result of first reference test (positive, negative).

**ref2\_result** result of second reference test (positive, negative).

**ref3\_result** result of third reference test (positive, negative).

**count** number of samples with the unique testing combination for the specific population.

---

dat_dichot	<i>Assay Validation Sensitivity and Specificity (Diagnostic Kit Format) example from CVB Data Guide.</i>
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---

### Description

Results from testing by diagnostic test kits with a dichotomous response for assay validation. See CVB Data Guide Appendix 1.8. [DiagnosticKitDichotomous.zip/Diagnostic Kit Dichotomous Senspec Example/dichotomoussenspec\\_deviceinfo.csv](#)

### Usage

```
dat_dichot
```

### Format

A data frame with 202 rows and 14 variables:

**deviceID** Device identifier; unique for each row.

**serialID** Identifier of the preparation used.

**tech** Identifier of the technician performing testing.

**sampleID** Unique identifier for the sample being tested.

**animalID** Unique identifier for an animal.

**specimen** Type of specimen (wholeblood, serum, plasma).

**species** Animal species.

**mfg\_date** Date of preparation manufacturer.

**date** Test date.

**visual\_read** Test interpretation by visual reading.

**instr\_read** Test interpretation by instrument reading.

**control\_read** Test interpretation of the control.

**ref\_result** Test interpretation of the reference.

**prod\_code** Veterinary Services Product Code

### Source

[https://www.aphis.usda.gov/animal\\_health/vet\\_biologics/publications/DiagnosticKitDichotomous.zip](https://www.aphis.usda.gov/animal_health/vet_biologics/publications/DiagnosticKitDichotomous.zip)



dat\_infal

*Counts data used in vignette "DiagTestKit GettingStarted" section 4***Description**

Counts of the positive and negative results for experimental and reference tests. A 2-state experimental test when an infallible reference test has been used to determine the true disease status of each sample.

**Usage**

dat\_infal

**Format**

A data frame with 4 rows and 3 variables:

**Experimental** Result of the experimental test (positive or negative).

**Reference** Result of the reference test (positive or negative).

**Count** Number of samples observed with the unique testing combination.

estimateSnSp

*Estimate Sensitivity and Specificity***Description**

A function written by CVB Statistics to estimate the sensitivity and specificity of an experimental diagnostic test kit in accordance with [CVB STATWI0002](#).

**Usage**

```
estimateSnSp(dat, Sn.ref, Sp.ref, prev.pop, nsim = 1000, control = NULL)
```

**Arguments**

**dat** `data.frame` This is a data frame where the first column includes information for the population sampled (if more than one population is sampled). The next column is the possible outcomes of the experimental test followed by one column for the possible outcomes for each reference test (one column per test). The last column of the data frame provides the number of samples with each pattern of test outcomes. The columns must be included in the order described. If more than one population is sampled, the column name for the column containing the population information must be 'population'. The column containing the test results for the experimental test must have 'exp' in the name, such as experimental, experiment, exp, Exp, etc. The column names containing the reference test results must contain 'ref' in the name, such as Ref1, Ref2, ref1\_results, Reference2, etc.

Sn.ref	data.frame Each column corresponds to one reference test. Row 1 contains the sensitivity for the reference test(s). Row 2 contains the probability of a suspect result as a fraction of the non-correct test result. This is a value between 0 and 1 (inclusive). Namely, $P(T?   D+) = \psi = \delta * (1 - \pi)$ where $\delta$ is the second row for a given column (reference test). $\delta = \frac{\psi}{(1-\pi)}$ . Use a zero for a 2-state test (i.e. no suspect region). Alternatively, if all reference tests are 2-state tests, the sensitivities can be input as a named vector. Specifically, each element in the vector must be given a name which includes 'ref' (see above) and the column names (or names of the elements within the vector) must match those for Sp.ref.
Sp.ref	data.frame Each column corresponds to one reference test. Row 1 contains the specificity for each reference test. Row 2 contains the probability of a suspect result as a fraction of the non-correct test result. This is a value between 0 and 1 (inclusive). Namely, $P(T?   D-) = \phi = \gamma * (1 - \theta)$ where $\gamma$ is the second row for a given column (reference test). $\gamma = \frac{\phi}{(1-\theta)}$ . Use a zero for a 2-state test (i.e. no suspect region). Alternatively, if all reference tests are 2-state tests, the specificity can be input as a named vector. Specifically, each element in the vector must be given a name which includes 'ref' (see above) and the column names (or names of the elements within the vector) must match those for Sn.ref.
prev.pop	vector A named vector containing the prevalence for each population sampled. The names in the vector must match the population labels used in 'dat'.
nsim	The number of simulations to draw from the sensitivity and specificity distribution(s) for each reference test and the prevalence distribution from each population.
control	list of control values to replace defaults. See <a href="#">estimateSnSpControl</a> for details.

## Value

An object of type snsp that extends list.

**calcVal** Point estimates and estimated simulated intervals for properties of the experimental kit. See below.

**detailOut** Detailed output values. See below.

**input** Simulated values. See below.

## calcVal

A list with the following values which will include the following for both 2- and 3-state experimental tests –

- **Nsim** Number of simulations performed.
- **Confidence**  $1 - \alpha$ .
- **SnPE** Sensitivity point estimate obtained as the median of the estimated values.
- **SnInterval** Estimated simulated interval for sensitivity.
- **SpPE** Specificity point estimate obtained as the median of the estimated values.
- **SpInterval** Estimated simulated interval for specificity.

If three states, the list will also include –

- **SusDisPosPE** Point estimate for the probability of test suspect given disease positive ( $\psi$ ) which is the median of the calculated values ( $\psi = \delta(1-\pi)$ ).
- **SusDisPosInterval** Estimated simulated interval for the probability of test suspect given disease positive ( $\psi$ ).
- **SusDisNegPE** Point estimate for the probability of test suspect given disease negative ( $\phi$ ) which is the median of the calculated values ( $\phi = \gamma(1-\theta)$ ).
- **SusDisNegInterval** Estimated simulated interval for the probability of test suspect given disease negative ( $\phi$ ).

#### detailOut

A list with the following detailed output values which will include the following for both 2- and 3-state experimental tests –

- **Exp.Sn** vector The optimized values for the sensitivity of the experimental test kit.
- **Exp.Sp** vector The optimized values for the specificity of the experimental test kit.
- **Converge** vector Each entry is an integer code detailing the convergence of the optimization for each iteration. 0 indicates successful completion. See also [optim](#).
- **Message** vector Each entry includes a character string providing any additional information returned by the optimizer or NULL. See also [optim](#).

If three states, the list will also include –

- **Exp.pos.p** vector The optimized values for the proportion of the remaining probability ( $1-Sn$ ) that corresponds to a suspect region for diseased samples, namely  $\delta$ .
- **Exp.sus.pos** vector The values for  $P(T? \mid D+)$  ( $\psi$ ) calculated from `Exp.sn` and `Exp.pos.p`.  $P(T? \mid D+) = \delta * (1 - \pi)$ .
- **Exp.neg.p** vector The optimized value for the proportion of the remaining probability ( $1-Sp$ ) that corresponds to a suspect region for non-diseased samples, namely  $\gamma$ .
- **Exp.sus.neg** vector The values for  $P(T? \mid D-)$  ( $\phi$ ) calculated from `Exp.sp` and `Exp.neg.p`.  $P(T? \mid D-) = \gamma * (1 - \theta)$ .

#### input

A list containing the seed used and the simulated values.

- **seed** The seed used in the random generation of the distributions of sensitivity and specificity for all reference tests and prevalence of each population. See also [set.seed](#)
- **Sn.sims** matrix The simulated values for the sensitivity of each reference test and  $\psi$  where  $\psi$  was specified in the second row of `Sn.ref` (or zero if `Sn.ref` was a vector). The first two columns correspond to the first reference test, columns 3 and 4 to the second reference test if it exists, etc.
- **Sp.sims** matrix The simulated values for the specificity of each reference test and  $\phi$  where  $\phi$  was specified in the second row of `Sp.ref` (or zero if `Sp.ref` was a vector). The first two columns correspond to the first reference test, columns 3 and 4 to the second reference test if it exists, etc.
- **prev.sims** matrix The simulated values of prevalence for each population. Each column correspond to one population.

**Author(s)**[DiagTestKit-package](#)**See Also**[estimateSnSpControl](#)**Examples**

```

data.1 <- data.frame(exp_result = rep(c('positive', 'negative'), each = 2),
                    ref1_result = rep(c('positive', 'negative'), 2),
                    count = c(82, 11, 5, 22))
example.1 <- estimateSnSp(dat = data.1,
                        Sn.ref = data.frame(ref = c(0.90, 0)),
                        Sp.ref = data.frame(ref = c(0.99, 0)),
                        prev.pop = c(A = 0.80),
                        control = estimateSnSpControl(seed = 64725))

example.1

# 1000 simulations
# 95 % Interval Estimates
#
#           Point.Estimate      Lower  Upper
# Sn = P(T+|D+)      0.9449821 0.9019639      1
# Sp = P(T-|D-)      0.9062769 0.7523346      1

## Not run:
data.2 <- data.frame(Population = rep(LETTERS[1:3], each = 24),
                    exp_result = rep(rep(
                        c('negative', 'positive', 'suspect'), each = 8), 3),
                    ref1_result = rep(rep(
                        c('negative', 'positive'), each = 4), 9),
                    ref2_result = rep(rep(
                        c('negative', 'positive'), each = 2), 18),
                    ref3_result = rep(c('negative', 'positive'), 36),
                    count = c(3, 0, 0, 0, 1, 0, 0, 1, 0, 1, 1, 5,
                              1, 8, 11, 62, 0, 0, 0, 0, 0, 0, 0,
                              2, 27, 2, 3, 0, 4, 0, 1, 1, 0, 0, 1,
                              4, 1, 6, 7, 41, 0, 0, 0, 0, 0, 0,
                              0, 2, 57, 5, 6, 1, 9, 1, 1, 0, 0, 0,
                              0, 1, 0, 2, 2, 12, 1, 0, 0, 0, 0, 0, 0))
example.2 <- estimateSnSp(dat = data.2,
                        Sn.ref = data.frame(ref1 = c(0.92, 0),
                                             ref2 = c(0.88, 0),
                                             ref3 = c(0.85, 0)),
                        Sp.ref = data.frame(ref1 = c(0.86, 0),
                                             ref2 = c(0.90, 0),
                                             ref3 = c(0.92, 0)),
                        prev.pop = c(A = 0.95, B = 0.62, C = 0.18),
                        control = estimateSnSpControl(seed = 865213))
# 1000 simulations
# 95 % Interval Estimates
#
#           Point.Estimate      Lower  Upper
# Sn = P(T+|D+)      0.96541704 0.8879949 1.00000000

```

```
# Sp = P(T-|D-)      0.98351924 0.9016964 1.00000000
# SsP = P(T?|D+)     0.02568427 0.00000000 0.06339616
# SsN = P(T?|D-)     0.01534125 0.00000000 0.05604950

## End(Not run)
```

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estimateSnSpControl	<i>control values for estimateSnSp</i>
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## Description

The values supplied in the function-call replace the defaults and a list with all possible arguments is returned. The returned list is used as the control argument to the function estimateSnSp.

## Usage

```
estimateSnSpControl(
  seed = NULL,
  Sn.distn = NULL,
  Sn.spread = NULL,
  Sp.distn = NULL,
  Sp.spread = NULL,
  prev.distn = NULL,
  prev.spread = NULL,
  tolerance = 0.001,
  alpha = 0.05,
  step.size = 1e-06,
  parm = NULL,
  rep.iter = TRUE,
  iter.n = 50
)
```

## Arguments

seed	The seed used in the random generation of the distributions of sensitivity and specificity for all reference tests and prevalence of each population. See also <a href="#">set.seed</a> .
Sn.distn	vector A named vector with length equal to the number of reference tests. Determines which distribution should be used for sampling sensitivity of each reference test. Inputs are 'beta' or 'triangular'. Defaults to 'beta' for each reference test.
Sn.spread	vector A named vector with length equal to the number of reference tests. Describes the width of the distribution for the sensitivity of each reference test. Inputs are 'wide', 'medium', or 'narrow'. Defaults to 'wide' for each reference test.
Sp.distn	vector A named vector with length equal to the number of reference tests. Determines which distribution should be used for sampling specificity of each reference test. Inputs are 'beta' or 'triangular'. Defaults to 'beta' for each reference test.

Sp.spread	vector A named vector with length equal to the number of reference tests. Describes the width of the distribution for the specificity of each reference test. Inputs are 'wide', 'medium', or 'narrow'. Defaults to 'wide' for each reference test.
prev.distn	vector A named vector with length equal to the number of populations. Determines which distribution should be used for sampling the prevalence of each population. Inputs are 'beta' or 'triangular'. Defaults to 'beta'.
prev.spread	vector A named vector with length equal to the number of populations. Describes the width of the distribution for the prevalence of each population. Inputs are 'wide', 'medium', or 'narrow'. Defaults to 'wide' for each population.
tolerance	Setting a limit on the pgtol used in the <code>optim</code> function with the 'L-BFGS-B' method. See also <code>optim</code> . Defaults to 1E-03.
alpha	Significance levels. Defaults to 0.05.
step.size	Provides the level of resolution in values simulated from a triangular distribution. Defaults to 1E-06.
parm	vector Starting values for the optimization of the parameters of the experimental test. If the experimental test has 2 states, this vector is of length two with elements corresponding to sensitivity and specificity, respectively. If the experimental test has 3 states, this vector is of length 4 with elements corresponding to sensitivity ( $\pi$ ), the proportion of 1-Sn corresponding to the suspect region for disease positive samples ( $\delta$ ), specificity ( $\theta$ ), and the proportion of 1-Sp corresponding to the suspect region for disease negative samples ( $\gamma$ ). All values are between 0 and 1, inclusive.
rep.iter	logical (TRUE/FALSE) Indicates if updates should be printed regarding the number of iterations completed. Defaults to TRUE.
iter.n	integer indicating the frequency of updates for the number of iterations completed. Defaults to 50.

### Value

A list with the following elements (as defined above): seed, Sn.distn, Sn.spread, Sp.distn, Sp.spread, prev.distn, prev.spread, tolerance, step.size, parm

### Author(s)

[DiagTestKit-package](#)

### Examples

```
estimateSnSpControl()
estimateSnSpControl(seed = 64725)
```

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snsp-class

*snsp-class*

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### Description

snsp-class

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updateAlpha	<i>Update alpha values for existing simulation</i>
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**Description**

Report interval estimates with updated alpha values, using a previously evaluated simulation.

**Usage**

```
updateAlpha(x, newAlpha)
```

**Arguments**

x	output from <a href="#">estimateSnSp</a>
newAlpha	updated alpha value. Must be within [0, 1]

**Value**

an object of type snsp. See output for [estimateSnSp](#)

**Author(s)**

[DiagTestKit-package](#)

**See Also**

[estimateSnSpControl](#)

**Examples**

```
data.1 <- data.frame(
  exp_result = rep(c('positive', 'negative'), each = 2),
  ref1_result = rep(c('positive', 'negative'), 2),
  count = c(82, 11, 5, 22))
example.1 <- estimateSnSp(dat      = data.1,
                        Sn.ref    = data.frame(ref = c(0.90, 0)),
                        Sp.ref    = data.frame(ref = c(0.99, 0)),
                        prev.pop  = c(A = 0.80),
                        control   = estimateSnSpControl(seed = 64725))
example.1a <- updateAlpha(example.1, newAlpha = 0.25)
example.1a

# 1000 simulations
# 75 % Interval Estimates
#
#               Point.Estimate   Lower   Upper
# Sn = P(T+|D+)    0.9449821     0.9053901 0.9791017
# Sp = P(T-|D-)    0.9062769     0.8336064 1.0000000
```

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