Package ‘hypersampleplan’

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Type Package

Title Attribute Sampling Plan with Exact Hypergeometric Probabilities using Chebyshev Polynomials

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Author XU Hang, Alvo Mayer, Zhi Wang

Maintainer XU Hang <xhang@hku.hk>

Description Implements an algorithm for efficient and exact calculation of hypergeometric and binomial probabilities using Chebyshev polynomials, while other algorithm use an approximation when N is large. A useful applications is also considered in this package for the construction of attribute sampling plans which is an important field of statistical quality control. The quantile, and the confidence limit for the attribute sampling plan are also implemented in this package. The hypergeometric distribution can be represented in terms of Chebyshev polynomials. This representation is particularly useful in the calculation of exact values of hypergeometric variables.

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`binomialquantile` *Calculation Binomial Quantiles Table using Chebyshev Polynomials*

Description

This is an algorithm for exact calculation of Binomial quantiles using Chebyshev polynomials. For a fixed population size n and probability of "success" p, such calculations produce quantile of q.

Usage

```
binomialquantile(q, n, p)
```

Arguments

`q`	probability, it must be between 0 and 1.
`n`	number of observations.
`p`	probability of "success"

Details

The detailed algorthim can be found: Alvo, M., & Cabilio, P. (2000). Calculation of hypergeometric probabilities using Chebyshev polynomials. The American Statistician, 54(2), 141-144.

Value

the required values of the binomial quantiles for q

Note

N can be very large in our algorthim.

References

Alvo, M., & Cabilio, P. (2000). Calculation of hypergeometric probabilities using Chebyshev polynomials. The American Statistician, 54(2), 141-144.

Examples

```
# Calculate the hypergeometric quantile for q=0.3, N=20, p=0.4.
binomialquantile(0.3,20,0.4)
```

`binomialtable` *Calculation exact Binomial Probabilities Table using Chebyshev Polynomials*

Description

This is an algorithm for efficient and exact calculation of Binomial probabilities using Chebyshev polynomials. For a fixed population size n and probability of "success" p, such calculations simultaneously produce distributions for all possible values of the number of "successes" x. The algorthim calculate the exact probability even for large n, while other algorthims simply use normal approximation.

Usage

```
binomialtable(n, p, output = "density")
```

Arguments

`n`	number of observations.
`p`	probability of "success"
`output`	The output can be 'density', 'distribution' or 'both'. Default output is 'density'

Details

The detailed algorthim can be found: Alvo, M., & Cabilio, P. (2000). Calculation of hypergeometric probabilities using Chebyshev polynomials. The American Statistician, 54(2), 141-144.

Value

a matrix containing the required values of the hypergeometric probabilities indexed by the columns x=0,1,..,n.

Note

n can be very large in our algorthim.

References

Alvo, M., & Cabilio, P. (2000). Calculation of hypergeometric probabilities using Chebyshev polynomials. The American Statistician, 54(2), 141-144.

Examples

```
# Calculate the binomialtable probabilities for n=10, p=0.4.
binomialtable(10,0.4)
# Calculate the binomialtable distribution for n=10, p=0.4.
binomialtable(10,0.4,output='distribution')
```

`hypergeoquantile` *Calculation Hypergeometric Quantiles Table using Chebyshev Polynomials*

Description

This is an algorithm for efficient and exact calculation of hypergeometric quantiles using Chebyshev polynomials. For a fixed population size N and fixed sample size n, such calculations simultaneously produce quantiles of q for all possible values of the population number of "successes" M.

Usage

```
hypergeoquantile(q, N, n)
```

Arguments

`q`	probability, it must be between 0 and 1.
`N`	population size N.
`n`	sample size n.

Details

The detailed algorthim can be found: Alvo, M., & Cabilio, P. (2000). Calculation of hypergeometric probabilities using Chebyshev polynomials. The American Statistician, 54(2), 141-144.

Value

a matrix containing all possible required values of the hypergeometric quantiles for q in row M=0,1,...,N.

Note

N can be very large say 2000 in our algorthim.

References

Alvo, M., & Cabilio, P. (2000). Calculation of hypergeometric probabilities using Chebyshev polynomials. The American Statistician, 54(2), 141-144.

Examples

```
# Calculate the hypergeometric quantile for q=0.05, N=10, n=5.
hypergeoquantile(0.05,10,5)
```

`hypergeotable` *Calculation exact Hypergeometric Probabilities Table using Chebyshev Polynomials*

Description

This is an algorithm for efficient and exact calculation of hypergeometric probabilities using Chebyshev polynomials. For a fixed population size N and fixed sample size n, such calculations simultaneously produce distributions for all possible values of the population number of "successes" M.

The well-known hypergeometric distribution arises in the combinatorial problem in which a finite population of N ob-jects contains M of one kind which may be labeled "success." A sample of n objects is picked without replacement from this set of N objects and it is wished to find the probability that the sample contains exactly x objects labeled "success", where x = 0,1, ... ,N. The probability of observing exactly x such objects is given by The hypergeometric distribution is used for sampling without replacement:

p(x)=choose(M,x)choose(N-M,n-x)/choose(N,n)

where max(0,n-N+M)<=x<=min(n,M)

This algorthim calculate the exact probability even for large N of n, while other algorthims simply use binomial approximation.

Usage

```
hypergeotable(N,n,output='density')
```

Arguments

`N`	population size N.
`n`	sample size n.
`output`	The output can be 'density', 'distribution' or 'both'. Default output is 'density'

Details

The detailed algorthim can be found: Alvo, M., & Cabilio, P. (2000). Calculation of hypergeometric probabilities using Chebyshev polynomials. The American Statistician, 54(2), 141-144.

Value

a matrix containing in row M=0,1,...,N, the required values of the hypergeometric probabilities(or distribution if output='distribution') indexed by the columns x=0,1,..,n.

Note

N can be very large say 2000 in our algorthim.

References

Alvo, M., & Cabilio, P. (2000). Calculation of hypergeometric probabilities using Chebyshev polynomials. The American Statistician, 54(2), 141-144.

Examples

```
# Calculate the hypergeometric probabilities for N=10, n=5.
hypergeotable(10,5)
# Calculate the hypergeometric distribution for N=10, n=5.
hypergeotable(10,5,output='distribution')
```

---

hypersampleplan — *Attribute sampling plans with Hypergeometric Probabilities using Chebyshev Polynomials*

Description

Attribute sampling is an important field of statistical quality control. When a lot is submitted for inspection of quality control, a sampling plan must specify both the number of samples to be drawn from the lot as well as the acceptance number which is the maximum number of defective items found in the sample that would still make the lot acceptable. Since the sample is not free of defective, there are probabilities of accepting a lot which is actually not acceptable and of rejecting one which is acceptable. The hypergeometric distribution using Chebyshev Polynomials forms the basis for calculating those exact probabilities.

This algorithm is proposed to generate an online table which displays the values of the sample size and the acceptance number given the values of proportional defective, associated risks and lot size. In this table, one can check the values for sample size and acceptance number according to every possible group of values of risks, proportional defective, and lot size.

Usage

```
hypersampleplan(a, a.prime, b, b.prime, k1, k2, N)
```

Arguments

`a`	Producer's risk alpha: the probability of rejecting a lot for proportion defective
`a.prime`	the lower bound for pre-specified Producer's risk alpha;
`b`	Consumer's risk beta: the probability of accepting a lot for proportion defective
`b.prime`	the lower bound for pre-specified Consumer's risk beta;
`k1`	Number of defective units in a satisfactory quality level;
`k2`	Number of defective units in an unsatisfactory quality level;
`N`	Lot Size

Value

a matrix that contains the values of the sample size n and acceptance number c (number of defective units allowed in a lot which is accepted).In this table, one can check the values for sample size and acceptance number according to every possible group of values of risks, proportional defective, and lot size.

Note

The Calculateion of Hypergeometric Probabilities involved is using Chebyshev Polynomials which is exact calculation campared to other methods using approximations.

The values for a.prime and b.prime can always set to be zero. However, to save the execution time, it is not suggested to set them too far from the pre-specified a and b. If the ranges are too narrow and no sampling plan is returned, the message "the ranges for alpha and/or beta are too narrow, please reselect them" will appear. Under this circumstance, one needs to widen the range for a or b or both.

References

Alvo, M., & Cabilio, P. (2000). Calculation of hypergeometric probabilities using Chebyshev polynomials. The American Statistician, 54(2), 141-144.

Odeh, R. (1983). Attribute sampling plans, tables of tests and confidence limits for proportions (Vol. 49). CRC Press.

See Also

hypergeotable

Examples

```
hypersampleplan(0.01, 0.005, 0.05, 0.04, 20, 40, 400)
```

---

hypersampleplan.CL *Compute upper and lower confidence limits for the number of defective in an attribute sampling plan*

Description

Attribute sampling is an important field of statistical quality control. When a lot is submitted for inspection of quality control, a sampling plan must specify both the number of samples to be drawn from the lot as well as the acceptance number which is the maximum number of defective items found in the sample that would still make the lot acceptable. Since the sample is not free of defective, there are probabilities of accepting a lot which is actually not acceptable and of rejecting one which is acceptable. The hypergeometric distribution using Chebyshev Polynomials forms the basis for calculating those exact probabilities.

This algorithm is proposed to compute upper and lower confidence limits for the number of defective in a lot given (n, x,N)

Usage

```
hypersampleplan.CL(n, x, N)
```

Arguments

n	sample size
x	the observed number of defective items in a random sample
N	lot size

Value

a matrix that provides one-sided confidence limits. For a lower confidence limit the confidence is CL.Lower; for an upper confidence limit the confidence is CL.Upper; for a two-sided limit it is CL.Upper - CL.Lower.

The value of k is interpreted as: For lower confidence limits, one can be (1 - Conf.Limits.1)% sure that the number of defective units in the lot is at least k1. For upper confidence limits, one can be (Conf.Limits.2)% sure that the number of defective units in the lot is at most k2.

Note

Since the real probability cannot be just equal to 0.95 or 975 and 0.025 or 0.05, the ranges are then taken to allow the output to include all possible values. It can be certainly changed to any ranges without interference with the execution of the program itself except the execution time may be shorter or longer.

References

Alvo, M., & Cabilio, P. (2000). Calculation of hypergeometric probabilities using Chebyshev polynomials. The American Statistician, 54(2), 141-144.

Odeh, R. (1983). Attribute sampling plans, tables of tests and confidence limits for proportions (Vol. 49). CRC Press.

Examples

```
# When one observes 12 defective items in a sample of size 160 taken from a lot size 1000,
# it will give the results for the one-sided 97.5% upper and lower confidence limits for
# the number of defective items in the lot.
hypersampleplan.CL(160, 12, 1000)
```

hypersampleplan.fixedn

Attribute sampling plans when the sample size n is known and fixed

Description

Attribute sampling is an important field of statistical quality control. When a lot is submitted for inspection, a sampling plan must specify both the number of samples to be drawn from the lot as well as the acceptance number which is the maximum number of defective items found in the sample that would still make the lot acceptable. Since the sample is not free of defective, there are probabilities of accepting a lot which is actually not acceptable and of rejecting one which is acceptable. The hypergeometric distribution using Chebyshev Polynomials forms the basis for calculating those exact probabilities.

This program is designed to compute the acceptance number c when the sample size n is known and fixed.

Usage

```
hypersampleplan.fixedn(a, b, k1, k2, n, N)
```

Arguments

a	Producer's risk alpha: the probability of rejecting a lot for proportion defective
b	Consumer's risk beta: the probability of accepting a lot for proportion defective
k1	Number of defective units in a satisfactory quality level;
k2	Number of defective units in an unsatisfactory quality level;
n	Fixed sample size
N	Lot Size

Value

a matrix that contain the acceptance number c (number of defective units allowed in a lot which is accepted) in the row of sampling.plan.X.

References

Alvo, M., & Cabilio, P. (2000). Calculation of hypergeometric probabilities using Chebyshev polynomials. The American Statistician, 54(2), 141-144.

Odeh, R. (1983). Attribute sampling plans, tables of tests and confidence limits for proportions (Vol. 49). CRC Press.

See Also

hypersampleplan

Examples

```
# For the attribute sampling plan with fixed sample size n
hypersampleplan.fixedn(0.01, 0.10, 40, 80, 307, 1000)
```

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