

Package ‘StAMPP’

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Type Package

Title Statistical Analysis of Mixed Ploidy Populations

Depends R (>= 3.2.0), pegas

Imports parallel, doParallel, foreach, adegenet, methods, utils

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Author LW Pembleton

Maintainer LW Pembleton <luke.pembleton@agriculture.vic.gov.au>

Description Allows users to calculate pairwise Nei's Genetic Distances (Nei 1972), pairwise Fixation Indexes (Fst) (Weir & Cockerham 1984) and also Genomic Relationship matrixes following Yang et al. (2010) in mixed and single ploidy populations. Bootstrapping across loci is implemented during Fst calculation to generate confidence intervals and p-values around pairwise Fst values. StAMPP utilises SNP genotype data of any ploidy level (with the ability to handle missing data) and is coded to utilise multithreading where available to allow efficient analysis of large datasets. StAMPP is able to handle genotype data from genlight objects allowing integration with other packages such as adegenet. Please refer to LW Pembleton, NOI Cogan & JW Forster, 2013, Molecular Ecology Resources, 13(5), 946-952. <doi:10.1111/1755-0998.12129> for the appropriate citation and user manual. Thank you in advance.

URL <https://github.com/lpembleton/StAMPP>

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potato	<i>Example genotype input format</i>
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Description

A data frame containing Solcap potato genotype data in tetraploid and diploid format as a small example of the input format required by StAMPP

Usage

```
data(potato)
```

Format

A data frame with 30 rows and 48 variables:

Sample Sample names

Pop Population name

Ploidy Ploidy level

Format Format of genotype data

solcap_snp_c1_1 genotype data

solcap_snp_c1_1000 genotype data

solcap_snp_c1_10000 genotype data

solcap_snp_c1_10001 genotype data

solcap_snp_c1_10011 genotype data

solcap_snp_c1_10012 genotype data

solcap_snp_c1_10031 genotype data

solcap_snp_c1_10042 genotype data

solcap_snp_c1_10050 genotype data

solcap_snp_c1_10054 genotype data

solcap_snp_c1_10109 genotype data
solcap_snp_c1_10130 genotype data
solcap_snp_c1_10157 genotype data
solcap_snp_c1_10202 genotype data
solcap_snp_c1_10252 genotype data
solcap_snp_c1_10253 genotype data
solcap_snp_c1_10255 genotype data
solcap_snp_c1_1029 genotype data
solcap_snp_c1_10295 genotype data
solcap_snp_c1_10297 genotype data
solcap_snp_c1_10351 genotype data
solcap_snp_c1_10384 genotype data
solcap_snp_c1_10397 genotype data
solcap_snp_c1_10457 genotype data
solcap_snp_c1_10491 genotype data
solcap_snp_c1_10492 genotype data
solcap_snp_c1_10494 genotype data
solcap_snp_c1_10579 genotype data
solcap_snp_c1_10646 genotype data
solcap_snp_c1_10669 genotype data
solcap_snp_c1_10715 genotype data
solcap_snp_c1_10737 genotype data
solcap_snp_c1_10743 genotype data
solcap_snp_c1_10762 genotype data
solcap_snp_c1_10855 genotype data
solcap_snp_c1_10873 genotype data
solcap_snp_c1_10879 genotype data
solcap_snp_c1_10900 genotype data
solcap_snp_c1_10932 genotype data
solcap_snp_c1_1094 genotype data
solcap_snp_c1_11137 genotype data
solcap_snp_c1_11144 genotype data
solcap_snp_c1_11196 genotype data
solcap_snp_c1_11206 genotype data

Source

The example genotype data is a subset of data from the publically available Solcap potato dataset http://solcap.msu.edu/potato_infinium.shtml which was re-scored in GenomeStudio in diploid and tetraploid formats

potato.mini

Smaller example genotype input format

Description

A data frame containing Solcap potato genotype data in tetraploid and diploid format as an small example of the input format required by StAMPP

Usage

```
data(potato.mini)
```

Format

A data frame with 6 rows and 48 variables:

Sample Sample names

Pop Population name

Ploidy Ploidy level

Format Format of genotype data

solcap_snp_c1_1 genotype data

solcap_snp_c1_1000 genotype data

solcap_snp_c1_10000 genotype data

solcap_snp_c1_10001 genotype data

solcap_snp_c1_10011 genotype data

solcap_snp_c1_10012 genotype data

solcap_snp_c1_10031 genotype data

solcap_snp_c1_10042 genotype data

solcap_snp_c1_10050 genotype data

solcap_snp_c1_10054 genotype data

solcap_snp_c1_10109 genotype data

solcap_snp_c1_10130 genotype data

solcap_snp_c1_10157 genotype data

solcap_snp_c1_10202 genotype data

solcap_snp_c1_10252 genotype data

solcap_snp_c1_10253 genotype data

solcap_snp_c1_10255 genotype data

solcap_snp_c1_1029 genotype data

solcap_snp_c1_10295 genotype data

solcap_snp_c1_10297 genotype data

solcap_snp_c1_10351 genotype data
solcap_snp_c1_10384 genotype data
solcap_snp_c1_10397 genotype data
solcap_snp_c1_10457 genotype data
solcap_snp_c1_10491 genotype data
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solcap_snp_c1_10646 genotype data
solcap_snp_c1_10669 genotype data
solcap_snp_c1_10715 genotype data
solcap_snp_c1_10737 genotype data
solcap_snp_c1_10743 genotype data
solcap_snp_c1_10762 genotype data
solcap_snp_c1_10855 genotype data
solcap_snp_c1_10873 genotype data
solcap_snp_c1_10879 genotype data
solcap_snp_c1_10900 genotype data
solcap_snp_c1_10932 genotype data
solcap_snp_c1_1094 genotype data
solcap_snp_c1_11137 genotype data
solcap_snp_c1_11144 genotype data
solcap_snp_c1_11196 genotype data
solcap_snp_c1_11206 genotype data

Source

The example genotype data is a subset of data from the publically available Solcap potato dataset http://solcap.msu.edu/potato_infinium.shtml which was re-scored in GenomeStudio in diploid and tetraploid formats

stamp2genlight *Convert StAMPP genotype data to genlight object*

Description

Converts a StAMPP formatted allele frequency data frame generated from the stampConvert function to a genlight object for use in other packages

Usage

```
stamp2genlight(geno, pop = TRUE)
```

Arguments

geno	a data frame containing allele frequency data generated from stampConvert
pop	logical. True if population IDs are present in the StAMPP genotype data, False if population IDs are absent.

Details

StAMPP only exports to genlight objects as they are able to handle mixed ploidy datasets unlike genpop and genloci objects. The genlight object allows the intergration between StAMPP and other common R packages such as ADEGENET

Value

A object of class genlight which contains genotype data, individual IDs, population IDs (if present) and ploidy levels

Author(s)

Luke Pembleton <luke.pembleton at agriculture.vic.gov.au>

Examples

```
# import genotype data and convert to allele frequencies
data(potato.mini, package="StAMPP")
potato.freq <- stampConvert(potato.mini, "r")
# Convert the StAMPP formatted allele frequency data frame to a genlight object
potato.genlight <- stamp2genlight(potato.freq, TRUE)
```

Description

Calculates an AMOVA based on the genetic distance matrix from `stamppNeisD()` using the `amova()` function from the package PEGAS for exploring within and between population variation

Usage

```
stamppAmova(dist.mat, geno, perm = 100)
```

Arguments

<code>dist.mat</code>	the matrix of genetic distances between individuals generated from <code>stamppNeisD()</code>
<code>geno</code>	a data frame containing allele frequency data generated from <code>stamppConvert</code> , or a <code>genlight</code> object containing genotype data, individual IDs, population IDs and ploidy levels
<code>perm</code>	the number of permutations for the tests of hypotheses

Details

Uses the formula `distance ~ populations`, to calculate an AMOVA for population differentiation and within & between population variation. This function uses the `amova` function from the PEGAS package.

Value

An object of class "amova" which is a list containing a table of sum of square deviations (SSD), mean square deviations (MSD) and the number of degrees of freedom as well as the variance components

Author(s)

Luke Pembleton <luke.pembleton at agriculture.vic.gov.au>

References

Paradis E (2010) `pegas`: an R package for population genetics with an integrated-modular approach. *Bioinformatics* 26, 419-420. <doi:10.1093/bioinformatics/btp696>

Examples

```
# import genotype data and convert to allele frequencies
data(potato.mini, package="StAMPP")
potato.freq <- stampConvert(potato.mini, "r")
# Calculate genetic distance between individuals
potato.D.ind <- stampNeisD(potato.freq, FALSE)
# Calculate AMOVA
stampAmova(potato.D.ind, potato.freq, 100)
```

stampConvert	<i>Import and Convert</i>
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Description

Imports biallelic AB formatted or allele A frequency genotype data. If the data is imported in biallelic AB format this function also converts it to allele frequencies

Usage

```
stampConvert(genotype.file, type = "csv")
```

Arguments

`genotype.file` the genotype input file. This should be a R matrix object or a file path for a csv file containing the genotype data in either biallelic AB format or allele 'A' frequency format, or a genlight object containing genotype data

`type` the type of file the genotype data is being imported from; "csv" = comma separated file, "r" = data frame in the R workspace, "genlight" = genlight object.

Value

An object of class data.frame which contains allele frequency data for use in other StAMPP functions

Author(s)

Luke Pembleton <luke.pembleton at agriculture.vic.gov.au>

Examples

```
# Import example data into the R workspace
data(potato.mini, package="StAMPP")
# Convert to allele frequencies
potato.freq <- stampConvert(potato.mini, "r")
```

`stampFst`*Fst Computation*

Description

This function calculates pairwise Fst values along with confidence intervals and p-values between populations according to the method proposed by Wright(1949) and updated by Weir and Cockerham (1984)

Usage

```
stampFst(geno, nboots = 100, percent = 95, nclusters = 1)
```

Arguments

<code>geno</code>	a data frame containing allele frequency data generated from stampConvert, or a genlight object containing genotype data, individual IDs, population IDs and ploidy levels
<code>nboots</code>	number of bootstraps to perform across loci to generate confidence intervals and p-values
<code>percent</code>	the percentile to calculate the confidence interval around
<code>nclusters</code>	number of processor threads or cores to use during calculations.

Details

If possible, using multiple processing threads or cores is recommended to assist in calculating Fst values over a large number of bootstraps.

Value

An object list with the components: `Fstsa` matrix of pairwise Fst values between populations `Pvaluesa` matrix of p-values for each of the pairwise Fst values contained in the 'Fsts' matrix `Bootstrapsa` dataframe of each Fst value generated during Bootstrapping and the associated confidence intervals If `nboots`<2, no bootstrapping is performed and therefore only a matrix of Fst values is returned.

Author(s)

Luke Pembleton <luke.pembleton at agriculture.vic.gov.au>

References

Wright S (1949) The Genetical Structure of Populations. *Annals of Human Genetics* 15, 323-354. <doi:10.1111/j.1469-1809.1949.tb02451.x> Weir BS, Cockerham CC (1984) Estimating F Statistics for the ANalysis of Population Structure. *Evolution* 38, 1358-1370. <doi:10.2307/2408641>

Examples

```
# import genotype data and convert to allele frequencies
data(potato.mini, package="StAMPP")
potato.freq <- stampConvert(potato.mini, "r")
# Calculate pairwise Fst values between each population
potato.fst <- stampFst(potato.freq, 100, 95, 1)
```

stampGmatrix

Genomic Relationship Calculation

Description

This function calculates a genomic relationship matrix following the method described by Yang et al (2010)

Usage

```
stampGmatrix(geno)
```

Arguments

geno a data frame containing allele frequency data generated from stampConvert, or a genlight object containing genotype data, individual IDs, population IDs and ploidy levels

Value

An object of class matrix which contains the genomic relationship values between each individual

Author(s)

Luke Pembleton <luke.pembleton at agriculture.vic.gov.au>

References

Yang J, Benyamin B, McEvoy BP, et al (2010) Common SNPs explain a large proportion of the heritability for human height. Nat Genet 42, 565-569. <doi:10.1038/ng.608>

Examples

```
# import genotype data and convert to allele frequencies
data(potato.mini, package="StAMPP")
potato.freq <- stampConvert(potato.mini, "r")
# Calculate genomic relationship values between each individual
potato.fst <- stampGmatrix(potato.freq)
```

`stampNeisD`*Genetic Distance Calculation*

Description

This function calculates Nei's genetic distance (Nei 1972) between populations or individuals

Usage

```
stampNeisD(geno, pop = TRUE)
```

Arguments

<code>geno</code>	a data frame containing allele frequency data generated from <code>stampConvert</code> , or a <code>genlight</code> object containing genotype data, individual IDs, population IDs and ploidy levels
<code>pop</code>	logical. True if genetic distance should be calculated between populations, false if it should be calculated between individual

Value

A object of class `matrix` which contains the genetic distance between each population or individual

Author(s)

Luke Pembleton <luke.pembleton at agriculture.vic.gov.au>

References

Nei M (1972) Genetic Distance between Populations. *The American Naturalist* 106, 283-292.

Examples

```
# import genotype data and convert to allele frequencies
data(potato.mini, package="StAMPP")
potato.freq <- stampConvert(potato.mini, "r")
# Calculate genetic distance between individuals
potato.D.ind <- stampNeisD(potato.freq, FALSE)
# Calculate genetic distance between populations
potato.D.pop <- stampNeisD(potato.freq, TRUE)
```

`stampPhylyp`*Export to Phylip Format*

Description

Converts the genetic distance matrix generated with stampNeisD into Phylip format and exports it as a text file

Usage

```
stampPhylyp(distance.mat, file = "")
```

Arguments

<code>distance.mat</code>	the matrix containing the genetic distances generated from stampNeisD to be converted into Phylip format
<code>file</code>	the file path and name to save the Phylip format matrix as

Details

The exported Phylip formatted text file can be easily imported into software packages such as DARWin (Perrier & Jacquemound-Collet 2006) to be used to generate neighbour joining trees

Author(s)

Luke Pembleton <luke.pembleton at agriculture.vic.gov.au>

References

Perrier X, Jacquemound-Collet JP (2006) DARWin - Dissimilarity Analysis and Representation for Windows. Agricultural Research for Development

Examples

```
# import genotype data and convert to allele frequencies
data(potato.mini, package="StAMPP")
potato.freq <- stampConvert(potato.mini, "r")
# Calculate genetic distance between populations
potato.D.pop <- stampNeisD(potato.freq, TRUE)
# Export the genetic distance matrix in Phylip format
## Not run: stampPhylyp(potato.D.pop, file="potato_distance.txt")
```

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