# Package ‘ASAFE’

**Type** Package  
**Title** Ancestry Specific Allele Frequency Estimation  
**Version** 1.0.0  
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**Description** Given admixed individuals' bi-allelic SNP genotypes and ancestry pairs (where each ancestry can take one of three values) for multiple SNPs, perform an EM algorithm to deal with the fact that SNP genotypes are unphased with respect to ancestry pairs, in order to estimate ancestry-specific allele frequencies for all SNPs.  
**License** Artistic-2.0  
**biocViews** SNP, GenomeWideAssociation, LinkageDisequilibrium, BiomedicalInformatics, Genetics, ExperimentalDesign  
**LazyData** TRUE  
**Suggests** knitr, testthat  
**VignetteBuilder** knitr  
**NeedsCompilation** no  
**Depends** R (>= 3.2)  

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**adm_ancestries_test**

**Ancestries of 250 admixed individuals at 6 SNPs**

**Description**

This matrix `adm_ancestries_test` stores a subset of the full data set of simulated phased ancestries (meaning ancestries at different markers are phased with respect to each other) that was used in the ASAFE paper. `adm_ancestries_test` contains ancestries at 6 markers for 250 admixed individuals.

For each individual at a marker, the ancestry pair is also phased with respect to the genotype given in `adm_genotypes_test`, so that true ancestry-specific allele frequencies can be calculated from `adm_ancestries_test` and `adm_genotypes_test` by overlaying ancestries on genotypes. The ASAFE EM algorithm does not assume that ancestries and genotypes at the same marker are phased with respect to each other, or that ancestries at different markers are phased with respect to each other, or that genotypes at different markers are phased with respect to each other, and provides estimates of true ancestry-specific allele frequencies.

**Usage**

`adm_ancestries_test`

**Format**

A 6 x 501 matrix with the following rows, columns, and entries:

1. Rows: 1 row per bi-allelic marker
2. Columns: First column is Marker ID. Following columns consist of 1 column per chromosome, with two consecutive columns per individual, corresponding to the individual’s pair of homologous chromosomes. For example, the first 5 column names are Marker, ADM1, ADM1.1, ADM2, and ADM2.1. Columns ADM1 and ADM1.1 correspond to one individual’s 2 homologous chromosomes, and columns ADM2 and ADM2.1 correspond to another individual’s 2 homologous chromosomes.
3. Entries: For an entry that is not in the Marker ID column, an entry can take value 0, 1, or 2, which are arbitrary labels for three ancestries.

**Author(s)**

Qian Zhang

**Source**

Simulated ancestry data

**References**

**Description**

This matrix `adm_genotypes_test` stores a subset of the full data set of simulated phased genotypes (meaning genotypes at different markers are phased with respect to each other) that was used in the ASAFE paper. `adm_genotypes_test` contains genotypes at 6 markers for 250 admixed individuals.

For each individual at a marker, the genotype is also phased with respect to the ancestry pair given in `adm_ancestries_test`, so that true ancestry-specific allele frequencies can be calculated from `adm_genotypes_test` and `adm_ancestries_test` by overlaying ancestries on genotypes. The ASAFE EM algorithm does not assume that ancestries and genotypes at the same marker are phased with respect to each other, or that ancestries at different markers are phased with respect to each other, or that genotypes at different markers are phased with respect to each other, and provides estimates of true ancestry-specific allele frequencies.

**Usage**

`adm_genotypes_test`

**Format**

A 6 x 251 matrix with the following rows, columns, and entries:

1. Rows: 1 row per bi-allelic marker, with alleles arbitrarily labeled 0 and 1
2. Columns: First column is Marker ID. Following columns consist of 1 column per individual. Individuals should be listed in the same order in the genotype matrix `adm_genotypes_test` as in the ancestry matrix `adm_ancestries_test`.
3. Entries: For an entry that is not in the Marker ID column, an entry can take value 0/0, 0/1, 1/0, or 1/1, where 0 and 1 are arbitrary labels for a bi-allelic SNP’s two alleles. A slash “/” indicates an unphased genotype, so 0/1 and 1/0 are the same unphased genotype. It just so happens that this particular `adm_genotypes_test` matrix contains phased genotypes, despite the presence of slashes.

**Author(s)**

Qian Zhang

**Source**

Simulated genetic data

**References**

algorithm_1snp

Estimate ancestry-specific allele frequencies for 1 marker (e.g. a SNP) from individuals’ alleles and ancestries at this marker.

Description

Take in genotypes (possibly unphased with respect to each other) and ancestries (possibly unphased with respect to each other) for all individuals at 1 marker to create the marker’s vector of observed data category counts, and then call the function em() on that vector of counts, to obtain ancestry-specific allele frequency estimates for that marker.

Usage

algorithm_1snp(alleles_1, ancestries_1)

Arguments

alleles_1

Vector of alleles for each individual’s 2 chromosomes, with chromosomes for the same individual consecutive. Each allele is either 0 or 1. This is a numeric vector.

Example: If there are 250 admixed individuals, the alleles might be ordered like so: ADM1, ADM1, ADM2, ADM2, ..., ADM250, ADM250, where ADMi is the ID for the i-th individual.

ancestries_1

Vector of ancestries for each individual’s 2 chromosomes, with chromosomes for the same individual consecutive. Each ancestry is either 0, 1, or 2. This is a numeric vector.

Example: If there are 250 admixed individuals, the ancestries might be ordered like so: ADM1, ADM1, ADM2, ADM2, ..., ADM250, ADM250, where ADMi is the ID for the i-th individual.

Value

Ancestry-specific allele frequency estimates of [P(Allele 1 l Ancestry 0), P(Allele 1 l Ancestry 1), P(Allele 1 l Ancestry 2)] from the EM Algorithm. This a numeric vector with 3 entries.

Author(s)

Qian Zhang

Examples

# adm_ancestries_test is a matrix with # Rows: Markers # Columns: Marker ID, individuals' chromosomes' ancestries # (e.g. ADM1, ADM1, ADM2, ADM2, and etc.)

# adm_genotypes_test is a matrix with # Rows: Markers # Columns: Marker ID, individuals' genotypes (a1/a2) # (e.g. ADM1, ADM2, ADM3, and etc.)
algorithm_1snp_wrapper

Wrapper for function algorithm_1snp

Description
Applies the function algorithm_1snp to a particular bi-allelic marker’s data stored in matrices alleles and ancestries. Can be used to apply algorithm_1snp to multiple bi-allelic markers.

Usage
algorithm_1snp_wrapper(i, alleles, ancestries)

Arguments
i
Index of marker in matrices alleles and ancestries. This is the index for the marker that we want to apply function algorithm_1snp to.

alleles
Rows: Alleles for individuals’ chromosomes ordered e.g. ADM1, ADM1, ..., ADM250, ADM250, where ADMi is the ID for the i-th individual. Cols: Bi-allelic markers. Each allele is either 0 or 1. This is a numeric matrix.

ancestries
Rows: Ancestries for individuals’ chromosomes ordered e.g. ADM1, ADM1, ..., ADM250, ADM250, where ADMi is the ID for the i-th individual. Cols: Bi-allelic markers. Each ancestry is either 0, 1, or 2. This is a numeric matrix.
algorithm_1snp_wrapper

Details

Markers in matrix alleles should be in 1-to-1 correspondence with markers in matrix ancestries. Markers in both matrices should be in the same order.

Value

A character vector with 4 elements. The first element is the Marker ID of the i-th marker in matrices alleles and ancestries. The next 3 elements are ancestry-specific allele frequency estimates of P(Allele 1 | Ancestry 0), P(Allele 1 | Ancestry 1), and P(Allele 1 | Ancestry 2), for the i-th marker in matrices alleles and ancestries.

Author(s)

Qian Zhang

Examples

```r
# adm_ancestries_test is a matrix with
# Rows: Markers
# Columns: Marker ID, individuals' chromosomes' ancestries
# (e.g. ADM1, ADM1, ADM2, ADM2, and etc.)

# adm_genotypes_test is a matrix with
# Rows: Markers
# Columns: Marker ID, individuals' genotypes (a1/a2)
# (e.g. ADM1, ADM2, ADM3, and etc.)

# Making the rsID column row names
row.names(adm_ancestries_test) <- adm_ancestries_test[,1]
row.names(adm_genotypes_test) <- adm_genotypes_test[,1]

adm_ancestries_test <- adm_ancestries_test[, -1]
adm_genotypes_test <- adm_genotypes_test[, -1]

# alleles_list is a list of lists.
# Outer list elements correspond to bi-allelic markers.
# Inner list elements correspond to 250 people's alleles with no delimiter separating alleles.
alleles_list <- apply(X = adm_genotypes_test, MARGIN = 1, FUN = strsplit, split = "/")

# Creates a matrix: Number of alleles (ADM1, ADM1, ..., ADM250, ADM250) x (bi-allelic markers)
alleles_unlisted <- sapply(alleles_list, unlist)
alleles <- apply(X = alleles_unlisted, MARGIN = 2, as.numeric)

# Apply EM algorithm to first bi-allelic marker
algorithm_1snp_wrapper(i = 1, alleles, adm_ancestries_test)

# Apply the EM algorithm to each bi-allelic marker to obtain
# ancestry-specific allele frequency estimates for all markers in
# matrices alleles and ancestries.
adm_estimates_test <- sapply(X = 1:ncol(alleles), FUN = algorithm_1snp_wrapper,
                            alleles = alleles, ancestries = adm_ancestries_test)
```
algorithm_1snp_wrapper

adm_estimates_test
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