

# Package ‘malan’

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**Type** Package

**Title** MAle Lineage ANalysis

**Version** 1.0.4

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**Description** MAle Lineage ANalysis by simulating genealogies backwards and imposing short tandem repeats (STR) mutations forwards. Intended for forensic Y chromosomal STR (Y-STR) haplotype analyses. Numerous analyses are possible, e.g. number of matches and meiotic distance to matches. Refer to papers mentioned in citation(`malan`) (DOI's: <doi:10.1371/journal.pgen.1007028>, <doi:10.21105/joss.00684> and <doi:10.1016/j.fsigen.2018.10.004>).

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**Imports** Rcpp (>= 0.12.7), RcppProgress (>= 0.2.1), RcppArmadillo (>= 0.9.880.1.0), igraph (>= 1.0.1), tibble (>= 1.1), magrittr (>= 1.5), methods

**Depends** R (>= 3.6), dplyr (>= 0.7.3), tidygraph (>= 1.0.0.9999)

**LinkingTo** Rcpp, RcppArmadillo, RcppProgress

**Suggests** knitr, rmarkdown, testthat, ggraph, dirmult, Rmpfr

**BugReports** <https://github.com/mikldk/malan/issues>

**URL** <https://mikldk.github.io/malan/>

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malan-package	<i>MAle Lineage ANalysis</i>
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---

## Description

Simulating genealogies backwards and imposing STR mutations forwards.

## Details

See vignettes and manual for documentation.

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## Author(s)

**Maintainer:** Mikkel Meyer Andersen <mikl@math.aau.dk>

## References

Andersen MM, Balding DJ (2017) How convincing is a matching Y-chromosome profile? PLoS Genet 13(11): e1007028. doi:10.1371/journal.pgen.1007028.

## See Also

Useful links:

- <https://mikldk.github.io/malan/>
- Report bugs at <https://github.com/mikldk/malan/issues>

---

`analyse_mixture_result`*Analyse mixture results*

---

**Description**

Calculate LR-like quantities by haplotype counts.

**Usage**

```
analyse_mixture_result(  
  mix_res,  
  unique_haps_in_mixture,  
  unique_haps_in_mixture_counts  
)
```

**Arguments**

`mix_res` Mixture result from [mixture\\_info\\_by\\_individuals\\_2pers\(\)](#), [mixture\\_info\\_by\\_individuals\\_3pers\(\)](#), [mixture\\_info\\_by\\_individuals\\_4pers\(\)](#), [mixture\\_info\\_by\\_individuals\\_5pers\(\)](#)

`unique_haps_in_mixture` Included unique haplotypes to use as elements in contributor sets.

`unique_haps_in_mixture_counts` Population counts of the included haplotypes

**Details**

NOTE: Only takes up to 9 contributors!

**Value**

A list with numeric quantities

---

`analyse_mixture_results`*Analyse mixture results in a vectorised fashion*

---

**Description**

Refer to [analyse\\_mixture\\_result\(\)](#) for details. Essentially, [analyse\\_mixture\\_result\(\)](#) is run on each element of `mixture_results`.

**Usage**

```
analyse_mixture_results(
  mixture_results,
  unique_haps_in_mixture_list,
  unique_haps_in_mixture_counts_list
)
```

**Arguments**

`mixture_results`  
List of n mixture results from `mixture_info_by_individuals_2pers()`, `mixture_info_by_individuals_3pers()`, `mixture_info_by_individuals_4pers()`, `mixture_info_by_individuals_5pers()`

`unique_haps_in_mixture_list`  
List of n included unique haplotypes, one for each element in `mix_res`

`unique_haps_in_mixture_counts_list`  
List of n population counts of the included unique haplotypes

**Details**

NOTE: Only takes up to 9 contributors!

**Value**

A list with lists of numeric quantities

---

`as_tbl_graph.malan_pedigreelist`  
*Get tidy graph object*

---

**Description**

Get tidy graph object `tidygraph::tbl_graph()`, e.g. to plot with `ggraph()`.

**Usage**

```
## S3 method for class 'malan_pedigreelist'
as_tbl_graph(x, ...)
```

**Arguments**

`x` malan\_pedigreelist  
`...` Ignored

**Value**

`tidygraph::tbl_graph()` object

---

brothers_matching	<i>Number of brothers with matching haplotype</i>
-------------------	---

---

**Description**

Get individual's number of brothers that matches individual's haplotype

**Usage**

```
brothers_matching(individual)
```

**Arguments**

individual	individual
------------	------------

**Value**

Number of brothers that matches individual's haplotype

---

build_haplotype_hashmap	<i>Build hashmap of haplotype to individuals</i>
-------------------------	--

---

**Description**

Makes it possible to find all individuals' pid with a certain haplotype. Must be used with e.g. [get\\_matching\\_pids\\_from\\_hashmap\(\)](#).

**Usage**

```
build_haplotype_hashmap(individuals, progress = TRUE)
```

**Arguments**

individuals	List of individuals to build hashmap of
progress	Show progress?

**Value**

External pointer to hashmap with haplotype as keys and vector of individuals' pid as value

**See Also**

[get\\_matching\\_pids\\_from\\_hashmap\(\)](#).

---

build_pedigrees	<i>Build pedigrees from (individuals in) a population.</i>
-----------------	--

---

### Description

In a newly simulated population, each individual only knows its father and children. Using this information, this function builds pedigrees. This makes it easier to e.g. population haplotypes, find path between two individuals (if they are not in the same pedigree, they are not connected).

### Usage

```
build_pedigrees(population, progress = TRUE)
```

### Arguments

population	Population generated by <a href="#">sample_geneology()</a> or <a href="#">sample_geneology_varying_size()</a> .
progress	Show progress.

### Value

An object with class malan\_pedigreelist (an internal list of external pointers to pedigrees).

### See Also

[sample\\_geneology\(\)](#) and [sample\\_geneology\\_varying\\_size\(\)](#) for simulating populations.

### Examples

```
sim <- sample_geneology(100, 10)
str(sim, 1)
sim$population
peds <- build_pedigrees(sim$population)
peds
```

---

calc_autosomal_genotype_conditional_cumdist	<i>Calculate conditional genotype cumulative probabilities with theta</i>
---	---

---

### Description

Calculate conditional genotype cumulative probabilities with theta

### Usage

```
calc_autosomal_genotype_conditional_cumdist(allele_dist, theta)
```

**Arguments**

allele\_dist Allele distribution (probabilities) – gets normalised  
theta Theta correction between 0 and 1 (both included)

**Value**

Matrix: row i: conditional cumulative distribution of alleles given allele i

---

calc\_autosomal\_genotype\_probs  
*Calculate genotype probabilities with theta*

---

**Description**

Calculate genotype probabilities with theta

**Usage**

calc\_autosomal\_genotype\_probs(allele\_dist, theta)

**Arguments**

allele\_dist Allele distribution (probabilities) – gets normalised  
theta Theta correction between 0 and 1 (both included)

---

construct\_M *Construct M matrix*

---

**Description**

Construct M matrix

**Usage**

construct\_M(meioses, mu\_dw, mu\_up)

**Arguments**

meioses number of meioses separating the two individuals  
mu\_dw mutation rate for 1-step down-mutation  
mu\_up mutation rate for 1-step up-mutation

count\_brothers      *Number of brothers*

---

**Description**

Get individual's number of brothers

**Usage**

```
count_brothers(individual)
```

**Arguments**

individual      individual

**Value**

Number of brothers

**See Also**

[get\\_brothers\(\)](#)

---

count\_haplotype\_near\_matches\_individuals  
*Count near haplotype matches in list of individuals*

---

**Description**

Counts the number of types close to haplotype in individuals.

**Usage**

```
count_haplotype_near_matches_individuals(individuals, haplotype, max_dist)
```

**Arguments**

individuals      List of individuals to count occurrences in.  
haplotype      Haplotype to count near-matches occurrences of.  
max\_dist      Maximum distance (0 = match, 1 = 1 STR allele difference, ...)

**Value**

Number of times that a haplotype within a radius of max\_dist of haplotype occurred amongst individuals.

**See Also**

[count\\_haplotype\\_occurrences\\_individuals\(\)](#), [pedigree\\_haplotype\\_matches\\_in\\_pedigree\\_meiosis\\_L1\\_dists\(\)](#)

---

count\_haplotype\_occurrences\_individuals  
*Count haplotypes occurrences in list of individuals*

---

**Description**

Counts the number of types haplotype appears in individuals.

**Usage**

```
count_haplotype_occurrences_individuals(individuals, haplotype)
```

**Arguments**

individuals     List of individuals to count occurrences in.  
haplotype       Haplotype to count occurrences of.

**Value**

Number of times that haplotype occurred amongst individuals.

**See Also**

[pedigree\\_haplotype\\_matches\\_in\\_pedigree\\_meiosis\\_L1\\_dists\(\)](#), [count\\_haplotype\\_near\\_matches\\_individuals\(\)](#)

**Examples**

```
sim <- sample_geneology(100, 10)  
peds <- build_pedigrees(sim$population)  
pedigrees_all_populate_haplotypes(peds, 2, c(0, 0))  
count_haplotype_occurrences_individuals(sim$end_generation_individuals, c(0, 0))
```

---

count\_haplotype\_occurrences\_pedigree  
*Count haplotypes occurrences in pedigree*

---

**Description**

Counts the number of types haplotype appears in pedigree.

**Usage**

```
count_haplotype_occurrences_pedigree(  
  pedigree,  
  haplotype,  
  generation_upper_bound_in_result = -1L  
)
```

**Arguments**

pedigree            Pedigree to count occurrences in.  
haplotype           Haplotype to count occurrences of.  
generation\_upper\_bound\_in\_result  
                    Only consider matches in generation 0, 1, ... generation\_upper\_bound\_in\_result.  
                    -1 means disabled, consider all generations. End generation is generation 0.  
                    Second last generation is 1. And so on.

**Value**

Number of times that haplotype occurred in pedigree.

**See Also**

[pedigree\\_haplotype\\_matches\\_in\\_pedigree\\_meiosis\\_L1\\_dists\(\)](#).

---

count\_uncles            *Number of uncles*

---

**Description**

Get individual's number of uncles

**Usage**

```
count_uncles(individual)
```

**Arguments**

individual      individual

**Value**

Number of uncles

**See Also**

[get\\_uncles\(\)](#)

---

*delete\_haplotypeids\_hashmap*  
*Delete haplotype hashmap*

---

**Description**

Delete hashmap made by [build\\_haplotype\\_hashmap\(\)](#).

**Usage**

```
delete_haplotypeids_hashmap(hashmap)
```

**Arguments**

hashmap      Hashmap made by [build\\_haplotype\\_hashmap\(\)](#)

**See Also**

[get\\_matching\\_pids\\_from\\_hashmap\(\)](#) and [build\\_haplotype\\_hashmap\(\)](#).

---

*estimate\_autotheta\_1subpop\_genotypes*  
*Estimate autosomal theta from genotypes*

---

**Description**

Estimate autosomal theta for one subpopulation given a sample of genotypes.

**Usage**

```
estimate_autotheta_1subpop_genotypes(genotypes, return_estimation_info = FALSE)
```

**Arguments**

genotypes        Matrix of genotypes: two columns (allele1 and allele2) and a row per individual  
 return\_estimation\_info        Whether to return the quantities used to estimate theta

**Details**

Assumes that [pedigrees\\_all\\_populate\\_autosomal\(\)](#) was used first to populate autosomal genotypes.

**Value**

List:

- theta
  - estimate: Vector of length 1 containing estimate of theta or NA if it could not be estimated
  - error: true if an error happened, false otherwise
  - details: contains description if an error happened
  - estimation\_info: If return\_estimation\_info = true: a list with information used to estimate theta. Else NULL.

---

estimate\_autotheta\_1subpop\_individuals

*Estimate autosomal theta from individuals*

---

**Description**

Estimate autosomal theta for one subpopulation given a list of individuals.

**Usage**

```
estimate_autotheta_1subpop_individuals(
  individuals,
  return_estimation_info = FALSE
)
```

**Arguments**

individuals        Individuals to get haplotypes for.  
 return\_estimation\_info        Whether to return the quantities used to estimate theta

**Details**

Assumes that [pedigrees\\_all\\_populate\\_autosomal\(\)](#) was used first to populate autosomal genotypes.

**Value**

List:

- theta
  - estimate: Vector of length 1 containing estimate of theta or NA if it could not be estimated
  - error: true if an error happened, false otherwise
  - details: contains description if an error happened
  - estimation\_info: If return\_estimation\_info = true: a list with information used to estimate theta. Else NULL.

---

estimate\_automtheta\_subpops\_genotypes

*Estimate autosomal F, theta, and f from subpopulations of genotypes*

---

**Description**

Estimates autosomal F, theta, and f for a number of subpopulations given a list of genotypes.

**Usage**

```
estimate_automtheta_subpops_genotypes(subpops, subpops_sizes)
```

**Arguments**

subpops            List of subpopulations, each a list of individuals  
subpops\_sizes    Size of each subpopulation

**Details**

Assumes that [pedigrees\\_all\\_populate\\_autosomal\(\)](#) was used first to populate autosomal genotypes.

Based on Bruce S Weir, Genetic Data Analysis 2, 1996. (GDA2).

**Value**

Estimates of autosomal F, theta, and f as well as additional information

---

```
estimate_autotheta_subpops_individuals
```

*Estimate autosomal F, theta, and f from subpopulations of individuals*

---

### Description

Estimates autosomal F, theta, and f for a number of subpopulations given a list of individuals.

### Usage

```
estimate_autotheta_subpops_individuals(subpops, subpops_sizes)
```

### Arguments

subpops	List of subpopulations, each a list of individuals
subpops_sizes	Size of each subpopulation

### Details

Assumes that [pedigrees\\_all\\_populate\\_autosomal\(\)](#) was used first to populate autosomal genotypes.

Based on Bruce S Weir, Genetic Data Analysis 2, 1996. (GDA2).

### Value

Estimates of autosomal F, theta, and f as well as additional information

---

```
estimate_autotheta_subpops_pids
```

*Estimate autosomal F, theta, and f from subpopulations of individual ids*

---

### Description

Estimates autosomal F, theta, and f for a number of subpopulations given a list of pids (individual ids).

### Usage

```
estimate_autotheta_subpops_pids(population, subpops, subpops_sizes)
```

### Arguments

population	Population obtain from simulation
subpops	List of individual pids
subpops_sizes	Size of each subpopulation

**Details**

Assumes that `pedigrees_all_populate_autosomal()` was used first to populate autosomal genotypes.

Based on Bruce S Weir, Genetic Data Analysis 2, 1996. (GDA2).

**Value**

Estimates of autosomal F, theta, and f as well as additional information

---

estimate\_autotheta\_subpops\_unweighted\_genotypes

*Unweighted estimate of autosomal theta from subpopulations of genotypes*

---

**Description**

Estimates unweighted autosomal theta for a number of subpopulations given a list of subpopulations of genotypes.

**Usage**

```
estimate_autotheta_subpops_unweighted_genotypes(subpops, assume_HWE)
```

**Arguments**

subpops	List of individual genotypes
assume_HWE	if the alleles themselves are used instead of genotypes

**Details**

Assumes that `pedigrees_all_populate_autosomal()` was used first to populate autosomal genotypes.

Based on Weir and Goudet, Genetics 2017: <http://www.genetics.org/content/early/2017/05/26/genetics.116.198424>

**Value**

Estimate of autosomal theta

---

estimate\_autotheta\_subpops\_unweighted\_pids

*Unweighted estimate of autosomal theta from subpopulations of individual ids*

---

### Description

Estimates unweighted autosomal theta for a number of subpopulations given a list of pids (individual ids).

### Usage

```
estimate_autotheta_subpops_unweighted_pids(population, subpops, assume_HWE)
```

### Arguments

population	Population obtain from simulation
subpops	List of individual pids
assume_HWE	if the alleles themselves are used instead of genotypes

### Details

Assumes that [pedigrees\\_all\\_populate\\_autosomal\(\)](#) was used first to populate autosomal genotypes.

Based on Weir and Goudet, Genetics 2017: <http://www.genetics.org/content/early/2017/05/26/genetics.116.198424>

### Value

Estimate of autosomal theta

---

father_matches	<i>Father matches</i>
----------------	-----------------------

---

### Description

Does the father have the same profile as individual?

### Usage

```
father_matches(individual)
```

### Arguments

individual	individual
------------	------------

### Value

Whether father has the same profile as individual or not

---

from_igraph	<i>Convert igraph to population</i>
-------------	-------------------------------------

---

**Description**

Convert igraph to population

**Usage**

```
from_igraph(x, ...)
```

**Arguments**

x	igraph, must be a forest of directed trees with unique positive integer names (as they will be pid's)
...	Ignored

**Value**

A population

**Examples**

```
g <- igraph::graph_from_literal( 2 +- 1 -- 3, 4 -- 5 )
plot(g)
pop <- from_igraph(g)
peds <- build_pedigrees(pop, progress = FALSE)
plot(peds)
infer_generations(peds)
get_generation(get_individual(pop, 1))
get_generation(get_individual(pop, 2))
get_generation(get_individual(pop, 3))
get_generation(get_individual(pop, 4))
get_generation(get_individual(pop, 5))
```

---

from_igraph_rcpp	<i>Generate paternal brothers population</i>
------------------	--

---

**Description**

Generate paternal brothers population

**Usage**

```
from_igraph_rcpp(vertices, edges)
```

**Arguments**

vertices	vector of vertices
edges	matrix with edges

**Value**

An external pointer to the population.

---

```
generate_get_founder_haplotype_db
```

*Generate a function to simulate pedigree founder haplotype based on a haplotype databasep*

---

**Description**

Generate a function to simulate pedigree founder haplotype based on a haplotype databasep

**Usage**

```
generate_get_founder_haplotype_db(db)
```

**Arguments**

db	data frame or matrix with haplotypes from which the founder is randomly simulated
----	---

---

```
generate_get_founder_haplotype_ladder
```

*Generate a function to simulate pedigree founder haplotype based on ladder information*

---

**Description**

Generate a function to simulate pedigree founder haplotype based on ladder information

**Usage**

```
generate_get_founder_haplotype_ladder(ladder_min, ladder_max)
```

**Arguments**

ladder_min	vector of minimum alleles; ladder_min[i] is the minimum allele at locus i
ladder_max	vector of minimum alleles; ladder_max[i] is the maximum allele at locus i

---

`get_allele_counts_genotypes`*Get autosomal allele counts from subpopulations of genotypes*

---

**Description**

Assumes that `pedigrees_all_populate_autosomal()` was used first to populate autosomal genotypes.

**Usage**

```
get_allele_counts_genotypes(subpops)
```

**Arguments**

subpops            List of individual genotypes

**Value**

Matrix with allele counts

---

`get_allele_counts_pids`*Get autosomal allele counts from subpopulations given by pids*

---

**Description**

Assumes that `pedigrees_all_populate_autosomal()` was used first to populate autosomal genotypes.

**Usage**

```
get_allele_counts_pids(population, subpops)
```

**Arguments**

population        Population obtain from simulation  
subpops            List of individual pids

**Value**

Matrix with allele counts

---

get_brothers	<i>Get brothers</i>
--------------	---------------------

---

**Description**

Get individual's brothers

**Usage**

```
get_brothers(individual)
```

**Arguments**

individual      individual

**Value**

List with brothers

**See Also**

[get\\_father\(\)](#), [get\\_uncles\(\)](#), [get\\_children\(\)](#), [get\\_cousins\(\)](#)

---

get_children	<i>Get children</i>
--------------	---------------------

---

**Description**

Get individual's children

**Usage**

```
get_children(individual)
```

**Arguments**

individual      individual

**Value**

List with children

**See Also**

[get\\_father\(\)](#), [get\\_brothers\(\)](#), [get\\_uncles\(\)](#), [get\\_cousins\(\)](#)

---

get_cousins	<i>Get cousins</i>
-------------	--------------------

---

**Description**

Get individual's cousins

**Usage**

```
get_cousins(individual)
```

**Arguments**

individual      individual

**Value**

List with cousins

**See Also**

[get\\_brothers\(\)](#), [get\\_uncles\(\)](#), [get\\_children\(\)](#)

---

get_family_info	<i>Get individual's family information</i>
-----------------	--

---

**Description**

Get individual's family information

**Usage**

```
get_family_info(individual)
```

**Arguments**

individual      individual

**Value**

List with family information

---

get_father	<i>Get father</i>
------------	-------------------

---

**Description**

Get individual's father

**Usage**

```
get_father(individual)
```

**Arguments**

individual      individual

**Value**

Father

**See Also**

[get\\_brothers\(\)](#), [get\\_uncles\(\)](#), [get\\_children\(\)](#), [get\\_cousins\(\)](#)

---

get_generation	<i>Get individual's generation number</i>
----------------	---

---

**Description**

Note that generation 0 is final, end generation. 1 is second last generation etc.

**Usage**

```
get_generation(individual)
```

**Arguments**

individual      Individual

**Value**

generation

**Examples**

```
sim <- sample_geneology(100, 10)
indv <- get_individual(sim$population, 1)
get_generation(indv)
```

---

get_haplotype	<i>Get haplotype from an individual</i>
---------------	---

---

**Description**

Requires that haplotypes are first populated, e.g. with [pedigrees\\_all\\_populate\\_haplotypes\(\)](#), [pedigrees\\_all\\_populate\\_haplotypes\\_custom\\_founders\(\)](#), or [pedigrees\\_all\\_populate\\_haplotypes\\_ladder\\_bound](#)

**Usage**

```
get_haplotype(individual)
```

**Arguments**

individual      Individual to get haplotypes for.

**Value**

Haplotype for individual.

**See Also**

[get\\_haplotypes\\_individuals\(\)](#) and [get\\_haplotypes\\_pids\(\)](#).

**Examples**

```
sim <- sample_geneology(100, 10)
peds <- build_pedigrees(sim$population)
pedigrees_all_populate_haplotypes(peds, 2, c(1, 1))
get_haplotype(sim$end_generation_individuals[[1]])
```

---

get_haplotypes_individuals	<i>Get haplotype matrix from list of individuals</i>
----------------------------	--

---

**Description**

Requires that haplotypes are first populated, e.g. with [pedigrees\\_all\\_populate\\_haplotypes\(\)](#), [pedigrees\\_all\\_populate\\_haplotypes\\_custom\\_founders\(\)](#), or [pedigrees\\_all\\_populate\\_haplotypes\\_ladder\\_bound](#)

**Usage**

```
get_haplotypes_individuals(individuals)
```

**Arguments**

individuals      Individuals to get haplotypes for.

**Value**

Matrix of haplotypes where row *i* is the haplotype of individuals[[*i*]].

**See Also**

[get\\_haplotypes\\_pids\(\)](#).

**Examples**

```
sim <- sample_geneology(100, 10)
peds <- build_pedigrees(sim$population)
pedigrees_all_populate_haplotypes(peds, 2, c(1, 1))
get_haplotypes_individuals(sim$end_generation_individuals)
```

---

get\_haplotypes\_in\_pedigree

*Get haplotypes in pedigree*

---

**Description**

Get haplotypes in pedigree

**Usage**

```
get_haplotypes_in_pedigree(ped)
```

**Arguments**

ped                      Pedigree

**Value**

List with haplotypes

**Examples**

```
sim <- sample_geneology(100, 10)
peds <- build_pedigrees(sim$population)
pedigrees_all_populate_haplotypes(peds, 2, c(1, 1))
get_haplotypes_in_pedigree(peds[[1]])
```

---

get\_haplotypes\_pids     *Get haplotypes from a vector of pids.*

---

**Description**

Requires that haplotypes are first populated, e.g. with [pedigrees\\_all\\_populate\\_haplotypes\(\)](#), [pedigrees\\_all\\_populate\\_haplotypes\\_custom\\_founders\(\)](#), or [pedigrees\\_all\\_populate\\_haplotypes\\_ladder\\_boundaries\(\)](#).

**Usage**

```
get_haplotypes_pids(population, pids)
```

**Arguments**

population	Population
pids	Vector of pids to get haplotypes for.

**Value**

Matrix of haplotypes where row *i* is the haplotype of individuals[[*i*]].

**See Also**

[get\\_haplotypes\\_individuals\(\)](#).

---

get\_individual     *Get individual by pid*

---

**Description**

Get individual by pid

**Usage**

```
get_individual(population, pid)
```

**Arguments**

population	Population
pid	pid

**Value**

Individual

**Examples**

```
sim <- sample_geneology(100, 10)
indv <- get_individual(sim$population, 1)
get_pid(indv)
```

---

<code>get_individuals</code>	<i>Get all individuals in population</i>
------------------------------	--

---

**Description**

Get all individuals in population

**Usage**

```
get_individuals(population)
```

**Arguments**

<code>population</code>	Population
-------------------------	------------

---

<code>get_matching_pids_from_hashmap</code>	<i>Get individuals with a certain haplotype id by hashmap lookup</i>
---	--

---

**Description**

By using hashmap made by [build\\_haplotype\\_hashmap\(\)](#), it is easy to get all individuals with a certain haplotype id.

**Usage**

```
get_matching_pids_from_hashmap(hashmap, haplotype)
```

**Arguments**

<code>hashmap</code>	Hashmap to make lookup in, made by <a href="#">build_haplotype_hashmap()</a>
<code>haplotype</code>	to get individuals that has this haplotype id

**Value**

List of individuals with a given haplotype id

**See Also**

[build\\_haplotype\\_hashmap\(\)](#).

---

get_nodes_edges	<i>Get nodes and edges</i>
-----------------	----------------------------

---

**Description**

Get nodes and edges in malan\_pedigreelist. For example to plot via `tidygraph::as_tbl_graph()`.

**Usage**

```
get_nodes_edges(x, ...)
```

**Arguments**

x	malan_pedigreelist
...	Ignored

**Value**

List with entries nodes and edges

---

get_pedigrees_tidy	<i>Get pedigrees information in tidy format</i>
--------------------	---

---

**Description**

Get pedigrees information in tidy format

**Usage**

```
get_pedigrees_tidy(pedigrees)
```

**Arguments**

pedigrees	Pedigrees
-----------	-----------

---

`get_pedigree_as_graph` *Get pedigree information as graph (mainly intended for plotting)*

---

**Description**

Get pedigree information as graph (mainly intended for plotting)

**Usage**

```
get_pedigree_as_graph(ped)
```

**Arguments**

<code>ped</code>	Pedigree
------------------	----------

---

`get_pedigree_from_individual`  
*Get pedigree from individual*

---

**Description**

Get pedigree from individual

**Usage**

```
get_pedigree_from_individual(individual)
```

**Arguments**

<code>individual</code>	Individual
-------------------------	------------

**Value**

pedigree

---

*get\_pedigree\_id*      *Get pedigree id*

---

**Description**

Get pedigree id

**Usage**

```
get_pedigree_id(ped)
```

**Arguments**

ped                  Pedigree

**Examples**

```
sim <- sample_geneology(100, 10)
peds <- build_pedigrees(sim$population)
get_pedigree_id(peds[[1]])
```

---

*get\_pedigree\_id\_from\_pid*  
*Get pedigree ids from pids*

---

**Description**

Get pedigree ids from pids

**Usage**

```
get_pedigree_id_from_pid(population, pids)
```

**Arguments**

population      Population  
pids             Pids

**Value**

Vector with pedigree ids

---

get_pid	<i>Get pid from individual</i>
---------	--------------------------------

---

**Description**

Get pid from individual

**Usage**

```
get_pid(individual)
```

**Arguments**

individual      Individual to get pid of

**Value**

pid

**Examples**

```
sim <- sample_geneology(100, 10)
indv <- get_individual(sim$population, 1)
get_pid(indv)
```

---

get_pids_in_pedigree	<i>Get pids in pedigree</i>
----------------------	-----------------------------

---

**Description**

Get pids in pedigree

**Usage**

```
get_pids_in_pedigree(ped)
```

**Arguments**

ped              Pedigree

**Examples**

```
sim <- sample_geneology(100, 10)
peds <- build_pedigrees(sim$population)
get_pids_in_pedigree(peds[[1]])
```

---

`get_uncles`*Get uncles*

---

**Description**

Get individual's uncles

**Usage**

```
get_uncles(individual)
```

**Arguments**

individual      individual

**Value**

List with uncles

**See Also**

[get\\_brothers\(\)](#), [get\\_children\(\)](#), [get\\_cousins\(\)](#)

---

`get_zero_haplotype_generator`*Generate a function to generate the zero haplotype*

---

**Description**

Generate a function to generate the zero haplotype

**Usage**

```
get_zero_haplotype_generator(loci)
```

**Arguments**

loci              Number of loci

---

grandfather\_matches    *Grandfather matches*

---

**Description**

Does the grandfather have the same profile as individual?

**Usage**

```
grandfather_matches(individual)
```

**Arguments**

individual    individual

**Value**

Whether grandfather has the same profile as individual or not

---

haplotypes\_to\_hashes    *Convert haplotypes to hashes (integers)*

---

**Description**

Individuals with the same haplotype will have the same hash (integer) and individuals with different haplotypes will have different hashes (integers).

**Usage**

```
haplotypes_to_hashes(population, pids)
```

**Arguments**

population    Population obtained from simulation  
pids    Vector of individual pids

**Details**

This can be useful if for example using haplotypes to define groups and the haplotype itself is not of interest.

**Value**

Integer vector with haplotype hashes

---

haplotype\_matches\_individuals  
*Get individuals matching from list of individuals*

---

**Description**

Get the individuals that matches haplotype in individuals.

**Usage**

```
haplotype_matches_individuals(individuals, haplotype)
```

**Arguments**

individuals     List of individuals to count occurrences in.  
haplotype       Haplotype to count occurrences of.

**Value**

List of individuals that matches haplotype amongst individuals.

**See Also**

[pedigree\\_haplotype\\_matches\\_in\\_pedigree\\_meiosis\\_L1\\_dists\(\)](#).

---

haplotype\_partially\_matches\_individuals  
*Get individuals partially matching from list of individuals*

---

**Description**

Get the individuals that partially matches haplotype in individuals.

**Usage**

```
haplotype_partially_matches_individuals(  
  individuals,  
  haplotype,  
  ignore_loci = as.integer(c())  
)
```

**Arguments**

individuals     List of individuals to count occurrences in.  
haplotype       Haplotype to count occurrences of.  
ignore\_loci     Vector of loci to ignore (1 = ignore first locus etc.)

**Value**

List of individuals that partially matches haplotype amongst individuals.

---

infer_generation	<i>Infer individual's generation number</i>
------------------	---

---

**Description**

Takes as input final generation, then moves up in pedigree and increments generation number.

**Usage**

```
infer_generation(final_generation)
```

**Arguments**

final_generation	Individuals in final generation
------------------	---------------------------------

**Details**

Note: Only works when all final generation individuals are provided.

---

infer_generations	<i>Infer generation numbers from pedigrees</i>
-------------------	--

---

**Description**

Infer generation numbers from pedigrees

**Usage**

```
infer_generations(peds)
```

**Arguments**

peds	Pedigrees infered by <a href="#">build_pedigrees()</a>
------	--

**Value**

Nothing

---

load_haplotypes	<i>Load haplotypes to individuals</i>
-----------------	---------------------------------------

---

**Description**

Note that individuals loaded this way does not have information about generation.

**Usage**

```
load_haplotypes(population, pid, haplotypes, progress = TRUE)
```

**Arguments**

population	of individuals
pid	ID of male
haplotypes	• row <i>i</i> has pid[ <i>i</i> ] ID
progress	Show progress.

---

load_individuals	<i>Construct a population from data</i>
------------------	---

---

**Description**

Note that individuals loaded this way does not have information about generation.

**Usage**

```
load_individuals(pid, pid_dad, progress = TRUE, error_on_pid_not_found = TRUE)
```

**Arguments**

pid	ID of male
pid_dad	ID of male's father, 0 if not known
progress	Show progress.
error_on_pid_not_found	Error if pid not found

---

```
meioses_generation_distribution
    Meiotic distribution
```

---

**Description**

Get the distribution of number of meioses from individual to all individuals in individual's pedigree. Note the `generation_upper_bound_in_result` parameter.

**Usage**

```
meioses_generation_distribution(
    individual,
    generation_upper_bound_in_result = -1L
)
```

**Arguments**

<code>individual</code>	Individual to calculate all meiotic distances from
<code>generation_upper_bound_in_result</code>	Limit on distribution; -1 means no limit. 0 is the final generation. 1 second last generation etc.

---

```
meiotic_dist    Meiotic distance between two individuals
```

---

**Description**

Get the number of meioses between two individuals. Note, that pedigrees must first have been inferred by `build_pedigrees()`.

**Usage**

```
meiotic_dist(ind1, ind2)
```

**Arguments**

<code>ind1</code>	Individual 1
<code>ind2</code>	Individual 2

**Value**

Number of meioses between `ind1` and `ind2` if they are in the same pedigree, else -1.

---

meiotic\_dist\_threshold *Meiotic distance between two individuals (with threshold)*

---

### Description

Get the number of meioses between two individuals. Note, that pedigrees must first have been inferred by `build_pedigrees()`.

### Usage

```
meiotic_dist_threshold(ind1, ind2, threshold)
```

### Arguments

ind1	Individual 1
ind2	Individual 2
threshold	Max search radius, if exceeding, return -1

### Value

Number of meioses between ind1 and ind2 if they are in the same pedigree, else -1.

---

meiotic\_radius *Meiotic radius*

---

### Description

Get all individual IDs within a meiotic radius. Note, that pedigrees must first have been inferred by `build_pedigrees()`.

### Usage

```
meiotic_radius(ind, radius)
```

### Arguments

ind	Individual
radius	Max radius

### Value

Matrix with ID and meiotic radius

mixture\_info\_by\_individuals\_2pers

*Mixture information about 2 persons' mixture of donor1 and donor2.*

---

**Description**

Mixture information about 2 persons' mixture of donor1 and donor2.

**Usage**

```
mixture_info_by_individuals_2pers(  
  individuals,  
  donor1,  
  donor2,  
  include_genealogy_info = TRUE  
)
```

**Arguments**

individuals	Individuals to consider as possible contributors and thereby get information from.
donor1	Contributor1/donor 1
donor2	Contributor2/donor 2
include_genealogy_info	Include information about meiotic distances and family info

**Value**

A list with mixture information about the mixture donor1+donor2+donor3 from individuals

**See Also**

[mixture\\_info\\_by\\_individuals\\_3pers](#), [mixture\\_info\\_by\\_individuals\\_4pers](#), [mixture\\_info\\_by\\_individuals\\_5pers](#)

---

mixture\_info\_by\_individuals\_3pers

*Mixture information about 3 persons' mixture of donor1, donor2 and donor3.*

---

**Description**

Mixture information about 3 persons' mixture of donor1, donor2 and donor3.

**Usage**

```
mixture_info_by_individuals_3pers(individuals, donor1, donor2, donor3)
```

**Arguments**

individuals	Individuals to consider as possible contributors and thereby get information from.
donor1	Contributor1/donor 1
donor2	Contributor2/donor 2
donor3	Contributor3/donor 3

**Value**

A list with mixture information about the mixture donor1+donor2+donor3 from individuals

**See Also**

[mixture\\_info\\_by\\_individuals\\_2pers](#), [mixture\\_info\\_by\\_individuals\\_4pers](#), [mixture\\_info\\_by\\_individuals\\_5pers](#)

---

mixture\_info\_by\_individuals\_4pers

*Mixture information about 4 persons' mixture of donor1, donor2, donor3 and donor4.*

---

**Description**

Mixture information about 4 persons' mixture of donor1, donor2, donor3 and donor4.

**Usage**

```
mixture_info_by_individuals_4pers(individuals, donor1, donor2, donor3, donor4)
```

**Arguments**

individuals	Individuals to consider as possible contributors and thereby get information from.
donor1	Contributor1/donor 1
donor2	Contributor2/donor 2
donor3	Contributor3/donor 3
donor4	Contributor4/donor 4

**Value**

A list with mixture information about the mixture donor1+donor2+donor3 from individuals

**See Also**

[mixture\\_info\\_by\\_individuals\\_2pers](#), [mixture\\_info\\_by\\_individuals\\_3pers](#), [mixture\\_info\\_by\\_individuals\\_5pers](#)

mixture\_info\_by\_individuals\_5pers

*Mixture information about 5 persons' mixture of donor1, donor2, donor3, donor4 and donor5.*

---

### **Description**

Mixture information about 5 persons' mixture of donor1, donor2, donor3, donor4 and donor5.

### **Usage**

```
mixture_info_by_individuals_5pers(  
  individuals,  
  donor1,  
  donor2,  
  donor3,  
  donor4,  
  donor5  
)
```

### **Arguments**

individuals	Individuals to consider as possible contributors and thereby get information from.
donor1	Contributor1/donor 1
donor2	Contributor2/donor 2
donor3	Contributor3/donor 3
donor4	Contributor4/donor 4
donor5	Contributor5/donor 5

### **Value**

A list with mixture information about the mixture donor1+donor2+donor3 from individuals

### **See Also**

[mixture\\_info\\_by\\_individuals\\_2pers](#), [mixture\\_info\\_by\\_individuals\\_3pers](#), [mixture\\_info\\_by\\_individuals\\_4pers](#)

---

`pedigrees_all_populate_autosomal`

*Populate 1-locus autosomal DNA profile in pedigrees with single-step mutation model.*

---

### Description

Populate 1-locus autosomal DNA profile from founder and down in all pedigrees. Note, that only alleles from ladder is assigned and that all founders draw type randomly.

### Usage

```
pedigrees_all_populate_autosomal(  
  pedigrees,  
  allele_dist,  
  theta,  
  mutation_rate,  
  progress = TRUE  
)
```

### Arguments

<code>pedigrees</code>	Pedigree list in which to populate genotypes
<code>allele_dist</code>	Allele distribution (probabilities) – gets normalised
<code>theta</code>	Theta correction between 0 and 1 (both included)
<code>mutation_rate</code>	Mutation rate between 0 and 1 (both included)
<code>progress</code>	Show progress

### Details

Note, that pedigrees must first have been inferred by [build\\_pedigrees\(\)](#).

### See Also

[pedigrees\\_all\\_populate\\_haplotypes\\_custom\\_founders\(\)](#) and [pedigrees\\_all\\_populate\\_haplotypes\\_ladder\\_bou](#)

---

pedigrees\_all\_populate\_haplotypes

*Populate haplotypes in pedigrees (0-founder/unbounded).*

---

### Description

Populate haplotypes from founder and down in all pedigrees. Note, that haplotypes are unbounded and that all founders get haplotype `rep(0L, loci)`.

### Usage

```
pedigrees_all_populate_haplotypes(
  pedigrees,
  loci,
  mutation_rates,
  prob_two_step = 0,
  prob_genealogical_error = 0,
  progress = TRUE
)
```

### Arguments

pedigrees	Pedigree list in which to populate haplotypes
loci	Number of loci
mutation_rates	Vector with mutation rates, length loci
prob_two_step	Given a mutation happens, this is the probability that the mutation is a two-step mutation
prob_genealogical_error	Probability that a genealogical error happens: if so, give individual haplotype <code>rep(0L, loci)</code> instead of father's
progress	Show progress

### Details

Note, that pedigrees must first have been inferred by [build\\_pedigrees\(\)](#).

### See Also

[pedigrees\\_all\\_populate\\_haplotypes\\_custom\\_founders\(\)](#) and [pedigrees\\_all\\_populate\\_haplotypes\\_ladder\\_boundaries\(\)](#)

### Examples

```
sim <- sample_geneology(100, 10)
peds <- build_pedigrees(sim$population)
pedigrees_all_populate_haplotypes(peds, 2, c(1, 1))
get_haplotype(sim$end_generation_individuals[[1]])
```

---

pedigrees\_all\_populate\_haplotypes\_custom\_founders  
*Populate haplotypes in pedigrees (custom founder/unbounded).*

---

### Description

Populate haplotypes from founder and down in all pedigrees. Note, that haplotypes are unbounded. All founders get a haplotype from calling the user provided function `get_founder_haplotype()`.

### Usage

```
pedigrees_all_populate_haplotypes_custom_founders(  
  pedigrees,  
  mutation_rates,  
  get_founder_haplotype = NULL,  
  prob_two_step = 0,  
  prob_genealogical_error = 0,  
  progress = TRUE  
)
```

### Arguments

<code>pedigrees</code>	Pedigree list in which to populate haplotypes
<code>mutation_rates</code>	Vector with mutation rates
<code>get_founder_haplotype</code>	Function taking no arguments returning a haplotype of length( <code>mutation_rates</code> )
<code>prob_two_step</code>	Given a mutation happens, this is the probability that the mutation is a two-step mutation
<code>prob_genealogical_error</code>	Probability that a genealogical error happens: if so, give individual haplotype <code>get_founder_haplotype()</code> instead of father's
<code>progress</code>	Show progress

### Details

Note, that pedigrees must first have been inferred by [build\\_pedigrees\(\)](#).

### See Also

[pedigrees\\_all\\_populate\\_haplotypes\(\)](#) and [pedigrees\\_all\\_populate\\_haplotypes\\_ladder\\_bounded\(\)](#).

**Examples**

```
sim <- sample_genealogy(100, 10)
peds <- build_pedigrees(sim$population)
pedigrees_all_populate_haplotypes_custom_founders(
  peds, c(1, 1), function(x) c(10, 10))
get_haplotype(sim$end_generation_individuals[[1]])
```

---

pedigrees\_all\_populate\_haplotypes\_ladder\_bounded

*Populate haplotypes in pedigrees (custom founder/bounded).*

---

**Description**

Populate haplotypes from founder and down in all pedigrees. Note, that haplotypes are bounded by `ladder_min` and `ladder_max`. All founders get a haplotype from calling the user provided function `get_founder_haplotype()`.

**Usage**

```
pedigrees_all_populate_haplotypes_ladder_bounded(
  pedigrees,
  mutation_rates,
  ladder_min,
  ladder_max,
  get_founder_haplotype = NULL,
  prob_two_step = 0,
  prob_genealogical_error = 0,
  progress = TRUE
)
```

**Arguments**

<code>pedigrees</code>	Pedigree list in which to populate haplotypes
<code>mutation_rates</code>	Vector with mutation rates
<code>ladder_min</code>	Lower bounds for haplotypes, same length as <code>mutation_rates</code>
<code>ladder_max</code>	Upper bounds for haplotypes, same length as <code>mutation_rates</code> ; all entries must be strictly greater than <code>ladder_min</code>
<code>get_founder_haplotype</code>	Function taking no arguments returning a haplotype of length( <code>mutation_rates</code> )
<code>prob_two_step</code>	Given a mutation happens, this is the probability that the mutation is a two-step mutation; refer to details for information about behaviour around ladder boundaries
<code>prob_genealogical_error</code>	Probability that a genealogical error happens: if so, give individual haplotype <code>get_founder_haplotype()</code> instead of father's
<code>progress</code>	Show progress

## Details

Given that a two step mutation should happen (probability specified by `prob_two_step`): With distances  $\geq 2$  to ladder bounds, mutations happen as usual. At distance = 0 or 1 to a ladder bound, the mutation is forced to move away from the boundary.

Note, that pedigrees must first have been inferred by `build_pedigrees()`.

## See Also

`pedigrees_all_populate_haplotypes()` and `pedigrees_all_populate_haplotypes_custom_founders()`.

## Examples

```
sim <- sample_geneology(100, 10)
peds <- build_pedigrees(sim$population)
pedigrees_all_populate_haplotypes_ladder_bounded(
  peds, c(1, 1), c(0L, 0L), c(10L, 10L),
  function(x) c(10, 10))
get_haplotype(sim$end_generation_individuals[[1]])
```

---

pedigrees_count	<i>Get number of pedigrees</i>
-----------------	--------------------------------

---

## Description

Get number of pedigrees

## Usage

```
pedigrees_count(pedigrees)
```

## Arguments

pedigrees      Pedigrees

## Examples

```
sim <- sample_geneology(100, 10)
peds <- build_pedigrees(sim$population)
pedigrees_count(peds)
```

---

pedigrees\_table      *Get distribution of pedigree sizes*

---

**Description**

Get distribution of pedigree sizes

**Usage**

```
pedigrees_table(pedigrees)
```

**Arguments**

pedigrees      Pedigrees

**Examples**

```
sim <- sample_geneology(100, 10)
peds <- build_pedigrees(sim$population)
pedigrees_table(peds)
```

---

pedigree\_as\_igraph      *Convert pedigree to igraph*

---

**Description**

Convert pedigree to igraph

**Usage**

```
pedigree_as_igraph(x, ...)
```

**Arguments**

x                  Pedigree  
...                ignored

**Value**

igraph object

---

pedigree\_haplotype\_matches\_in\_pedigree\_meiosis\_L1\_dists  
*Information about matching individuals*

---

## Description

Gives information about all individuals in pedigree that matches an individual. Just as [count\\_haplotype\\_occurrences\\_individuals\(\)](#) counts the number of occurrences amongst a list of individuals, this gives detailed information about matching individuals in the pedigree, e.g. meiotic distances and maximum L1 distance on the path as some of these matches may have (back)mutations between in between them (but often this will be 0).

## Usage

```
pedigree_haplotype_matches_in_pedigree_meiosis_L1_dists(  
    suspect,  
    generation_upper_bound_in_result = -1L,  
    error_on_no_haplotype = TRUE  
)
```

## Arguments

`suspect`            Individual that others must match the profile of.

`generation_upper_bound_in_result`  
Only consider matches in generation 0, 1, ... `generation_upper_bound_in_result`.  
-1 means disabled, consider all generations. End generation is generation 0.  
Second last generation is 1. And so on.

`error_on_no_haplotype`  
raise error or silently ignore individuals with no haplotype

## Value

Matrix with information about matching individuals. Columns in order: meioses (meiotic distance to suspect), max\_L1 (on the path between the matching individual and suspect, what is the maximum L1 distance between the suspect's profile and the profiles of the individuals on the path), pid (pid of matching individual)

## See Also

[count\\_haplotype\\_occurrences\\_individuals\(\)](#).

---

pedigree\_haplotype\_near\_matches\_meiosis

*Information about almost matching individuals*

---

### Description

Gives information about all individuals in pedigree that almost matches an individual. Just as [count\\_haplotype\\_near\\_matches\\_individuals\(\)](#) counts the number of occurrences amongst a list of individuals, this gives detailed information about almost matching individuals in the pedigree: for now, the meiotic distances.

### Usage

```
pedigree_haplotype_near_matches_meiosis(
  suspect,
  max_dist,
  generation_upper_bound_in_result = -1L
)
```

### Arguments

suspect	Individual that others must match the profile of.
max_dist	Maximum distance (0 = match, 1 = 1 STR allele difference, ...)
generation_upper_bound_in_result	Only consider matches in generation 0, 1, ... generation_upper_bound_in_result. -1 means disabled, consider all generations. End generation is generation 0. Second last generation is 1. And so on.

### Value

Matrix with information about matching individuals. Columns in order: 1) meioses (meiotic distance to suspect), 2) haplotype distance, 3) pid (pid of matching individual)

### See Also

[count\\_haplotype\\_near\\_matches\\_individuals\(\)](#).

---

pedigree\_size

*Get pedigree size*

---

### Description

Get pedigree size

**Usage**

```
pedigree_size(ped)
```

**Arguments**

ped                    Pedigree

**Examples**

```
sim <- sample_geneology(100, 10)
peds <- build_pedigrees(sim$population)
pedigree_size(peds[[1]])
```

---

pedigree\_size\_generation  
*Size of pedigree*

---

**Description**

Get the size of the pedigree. Note the generation\_upper\_bound\_in\_result parameter.

**Usage**

```
pedigree_size_generation(pedigree, generation_upper_bound_in_result = -1L)
```

**Arguments**

pedigree              Pedigree to get size of  
generation\_upper\_bound\_in\_result  
                      Limit on generation to include in count; -1 means no limit. 0 only include the  
                      final generation. 1 only second last generation etc.

---

plot.malan\_pedigree    *Plot pedigree*

---

**Description**

Plot malan\_pedigree.

**Usage**

```
## S3 method for class 'malan_pedigree'
plot(
  x,
  ids = TRUE,
  haplotypes = FALSE,
  locus_sep = " ",
  mark_pids = NULL,
  label_color = "black",
  node_color = "lightgray",
  mark_color = "orange",
  ...
)
```

**Arguments**

x	Pedigree
ids	Show pids
haplotypes	Show haplotypes
locus_sep	Locus separator in haplotypes
mark_pids	Vector of pids to highlight
label_color	Label color
node_color	Node color
mark_color	Highlight color
...	Passed to <code>igraph::plot.igraph</code>

---

```
plot.malan_pedigreelist
```

*Plot pedigree list*

---

**Description**

Plot malan\_pedigreelist generated by [build\\_pedigrees\(\)](#).

**Usage**

```
## S3 method for class 'malan_pedigreelist'
plot(x, ...)
```

**Arguments**

x	Pedigree list
...	ignored

---

population\_populate\_autosomal\_infinite\_alleles

*Populate 1-locus autosomal DNA profile in pedigrees with infinite alleles mutation model.*

---

### Description

Populate 1-locus autosomal DNA profile from founder and down in all pedigrees. Note, that all founders have type 0 to begin with.

### Usage

```
population_populate_autosomal_infinite_alleles(
  population,
  mutation_rate,
  progress = TRUE
)
```

### Arguments

population	Population in which to populate genotypes
mutation_rate	Mutation rate between 0 and 1 (both included)
progress	Show progress

### Details

The maternal allele is taken by random from the  $2 \cdot N[g]$  alleles in the previous generation consisting of  $N[g]$  males with descendants in the live population.

This is also why this is not using pedigrees but instead the population.

Note, that pedigrees need not be inferred.

### See Also

[pedigrees\\_all\\_populate\\_haplotypes\\_custom\\_founders\(\)](#) and [pedigrees\\_all\\_populate\\_haplotypes\\_ladder\\_boundaries\(\)](#)

---

population\_size\_generation

*Size of population*

---

### Description

Get the size of the population. Note the `generation_upper_bound_in_result` parameter.

**Usage**

```
population_size_generation(population, generation_upper_bound_in_result = -1L)
```

**Arguments**

population	Population to get size of
generation_upper_bound_in_result	Limit on generation to include in count; -1 means no limit. 0 only include the final generation. 1 only second last generation etc.

---

```
print.malan_pedigree Print pedigree
```

---

**Description**

Print pedigree

**Usage**

```
## S3 method for class 'malan_pedigree'
print(x, ...)
```

**Arguments**

x	Pedigree
...	ignored

---

```
print.malan_pedigreelist
Print pedigree list
```

---

**Description**

Print malan\_pedigreelist generated by [build\\_pedigrees\(\)](#).

**Usage**

```
## S3 method for class 'malan_pedigreelist'
print(x, ...)
```

**Arguments**

x	Pedigrees (malan_pedigreelist)
...	ignored

---

```
print.malan_population
      Print population
```

---

### **Description**

Print malan\_population generated by [sample\\_geneology\(\)](#) or [sample\\_geneology\\_varying\\_size\(\)](#).

### **Usage**

```
## S3 method for class 'malan_population'
print(x, ...)
```

### **Arguments**

x	Population (malan_population)
...	ignored

---

```
print.malan_population_abort
      Print malan_population_abort
```

---

### **Description**

Print malan\_population\_abort

### **Usage**

```
## S3 method for class 'malan_population_abort'
print(x, ...)
```

### **Arguments**

x	malan_population_abort
...	ignored

---

```
print_individual      Print individual
```

---

**Description**

Print individual

**Usage**

```
print_individual(individual)
```

**Arguments**

```
individual      Individual
```

**Examples**

```
sim <- sample_geneology(100, 10)
indv <- get_individual(sim$population, 1)
print_individual(indv)
```

---

```
relationship_allele_diff_dist
      Calculate distribution of allele difference
```

---

**Description**

Calculate distribution of allele difference after  $m$  meioses.

**Usage**

```
relationship_allele_diff_dist(meioses, mu_dw, mu_up, method = "explicit")
```

**Arguments**

```
meioses      number of meioses separating the two individuals
mu_dw       mutation rate for 1-step down-mutation
mu_up       mutation rate for 1-step up-mutation
method      "explicit" (default): use known formulas for eigenvalues and eigenvectors.
            Can cause numerical problems. "matmult": do matrix multiplication instead
            of diagonalisation. "matmult_mpfr": as "matmult" but with the Rmpfr li-
            brary (note that this returns list instead of data.frame). "r_eigen": use R's
            eigen\(\) function to find eigen values. Mostly for debugging.
```

**Value**

data.frame with columns d (allele difference) and p (prob)

---

relationship\_allele\_diff\_dist\_sym

*Calculate distribution of allele difference for symmetric mutation rates*

---

**Description**

Calculate distribution of allele difference after m meioses.

**Usage**

```
relationship_allele_diff_dist_sym(meioses, mu_updw, method = "explicit")
```

**Arguments**

meioses	number of meioses separating the two individuals
mu_updw	mutation rate for 1-step down- and up-mutations, i.e. total mutation rate is $2 * \mu_{updw}$
method	"explicit" (default): use known formulas for eigenvalues and eigenvectors. Can cause numerical problems. "matmult": do matrix multiplication instead of diagonalisation. "matmult_mpfpr": as "matmult" but with the Rmpfr library (note that this returns list instead of data.frame). "r_eigen": use R's <a href="#">eigen()</a> function to find eigen values. Mostly for debugging.

**Value**

data.frame with columns d (allele difference) and p (prob)

---

sample\_autosomal\_genotype

*Sample genotype with theta*

---

**Description**

Sample genotype with theta

**Usage**

```
sample_autosomal_genotype(allele_dist, theta)
```

**Arguments**

allele_dist	Allele distribution (probabilities) – gets normalised
theta	Theta correction between 0 and 1 (both included)

---

sample\_geneology      *Simulate a geneology with constant population size.*

---

### Description

This function simulates a geneology where the last generation has `population_size` individuals.

### Usage

```
sample_geneology(
  population_size,
  generations,
  generations_full = 1L,
  generations_return = 3L,
  enable_gamma_variance_extension = FALSE,
  gamma_parameter_shape = 5,
  gamma_parameter_scale = 1/5,
  progress = TRUE,
  verbose_result = FALSE
)
```

### Arguments

`population_size`      The size of the population.

`generations`      The number of generations to simulate:

- -1 for simulate to 1 founder
- else simulate this number of generations.

`generations_full`      Number of full generations to be simulated.

`generations_return`      How many generations to return (pointers to) individuals for.

`enable_gamma_variance_extension`      Enable symmetric Dirichlet (and disable standard Wright-Fisher).

`gamma_parameter_shape`      Parameter related to symmetric Dirichlet distribution for each man's probability to be father. Refer to details.

`gamma_parameter_scale`      Parameter related to symmetric Dirichlet distribution for each man's probability to be father. Refer to details.

`progress`      Show progress.

`verbose_result`      Verbose result.

## Details

By the backwards simulating process of the Wright-Fisher model, individuals with no descendants in the end population are not simulated. If for some reason additional full generations should be simulated, the number can be specified via the `generations_full` parameter. This can for example be useful if one wants to simulate the final 3 generations although some of these may not get (male) children.

Let  $\alpha$  be the parameter of a symmetric Dirichlet distribution specifying each man's probability to be the father of an arbitrary male in the next generation. When  $\alpha = 5$ , a man's relative probability to be the father has 95\ constant 1 under the standard Wright-Fisher model and the standard deviation in the number of male offspring per man is 1.10 (standard Wright-Fisher = 1).

This symmetric Dirichlet distribution is implemented by drawing father (unscaled) probabilities from a Gamma distribution with parameters `gamma_parameter_shape` and `gamma_parameter_scale` that are then normalised to sum to 1. To obtain a symmetric Dirichlet distribution with parameter  $\alpha$ , the following must be used: `'gamma_parameter_shape' =  $\alpha$`  and `'gamma_parameter_scale' =  $1/\alpha$` .

## Value

A `malan_simulation` / list with the following entries:

- `population`. An external pointer to the population.
- `generations`. Generations actually simulated, mostly useful when parameter `generations` = -1.
- `founders`. Number of founders after the simulated generations.
- `growth_type`. Growth type model.
- `sdo_type`. Standard deviation in a man's number of male offspring. StandardWF or GammaVariation depending on `enable_gamma_variance_extension`.
- `end_generation_individuals`. Pointers to individuals in end generation.
- `individuals_generations`. Pointers to individuals in last `generations_return` generation (if `generations_return` = 3, then individuals in the last three generations are returned).

If `verbose_result` is true, then these additional components are also returned:

- `individual_pids`. A matrix with pid (person id) for each individual.
- `father_pids`. A matrix with pid (person id) for each individual's father.
- `father_indices`. A matrix with indices for fathers.

## See Also

[sample\\_geneology\\_varying\\_size\(\)](#).

## Examples

```
sim <- sample_geneology(100, 10)
str(sim, 1)
sim$population
peds <- build_pedigrees(sim$population)
```

peds

---

sample\_geneology\_varying\_size

*Simulate a geneology with varying population size.*

---

### Description

This function simulates a geneology with varying population size specified by a vector of population sizes, one for each generation.

### Usage

```
sample_geneology_varying_size(
  population_sizes,
  generations_full = 1L,
  generations_return = 3L,
  enable_gamma_variance_extension = FALSE,
  gamma_parameter_shape = 5,
  gamma_parameter_scale = 1/5,
  progress = TRUE
)
```

### Arguments

`population_sizes`  
The size of the population at each generation, `g`. `population_sizes[g]` is the population size at generation `g`. The length of `population_sizes` is the number of generations being simulated.

`generations_full`  
Number of full generations to be simulated.

`generations_return`  
How many generations to return (pointers to) individuals for.

`enable_gamma_variance_extension`  
Enable symmetric Dirichlet (and disable standard Wright-Fisher).

`gamma_parameter_shape`  
Parameter related to symmetric Dirichlet distribution for each man's probability to be father. Refer to details.

`gamma_parameter_scale`  
Parameter related to symmetric Dirichlet distribution for each man's probability to be father. Refer to details.

`progress`  
Show progress.

## Details

By the backwards simulating process of the Wright-Fisher model, individuals with no descendants in the end population are not simulated. If for some reason additional full generations should be simulated, the number can be specified via the `generations_full` parameter. This can for example be useful if one wants to simulate the final 3 generations although some of these may not get (male) children.

Let  $\alpha$  be the parameter of a symmetric Dirichlet distribution specifying each man's probability to be the father of an arbitrary male in the next generation. When  $\alpha = 5$ , a man's relative probability to be the father has 95% constant 1 under the standard Wright-Fisher model and the standard deviation in the number of male offspring per man is 1.10 (standard Wright-Fisher = 1).

This symmetric Dirichlet distribution is implemented by drawing father (unscaled) probabilities from a Gamma distribution with parameters `gamma_parameter_shape` and `gamma_parameter_scale` that are then normalised to sum to 1. To obtain a symmetric Dirichlet distribution with parameter  $\alpha$ , the following must be used: '`gamma_parameter_shape`' =  $\alpha$  and '`gamma_parameter_scale`' =  $1/\alpha$ .

## Value

A `malan_simulation` / list with the following entries:

- `population`. An external pointer to the population.
- `generations`. Generations actually simulated, mostly useful when parameter `generations` = -1.
- `founders`. Number of founders after the simulated generations.
- `growth_type`. Growth type model.
- `sdo_type`. Standard deviation in a man's number of male offspring. `StandardWF` or `GammaVariation` depending on `enable_gamma_variance_extension`.
- `end_generation_individuals`. Pointers to individuals in end generation.
- `individuals_generations`. Pointers to individuals in last `generations_return` generation (if `generations_return` = 3, then individuals in the last three generations are returned).

## See Also

[sample\\_geneology\(\)](#).

## Examples

```
sim <- sample_geneology_varying_size(10*(1:10))
str(sim, 1)
sim$population
peds <- build_pedigrees(sim$population)
peds
```

---

set\_generation      *Set individual's generation number*

---

**Description**

Note that generation 0 is final, end generation. 1 is second last generation etc.

**Usage**

```
set_generation(individual, generation)
```

**Arguments**

individual	Individual
generation	Generation to assign

**Examples**

```
sim <- sample_geneology(100, 10)
indv <- get_individual(sim$population, 1)
get_generation(indv)
set_generation(indv, 100)
get_generation(indv)
```

---

split\_by\_haplotypes      *Split pids by haplotype*

---

**Description**

Individuals with the same haplotype will be in the same group and individuals with different haplotypes will be in different groups.

**Usage**

```
split_by_haplotypes(population, pids)
```

**Arguments**

population	Population obtained from simulation
pids	Vector of individual pids

**Value**

List of integer vector, element *i* is an IntegerVector with all pids from pids with the same haplotype

---

test\_create\_population  
*Generate test population*

---

**Description**

Generate test population

**Usage**

```
test_create_population()
```

**Value**

An external pointer to the population.

---

ystr\_kits                    *Kit information about Y-STR markers*

---

**Description**

A dataset containing information about the Y chromosomal short tandem repeat (Y-STR) markers that are present in the kit.

**Usage**

```
ystr_kits
```

**Format**

A data frame with 88 rows and 2 variables:

**Marker** name of Y-STR marker

**Kit** name of Y-STR kit

**Source**

<https://www.yhrd.org>

---

ystr\_markers

*Mutational information about Y-STR markers*


---

### Description

A dataset from yhrd.org (and their sources) containing mutational information about Y chromosomal short tandem repeat (Y-STR) markers used in forensic genetics.

### Usage

```
ystr_markers
```

### Format

A data frame with 29 rows and 5 variables:

**Marker** name of Y-STR marker

**Meioses** number of meioses observed

**Mutations** number of mutations observed in the corresponding number of Meioses

**MutProb** point estimate of mutation probability, MutProb = Mutations/Meioses

**Alleles** observed alleles

### Details

Note, that loci with duplications (DYS385a/b as well as DYF387S1a/b have been split into two loci).

### Source

<https://www.yhrd.org>

---

[[.malan\_pedigreelist *Get pedigree from pedigree list*


---

### Description

Get pedigree from malan\_pedigreelist generated by `build_pedigrees()`.

### Usage

```
## S3 method for class 'malan_pedigreelist'
x[[...]]
```

**Arguments**

<code>x</code>	Element id
<code>...</code>	ignored

**Value**

Pedigree

---

`[[.malan_population`    *Get individual from population by pid*

---

**Description**

Get individual from population by pid

**Usage**

```
## S3 method for class 'malan_population'  
x[[...]]
```

**Arguments**

<code>x</code>	<code>pid</code>
<code>...</code>	ignored

**Value**

Individual

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