

# Package

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**Type** Package

**Title** Simulated Haploid Asexual Population Evolution

**Version** 0.2.2

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**Description** This is an R package grouping together the set of scripts I originally wrote to become SHAPE. There are numerous sub functions and some few wrapper functions which run the actual simulations. Simulation will create directories and files on your drive, and even perform some measure of post-analysis of the output. However, using the results of a SHAPE run is open users. SHAPE will generate numerous replicate simulations for a defined range of parameters at the onset of an ``experiment". The experiment will be built all under a root path built by SHAPE wherein you'll find folders which group parameter combinations into jobs and their independent replicates. Jobs can themselves be replicated into groups of jobs in order to allow significance testing for aspects defined by parameters but are still random (eg: fitness landscapes). The resultant output will be SQL database files detailing the population demographics throughout the run and the associated fitness landscape that was explored in the simulation. Processed runs will have RData files created which will contain named list objects containing summary information I presume to be usefull. The rest is open to you! If you want to simulate evolution and care to then explore how evolutionary parameters affect your system - which can be varried by different evolutionary models - enjoy SHAPE.

**License** GPL-3

**Depends** R (>= 3.2), abind, graphics, sn, VGAM, evd, stats, RSQLite, DBI

**Imports** abind, graphics, sn, VGAM, evd, stats, RSQLite, DBI

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addDrift	<i>This is a simple little function used to represent drift by introducing stochasticity to the vector passed by making poisson distribution calls. At present it forces values to integers because I've not been able to implement an appropriate continuous distribution for such calls that works with tested models and expected outcome.</i>
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### Description

This is a simple little function used to represent drift by introducing stochasticity to the vector passed by making poisson distribution calls. At present it forces values to integers because I've not been able to implement an appropriate continuous distribution for such calls that works with tested models and expected outcome.

### Usage

```
addDrift(func_inVector, func_integerValues = TRUE)
```

### Arguments

**func\_inVector** A vector of value to which stochasticity is to be added, integer values will be returned.

**func\_integerValues** Logical toggle if a discrete or continous distribution is to be used for draws. DISABLED - as testing could not identify a continuous distribution which works for obtaining expected results from established models.

### Value

A vector of values, with same length as func\_inVector

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addQuotes	<i>This is a function to add quotation marks around each element of a character string vector</i>
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### Description

This is a function to add quotation marks around each element of a character string vector

### Usage

```
addQuotes(funcIn)
```

### Arguments

**funcIn** a vector of character strings which you want padded by quotation marks

### Value

character vector of length equal to the input

---

adjustBirths	<i>This function ensures that a vector of values will sum to a given number. It's implemented in certain growth forms (currently: <b>constant</b> and <b>logistic</b>)</i>
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### Description

This function ensures that a vector of values will sum to a given number. It's implemented in certain growth forms (currently: **constant** and **logistic**)

### Usage

```
adjustBirths(func_adjVector, func_sumTotal,
             func_roundValues = func_roundValues)
```

### Arguments

`func_adjVector` Vector of values which must sum to the `func_sumTotal`.  
`func_sumTotal` A single integer value which is to be the target summed value.  
`func_roundValues` Logical toggle to control in values must be rounded to integers.

### Value

A vector of values adjusted to sum to a single value. These may have been forced to be rounded or could still contain decimals.

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birthFunction	<i>This function calculates the number of births for the vector of populations which are expected to be passed. The number of parameters which can be passed may be more than the number required to use one of the growth forms.</i>
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### Description

This function calculates the number of births for the vector of populations which are expected to be passed. The number of parameters which can be passed may be more than the number required to use one of the growth forms.

### Usage

```
birthFunction(func_inSize, func_inFitness, func_bProb, func_sizeStep,
             func_growthForm = c("logistic", "exponential", "constant", "poisson"),
             func_deaths = NULL, func_carryingCapacity = NULL,
             func_basalRate = NULL, func_deathScale = FALSE, func_drift = TRUE,
             func_roundValues = TRUE)
```

**Arguments**

func_inSize	This is the vector of population sizes within the community
func_inFitness	This is the vector of fitness value for the community
func_bProb	This is the general birth probability defined for this run of SHAPE
func_sizeStep	This is a proportional scalar that will control what proportion of a standard "generation" is simulated for each step within a SHAPE run. NOTE: This parameter is not perfectly validated to run as may be expected with all models. For now, it should be left as a value of "1", but exists for future implementation and testing.
func_growthForm	This is the implemented growth model to be simulated in this run. Currently this can be one of " <b>logistic</b> ", " <b>exponential</b> ", " <b>constant</b> ", " <b>poisson</b> ".
func_deaths	This is the vector of deaths for the genotypes within the community
func_carryingCapacity	This is the maximum community size supported by the simulated environment.
func_basalRate	This is the basal growth rate, otherwise definable as the number of offspring an individual will produce from a single birth event.
func_deathScale	This is a logical toggle to define if the number of births should be scaled by the number of deaths. The exact interpretation of this varies by growth model, but in general it forces growth to follow rates expected by standard pure birth models while still simulating deaths within the community.
func_drift	This is a logical toggle as to whether or not stochasticity is introduced into the deterministic calculations that may be encountered within the growth function. Its exact implementation varies based on the growth model being simulated.
func_roundValues	This is a logical toggle to define if the number of births and deaths are forced to be tracked as integer values. If TRUE, then any fractional amounts will be stochastically rounded to the nearest integer with a probability of being rounded up equal to the decimal value – ie: 0.32 means 32% chance of being rounded up

**Value**

A vector of births with the same length as the vector of population sizes passed.

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buildPedigree	<i>This is a convenience script to build an named list of empty lists, where the names are based on the genotype IDs being passed.</i>
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**Description**

This is a convenience script to build an named list of empty lists, where the names are based on the genotype IDs being passed.

**Usage**

```
buildPedigree(func_focalID)
```

**Arguments**

`func_focalID` This should be any vector, that can be interpreted as character, and faithfully represent the genotype IDs of interest for your pedigree.

**Value**

a named list of empty lists.

---

`calc_relativeFitness` *This is a function to calculate the relative fitness for a vector of fitnesses. As a frame of reference it can use either an ancestral fitness value or the mean fitness of the passed vector. If the frame of reference is a value of zero - OR - the `func_absDistance` is set to `TRUE` then instead the vector is centered around a value of 1 where negative values will be set to zero.*

---

**Description**

This is a function to calculate the relative fitness for a vector of fitnesses. As a frame of reference it can use either an ancestral fitness value or the mean fitness of the passed vector. If the frame of reference is a value of zero - OR - the `func_absDistance` is set to `TRUE` then instead the vector is centered around a value of 1 where negative values will be set to zero.

**Usage**

```
calc_relativeFitness(func_fitVector, func_ancestFit = NULL,
  func_weights = NULL, func_absDistance = (getOption("shape_simModel")
    == "RMF"))
```

**Arguments**

`func_fitVector` a numeric vector of values to be interpreted as fitnesses

`func_ancestFit` An optional single numeric value to be used as a frame of reference for calculating relative fitness.

`func_weights` An optional vector of weights to be used for calculating relative fitness as an absolute distance from the mean of the `func_fitVector` vector.

`func_absDistance` A logical toggle to override if relative fitnesses are to be calculated as the absolute distance from 1. Will be overrode if either the mean of `func_fitVector` or `func_ancestFit` are zero.

**Value**

A vector of relative fitness values of length equal to the input vector.

---

compute_distGrowth	<i>This function is used to calculate the effect size and timing of the next stochastic population disturbance in a SHAPE run.</i>
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---

## Description

This function is used to calculate the effect size and timing of the next stochastic population disturbance in a SHAPE run.

## Usage

```
compute_distGrowth(func_distFactor, func_growthType, func_distType,
  func_growthRate, func_popSize, func_focalSize, func_manualGenerations,
  func_stepDivs)
```

## Arguments

func_distFactor	This is the expected effect size of the disturbance, it should be a named vector with elements <b>factor</b> , <b>random</b> which are each used as per the func_distType
func_growthType	This is the growth model of the SHAPE run
func_distType	This is the type of disturbance to be simulated. Currently I've implemented <b>bottleneck</b> , <b>random</b> options for constant bottlenecks or normally distributed random effect sizes
func_growthRate	This is the basal growth rate of the SHAPE run
func_popSize	This is a vector of the number of individuals in each of the populations
func_focalSize	This only matters if the growth model is exponential in which case the disturbance is always such that the community size is reduced to the func_focalSize value
func_manualGenerations	If not NULL, it will be rounded to an integer value and taken as the manually controlled number of generations between disturbances. Otherwise, the disturbance factor and growth rate are used to estimate the number of steps required for a community with relative fitness 1 to rebound.
func_stepDivs	This is the value that controls what proportion of a standard biological "generation" is simulated in each step of a SHAPE run.

## Value

A named vector with three elements describing the simulated reduction factor of populations, the number of individuals lost, and the number of steps estimated until the next disturbance.

---

createGenotypes	<i>This function searches the nearby mutational space of a focal genotype, identifies which genotypes in that space have not yet been identified, and create new database entries for any new genotypes.</i>
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---

## Description

This function searches the nearby mutational space of a focal genotype, identifies which genotypes in that space have not yet been identified, and create new database entries for any new genotypes.

## Usage

```
createGenotypes(tmp_focalGenotype, tmp_focalFitness, maxHamming,
  tmp_landModel = "HoC", tmp_sepString = getOption("shape_sepString"),
  tmpDirection = getOption("shape_allow_backMutations"),
  tmp_relativeFitness = getOption("shape_const_relativeFitness"),
  tmp_currNeighbours = NULL, tmp_genCon,
  tmp_tableSplit = getOption("shape_db_splitTables"),
  tmp_maxRows = getOption("shape_maxRows"),
  tmp_genomeLength = getOption("shape_genomeLength"),
  tmp_distAsS = getOption("shape_const_distAsS"), ...)
```

## Arguments

tmp_focalGenotype	This is the focal genotype for which we want to create missing mutational neighbours.
tmp_focalFitness	This is the fitness value of the tmp_focalGenotype.
maxHamming	The maximum number of sites that could be changed by mutation of the tmp_focalGenotype. NOTE: At present I've not made the code work for anything other than a value of 1. So do not update without updating associated code. where appropriate.
tmp_landModel	This is the character string that defines the fitness landscape model being simulated in this SHAPE run. At present it can be one of: <b>Additive, Fixed, HoC, NK, RMF</b>
tmp_sepString	This is a character string used to collapse vectors of characters.
tmpDirection	This is a logical which controls if reversions are allowed (ie: if TRUE sites can revert from mutated to WT)
tmp_relativeFitness	This is a logical which controls if fitness values are to be calculated as relative and no absolute values that would otherwise be calculated via calls to the fitness landscape model.
tmp_currNeighbours	This is an optional vector that would define the genotype of all neighbours within the 1 step mutational neighbourhood of the tmp_focalGenotype genotype. If NULL then this vector will be calculated within the function.
tmp_genCon	This is the filepath for the database file that contains the fitness landscape information.



tmp_tableSplit	This is a logical which controls if the tables which report on all genotypes with X mutations should be forced into a single table or if SHAPE is allowed to split them into multiple tables.
tmp_maxRows	The maximum number of rows allowed in a database table before a new table is created. This has no meaning if tmp_tableSplit is FALSE.
tmp_genomeLength	The length of the genomes, or number of mutable sites/positions, being simulated.
tmp_distAsS	This argument is passed through to downstream function, but will control if the stochastic portion of fitness effect will be considered as selection coefficients (meaning subtracting 1 from the initially drawn value).
...	Additional arguments that may get passed to internal functions.

### Value

This invisibly returns NULL, this function is to perform work on databases.

---

create_genotypeFrame	<i>This is a convenience function to ensure that we have a standard shaped data.frame. It is used to initiate a new table for the fitness landscape.</i>
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---

### Description

This is a convenience function to ensure that we have a standard shaped data.frame. It is used to initiate a new table for the fitness landscape.

### Usage

```
create_genotypeFrame(tmpID, tmpStrings, tmpFitnesses)
```

### Arguments

tmpID	A numeric vector of the unique identifiers for genotypes
tmpStrings	A vector of the character strings that represent the binary string of genotypes
tmpFitnesses	A vector of the numeric fitness values to be input

### Value

A 4 column data frame with column names of genotypeID, binaryString, fitness, isExplored

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deathFunction	<i>This allows SHAPE to simulate the death process as a deterministic value, and may be density dependent.</i>
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---

## Description

This allows SHAPE to simulate the death process as a deterministic value, and may be density dependent.

## Usage

```
deathFunction(func_inSize, func_inProb = 0, func_roundValues = TRUE,
  func_depDensity = FALSE, func_densityMax = NULL,
  func_densityPower = 4)
```

## Arguments

func_inSize	This is the vector of population sizes within the community
func_inProb	This is the general death probability defined for this run of SHAPE
func_roundValues	This is a logical toggle to define if the number of births and deaths are forced to be tracked as integer values. If TRUE, then any fractional amounts will be stochastically rounded to the nearest integer with a probability of being rounded up equal to the decimal value – ie: 0.32 means 32% chance of being rounded up –
func_depDensity	This is a logical toggle as to whether or not the calculation is density dependent. If TRUE, then func_densityMax requires a value.
func_densityMax	This is the community size at which maximum density dependent deaths (ie: 100% of func_inSize) occur.
func_densityPower	This is a scaling factor that controls the rate of transition between minimal and maximal values of the density dependent deaths. Higher values mean a steeper transition such that there are fewer deaths until higher densities are reached.

## Value

A vector of the number of deaths calculated for each of the populations represented by the func\_inSize vector

---

defineNeighbours	<i>The function will identify the binary string of all possible neighbours to a focal genotype. It is important when querying the fitness landscape.</i>
------------------	--

---

## Description

The function will identify the binary string of all possible neighbours to a focal genotype. It is important when querying the fitness landscape.

## Usage

```
defineNeighbours(func_tmpGenotype, func_tmpDirection,
  func_maxHamming = getOption("shape_max_numMutations"),
  func_sepString = getOption("shape_sepString"),
  func_genomeLength = getOption("shape_genomeLength"))
```

## Arguments

func_tmpGenotype	This is the binary string of the focal genotype for which we want to define possible neighbours.
func_tmpDirection	This is a logical which controls if reversions are allowed (ie: if TRUE sites can revert from mutated to WT)
func_maxHamming	The maximum number of sites that could be changed by mutation of the tmp_focalGenotype. NOTE: At present I've not made the code work for anything other than a value of 1. So do not update without updating associated code, where appropriate.
func_sepString	This is a character string used to collapse vectors of characters.
func_genomeLength	The length of the genomes, or number of mutable sites/positions, being simulated.

## Value

Vector of all the genotypes in the neighbouring mutational space accessible within 1 mutation event

---

defineSHAPE	<i>These are some global reference options that SHAPE will use and I consider the defaults. SHAPE parameters can be changed by calling this function and changing values OR by using the accessory SHAPE_parameters script, called in the SHAPE_runBody script. This second approach is considered more practical for building and running experiments.</i>
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---

## Description

These are some global reference options that SHAPE will use and I consider the defaults. SHAPE parameters can be changed by calling this function and changing values OR by using the accessory SHAPE\_parameters script, called in the SHAPE\_runBody script. This second approach is considered more practical for building and running experiments.

## Usage

```
defineSHAPE(shape_allow_backMutations = TRUE,
  shape_collapseString = "__:__", shape_constDist = "exp",
  shape_const_relativeFitness = TRUE,
  shape_const_hoodDepth = "limited",
  shape_const_focal_popValue = 1e+05, shape_const_mutProb = 0.001,
  shape_const_distParameters = 20, shape_const_distAsS = FALSE,
  shape_const_RMF_initiDistance = 5, shape_const_RMF_theta = 0.35,
  shape_const_numInteractions = 4, shape_const_fixedFrame = NULL,
  shape_const_birthProb = 1, shape_const_deathProb = 1,
  shape_const_ancestFitness = 0, shape_const_estProp = 0.001,
  shape_const_hoodThresh = 1000, shape_const_distType = "bottleneck",
  shape_const_growthForm = "logistic", shape_const_growthRate = 2,
  shape_const_growthGenerations = NULL, shape_db_splitTables = TRUE,
  shape_death_byDensity = TRUE, shape_death_densityCorrelation = 4,
  shape_death_densityCap = NULL, shape_externalSelfing = FALSE,
  shape_external_stopFile = "someNamed.file", shape_finalDir = NULL,
  shape_genomeLength = 100, shape_includeDrift = TRUE,
  shape_init_distPars = c(factor = 100, random = 1),
  shape_maxReplicates = 30, shape_maxRows = 2.5e+07,
  shape_muts_onlyBirths = FALSE, shape_nextID = 0,
  shape_numGenerations = 100, shape_postDir = NULL,
  shape_recycle_repStart = 1, shape_results_removeSteps = TRUE,
  shape_run_isRecycling = c(Landscape = TRUE, Steps = FALSE, Parameters =
  TRUE, Neighbourhood = FALSE), shape_save_batchBase = "yourJob",
  shape_save_batchSet = 1, shape_save_batchJob = 1,
  shape_scaleGrowth_byDeaths = TRUE, shape_sepString = "_",
  shape_serverFarm = FALSE, shape_simModel = "HoC",
  shape_size_timeStep = 1, shape_stringsAsFactors = FALSE,
  shape_string_lineDescent = "_->_",
  shape_string_tableNames = "numMutations", shape_thisRep = 1,
  shape_tmp_selfScript = "~/random_nullFile.txt", shape_use_sigFig = 4,
  shape_toggle_forceCompletion = FALSE, shape_track_asWhole = FALSE,
  shape_track_distSize = NULL, shape_workDir = "~/defaultSHAPE/")
```

## Arguments

shape\_allow\_backMutations

This is a logical toggle controlling if revertant mutants are allowed.

shape\_collapseString

This is a string to collapse the progenitor and number of mutants pieces of information.

shape\_constDist

This is a character string to control the distribution used for drawing fitness value random components.

shape\_const\_relativeFitness  
This is a logical toggle which controls if the absolute fitness values calculated should be reinterpreted as relative fitness values.

shape\_const\_hoodDepth  
shape\_const\_hoodDepth This is an object to control which strains we get deep neighbourhood information for It should be one of "**none**", "**limited**", "**priority**", "**full**" setting this higher will cost more and more in post analysis runtime.

shape\_const\_focal\_popValue  
This is the focal population value which has different meanings based on the growth model implemented.

shape\_const\_mutProb  
This is the probability of a mutation event - occurring relative to the number of mutable events - in a standard biological generation.

shape\_const\_distParameters  
This allows a single parameter to be passed for use in the distribution of fitness fitness effects. NOTE: you are likely going to want to pass multiple values in which case simply set this value prior to a run's start but after loading the library.

shape\_const\_distAsS  
This is a logical toggle controlling if fitness landscape values calculated should be interpreted as selection coefficients rather than relative fitness values.

shape\_const\_RMF\_initiDistance  
This is the distance of the independent global fitness optima away from the WT genotype. It matters for the Rough Mount Fuji landscapes.

shape\_const\_RMF\_theta  
This is the Rough Mount Fuji value that controls the scalar of the independent fitness contribution.

shape\_const\_numInteractions  
This is the number of sites which interact with respect to fitness calculations in models such as the NK.

shape\_const\_fixedFrame  
This defines the fitness landscape when our model is "Fixed", it must be user defined and be explicit to all genotypes possible.

shape\_const\_birthProb  
This is the proportion of individuals with fitness == 1 having births events in a standard biological generation.

shape\_const\_deathProb  
This is the proportion of individuals having a death event in a standard biological generation.

shape\_const\_ancestFitness  
This is the fitness value of the ancestral genotype.

shape\_const\_estProp  
This is the value controlling when SHAPE considers a population to be established.

shape\_const\_hoodThresh  
This is the numeric value controlling when a population is of sufficient size for SHAPE to consider it worth having the genotype's mutational neighbourhood to be stored in a convenience DB for easier access - ie: this can save computational time but will cost diskpace during the run.

shape\_const\_distType  
This is the type of stochastic disturbance events to be simulated.

shape_const_growthForm	This is the growth form model to be simulated
shape_const_growthRate	This is the number of offspring from every division event where 1 would mean replacement, 2 is normal binary fission, etc....
shape_const_growthGenerations	This is an optional integer value controlling if you want a standard number of time steps between each stochastic disturbance function call. Not defining this means it will be calculated based on other parameters defined.
shape_db_splitTables	This is a logical toggle as to whether or not fitness landscape tables - for genotypes with the same number of mutations - are allowed to be split into sub-tables.
shape_death_byDensity	This is the logical toggle controlling if deaths are density dependent.
shape_death_densityCorrelation	This is a positive numeric controlling the rate at which density dependent deaths increase from minimal to maximal effect. Where 1 is linear, > 1 creates an exponential form of curve and values < 1 will create a root function curve.
shape_death_densityCap	If deaths are density dependent this is the maximal community size for when deaths are 100% expected.
shape_externalSelfing	This is the logical toggle controlling if replicates are to be handled as individual external calls rather than through the normal internal for loop. It has limited value and was designed for when you work on compute nodes with limited wall time.
shape_external_stopFile	This is the filename for a file which is used to control self-replication of SHAPE when selfing is external.
shape_finalDir	This is the directory where file from a remote server's compute node are to be back ported regularly. Only matters under the correct conditions.
shape_genomeLength	This is the length of a simulant's genome, or in other words the number of sites where mutations can occur.
shape_includeDrift	This is a logical toggle as to whether or not we should add stochasticity to the growth function calculations. It is meant to simulate drift in calculations that would otherwise be deterministic.
shape_init_distPars	This is the vector of initial values of the dilution factor and random component of the stochastic disturbance function. It needs to be set with a number and range of values appropriate to the distribution to be simulated.
shape_maxReplicates	This is the number of replicates to be run.
shape_maxRows	This is the integer number of rows stored in a single table of the fitness landscape DB. Only matters if tables are split/
shape_muts_onlyBirths	This is a logical flag to control if mutants only appear as a result of birth events.
shape_nextID	This is the next genotype ID to be assigned for a genotype that gets created.

`shape_numGenerations`  
 This is the number of generations to be simulated in the run.

`shape_postDir` This is the filepath to the directory where post-analysis results will be stored.

`shape_recycle_repStart`  
 This is the first replicate being simulated once a SHAPE call is made.

`shape_results_removeSteps`  
 This is a logical flag controlling if the steps log is removed after being processed.

`shape_run_isRecycling`  
 This is a named vector of four logicals which control which parts of a run is meant to be recycled between replicates.

`shape_save_batchBase`  
 This is a character string for naming your experiment.

`shape_save_batchSet`  
 This is an integer value for the set of this experiment associated to this job.

`shape_save_batchJob`  
 This is an integer value for the batch of this experiment associated to this job.

`shape_scaleGrowth_byDeaths`  
 This is a logical flag that controls if growth is scaled by deaths so that the growth form follows standard expectations.

`shape_sepString`  
 This is a string character that is used for collapsing vectors of information into a single character string, and subsequently splitting that information back out.

`shape_serverFarm`  
 This is a logical flag of whether or not your simulations are going to be run on a remote server or other situation with compute and host nodes where you might want to handle particularities I experienced and thus accounted for.

`shape_simModel` This is the fitness landscape model to be simulated.

`shape_size_timeStep`  
 This is the proportion of a standard biological generation to be simulated in a single time step of a SHAPE run. Values greater than 1 are not guaranteed to work as expected. Negative numbers will cause errors.

`shape_stringsAsFactors`  
 I don't like strings to be factors and so SHAPE will avoid treating them as so.

`shape_string_lineDescent`  
 This is a string that will be used to collapse vectors of character strings into a single string. It gets used when we are tracking sequential genotypes through the line of descent.

`shape_string_tableNames`  
 This is a string value used as the prefix when naming table in the fitness landscape DB.

`shape_thisRep` This is the replicate number of the first replicate processed in the called run.

`shape_tmp_selfScript`  
 This is an optionally defined filepath location for a file that will exist to signal that an externally replicating SHAPE run can stop. This only matters if selfing is external.

`shape_use_sigFig`  
 This is the number of significant figures that will be kept for processed output.

`shape_toggle_forceCompletion`  
 This is a logical toggle controlling if a run crashes when it is ended prior to the maximum number of replicates being completed.

shape_track_asWhole	This is a logical toggle controlling if population sizes must be tracked as integer values
shape_track_distSize	This is a numeric, the size of a disturbance caused by stochastic events. It is the dilution factor or the divisor of the community size. It must be > 1 or is forced to that value.
shape_workDir	This is the main working directory relative to which your SHAPE experiment will be built and run.
shape_tmpGenoTable	This is the name of temporary genotype space tables we may create or collected in-situ
<hr/>	
expGrowth	<i>This function uses the exponential growth model and can either calculated the expected growth for a single time step OR it can work backwards to calculated what was the expected starting population size prior to a step of exponential growth.</i>
<hr/>	

### Description

This function uses the exponential growth model and can either calculated the expected growth for a single time step OR it can work backwards to calculated what was the expected starting population size prior to a step of exponential growth.

### Usage

```
expGrowth(func_rate, func_step, func_startPop = NULL,
          func_endPop = NULL, func_basalExponent = exp(1))
```

### Arguments

func_rate	This is the number of offpsring expected to be produced by an individual. When calculating the expected population size after a time step, we force this rate to be no less than 1 since this function has meaning only in the birth function and so we do not want to calculate negative births (which would mean deaths).
func_step	This is a proportional scalar that will control what proportion of a standard "generation" is simulated for each step within a SHAPE run. NOTE: This parameter is not perfectly validated to run as may be expected with all models. For now, it should be left as a value of "1", but exists for future implementation and testing.
func_startPop	This is the initial population size(s) for which you want to calculate a final size. Leave NULL if trying to calculated the expected initial size from a final population.
func_endPop	This is the final population size(s) for which you want to calculate a initial size. Leave NULL if trying to calculated the expected final size from an initial population.
func_basalExponent	This controls the basal exponent of the reverse calculation for exponential growth. It defaults to the natural exponent and sohuld not be changed from that value. Modify at your own risk.



**Value**

numeric value

---

extractInfo_focalID	<i>This is a function to extract genotype/lineage specific information. This info will be mostly through time style of information but will also include information about it's line of descent, growth pressures pre-establishment, and population size.</i>
---------------------	---

---

**Description**

This is a function to extract genotype/lineage specific information. This info will be mostly through time style of information but will also include information about it's line of descent, growth pressures pre-establishment, and population size.

**Usage**

```
extractInfo_focalID(func_focalID, func_estValue, func_stepsCon,
  func_landscapeCon, func_hoodCon, func_refMatrix, func_subNaming,
  func_genomeLength = getOption("shape_genomeLength"),
  func_max_numMutations = getOption("shape_max_numMutations"),
  func_allow_backMutations = getOption("shape_allow_backMutations"),
  func_descentSep = getOption("shape_string_lineDescent"),
  func_hoodExplore = getOption("shape_const_hoodDepth"),
  func_stringSep = getOption("shape_sepString"))
```

**Arguments**

func_focalID	This is the vector of genotype ID(s) of the focal lineage(s) for which information is to be extracted.
func_estValue	This value is used to define the threshold size required for a population before it is considered established.
func_stepsCon	This is the filepath to an SQLite database storing information for the stepwise changes of a SHAPE run.
func_landscapeCon	This is the filepath to an SQLite database storing information for the complete explored and neighbouring fitness landscape of a SHAPE run.
func_hoodCon	This is the filepath to an SQLite database storing information for high priority mutational neighbourhood information
func_refMatrix	Is a matrix of a SHAPE run's population demographics at a step in time. I will be queried for information regarding a genotype's number of mutations and fitness value. of genotypes, but is not required but is also required
func_subNaming	This is a logical which controls if the tables which report on all genotypes with X mutations should be forced into a single table or if SHAPE is allowed to split them into multiple tables.
func_genomeLength	The number of positions simulated within the individual's genomes.

func\_max\_numMutations

The maximum number of mutations that could occur in a single mutation event – CAUTION: This should never be anything other than 1 as per how SHAPE is currently implemented.

func\_allow\_backMutations

This is a logical toggle controlling if reversions are allowed – meaning loss of mutations.

func\_descentSep

This is the standard string used to collapse line of descent information.

func\_hoodExplore

This is an object to control which strains we get deep neighbourhood information for. It should be one of **"none"**, **"limited"**, **"priority"**, **"full"** setting this higher will cost more and more in post analysis runtime. NOTE: That use of **limited** requires that you pass a func\_refMatrix of expected shape (has a "genotypeID" column)!

func\_stringSep A common string separator used to merge information.

### Value

This returns a list object with several pieces of summary information for the focal genotype ID.

---

extract\_popDemographics

*This is a function that steps forward through time steps of a SHAPE run and extracts population demographic information. This includes Fitness, Number of Lineages, and Transitions between dominant genotypes. Most important it will also return the information related to which lineages will eventually establish in the population, a piece of information that will be critical for downstream lineage specific information extraction.*

---

### Description

This is a function that steps forward through time steps of a SHAPE run and extracts population demographic information. This includes Fitness, Number of Lineages, and Transitions between dominant genotypes. Most important it will also return the information related to which lineages will eventually establish in the population, a piece of information that will be critical for downstream lineage specific information extraction.

### Usage

```
extract_popDemographics(func_stepsCon, func_estValue, func_landscapeCon,
  func_hoodCon, func_size_timeStep)
```

### Arguments

func\_stepsCon This is the filepath to an SQLite database storing information for the stepwise changes of a SHAPE run.

func\_estValue This value is used to define the threshold size required for a population before it is considered established.

func_landscapeCon	This is the filepath to an SQLite database storing information for the complete explored and neighbouring fitness landscape of a SHAPE run.
func_hoodCon	This is the filepath to an SQLite database storing information for high priority mutational neighbourhood information (which is simply a subset of the full mutational landscape).
func_size_timeStep	This is the proportion of a standard biological generation which is to be simulated in a single time step.

### Value

This return a list object that contains various pieces of usefull summary demographic information.

---

findParent	<i>This function will look through a pedigree data.frame and recursively continue building that back through the history of the SHAPE run being processed.</i>
------------	--

---

### Description

This function will look through a pedigree data.frame and recursively continue building that back through the history of the SHAPE run being processed.

### Usage

```
findParent(func_focalGenotype, func_startStep, func_stepMatrix,
           func_progenitorList, func_demoArray, func_pedigreeAll,
           func_lineString = getOption("shape_string_lineDescent"))
```

### Arguments

func_focalGenotype	a vector of genotype IDs whose lineage you wish to identify.
func_startStep	this is the first step in the SHAPE run from which you wish to consider re-tracing the lineage.
func_stepMatrix	this is the matrix that represent what happened at each step in the SHAPE run.
func_progenitorList	this is a list of the known progenitor(s) for our func_focalGenotypes
func_demoArray	this is the whole array of step-wise SHAPE records for population demographics and feeds func_stepMatrix.
func_pedigreeAll	this is a data.frame which contains all currently known pedigree information and informs our step-wise focus.
func_lineString	this is the string that will be used to collapse the vector of progenitor genotype's into a single charater string. This collapse is done as a convenience for storage and retrieval.

**Value**

a vector of character strings, each of which is the found lineage of the func\_focalGenotypes

---

find\_neededNeighbours *This function queries if a suite of genotypes exist within the fitness landscape database.*

---

**Description**

This function queries if a suite of genotypes exist within the fitness landscape database.

**Usage**

```
find_neededNeighbours(tmp_possibleNeighbours, tmp_focal_numMuts,
  tmp_refTables, maxHamming = getOption("shape_max_numMutations"),
  tmp_tableSplit = getOption("shape_db_splitTables"),
  tmp_genomeLength = getOption("shape_genomeLength"),
  tmpDirection = getOption("shape_allow_backMutations"),
  tmpRange_numMuts = NULL, tmp_genCon)
```

**Arguments**

tmp_possibleNeighbours	This is a vector of all possible mutants that we're trying to query within the fitness landscape database.
tmp_focal_numMuts	This is the number of mutations in the focal genotype, it controls - along with other parameters - what tables of the fitness landscape database are queried.
tmp_refTables	This is the a vector of named tables that exist within the fitness landscape. It can not be passed in which case the database at tmp_genCon is queried for this information.
maxHamming	The maximum number of sites that could be changed by mutation of the tmp_focalGenotype.
tmp_tableSplit	This is a logical which controls if the tables which report on all genotypes with X mutations should be forced into a single table or if SHAPE is allowed to split them into multiple tables.
tmp_genomeLength	The length of the genomes, or number of mutable sites/positions, being simulated.
tmpDirection	This is a logical which controls if reversions are allowed (ie: if TRUE sites can revert from mutated to WT)
tmpRange_numMuts	This is the range of number of mutations which a mutant neighbour may posses. If not supplied that will be calculated in line via other parameters passed to the function.
tmp_genCon	This is the filepath for the database file that contains the fitness landscape information.

**Value**

A vector of the genotypes that need to be created as they've not yet been defined within the fitness landscape.

---

fitnessDist	<i>This is the function that will call for draws from distributions.</i>
-------------	--

---

### Description

This is the function that will call for draws from distributions.

### Usage

```
fitnessDist(tmpDraws, tmpDistribution, tmpParameters)
```

### Arguments

tmpDraws	This is the number of draws sought from the distribution being called
tmpDistribution	This is the character string that represents the implemented distribution you want called. It must be one of: <b>Fixed, Gamma, Uniform, Normal, Chi2, beta, exp, evd, rweibull, frechet, skewNorm</b>
tmpParameters	This is the ordered vector of parameters to be passed in order to parameterise the distribution from which you want to draw

### Value

A vector of values with length equal to tmpDraws

---

fitnessLandscape	<i>This function will calculate the fitness values for genotypes being newly recorded to the fitness landscape.</i>
------------------	---

---

### Description

This function will calculate the fitness values for genotypes being newly recorded to the fitness landscape.

### Usage

```
fitnessLandscape(tmpGenotypes, tmp_focalFitness, landscapeModel = "HoC",
  tmp_ancestralFitness = getOption("shape_const_ancestFitness"),
  tmp_weightsRMF = getOption("shape_const_RMF_theta"),
  tmp_optimaRMF = getOption("shape_const_RMF_globalOptima"),
  tmp_correlationsNK = getOption("shape_const_NK_interactionMat"),
  tmp_const_numInteractionsNK = getOption("shape_const_numInteractions"),
  tmp_NK_ancestDep = getOption("shape_const_DepbySite_ancestFitness"),
  relativeFitness = TRUE,
  func_genomeLength = getOption("shape_genomeLength"),
  func_distribution = getOption("shape_constDist"),
  func_distParameters = getOption("shape_const_distParameters"),
  func_distAsS = getOption("shape_const_distAsS"),
  func_sepString = getOption("shape_sepString"))
```

## Arguments

tmpGenotypes	This is a vector of the binaryString values that represent the genotype(s) for which you want to calculate new fitness values.
tmp_focalFitness	This argument has different meaning depending upon the fitness landscape model being simulated. It can be a vector of fitness values, a matrix, a single value, etc...
landscapeModel	This is the character string that defines the fitness landscape model being simulated in this SHAPE run. At present it can be one of: <b>Additive, Fixed, HoC, NK, RMF</b>
tmp_ancestralFitness	This is the fitness value of the pure WT genotype, it does not always have meaning.
tmp_weightsRMF	This is the weighting of the constant/deterministic term calculated in the RMF fitness landscape equation.
tmp_optimaRMF	This is the binary string genotype of the optimal genotype in the current RMF fitness landscape. It needn't yet have been yet explored, it is simply the genotype that will be the deterministic global optimum.
tmp_correlationsNK	This is the matrix of fitness values and interactions between mutational states for the NK fitness lanscape model
tmp_const_numInteractionsNK	This is the "K" value of the NK fitness landscape value and represents the number of other sites correlated to the fitness of a focal site.
tmp_NK_ancestDep	This is the fitness value of the WT mutant for an NK fitness landscape, it is passed as a computational ease so that it needn't be calculated each time this function is called.
relativeFitness	This is a logical toggle controlling if the fitness values returned should be relative fitness values
func_genomeLength	This is the genome length of individuals.
func_distribution	This is a character string representing which of the allowed distribution functions can be called for draws of stochastic values when calculating fitness values. See fitnessDist for those implemented.
func_distParameters	This is a vector of the ordered distribution parameters expected by the distribution referenced by func_distribution
func_distAsS	This is a logical toggle to control in the final returned values should be considered as selection coefficients, which is achieved by subtracting the calculated value by 1.
func_sepString	This is a character string used for collapsing vectors of information, and expanding the collapsed information back into a vector of values.

## Value

A vector of fitness values to be assigned for each of the newly explored genotypes defined in the vector tmpGenotypes

---

growthFunction	<i>This is a wrapper function where the birth and death related parameters of a SHAPE run are passed before the appropriate functions (and their associated methods) are called. This function will be called once per time step of a SHAPE run.</i>
----------------	--

---

## Description

This is a wrapper function where the birth and death related parameters of a SHAPE run are passed before the appropriate functions (and their associated methods) are called. This function will be called once per time step of a SHAPE run.

## Usage

```
growthFunction(func_inSize, func_inFitness, func_bProb, func_dProb,
  func_deathDen_logical = FALSE, func_deathDen_max = NULL,
  func_deathDen_power = 4, func_sizeStep,
  func_growthForm = c("logistic", "exponential", "constant", "poisson"),
  func_carryingCapacity = NULL, func_basalRate = NULL,
  func_deathScale = FALSE, func_drift = TRUE,
  func_roundValues = FALSE, func_inIDs = NULL)
```

## Arguments

func_inSize	This is the vector of population sizes within the community
func_inFitness	This is the vector of fitness value for the community
func_bProb	This is the general birth probability defined for this run of SHAPE
func_dProb	This is the general death probability defined for this run of SHAPE
func_deathDen_logical	This is a logical toggle to define if deaths are calculated in a density dependent manner.
func_deathDen_max	This is the community size at which maximum density dependent deaths (ie: 100% of func_inSize) occur.
func_deathDen_power	This is a scaling factor that controls the rate of transition between minimal and maximal values of the density dependent deaths. Higher values mean a steeper transition such that there are fewer deaths until higher densities are reached.
func_sizeStep	This is a proportional scalar that will control what proportion of a standard "generation" is simulated for each step within a SHAPE run. NOTE: This parameter is not perfectly validated to run as may be expected with all models. For now, it should be left as a value of "1", but exists for future implementation and testing.
func_growthForm	This is the implemented growth model to be simulated in this run. Currently this can be one of <b>"logistic"</b> , <b>"exponential"</b> , <b>"constant"</b> , <b>"poisson"</b> .
func_carryingCapacity	This is the maximum community size supported by the simulated environment.
func_basalRate	This is the basal growth rate, otherwise definable as the number of offspring an individual will produce from a single birth event.

func_deathScale	This is a logical toggle to define if the number of births should be scaled by the number of deaths. The exact interpretation of this varies by growth model, but in general it forces growth to follow rates expected by standard pure birth models while still simulating deaths within the community.
func_drift	This is a logical toggle as to whether or not stochasticity is introduced into the deterministic calculations that may be encountered within the growth function. Its exact implementation varies based on the growth model being simulated.
func_roundValues	This is a logical toggle to define if the number of births and deaths are forced to be tracked as integer values. If TRUE, then any fractional amounts will be stochastically rounded to the nearest integer with a probability of being rounded up equal to the decimal value – ie: 0.32 means 32% chance of being rounded up –
func_inIDs	This is a vector of the genotype IDs passed to this function, its order should be representative of the ordered genotypeIDs passed for func_inSize and func_inFitness.

### Value

A 2 column matrix of numeric values with columns "births" and "deaths", and rownames equal to func\_inIDs (as.character).

---

logisticGrowth	<i>This function is simply an implementation of the logistic growth equation where: <math>f(x) = K / (1 + ((K - N_0)/N_0) * \exp(-k(x-x_0)))</math>; Where <math>x_0</math> is an adjustment to the position of the midpoint of the curve's maximum value <math>K</math> = the curves maximum value, <math>k</math> = the steepness of the curve (growth rate), and <math>N_0</math> is the starting population it includes parameters to change the midpoint as well as change the natural exponent (ie: <math>\exp</math>) to some other value. NOTE: This is for continuous growth, and since SHAPE is discrete at present this is an unused function.</i>
----------------	---

---

### Description

This function is simply an implementation of the logistic growth equation where:  $f(x) = K / (1 + ((K - N_0)/N_0) * \exp(-k(x-x_0)))$ ; Where  $x_0$  is an adjustment to the position of the midpoint of the curve's maximum value  $K$  = the curves maximum value,  $k$  = the steepness of the curve (growth rate), and  $N_0$  is the starting population it includes parameters to change the midpoint as well as change the natural exponent (ie:  $\exp$ ) to some other value. NOTE: This is for continuous growth, and since SHAPE is discrete at present this is an unused function.

### Usage

```
logisticGrowth(func_rate, func_step, func_startPop = NULL,
  func_maxPop = NULL, func_midAdjust = 0,
  func_basalExponent = exp(1))
```



**Arguments**

func_rate	The basal growth rate of individuals in the SHAPE run.
func_step	This is the number of steps forward for which you wish to calculate the growth expected.
func_startPop	The sum of the populations in the evolving community.
func_maxPop	The carrying capacity of the environment being simulated.
func_midAdjust	The midpoint which controls the point of inflection for the logistic equation. Beware, change this at your own risk as its impact will vary based on the population sizes being simulated. Ideally, don't change this value from its default.
func_baseExponent	This defaults as the natural exponent "e" / "exp". Change it at your own risk.

**Value**

Returns a single value representing the amount of logistic growth expected by the community

---

logisticMap	<i>This is the discrete time logistic growth function known as the logistic map. It calculates the amount of growth expected in a step of time given by: <math>N_{t+1} = N_t + r * (N_t (K - N_t)/K)</math>; where <math>N_t</math> is community size at a time point, <math>r</math> is the per step growth rate, and <math>K</math> is the environmental carrying capacity.</i>
-------------	---

---

**Description**

This is the discrete time logistic growth function known as the logistic map. It calculates the amount of growth expected in a step of time given by:  $N_{t+1} = N_t + r * (N_t (K - N_t)/K)$ ; where  $N_t$  is community size at a time point,  $r$  is the per step growth rate, and  $K$  is the environmental carrying capacity.

**Usage**

```
logisticMap(func_rate, func_startPop, func_maxPop)
```

**Arguments**

func_rate	Per time step intrinsic growth rate of individuals
func_startPop	The initial summed size of the evolving community
func_maxPop	The carrying capacity of the simulated environment

**Value**

A single value as to the expected summed size of evolving populations in the considered environment.

---

lossSampling	<i>This function actually calculates the stochastic loss to populations.</i>
--------------	--

---

### Description

This function actually calculates the stochastic loss to populations.

### Usage

```
lossSampling(func_inPopulation, func_dilutionFactor)
```

### Arguments

func_inPopulation	This is a vector of the number of individuals in the populations within the community.
func_dilutionFactor	This is expected proportion of the current population sizes that should remain.

### Value

A vector of the resultant population sizes remaining.

---

mutationFunction	<i>This allows SHAPE to simulate the mutation process as a deterministic value. At present, values must be tracked as integer results for reasons of how I am passing to functions which identify what mutant genotype(s) are created.</i>
------------------	--

---

### Description

This allows SHAPE to simulate the mutation process as a deterministic value. At present, values must be tracked as integer results for reasons of how I am passing to functions which identify what mutant genotype(s) are created.

### Usage

```
mutationFunction(func_inSize, func_inProb = 0)
```

### Arguments

func_inSize	This is the vector of the population sizes, or perhaps number of births, or sum of both, within the community. Which vector gets passed will depend on which growth form and other parameters are being implemented by SHAPE.
func_inProb	This is the general mutation rate (probability) defined for this run of SHAPE. It is a per individual considered value, by which I mean that each mutant will have a single new mutation (or reversion if allowed - handled elsewhere) and so this probability is based on the vector of individuals passed and any context of if it is a "per generation" value relates to how time steps and birth probabilities are handled in the run.

**Value**

A vector of the number of mutants produced by each of the populations represented by the func\_inSize vector

---

nameTable	<i>This is a standardising function which allows SHAPE to programatically name tables for the fitness landscape OR split a named table and extract the embedded information from its naming.</i>
-----------	--

---

**Description**

This is a standardising function which allows SHAPE to programatically name tables for the fitness landscape OR split a named table and extract the embedded information from its naming.

**Usage**

```
nameTable(func_tmpMutations, func_tmpIndex = NULL,
  func_baseString = getOption("shape_string_tableNames"),
  func_sepString = getOption("shape_sepString"),
  func_splitName = FALSE,
  func_subNaming = getOption("shape_db_splitTables"))
```

**Arguments**

func\_tmpMutations Integer value(s) for the number of mutations to be expected in mutants stored within the named tables.

func\_tmpIndex An optional element that will be used to insert a unique vector ID

func\_baseString This is the standard prefix character string used in table naming.

func\_sepString This is a character string used to collapse vectors of characters.

func\_splitName A logical toggle to control if this function is splitting a named table or not. So, FALSE (default) means we're creating a table name whereas TRUE is splitting a named table into it's parts.

func\_subNaming This is a logical which controls if the tables which report on all genotypes with X mutations should be forced into a single table or if SHAPE is allowed to split them into multiple tables.

**Value**

If func\_splitName is TRUE, then a vector of table names is returned, it would be best practice to not assume recycling of passed elements and so pass equally lengthed vectors as input. If FALSE, we split the table and return the data detailing the number of mutations which ought to be present for genotypes stored in the named table.

---

nameTable\_neighbourhood

*This is a standardising function which allows SHAPE to programatically name tables for the neighbourhood record OR split a named table and extract the embedded information from its naming.*

---

### Description

This is a standardising function which allows SHAPE to programatically name tables for the neighbourhood record OR split a named table and extract the embedded information from its naming.

### Usage

```
nameTable_neighbourhood(func_Index, funcSplit = FALSE,
  func_sepString = getOption("shape_sepString"))
```

### Arguments

func_Index	Integer value(s) for the unique genotype ID whose neighbourhood which will be recorded by the named table
funcSplit	A logical toggle to control if this function is splitting a named table or not. So, FALSE (default) means we're creating a table name whereas TRUE is splitting a named table into it's parts.
func_sepString	This is a character string used to collapse vectors of characters.

### Value

If funcSplit is TRUE, then a vector of table names is returned. If FALSE, we split the table and return the data detailing the genotype ID whose neighbourhood is being recorded on the named table.

---

nameTable\_step

*This is a standardising function which allows SHAPE to programatically name tables for the step-wise record OR split a named table and extract the embedded information from its naming.*

---

### Description

This is a standardising function which allows SHAPE to programatically name tables for the step-wise record OR split a named table and extract the embedded information from its naming.

### Usage

```
nameTable_step(func_Index, funcSplit = FALSE,
  func_sepString = getOption("shape_sepString"))
```

**Arguments**

- func\_Index Integer value(s) for the step of a SHAPE run which will be recorded by this table
- funcSplit A logical toggle to control if this function is splitting a named table or not. So, FALSE (default) means we're creating a table name whereas TRUE is splitting a named table into it's parts.
- func\_sepString This is a character string used to collapse vectors of characters.

**Value**

If funcSplit is TRUE, then a vector of table names is returned. If FALSE, we split the table and return the data detailing the step number being recorded on the named table.

---

name_batchString	<i>This function is used to build or split character string to be used for naming batches of SHAPE runs.</i>
------------------	--

---

**Description**

This function is used to build or split character string to be used for naming batches of SHAPE runs.

**Usage**

```
name_batchString(funcBase, func_setID = NULL, func_jobID = NULL,
  func_repID = NULL, funcSplit = FALSE,
  func_sepString = getOption("shape_sepString"))
```

**Arguments**

- funcBase If building names this is the basal string element prefixing the name. If splitting, it is the vector of names to be split.
- func\_setID If building names, a vector of the unique set IDs to be named, otherwise a logical of whether or not the batch naming structure includes sets
- func\_jobID If building names, a vector of the unique job IDs to be named, otherwise a logical of whether or not the batch naming structure includes jobs
- func\_repID If building names, a vector of the unique replicate IDs to be named, otherwise a logical of whether or not the batch naming structure includes replicates
- funcSplit Logical toggle TRUE if splitting names, FALSE to build string characters
- func\_sepString This is the standard string separator for the SHAPE run

**Value**

Either a vector of character strings for the created batch names, or a matrix with the decomposed elements of the split batch name strings

---

name_batchSubmit	<i>This is a function to programatically create R batch submission script names</i>
------------------	---

---

**Description**

This is a function to programatically create R batch submission script names

**Usage**

```
name_batchSubmit(inVar)
```

**Arguments**

inVar	This is the vector of character string(s) to be used for naming
-------	---

**Value**

A vector of character string of length equal to input.

---

name_bodyScript	<i>This is a function to programatically create R script names</i>
-----------------	--

---

**Description**

This is a function to programatically create R script names

**Usage**

```
name_bodyScript(inVar)
```

**Arguments**

inVar	This is the vector of character string(s) to be used for naming
-------	---

**Value**

A vector of character string of length equal to input.

---

name_parameterScript	<i>This is a function to programatically create R script names</i>
----------------------	--

---

**Description**

This is a function to programatically create R script names

**Usage**

```
name_parameterScript(inVar)
```

**Arguments**

inVar	This is the vector of character string(s) to be used for naming
-------	---

**Value**

A vector of character string of length equal to input.

---

name_subScript	<i>This is a function to programatically create R batch submission script names</i>
----------------	---

---

**Description**

This is a function to programatically create R batch submission script names

**Usage**

```
name_subScript(inVar)
```

**Arguments**

inVar	This is the vector of character string(s) to be used for naming
-------	---

**Value**

A vector of character string of length equal to input.

---

querryEstablished	<i>This function is used to find which elements of a population matrix are deemed as established. Established is determined by having a number of individuals greater than or equal to a definable proportion of the summed community size.</i>
-------------------	---

---

### Description

This function is used to find which elements of a population matrix are deemed as established. Established is determined by having a number of individuals greater than or equal to a definable proportion of the summed community size.

### Usage

```
querryEstablished(func_inMatrix, func_sizeCol = "popSize",
  func_fitCol = "fitness", func_estProp = 0.01)
```

### Arguments

func_inMatrix	This is a matrix which must contain at least one column named as func_sizeCol which contains the number of individuals in the communities' populations. But it may also be required to include a column func_fitCol if func_estProp is "Desai".
func_sizeCol	DO NOT MODIFY - this is the column name that is queried to find population sizes
func_fitCol	DO NOT MODIFY - this is the column name that is queried to find population fitness - only important if func_estProp is set to "Desai"
func_estProp	If this value is less than 1 - This is the proportion of the current community size which is used to define a population as established it returns the rows of. If this value is greater than 1, it is the minimum number of individuals required before a population is considered as established. Lastly, it can be the character string "Desai", at which point - as per Desai 2007 - a lineage is established once it has 1/s individuals.

### Value

A subset form of the input func\_inMatrix matrix object containing the populations which are calculated as established.

---

reportPopulations	<i>This is a convenience function to ensure that our population demographics are stored in a data frame and exists because R's standard functions can collapse single row frames to named vectors. It requires that all passed vectors be of the same length</i>
-------------------	--

---

### Description

This is a convenience function to ensure that our population demographics are stored in a data frame and exists because R's standard functions can collapse single row frames to named vectors. It requires that all passed vectors be of the same length



**Usage**

```
reportPopulations(func_numMuts, func_genotypeID, func_popSizes,
  func_fitnesses, func_births, func_deaths, func_mutants, func_progenitor,
  func_reportMat_colnames = getOption("shape_reportMat_colnames"))
```

**Arguments**

func_numMuts	This is a vector of the number of mutations held within each tracked genotype.
func_genotypeID	This is a vector of the unique genotype ID for each tracked population in the community.
func_popSizes	This is a vector of the number of individuals for each population of genotypes in the community.
func_fitnesses	This is a vector of the fitness for each genotype being tracked.
func_births	This is a vector of the number of births produced by each population in this time step.
func_deaths	This is a vector of the number of deaths in each population in this time step.
func_mutants	This is a vector of the number of mutants produced by each population in this time step.
func_progenitor	This is a vector of character strings expressing any progenitor genotypes which generated a mutant that fed into each genotype's population in this time step.
func_reportMat_colnames	DO NOT MODIFY - This is the vector of character strings to be assigned as the column names.

**Value**

A data frame with columns named as per func\_reportMat\_colnames.

---

resetDatabase	<i>This is a convenience function to refresh connections to database files.</i>
---------------	---

---

**Description**

This is a convenience function to refresh connections to database files.

**Usage**

```
resetDatabase(func_conName, func_existingCon = NULL,
  func_type = "connect")
```

**Arguments**

func_conName	The filepath to which an SQLite connection is sought.
func_existingCon	If any value other than NULL, then any existing connection is first dropped prior to attempting to form a connection to the func_conName filepath.
func_type	This should be a character string of either <b>connect</b> , in which case a connection is made/refreshed to the filepath in func_conName, or any other value will cause disconnection

**Value**

An SQLite connection object to an SQLite database.

---

`retrieve_binaryString` *This is a function to search our mutational database and then find the binary string of the genotypeID passed. This function is more efficient when the number of mutations for each genotypeID be passed as this helps reduce the tables of the mutational space that are searched. This matters when large genotypes are simulated.*

---

**Description**

This is a function to search our mutational database and then find the binary string of the genotypeID passed. This function is more efficient when the number of mutations for each genotypeID be passed as this helps reduce the tables of the mutational space that are searched. This matters when large genotypes are simulated.

**Usage**

```
retrieve_binaryString(func_genotypeID, func_numMuts = NULL,
  func_subNaming, func_landscapeCon)
```

**Arguments**

`func_genotypeID` This is a vector of the unique genotype ID for each tracked population in the community.

`func_numMuts` This is a vector of the number of mutations held within each tracked genotype.

`func_subNaming` This is a logical which controls if the tables which report on all genotypes with X mutations should be forced into a single table or if SHAPE is allowed to split them into multiple tables.

`func_landscapeCon` This is the filepath to an SQLite database storing information for the complete explored and neighbouring fitness landscape of a SHAPE run.

**Value**

This returns a vector of character strings that represent the binary strings of the genotypes

---

runProcessing	<i>This is a wrapper function to process a SHAPE run and extract meaningful summary information.</i>
---------------	--

---

## Description

This is a wrapper function to process a SHAPE run and extract meaningful summary information.

## Usage

```
runProcessing(func_saveFile, func_subNaming, func_stepsCon,
  func_landscapeCon, func_hoodCon, func_estProp, func_size_timeStep,
  func_processObjects = getOption("shape_processedObjects"),
  func_hoodPriority = getOption("shape_const_hoodDepth"))
```

## Arguments

func_saveFile	This is the filepath where the SHAPE run processed objects are to be saved.
func_subNaming	This is a logical which controls if the tables which report on all genotypes with X mutations should be forced into a single table or if SHAPE is allowed to split them into multiple tables.
func_stepsCon	This is the filepath to an SQLite database storing information for the stepwise changes of a SHAPE run.
func_landscapeCon	This is the filepath to an SQLite database storing information for the complete explored and neighbouring fitness landscape of a SHAPE run.
func_hoodCon	This is the filepath to an SQLite database storing information for high priority mutational neighbourhood information
func_estProp	This value is used to define the threshold size required for a population before it is considered established.
func_size_timeStep	This is the proportion of a standard biological generation being considered to be within a single time step.
func_processObjects	This is a vector of character strings which define the names of what objects will be produced and creates a global objects. DO NOT CHANGE THESE VALUES.
func_hoodPriority	This is an object to control which strains we get deep neighbourhood information for. It should be one of <b>"none"</b> , <b>"limited"</b> , <b>"priority"</b> , <b>"full"</b> setting this higher will cost more and more in post analysis runtime.

## Value

This returns a string vector stating the result of trying to process for the specified filepath.

---

runReplicate	<i>This is the function that runs the main body, or meaningful execution, of SHAPE experiments. In other words this is the main work-horse function that calls all the other parts and will execute you simulation run. It has the main parts of: 1. Stochastic Events; 2. Deaths; 3. Births; 4. Mutations; and during mutations this is where the mutational landscape is queried and updated as required. NOTE: Many of its internal operations are controlled by options with the suffix "shape_" and are not explicitly passed as arguments at call to this function.</i>
--------------	---

---

## Description

This is the function that runs the main body, or meaningful execution, of SHAPE experiments. In other words this is the main work-horse function that calls all the other parts and will execute you simulation run. It has the main parts of: 1. Stochastic Events; 2. Deaths; 3. Births; 4. Mutations; and during mutations this is where the mutational landscape is queried and updated as required. NOTE: Many of its internal operations are controlled by options with the suffix "shape\_" and are not explicitly passed as arguments at call to this function.

## Usage

```
runReplicate(func_inputFrames, func_currStep, func_stepCounter,
  func_growthModel = getOption("shape_const_growthForm"),
  func_growthRate = getOption("shape_const_growthRate"),
  func_landscapeModel = getOption("shape_simModel"),
  func_fileName_dataBase = getOption("shape_fileName_dataBase"))
```

## Arguments

func_inputFrames	This is a list of data.frames, either 1 or 2 elements, reporting on the last one or two steps in the simulation.
func_currStep	This is an integer value counting the absolute step in the simulation, its value is never reset.
func_stepCounter	This is an integer value which is a counter in the most traditional sense. It's job is to track if it's time for a Stochastic event to trigger and its value is reset at that point.
func_growthModel	This is the growth model of the SHAPE run, it is passed here as a computational convenience since it is used numerous times in the function
func_growthRate	This is the growth rate of the SHAPE run, it is passed here as a computational convenience since it is used numerous times in the function
func_landscapeModel	This is the fitness landscape model of the SHAPE run, it is passed here as a computational convenience since it is used numerous times in the function
func_fileName_dataBase	This is the filepaths of DBs of the SHAPE run, it is passed here as a computational convenience since it is used numerous times in the function

**Value**

Returns a new list of 2 data.frames reporting on the state of SHAPE community for the last 2 time steps - ie: the one just run, and the most prior step.

runSHAPE

*This is the actual running of shape, it will initialise objects and values which are calculated from the parameters that have been set - see the options with the suffix 'shape\_'. It will establish the database output files and other initial conditions and then perform replicate simulations as appropriately defined. In essence this is the master wrapper function for all other functions. If you want to test/see SHAPE's default run then simply call this function after loading the library you'll see an experiment built under your root directory. It at least requires that defineSHAPE have been run, else this is going to fail.*

**Description**

This is the actual running of shape, it will initialise objects and values which are calculated from the parameters that have been set - see the options with the suffix 'shape\_'. It will establish the database output files and other initial conditions and then perform replicate simulations as appropriately defined. In essence this is the master wrapper function for all other functions. If you want to test/see SHAPE's default run then simply call this function after loading the library you'll see an experiment built under your root directory. It at least requires that defineSHAPE have been run, else this is going to fail.

**Usage**

```
runSHAPE(loop_thisRep = getOption("shape_thisRep"),
  workingReplicates = seq(getOption("shape_thisRep"),
    getOption("shape_maxReplicates"), by = 1))
```

**Arguments**

**loop\_thisRep** This is the first replicate value to be simulated in this run, it is standard 1 but can be changed to help with recovery in the middle of a series of replicates.

**workingReplicates** This is the maximum replicate number to be simulated in this call. It is meaningfully different from the number of replicates to be run only when loop\_thisRep != 1.

set\_const\_NK\_interactionsMat

*This is a function to just return a matrix that defines the sitewise dependencies for an NK fitness landscape. If K == 0 or, this is not an NK simulation, it return NULL*

**Description**

This is a function to just return a matrix that defines the sitewise dependencies for an NK fitness landscape. If K == 0 or, this is not an NK simulation, it return NULL

**Usage**

```
set_const_NK_interactionsMat(func_simModel = getOption("shape_simModel"),
  func_genomeLength = getOption("shape_genomeLength"),
  func_numInteractions = getOption("shape_const_numInteractions"))
```

**Arguments**

`func_simModel` This is the fitness landscape model being simulated

`func_genomeLength` This is the number of sites in the genome being simulated

`func_numInteractions` An integer value defining the number of sites that interact with each other site

**Value**

Either NULL, or a matrix with  $K + 1$  columns, detailing the sites interacting with a focal site - identified by the row number and the cell values of the columns.

---

`set_const_RMF_globalOptima`

*This function samples the space of all possible genotypes and then defines one that will be considered as the independent fitness contribution global optima.*

---

**Description**

This function samples the space of all possible genotypes and then defines one that will be considered as the independent fitness contribution global optima.

**Usage**

```
set_const_RMF_globalOptima(func_simModel = getOption("shape_simModel"),
  func_genomeLength = getOption("shape_genomeLength"),
  func_initDistance = getOption("shape_const_RMF_initiDistance"),
  func_sepString = getOption("shape_sepString"))
```

**Arguments**

`func_simModel` This is the fitness landscape model being simulated

`func_genomeLength` The number of sites in the genome being simulated

`func_initDistance` This is the number of mutations found in the global optimal genotype

`func_sepString` This is the string collapse separator used in the run

**Value**

A character string of genome positions at which there ought to be mutations to be optimal

---

set\_DepbySite\_ancestFitness

*This is a convenience function for setting the dependent fitness values of sites in an NK fitness landscape model. This allows the dependent fitness of sites to be calculated once and then referenced as mutations occur. It makes exploring this style of fitness landscape a bit more computationally friendly - as it generally isn't.*

---

### Description

This is a convenience function for setting the dependent fitness values of sites in an NK fitness landscape model. This allows the dependent fitness of sites to be calculated once and then referenced as mutations occur. It makes exploring this style of fitness landscape a bit more computationally friendly - as it generally isn't.

### Usage

```
set_DepbySite_ancestFitness(func_simModel = getOption("shape_simModel"),
  func_const_siteBystate_fitnessMat = getOption("shape_const_siteBystate_fitnessMat"),
  func_const_NK_interactionMat = getOption("shape_const_NK_interactionMat"))
```

### Arguments

func\_simModel    This is the fitness landscape model being simulated  
 func\_const\_siteBystate\_fitnessMat  
                     This is the sitewise independent fitness contributions in the fitness landscape  
 func\_const\_NK\_interactionMat  
                     This defines the sitewise dependencies based on the K interactions.

### Value

Either the dependent sitewise fitness contributions in an NK fitness landscape, or NA.

---

set_RMF_indWeight	<i>In a RMF fitness landscape model, there is a weighting value applied to the independent fitness contribution term. This function calculates that value for the run</i>
-------------------	---

---

### Description

In a RMF fitness landscape model, there is a weighting value applied to the independent fitness contribution term. This function calculates that value for the run

### Usage

```
set_RMF_indWeight(func_simModel = getOption("shape_simModel"),
  func_numDraws = 1e+08, func_distType = getOption("shape_constDist"),
  func_distParms = getOption("shape_const_distParameters"),
  func_const_RMF_theta = getOption("shape_const_RMF_theta"))
```

**Arguments**

func_simModel	This is the model of fitness landscape being considered
func_numDraws	This is the number of draws taken from the independent term's distribution so that we can identify the amount of variance in that distribution. It should be a large integer – eg 5e7
func_distType	This is the distribution string reference for this run
func_distParms	These are the parameters for this runs distribution function
func_const_RMF_theta	This is the theta value which is multiplied to the variance in the distribution. The value returned will be a product of this numeric and the variance calculated. From Neidhart 2014 theta is measured as: $\theta = c / \sqrt{\text{var random\_component}}$ and so if we want to calculate "c" we return the product of theta and sqrt of variance in the distribution

**Value**

A single numeric value, which may be NA if a non Rough Mount Fuji model is being simulated

---

**set\_siteByState\_fitnessMat**

*This function is designed to establish an initial object which maps the fitness values of genome positions based on the state of that site. At present, this has no meaning if the model of simulation is no NK, Additive, or Fixed. Where the first is Kauffman's NK model and form of calculations, Additive is what that word would make you think for fitness effects of mutations at sites, and Fixed is when user supplied a defined fitness matrix that describes the entire fitness landscape. NOTE: This function should likely be called without supplying any non-default arguments as it will use the shape\_options defined.*

---

**Description**

This function is designed to establish an initial object which maps the fitness values of genome positions based on the state of that site. At present, this has no meaning if the model of simulation is no NK, Additive, or Fixed. Where the first is Kauffman's NK model and form of calculations, Additive is what that word would make you think for fitness effects of mutations at sites, and Fixed is when user supplied a defined fitness matrix that describes the entire fitness landscape. NOTE: This function should likely be called without supplying any non-default arguments as it will use the shape\_options defined.

**Usage**

```
set_siteByState_fitnessMat(func_simModel = getOption("shape_simModel"),
  func_const_fixedFrame = getOption("shape_const_fixedFrame"),
  func_const_siteStates = getOption("shape_const_siteStates"))
```



**Arguments**

func\_simModel    This is the fitness landscape model being simulated

func\_const\_fixedFrame    This is a contextual object that described constant fitness effects

func\_const\_siteStates    These are the possible states for genome sites, at present this ought to be "0" and/or "1"

**Value**

A contextually meaningful matrix describing fitness effects of mutations/genotypes, where based on the context NULL may be returned.

---

shapeCombinations	<i>This is a function to take the input parameters and build the parameter combinations</i>
-------------------	---

---

**Description**

This is a function to take the input parameters and build the parameter combinations

**Usage**

```
shapeCombinations(func_inLines, func_comboRef, func_indepRef, func_condRef)
```

**Arguments**

func\_inLines    These are the template lines of text to be updated.

func\_comboRef    This is the reference identifiers for grouped as pairwise parameter combinations

func\_indepRef    This is the reference identifiers for independent parameter values not to be done pairwise

func\_condRef    This is the reference identifiers for grouped parameter combinations which are conditional on others.

**Value**

A table of parameter combinations which represents the combination of experimental parameters for a SHAPE experiment.

---

shapeExperiment	<i>This is a function used to read the SHAPE_experimentalDesign type input file and then build a SHAPE experiment by creating all the folder structure, .R and .sh scripts required to programatically run your experiment – excluding post-analysis, that’s a you problem.</i>
-----------------	---

---

## Description

This is a function used to read the SHAPE\_experimentalDesign type input file and then build a SHAPE experiment by creating all the folder structure, .R and .sh scripts required to programatically run your experiment – excluding post-analysis, that’s a you problem.

## Usage

```
shapeExperiment(func_filapath_toDesign, func_templateDir,
  func_maxGrouped_perShell = 2, func_filePath_R = NULL,
  func_baseCall = "CMD BATCH",
  func_rArgs = "\"--args shape_thisRep=1 shape_outDir='fake_serverPath/fakeDir/'\"",
  func_remoteLocation = "$TMPDISK", func_submitArgs = c(number_ofCores
    = "-c 1", memory = "--mem=8192", jobName = "-J fakeJob", wallTime =
    "-t 14-00:00:00", fileOut = "-o fakeOut"))
```

## Arguments

func_filapath_toDesign	This is the absolute filepath which points to the SHAPE_experimentalDesign like template you’d like used to identify parameter combinations for building your experiment.
func_maxGrouped_perShell	Integer value defining the maximal number of jobs that an output shell script will try to have run in parallel once executed. This is related to your parallel computing potential.
func_filePath_R	This is the absolute path to the R application on the system where SHAPE would be run via BATCH MODE, its value is applied in shell scripts written for running the experiment. If left NULL then this function will try to use standard R install paths of which I’m aware.
func_baseCall	This is a string element of arguments when calling BATCH MODE if R via shell script.
func_rArgs	This is a character string which represent additional arguments to be passed via shell script BATCH mode call of R. I consider it most practicable to set the replicate and output directory of SHAPE.
func_remoteLocation	The filepath of the compute node on a remote server where your job would be run. The default is based on the environment variable value used in CAC’s SLURM submission system.
func_submitArgs	This is information concerning sheel script lines for automatic submission of jobs to a remote server’s submission system. I’m basing this off of the SLURM

system of the Center for Advanced Computing Queen's University computing platform. If your system is different you may need to tweak this. Sorry? This should be a vector of arguments passed for job submissions on a remote server. The example here would call 1 core with 8 Gb RAM and a wall time of 14 days and an outFile be named You can add more arguments if your server requires this, they'll get used. BUT where the job's name MUST be identified as — fakeJob — and the output log as — fakeOut —, you can change the argument queues I also assume your remote server will create a local directory on the compute nodes where your job once submitted, and that there will be the location defined by func\_remoteLocation.

### Value

If no error is encountered, a message will be returned suggesting the build was successful. SHAPE makes no effort to perform validation of this effort to build the experiment and presumes no fatal errors is sufficient evidence.

---

stopError	<i>This is a convenience wrapper for sending an error and ending the SHAPE run as well as the R environment. It will print a message and then traceback() report before pausing and quitting the R session. This exists to help debugging when SHAPE is run in batch-mode.</i>
-----------	--

---

### Description

This is a convenience wrapper for sending an error and ending the SHAPE run as well as the R environment. It will print a message and then traceback() report before pausing and quitting the R session. This exists to help debugging when SHAPE is run in batch-mode.

### Usage

```
stopError(func_message)
```

### Arguments

func\_message     The message to be sent to screen prior to ending the R session.

---

trimQuotes	<i>This is a function to trim a string by removing the first and last character, it's used to trim quotation marks used in the parameter input</i>
------------	--

---

### Description

This is a function to trim a string by removing the first and last character, it's used to trim quotation marks used in the parameter input

### Usage

```
trimQuotes(funcIn)
```

**Arguments**

funcIn                      a vector of character strings which you want trimmed

**Value**

character vector of length equal to the input

---

updateLines	<i>This is a function which is used to update lines that are searched and replace in a manner conditional to this script's circumstances The input lines can be a vector of any length, and the search patterns can be a list of any length where each list vector is used together. The values should be a list of information used as replacement info.</i>
-------------	---

---

**Description**

This is a function which is used to update lines that are searched and replace in a manner conditional to this script's circumstances The input lines can be a vector of any length, and the search patterns can be a list of any length where each list vector is used together. The values should be a list of information used as replacement info.

**Usage**

```
updateLines(func_inLines, func_searchPattern, func_values)
```

**Arguments**

func\_inLines      These are the lines that are to be updated before output  
 func\_searchPattern      These are the string-s- to be searched for replacement  
 func\_values      These are the values that are to replace the searched strings.

**Value**

A vector of character strings that has now been updated.

---

writeParameters	<i>This is a file for updating the post analysis plotting script and creating an updated copy in the experiment's folder</i>
-----------------	--

---

**Description**

This is a file for updating the post analysis plotting script and creating an updated copy in the experiment's folder

**Usage**

```
writeParameters(func_infile, func_inParms, func_inCombos, func_outDir,  
  func_bodyScript, func_ExternalStopper,  
  func_sepString = getOption("shape_sepString"))
```

**Arguments**

func_infile	This is the filepath location for the template script to be written in.
func_inParms	These are the parameters to be updated in the plotting file
func_inCombos	This is the combination of parameters to be written
func_outDir	This is the directory filepath to which output should be written.
func_bodyScript	This is a run body of SHAPE script to be read in as template
func_ExternalStopper	This is a file placed externally used as a logical flag that SHAPE should stop trying to seed new replicates to be run.
func_sepString	This is the common string for collapsing information.

**Value**

A character string indicating that the plotting file-s- have been written

---

write_subScript	<i>This function is used to programatically take vectors of parameters and write suites of R parameter scripts that will form part of a SHAPE experiment that is being built for running. This is a wrapper for writing out the suite of necessary scripts to form a run.</i>
-----------------	---

---

**Description**

This function is used to programatically take vectors of parameters and write suites of R parameter scripts that will form part of a SHAPE experiment that is being built for running. This is a wrapper for writing out the suite of necessary scripts to form a run.

**Usage**

```
write_subScript(func_subScript, func_outDir, func_inCombos, func_inParms,
  func_maxJobs, func_appLocation, func_commonArgs, func_submitArgs,
  func_remoteLocation, func_passedArgs,
  func_externalStopper = getOption("shape_external_stopFile"),
  func_sepString = getOption("shape_sepString"))
```

**Arguments**

func_subScript	This is the template script that needs to be replicated
func_outDir	This is the filepath directory where output should be placed
func_inCombos	This is the combinations of parameters that are to be used in the experiment.
func_inParms	# These are additional parameters to be implemented in writing out combinations.
func_maxJobs	This is the maximum number of individual R jobs that should be called at once by the shell submission scripts, it can affect both local and remote server calls.
func_appLocation	This is the filepath for R so that batch mode runs can be called.

func\_commonArgs

These are common arguments important when running the batch mode

func\_submitArgs

These are common arguments important when submitting the batch mode

func\_remoteLocation

This is a remote server location where an experiment built is to be run it affects the filepathing called by submission scripts and the associated batch mode runs performed.

func\_passedArgs

These are arguments passed through this wrapper to inner functions.

func\_externalStopper

This is a file which exists as a flag for stopping SHAPE from trying to create additional replicates.

func\_sepString This is the common string used to collapse information.

### **Value**

A character string that should indicate the experiment has been created. Otherwise this has failed.

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