Package ‘phylobase’

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Emmanuel Paradis, Jim Regetz, Derrick Zwickl)
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one or more trees and trait data.
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phylobase-package

Description

Base package for phylogenetic structures and comparative data.

Details

phylobase provides a set of functions to associate and manipulate phylogenetic information and data about the species/individuals that are in the tree.

phylobase intends to be robust, fast and efficient. We hope other people use the data structure it provides to develop new comparative methods in R.

With phylobase it is easy to ensure that all your data are represented and associated with the tips or the internal nodes of your tree. phylobase provides functions to:

• prune (subset) your trees, find ancestor(s) a descendant(s)
• find the most common recent ancestor of 2 nodes (MRCA)
• calculate the distance of a given node from the tip or between two nodes in your tree
• robust functions to import data from NEXUS and Newick files using the NEXUS Class Library (https://github.com/mtholder/ncl/)

History

phylobase was started during a Hackathon at NESCenct on December 10-14 2007.

Peter Cowan was a Google Summer of Code fellow in 2008 and developed all the code for plotting.

In December 2008, a mini-virtual Hackathon was organized to clean up and make the code more robust.

In the spring and summer of 2009, Jim Regetz made several contributions that made the code faster (in particular with the re-ordering parts), found many bugs, and wrote most of the testing code.

phylobase was first released on CRAN on November 1st, 2009 with version 0.5.

Since then, several releases have followed adding new functionalities: better support of NEXUS files, creation of phylobase.options() function that controls the phylotree validator, rewrite of the validator in C++.

Starting with 0.6.8, Francois Michonneau succeeds to Ben Bolker as the maintainer of the package.

More Info

See the help index help(package="phylobase") and run vignette("phylobase", "phylobase") for further details and examples about how to use phylobase.
addData

Adding data to a phylo4 or a phylo4d object

Description

addData adds data to a phylo4 (converting it in a phylo4d object) or to a phylo4d object

Usage

addData(x, ...)

## S4 method for signature 'phylo4d'
addData(x, tip.data = NULL, node.data = NULL,
       all.data = NULL, merge.data = TRUE, pos = c("after", "before"),
       ...)

## S4 method for signature 'phylo4'
addData(x, tip.data = NULL, node.data = NULL,
       all.data = NULL, merge.data = TRUE, pos = c("after", "before"),
       ...)

Arguments

x  a phylo4 or a phylo4d object

...  additional arguments to control how matching between data and tree (see Details section of phylo4d-methods for more details).

tip.data  a data frame (or object to be coerced to one) containing only tip data

node.data  a data frame (or object to be coerced to one) containing only node data

all.data  a data frame (or object to be coerced to one) containing both tip and node data

merge.data  if both tip.data and node.data are provided, it determines whether columns with common names will be merged together (default TRUE). If FALSE, columns with common names will be preserved separately, with ".tip" and "node" appended to the names. This argument has no effect if tip.data and node.data have no column names in common.

pos  should the new data provided be bound before or after the pre-existing data?

Details

Rules for matching data to tree nodes are identical to those used by the phylo4d-methods constructor.

If any column names in the original data are the same as columns in the new data, ".old" is appended to the former column names and ".new" is appended to the new column names.

The option pos is ignored (silently) if x is a phylo4 object. It is provided for compatibility reasons.
Value

addData returns a phylo4 object.

Author(s)
Francois Michonneau

See Also
tdata for extracting or updating data and phylo4d-methods constructor.

Examples

data(geospiza)
nDt <- data.frame(a=rnorm(nNodes(geospiza)), b=1:nNodes(geospiza),
                      row.names=nodeId(geospiza, "internal"))
t1 <- addData(geospiza, node.data=nDt)

ancestor

Tree traversal and utility functions

Description
Functions for describing relationships among phylogenetic nodes (i.e. internal nodes or tips).

Usage

ancestor(phy, node)

children(phy, node)

descendants(phy, node, type = c("tips", "children", "all", "ALL"))

siblings(phy, node, include.self = FALSE)

ancestors(phy, node, type = c("all", "parent", "ALL"))

Arguments

phy a phylo4 object (or one inheriting from phylo4, e.g. a phylo4d object)

node either an integer corresponding to a node ID number, or a character corresponding to a node label; for ancestors and descendants, this may be a vector of multiple node numbers or names

type (ancestors) specify whether to return just direct ancestor ("parent"), all ancestor nodes ("all"), or all ancestor nodes including self ("ALL"); (descendants) specify whether to return just direct descendants ("children"), all extant descendants ("tips"), or all descendant nodes ("all") or all descendant nodes including self ("ALL").
include.self whether to include self in list of siblings

... a list of node numbers or names, or a vector of node numbers or names

Details

ancestors and descendants can take node vectors of arbitrary length, returning a list of output vectors if the number of valid input nodes is greater than one. List element names are taken directly from the input node vector.

If any supplied nodes are not found in the tree, the behavior currently varies across functions.

- Invalid nodes are automatically omitted by ancestors and descendants, with a warning.
- ancestor will return NA for any invalid nodes, with a warning.
- Both children and siblings will return an empty vector, again with a warning.

Value

ancestors return a named vector (or a list of such vectors in the case of multiple input nodes) of the ancestors and descendants of a node

descendants return a named vector (or a list of such vectors in the case of multiple input nodes) of the ancestors and descendants of a node

ancestor ancestor is analogous to ancestors(...{}, type="parent") (i.e. direct ancestor only), but returns a single concatenated vector in the case of multiple input nodes

children is analogous to descendants(...{}, type="children") (i.e. direct descendants only), but is not currently intended to be used with multiple input nodes

siblings returns sibling nodes (children of the same parent)

See Also

mrca, in the ape package, gives a list of all subtrees

Examples

data(geospiza)
nodeLabels(geospiza) <- LETTERS[1:nNodes(geospiza)]
plot(as(geospiza, "phylo4"), show.node.label=TRUE)
ancestor(geospiza, "E")
children(geospiza, "C")
descendants(geospiza, "D", type="tips")
descendants(geospiza, "D", type="all")
ancestors(geospiza, "D")
MRCA(geospiza, "conirostris", "difficilis", "fuliginosa")
MRCA(geospiza, "olivacea", "conirostris")

## shortest path between 2 nodes
shortestPath(geospiza, "fortis", "fuliginosa")
shortestPath(geospiza, "F", "L")

## branch length from a tip to the root
sumEdgeLength(geospiza, ancestors(geospiza, "fortis", type="ALL"))
checkPhylo4

Validity checking for phylo4 objects

Description
Basic checks on the validity of S4 phylogenetic objects

Usage
checkPhylo4(object)

Arguments
object A prospective phylo4 or phylo4d object

Value
As required by validObject, returns an error string (describing problems) or TRUE if everything is OK.

Note
These functions are only intended to be called by other phylobase functions. checkPhylo4 is an (inflexible) wrapper for checkTree. The rules for phylo4 objects essentially follow those for phylo objects from the ape package, which are in turn defined in http://ape-package.ird.fr/misc/FormatTreeR_24Oct2012.pdf. These are essentially that:

• if the tree has edge lengths defined, the number of edge lengths must match the number of edges;
• the number of tip labels must match the number of tips;
• in a tree with ntips tips and nnodes (total) nodes, nodes 1 to ntips must be tips
• if the tree is rooted, the root must be node number ntips+1 and the root node must be the first row of the edge matrix
• tip labels, node labels, edge labels, edge lengths must have proper internal names (i.e. internal names that match the node numbers they document)
• tip and node labels must be unique

You can alter some of the default options by using the function phylobase.options.

For phylo4d objects, checkTree also calls checkPhylo4Data to check the validity of the data associated with the tree. It ensures that (1) the data associated with the tree have the correct dimensions, (2) that the row names for the data are correct.

Author(s)
Ben Bolker, Steven Kembel, Francois Michonneau
See Also

the phylo4 constructor and phylo4 class; the phylo4d-methods constructor and the phylo4d class
do checks for the data associated with trees. See coerce-methods for translation functions and
phylobase.options to change some of the default options of the validator.

edges  Edges accessors

Description

Access or modify information about the edges.

Usage

edges(x, ...)

## S4 method for signature 'phylo4'
edges(x, drop.root = FALSE)

edgeOrder(x, ...)

## S4 method for signature 'phylo4'
edgeOrder(x)

internalEdges(x)

## S4 method for signature 'phylo4'
internalEdges(x)

terminalEdges(x)

## S4 method for signature 'phylo4'
terminalEdges(x)

Arguments

x  a phylo4 or phylo4d object.
...  Optional arguments used by specific methods. (None used at present).
drop.root  logical (default FALSE), should the edge connecting the root be included in the
drop.root

Value

edges  returns the edge matrix that represent the ancestor-descendant relationships among the nodes
of the tree.
edgeOrder  returns the order in which the edge matrix is in.
internalEdges returns a logical vector indicating internal edges (edges that connect an internal node to another). This vector is named with the edgeId.

terminalEdges returns a logical vector indicating terminal edges (edges that connect an internal node to a tip). This vector is named with the edgeId.

Author(s)
Ben Bolker, Francois Michonneau, Thibaut Jombart

See Also
reorder, edgeId

Examples

data(geospiza)
edges(geospiza)
edgeOrder(geospiza)
geoPost <- reorder(geospiza, "postorder")
edgeOrder(geoPost)
## with a binary tree this should always be true
identical(!terminalEdges(geospiza), internalEdges(geospiza))

extractTree

Get tree from tree+data object

Description

Extracts a phylo4 tree object from a phylo4d tree+data object.

Usage

extractTree(from)

Arguments

from a phylo4d object, containing a phylogenetic tree plus associated phenotypic data. Created by the phylo4d() function.

Details

extractTree extracts just the phylogeny from a tree+data object. The phylogeny contains the topology (how the nodes are linked together), the branch lengths (if any), and any tip and/or node labels. This may be useful for extracting a tree from a phylo4d object, and associating with another phenotypic dataset, or to convert the tree to another format.

Author(s)
Ben Bolker
See Also

phylo4-methods, phylo4d-methods, coerce-methods for translation functions.

Examples

tree.phylo <- ape::read.tree(text = "((a,b),c);")
tree <- as(tree.phylo, "phylo4")
plot(tree)
tip.data <- data.frame(size = c(1, 2, 3), row.names = c("a", "b", "c"))
treedata <- phylo4d(tree, tip.data)
plot(treedata)
tree1 <- extractTree(treedata)
plot(tree1)

formatData

Format data for use in phylo4d objects

Description

Associates data with tree nodes and applies consistent formatting rules.

Usage

formatData(phy, dt, type = c("tip", "internal", "all"),
match.data = TRUE, rownamesAsLabels = FALSE,
label.type = c("rownames", "column"), label.column = 1,
missing.data = c("fail", "warn", "OK"), extra.data = c("warn", "OK", "fail"), keep.all = TRUE)

Arguments

phy a valid phylo4 object
dt a data frame, matrix, vector, or factor
type type of data to attach
match.data (logical) should the rownames of the data frame be used to be matched against tip and internal node identifiers? See details.
rownamesAsLabels (logical), should the row names of the data provided be matched only to labels (TRUE), or should any number-like row names be matched to node numbers (FALSE and default)
label.type character, rownames or column: should the labels be taken from the row names of dt or from the label.column column of dt?
label.column if label.type=="column", column specifier (number or name) of the column containing tip labels
Details

formatData is an internal function that should not be called directly by the user. It is used to format data provided by the user before associating it with a tree, and is called internally by the phylo4d, tdata, and addData methods. However, users may pass additional arguments to these methods in order to control how the data are matched to nodes.

Rules for matching rows of data to tree nodes are determined jointly by the match.data and rownamesAsLabels arguments. If match.data is TRUE, data frame rows will be matched exclusively against tip and node labels if rownamesAsLabels is also TRUE, whereas any all-digit row names will be matched against tip and node numbers if rownamesAsLabels is FALSE (the default). If match.data is FALSE, rownamesAsLabels has no effect, and row matching is purely positional with respect to the order returned by nodeID(phy, type).

formatData (1) converts labels provided in the data into node numbers, (2) makes sure that the data are appropriately matched against tip and/or internal nodes, (3) checks for differences between data and tree, (4) creates a data frame with the correct dimensions given a tree.

Value

formatData returns a data frame having node numbers as row names. The data frame is also formatted to have the correct dimension given the phylo4 object provided.

Author(s)

Francois Michonneau

See Also

the phylo4d-methods constructor, the phylo4d class. See coerce-methods for translation functions.

Description

Phylogenetic tree and morphological data for Darwin’s finches, in different formats

Format

geospiza is a phylo4d object; geospiza_raw is a list containing tree, a phylo object (the tree), data, and a data frame with the data (for showing examples of how to merge tree and data)
Note
Stolen from Luke Harmon’s Geiger package, to avoid unnecessary dependencies

Source
Dolph Schluter via Luke Harmon

Examples

data(geospiza)
plot(geospiza)

getNode
Node and Edge look-up functions

Description
Functions for retrieving node and edge IDs (possibly with corresponding labels) from a phylogenetic tree.

Usage

getNode(x, node, type = c("all", "tip", "internal"),
missing = c("warn", "OK", "fail"))

## S4 method for signature 'phylo4'
getNode(x, node, type = c("all", "tip", "internal"),
missing = c("warn", "OK", "fail"))

getEdge(x, node, type = c("descendant", "ancestor"),
missing = c("warn", "OK", "fail"))

## S4 method for signature 'phylo4'
getEdge(x, node, type = c("descendant", "ancestor"),
missing = c("warn", "OK", "fail"))

Arguments

x  a phylo4 object (or one inheriting from phylo4, e.g. a phylo4d object)

node  either an integer vector corresponding to node ID numbers, or a character vector
corresponding to node labels; if missing, all nodes appropriate to the specified
type will be returned by getNode, and all edges appropriate to the specified type
will be returned by getEdge.
getNode

**type**

(getNode) specify whether to return nodes matching "all" tree nodes (default), only "tip" nodes, or only "internal" nodes; (nodeId, edgeId) specify whether to return "all" tree nodes, or only those corresponding to "tip", "internal", or "root" nodes; (getNode) specify whether to look up edges based on their descendant node ("descendant") or ancestral node ("ancestor")

**missing**

what to do if some requested node IDs or names are not in the tree: warn, do nothing, or stop with an error

**Details**

getNode and getEdge are primarily intended for looking up the IDs either of nodes themselves or of edges associated with those nodes. Note that they behave quite differently. With getNode, any input nodes are looked up against tree nodes of the specified type, and those that match are returned as numeric node IDs with node labels (if they exist) as element names. With getEdge, any input nodes are looked up against edge ends of the specified type, and those that match are returned as character edge IDs with the corresponding node ID as element names.

If missing is "warn" or "OK", NA is returned for any nodes that are unmatched for the specified type. This can provide a mechanism for filtering a set of nodes or edges.

**nodeId** provides similar output to getNode in the case when no node is supplied, but it is faster and returns an unnamed vector of the numeric IDs of all nodes of the specified node type. Similarly, edgeId simply returns an unnamed vector of the character IDs of all edges for which the descendant node is of the specified node type.

**Value**

list("getNode")
returns a named integer vector of node IDs, in the order of input nodes if provided, otherwise in nodeId order

list("getEdge")
returns a named character vector of edge IDs, in the order of input nodes if provide, otherwise in nodeId order

list("nodeId")
returns an unnamed integer vector of node IDs, in ascending order

list("getEdge")
returns an unnamed character vector of edge IDs, in edge matrix order

**Examples**

data(geospiza)
nodeLabels(geospiza) <- LETTERS[1:nNodes(geospiza)]
plot(as(geospiza, "phylo4"), show.node.label=TRUE)
getNode(geospiza, 18)
getNode(geospiza, "D")
getEdge(geospiza, "D")
getEdge(geospiza, "D", type="ancestor")

## match nodes only to tip nodes, flagging invalid cases as NA
getNode(geospiza, c(1, 18, 999), type="tip", missing="OK")
```r
## get all edges that descend from internal nodes
getEdge(geospiza, type="ancestor")

## identify an edge from its terminal node
getEdge(geospiza, c("olivacea", "B", "fortis"))
getNode(geospiza, c("olivacea", "B", "fortis"))
edges(geospiza)[c(26, 1, 11),]

## quickly get all tip node IDs and tip edge IDs
nodeId(geospiza, "tip")
edgeId(geospiza, "tip")
```

---

**Description**

These functions give information about and allow replacement of edge lengths.

**Usage**

```r
class <- phylo

## S4 method for signature 'phylo4'
hasEdgeLength(x)

## S4 method for signature 'phylo4'
edgeLength(x, ...)

## S4 method for signature 'phylo4'
edgeLength(x, node)

## S4 replacement method for signature 'phylo4'
edgeLength(x, use.names = TRUE, ...) <- value

## S4 replacement method for signature 'phylo4'
edgeLength(x, use.names = TRUE, ...) <- value

depthTips(x)

## S4 method for signature 'phylo4'
depthTips(x)

## S4 method for signature 'phylo4'
nodeDepth(x, node)

## S4 method for signature 'phylo4'
nодеDepth(x, node)

## S4 method for signature 'phylo4'
nodeHeight(x, node, from)
```
## Arguments

- **x**: a phylo4 or phylo4d object.
- **...**: optional arguments (none used at present).
- **node**: optional numeric or character vector indicating the nodes for which edge length should be calculated.
- **use.names**: should the name attributes of `node` be used to match the length to a given edge.
- **value**: a numeric vector indicating the new values for the edge lengths.
- **from**: the point of reference for calculating the height of the node. `root` calculates the distance between the root of the tree and the node. `all_tip` returns the distance between the node and all the tips descending from it. `min_tip` the distance between the node and its closest tip. `max_tip` the distance between the node and its farther tip. `min_tip` and `max_tip` will be identical if the tree is ultrametric. If more than one tip is equidistant from the node, the tip with the lowest node id will be returned.
- **tol**: the tolerance to decide whether all the tips have the same depth to test if the tree is ultrametric. Default is `.Machine$double.eps^0.5`.

## Details

The `edgeLength` function returns the edge length in the same order as the edges in the matrix.

## Value

- **hasEdgeLength**: whether or not the object has edge lengths (logical)
- **edgeLength**: a named vector of the edge length for the object
- **isUltrametric**: whether or not the tree is ultrametric (all the tips are have the same depth (distance from the root) (logical)
- **sumEdgeLength**: the sum of the edge lengths for a set of nodes (intended to be used with ancestors or descendants)
- **nodeHeight**: the distance between a node and the root or the tips. The format of the result will depend on the options and the number of nodes provided, either a vector or a list.
nodeDepth Deprecated, now replaced by nodeHeight. A named vector indicating the “depth” (the distance between the root and a given node).

depthTip Deprecated, now replaced by nodeHeight.

See Also

ancestors, descendants, .Machine for more information about tolerance.

Examples

data(geospiza)
hasEdgeLength(geospiza) # TRUE
topoGeo <- geospiza
dgeLength(topoGeo) <- NULL
hasEdgeLength(topoGeo) # FALSE

egeLength(geospiza)[2] # use the position in vector
egeLength(geospiza)[“16-17”] # or the name of the ege
egeLength(geospiza, 17) # or the descendant node of the edge

## The same methods can be used to update an edge length
egeLength(geospiza)[2] <- 0.33
egeLength(geospiza)[“16-17”] <- 0.34
egeLength(geospiza, 17) <- 0.35

## Test if tree is ultrametric
isUltrametric(geospiza) # TRUE
## indeed all tips are at the same distance from the root
dgeHeight(geospiza, nodeId(geospiza, “tip”), from=“root”)
## compare distances from tips of two MRCA
dgeHeight(geospiza, MRCA(geospiza, c(“pallida”, “psittacula”), from=“min_tip”)
dgeHeight(geospiza, MRCA(geospiza, c(“fortis”, “difficilis”), from=“min_tip”)
## or the same but from the root
dgeHeight(geospiza, MRCA(geospiza, c(“pallida”, “psittacula”), from=“root”)
dgeHeight(geospiza, MRCA(geospiza, c(“fortis”, “difficilis”), from=“root”)

hasSingle Test trees for polytomies, inline nodes (singletons), or reticulation

Description

Methods to test whether trees have (structural) polytomies, inline nodes (i.e., nodes with a single descendant), or reticulation (i.e., nodes with more than one ancestor). hasPoly only check for structural polytomies (1 node has more than 2 descendants) and not polytomies that result from having edges with a length of 0.
hasSingle

Usage

hasSingle(object)

## S4 method for signature 'phylo4'
hasSingle(object)

hasRetic(object)

## S4 method for signature 'phylo4'
hasRetic(object)

hasPoly(object)

## S4 method for signature 'phylo4'
hasPoly(object)

Arguments

object an object inheriting from class phylo4

Value

Logical value

Note

Some algorithms are unhappy with structural polytomies (i.e., >2 descendants from a node), with
single-descendant nodes, or with reticulation; these functions check those properties. We haven’t
bothered to check for zero branch lengths: the consensus is that it doesn’t come up much, and that
it’s simple enough to test \( \text{any}(\text{edgeLength}(x) == 0) \) in these cases. (Single-descendant nodes are
used e.g. in OUCH, or in other cases to represent events occurring along a branch.)

Author(s)

Ben Bolker

Examples

tree.owls.bis <- ape::read.tree(text="((Strix_aluco:4.2,Asio_otus:4.2):3.1,Athene_noctua:7.3);")

owls4 <- as(tree.owls.bis, "phylo4")

hasPoly(owls4)

hasSingle(owls4)
hasTipData

Tests for presence of data associated with trees stored as phylo4d objects

Description

Methods that test for the presence of data associated with trees stored as phylo4d objects.

Usage

```r
hasTipData(x)
```  
## S4 method for signature 'phylo4d'
```r
hasTipData(x)
```  
```r
hasNodeData(x)
```  
## S4 method for signature 'phylo4d'
```r
hasNodeData(x)
```  
```r
nData(x)
```  
## S4 method for signature 'phylo4d'
```r
nData(x)
```  
Arguments

- **x** a phylo4d object

Details

nData tests for the presence of data associated with the object.
hasTipData and hasNodeData tests for the presence of data associated with the tips and the internal nodes respectively. The outcome of the test is based on row names of the data frame stored in the data slot. If no rows have names from the set nodeId(x, "tip"), then hasTipData returns FALSE. Likewise, if no rows have names from the set nodeId(x, "internal"), then hasNodeData returns FALSE.

Value

nData returns the number of datasets (i.e., columns) associated with the object.
hasTipData, hasNodeData return TRUE or FALSE depending whether data associated with the tree are associated with either tips or internal nodes respectively.

Methods

**hasNodeData** signature(object = "phylo4d"): whether tree has internal node data

**hasTipData** signature(object = "phylo4d"): whether tree has data associated with its tips
Import Nexus and Newick files

Author(s)
Ben Bolker, Thibault Jombart, Francois Michonneau

See Also
phylo4d-methods constructor and phylo4d class.

Examples

data(geospiza)
nData(geospiza)    ## 5
hasTipData(geospiza) ## TRUE
hasNodeData(geospiza) ## FALSE

---

Import Nexus and Newick files

Create a phylo4, phylo4d or data.frame object from a NEXUS or a Newick file

Description
readNexus reads a NEXUS file and outputs a phylo4, phylo4d or data.frame object.

Usage

readNCL(file, simplify = FALSE, type = c("all", "tree", "data"),
spacesAsUnderscores = TRUE, char.all = FALSE,
polymorphic.convert = TRUE, levels.uniform = FALSE, quiet = TRUE,
check.node.labels = c("keep", "drop", "asdata"),
return.labels = TRUE, file.format = c("nexus", "newick"),
check.names = TRUE, convert.edge.length = FALSE, ...
)

readNexus(file, simplify = FALSE, type = c("all", "tree", "data"),
char.all = FALSE, polymorphic.convert = TRUE,
levels.uniform = FALSE, quiet = TRUE, check.node.labels = c("keep",
"drop", "asdata"), return.labels = TRUE, check.names = TRUE,
convert.edge.length = FALSE, ...
)

readNewick(file, simplify = FALSE, quiet = TRUE,
check.node.labels = c("keep", "drop", "asdata"),
convert.edge.length = FALSE, ...)
Import Nexus and Newick files

Arguments

- **file**: a NEXUS file for `readNexus` or a file that contains Newick formatted trees for `readNewick`.
- **simplify**: If TRUE, if there are multiple trees in the file, only the first one is returned; otherwise a list of `phylo4(d)` objects is returned if the file contains multiple trees.
- **type**: Determines which type of objects to return, if present in the file (see Details).
- **spacesAsUnderscores**: In the NEXUS file format white spaces are not allowed in taxa labels and are represented by underscores. Therefore, NCL converts underscores found in taxa labels in the NEXUS file into white spaces (e.g. `species_1` will become `species 1`). If you want to preserve the underscores, set as TRUE, the default).
- **char.all**: If TRUE, returns all characters, even those excluded in the NEXUS file
- **polymorphic.convert**: If TRUE, converts polymorphic characters to missing data
- **levels.uniform**: If TRUE, uses the same levels for all characters
- **quiet**: If FALSE the output of the NCL interface is printed. This is mainly for debugging purposes. This option can considerably slow down the process if the tree is big or there are many trees in the file.
- **check.node.labels**: Determines how the node labels in the NEXUS or Newick files should be treated in the phylo4 object, see Details for more information.
- **return.labels**: Determines whether state names (if TRUE) or state codes should be returned.
- **file.format**: character indicating the format of the specified file (either “newick” or “nexus”). It’s more convenient to just use `readNexus` or `readNewick`.
- **check.names**: logical. If ‘TRUE’ then the names of the characters from the NEXUS file are checked to ensure that they are syntactically valid variable names and are not duplicated. If necessary they are adjusted using ‘make.names’.
- **convert.edge.length**: logical. If TRUE negative edge lengths are replaced with 0. At this time phylobase does not accept objects with negative branch lengths, this workaround allows to import trees with negative branch lengths.
- **...**: Additional arguments to be passed to phylo4 or phylo4d constructor (see Details)

Details

- `readNewick` reads a Newick file and outputs a `phylo4` or `phylo4d` object.
- `readNexus` is used internally by both `readNexus` and `readNewick` to extract data held in a tree files, specifically in NEXUS files from DATA, CHARACTER or TREES blocks.

The type argument specifies which of these is returned:

- **data**: will only return a `data.frame` of the contents of all DATA and CHARACTER blocks.
Import Nexus and Newick files

- **tree** will only return a phylo4 object of the contents of the TREES block.
- **all** if only data or a tree are present in the file, this option will act as the options above, returning either a data.frame or a phylo4 object respectively. If both are present then a phylo4d object is returned containing both.

The function returns NULL if the type of data requested is not present in the file, or if neither data nor tree blocks are present.

Depending on the context readNexus will call either the phylo4 or phylo4d constructor. The phylo4d constructor will be used with type="all", or if the option check.node.labels="asdata" is invoked.

readNewick imports Newick formatted tree files and will return a phylo4 or a phylo4d object if the option check.node.labels="asdata" is invoked.

For both readNexus and readNewick, the options for check.node.labels can take the values:

- **keep** the node labels of the trees will be passed as node labels in the phylo4 object
- **drop** the node labels of the trees will be ignored in the phylo4 object
- **asdata** the node labels will be passed as data and a phylo4d object will be returned.

If you use the option asdata on a file with no node labels, a warning message is issued, and is thus equivalent to the value drop.

For both readNexus and readNewick, additional arguments can be passed to the constructors such as annotate, missing.data or extra.data. See the ‘Details’ section of phylo4d-methods for the complete list of options.

**Value**

Depending on the value of type and the contents of the file, one of: a data.frame, a phylo4 object, a phylo4d object or NULL. If several trees are included in the NEXUS file and the option simplify=FALSE a list of phylo4 or phylo4d objects is returned.

**Note**

Underscores in state labels (i.e. trait or taxon names) will be translated to spaces. Unless check.names=FALSE, trait names will be converted to valid R names (see make.names) on input to R, so spaces will be translated to periods.

**Author(s)**

Brian O’Meara, Francois Michonneau, Derrick Zwickl

**See Also**

the phylo4d class, the phylo4 class
isRooted

Methods to test, access (and modify) the root of a phylo4 object.

Description

Methods to test, access (and modify) the root of a phylo4 object.

Usage

isRooted(x)

```r
## S4 method for signature 'phylo4'
isRooted(x)

rootNode(x)

## S4 method for signature 'phylo4'
rootNode(x)

rootNode(x) <- value

## S4 replacement method for signature 'phylo4'
rootNode(x) <- value
```

Arguments

- `x` a phylo4 or phylo4d object.
- `value` a character string or a numeric giving the new root.

Value

- **isRooted** logical whether the tree is rooted
- **rootNode** the node corresponding to the root

Author(s)

Ben Bolker, Francois Michonneau

Examples

data(geospiza)
isRooted(geospiza)
rootNode(geospiza)
Description

Most Recent Common Ancestor (MRCA) of 2 or more nodes.

Usage

MRCA(phy, ...)

## S4 method for signature 'phylo4'
MRCA(phy, ...)

## S4 method for signature 'phylo'
MRCA(phy, ...)

Arguments

phy  a phylogenetic tree in phylo4, phylo4d or phylo format.
...  a vector of nodes

Details

Given some nodes (i.e., tips and/or internal), this function returns the node corresponding to the most recent common ancestor.

If phy is a phylo4 or phylo4d object, the nodes can contain both numeric or character values that will be used by getNode to retrieve the correct node. However, if phy is a phylo object, the nodes must be a numeric vector.

With phylo4 and phylo4d objects, if a single node is provided, it will be returned.

Value

the node corresponding to the most recent common ancestor

Examples

data(geospiza)
MRCA(geospiza, 1, 5)
MRCA(geospiza, "fortis", 11)
MRCA(geospiza, 2, 4, "fusca", 3)
geo <- as(geospiza, "phylo")
MRCA(geo, c(1,5))
Classes for lists of phylogenetic trees. These classes and methods are planned for a future version of phylobase.

These functions give the node \( (\text{nodeId}) \) or edge \( (\text{edgeId}) \) identity.

**Usage**

```r
nodeId(x, type = c("all", "tip", "internal", "root"))
```

```r
# S4 method for signature 'phylo4'
nodeId(x, type = c("all", "tip", "internal", "root"))
```

```r
edgeId(x, type = c("all", "tip", "internal", "root"))
```

```r
# S4 method for signature 'phylo4'
edgeId(x, type = c("all", "tip", "internal", "root"))
```

**Arguments**

- \( x \) a phylo4 or phylo4d object.
- \( \text{type} \) a character vector indicating which subset of the nodes or edges you are interested in.

**Details**

\( \text{nodeId} \) returns the node in ascending order, and \( \text{edgeId} \) in the same order as the edges are stored in the edge matrix.

**Value**

- \( \text{nodeId} \) an integer vector indicating node numbers
- \( \text{edgeId} \) a character vector indicating the edge identity
\textbf{nTips}

\textbf{Examples}

```
data(geospiza)
identical(nodeId(geospiza, "tip"), 1:nTips(geospiza))
nodeId(geospiza, "internal")
edgeId(geospiza, "internal")
nodeId(geospiza, "root")
```

\begin{tabular}{llll}
\hline
nTips & \multicolumn{3}{l}{\textit{nTips, nNodes, nEdges}} \\
\hline
\end{tabular}

\textbf{Description}

Number of tips, nodes and edges found in a tree.

\textbf{Usage}

```
nTips(x)
```

\textbf{Arguments}

\textit{x} \hspace{1cm} a phylo4 or phylo4d object

\textbf{Details}

Function to return the number of tips, nodes and edges found in a tree in the phylo4 or phylo4d format.

\textbf{Value}

a numeric vector indicating the number of tips, nodes or edge respectively.
### Description

A tiny tree, for testing/example purposes, using one of the examples from the ape package.

### Format

This is the standard ‘owls’ tree from the ape package, in phylo4 format.

### Source

From various examples in the ape package.

### Examples

```r
data(owls4)
plot(owls4)
```

---

### pdata

**Constructor for pdata (phylogenetic data) class**

### Description

Combine data, type, comments, and metadata information to create a new pdata object, or check such an object for consistency.

### Usage

`pdata(data, type, comment, metadata)`

### Arguments

- `data`: a data frame
- `type`: a factor with levels as specified by `pdata`, the same length as `ncol(data)`
- `comment`: a character vector, the same length as `ncol(data)`
- `metadata`: an arbitrary list

### Value

An object of class `pdata`
Author(s)
Ben Bolker

See Also
pdata

pdata-class  
Class "pdata"

Description
Data class for phylo4d objects

Objects from the Class
Objects can be created by calls of the form new("pdata", ...).

Author(s)
Ben Bolker

phylo4-class  
The phylo4 class

Description
Classes for phylogenetic trees

Objects from the Class
Phylogenetic tree objects can be created by calls to the phylo4 constructor function. Translation functions from other phylogenetic packages are also available. See coerce-methods.

Author(s)
Ben Bolker, Thibaut Jombart

See Also
The phylo4-methods constructor, the checkPhylo4 function to check the validity of phylo4 objects. See also the phylo4d-methods constructor and the phylo4d class.
phylo4-labels  

**Labels for phylo4/phylo4d objects**

**Description**

Methods for creating, accessing and updating labels in phylo4/phylo4d objects

**Usage**

```r
labels(object, ...)

## S4 method for signature 'phylo4'
labels(object, type = c("all", "tip", "internal"))

labels(x, type, use.names, ...) <- value

## S4 replacement method for signature 'phylo4'
labels(x, type = c("all", "tip", "internal"),
       use.names, ...) <- value

hasDuplicatedLabels(x, type)

## S4 method for signature 'phylo4'
hasDuplicatedLabels(x, type = c("all", "tip", "internal"))

hasNodeLabels(x)

## S4 method for signature 'phylo4'
hasNodeLabels(x)

nodeLabels(x)

## S4 method for signature 'phylo4'
odeLabels(x)

nodeLabels(x, ...) <- value

## S4 replacement method for signature 'phylo4'
nodeLabels(x, ...) <- value

tipLabels(x)

## S4 method for signature 'phylo4'
tipLabels(x)

tipLabels(x, ...) <- value
```
## S4 replacement method for signature 'phylo4'

```r
tipLabels(x, ...) <- value
```

```r
hasEdgeLabels(x)
```

## S4 method for signature 'phylo4'

```r
hasEdgeLabels(x)
```

```r
edgeLabels(x)
```

## S4 method for signature 'phylo4'

```r
edgeLabels(x)
```

## S4 replacement method for signature 'phylo4'

```r
edgeLabels(x, ...) <- value
```

### Arguments

- `object`: a phylo4 or phylo4d object.
- `...`: additional optional arguments (not in use)
- `type`: which type of labels: all (tips and internal nodes), tip (tips only), internal (internal nodes only).
- `x`: a phylo4 or phylo4d object.
- `use.names`: should the names of the vector used to create/update labels be used to match the labels? See Details for more information.
- `value`: a vector of class character, see Details for more information.

### Details

In phylo4/phylo4d objects, tips must have labels (that’s why there is no method for hasTipLabels), internal nodes and edges can have labels.

Labels must be provided as a vector of class character. The length of the vector must match the number of elements they label.

The option `use.names` allows the user to match a label to a particular node. In this case, the vector must have names that match the node numbers.

The function `labels` is mostly intended to be used internally.

### Value

labels in ascending order.
Methods

labels signature(object = "phylo4"): tip and/or internal node labels, ordered by node ID

hasDuplicatedLabels signature(object = "phylo4"): are any labels duplicated?

tipLabels signature(object = "phylo4"): tip labels, ordered by node ID

hasNodeLabels signature(object = "phylo4"): whether tree has (internal) node labels

nodeLabels signature(object = "phylo4"): internal node labels, ordered by node ID

hasEdgeLabels signature(object = "phylo4"): whether tree has (internal) edge labels

edgeLabels signature(object = "phylo4"): internal edge labels, ordered according to the edge matrix

Author(s)

Ben Bolker, Peter Cowan, Steve Kembel, Francois Michonneau

Examples

data(geospiza)

## Return labels from geospiza

tipLabels(geospiza)

## Internal node labels in geospiza are empty

nodeLabels(geospiza)

## Creating internal node labels

dLbl <- paste("n", 1:nNodes(geospiza), sep="")

nodeLabels(geospiza) <- dLbl

nodeLabels(geospiza)

## naming the labels

names(dLbl) <- nodeId(geospiza, "internal")

## shuffling the labels

(dLbl <- sample(dLbl))

## by default, the labels are attributed in the order
## they are given:

nodeLabels(geospiza) <- dLbl

nodeLabels(geospiza)

## but use.names puts them in the correct order

labels(geospiza, "internal", use.names=TRUE) <- dLbl

nodeLabels(geospiza)
**Create a phylogenetic tree**

**Description**

`phylo4` is a generic constructor that creates a phylogenetic tree object for use in phylobase methods. Phylobase contains functions for input of phylogenetic trees and data, manipulation of these objects including pruning and subsetting, and plotting. The phylobase package also contains translation functions to forms used in other comparative phylogenetic method packages.

**Usage**

```r
phylo4(x, ...)  
phylo4_orderings
```

```r
## S4 method for signature 'matrix'
phylo4(x, edge.length = NULL, tip.label = NULL,  
       node.label = NULL, edge.label = NULL, order = "unknown",  
       annotate = list())

## S4 method for signature 'phylo'
phylo4(x, check.node.labels = c("keep", "drop"),  
       annotate = list())

## S4 method for signature 'nexml'
phylo4(x)
```

**Arguments**

- **x**: a matrix of edges or an object of class `phylo` (see above).
- **...**: optional arguments (none used at present).
- **edge.length**: Edge (branch) length. (Optional)
- **tip.label**: A character vector of species names (names of "tip" nodes). (Optional)
- **node.label**: A character vector of internal node names. (Optional)
- **edge.label**: A character vector of edge (branch) names. (Optional)
- **order**: character: tree ordering (allowable values are listed in phylo4_orderings, currently "unknown", "preorder" (="cladewise" in ape), and "postorder", with "cladewise" and "pruningwise" also allowed for compatibility with ape)
- **annotate**: any additional annotation data to be passed to the new object
- **check.node.labels**: if `x` is of class `phylo`, either "keep" (the default) or "drop" node labels. This argument is useful if the `phylo` object has non-unique node labels.
- **edge**: A numeric, two-column matrix with as many rows as branches in the phylogeny.
Format

An object of class character of length 5.

Details

The minimum information necessary to create a phylobase tree object is a valid edge matrix. The edge matrix describes the topology of the phylogeny. Each row describes a branch of the phylogeny, with the (descendant) node number in column 2 and its ancestor’s node number in column 1. These numbers are used internally and must be unique for each node.

The labels designate either nodes or edges. The vector node.label names internal nodes, and together with tip.label, name all nodes in the tree. The vector edge.label names all branches in the tree. All label vectors are optional, and if they are not given, internally-generated labels will be assigned. The labels, whether user-specified or internally generated, must be unique as they are used to join species data with phylogenetic trees.

phylobase also allows to create phylo4 objects using the function phylo4() from objects of the classes: phylo (from ape), and nexml (from RNeXML).

Note

Translation functions are available from many valid tree formats. See coerce-methods.

Author(s)

phylobase team

See Also

coerce-methods for translation functions. The phylo4 class. See also the phylo4d-methods constructor, and phylo4d class.

Examples

# a three species tree:
mytree <- phylo4(x=matrix(data=c(4,1, 4, 5, 5, 2, 5, 3, 0,4), ncol=2,
byrow=TRUE), tip.label=c("speciesA", "speciesB", "speciesC"))
mytree
plot(mytree)

# another way to specify the same tree:
mytree <- phylo4(x=cbind(c(4, 4, 5, 5, 0), c(1, 5, 2, 3, 4)),
tip.label=c("speciesA", "speciesB", "speciesC"))

# another way:
mytree <- phylo4(x=rbind(c(4, 1), c(4, 5), c(5, 2), c(5, 3), c(0, 4)),
tip.label=c("speciesA", "speciesB", "speciesC"))

# with branch lengths:
mytree <- phylo4(x=rbind(c(4, 1), c(4, 5), c(5, 2), c(5, 3), c(0, 4)),
tip.label=c("speciesA", "speciesB", "speciesC"), edge.length=c(1, .2,
**Description**

S4 class for phylogenetic tree and data.

**Objects from the Class**

Objects can be created from various trees and a data.frame using the constructor phylo4d, or using `new("phylo4d", ...{})` for empty objects.

**Author(s)**

Ben Bolker, Thibaut Jombart

**See Also**

`coerce-methods` for translation functions. The `phylo4d-methods` constructor. See also the `phylo4-methods` constructor, the `phylo4` class, and the `checkPhylo4` function to check the validity of phylo4 trees.

**Examples**

```r
example(read.tree, "ape")
obj <- phylo4d(as(tree.ows.bis,"phylo4"), data.frame(wing=1:3))
obj
names(obj)
summary(obj)
```

**Description**

phylo4d is a generic constructor which merges a phylogenetic tree with data frames to create a combined object of class phylo4d.
Usage

phylo4d(x, ...)

## S4 method for signature 'phylo4'
phylo4d(x, tip.data = NULL, node.data = NULL,
        all.data = NULL, merge.data = TRUE, metadata = list(), ...)

## S4 method for signature 'matrix'
phylo4d(x, tip.data = NULL, node.data = NULL,
        all.data = NULL, merge.data = TRUE, metadata = list(),
        edge.length = NULL, tip.label = NULL, node.label = NULL,
        edge.label = NULL, order = "unknown", annotate = list(), ...)

## S4 method for signature 'phylo'
phylo4d(x, tip.data = NULL, node.data = NULL,
        all.data = NULL, check.node.labels = c("keep", "drop", "asdata"),
        annotate = list(), metadata = list(), ...)

## S4 method for signature 'phylo4d'
phylo4d(x, ...)

## S4 method for signature 'nxml'
phylo4d(x)

Arguments

x an object of class phylo4, phylo, nexml or a matrix of edges (see above)
...
further arguments to control the behavior of the constructor in the case of missing/extra data and where to look for labels in the case of non-unique labels that cannot be stored as row names in a data frame (see Details).
tip.data a data frame (or object to be coerced to one) containing only tip data (Optional)
node.data a data frame (or object to be coerced to one) containing only node data (Optional)
all.data a data frame (or object to be coerced to one) containing both tip and node data (Optional)
merge.data if both tip.data and node.data are provided, should columns with common names will be merged together (default TRUE) or not (FALSE)? See details.
metadata any additional metadata to be passed to the new object
data.length Edge (branch) length. (Optional)
tip.label A character vector of species names (names of "tip" nodes). (Optional)
node.label A character vector of internal node names. (Optional)
edge.label A character vector of edge (branch) names. (Optional)
order character: tree ordering (allowable values are listed in phylo4_orderings, currently "unknown", "preorder" (="cladewise" in ape), and "postorder", with "cladewise" and "pruningwise" also allowed for compatibility with ape)
annotate any additional annotation data to be passed to the new object

check.node.labels

if x is of class phylo, use either “keep” (the default) to retain internal node labels, “drop” to drop them, or “asdata” to convert them to numeric tree data. This argument is useful if the phylo object has non-unique node labels or node labels with informative data (e.g., posterior probabilities).

Details

You can provide several data frames to define traits associated with tip and/or internal nodes. By default, data row names are used to link data to nodes in the tree, with any number-like names (e.g., “10”) matched against node ID numbers, and any non-number-like names (e.g., “n10”) matched against node labels. Alternative matching rules can be specified by passing additional arguments (listed in the Details section); these include positional matching, matching exclusively on node labels, and matching based on a column of data rather than on row names.

Matching rules will apply the same way to all supplied data frames. This means that you need to be consistent with the row names of your data frames. It is good practice to use tip and node labels (or node numbers if you use duplicated labels) when you combine data with a tree.

If you provide both tip.data and node.data, the treatment of columns with common names will depend on the merge.data argument. If TRUE, columns with the same name in both data frames will be merged; when merging columns of different data types, coercion to a common type will follow standard R rules. If merge.data is FALSE, columns with common names will be preserved independently, with “.tip” and “.node” appended to the names. This argument has no effect if tip.data and node.data have no column names in common.

If you provide all.data along with either of tip.data and node.data, it must have distinct column names, otherwise an error will result. Additionally, although supplying columns with the same names within data frames is not illegal, automatic renaming for uniqueness may lead to surprising results, so this practice should be avoided.

This is the list of additional arguments that can be used to control matching between the tree and the data:

- match.data(logical) should the rownames of the data frame be used to be matched against tip and internal node identifiers?
- rownamesAsLabels(logical), should the row names of the data provided be matched only to labels (TRUE), or should any number-like row names be matched to node numbers (FALSE and default)
- label.type character, rownames or column: should the labels be taken from the row names of dt or from the label.column column of dt?
- label.column if label.type is a column specifier (number or name) of the column containing tip labels
- missing.data action to take if there are missing data or if there are data labels that don’t match
- extra.data action to take if there are extra data or if there are labels that don’t match
- keep.all(logical), should the returned data have rows for all nodes (with NA values for internal rows when type=’tip’, and vice versa) (TRUE and default) or only rows corresponding to the type argument
Rules for matching rows of data to tree nodes are determined jointly by the `match.data` and `rownamesAsLabels` arguments. If `match.data` is TRUE, data frame rows will be matched exclusively against tip and node labels if `rownamesAsLabels` is also TRUE, whereas any all-digit row names will be matched against tip and node numbers if `rownamesAsLabels` is FALSE (the default). If `match.data` is FALSE, `rownamesAsLabels` has no effect, and row matching is purely positional with respect to the order returned by `nodeId(phy, type)`.

**Value**

An object of class `phylo4d`.

**Methods**

- `x = "phylo4"` merges a tree of class `phylo4` with a data.frame into a `phylo4d` object
- `x = "matrix"` merges a matrix of tree edges similar to the edge slot of a `phylo4` object (or to `$edge` of a `phylo` object) with a data.frame into a `phylo4d` object
- `x = "phylo"` merges a tree of class `phylo` with a data.frame into a `phylo4d` object

**Note**

Checking on matches between the tree and the data will be done by the validity checker (label matches between data and tree tips, number of rows of data vs. number of nodes/tips/etc.)

**Author(s)**

Ben Bolker, Thibaut Jombart, Steve Kembel, Francois Michonneau, Jim Regetz

**See Also**

- `coerce-methods` for translation functions. The `phylo4d` class; `phylo4` class and `phylo4` constructor.

**Examples**

```r

## Fix differences in tip names between the tree and the data
geoData <- rbind(geoData, array(dim = c(1, ncol(geoData)), dimnames = list("olivacea", colnames(geoData))))
```
### Example using a tree of class 'phylo'

```r
exGeo1 <- phylo4d(geoTree, tip.data = geoData)
```

### Example using a tree of class 'phylo4'

```r
gtree <- as(geoTree, "phylo4")
```

### some random node data

```r
rNodeData <- data.frame(randomTrait = rnorm(nNodes(geoTree)),
                         row.names = nodeId(geoTree, "internal"))
```

```r
exGeo2 <- phylo4d(geoTree, tip.data = geoData, node.data = rNodeData)
```

### Example using 'merge.data'

```r
data(geospiza)
trGeo <- extractTree(geospiza)
tDt <- data.frame(a=rnorm(nTips(trGeo)), row.names=nodeId(trGeo, "tip"))
nDt <- data.frame(a=rnorm(nNodes(trGeo)), row.names=nodeId(trGeo, "internal"))
```

```r
(matchData1 <- phylo4d(trGeo, tip.data=tDt, node.data=nDt, merge.data=FALSE))
(matchData2 <- phylo4d(trGeo, tip.data=tDt, node.data=nDt, merge.data=TRUE))
```

### Example with 'all.data'

```r
nodeLabels(geoTree) <- as.character(nodeId(geoTree, "internal"))
rAllData <- data.frame(randomTrait = rnorm(nTips(geoTree)) + nNodes(geoTree)),
                          row.names = labels(geoTree, 'all'))
```

```r
exGeo5 <- phylo4d(geoTree, all.data = rAllData)
```

### Examples using 'rownamesAsLabels' and comparing with match.data=FALSE

```r
tDt <- data.frame(x=letters[1:nTips(trGeo)],
                  row.names=nodeId(trGeo, "tip")))
tipLabels(trGeo) <- as.character(sample(1:nTips(trGeo)))
(exGeo6 <- phylo4d(trGeo, tip.data=tDt, rownamesAsLabels=TRUE))
(exGeo7 <- phylo4d(trGeo, tip.data=tDt, rownamesAsLabels=FALSE))
(exGeo8 <- phylo4d(trGeo, tip.data=tDt, match.data=FALSE))
```

### generate a tree and some data

```r
set.seed(1)
p3 <- ape::rcoal(5)
dat <- data.frame(a = rnorm(5), b = rnorm(5), row.names = p3$tip.label)
dat.defaultnames <- dat
row.names(dat.defaultnames) <- NULL
dat.superset <- rbind(dat, rnorm(2))
dat.subset <- dat[-1, ]
```

### create a phylo4 object from a phylo object

```r
p4 <- as(p3, "phylo4")
```

### create phylo4d objects with tip data

```r
p4d <- phylo4d(p4, dat)
checkData(p4d)
p4d.sorted <- phylo4d(p4, dat[5:1, ])
try(p4d.nonames <- phylo4d(p4, dat.defaultnames))
```
phylobase.options

Set or return options of phylobase

Description

Provides a mean to control the validity of phylobase objects such as singletons, reticulated trees, polytomies, etc.

Usage

phylobase.options(...)

Arguments

...  

A list may be given as the only argument, or any number of arguments may be in the name=value form, or no argument at all may be given. See the Value and Details sections for explanation.

Details

The parameter values set via a call to this function will remain in effect for the rest of the session, affecting the subsequent behavior of phylobase.

Value

A list with the updated values of the parameters. If arguments are provided, the returned list is invisible.
Author(s)
Francois Michonneau (adapted from the package sm)

Examples

```r
## Not run:
phylobase.options(poly="fail")
# subsequent trees with polytomies will fail the validity check

## End(Not run)
```

phylobubbles

Bubble plots for phylo4d objects

Description

Plots either circles or squares corresponding to the magnitude of each cell of a phylo4d object.

Usage

```r
phylobubbles(type = type, place.tip.label = "right",
             show.node.label = show.node.label, rot = 0,
             edge.color = edge.color, node.color = node.color,
             tip.color = tip.color, edge.width = edge.width, newpage = TRUE,
             ..., XXY, square = FALSE, grid = TRUE)
```

Arguments

- `type` the type of plot
- `place.tip.label` A string indicating whether labels should be plotted to the right or to the left of the bubble plot
- `show.node.label` A logical indicating whether internal node labels should be plotted
- `rot` The number of degrees that the plot should be rotated
- `edge.color` A vector of colors for the tree edge segments
- `node.color` A vector of colors for the coloring the nodes
- `tip.color` A vector of colors for the coloring the tip labels
- `edge.width` A vector of line widths for the tree edges
- `newpage` Logical to control whether the device is cleared before plotting, useful for adding plot inside other plots
- `...` Additional parameters passed to the bubble plotting functions
- `XXXY` The output from the phyloXXXY function
- `square` Logical indicating whether the plot ‘bubbles’ should be squares
- `grid` A logical indicating whether a grey grid should be plotted behind the bubbles
Author(s)

Peter Cowan <pdc@berkeley.edu>

See Also

phyloXXYY, treePlot

Examples

```r
### Should be DIRECTLY executable !! ----
### --== Define data, use random, 
### --or do help(data=index) for the standard data sets.
```
phyloXXXYY

Calculate node x and y coordinates

Description

Calculates the node x and y locations for plotting a phylogenetic tree.

Usage

phyloXXXYY(phy, tip.order = NULL)

Arguments

- **phy** A phylo4 or phylo4d object.
- **tip.order** A character vector of tip labels, indicating their order along the y axis (from top to bottom). Or, a numeric vector of tip node IDs indicating the order.

Details

The y coordinates of the tips are evenly spaced from 0 to 1 in pruningwise order. Ancestor y nodes are given the mean value of immediate descendants. The root is given the x coordinate 0 and descendant nodes are placed according to the cumulative branch length from the root, with a maximum x value of 1.

Value

- **yy** Internal node and tip y coordinates
- **xx** Internal node and tip x coordinates
- **phy** A phylo4 or phylo4d object
- **segs** A list of h0x, h1x, v0x, v1x and h0y, h1y, v0y, v1y describing the start and end points for the plot line segments
torder The tip order provided as tip.order or if NULL the preoder tip order
eorder The an index of the reordered edges compared to the result of edges(phy)

Author(s)
Peter Cowan <pdc@berkeley.edu>

See Also
treePlot, plotOneTree

Examples

data(geospiza)
coor <- phyloXXXY(geospiza)
plot(coor$xx, coor$yy, pch = 20)

plotOneTree  Plot a phylo4 object

Description
Plots the phylogenetic tree contained in a phylo4 or phylo4d object.

Usage
plotOneTree(xxyy, type, show.tip.label, show.node.label, edge.color,
node.color, tip.color, edge.width, rot)

Arguments
xxyy A list created by the phyloXXXY function
type A character string indicating the shape of plotted tree
show.tip.label Logical, indicating whether tip labels should be shown
show.node.label Logical, indicating whether node labels should be shown
edge.color A vector of colors in the order of edges(phy)
node.color A vector of colors indicating the colors of the node labels
tip.color A vector of colors indicating the colors of the tip labels
edge.width A vector in the order of edges(phy) indicating the widths of edge lines
rot Numeric indicating the rotation of the plot in degrees
Value

Returns no values, function invoked for the plotting side effect.

Author(s)

Peter Cowan <pdc@berkeley.edu>

See Also

treePlot, phyloXXYY

Examples

library(grid)
data(geospiza)
grid.newpage()
xxyy <- phyloXXYY(geospiza)
plotOneTree(xxyy, type = 'phylogram',
  show.tip.label = TRUE, show.node.label = TRUE,
  edge.color = 'black', node.color = 'orange', tip.color = 'blue',
  edge.width = 1, rot = 0
)
grid.newpage()
pushViewport(viewport(w = 0.8, h = 0.8))
plotOneTree(xxyy, type = 'phylogram',
  show.tip.label = TRUE, show.node.label = TRUE,
  edge.color = 'black', node.color = 'orange', tip.color = 'blue',
  edge.width = 1, rot = 0
)
popViewport()

print

print a phylogeny

Description

Prints a phylo4 or phylo4d object in data.frame format with user-friendly column names

Usage

print(x, ...)

## S4 method for signature 'phylo4'
print(x, edgeOrder = c("pretty", "real"),
  printall = TRUE)

show(object)
Arguments

- **x**: A `phylo4` tree or `phylo4d` tree+data object
- **...**: Optional additional arguments (not in use)
- **edgeOrder**: In the data frame returned, the option 'pretty' returns the internal nodes followed by the tips, the option 'real' returns the nodes in the order they are stored in the edge matrix.
- **printall**: Default prints entire tree. `printall=FALSE` returns the first 6 rows
- **object**: A `phylo4` or `phylo4d` object
- **n**: For `head()` and `tail()`, the number of lines to print

Details

This is a user-friendly version of the tree representation, useful for checking that objects were read in completely and translated correctly. The phylogenetic tree is represented as a list of numbered nodes, linked in a particular way through time (or rates of evolutionary change). The topology is given by the pattern of links from each node to its ancestor. Also given are the taxon names, node type (root/internal/tip) and phenotypic data (if any) associated with the node, and the branch length from the node to its ancestor. A list of nodes (descendants) and ancestors is minimally required for a `phylo4` object.

Value

A data.frame with a row for each node (descendant), sorted as follows: root first, then other internal nodes, and finally tips.

The returned data.frame has the following columns:

- **label**: Label for the taxon at the node (usually species name).
### reorder-methods

Node number, i.e. the number identifying the node in edge matrix.

**ancestor**

Node number of the node’s ancestor.

**branch.length**

The branch length connecting the node to its ancestor (NAs if missing).

**node.type**

"root", "internal", or "tip". (internally generated)

**data**

Phenotypic data associated with the nodes, with separate columns for each variable.

### Note

This is the default show() method for phylo4, phylo4d. It prints the user-supplied information for building a phylo4 object. For a full description of the phylo4 S4 object and slots, see phylo4.

### Author(s)

Marguerite Butler, Thibaut Jombart <jombart@biomserv.univ-lyon1.fr>, Steve Kembel

### Examples

```r
tree.phylo <- ape::read.tree(text="((a,b),c);")
tree <- as(tree.phylo, "phylo4")
#plot(tree, show.node=TRUE) # plotting broken with empty node labels: FIXME
tip.data <- data.frame(size=c(1,2,3), row.names=c("a", "b", "c"))
treedata <- phylo4d(tree, tip.data)
plot(treedata)
print(treedata)
```

---

**reorder-methods**

**reordering trees within phylo4 objects**

### Description

Methods for reordering trees into various traversal orders

### Usage

```r
reorder(x, ...)
```

## S4 method for signature 'phylo4'

```r
reorder(x, order = c("preorder", "postorder"))
```
Arguments

x  a phylo4 or phylo4d object
...
order  The desired traversal order; currently only “preorder” and “postorder” are allowed for phylo4 and phylo4d objects.

Details

The reorder method takes a phylo4 or phylo4d tree and orders the edge matrix (i.e. edges(x)) in the requested traversal order. Currently only two orderings are permitted, and both require rooted trees. In postorder, a node’s descendants come before that node, thus the root, which is ancestral to all nodes, comes last. In preorder, a node is visited before its descendants, thus the root comes first.

Value

A phylo4 or phylo4d object with the edge, label, length and data slots ordered as order, which is itself recorded in the order slot.

Note

The preorder parameter corresponds to cladewise in the ape package, and postorder corresponds (almost) to pruningwise.

Author(s)

Peter Cowan, Jim Regetz

See Also

reorder.phylo in the ape package. ancestors ancestor siblings children descendants

Examples

phy <- phylo4(ape::rtree(5))
edges(reorder(phy, "preorder"))
edges(reorder(phy, "postorder"))
shortestPath

Usage

as(object, class)

Author(s)

Ben Bolker, Thibaut Jombart, Marguerite Butler, Steve Kembel, Francois Michonneau

See Also

generic as, phylo4-methods, phylo4d-methods, extractTree, nxml class from the RNeXML package, phylog from the ade4 package and as.phylo from the ape package.

Examples

tree.owls <- ape::read.tree(text=tree_string)  ## round trip conversion 
tree_in_phylo <- tree.owls  # tree is a phylo object 
(tree_in_phylo4 <- as(tree.owls,"phylo4"))  # phylo converted to phylo4
identical(tree_in_phylo,as(tree_in_phylo4,"phylo"))  # test if phylo, and phylo4 converted to phylo are identical  
(## no, because of dimnames)

## Conversion to phylog (ade4) 
as(tree_in_phylo4, "phylog")

## Conversion to data.frame 
as(tree_in_phylo4, "data.frame")

## Conversion to phylo (ape) 
as(tree_in_phylo4, "phylo")

## Conversion to phylo4d, (data slots empty) 
as(tree_in_phylo4, "phylo4d")

shortestPath  shortestPath-methods

Description

Finds the shortest path between two nodes in a tree

Usage

shortestPath(x, node1, node2)

## S4 method for signature 'phylo4'
shortestPath(x, node1, node2)
## S4 method for signature 'phylo'
shortestPath(x, node1, node2)

### Arguments
- **x**: a tree in the phylo, phylo4d or phylo format
- **node1**: a numeric or character (passed to getNode) indicating the beginning from which the path should be calculated.
- **node2**: a numeric or character (passed to getNode) indicating the end of the path.

### Details
Given two nodes (i.e., tips or internal nodes), this function returns the shortest path between them (excluding node1 and node2 as a vector of nodes).

### Value
- a vector of nodes indicating the shortest path between 2 nodes

### See Also
- getNode

---

subset-methods

### Methods for creating subsets of phylogenies

### Description
Methods for creating subsets of phylogenies, based on pruning a tree to include or exclude a set of terminal taxa, to include all descendants of the MRCA of multiple taxa, or to return a subtree rooted at a given node.

### Usage
- `subset(x, ...)
  ```
  # S4 method for signature 'phylo'
subset(x, tips.include = NULL, tips.exclude = NULL,
    mrca = NULL, node.subtree = NULL, ...)
  ```
  ```
  "["(x, i, j, ..., drop = TRUE)
  ```
  ```
  ## S4 method for signature 'phylo4,character,missing,missing'
x[i, j, ..., drop = TRUE]
  ```
  ```
  ## S4 method for signature 'phylo4,numeric,missing,missing'
x[i, j, ..., drop = TRUE]
  ```
Arguments

- `x`: an object of class "phylo4" or "phylo4d"
- `...`: optional additional parameters (not in use)
- `tips.include`: A vector of tips to include in the subset tree
- `tips.exclude`: A vector of tips to exclude from the subset tree
- `mrca`: A vector of nodes for determining the most recent common ancestor, which is then used as the root of the subset tree
- `node.subtree`: A single internal node specifying the root of the subset tree
- `i`: ([method] An index vector indicating tips to include)
- `j`: ([method, phylo4d only] An index vector indicating columns of node/tip data to include)
- `drop`: (not in use: for compatibility with the generic method)
- `trim.internal`: A logical specifying whether to remove internal nodes that no longer have tip descendants in the subset tree

Details

The subset methods must be called using no more than one of the four main subsetting criteria arguments (tips.include, tips.exclude, mrca, or node.subtree). Each of these arguments can
be either character or numeric. In the first case, they are treated as node labels; in the second case, they are treated as node numbers. For the first two arguments, any supplied tips not found in the tree \((\text{tipLabels}(x))\) will be ignored, with a warning. Similarly, for the \text{mrca} argument, any supplied tips or internal nodes not found in the tree will be ignored, with a warning. For the \text{nodeSubtree} argument, failure to provide a single, valid internal node will result in an error.

Although \text{prune} is mainly intended as the workhorse function called by \text{subset}, it may also be called directly. In general it should be equivalent to the \text{tips.exclude} form of \text{subset} (although perhaps with less up-front error checking).

The "[" operator, when used as \(x[i]\), is similar to the \text{tips.include} form of \text{subset}. However, the indices used with this operator can also be logical, in which case the corresponding tips are assumed to be ordered as in \text{nodeId}(x,"tip"), and recycling rules will apply (just like with a vector or a matrix). With a \text{phylo4d} object \(x\), \(x[i,j]\) creates a subset of \(x\) taking \(i\) for a tip index and \(j\) for the index of data variables in \text{tdata(geospiza, "all")}. Note that the second index is optional: \(x[i, \text{TRUE}]\), \(x[i,\] and \(x[i]\) are all equivalent.

Regardless of which approach to subsetting is used, the argument values must be such that at least two tips are retained.

If the most recent common ancestor of the retained tips is not the original root node, then the root node of the subset tree will be a descendant of the original root. For rooted trees with non-NA root edge length, this has implications for the new root edge length. In particular, the new length will be the summed edge length from the new root node back to the original root (including the original root edge). As an alternative, see the examples for a way to determine the length of the edge that was immediately ancestral to the new root node in the original tree.

Note that the correspondance between nodes and labels (and data in the case of \text{phylo4d}) will be retained after all forms of subsetting. Beware, however, that the node numbers (IDs) will likely be altered to reflect the new tree topology, and therefore cannot be compared directly between the original tree and the subset tree.

\textbf{Value}

an object of class "phylo4" or "phylo4d"

\textbf{Methods}

\(x = "\text{phylo4}\"\) subset tree
\(x = "\text{phylo4d}\"\) subset tree and corresponding node and tip data

\textbf{Author(s)}

Jim Regetz <regetz@nceas.ucsb.edu>
Steven Kembel <skembel@berkeley.edu>
Damien de Vienne <damien.de-vienne@u-psud.fr>
Thibaut Jombart <jombart@biomserv.univ-lyon1.fr>

\textbf{Examples}

data(geospiza)
nodelabels(geospiza) <- paste("N", nodeId(geospiza, "internal"), sep="")
geotree <- extractTree(geospiza)
## "subset" examples

```r
tips <- c("difficilis", "fortis", "fuliginosa", "fusca", "olivacea", "pallida", "parvulus", "scandens")
plot(subset(geotree, tips.include=tips))
plot(subset(geotree, tips.include=tips, trim.internal=FALSE))
plot(subset(geotree, tips.exclude="scandens"))
plot(subset(geotree, mrca=c("scandens", "fortis", "pauper")))
plot(subset(geotree, node.subtree=18))
```

## "prune" examples (equivalent to subset using tips.exclude)

```r
plot(prune(geotree, tips))
```

## "[" examples (equivalent to subset using tips.include)

```r
plot(geotree[c(1:6,14)])
plot(geospiza[c(1:6,14)])
```

## for phylo4d, subset both tips and data columns

```r
geospiza[c(1:6,14), c("wing", "beakD")]
```

## note handling of root edge length:
```r
degreeLength(geotree)["0-15"] <- 0.1
geotree2 <- geotree[1:2]
```

## in subset tree, edge of new root extends back to the original root
```r
degreeLength(geotree2)["0-3"]
```

## edge length immediately ancestral to this node in the original tree
```r
degreeLength(geotree, MRCA(geotree, tipLabels(geotree2)))
```

---

**summary-methods**

*Summary for phylo4/phylo4d objects*

**Description**

Summary of information for the tree (phylo4 only) and/or the associated data (phylo4d).

**Usage**

```r
summary(object, ...)
```

## S4 method for signature 'phylo4'
```r
summary(object, quiet = FALSE)
```

## S4 method for signature 'phylo4d'
```r
summary(object, quiet = FALSE)
```

```r
nodeType(object)
```

## S4 method for signature 'phylo4'
```r
nodeType(object)
```
Arguments

object a phylo4d object
...
quiet Should the summary be displayed on screen?

Value

The `nodeType` method returns named vector which has the type of node (internal, tip, root) for value, and the node number for name.

The summary method invisibly returns a list with the following components:

- `list("name")` the name of the object
- `list("nb.tips")` the number of tips
- `list("nb.nodes")` the number of nodes
- `list("mean.el")` mean of edge lengths
- `list("var.el")` variance of edge lengths (estimate for population)
- `list("sumiy.el")` summary (i.e. range and quartiles) of the edge lengths
- `list("degree")` (optional) type of polytomy for each node: ‘node’, ‘terminal’ (all descendants are tips) or ‘internal’ (at least one descendant is an internal node); displayed only when there are polytomies
- `list("sumry.tips")` (optional) summary for the data associated with the tips
- `list("sumry.nodes")` (optional) summary for the data associated with the internal nodes

Author(s)

Ben Bolker, Thibaut Jombart, Francois Michonneau

See Also

`phylo4d-methods` constructor and `phylo4d` class.

Examples

tree.owls <- ape::read.tree(text=tOwls)
P1 <- as(tree.owls, "phylo4")
P1
summary(P1)
nodeType(P1)

## summary of a polytomous tree
E <- matrix(c(8, 9, 9, 10, 10, 1, 10, 2, 9, 3, 9, 4, 8, 11, 11, 5, 11, 6, 11, 7, 0, 8), ncol=2, byrow=TRUE)

P2 <- phylo4d(E)
nodelabels(P2) <- as.character(nodId(P2, "internal"))
plot(P2, show.node.label=TRUE)
sumryP2 <- summary(P2)
sumryP2

### Retrieving or updating tip and node data in phylo4d objects

#### Description

Methods to retrieve or update tip, node or all data associated with a phylogenetic tree stored as a phylo4d object

#### Usage

tdata(x, ...)

## S4 method for signature 'phylo4d'
tdata(x, type = c("all", "tip", "internal"),
      label.type = c("row.names", "column"), empty.columns = TRUE)

tdata(x, ...) <- value

## S4 replacement method for signature 'phylo4d'
tdata(x, type = c("all", "tip", "internal"),
      merge.data = TRUE, clear.all = FALSE, ...) <- value

tipData(x, ...)

## S4 method for signature 'phylo4d'
tipData(x, ...)

tipData(x, ...) <- value
## Arguments

**x**
A `phylo4d` object

**...**
For the `tipData` and `nodeData` accessors, further arguments to be used by `tdata`. For the replacement forms, further arguments to be used to control matching between tree and data (see Details section of `phylo4d-methods`).

**type**
The type of data to retrieve or update: “all” (default) for data associated with both tip and internal nodes, “tip” for data associated with tips only, “internal” for data associated with internal nodes only.

**label.type**
How should the tip/node labels from the tree be returned? “row.names” returns them as row names of the data frame, “column” returns them in the first column of the data frame. This options is useful in the case of missing (NA) or non-unique labels.

**empty.columns**
Should columns filled with NA be returned?

**value**
a data frame (or object to be coerced to one) to replace the values associated with the nodes specified by the argument `type`

**merge.data**
if tip or internal node data are provided and data already exists for the other type, this determines whether columns with common names will be merged together (default TRUE). If FALSE, columns with common names will be preserved separately, with “.tip” and “.node” appended to the names. This argument has no effect if tip and node data have no column names in common, or if `type=“all”`.

**clear.all**
If only tip or internal node data are to be replaced, should data of the other type be dropped?

## Value

tdata returns a data frame

## Methods

**tdata** signature(object=“phylo4d“): retrieve or update data associated with a tree in a phylo4d object
**tip.data.plot**

**Author(s)**

Ben Bolker, Thibaut Jombart, Francois Michonneau

**See Also**

*phylo4d-methods, phylo4d*

**Examples**

```r
data(geospiza)
tdata(geospiza)
tipData(geospiza) <- 1:nTips(geospiza)
tdata(geospiza)
```

---

**tip.data.plot**  
*Plotting trees and associated data*

**Description**

Plotting phylogenetic trees and associated data

**Usage**

```r
tip.data.plot(xxyy, type = c("phylogram", "cladogram", "fan"),
  show.tip.label = TRUE, show.node.label = FALSE, rot = 0,
  tip.plot.fun = grid.points, edge.color = "black",
  node.color = "black", tip.color = "black", edge.width = 1, ...)
```

**Arguments**

- **xxyy**: A list created by the `phyloXXX` function
- **type**: A character string indicating the shape of plotted tree
- **show.tip.label**: Logical, indicating whether tip labels should be shown
- **show.node.label**: Logical, indicating whether node labels should be shown
- **rot**: Numeric indicating the rotation of the plot in degrees
- **tip.plot.fun**: A function used to plot the data elements of a `phylo4d` object
- **edge.color**: A vector of colors in the order of `edges(phy)`
- **node.color**: A vector of colors indicating the colors of the node labels
- **tip.color**: A vector of colors indicating the colors of the tip labels
- **edge.width**: A vector in the order of `edges(phy)` indicating the widths of edge lines
- **...**: Additional parameters passed to `tip.plot.fun`
Value

creates a plot on the current graphics device.

Author(s)

Peter Cowan

Phylogeny plotting

Description

Plot phylo4 or phylo4d objects, including associated data.

Usage

```r
treePlot(phy, type = c("phylogram", "cladogram", "fan"),
        show.tip.label = TRUE, show.node.label = FALSE, tip.order = NULL,
        plot.data = is(phy, "phylo4d"), rot = 0, tip.plot.fun = "bubbles",
        plot.at.tip = TRUE, edge.color = "black", node.color = "black",
        tip.color = "black", edge.width = 1, newpage = TRUE,
        margins = c(1.1, 1.1, 1.1, 1.1), ...)
```

```r
plot(x, y, ...)
```

## S4 method for signature 'phylo4,missing'

```r
plot(x, y, ...)
```

Arguments

- **phy**: A phylo4 or phylo4d object
- **type**: A character string indicating the shape of plotted tree
- **show.tip.label**: Logical, indicating whether tip labels should be shown
- **show.node.label**: Logical, indicating whether node labels should be shown
- **tip.order**: If NULL the tree is plotted with tips in preorder, if "rev" this is reversed. Otherwise, it is a character vector of tip labels, indicating their order along the y axis (from top to bottom). Or, a numeric vector of tip node IDs indicating the order.
- **plot.data**: Logical indicating whether phylo4d data should be plotted
- **rot**: Numeric indicating the rotation of the plot in degrees
- **tip.plot.fun**: A function used to generate plot at the each tip of the phylogenetic trees
- **plot.at.tip**: Should the data plots be at the tip? (logical)
- **edge.color**: A vector of colors in the order of edges(phy)
- **node.color**: A vector of colors indicating the colors of the node labels
**treePlot-methods**

- **tip.color** A vector of colors indicating the colors of the tip labels
- **edge.width** A vector in the order of edges(phy) indicating the widths of edge lines
- **newpage** Logical indicating whether the page should be cleared before plotting
- **margins** number of lines around the plot (similar to `par(mar)`).
- **...** additional arguments
- **x** A phylo4 or phylo4d object
- **y** (only here for compatibility)

**Details**

Currently, `treePlot` can only plot numeric values for tree-associated data. The dataset will be subset to only include columns of class `numeric`, `integer` or `double`. If a phylo4d object is passed to the function and it contains no data, or if the data is in a format that cannot be plotted, the function will produce a warning. You can avoid this by using the argument `plot.data=FALSE`.

**Value**

No return value, function invoked for plotting side effect

**Methods**

- `phy = "phylo4"` plots a tree of class `phylo4`
- `phy = "phylo4d"` plots a tree with one or more quantitative traits contained in a `phylo4d` object.

**Author(s)**

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**See Also**

- `phylobubbles`

**Examples**

```r
## example of plotting two grid plots on the same page
library(grid)
data(geospiza)
geotree <- extractTree(geospiza)
grid.newpage()
pushViewport(viewport(layout=grid.layout(nrow=1, ncol=2), name="base"))
pushViewport(viewport(layout.pos.col=1, name="plot1"))
  treePlot(geotree, newpage=FALSE)
popViewport()

pushViewport(viewport(layout.pos.col=2, name="plot2"))
  treePlot(geotree, newpage=FALSE, rot=180)
popViewport(2)
```
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