Package: pdi (via r-universe)

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Type Package

Title Phenotypic Index Measures for Oak Decline Severity

Version 0.4.3

Description Oak declines are complex disease syndromes and consist of many visual indicators that include aspects of tree size, crown condition and trunk condition. This can cause difficulty in the manual classification of symptomatic and non-symptomatic trees from what is in reality a broad spectrum of oak tree health condition. Two phenotypic oak decline indexes have been developed to quantitatively describe and differentiate oak decline syndromes in Quercus robur. This package provides a toolkit to generate these decline indexes from phenotypic descriptors using the machine learning algorithm random forest. The methodology for generating these indexes is outlined in Finch et al. (2021) <doi:10.1016/j.foreco.2021.118948>.

URL `https://jasenfinch.github.io/pdi/`

BugReports `https://github.com/jasenfinch/pdi/issues`

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Encoding UTF-8

Imports dplyr, magrittr, purrr, randomForest, readxl, stringr, tibble, tidyr, tidyselect

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Suggests testthat, covr, knitr, rmarkdown, ggplot2

VignetteBuilder knitr

NeedsCompilation no

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Contents

`agrilusExitHoleDensity`

Agrilus exit hole density (m^-2)

Description

Calculate Agrilus biguttatus exit hole density.

Usage

```
agrilusExitHoleDensity(n, d, s = 2)
```

Arguments

`n`	number of Agrilus exit holes
`d`	diameter at breast height (m)
`s`	height to which stem surveyed from the tree base (m)

Examples

```
agrilusExitHoleDensity(2,1.02,1.3)
```

`bleedPrevalence` *Estimated bleed prevalence (%)*

Description

Calculate estimated bleed prevalence.

Usage

```
bleedPrevalence(a, A, b, B, d, s = 3)
```

Arguments

`a`	average active bleed size (mm)
`A`	number of active bleeds
`b`	average black stain size (mm)
`B`	number of black stains
`d`	diameter at breast height (m)
`s`	height to which stem surveyed from the tree base (m)

Examples

```
bleedPrevalence(30,10,40,5,1,1.3)
```

`calcDIs` *Calculate Decline Indexes*

Description

Calculate Phenotypic Decline Index (PDI) and Decline Acuteness Index (DAI).

Usage

```
calcDIs(rfModels, PDI = TRUE, DAI = TRUE, invertPDI = TRUE, invertDAI = TRUE)
```

Arguments

`rfModels`	list containing random forest models as returned by `rf()`
`PDI`	TRUE/FALSE, calculate PDI?
`DAI`	TRUE/FALSE, calculate DAI?
`invertPDI`	invert the PDI scale? TRUE/FALSE. Ignored if argument PDI is FALSE
`invertDAI`	invert the DAI scale? TRUE/FALSE. Ignored if argument DAI is FALSE

Examples

```
library(dplyr)

## Retrieve file paths for example data
files <- list.files(system.file('phenotypeDataCollectionSheets',
  package = 'pdi'),full.names = TRUE)

## Prepare data
d <- map(files,readPhenotypeSheet) %>%
  map(preparePhenotypeData) %>%
  bind_rows() %>%
  siteAdjustment() %>%
   mutate(`Live crown ratio (%)` = liveCrownRatio(`Total height (m)`,
     `Lower crown height (m)`),
     `Crown condition (%)` = crownCondition(`Missing crown (%)`,
                                 `Crown transparency (%)`),
     `Crown volume (m^3)` = crownVolume(`Crown radius (m)`,
                                 `Total height (m)`,
                                 `Lower crown height (m)`,
                                 `Crown condition (%)`),
     `Bleed prevalence (%)` = bleedPrevalence(`Active bleed length (mm)`,
                                 `Active bleeds`,
                                 `Black staining length (mm)`,
                                 `Black staining`,
                                 `Diameter at breast height (m)`),
     `Agrilus exit hole density (m^-2)` = agrilusExitHoleDensity(`Agrilus exit holes`,
                                 `Diameter at breast height (m)`)
)

t <- makeAnalysisTable(d)

## Generate random forest models
m <- rf(t,cls = NULL,nreps = 10)

## Calculate decline indexese
DIs <- calcDIs(m,DAI = FALSE,invertPDI = FALSE) %>%
  bind_cols(d %>%
    select(Location,ID,Status))
```

`crownCondition` *Crown condition*

Description

Calculate crown condition (%).

Usage

```
crownCondition(m, t)
```

Arguments

`m`	missing crown (%)
`t`	crown transparency (%)

Examples

```
crownCondition(50,60)
```

`crownProductionEfficiency` *Crown production efficiency*

Description

Calculate the crown production efficiency

Usage

```
crownProductionEfficiency(crown_surface_area, crown_volume)
```

Arguments

`crown_surface_area`	crown surface area (m^2)
`crown_volume`	crown volume (m^3)

Examples

```
crownProductionEfficiency(34,35)
```

`crownSurfaceArea` *Crown surface area (m^2)*

Description

Calculate the crown surface area

Usage

```
crownSurfaceArea(r, h, l, c)
```

Arguments

`r`	crown radius (m)
`h`	total height (m)
`l`	lower crown height (m)
`c`	crown condition (%)

Examples

```
crownSurfaceArea(3,15,10,50)
```

`crownVolume` *Estimated crown volume (m^3)*

Description

Calculate estimated crown volume.

Usage

```
crownVolume(r, h, l, c)
```

Arguments

`r`	crown radius (m)
`h`	total height (m)
`l`	lower crown height (m)
`c`	crown condition (%)

Examples

```
crownVolume(3,15,10,50)
```

`descriptorContributions` *Descriptor contributions*

Description

Calculate average descriptor contributions to random forest models.

Usage

```
descriptorContributions(rfModels)
```

Arguments

`rfModels`	list containing random forest models as returned by `rf()`

Details

See see `?randomForest::importance` for details on random forest importance metrics.

Examples

```
library(dplyr)

## Retrieve file paths for example data
files <- list.files(system.file('phenotypeDataCollectionSheets',
  package = 'pdi'),full.names = TRUE)

## Prepare data
d <- map(files,readPhenotypeSheet) %>%
  map(preparePhenotypeData) %>%
  bind_rows() %>%
  siteAdjustment() %>%
   mutate(`Live crown ratio (%)` = liveCrownRatio(`Total height (m)`,
     `Lower crown height (m)`),
     `Crown condition (%)` = crownCondition(`Missing crown (%)`,
                              `Crown transparency (%)`),
     `Crown volume (m^3)` = crownVolume(`Crown radius (m)`,
                              `Total height (m)`,
                              `Lower crown height (m)`,
                              `Crown condition (%)`),
     `Bleed prevalence (%)` = bleedPrevalence(`Active bleed length (mm)`,
                              `Active bleeds`,
                              `Black staining length (mm)`,
                              `Black staining`,
                              `Diameter at breast height (m)`),
     `Agrilus exit hole density (m^-2)` = agrilusExitHoleDensity(`Agrilus exit holes`,
                              `Diameter at breast height (m)`)
)
```

```
t <- makeAnalysisTable(d)

## Generate random forest models
m <- rf(t,cls = NULL,nreps = 10)

descriptor_contributions <- m %>%
  descriptorContributions()
```

`liveCrownRatio` *Live crown ratio*

Description

Calculate the live crown ratio

Usage

```
liveCrownRatio(h, l)
```

Arguments

`h`	total height (m)
`l`	lower crown height (m)

Examples

```
liveCrownRatio(15,10)
```

`makeAnalysisTable` *Make analysis table*

Description

prepare data table ready for random forest analysis

Usage

```
makeAnalysisTable(phenoData)
```

Arguments

`phenoData`	tibble containing phenotype data

Examples

```
library(dplyr)

## Retrieve file paths for example data
files <- list.files(system.file('phenotypeDataCollectionSheets',
  package = 'pdi'),full.names = TRUE)

## Prepare data
d <- map(files,readPhenotypeSheet) %>%
  map(preparePhenotypeData) %>%
  bind_rows() %>%
  siteAdjustment() %>%
   mutate(`Live crown ratio (%)` = liveCrownRatio(`Total height (m)`,
     `Lower crown height (m)`),
     `Crown condition (%)` = crownCondition(`Missing crown (%)`,
                              `Crown transparency (%)`),
     `Crown volume (m^3)` = crownVolume(`Crown radius (m)`,
                              `Total height (m)`,
                              `Lower crown height (m)`,
                              `Crown condition (%)`),
     `Bleed prevalence (%)` = bleedPrevalence(`Active bleed length (mm)`,
                              `Active bleeds`,
                              `Black staining length (mm)`,
                              `Black staining`,
                              `Diameter at breast height (m)`),
     `Agrilus exit hole density (m^-2)` = agrilusExitHoleDensity(`Agrilus exit holes`,
                              `Diameter at breast height (m)`)
)

t <- makeAnalysisTable(d)
```

`mds` *Multidimensional scaling*

Description

perform multidimensional scaling of random forest proximities

Usage

```
mds(rfModels, dimensions = 2)
```

Arguments

`rfModels`	list containing random forest models as returned by `rf()`
`dimensions`	number of dimensions to scale to

Examples

```
library(dplyr)

## Retrieve file paths for example data
files <- list.files(system.file('phenotypeDataCollectionSheets',
  package = 'pdi'),full.names = TRUE)

## Prepare data
d <- map(files,readPhenotypeSheet) %>%
  map(preparePhenotypeData) %>%
  bind_rows() %>%
  siteAdjustment() %>%
   mutate(`Live crown ratio (%)` = liveCrownRatio(`Total height (m)`,
     `Lower crown height (m)`),
     `Crown condition (%)` = crownCondition(`Missing crown (%)`,
                              `Crown transparency (%)`),
     `Crown volume (m^3)` = crownVolume(`Crown radius (m)`,
                              `Total height (m)`,
                              `Lower crown height (m)`,
                              `Crown condition (%)`),
     `Bleed prevalence (%)` = bleedPrevalence(`Active bleed length (mm)`,
                              `Active bleeds`,
                              `Black staining length (mm)`,
                              `Black staining`,
                              `Diameter at breast height (m)`),
     `Agrilus exit hole density (m^-2)` = agrilusExitHoleDensity(`Agrilus exit holes`,
                              `Diameter at breast height (m)`)
)

t <- makeAnalysisTable(d)

## Generate random forest models
m <- rf(t,cls = NULL,nreps = 10)

mds_data <- mds(m,2)
```

`minMaxScale` *Min-max scaling*

Description

Variable min-max scaling.

Usage

```
minMaxScale(vec)
```

Arguments

`vec`	vector of numbers to scale

Examples

```
set.seed(1234)

d <- runif(20,1,10)

minMaxScale(d)
```

`phenotypingTemplate` *Phenotyping template*

Description

Export a copy of the oak phenotyping data collection spreadsheet.

Usage

```
phenotypingTemplate(path = ".")
```

Arguments

`path`	directory path for export output

Examples

```
## Not run:
phenotypingTemplate()

## End(Not run)
```

`preparePhenotypeData` *Prepare phenotype data*

Description

Process parsed phenotype data sheets into a tibble suitable for random forest analysis.

Usage

```
preparePhenotypeData(phenotypeData)
```

Arguments

`phenotypeData`	parsed phenotype data collection sheet returned from `readPhenotypeSheet`

Examples

```
library(dplyr)

## Retrieve file paths for example data
files <- list.files(system.file('phenotypeDataCollectionSheets',
  package = 'pdi'),full.names = TRUE)

## Prepare data
d <- map(files,readPhenotypeSheet) %>%
  map(preparePhenotypeData)
```

`readPhenotypeSheet` *Read phenptyping sheet*

Description

Parse .xlsx phenotype data collection sheets.

Usage

```
readPhenotypeSheet(file)
```

Arguments

`file`	file path to excel file to parse

Examples

```
library(dplyr)

## Retrieve file paths for example data
files <- list.files(system.file('phenotypeDataCollectionSheets',
  package = 'pdi'),full.names = TRUE)

## Prepare data
d <- readPhenotypeSheet(files[1])
```

`rf` *Random forest analysis*

Description

Perform random forest repetitions.

Usage

```
rf(analysisTable, cls, params = list(), nreps = 100, seed = 1234)
```

Arguments

`analysisTable`	tibble of phenotype data suitable for random forest analysis as returned by `preparePhenotypeData`
`cls`	analysisTable column to use as response vector. NULL for unsupervised analyses.
`params`	additional arguments to pass to randomForest::randomForest
`nreps`	number of repetitions
`seed`	random number seed

Examples

```
library(dplyr)

## Retrieve file paths for example data
files <- list.files(system.file('phenotypeDataCollectionSheets',
  package = 'pdi'),full.names = TRUE)

## Prepare data
d <- map(files,readPhenotypeSheet) %>%
  map(preparePhenotypeData) %>%
  bind_rows() %>%
  siteAdjustment() %>%
   mutate(`Live crown ratio (%)` = liveCrownRatio(`Total height (m)`,
     `Lower crown height (m)`),
     `Crown condition (%)` = crownCondition(`Missing crown (%)`,
                               `Crown transparency (%)`),
     `Crown volume (m^3)` = crownVolume(`Crown radius (m)`,
                               `Total height (m)`,
                               `Lower crown height (m)`,
                               `Crown condition (%)`),
     `Bleed prevalence (%)` = bleedPrevalence(`Active bleed length (mm)`,
                               `Active bleeds`,
                               `Black staining length (mm)`,
                               `Black staining`,
                               `Diameter at breast height (m)`),
     `Agrilus exit hole density (m^-2)` = agrilusExitHoleDensity(`Agrilus exit holes`,
                               `Diameter at breast height (m)`)
)

t <- makeAnalysisTable(d)

## Generate random forest models
m <- rf(t,cls = NULL,nreps = 10)
```

`siteAdjustment` *Site adjustment*

Description

Perform a site adjustment of selected descriptors.

Usage

```
siteAdjustment(
  phenoData,
  descriptors = c("Diameter at breast height (m)", "Lower crown height (m)",
    "Timber height (m)", "Total height (m)", "Crown radius (m)")
)
```

Arguments

`phenoData`	phenoData tibble containing phenotype data
`descriptors`	columns of phenoData on which to perform site correction

Examples

```
library(dplyr)

## Retrieve file paths for example data
files <- list.files(system.file("phenotypeDataCollectionSheets",
  package = "pdi"
), full.names = TRUE)

## Prepare data
d <- map(files, readPhenotypeSheet) %>%
  map(preparePhenotypeData) %>%
  bind_rows() %>%
  siteAdjustment()
```

`siteAdjustmentFactors` *Site adjustment factors*

Description

Return site adjustment factors of selected phenotypic descriptors.

Usage

```
siteAdjustmentFactors(
  phenoData,
  descriptors = c("Diameter at breast height (m)", "Lower crown height (m)",
    "Timber height (m)", "Total height (m)", "Crown radius (m)")
)
```

Arguments

`phenoData`	phenoData tibble containing phenotype data
`descriptors`	columns of phenoData on which calculate site correction factors

Examples

```
library(dplyr)

## Retrieve file paths for example data
files <- list.files(system.file("phenotypeDataCollectionSheets",
  package = "pdi"
), full.names = TRUE)

## Prepare data
d <- map(files, readPhenotypeSheet) %>%
  map(preparePhenotypeData) %>%
  bind_rows() %>%
  siteAdjustment()

sa_factors <- siteAdjustmentFactors(d)
```

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