Package ‘timbeR’

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Estimate the diameter at a given height based on a fitted Bi (2000) taper equation.

Description

Estimates the diameter at a given height of a tree from the diameter at breast height, total height and the coefficients of the Bi taper function.

Usage

```r
bi_di(dbh, h, hi, coef)
```

Arguments

- `dbh`: tree diameter at breast height, in centimeters.
- `h`: total tree height, in meters.
- `hi`: height at which the diameter will be calculated, in meters.
- `coef`: numerical vector containing seven coefficients of the Bi taper function.

Details

The Bi (2000) variable-form taper function is represented mathematically by the following expression

\[ \text{di} \sim \text{dbh} \times \left( \frac{\log(\sin((\pi/2) \times (\text{hi}/\text{h})))}{\log(\sin((\pi/2) \times (1.3/\text{h})))}\right)^{b0 + b1 \times \sin((\pi/2) \times (\text{hi}/\text{h})) + b2 \times \cos((3 \times \pi/2) \times (\text{hi}/\text{h})) + b3 \times (\sin((\pi/2) \times (\text{hi}/\text{h})))/(\text{hi}/\text{h})) + b4 \times \text{dbh} + b5 \times (\text{hi}/\text{h}) + \text{dbh}^0.5 + b6 \times (\text{hi}/\text{h}) \times \text{h}^0.5} \]

Value

A numeric value indicating the diameter at the given height.
library(dplyr)
library(minpack.lm)
library(timbeR)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
        hih = hi/h)

bi <- nlsLM(di ~ taper_bi(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6),
           data = tree_scaling,
           start = list(b0=1.8,b1=-0.2,b2=-0.04,b3=-0.9,b4=-0.0006,b5=0.07,b6=-.14))

coef_bi <- coef(bi)

dbh <- 25
h <- 20
hi <- 15

bi_di(dbh, h, hi, coef_bi)

---

**bi_hi**  
*Estimate the height at which a given diameter occurs in a tree, based on a fitted Bi (2000) taper equation.*

**Description**

Estimates the height at which a given diameter occurs in a tree, from the diameter at breast height, total height and coefficients of the Bi taper function.

**Usage**

`bi_hi(dbh, h, di, coef)`

**Arguments**

- **dbh**: tree diameter at breast height, in centimeters.
- **h**: total tree height, in meters.
- **di**: diameter whose height of occurrence will be estimated, in centimeters.
- **coef**: numerical vector containing seven coefficients of the Bi taper equation.
Details

the Bi (2000) variable-form taper function is represented mathematically by the following expression

\[ di \sim dbh \times \left( \frac{\log(\sin((\pi/2) \times (hi/h)))}{\log(\sin((\pi/2) \times (1.3/h))))} \right)^{(b0 + b1 \times \sin((\pi/2) \times (hi/h)) + b2 \times \cos((3 \times \pi/2) \times (hi/h)) + b3 \times (\sin((\pi/2) \times (hi/h))/(hi/h)) + b4 \times dbh + b5 \times (hi/h) \times dbh^{0.5} + b6 \times (hi/h) \times h^{0.5}) \]

Value

a numeric value indicating the height at which the given diameter occurs.

Examples

```r
library(dplyr)
library(minpack.lm)
library(timbeR)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
         hih = hi/h)

bi <- nlsLM(di ~ taper_bi(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6),
            data=tree_scaling,
            start=list(b0=1.8,b1=-0.2,b2=-0.04,b3=-0.9,b4=-0.0006,b5=0.07,b6=-.14))

coef_bi <- coef(bi)

dbh <- 25
h <- 20
di <- 5
bi_hi(dbh, h, di, coef_bi)
```

---

**bi_logs** | *Simulate log extraction using a Bi (2000) variable-form taper equation that describes the taper of the tree.*

---

**Description**

Simulate the extraction of logs from a tree from its measurements, taper function (Bi (2000) variable-form taper equation), trunk quality characteristics and harvest parameters such as stump height and assortments.
bi_logs

Usage

bi_logs(
  dbh,
  h,
  coef,
  assortments,
  stump_height,
  downgrade,
  broken,
  defect_height,
  eliminate,
  total_volume,
  only_vol
)

Arguments

dbh  tree diameter at breast height, in centimeters.
h    total tree height, in meters.
coef  numerical vector containing seven coefficients of the Bi taper equation.
assortments  a data.frame with five columns and n rows, where n is the number of different wood assortments to be obtained from the tree stem. The first column must contain the names of the assortments, the second, numerical, contains the minimum diameters at the small end of the logs, in centimeters. The third column, numerical, contains the minimum lengths of the logs, in meters. The fourth column, numerical, contains the maximum lengths of the logs, in meters. The fifth column, numerical, contains the values in centimeters referring to the loss of wood due to cutting logs. The algorithm prioritizes the extraction of assortments along the stem in the order presented in the data.frame, starting from the first line, to the last.
stump_height  tree cutting height, in meters. Default is 0.
downgrade  if TRUE, the algorithm, from the defect_height onwards, simulates log extraction only for the last assortment in the assortments data.frame. Default is FALSE.
broken  if TRUE, the algorithm will simulate the extraction of logs only up to the defect_height. Default is FALSE.
defect_height  the height, in meters, from which the logs will be downgraded (if downgrade is TRUE) or log extraction simulation will be stopped (if broken is TRUE). Default is 0 for downgrade = TRUE (the whole tree is downgraded) and h * 0.5 for broken = TRUE (the tree is broken from half its original/estimated total height).
eliminate  if TRUE, the algorithm does not get logs for any assortment present in the assortments table. All will be zero. Default is FALSE.
total_volume  if TRUE, it adds an additional column to the results data.frame with the estimate of the total volume of the tree, from the ground height to h if broken argument is FALSE, or to defect_height if broken is TRUE. Default is FALSE.
only_vol

if TRUE returns only volumes (does not return the number of logs). Default is FALSE.

Details

when the broken and downgrade arguments are set to TRUE, the defect_height value is considered as the break height of the tree, and the entire tree is downgraded.

Value

a list of two data.frames, the first (volumes) with the calculated volumes per assortment, and the second (logs) with the number of logs per assortment.

Examples

library(dplyr)
library(minpack.lm)
library(timbeR)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
         hih = hi/h)

bi <- nlsLM(di ~ taper_bi(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6),
            data = tree_scaling,
            start = list(b0=1.8,b1=-0.2,b2=-0.04,b3=-0.9,b4=-0.0006,b5=0.07,b6=-.14))

tcoef_bi <- coef(bi)

dbh <- 25
h <- 20

assortments <- data.frame(
  NAME = c('15-25','4-15'),
  SED = c(15,4),
  MINLENGTH = c(2.65,2),
  MAXLENGTH = c(2.65,4.2),
  LOSS = c(5,5)
)

bi_logs(dbh, h, coef_bi, assortments)

bi_logs_plot

Visualize the simulation of log cutting along the stem using a Bi (2000) variable-form taper equation.
**bi_logs_plot**

**Description**

Plot the shape of the tree and visualize the extracted logs based on the tree measurements, assortments data.frame, and the Bi (2000) variable-form taper equation.

**Usage**

```r
bi_logs_plot(
  dbh,
  h,
  coef,
  assortments,
  stump_height,
  downgrade,
  broken,
  defect_height,
  lang
)
```

**Arguments**

- **dbh**: tree diameter at breast height, in centimeters.
- **h**: total tree height, in meters.
- **coef**: numerical vector containing seven coefficients of the Bi variable-form taper equation.
- **assortments**: a data.frame with five columns and n rows, where n is the number of different wood assortments to be obtained from the tree stem. The first column must contain the names of the assortments, the second, numerical, contains the minimum diameters at the small end of the logs, in centimeters. The third column, numerical, contains the minimum lengths of the logs, in meters. The fourth column, numerical, contains the maximum lengths of the logs, in meters. The fifth column, numerical, contains the values in centimeters referring to the loss of wood due to cutting logs. The algorithm prioritizes the extraction of assortments along the stem in the order presented in the data.frame, starting from the first line, to the last.
- **stump_height**: tree cutting height, in meters. Default is 0.
- **downgrade**: if TRUE, the algorithm, from the defect_height onwards, simulates log extraction only for the last assortment in the assortments data.frame. Default is FALSE.
- **broken**: if TRUE, the algorithm will simulate the extraction of logs only up to the defect_height. Default is FALSE.
- **defect_height**: the height, in meters, from which the logs will be downgraded (if downgrade is TRUE) or log extraction simulation will be stopped (if broken is TRUE). Default is h * 0.5.
- **lang**: language in which plot labels will be displayed. Current options are 'en' and 'pt-BR'. Default is 'en'.
Details

check the bi_logs function help for more details.

Value

a ggplot object.

Examples

```r
library(dplyr)
library(minpack.lm)
library(timberR)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
         hih = hi/h)

bi <- nlsLM(di ~ taper_bi(dbh, h, h0, b1, b2, b3, b4, b5, b6),
            data=tree_scaling,
            start=list(b0=1.8, b1=-0.2, b2=-0.04, b3=-0.9, b4=-0.0006, b5=0.07, b6=-.14))

dbh <- 25
h <- 20

assortments <- data.frame(
    NAME = c('15-25','4-15'),
    SED = c(15,4),
    MINLENGTH = c(2.65,2),
    MAXLENGTH = c(2.65,4.2),
    LOSS = c(5,5)
)

bi_logs_plot(dbh, h, coef(bi), assortments)
```

---

**bi_vol**

Estimate the total or partial volume of the tree, based on a fitted Bi (2000) taper function.

**Description**

Estimates the total or partial volume of the tree from the diameter at breast height, total height, initial section height, final section height and coefficients of the Bi (2000) taper equation.

**Usage**

```r
bi_vol(dbh, h, coef, hi, h0)
```
Arguments

- `dbh`: tree diameter at breast height, in centimeters.
- `h`: total tree height, in meters.
- `coef`: numerical vector containing seven coefficients of the Bi taper equation.
- `hi`: final height of the tree section whose volume will be calculated, in meters. Default is the total tree height (h).
- `h0`: initial height of the tree section whose volume will be calculated, in meters. Default is 0 (ground height).

Details

The Bi (2000) variable-form taper function is represented mathematically by the following expression:

\[ d_i = \frac{dbh \cdot \frac{\log(\sin((\pi/2) \cdot (hi/h)))}{\log(\sin((\pi/2) \cdot (1.3/h))))^{b0 + b1 \cdot \sin((\pi/2) \cdot (hi/h)) + b2 \cdot \cos(3 \cdot \pi/2) \cdot (hi/h)) + b3 \cdot (\sin((\pi/2) \cdot (hi/h))/(hi/h)) + b4 \cdot dbh + b5 \cdot (hi/h) \cdot dbh^{0.5} + b6 \cdot (hi/h) \cdot h^{0.5})}{dbh \cdot \log(\sin((\pi/2) \cdot (hi/h)))^{b0 + b1 \cdot \sin((\pi/2) \cdot (hi/h)) + b2 \cdot \cos(3 \cdot \pi/2) \cdot (hi/h)) + b3 \cdot (\sin((\pi/2) \cdot (hi/h))/(hi/h)) + b4 \cdot dbh + b5 \cdot (hi/h) \cdot dbh^{0.5} + b6 \cdot (hi/h) \cdot h^{0.5})} \]

Value

A numeric value indicating the total or partial volume of the tree.

Examples

```r
library(dplyr)
library(minpack.lm)
library(timber)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
         hih = hi/h)

bi <- nlsLM(di ~ taper_bi(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6),
            data=tree_scaling,
            start=list(b0=1.8,b1=-0.2,b2=-0.04,b3=-0.9,b4=-0.0006,b5=0.07,b6=-0.14))

coef_bi <- coef(bi)

dbh <- 25
h <- 20

bi_vol(dbh, h, coef_bi)

hi = 15
h0 = .2

bi_vol(dbh, h, coef_bi, hi, h0)
```
**kozak_di**

*Estimate the diameter at a given height based on a fitted Kozak (2004) taper equation.*

**Description**

Estimates the diameter at a given height of a tree from the diameter at breast height, total height and the coefficients of the Kozak (2004) taper function.

**Usage**

`kozak_di(dbh, h, hi, coef, p)`

**Arguments**

- `dbh`: tree diameter at breast height, in centimeters.
- `h`: total tree height, in meters.
- `hi`: height at which the diameter will be calculated, in meters.
- `coef`: numerical vector containing nine coefficients of the Kozak taper function.
- `p`: numerical value representing the first inflection point calculated in the segmented model of Max and Burkhart (1976).

**Details**

the Kozak (2004) variable-form taper function is represented mathematically by the following expression

\[
di = b_0 \times (dbh^{b_1}) \times (h^{b_2}) \times \left( \frac{1}{(1-(hi/h)^{1/4})} \right) \times \left( \frac{1}{(1-(p^{1/3}))} \right) + b_6 + b_7 \times (h^{1-(hi/h)^{1/3}}) + b_8 \times (1-(hi/h)^{1/4}) \times (1-(p^{1/3}))
\]

**Value**

a numeric value indicating the diameter at the given height.

**Examples**

```r
library(dplyr)
library(minpack.lm)
library(timbeR)

tree_scaling <- tree_scaling %>%
  mutate(did = didbh,
         hih = hi/h)

kozak <- nlsLM(di ~ taper_kozak(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6, b7, b8, p),
               start=list(b0=1.00,b1=.97,b2=.03,b3=.49,b4=-.87,b5=0.50,b6=3.88,b7=0.03,b8=-0.19, p = .1),
```
data = tree_scaling,
control = nls.lm.control(maxiter = 1000, maxfev = 2000)
)

coe_kozak <- coef(kozak)[-10]
p_kozak <- coef(kozak)[10]

h <- 20
dbh <- 25
di <- 5

kozak_di(dbh, h, di, coef_kozak, p_kozak)

---

kozak_hi

Estimate the height at which a given diameter occurs in a tree, based on a fitted Kozak (2004) taper equation.

Description

Estimates the height at which a given diameter occurs in a tree, from the diameter at breast height, total height and coefficients of the Kozak (2004) taper function.

Usage

kozak_hi(dbh, h, di, coef, p)

Arguments

dbh tree diameter at breast height, in centimeters.
h total tree height, in meters.
di diameter whose height of occurrence will be estimated, in centimeters.
coef numerical vector containing nine coefficients of the Kozak taper equation
p numerical value representing the first inflection point calculated in the segmented model of Max and Burkhart (1976).

Details

the Kozak (2004) variable-form taper function is represented mathematically by the following expression

\[
di = b_0 \times (dbh^{b_1}) \times h^{b_2} / ((1-(hi/h)^{b_3}((1/4))/(1-(p^{(1/3)})))) \times ((b_3+(hi/h)^{b_4(1/exp(dbh/h))}+b_5((1-(hi/h)^{b_6*(1/dbh)+b_7*(h^{1-(hi/h)^{b_8*((1-(hi/h)^{b_9*(1/4))/(1-(p^{(1/3)})))))}}))\times 0.1+b_6*(1/dbh)+b_7*(h^{1-(hi/h)^{b_8*(1/(1/3))}})+b_8*((1-(hi/h)^{b_9*(1/4))/(1-(p^{(1/3)}))))
\]

Value

as numeric value indicating the height at which the given diameter occurs.
Examples

library(dplyr)
library(minpack.lm)
library(timbeR)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
         hih = hi/h)

kozak <- nlsLM(di ~ taper_kozak(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6, b7, b8, p),
               start=list(b0=1.00,b1=.97,b2=.03,b3=.49,b4=-
                          0.87,b5=0.50,b6=3.88,b7=0.03,b8=0.19, p = .1),
               data = tree_scaling,
               control = nls.lm.control(maxiter = 1000, maxfev = 2000))

coef_kozak <- coef(kozak)[-10]
p_kozak <- coef(kozak)[10]

h <- 20
dbh <- 25
hi <- 15

kozak_hi(dbh, h, hi, coef_kozak, p_kozak)

---

kozak_logs
Simulate log extraction using a Kozak (2004) variable-form taper equation that describes the taper of the tree.

Description
Simulate the extraction of logs from a tree from its measurements, taper function (Kozak (2004) variable-form taper equation ), trunk quality characteristics and harvest parameters such as stump height and assortments.

Usage
kozak_logs(
  dbh,
  h,
  coef,
  p,
  assortments,
  stump_height,
  downgrade,
  broken,
defect_height,
eliminate,
total_volume,
only_vol)

Arguments
dbh tree diameter at breast height, in centimeters.
h total tree height, in meters.
coef numerical vector containing nine coefficients of the Kozak taper equation.
p numerical value representing the first inflection point calculated in the segmented model of Max and Burkhart (1976).
assortments a data.frame with five columns and n rows, where n is the number of different wood assortments to be obtained from the tree stem. The first column must contain the names of the assortments, the second, numerical, contains the minimum diameters at the small end of the logs, in centimeters. The third column, numerical, contains the minimum lengths of the logs, in meters. The fourth column, numerical, contains the maximum lengths of the logs, in meters. The fifth column, numerical, contains the values in centimeters referring to the loss of wood due to cutting logs. The algorithm prioritizes the extraction of assortments along the stem in the order presented in the data.frame, starting from the first line, to the last.
stump_height tree cutting height, in meters. Default is 0.
downgrade if TRUE, the algorithm, from the defect_height onwards, simulates log extraction only for the last assortment in the assortments data.frame. Default is FALSE.
broken if TRUE, the algorithm will simulate the extraction of logs only up to the defect_height. Default is FALSE.
defect_height the height, in meters, from which the logs will be downgraded (if downgrade is TRUE) or log extraction simulation will be stopped (if broken is TRUE). Default is 0 for downgrade = TRUE (the whole tree is downgraded) and h * 0.5 for broken = TRUE (the tree is broken from half its original/estimated total height).
eliminate if TRUE, the algorithm does not get logs for any assortment present in the assortments table. All will be zero. Default is FALSE.
total_volume if TRUE, it adds an additional column to the results data.frame with the estimate of the total volume of the tree, from the ground height to h if broken argument is FALSE, or to defect_height if broken is TRUE. Default is FALSE.
only_vol if TRUE returns only volumes (does not return the number of logs). Default is FALSE.

Details

when the broken and downgrade arguments are set to TRUE, the defect_height value is considered as the break height of the tree, and the entire tree is downgraded.
Value

a list of two data.frames, the first (volumes) with the calculated volumes per assortment, and the second (logs) with the number of logs per assortment.

Examples

library(dplyr)
library(minpack.lm)
library(timber)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
         hih = hi/h)

kozak <- nlsLM(di ~ taper_kozak(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6, b7, b8, p),
               start=list(b0=1.00, b1=0.97, b2=0.03, b3=0.49, b4=-0.87, b5=0.50, b6=3.88, b7=0.03, b8=-0.19, p = 0.1),
               data = tree_scaling,
               control = nls.lm.control(maxiter = 1000, maxfev = 2000))

coef_kozak <- coef(kozak)[-10]
p_kozak <- coef(kozak)[10]

h <- 20
dbh <- 25

assortments <- data.frame(
  NAME = c('15-25', '4-15'),
  SED = c(15, 4),
  MINLENGTH = c(2.65, 2),
  MAXLENGTH = c(2.65, 4.2),
  LOSS = c(5, 5)
)

kozak_logs(dbh, h, coef_kozak, p_kozak, assortments)

kozak_logs_plot

Visualize the simulation of log cutting along the stem using a Kozak (2004) variable-form taper equation.

Description

Plot the shape of the tree and visualize the extracted logs based on the tree measurements, assortments data.frame, and the Kozak (2004) variable-form taper equation.
kozak_logs_plot

Usage

kozak_logs_plot(
  dbh,
  h,
  coef,
  p,
  assortments,
  stump_height,
  downgrade,
  broken,
  defect_height,
  lang
)

Arguments

dbh  tree diameter at breast height, in centimeters.

h    total tree height, in meters.

coef numerical vector containing seven coefficients of the Kozak variable-form taper equation.

p    numerical value representing the first inflection point calculated in the segmented model of Max and Burkhart (1976).

assortments a data.frame with five columns and n rows, where n is the number of different wood assortments to be obtained from the tree stem. The first column must contain the names of the assortments, the second, numerical, contains the minimum diameters at the small end of the logs, in centimeters. The third column, numerical, contains the minimum lengths of the logs, in meters. The fourth column, numerical, contains the maximum lengths of the logs, in meters. The fifth column, numerical, contains the values in centimeters referring to the loss of wood due to cutting logs. The algorithm prioritizes the extraction of assortments along the stem in the order presented in the data.frame, starting from the first line, to the last.

stump_height tree cutting height, in meters. Default is 0.

downgrade if TRUE, the algorithm, from the defect_height onwards, simulates log extraction only for the last assortment in the assortments data.frame. Default is FALSE.

broken if TRUE, the algorithm will simulate the extraction of logs only up to the defect_height. Default is FALSE.

defect_height the height, in meters, from which the logs will be downgraded (if downgrade is TRUE) or log extraction simulation will be stopped (if broken is TRUE). Default is h * 0.5.

lang language in which plot labels will be displayed. Current options are ‘en’ and ‘pt-BR’. Default is ‘en’.

Details

check the kozak_logs function help for more details.
kozak_vol

Value

a ggplot object.

Examples

```r
library(dplyr)
library(minpack.lm)
library(timbeR)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
         hih = hi/h)

kozak <- nlsLM(di ~ taper_kozak(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6, b7, b8, p),
               start=list(b0=1.00,b1=.97,b2=.03,b3=-.49,b4=-.87,b5=0.50,b6=3.88,b7=0.03,b8=-0.19, p = .1),
               data = tree_scaling,
               control = nls.lm.control(maxiter = 1000, maxfev = 2000))

coef_kozak <- coef(kozak)[-10]
p_kozak <- coef(kozak)[10]

h <- 20
dbh <- 25

assortments <- data.frame(
    NAME = c('15-25','4-15'),
    SED = c(15,4),
    MINLENGTH = c(2.65,2),
    MAXLENGTH = c(2.65,4.2),
    LOSS = c(5,5)
)

kozak_logs(dbh, h, coef_kozak, p_kozak, assortments)
```

---

**kozak_vol**

Estimate the total or partial volume of the tree, based on a fitted Kozak (2004) taper function.

**Description**

Estimates the total or partial volume of the tree from the diameter at breast height, total height, initial section height, final section height and coefficients of the Kozak (2004) taper equation.

**Usage**

`kozak_vol(dbh, h, coef, p, hi, h0)`
Arguments

dbh  tree diameter at breast height, in centimeters.

h    total tree height, in meters.

coeff numerical vector containing eight coefficients of the Kozak taper equation.

p    numerical value representing the first inflection point calculated in the segmented
      model of Max and Burkhart (1976).

hi   final height of the tree section whose volume will be calculated, in meters. De-
      fault is the total tree height (h).

h0   initial height of the tree section whose volume will be calculated, in meters. De-
      fault is 0 (ground height).

Details

the Kozak (2004) variable-form taper function is represented mathematically by the following ex-
pression

\[
di = \frac{b_0 \times (dbh \times b_1)}{h \times b_2} \times (1 + (hi/h) \times (1/4)) \times (1 - (p^{(1/3)}))^{(b_3 \times (hi/h) \times 4 + b_4 \times (1/\exp(dbh/h)) + b_5 \times (1 - (hi/h) \times (1/4)) / (1 - (p^{(1/3)}))}^{0.1 + b_6 \times (1/dbh) + b_7 \times (h \times (hi/h) \times (1/3)) + b_8 \times ((1 - (hi/h) \times (1/4)) / (1 - (p^{(1/3)})))}
\]

Value

a numeric value indicating the total or partial volume of the tree.

Examples

```r
library(dplyr)
library(minpack.lm)
library(timbeR)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
         hih = hi/h)

kozak <- nlsLM(di ~ taper_kozak(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6, b7, b8, p),
               start=list(b0=1.00, b1=-.97, b2=-.03, b3=-.49, b4=-.87, b5=.50, b6=3.88, b7=.03, b8=-.19, p = .1),
               data = tree_scaling,
               control = nls.lm.control(maxiter = 1000, maxfev = 2000))

coef_kozak <- coef(kozak)[-10]
p_kozak <- coef(kozak)[10]

h <- 20
dbh <- 25
di <- 5

kozak_vol(dbh, h, coef_kozak, p_kozak)
```
poly5_di

Estimate the diameter at a given height based on a 5th degree polynomial function.

Description

Estimates the diameter at a given height of a tree from the diameter at breast height, total height and the coefficients of the 5th degree polynomial function that describes the tree’s taper.

Usage

poly5_di(dbh, h, hi, coef)

Arguments

dbh  
  tree diameter at breast height, in centimeters.

h  
  total tree height, in meters.

hi  
  height at which the diameter will be calculated, in meters.

coef  
  numerical vector containing six coefficients of the 5th degree polynomial function that describes the tree’s taper.

Value

a numeric value indicating the diameter at the given height.

Examples

library(dplyr)
library(minpack.lm)
library(timberR)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
         hih = hi/h)

poli5 <- lm(did~hih+I(hih^2)+I(hih^3)+I(hih^4)+I(hih^5),tree_scaling)

coef_poli <- coef(poli5)

dbh <- 25
h <- 20
di <- 5
poly5_di(dbh, h, di, coef_poli)

---

poly5_hi

Estimate the height at which a given diameter occurs in a tree, based on a 5th degree polynomial function.

Description

Estimates the height at which a given diameter occurs in a tree, from the diameter at breast height, total height and coefficients of the 5th degree polynomial function that describes the tree’s taper.

Usage

poly5_hi(dbh, h, di, coef)

Arguments

dbh  tree diameter at breast height, in centimeters.
h total tree height, in meters.
di diameter whose height of occurrence will be estimated, in centimeters.
coef numerical vector containing six coefficients of the 5th degree polynomial function that describes the tree’s taper.

Value

as numeric value indicating the height at which the given diameter occurs.

Examples

```r
library(dplyr)
library(minpack.lm)
library(timber)

tree_scaling <- tree_scaling %>%
    mutate(did = di/dbh,
           hih = hi/h)

poli5 <- lm(did~hih+I(hih^2)+I(hih^3)+I(hih^4)+I(hih^5),tree_scaling)
coef_poli <- coef(poli5)

dbh <- 25
h <- 20
hi <- 15
```
poly5_logs

Description

Simulate the extraction of logs from a tree from its measurements, taper function (5th degree polynomial), trunk quality characteristics and harvest parameters such as stump height and assortments.

Usage

dbh, h, coef, assortments, stump_height, downgrade, broken, defect_height, eliminate, total_volume, only_vol

Arguments

dbh tree diameter at breast height, in centimeters.
h total tree height, in meters.
coef numerical vector containing six coefficients of the 5th degree polynomial function that describes the tree's taper.
assortments a data.frame with five columns and n rows, where n is the number of different wood assortments to be obtained from the tree stem. The first column must contain the names of the assortments, the second, numerical, contains the minimum diameters at the small end of the logs, in centimeters. The third column, numerical, contains the minimum lengths of the logs, in meters. The fourth column, numerical, contains the maximum lengths of the logs, in meters. The fifth column, numerical, contains the values in centimeters referring to the loss of wood due to cutting logs. The algorithm prioritizes the extraction of assortments along the stem in the order presented in the data.frame, starting from the first line, to the last.
stump_height tree cutting height, in meters. Default is 0.
downgrade if TRUE, the algorithm, from the defect_height onwards, simulates log extraction only for the last assortment in the assortments data.frame. Default is FALSE.

broken if TRUE, the algorithm will simulate the extraction of logs only up to the defect_height. Default is FALSE.

defect_height the height, in meters, from which the logs will be downgraded (if downgrade is TRUE) or log extraction simulation will be stopped (if broken is TRUE). Default is 0 for downgrade = TRUE (the whole tree is downgraded) and h * 0.5 for broken = TRUE (the tree is broken from half its original/estimated total height).

eliminate if TRUE, the algorithm does not get logs for any assortment present in the assortments table. All will be zero. Default is FALSE.

total_volume if TRUE, it adds an additional column to the results data.frame with the estimate of the total volume of the tree, from the ground height to h if broken argument is FALSE, or to defect_height if broken is TRUE. Default is FALSE.

only_vol if TRUE returns only volumes (does not return the number of logs). Default is FALSE.

Details

when the broken and downgrade arguments are set to TRUE, the defect_height value is considered as the break height of the tree, and the entire tree is downgraded.

Value

a list of two data.frames, the first (volumes) with the calculated volumes per assortment, and the second (logs) with the number of logs per assortment.

Examples

```r
library(dplyr)
library(minpack.lm)
library(timbeR)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
         hih = hi/h)

poli5 <- lm(did~hih+I(hih^2)+I(hih^3)+I(hih^4)+I(hih^5),tree_scaling)

coef_poli <- coef(poli5)

dbh <- 25
h <- 20

assortments <- data.frame(
  NAME = c(‘15-25’,'4-15’),
  SED = c(15,4),
  MINLENGTH = c(2.65,2),
```

poly5_logs_plot

Visualize the simulation of log cutting along the stem using a 5th degree polynomial that describes the tree taper.

Description
Plot the shape of the tree and visualize the extracted logs based on the tree measurements, assortments data.frame, and the 5th degree polynomial function that describes the tree’s taper.

Usage
poly5_logs_plot(
    dbh, h, coef, assortments
)

Arguments
dbh tree diameter at breast height, in centimeters.
h total tree height, in meters.
coef numerical vector containing six coefficients of the 5th degree polynomial function that describes the tree’s taper.
assortments a data.frame with five columns and n rows, where n is the number of different wood assortments to be obtained from the tree stem. The first column must contain the names of the assortments, the second, numerical, contains the minimum diameters at the small end of the logs, in centimeters. The third column, numerical, contains the minimum lengths of the logs, in meters. The fourth column, numerical, contains the maximum lengths of the logs, in meters. The fifth column, numerical, contains the values in centimeters referring to the loss of wood due to cutting logs. The algorithm prioritizes the extraction of assortments along the stem in the order presented in the data.frame, starting from the first line, to the last.
stump_height  tree cutting height, in meters. Default is 0.
downgrade  if TRUE, the algorithm, from the defect_height onwards, simulates log extraction only for the last assortment in the assortments data.frame. Default is FALSE.
broken  if TRUE, the algorithm will simulate the extraction of logs only up to the defect_height. Default is FALSE.
defect_height  the height, in meters, from which the logs will be downgraded (if downgrade is TRUE) or log extraction simulation will be stopped (if broken is TRUE). Default is h * 0.5.
lang  language in which plot labels will be displayed. Current options are 'en' and 'pt-BR'. Default is 'en'.

Details
check the poly5_logs function help for more details.

Value
a ggplot object.

Examples

library(dplyr)
library(minpack.lm)
library(timber)

tree_scaling <- tree_scaling %>%
mutate(did = di/dbh,
   hih = hi/h)

poli5 <- lm(did~hih+I(hih^2)+I(hih^3)+I(hih^4)+I(hih^5),tree_scaling)

coef_poli <- coef(poli5)

dbh <- 25
h <- 20

assortments <- data.frame(
   NAME = c('15-25','4-15'),
   SED = c(15,4),
   MINLENGTH = c(2.65,2),
   MAXLENGTH = c(2.65,4.2),
   LOSS = c(5,5)
)

poly5_logs_plot(dbh, h, coef_poli, assortments)
poly5_vol

*Estimate the total or partial volume of the tree, based on a 5th degree polynomial function that describes the taper of the tree.*

### Description

Estimates the total or partial volume of the tree from the diameter at breast height, total height, initial section height, final section height and coefficients of the 5th degree polynomial function that describes the tree’s taper.

### Usage

```
poly5_vol(dbh, h, coef, hi, h0)
```

### Arguments

- **dbh**: tree diameter at breast height, in centimeters.
- **h**: total tree height, in meters.
- **coef**: numerical vector containing six coefficients of the 5th degree polynomial function that describes the tree’s taper.
- **hi**: final height of the tree section whose volume will be calculated, in meters. Default is the total tree height (h).
- **h0**: initial height of the tree section whose volume will be calculated, in meters. Default is 0 (ground height).

### Value

A numeric value indicating the total or partial volume of the tree.

### Examples

```r
library(dplyr)
library(minpack.lm)
library(timber)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
         hih = hi/h)

poli5 <- lm(did~hih*I(hih^2)+I(hih^3)+I(hih^4)+I(hih^5),tree_scaling)

coef_poli <- coef(poli5)

dbh <- 25
h <- 20
```
select_and_remove

poly5_vol(dbh, h, coef_poli)
hi = 15
h0 = .2
poly5_vol(dbh, h, coef_poli, hi, h0)

select_and_remove Remove unwanted data by selecting it

Description
Delete unwanted records from the dataset (e.g. outliers) by selecting them in a scatter plot.

Usage
select_and_remove(data, xvar, yvar)

Arguments
- data a data.frame.
- xvar quoted name of the variable to be displayed in the x axis.
- yvar quoted name of the variable to be displayed in the y axis.

Value
the data.frame given to the data argument, without the selected points.

Examples

## Not run:
library(dplyr)
library(timbeR)
tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
          hih = hi/h) %>%
  select_and_remove(., 'hih', 'did')

## End(Not run)
taper_bi


Description


Usage

taper_bi(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6)

Arguments

dbh  
  tree diameter at breast height, in centimeters.

h  
  total tree height, in meters.

hih  
  ratio between the height of the section (hi) and the total height (h).

b0, b1, b2, b3, b4, b5, b6  
  model parameters.

Value

A numeric value indicating the diameter at the section.

References


Examples

library(dplyr)
library(minpack.lm)
library(timberR)

tree_scaling <- tree_scaling %>%
  mutate(did = di/dbh,
         hih = hi/h)

bi <- nlsLM(di ~ taper_bi(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6),
data=tree_scaling,
start=list(b0=1.8,b1=-0.2,b2=-0.04,b3=-0.9,b4=-0.0006,b5=0.07,b6=-.14))
**taper_kozak**


**Description**


**Usage**

`taper_kozak(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6, b7, b8, p)`

**Arguments**

- **dbh**: tree diameter at breast height, in centimeters.
- **h**: total tree height, in meters.
- **hih**: ratio between the height of the section (hi) and the total height (h).
- **b0, b1, b2, b3, b4, b5, b6, b7, b8**: model parameters.
- **p**: numerical value representing the first inflection point calculated in the segmented model of Max and Burkhart (1976).

**Value**

a numeric value indicating the diameter at the section.

**References**


**Examples**

```r
library(dplyr)
library(minpack.lm)
library(timber)

tree_scaling <- tree_scaling %>%
mutate(did = di/dbh,
       hih = hi/h)

taper_kozak <- nlsLM(di ~ taper_kozak(dbh, h, hih, b0, b1, b2, b3, b4, b5, b6, b7, b8, p),
data = tree_scaling,
start = list(b0 = 1.00, b1 = .97, b2 = .03, b3 = .49, b4 = -0.87, b5 = 0.50, b6 = 3.88, b7 = 0.03, b8 = -0.19, p = .1))
```
**Description**

Diameter (cm) and height (m) measurements along the bole of 8 Pinus taeda trees.

**Usage**

```r
data(tree_scaling)
```

**Format**

A data frame with 136 rows and 5 variables:

- **tree_id**: tree unique id
- **dbh**: diameter at breast height, in centimeters
- **h**: total tree height, in meters
- **hi**: tree section height, in meters
- **di**: diameter at the tree section, in centimeters
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