

Package: CspStandSegmentation (via r-universe)

June 4, 2026

Type Package

Title Comparative Shortest Path Forest Stand Segmentation from LiDAR Data

Version 0.2.0

Description Functionality for segmenting individual trees from a forest stand scanned with a close-range (e.g., terrestrial or mobile) laser scanner. The complete workflow from a raw point cloud to a complete tabular forest inventory is provided. The package contains several algorithms for detecting tree bases and a graph-based algorithm to attach all remaining points to these tree bases. It builds heavily on the 'lidR' package. A description of the segmentation algorithm can be found in Larysch et al. (2025) <[doi:10.1007/s10342-025-01796-z](https://doi.org/10.1007/s10342-025-01796-z)>.

URL <https://github.com/JulFrey/CspStandSegmentation>

BugReports <https://github.com/JulFrey/CspStandSegmentation/issues>

License GPL-3

Encoding UTF-8

Imports Rcpp (>= 1.0.5), lidR, dbscan, igraph, foreach, doParallel, magrittr, data.table, sf, terra, RCSF, conicfit, rgl, RANN, colorspace, methods, stats

LinkingTo Rcpp, RcppArmadillo, lidR, BH

RoxygenNote 7.3.3

Depends R (>= 4.1.0)

Suggests testthat (>= 3.0.0)

Config/testthat/edition 3

Config/pak/sysreqs libabsl-dev cmake libfreetype6-dev libgdal-dev gdal-bin libgeos-dev libglpk-dev libglu1-mesa-dev make texlive libpng-dev libuv1-dev libxml2-dev libg11-mesa-dev libssl-dev libproj-dev libsqlite3-dev libudunits2-dev zlib1g-dev

Repository <https://julfrey.r-universe.dev>

Date/Publication 2026-05-05 04:51:55 UTC

RemoteUrl <https://github.com/julfrey/cspstandsegmentation>

RemoteRef HEAD

RemoteSha 69ac1ba9c8a759ad45e2f0a5ac1a46c3a8705c2e

Contents

add_geometry	2
add_las_attributes	3
add_voxel_coordinates	4
color_ids	5
comparative_shortest_path	6
csp_cost_segmentation	8
eigen_decomposition	9
fast_unlist	10
fast_unlist_dist	11
fds	11
find_base_coordinates_geom	12
find_base_coordinates_raster	13
forest_inventory	14
forest_inventory_simple	16
get_pal	16
las_merge	17
p_dist	18
p_mat_dist	19
plot_inventory	19
point_center_angle	20
point_circle_distance	21
ransac_circle_fit	21
suppress_cat	22
voxelize_points_mean_attributes	22
Index	24

add_geometry	<i>Add geometric features to a LAS object</i>
--------------	---

Description

The function calls a fast cpp multi-core function to calculate eigenvalues for the points in a point cloud based on the k nearest neighbors. Afterwards it adds geometric features like Curvature, Linearity, Planarity, Sphericity, Anisotropy and Verticlicity to the points itself.

Usage

```
add_geometry(las, k = 10L, n_cores = 1)
```

Arguments

las	A LAS object (see lidR::LAS)
k	the k nearest neighbors to use for the eigenvalue calculation
n_cores	The number of CPU cores to use

Details

Details of the metrics can be found in: Hackel, T., Wegner, J.D. & Schindler, K. (2016) Contour Detection in Unstructured 3D Point Clouds. In 2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR). Presented at the 2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), IEEE, Las Vegas, NV, USA, pp. 1610-1618.

Value

The function returns a single LAS object with the geometric features attached to it in the LAS@data section.

Author(s)

Julian Frey <julian.frey@wwd.uni-freiburg.de>

Examples

```
LASfile <- system.file("extdata", "beech.las", package="CspStandSegmentation")
las <- lidR::readLAS(LASfile, select = "xyz")

las <- add_geometry(las, k = 5, n_cores = 2)
summary(las@data)
```

add_las_attributes *Add all las_attributes from las@data to the header of a las element*

Description

The helper function adds all headings from las@data which are not part of lidR:::LASATTRIBUTES to the las header using lidR::add_lasattribute. Only attributes that are included in the header got saved when using lidR::writeLAS, this is a convenient way to add them.

Usage

```
add_las_attributes(las)
```

Arguments

las	an element of lidR::LAS class
-----	-------------------------------

Value

the las file with updated header

Author(s)

Julian Frey <julian.frey@wwd.uni-freiburg.de>

Examples

```
file <- system.file("extdata", "beech.las", package="CspStandSegmentation")
las <- lidR::readTLAS(file)

las@data$noise <- runif(nrow(las@data))
las@data$noiseZ <- las@data$var1 * las@data$Z

las <- add_las_attributes(las)
```

add_voxel_coordinates *Add voxel coordinates to a las file*

Description

Adds the columns `x_vox`, `y_vox` and `z_vox` in the given resolution to the las element. This is convenient if information has been derived in voxel space and these should be attached to the original points.

Usage

```
add_voxel_coordinates(las, res)
```

Arguments

<code>las</code>	an element of <code>lidR::LAS</code> class
<code>res</code>	voxel resolution in [m]

Details

Voxel coordinates derived with this function are identical to those derived by `lidR::voxelize`.

Value

las file with additional voxel coordinates

Author(s)

Julian Frey <julian.frey@wwd.uni-freiburg.de>

Examples

```
file = system.file("extdata", "beech.las", package="CspStandSegmentation")
las = lidR::readTLSLAS(file)

las <- add_voxel_coordinates(las, res = 1)
```

color_ids	<i>Assign colours to instances in a LAS object using a graph-colouring heuristic</i>
-----------	--

Description

color_ids computes a per-instance colour assignment and merges RGB (R,G,B) and a numeric color_ID back into las@data. Colour assignment is driven by spatial adjacency (k-nearest neighbours on instance centroids) and maximizing colour LAB distance from neighbouring instances.

Usage

```
color_ids(
  las,
  col = "sky",
  n_col = 10,
  n_neighbors = 10,
  instance_id = "TreeID",
  ground_id = 0,
  ground_color = "#ffffff",
  overwrite_rgb = TRUE
)
```

Arguments

las	A LAS object (from the lidR package).
col	Either a character string naming a palette supported by get_pal() or a character vector of hex colours. Default: "sky".
n_col	Integer. Number of discrete colours to generate from the palette. Default: 10.
n_neighbors	Integer. Number of nearest neighbours to treat as adjacency when assigning colours. Default: 10.
instance_id	Character. Column name in las@data that identifies instances (for example tree or stand IDs). Default: "TreeID".
ground_id	Value used to identify ground or background instance; assigned ground_color. Default: 0.
ground_color	Character. Hex colour used for the ground instance. Default: "#ffffff".
overwrite_rgb	Logical. If TRUE existing R/G/B columns in las@data will be overwritten. Default: TRUE.

Details

The function computes instance centroids, builds a k-nearest-neighbour graph, sorts instances by local neighbour density and assigns discrete colours greedily so neighbouring instances receive maximally different colours in LAB space.

Value

A LAS object with R, G, B (0-255 integers) and color_ID merged into las@data. If `overwrite_rgb` is FALSE and the LAS already had RGB columns, those channels are preserved.

Author(s)

Zoe Schindler

Examples

```
## Not run:
# read example data
\donttest{
file = system.file("extdata", "beech.las", package="CspStandSegmentation")
las = lidR::readTSLAS(file)

# Find tree positions as starting points for segmentation
map <- CspStandSegmentation::find_base_coordinates_raster(las)

# segment trees
segmented <- las |>
CspStandSegmentation::csp_cost_segmentation(map, 1, S_w = 0.5)
las_col <- CspStandSegmentation::color_ids(segmented, col = "sky", instance_id = "TreeID", ground_color = "#ff0000")
lidR::plot(las_col, color = "RGB")
}

## End(Not run)
```

comparative_shortest_path

helper function for csp_cost_segemntation

Description

The function performs a Dijkstra algorithm on a 3D voxel file to assign every voxel to the closest seed point using the `igraph` package.

Usage

```
comparative_shortest_path(  
  vox = vox,  
  adjacency_df = adjacency_df,  
  seeds,  
  v_w = 0,  
  l_w = 0,  
  s_w = 0,  
  N_cores = parallel::detectCores() - 1,  
  Voxel_size,  
  N_trees = 1  
)
```

Arguments

vox	a LAS S4 element with XYZ voxel coordinates in the @data slot.
adjacency_df	a data.frame with voxel ids (row numbers) in the first column and a neighboring voxel ID in the second column and the weight (distance) in the third column. Might be generated using the dbscan::frNN function (which requires reshaping the data).
seeds	seed points for tree positions.
v_w, l_w, s_w	weights for verticality, linearity sphericity see csp_cost_segmentation
N_cores	Number of CPU cores for multi-threading
Voxel_size	Edge length used to create the voxels. This is only important to gain comparable distance weights on different voxel sizes. Should be greater than 0.
N_trees	The number of closest stem locations to add to the point cloud If > 1 the distances will be added as well.

Value

voxels with the TreeID in the data slot

Author(s)

Julian Frey <julian.frey@wwd.uni-freiburg.de>

See Also

[csp_cost_segmentation](#)

csp_cost_segmentation *Comparative Shortest Path with cost weighting tree segmentation*

Description

Segments single trees from forest point clouds based on tree positions (xyz-coordinates) provided in the map argument.

Usage

```
csp_cost_segmentation(
  las,
  map,
  Voxel_size = 0.3,
  V_w = 0,
  L_w = 0,
  S_w = 0,
  N_cores = 1,
  N_trees = 1
)
```

Arguments

las	A lidR LAS S4 object.
map	A data.frame, including the columns X, Y, Z, TreeID, with X and Y depicting the location of the trees. Can be generated using CspStandSegmentation::find_base_coordinates_raster
Voxel_size	The voxel size (3D resolution) for the routing graph to determine the nearest map location for every point in the point cloud.
V_w	verticality weight. Since trunks are vertical structures, routing through voxels with high verticality can be rated 'cheaper.' should be a number between 0 and 1 with 0 meaning no benefit for more vertical structures.
L_w	Linearity weight. Similar to V_w but for linearity, higher values indicate a malus for linear shapes (usually branches).
S_w	Sphericity weight. Similar to V_w but for sphericity, higher values indicate a malus for spherical shapes (usually small branches and leaves).
N_cores	number of CPU cores used for parallel routing using the foreach package.
N_trees	The number of closest stem locations to add to the point cloud

Details

The whole point cloud is voxelized in the given resolution and the center of gravity for the points inside is calculated as voxel coordinate. A graph is build, which connects the voxel coordinates based on a db-scan algorithm. The distances between the voxel coordinates is weighted based on geometric features computed for the points in the voxels. Distances along planar and/or vertical faces like stems are weighted shorter than distances through voxels with high sphericity like leaves

and clusters of twigs. This avoids small individuals spreading into the upper canopy. For every voxel center, the weighted distance in the network is calculated to all tree locations from the map argument. The TreeID of the map argument with the shortest distance is assigned to the voxel. All points in the point cloud receive the TreeID from their parent voxel.

Value

Returns a copy of the las point cloud with an additional field for the TreeID.

Author(s)

Julian Frey <julian.frey@wwd.uni-freiburg.de>

See Also

[comparative_shortest_path](#)

Examples

```
# read example data

file = system.file("extdata", "beech.las", package="CspStandSegmentation")
las = lidR::readTLSLAS(file)

# Find tree positions as starting points for segmentation
map <- CspStandSegmentation::find_base_coordinates_raster(las)

# segment trees
segmented <- las |>
  CspStandSegmentation::add_geometry() |>
  CspStandSegmentation::csp_cost_segmentation(map, 1, S_w = 0.5)
```

eigen_decomposition *Fast Eigenvalues decomposition for k nearest neighbors using a C++ function*

Description

C++ helper function to compute eigenvalues for geometric feature calculation.

Usage

```
eigen_decomposition(las, k, ncpu = 1L)
```

Arguments

las	LAS element
k	k nearest neighbors
ncpu	number of cpu cores to use

Value

The function returns for every point the 3 eigenvalues and the third element of the third eigenvector. These values are needed to compute planarity, linerity, verticality etc. in the add_geometry function

Author(s)

Julian Frey <julian.frey@iww.uni-freiburg.de>

See Also

[add_geometry](#)

fast_unlist

helper function to unlist IDs generated by dbscan::frNN

Description

creates a vector of indices from a nested list created by dbscan::frNN

Usage

```
fast_unlist(list, l)
```

Arguments

list	a list element created by dbscan::frNN
l	the expected length of the result

Value

Returns a vector with the values in the list.

Author(s)

Julian Frey <julian.frey@iww.uni-freiburg.de>

fast_unlist_dist	<i>helper function to unlist distances computed by dbscan::frNN</i>
------------------	---

Description

extracts the distances from a nested list created by dbscan::frNN

Usage

```
fast_unlist_dist(list, l)
```

Arguments

list	a list element created by dbscan::frNN
l	the expected length of the result

Value

Returns a vector with the values in the list.

Author(s)

Julian Frey <julian.frey@iww.uni-freiburg.de>

fds	<i>Farthest Distance Sampling (Farthest Point Sampling)</i>
-----	---

Description

This function selects n points from a matrix of points such that the minimum distance between any two points is maximized. Either a fixed number of points can be selected (using the 'n' parameter) or points can be selected until a specified minimum spacing is violated (using the 'spacing' parameter). This version is memory efficient and can handle large matrices.

Usage

```
fds(mat, n = NULL, spacing = NULL, ret = "idx", scale = FALSE)
```

Arguments

mat	a matrix of points with one row for each point and one column for each dimension, can also be a las object then only XYZ will be used
n	the number of points to select, or if <1 the proportion of points to select
spacing	If supplied, sampling continues until the minimum nearest- neighbour distance among selected points drops below 'spacing'.
ret	the type of output to return. Options are "idx" (default) to return the indices of the selected points, "mat" to return the selected points.
scale	logical. If TRUE, the dimensions are scaled to have a mean of 0 and a standard deviation of 1 before calculating distances.

Value

a vector of indices or a matrix of points

Examples

```
mat <- matrix(rnorm(1000), ncol = 10)
sample <- fds(mat, n = 50, ret = "mat")
str(sample)
```

find_base_coordinates_geom

Find stem base position using a geometric feature filtering and clustering approach

Description

Find stem base position using a geometric feature filtering and clustering approach

Usage

```
find_base_coordinates_geom(  
  las,  
  zmin = 0.5,  
  zmax = 2,  
  res = 0.5,  
  min_verticality = 0.9,  
  min_planarity = 0.5,  
  min_cluster_size = NULL  
)
```

Arguments

las	an element of lidR::LAS class
zmin	lower search boundary
zmax	upper search boundary
res	cluster search radius
min_verticality	minimum verticality >0 & <1 for a point to be considered a stem point
min_planarity	minimum planarity >0 & <1 for a point to be considered a stem point
min_cluster_size	minimum number of points in the cluster to be considered a tree, if NULL median cluster size is chosen

Value

data.frame with X, Y, Z and TreeID for stem base positions

Author(s)

Julian Frey <julian.frey@wwd.uni-freiburg.de>

Examples

```
# read example data
file = system.file("extdata", "beech.las", package="CspStandSegmentation")
tls = lidR::readTLSLAS(file)

# Find tree positions
map <- CspStandSegmentation::find_base_coordinates_geom(tls)
```

find_base_coordinates_raster

Find stem base position using a density raster approach

Description

Find stem base position using a density raster approach

Usage

```
find_base_coordinates_raster(
  las,
  res = 0.1,
  zmin = 0.5,
  zmax = 2,
  q = 0.975,
  eps = 0.2
)
```

Arguments

las	an element of lidR::LAS class
res	raster resolution
zmin	lower search boundary
zmax	upper search boundary
q	quantile of raster density to assign a tree region
eps	search radius to merge base points

Value

data.frame with X, Y, Z and TreeID for stem base positions

Author(s)

Julian Frey <julian.frey@wwd.uni-freiburg.de>

Examples

```
# read example data
file = system.file("extdata", "beech.las", package="CspStandSegmentation")
tls = lidR::readTLSLAS(file)

# Find tree positions
map <- CspStandSegmentation::find_base_coordinates_raster(tls)
```

forest_inventory	<i>Function to perform a forest inventory based on a segmented las object (needs to contain TreeID)</i>
------------------	---

Description

This function estimates a taper curve for every tree and returns the DBH at 1.3m, its position in XY coordinates, the tree height and the trees 2D projection area.

Usage

```
forest_inventory(
  las,
  slice_min = 0.3,
  slice_max = 4,
  increment = 0.2,
  width = 0.1,
  max_dbh = 1,
  n_cores = 1,
  tree_id_col = "TreeID",
  non_tree_id = 0,
```

```

    use_stem_segmentation = FALSE,
    semantic_colname = NULL,
    stem_semantic_label = NULL
  )

```

Arguments

las	lidR las object with the segmented trees
slice_min	the minimum height of a slice for stems to estimate the taper curve
slice_max	the maximum height of a slice for stems to estimate the taper curve
increment	the increment of the slices
width	the width of the slices
max_dbh	the maximum DBH allowed
n_cores	number of cores to use
tree_id_col	Column name for the instance segmentation ID (TreeIDs)
non_tree_id	tree_id_col value for non tree elements (can be a vector of IDs)
use_stem_segmentation	logical whether to use only points classified as stem for DBH estimation
semantic_colname	character name of the semantic segmentation column (only needed if use_stem_segmentation is TRUE)
stem_semantic_label	integer semantic label value for stem points (only needed if use_stem_segmentation is TRUE)

Value

a data.frame with the TreeID, X, Y, DBH, quality_flag, Height and ConvexHullArea

Examples

```

# read example data
file = system.file("extdata", "beech.las", package="CspStandSegmentation")
las = lidR::readTLSLAS(file)

# find tree positions as starting points for segmentation
map <- CspStandSegmentation::find_base_coordinates_raster(las)

# segment trees
segmented <- las |>
  CspStandSegmentation::add_geometry(n_cores = 2) |>
  CspStandSegmentation::csp_cost_segmentation(map, 1, N_cores = 2)

# perform inventory
inventory <- CspStandSegmentation::forest_inventory(segmented, n_cores = 2)

```

forest_inventory_simple

Function to perform a forest inventory based on a segmented las object (needs to contain TreeID) This version is a faster but more simplistic approach than forest_inventory() for the DBH estimates

Description

Function to perform a forest inventory based on a segmented las object (needs to contain TreeID)
This version is a faster but more simplistic approach than forest_inventory() for the DBH estimates

Usage

```
forest_inventory_simple(
  las,
  slice_min = 1.2,
  slice_max = 1.4,
  max_dbh = 1,
  n_cores = max(c(1, parallel::detectCores()/2 - 1))
)
```

Arguments

las	lidR las object with the segmented trees
slice_min	the minimum height of a DBH slice
slice_max	the maximum height of a DBH slice
max_dbh	the maximum DBH allowed
n_cores	number of cores to use

Value

a data.frame with the TreeID, X, Y, DBH, quality_flag, Height and ConvexHullArea

get_pal

Return a palette-generating function

Description

get_pal returns a function that produces a character vector of hex colours given a required length. It exposes a set of named palettes used by color_ids().

Usage

```
get_pal(name = "rainbow")
```

Arguments

name Character scalar. Name of the palette to use. Supported names: "sky", "sea", "cozy", "fairy", "winter", "rainbow", "pastel", "candy", "boring". Default: "rainbow".

Value

A function with signature `function(n)` that returns `n` hex colour strings.

Author(s)

Zoe Schindler

Examples

```
get_pal("sky")
```

las_merge

Makes one las-object from multiple las-objects

Description

This function merges multiple las objects into one las object. The function checks if all inputs are las-objects and if they have the same CRS. The function will also add a column `oci` with the original cloud index to each las-object. The function will then `rbind` all data by the minimum set of columns. If the `fill` argument is set to `False`, columns which do not exist in all las objects will be removed. If the `fill` argument is set to `True`, missing columns will be filled with `NA`.

Usage

```
las_merge(..., oci = FALSE, fill = FALSE)
```

Arguments

... any number of las objects or a list with las objects

oci add a column with the original cloud index

fill fill missing columns with `NA` if it is set to `False` columns which do not exist in all las-objects will be removed

Value

A single las-object with only the overlapping column name

Examples

```
# number of points per las
n <- 100
las1 <- lidR::LAS(data.frame(X = runif(n), Y = runif(n), Z = runif(n)))
las2 <- lidR::LAS(data.frame(X = runif(n) + 2, Y = runif(n), Z = runif(n)))
las3 <- lidR::LAS(data.frame(X = runif(n) + 4, Y = runif(n), Z = runif(n)))
merged <- las_merge(las1, las2, las3)
lidR::npoints(merged) == (n*3)

lasList <- list(las1, las2, las3)
merged <- las_merge(lasList)
lidR::npoints(merged) == (n*3)
```

p_dist

Point distance function

Description

calculates euclidean distances for n dimensions

Usage

```
p_dist(p1, p2)
```

Arguments

p1	point 1
p2	point 2

Value

the distance between the two points

Examples

```
p_dist(c(0,0), c(3,4))
```

p_mat_dist	<i>Point distance function</i>
------------	--------------------------------

Description

calculates euclidean distances for n dimensions between a matrix of points and a single point

Usage

```
p_mat_dist(mat, p, nthreads = 0L)
```

Arguments

mat	matrix with points as rows
p	point to calculate distances
nthreads	number of threads to use. If 0 or negative, the maximum number of threads available will be used.

Value

the distances between every row of mat and p

Examples

```
p_mat_dist(as.matrix(cbind(runif(100),runif(100))), c(3,4))
```

plot_inventory	<i>Function to plot the inventory results into a lidR 3d plot of the point cloud</i>
----------------	--

Description

Function to plot the inventory results into a lidR 3d plot of the point cloud

Usage

```
plot_inventory(plot, inventory, col = NA, cex = 1.5, label_col = "white")
```

Arguments

plot	lidR 3d plot
inventory	data.frame with the inventory results
col	color of the spheres
cex	numeric size of the labels
label_col	character color of the labels

Value

the plot with the inventory results

Examples

```
# read example data
file = system.file("extdata", "beech.las", package="CspStandSegmentation")
las = lidR::readTLSLAS(file)

# find tree positions as starting points for segmentation
map <- CspStandSegmentation::find_base_coordinates_raster(las)

# segment trees
segmented <- las |>
  CspStandSegmentation::add_geometry(n_cores = 2) |>
  CspStandSegmentation::csp_cost_segmentation(map, 1, N_cores = 2)

# perform inventory
inventory <- CspStandSegmentation::forest_inventory(segmented, n_cores = 2)

# plot the results
## Not run:
x <- lidR::plot(segmented, color = "TreeID")
plot_inventory(x, inventory)

## End(Not run)
```

point_center_angle	<i>Returns the angle between the center of the circle and a point in degrees</i>
--------------------	--

Description

Returns the angle between the center of the circle and a point in degrees

Usage

```
point_center_angle(point, circle)
```

Arguments

point	numeric vector of length 2 c(X,Y)
circle	numeric vector of length 3 c(center_X, center_Y, radius)

Value

numeric angle in degrees

point_circle_distance *Helper function to compute distances from a point to the circle*

Description

Helper function to compute distances from a point to the circle

Usage

```
point_circle_distance(point, circle)
```

Arguments

point	numeric vector of length 2 c(X,Y)
circle	numeric vector of length 3 c(center_X, center_Y, radius)

Value

numeric distance from the point to the circle

ransac_circle_fit *RANSAC circle fitting algorithm specially adapted for tree DBH estimation*

Description

This function fits a circle to a set of points using the RANSAC algorithm it maximizes the points that are in the circle and the number of filled 36 degree angle segments Therefore, this function searches for the most complete circle with the highest number of points represented.

Usage

```
ransac_circle_fit(
  data,
  n_iterations = 1000L,
  distance_threshold = 0.01,
  min_inliers = 3L
)
```

Arguments

data	numeric matrix with 2 columns (X, Y) representing the point cloud
n_iterations	integer maximum number of iterations
distance_threshold	numeric maximum distance from a point to the circle to be considered an inlier
min_inliers	integer minimum number of inliers to consider the circle as valid

Value

a list with the following elements: circle: the center coordinates and radius of the circle inliers: number of points within the circles dist threshold angle_segs: number of populated 10deg angular segments of the circle using the distance_threshold n_iter: number of iterations run

suppress_cat	<i>Suppress only the cat() output</i>
--------------	---------------------------------------

Description

Suppress only the cat() output

Usage

```
suppress_cat(f, ...)
```

Arguments

f	function to be called
...	parameters to the function

Value

the return value of the function

voxelize_points_mean_attributes	<i>helper function to voxelize a las element</i>
---------------------------------	--

Description

Calculate voxel mean values for all numeric attributes in the las@data table including the XYZ-coordinates.

Usage

```
voxelize_points_mean_attributes(las, res)
```

Arguments

las	a lidR::LAS element
res	voxel resolution in meter

Value

a las element with XYZ-coordinates as the voxel center and X_gr, Y_gr, Z_gr as the center of gravity (mean point coordinates) as well as all other numeric columns voxel mean values with their original name.

Author(s)

Julian Frey <julian.frey@wwd.uni-freiburg.de>

See Also

[voxelize_points](#)

Examples

```
# read example data
file = system.file("extdata", "beech.las", package="CspStandSegmentation")
las = lidR::readTSLAS(file)
vox <- las |> voxelize_points_mean_attributes(1)
```

Index

[add_geometry](#), [2](#), [10](#)
[add_las_attributes](#), [3](#)
[add_voxel_coordinates](#), [4](#)

[color_ids](#), [5](#)
[comparative_shortest_path](#), [6](#), [9](#)
[csp_cost_segmentation](#), [7](#), [8](#)

[eigen_decomposition](#), [9](#)

[fast_unlist](#), [10](#)
[fast_unlist_dist](#), [11](#)
[fds](#), [11](#)
[find_base_coordinates_geom](#), [12](#)
[find_base_coordinates_raster](#), [13](#)
[forest_inventory](#), [14](#)
[forest_inventory_simple](#), [16](#)

[get_pal](#), [16](#)

[las_merge](#), [17](#)

[p_dist](#), [18](#)
[p_mat_dist](#), [19](#)
[plot_inventory](#), [19](#)
[point_center_angle](#), [20](#)
[point_circle_distance](#), [21](#)

[ransac_circle_fit](#), [21](#)

[suppress_cat](#), [22](#)

[voxelize_points](#), [23](#)
[voxelize_points_mean_attributes](#), [22](#)