Package 'imager'

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Type Package

Title Image Processing Library Based on 'CImg'

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Description Fast image processing for images in up to 4 dimensions (two spatial dimensions, one time/depth dimension, one colour dimension). Provides most traditional image processing tools (filtering, morphology, transformations, etc.) as well as various functions for easily analysing image data using R. The package wraps 'CImg', <http://cimg.eu>, a simple, modern C++ library for image processing.

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Imports Rcpp (>= 0.11.5),methods,stringr,png,jpeg,readbitmap,grDevices,purrr,downloader,igraph

Depends R (>= 2.10.0),magrittr

URL http://dahtah.github.io/imager/, https://github.com/dahtah/imager/

BugReports https://github.com/dahtah/imager/issues

SystemRequirements fftw3,libtiff,C++11,X11

LinkingTo Rcpp

LazyData true

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VignetteBuilder knitr

NeedsCompilation yes

Repository CRAN

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R topics documented:

`add.colour` *Add colour channels to a grayscale image or pixel set*

Description

Add colour channels to a grayscale image or pixel set

Usage

```
add.colour(im, simple = TRUE)

add.color(im, simple = TRUE)
```

Arguments

`im`	a grayscale image
`simple`	if TRUE just stack three copies of the grayscale image, if FALSE treat the image as the L channel in an HSL representation. Default TRUE. For pixel sets this option makes no sense and is ignored.

Value

an image of class cimg

Functions

- `add.color()`: Alias for add.colour

Author(s)

Simon Barthelme

Examples

```
grayscale(boats) #No more colour channels
add.colour(grayscale(boats)) #Image has depth = 3 (but contains only grays)
```

`as.cimg` *Convert to cimg object*

Description

Imager implements various converters that turn your data into cimg objects. If you convert from a vector (which only has a length, and no dimension), either specify dimensions explicitly or some guesswork will be involved. See examples for clarifications.

Usage

```
as.cimg(obj, ...)

## S3 method for class 'numeric'
as.cimg(obj, ...)

## S3 method for class 'logical'
as.cimg(obj, ...)

## S3 method for class 'double'
as.cimg(obj, ...)

## S3 method for class 'cimg'
as.cimg(obj, ...)

## S3 method for class 'vector'
as.cimg(obj, x = NA, y = NA, z = NA, cc = NA, dim = NULL, ...)

## S3 method for class 'matrix'
as.cimg(obj, ...)
```

Arguments

`obj`	an object
`...`	optional arguments
`x`	width
`y`	height
`z`	depth
`cc`	spectrum
`dim`	a vector of dimensions (optional, use instead of xyzcc)

Methods (by class)

- `as.cimg(numeric)`: convert numeric
- `as.cimg(logical)`: convert logical

- as.cimg(double): convert double
- as.cimg(cimg): return object
- as.cimg(vector): convert vector
- as.cimg(matrix): Convert to matrix

Author(s)

Simon Barthelme

See Also

as.cimg.array, as.cimg.function, as.cimg.data.frame

Examples

```
as.cimg(1:100,x=10,y=10) #10x10, grayscale image
as.cimg(rep(1:100,3),x=10,y=10,cc=3) #10x10 RGB
as.cimg(1:100,dim=c(10,10,1,1))
as.cimg(1:100) #Guesses dimensions, warning is issued
as.cimg(rep(1:100,3)) #Guesses dimensions, warning is issued
```

---

as.cimg.array *Turn an numeric array into a cimg object*

Description

If the array has two dimensions, we assume it's a grayscale image. If it has three dimensions we assume it's a video, unless the third dimension has a depth of 3, in which case we assume it's a colour image,

Usage

```
## S3 method for class 'array'
as.cimg(obj, ...)
```

Arguments

obj	an array
...	ignored

Examples

```
as.cimg(array(1:9,c(3,3)))
as.cimg(array(1,c(10,10,3))) #Guesses colour image
as.cimg(array(1:9,c(10,10,4))) #Guesses video
```

`as.cimg.data.frame` *Create an image from a data.frame*

Description

This function is meant to be just like as.cimg.data.frame, but in reverse. Each line in the data frame must correspond to a pixel. For example, the data fame can be of the form (x,y,value) or (x,y,z,value), or (x,y,z,cc,value). The coordinates must be valid image coordinates (i.e., positive integers).

Usage

```
## S3 method for class 'data.frame'
as.cimg(obj, v.name = "value", dims, ...)
```

Arguments

`obj`	a data.frame
`v.name`	name of the variable to extract pixel values from (default "value")
`dims`	a vector of length 4 corresponding to image dimensions. If missing, a guess will be made.
`...`	ignored

Value

an object of class cimg

Author(s)

Simon Barthelme

Examples

```
#Create a data.frame with columns x,y and value
df <- expand.grid(x=1:10,y=1:10) %>% dplyr::mutate(value=x*y)
#Convert to cimg object (2D, grayscale image of size 10*10
as.cimg(df,dims=c(10,10,1,1)) %>% plot
```

`as.cimg.function` *Create an image by sampling a function*

Description

Similar to as.im.function from the spatstat package, but simpler. Creates a grid of pixel coordinates x=1:width,y=1:height and (optional) z=1:depth, and evaluates the input function at these values.

Usage

```
## S3 method for class '`function`'
as.cimg(
  obj,
  width,
  height,
  depth = 1,
  spectrum = 1,
  standardise = FALSE,
  dim = NULL,
  ...
)
```

Arguments

`obj`	a function with arguments (x,y), or (x,y,cc), or (x,y,z), etc. Must be vectorised; see examples.
`width`	width of the image (in pixels)
`height`	height of the image (in pixels)
`depth`	depth of the image (in pixels). Default 1.
`spectrum`	number of colour channels. Defaut 1.
`standardise`	coordinates are scaled and centered (see doc for pixel.grid)
`dim`	a vector of image dimensions (can be used instead of width, height, etc.)
`...`	ignored

Value

an object of class cimg

Author(s)

Simon Barthelme

Examples

```
im = as.cimg(function(x,y) cos(sin(x*y/100)),100,100)
plot(im)
#The following is just a rectangle at the center of the image
im = as.cimg(function(x,y) (abs(x) < .1)*(abs(y) < .1) ,100,100,standardise=TRUE)
plot(im)
#Since coordinates are standardised the rectangle scales with the size of the image
im = as.cimg(function(x,y) (abs(x) < .1)*(abs(y) < .1) ,200,200,standardise=TRUE)
plot(im)
#A Gaussian mask around the center
im = as.cimg(function(x,y) dnorm(x,sd=.1)*dnorm(y,sd=.3) ,dim=dim(boats),standardise=TRUE)
im = im/max(im)

plot(im*boats)
#A Gaussian mask for just the red channel
fun = function(x,y,cc) ifelse(cc==1,dnorm(x,sd=.1)*dnorm(y,sd=.3),0)
im = as.cimg(fun,dim=dim(boats),standardise=TRUE)
plot(im*boats)
```

`as.cimg.raster` *Convert a raster object to a cimg object*

Description

R's native object for representing images is a "raster". This function converts raster objects to cimg objects.

Usage

```
## S3 method for class 'raster'
as.cimg(obj, ...)
```

Arguments

`obj`	a raster object
`...`	ignored

Value

a cimg object

Author(s)

Simon Barthelme

Examples

```
rst <- as.raster(matrix((1:4)/4,2,2))
as.cimg(rst) %>% plot(int=FALSE)
all.equal(rst,as.raster(as.cimg(rst)))
```

`as.data.frame.cimg` *Convert a pixel image to a data.frame*

Description

This function combines the output of pixel.grid with the actual values (stored in $value)

Usage

```
## S3 method for class 'cimg'
as.data.frame(x, ..., wide = c(FALSE, "c", "d"))
```

Arguments

`x`	an image of class cimg
`...`	arguments passed to pixel.grid
`wide`	if "c" or "d" return a data.frame that is wide along colour or depth (for example with rgb values along columns). The default is FALSE, with each pixel forming a separate entry.

Value

a data.frame

Author(s)

Simon Barthelme

Examples

```
#First five pixels
as.data.frame(boats) %>% head(5)
#Wide format along colour axis
as.data.frame(boats,wide="c") %>% head(5)
```

as.data.frame.imlist *Convert image list to data.frame*

Description

Convert image list to data.frame

Usage

```
## S3 method for class 'imlist'
as.data.frame(x, ..., index = "im")
```

Arguments

x	an image list (an imlist object)
...	Passed on to as.data.frame.cimg
index	Name of the column containing the index (or name) of the image in the list. Default: "im"

Examples

```
#Transform the image gradient into a data.frame
gr <- imgradient(boats,"xy") %>% setNames(c("dx","dy")) %>% as.data.frame
str(gr)
```

as.data.frame.pixset *Methods to convert pixsets to various objects*

Description

Methods to convert pixsets to various objects

Usage

```
## S3 method for class 'pixset'
as.data.frame(x, ..., drop = FALSE)
```

Arguments

x	pixset to convert
...	ignored
drop	drop flat dimensions

See Also

where

Examples

```
px <- boats > 250
#Convert to array of logicals
as.logical(px) %>% dim
#Convert to data.frame: gives all pixel locations in the set
as.data.frame(px) %>% head
#Drop flat dimensions
as.data.frame(px,drop=TRUE) %>% head
```

`as.igraph.cimg` *Form a graph from an image*

Description

In this graph representation, every pixel is a vertex connected to its neighbours. The image values along edges are stored as graph attributes (see examples).

Usage

```
## S3 method for class 'cimg'
as.igraph(x, mask = px.all(channel(im, 1)), ...)
```

Arguments

`x`	an image (must be 2D, 3D not implemented yet)
`mask`	optional: a pixset. if provided, pixels are only connected if they are both in the pixset.
`...`	ignored

Value

a graph (igraph format) with attributes value.from, value.to and dist

Author(s)

Simon Barthelme

See Also

as.igraph.pixset

Examples

```
library(igraph)
im <- imfill(5,5)
G <- as.igraph(im)
plot(G)
#Shortest-path distance from pixel 1 to all other pixels
d <- igraph::distances(G,1) %>% as.vector
as.cimg(d,dim=gsdim(im)) %>% plot(interpolate=FALSE)
#Notice that moving along the diagonal has the same cost
#as moving along the cardinal directions, whereas the Euclidean distance
#is actually sqrt(2) and not 1.
#Modify weight attribute, to change the way distance is computed
igraph::E(G)$weight <- G$dist
d2 <- igraph::distances(G,1) %>% as.vector
as.cimg(d2,dim=gsdim(im)) %>% plot(interpolate=FALSE)
#More interesting example
im <- grayscale(boats)
G <- as.igraph(im)
#value.from holds the value of the source pixel, value.to the sink's
#set w_ij = (|v_i - v_j|)/d_ij
igraph::E(G)$weight <- (abs(G$value.from - G$value.to))/G$dist
igraph::distances(G,5000) %>% as.vector %>%
    as.cimg(dim=gsdim(im)) %>% plot
```

---

as.igraph.pixset *Form an adjacency graph from a pixset*

Description

Return a graph where nodes are pixels, and two nodes are connected if and only if both nodes are in the pixset, and the pixels are adjacent. Optionnally, add weights corresponding to distance (either 1 or sqrt(2), depending on the orientation of the edge). The graph is represented as an igraph "graph" object

Usage

```
## S3 method for class 'pixset'
as.igraph(x, weighted = TRUE, ...)
```

Arguments

x	a pixset
weighted	add weight for distance (default TRUE)
...	ignored

Value

an igraph "graph" object

See Also

as.igraph.cimg

Examples

```
library(igraph)
#Simple 3x3 lattice
px <- px.all(imfill(3,3))
as.igraph(px) %>% plot
#Disconnect central pixel
px[5] <- FALSE
as.igraph(px) %>% plot
#Form graph from thresholded image
im <- load.example("coins")
px <- threshold(im) %>% fill(5)
G <- as.igraph(px)
#Label connected components
v <- (igraph::clusters(G)$membership)
as.cimg(v,dim=dim(px)) %>% plot
#Find a path across the image that avoids all
#the coins
G <- as.igraph(!px)
start <- index.coord(im,data.frame(x=1,y=100))
end <- index.coord(im,data.frame(x=384,y=300))
sp <- igraph::shortest_paths(G,start,end,output="vpath")
path <- sp$vpath[[1]] %>% as.integer %>% coord.index(im,.)
```

---

as.imlist.list *Convert various objects to image lists*

Description

Convert various objects to image lists

Usage

```
## S3 method for class 'list'
as.imlist(obj, ...)

as.imlist(obj, ...)

## S3 method for class 'imlist'
as.imlist(obj, ...)

## S3 method for class 'cimg'
as.imlist(obj, ...)
```

Arguments

obj	an image list
...	ignored

Value

a list

Methods (by class)

- as.imlist(list): convert from list
- as.imlist(imlist): Convert from imlist (identity)
- as.imlist(cimg): Convert from image

Examples

```
list(a=boats,b=boats*2) %>% as.imlist
```

---

as.pixset *Methods to convert various objects to pixsets*

Description

Methods to convert various objects to pixsets

Usage

```
as.pixset(x, ...)

## S3 method for class 'cimg'
as.pixset(x, ...)

## S3 method for class 'pixset'
as.cimg(obj, ...)
```

Arguments

x	object to convert to pixset
...	ignored
obj	pixset to convert

Methods (by class)

- as.pixset(cimg): convert cimg to pixset

Functions

- `as.cimg(pixset)`: convert pixset to cimg

Examples

```
#When converting an image to a pixset, the default is to include all pixels with non-zero value
as.pixset(boats)
#The above is equivalent to:
boats!=0
```

---

as.raster.cimg *Convert a cimg object to a raster object for plotting*

Description

raster objects are used by R's base graphics for plotting. R wants hexadecimal RGB values for plotting, e.g. gray(0) yields #000000, meaning black. If you want to control precisely how numerical values are turned into colours for plotting, you need to specify a colour scale using the colourscale argument (see examples). Otherwise the default is "gray" for grayscale images, "rgb" for colour. These expect values in [0..1], so the default is to rescale the data to [0..1]. If you wish to over-ride that behaviour, set rescale=FALSE.

Usage

```
## S3 method for class 'cimg'
as.raster(
  x,
  frames,
  rescale = TRUE,
  colourscale = NULL,
  colorscale = NULL,
  col.na = rgb(0, 0, 0, 0),
  ...
)
```

Arguments

`x`	an image (of class cimg)
`frames`	which frames to extract (in case depth > 1)
`rescale`	rescale so that pixel values are in [0,1]? (subtract min and divide by range). default TRUE
`colourscale`	a function that returns RGB values in hexadecimal
`colorscale`	same as above in American spelling
`col.na`	which colour to use for NA values, as R rgb code. The default is "rgb(0,0,0,0)", which corresponds to a fully transparent colour.
`...`	ignored

Value

a raster object

Author(s)

Simon Barthelme

See Also

plot.cimg, rasterImage

Examples

```
#A raster is a simple array of RGB values
as.raster(boats) %>% str
#By default as.raster rescales input values, so that:
all.equal(as.raster(boats),as.raster(boats/2)) #TRUE
#Setting rescale to FALSE changes that
as.raster(boats,rescale=FALSE) %>% plot
as.raster(boats/2,rescale=FALSE) %>% plot
#For grayscale images, a colourmap should take a single value and
#return  an RGB code
#Example: mapping grayscale value to saturation
cscale <- function(v) hsv(.5,v,1)
grayscale(boats) %>% as.raster(colourscale=cscale) %>% plot
```

---

at *Return or set pixel value at coordinates*

Description

Return or set pixel value at coordinates

Usage

```
at(im, x, y, z = 1, cc = 1)

at(im, x, y, z = 1, cc = 1) <- value

color.at(im, x, y, z = 1)

color.at(im, x, y, z = 1) <- value
```

Arguments

im	an image (cimg object)
x	x coordinate (vector)
y	y coordinate (vector)
z	z coordinate (vector, default 1)
cc	colour coordinate (vector, default 1)
value	replacement

Value

pixel values

Functions

- `at(im, x, y, z = 1, cc = 1) <- value`: set value of pixel at a location
- `color.at()`: return value of all colour channels at a location
- `color.at(im, x, y, z = 1) <- value`: set value of all colour channels at a location

Author(s)

Simon Barthelme

Examples

```
im <- as.cimg(function(x,y) x+y,50,50)
at(im,10,1)
at(im,10:12,1)
at(im,10:12,1:3)
at(im,1,2) <- 10
at(im,1,2)
color.at(boats,x=10,y=10)
im <- boats
color.at(im,x=10,y=10) <- c(255,0,0)
#There should now be a red dot
imsub(im, x %inr% c(1,100), y %inr% c(1,100)) %>% plot
```

---

autocrop *Autocrop image region*

Description

Autocrop image region

Usage

```
autocrop(im, color = color.at(im, 1, 1), axes = "zyx")
```

Arguments

im	an image
color	Colour used for the crop. If missing, the colour is taken from the top-left pixel. Can also be a colour name (e.g. "red", or "black")
axes	Axes used for the crop.

Examples

```
#Add pointless padding
padded <- pad(boats,30,"xy")
plot(padded)
#Remove padding
autocrop(padded) %>% plot
#You can specify the colour if needs be
autocrop(padded,"black") %>% plot
#autocrop has a zero-tolerance policy: if a pixel value is slightly different from the one you gave
#the pixel won't get cropped. A fix is to do a bucket fill first
padded <- isoblur(padded,10)
autocrop(padded) %>% plot
padded2 <- bucketfill(padded,1,1,col=c(0,0,0),sigma=.1)
autocrop(padded2) %>% plot
```

---

bbox *Compute the bounding box of a pixset*

Description

This function returns the bounding box of a pixset as another pixset. If the image has more than one frame, a bounding cube is returned. If the image has several colour channels, the bounding box is computed separately in each channel. crop.bbox crops an image using the bounding box of a pixset.

Usage

```
bbox(px)

crop.bbox(im, px)
```

Arguments

px	a pixset
im	an image

Value

a pixset object

Functions

- `crop.bbox()`: crop image using the bounding box of pixset px

Author(s)

Simon Barthelme

Examples

```
im <- grayscale(boats)
px <- im > .85
plot(im)
highlight(bbox(px))
highlight(px,col="green")
crop.bbox(im,px) %>% plot
```

---

blur_anisotropic *Blur image anisotropically, in an edge-preserving way.*

Description

Standard blurring removes noise from images, but tends to smooth away edges in the process. This anisotropic filter preserves edges better.

Usage

```
blur_anisotropic(
  im,
  amplitude,
  sharpness = 0.7,
  anisotropy = 0.6,
  alpha = 0.6,
  sigma = 1.1,
  dl = 0.8,
  da = 30,
  gauss_prec = 2,
  interpolation_type = 0L,
  fast_approx = TRUE
)
```

Arguments

`im`	an image
`amplitude`	Amplitude of the smoothing.
`sharpness`	Sharpness.
`anisotropy`	Anisotropy.

alpha	Standard deviation of the gradient blur.
sigma	Standard deviation of the structure tensor blur.
dl	Spatial discretization.
da	Angular discretization.
gauss_prec	Precision of the diffusion process.
interpolation_type	Interpolation scheme. Can be 0=nearest-neighbor | 1=linear | 2=Runge-Kutta
fast_approx	If true, use fast approximation (default TRUE)

Examples

```
im <- load.image(system.file('extdata/Leonardo_Birds.jpg',package='imager'))
im.noisy <- (im + 80*rnorm(prod(dim(im))))
blur_anisotropic(im.noisy,ampl=1e4,sharp=1) %>% plot
```

---

boats *Photograph of sailing boats from Kodak set*

Description

This photograph was downloaded from http://r0k.us/graphics/kodak/kodim09.html. Its size was reduced by half to speed up loading and save space.

Usage

```
boats
```

Format

an image of class cimg

Source

http://r0k.us/graphics/kodak/kodim09.html

boundary *Find the boundary of a shape in a pixel set*

Description

Find the boundary of a shape in a pixel set

Usage

```
boundary(px, depth = 1, high_connexity = FALSE)
```

Arguments

px	pixel set
depth	boundary depth (default 1)
high_connexity	if FALSE, use 4-point neighbourhood. If TRUE, use 8-point. (default FALSE)

Examples

```
px.diamond(10,30,30) %>% boundary %>% plot
px.square(10,30,30) %>% boundary %>% plot
px.square(10,30,30) %>% boundary(depth=3) %>% plot
px <- (px.square(10,30,30) | px.circle(12,30,30))
boundary(px,high=TRUE) %>% plot(int=TRUE,main="8-point neighbourhood")
boundary(px,high=TRUE) %>% plot(int=FALSE,main="4-point neighbourhood")
```

boxblur *Blur image with a box filter (square window)*

Description

Blur image with a box filter (square window)

Usage

```
boxblur(im, boxsize, neumann = TRUE)
```

Arguments

im	an image
boxsize	Size of the box window (can be subpixel).
neumann	If true, use Neumann boundary conditions, Dirichlet otherwise (default true, Neumann)

See Also

deriche(), vanvliet().

Examples

```
boxblur(boats,5) %>% plot(main="Dirichlet boundary")
boxblur(boats,5,TRUE) %>% plot(main="Neumann boundary")
```

---

boxblur_xy *Blur image with a box filter.*

Description

This is a recursive algorithm, not depending on the values of the box kernel size.

Usage

```
boxblur_xy(im, sx, sy, neumann = TRUE)
```

Arguments

im	an image
sx	Size of the box window, along the X-axis.
sy	Size of the box window, along the Y-axis.
neumann	If true, use Neumann boundary conditions, Dirichlet otherwise (default true, Neumann)

See Also

blur().

Examples

```
boxblur_xy(boats,20,5) %>% plot(main="Anisotropic blur")
```

bucketfill *Bucket fill*

Description

Bucket fill

Usage

```
bucketfill(
  im,
  x,
  y,
  z = 1,
  color,
  opacity = 1,
  sigma = 0,
  high_connexity = FALSE
)
```

Arguments

im	an image
x	X-coordinate of the starting point of the region to fill.
y	Y-coordinate of the starting point of the region to fill.
z	Z-coordinate of the starting point of the region to fill.
color	a vector of values (of length spectrum(im)), or a colour name (e.g. "red"). If missing, use the colour at location (x,y,z).
opacity	opacity. If the opacity is below 1, paint with transparency.
sigma	Tolerance for neighborhood values: spread to neighbours if difference is less than sigma (for grayscale). If there are several channels, the sum of squared differences is used: if it below sigma^2, the colour spreads.
high_connexity	Use 8-connexity (only for 2d images, default FALSE).

See Also

px.flood

Examples

```
#Change the colour of a sail
boats.new <- bucketfill(boats,x=169,y=179,color="pink",sigma=.2)
layout(t(1:2))
plot(boats,main="Original")
plot(boats.new,main="New sails")
```

```
#More spreading, lower opacity, colour specified as vector
ugly <- bucketfill(boats,x=169,y=179,color=c(0,1,0),sigma=.6,opacity=.5)
plot(ugly)
```

---

cannyEdges *Canny edge detector*

Description

If the threshold parameters are missing, they are determined automatically using a k-means heuristic. Use the alpha parameter to adjust the automatic thresholds up or down The thresholds are returned as attributes. The edge detection is based on a smoothed image gradient with a degree of smoothing set by the sigma parameter.

Usage

```
cannyEdges(im, t1, t2, alpha = 1, sigma = 2)
```

Arguments

im	input image
t1	threshold for weak edges (if missing, both thresholds are determined automatically)
t2	threshold for strong edges
alpha	threshold adjusment factor (default 1)
sigma	smoothing

Author(s)

Simon Barthelme

Examples

```
cannyEdges(boats) %>% plot
#Make thresholds less strict
cannyEdges(boats,alpha=.4) %>% plot
#Make thresholds more strict
cannyEdges(boats,alpha=1.4) %>% plot
```

capture.plot *Capture the current R plot device as a cimg image*

Description

Capture the current R plot device as a cimg image

Usage

```
capture.plot()
```

Value

a cimg image corresponding to the contents of the current plotting window

Author(s)

Simon Barthelme

Examples

```
##interactive only:
##plot(1:10)
###Make a plot of the plot
##capture.plot() %>% plot
```

center.stencil *Center stencil at a location*

Description

Center stencil at a location

Usage

```
center.stencil(stencil, ...)
```

Arguments

stencil	a stencil (data.frame with coordinates dx,dy,dz,dc)
...	centering locations (e.g. x=4,y=2)

Examples

```
stencil <- data.frame(dx=seq(-2,2,1),dy=seq(-2,2,1))
center.stencil(stencil,x=10,y=20)
```

channels *Split a colour image into a list of separate channels*

Description

Split a colour image into a list of separate channels

Usage

```
channels(im, index, drop = FALSE)
```

Arguments

im	an image
index	which channels to extract (default all)
drop	if TRUE drop extra dimensions, returning normal arrays and not cimg objects

Value

a list of channels

See Also

frames

Examples

```
channels(boats)
channels(boats,1:2)
channels(boats,1:2,drop=TRUE) %>% str #A list of 2D arrays
```

ci *Concatenation for image lists*

Description

Allows you to concatenate image lists together, or images with image lists. Doesn't quite work like R's "c" primitive: image lists are always *flat*, not nested, meaning each element of an image list is an image.

Usage

```
ci(...)
```

Arguments

...	objects to concatenate

Value

an image list

Author(s)

Simon Barthelme

Examples

```
l1 <- imlist(boats,grayscale(boats))
l2 <- imgradient(boats,"xy")
ci(l1,l2) #List + list
ci(l1,imfill(3,3)) #List + image
ci(imfill(3,3),l1,l2) #Three elements, etc.
```

---

cimg *Create a cimg object*

Description

cimg is a class for storing image or video/hyperspectral data. It is designed to provide easy interaction with the CImg library, but in order to use it you need to be aware of how CImg wants its image data stored. Images have up to 4 dimensions, labelled x,y,z,c. x and y are the usual spatial dimensions, z is a depth dimension (which would correspond to time in a movie), and c is a colour dimension. Images are stored linearly in that order, starting from the top-left pixel and going along *rows* (scanline order). A colour image is just three R,G,B channels in succession. A sequence of N images is encoded as R1,R2,....,RN,G1,...,GN,B1,...,BN where R_i is the red channel of frame i. The number of pixels along the x,y,z, and c axes is called (in that order), width, height, depth and spectrum. NB: Logical and integer values are automatically converted to type double. NAs are not supported by CImg, so you should manage them on the R end of things.

Usage

```
cimg(X)
```

Arguments

X	a four-dimensional numeric array

Value

an object of class cimg

Author(s)

Simon Barthelme

Examples

```
cimg(array(1,c(10,10,5,3)))
```

`cimg.dimensions` *Image dimensions*

Description

Image dimensions

Usage

```
width(im)

height(im)

spectrum(im)

depth(im)

nPix(im)
```

Arguments

`im`	an image

Functions

- `width()`: Width of the image (in pixels)
- `height()`: Height of the image (in pixels)
- `spectrum()`: Number of colour channels
- `depth()`: Depth of the image/number of frames in a video
- `nPix()`: Total number of pixels (prod(dim(im)))

`cimg.extract` *Various shortcuts for extracting colour channels, frames, etc*

Description

Various shortcuts for extracting colour channels, frames, etc

Extract one frame out of a 4D image/video

Usage

```
frame(im, index)

imcol(im, x)

imrow(im, y)

channel(im, ind)

R(im)

G(im)

B(im)
```

Arguments

`im`	an image
`index`	frame index
`x`	x coordinate of the row
`y`	y coordinate of the row
`ind`	channel index

Functions

- `frame()`: Extract frame
- `imcol()`: Extract a particular column from an image
- `imrow()`: Extract a particular row from an image
- `channel()`: Extract an image channel
- `R()`: Extract red channel
- `G()`: Extract green channel
- `B()`: Extract blue channel

Author(s)

Simon Barthelme

Examples

```
#Extract the red channel from the boats image, then the first row, plot
rw <- R(boats) %>% imrow(10)
plot(rw,type="l",xlab="x",ylab="Pixel value")
#Note that R(boats) returns an image
R(boats)
#while imrow returns a vector or a list
R(boats) %>% imrow(1) %>% str
imrow(boats,1) %>% str
```

`cimg.use.openmp` *Control CImg's parallelisation*

Description

On supported architectures CImg can parallelise many operations using OpenMP. Use this function to turn parallelisation on or off.

Usage

```
cimg.use.openmp(mode = "adaptive")
```

Arguments

mode	Either "adaptive","always" or "none". The default is adaptive (parallelisation for large images only).

Value

NULL (function is used for side effects)

Author(s)

Simon Barthelme

Examples

```
cimg.use.openmp("never") #turn off parallelisation
```

cimg2im *Convert cimg to spatstat im object*

Description

The spatstat library uses a different format for images, which have class "im". This utility converts a cimg object to an im object. spatstat im objects are limited to 2D grayscale images, so if the image has depth or spectrum > 1 a list is returned for the separate frames or channels (or both, in which case a list of lists is returned, with frames at the higher level and channels at the lower one).

Usage

```
cimg2im(img, W = NULL)
```

Arguments

img	an image of class cimg
W	a spatial window (see spatstat doc). Default NULL

Value

an object of class im, or a list of objects of class im, or a list of lists of objects of class im

Author(s)

Simon Barthelme

See Also

im, as.im

circles *Add circles to plot*

Description

Base R has a function for plotting circles called "symbols". Unfortunately, the size of the circles is inconsistent across devices. This function plots circles whose radius is specified in used coordinates.

Usage

```
circles(x, y, radius, bg = NULL, fg = "white", ...)
```

Arguments

x	centers (x coordinate)
y	centers (y coordinate)
radius	radius (in user coordinates)
bg	background colour
fg	foreground colour
...	passed to polygon, e.g. lwd

Value

none, used for side effect

Author(s)

Simon Barthelme

See Also

hough_circle

---

clean *Clean up and fill in pixel sets (morphological opening and closing)*

Description

Cleaning up a pixel set here means removing small isolated elements (speckle). Filling in means removing holes. Cleaning up can be achieved by shrinking the set (removing speckle), followed by growing it back up. Filling in can be achieved by growing the set (removing holes), and shrinking it again.

Usage

```
clean(px, ...)

fill(px, ...)
```

Arguments

px	a pixset
...	parameters that define the structuring element to use, passed on to "grow" and "shrink"

Functions

- `fill()`: Fill in holes using morphological closing

Author(s)

Simon Barthelme

Examples

```
im <- load.example("birds") %>% grayscale
sub <- imsub(-im,y> 380) %>% threshold("85%")
plot(sub)
#Turn into a pixel set
px <- sub==1
layout(t(1:2))
plot(px,main="Before clean-up")
clean(px,3) %>% plot(main="After clean-up")
#Now fill in the holes
px <- clean(px,3)
plot(px,main="Before filling-in")
fill(px,28) %>% plot(main="After filling-in")
```

---

colorise *Fill in a colour in an area given by a pixset*

Description

Paint all pixels in pixset px with the same colour

Usage

```
colorise(im, px, col, alpha = 1)
```

Arguments

im	an image
px	either a pixset or a formula, as in imeval.
col	colour to fill in. either a vector of numeric values or a string (e.g. "red")
alpha	transparency (default 1, no transparency)

Value

an image

Author(s)

Simon Barthelme

Examples

```
im <- load.example("coins")
colorise(im,Xc(im) < 50,"blue") %>% plot
#Same thing with the formula interface
colorise(im,~ x < 50,"blue") %>% plot
#Add transparency
colorise(im,~ x < 50,"blue",alpha=.5) %>% plot
#Highlight pixels with low luminance values
colorise(im,~ . < 0.3,"blue",alpha=.2) %>% plot
```

`common_pixsets` *Various useful pixsets*

Description

These functions define some commonly used pixsets. px.left gives the left-most pixels of an image, px.right the right-most, etc. px.circle returns an (approximately) circular pixset of radius r, embedded in an image of width x and height y Mathematically speaking, the set of all pixels whose L2 distance to the center equals r or less. px.diamond is similar but returns a diamond (L1 distance less than r) px.square is also similar but returns a square (Linf distance less than r)

Usage

```
px.circle(r, x = 2 * r + 1, y = 2 * r + 1)

px.diamond(r, x = 2 * r + 1, y = 2 * r + 1)

px.square(r, x = 2 * r + 1, y = 2 * r + 1)

px.left(im, n = 1)

px.top(im, n = 1)

px.bottom(im, n = 1)

px.right(im, n = 1)

px.borders(im, n = 1)

px.all(im)

px.none(im)
```

Arguments

`r`	radius (in pixels)
`x`	width (default 2*r+1)

y	height (default 2*r+1)
im	an image
n	number of pixels to include

Value

a pixset

Functions

- px.circle(): A circular-shaped pixset
- px.diamond(): A diamond-shaped pixset
- px.square(): A square-shaped pixset
- px.left(): n left-most pixels (left-hand border)
- px.top(): n top-most pixels
- px.bottom(): n bottom-most pixels
- px.right(): n right-most pixels
- px.borders(): image borders (to depth n)
- px.all(): all pixels in image
- px.none(): no pixel in image

Author(s)

Simon Barthelme

Examples

```
px.circle(20,350,350) %>% plot(interp=FALSE)
px.circle(3) %>% plot(interp=FALSE)
r <- 5
layout(t(1:3))
plot(px.circle(r,20,20))
plot(px.square(r,20,20))
plot(px.diamond(r,20,20))
#These pixsets are useful as structuring elements
px <- grayscale(boats) > .8
grow(px,px.circle(5)) %>% plot
#The following functions select pixels on the left, right, bottom, top of the image
im <- imfill(10,10)
px.left(im,3) %>% plot(int=FALSE)
px.right(im,1) %>% plot(int=FALSE)
px.top(im,4) %>% plot(int=FALSE)
px.bottom(im,2) %>% plot(int=FALSE)
#All of the above
px.borders(im,1) %>% plot(int=FALSE)
```

`contours` *Return contours of image/pixset*

Description

This is just a light interface over contourLines. See help for contourLines for details. If the image has more than one colour channel, return a list with the contour lines in each channel. Does not work on 3D images.

Usage

```
contours(x, nlevels, ...)
```

Arguments

`x`	an image or pixset
`nlevels`	number of contour levels. For pixsets this can only equal two.
`...`	extra parameters passed to contourLines

Value

a list of contours

Author(s)

Simon Barthelme

See Also

highlight

Examples

```
boats.gs <- grayscale(boats)
ct <- contours(boats.gs,nlevels=3)
plot(boats.gs)
#Add contour lines
purrr::walk(ct,function(v) lines(v$x,v$y,col="red"))
#Contours of a pixel set
px <- boats.gs > .8
plot(boats.gs)
ct <- contours(px)
#Highlight pixset
purrr::walk(ct,function(v) lines(v$x,v$y,col="red"))
```

coord.index *Coordinates from pixel index*

Description

Compute (x,y,z,cc) coordinates from linear pixel index.

Usage

```
coord.index(im, index)
```

Arguments

im	an image
index	a vector of indices

Value

a data.frame of coordinate values

Author(s)

Simon Barthelme

See Also

index.coord for the reverse operation

Examples

```
cind <- coord.index(boats,33)
#Returns (x,y,z,c) coordinates of the 33rd pixel in the array
cind
all.equal(boats[33],with(cind,at(boats,x,y,z,cc)))
all.equal(33,index.coord(boats,cind))
```

correlate *Correlation/convolution of image by filter*

Description

The correlation of image im by filter flt is defined as: $res(x,y,z) = sum_{i,j,k} im(x+i, y+j, z+k) * flt(i,j,k)$. The convolution of an image img by filter flt is defined to be: $res(x,y,z) = sum_{i,j,k} img(x-i, y-j, z-k) * flt(i,j,k)$

Usage

```
correlate(im, filter, dirichlet = TRUE, normalise = FALSE)

convolve(im, filter, dirichlet = TRUE, normalise = FALSE)
```

Arguments

im	an image
filter	the correlation kernel.
dirichlet	boundary condition. Dirichlet if true, Neumann if false (default TRUE, Dirichlet)
normalise	compute a normalised correlation (ie. local cosine similarity)

Functions

- convolve(): convolve image with filter

Examples

```
#Edge filter
filter <- as.cimg(function(x,y) sign(x-5),10,10)
layout(t(1:2))
#Convolution vs. correlation
correlate(boats,filter) %>% plot(main="Correlation")
convolve(boats,filter) %>% plot(main="Convolution")
```

---

crop.borders *Crop the outer margins of an image*

Description

This function crops pixels on each side of an image. This function is a kind of inverse (centred) padding, and is useful e.g. when you want to get only the valid part of a convolution

Usage

```
crop.borders(im, nx = 0, ny = 0, nz = 0, nPix)
```

Arguments

im	an image
nx	number of pixels to crop along horizontal axis
ny	number of pixels to crop along vertical axis
nz	number of pixels to crop along depth axis
nPix	optional: crop the same number of pixels along all dimensions

Value

an image

Author(s)

Simon Barthelme

Examples

```
#These two versions are equivalent
imfill(10,10) %>% crop.borders(nx=1,ny=1)
imfill(10,10) %>% crop.borders(nPix=1)

#Filter, keep valid part
correlate(boats,imfill(3,3)) %>% crop.borders(nPix=2)
```

---

deriche *Apply recursive Deriche filter.*

Description

The Deriche filter is a fast approximation to a Gaussian filter (order = 0), or Gaussian derivatives (order = 1 or 2).

Usage

```
deriche(im, sigma, order = 0L, axis = "x", neumann = FALSE)
```

Arguments

im	an image
sigma	Standard deviation of the filter.
order	Order of the filter. 0 for a smoothing filter, 1 for first-derivative, 2 for second.
axis	Axis along which the filter is computed ('x' , 'y', 'z' or 'c').
neumann	If true, use Neumann boundary conditions (default false, Dirichlet)

Examples

```
deriche(boats,sigma=2,order=0) %>% plot("Zeroth-order Deriche along x")
deriche(boats,sigma=2,order=1) %>% plot("First-order Deriche along x")
deriche(boats,sigma=2,order=1) %>% plot("Second-order Deriche along x")
deriche(boats,sigma=2,order=1,axis="y") %>% plot("Second-order Deriche along y")
```

diffusion_tensors *Compute field of diffusion tensors for edge-preserving smoothing.*

Description

Compute field of diffusion tensors for edge-preserving smoothing.

Usage

```
diffusion_tensors(
  im,
  sharpness = 0.7,
  anisotropy = 0.6,
  alpha = 0.6,
  sigma = 1.1,
  is_sqrt = FALSE
)
```

Arguments

im	an image
sharpness	Sharpness
anisotropy	Anisotropy
alpha	Standard deviation of the gradient blur.
sigma	Standard deviation of the structure tensor blur.
is_sqrt	Tells if the square root of the tensor field is computed instead.

displacement *Estimate displacement field between two images.*

Description

Estimate displacement field between two images.

Usage

```
displacement(
  sourceIm,
  destIm,
  smoothness = 0.1,
  precision = 5,
  nb_scales = 0L,
  iteration_max = 10000L,
  is_backward = FALSE
)
```

Arguments

sourceIm	Reference image.
destIm	Reference image.
smoothness	Smoothness of estimated displacement field.
precision	Precision required for algorithm convergence.
nb_scales	Number of scales used to estimate the displacement field.
iteration_max	Maximum number of iterations allowed for one scale.
is_backward	If false, match I2(X + U(X)) = I1(X), else match I2(X) = I1(X - U(X)).

---

display *Display object using CImg library*

Description

CImg has its own functions for fast, interactive image plotting. Use this if you get frustrated with slow rendering in RStudio. Note that you need X11 library to use this function.

Usage

```
display(x, ...)
```

Arguments

x	an image or a list of images
...	ignored

See Also

display.cimg, display.imlist

---

display.cimg *Display image using CImg library*

Description

Press escape or close the window to exit. Note that you need X11 library to use this function.

Usage

```
## S3 method for class 'cimg'
display(x, ..., rescale = TRUE)
```

Arguments

x	an image (cimg object)
...	ignored
rescale	if true pixel values are rescaled to [0-1] (default TRUE)

Examples

```
##Not run: interactive only
##display(boats,TRUE) #Normalisation on
##display(boats/2,TRUE) #Normalisation on, so same as above
##display(boats,FALSE) #Normalisation off
##display(boats/2,FALSE) #Normalisation off, so different from above
```

---

display.list *Display image list using CImg library*

Description

Click on individual images to zoom in.

Usage

```
## S3 method for class 'list'
display(x, ...)
```

Arguments

x	a list of cimg objects
...	ignored

Examples

```
##Not run: interactive only
## imgradient(boats,"xy") %>% display
```

distance_transform *Compute Euclidean distance function to a specified value.*

Description

The distance transform implementation has been submitted by A. Meijster, and implements the article 'W.H. Hesselink, A. Meijster, J.B.T.M. Roerdink, "A general algorithm for computing distance transforms in linear time.", In: Mathematical Morphology and its Applications to Image and Signal Processing, J. Goutsias, L. Vincent, and D.S. Bloomberg (eds.), Kluwer, 2000, pp. 331-340.' The submitted code has then been modified to fit CImg coding style and constraints.

Usage

```
distance_transform(im, value, metric = 2L)
```

Arguments

im	an image
value	Reference value.
metric	Type of metric. Can be <tt> 0=Chebyshev | 1=Manhattan | 2=Euclidean | 3=Squared-euclidean </tt>.

Examples

```
imd <- function(x,y) imdirac(c(100,100,1,1),x,y)
#Image is three white dots
im <- imd(20,20)+imd(40,40)+imd(80,80)
plot(im)
#How far are we from the nearest white dot?
distance_transform(im,1) %>% plot
```

draw_circle *Draw circle on image*

Description

Add circle or circles to an image. Like other native CImg drawing functions, this is meant to be basic but fast. Use implot for flexible drawing.

Usage

```
draw_circle(im, x, y, radius, color = "white", opacity = 1, filled = TRUE)
```

Arguments

im	an image
x	x coordinates
y	y coordinates
radius	radius (either a single value or a vector of length equal to length(x))
color	either a string ("red"), a character vector of length equal to x, or a matrix of dimension length(x) times spectrum(im)
opacity	scalar or vector of length equal to length(x). 0: transparent 1: opaque.
filled	fill circle (default TRUE)

Value

an image

Author(s)

Simon Barthelme

See Also

implot

Examples

```
draw_circle(boats,c(50,100),c(150,200),30,"darkgreen") %>% plot
draw_circle(boats,125,60,radius=30,col=c(0,1,0),opacity=.2,filled=TRUE) %>% plot
```

---

draw_rect *Draw rectangle on image*

Description

Add a rectangle to an image. Like other native CImg drawing functions, this is meant to be basic but fast. Use implot for flexible drawing.

Usage

```
draw_rect(im, x0, y0, x1, y1, color = "white", opacity = 1, filled = TRUE)
```

Arguments

im	an image
x0	x coordinate of the bottom-left corner
y0	y coordinate of the bottom-left corner
x1	x coordinate of the top-right corner
y1	y coordinate of the top-right corner
color	either a vector, or a string (e.g. "blue")
opacity	0: transparent 1: opaque.
filled	fill rectangle (default TRUE)

Value

an image

Author(s)

Simon Barthelme

See Also

implot,draw_circle

Examples

```
draw_rect(boats,1,1,50,50,"darkgreen") %>% plot
```

---

draw_text *Draw text on an image*

Description

Like other native CImg drawing functions, this is meant to be basic but fast. Use implot for flexible drawing.

Usage

```
draw_text(im, x, y, text, color, opacity = 1, fsize = 20)
```

Arguments

im	an image
x	x coord.
y	y coord.
text	text to draw (a string)
color	either a vector or a string (e.g. "red")
opacity	0: transparent 1: opaque.
fsize	font size (in pix., default 20)

Value

an image

Author(s)

Simon Barthelme

See Also

implot,draw_circle,draw_rect

Examples

```
draw_text(boats,100,100,"Some text",col="black") %>% plot
```

---

erode *Erode/dilate image by a structuring element.*

Description

Erode/dilate image by a structuring element.

Usage

```
erode(im, mask, boundary_conditions = TRUE, real_mode = FALSE)

erode_rect(im, sx, sy, sz = 1L)

erode_square(im, size)

dilate(im, mask, boundary_conditions = TRUE, real_mode = FALSE)

dilate_rect(im, sx, sy, sz = 1L)

dilate_square(im, size)

mopening(im, mask, boundary_conditions = TRUE, real_mode = FALSE)

mopening_square(im, size)

mclosing_square(im, size)

mclosing(im, mask, boundary_conditions = TRUE, real_mode = FALSE)
```

Arguments

im	an image
mask	Structuring element.
boundary_conditions	Boundary conditions. If FALSE, pixels beyond image boundaries are considered to be 0, if TRUE one. Default: TRUE.
real_mode	If TRUE, perform erosion as defined on the reals. If FALSE, perform binary erosion (default FALSE).
sx	Width of the structuring element.
sy	Height of the structuring element.
sz	Depth of the structuring element.
size	size of the structuring element.

Functions

- `erode_rect()`: Erode image by a rectangular structuring element of specified size.
- `erode_square()`: Erode image by a square structuring element of specified size.
- `dilate()`: Dilate image by a structuring element.
- `dilate_rect()`: Dilate image by a rectangular structuring element of specified size
- `dilate_square()`: Dilate image by a square structuring element of specified size
- `mopening()`: Morphological opening (erosion followed by dilation)
- `mopening_square()`: Morphological opening by a square element (erosion followed by dilation)
- `mclosing_square()`: Morphological closing by a square element (dilation followed by erosion)
- `mclosing()`: Morphological closing (dilation followed by erosion)

Examples

```
fname <- system.file('extdata/Leonardo_Birds.jpg',package='imager')
im <- load.image(fname) %>% grayscale
outline <- threshold(-im,"95%")
plot(outline)
mask <- imfill(5,10,val=1) #Rectangular mask
plot(erode(outline,mask))
plot(erode_rect(outline,5,10)) #Same thing
plot(erode_square(outline,5))
plot(dilate(outline,mask))
plot(dilate_rect(outline,5,10))
plot(dilate_square(outline,5))
```

`extract_patches` *Extract image patches and return a list*

Description

Patches are rectangular (cubic) image regions centered at cx,cy (cz) with width wx and height wy (opt. depth wz) WARNINGS: - values outside of the image region are subject to boundary conditions. The default is to set them to 0 (Dirichlet), other boundary conditions are listed below. - widths and heights should be odd integers (they're rounded up otherwise).

Usage

```
extract_patches(im, cx, cy, wx, wy, boundary_conditions = 0L)

extract_patches3D(im, cx, cy, cz, wx, wy, wz, boundary_conditions = 0L)
```

Arguments

`im`	an image
`cx`	vector of x coordinates for patch centers
`cy`	vector of y coordinates for patch centers
`wx`	vector of patch widths (or single value)
`wy`	vector of patch heights (or single value)
`boundary_conditions`	integer. Can be 0 (Dirichlet, default), 1 (Neumann) 2 (Periodic) 3 (mirror).
`cz`	vector of z coordinates for patch centers
`wz`	vector of coordinates for patch depth

Value

a list of image patches (cimg objects)

Functions

- `extract_patches3D()`: Extract 3D patches

Examples

```
#2 patches of size 5x5 located at (10,10) and (10,20)
extract_patches(boats,c(10,10),c(10,20),5,5)
```

FFT *Compute the Discrete Fourier Transform of an image*

Description

This function is equivalent to R's builtin fft, up to normalisation (R's version is unnormalised, this one is). It calls CImg's implementation. Important note: FFT will compute a multidimensional Fast Fourier Transform, using as many dimensions as you have in the image, meaning that if you have a colour video, it will perform a 4D FFT. If you want to compute separate FFTs across channels, use imsplit.

Usage

```
FFT(im.real, im.imag, inverse = FALSE)
```

Arguments

im.real	The real part of the input (an image)
im.imag	The imaginary part (also an image. If missing, assume the signal is real).
inverse	If true compute the inverse FFT (default: FALSE)

Value

a list with components "real" (an image) and "imag" (an image), corresponding to the real and imaginary parts of the transform

Author(s)

Simon Barthelme

Examples

```
im <- as.cimg(function(x,y) sin(x/5)+cos(x/4)*sin(y/2),128,128)
ff <- FFT(im)
plot(ff$real,main="Real part of the transform")
plot(ff$imag,main="Imaginary part of the transform")
sqrt(ff$real^2+ff$imag^2) %>% plot(main="Power spectrum")
#Check that we do get our image back
check <- FFT(ff$real,ff$imag,inverse=TRUE)$real #Should be the same as original
mean((check-im)^2)
```

`flatten.alpha` *Flatten alpha channel*

Description

Flatten alpha channel

Usage

```
flatten.alpha(im, bg = "white")
```

Arguments

`im`	an image (with 4 RGBA colour channels)
`bg`	background: either an RGB image, or a vector of colour values, or a string (e.g. "blue"). Default: white background.

Value

a blended image

Author(s)

Simon Barthelme

See Also

rm.alpha

Examples

```
#Add alpha channel
alpha <- Xc(grayscale(boats))/width(boats)
boats.a <- imlist(boats,alpha) %>% imappend("c")
flatten.alpha(boats.a) %>% plot
flatten.alpha(boats.a,"darkgreen") %>% plot
```

frames *Split a video into separate frames*

Description

Split a video into separate frames

Usage

```
frames(im, index, drop = FALSE)
```

Arguments

im	an image
index	which channels to extract (default all)
drop	if TRUE drop extra dimensions, returning normal arrays and not cimg objects

Value

a list of frames

See Also

channels

get.locations *Return coordinates of subset of pixels*

Description

Typical use case: you want the coordinates of all pixels with a value above a certain threshold

Usage

```
get.locations(im, condition)
```

Arguments

im	the image
condition	a function that takes scalars and returns logicals

Value

coordinates of all pixels such that condition(pixel) == TRUE

Author(s)

Simon Barthelme

Examples

```
im <- as.cimg(function(x,y) x+y,10,10)
get.locations(im,function(v) v < 4)
get.locations(im,function(v) v^2 + 3*v - 2 < 30)
```

---

get.stencil *Return pixel values in a neighbourhood defined by a stencil*

Description

A stencil defines a neighbourhood in an image (for example, the four nearest neighbours in a 2d image). This function centers the stencil at a certain pixel and returns the values of the neighbourhing pixels.

Usage

```
get.stencil(im, stencil, ...)
```

Arguments

im	an image
stencil	a data.frame with values dx,dy,[dz],[dcc] defining the neighbourhood
...	where to center, e.g. x = 100,y = 10,z=3,cc=1

Value

pixel values in neighbourhood

Author(s)

Simon Barthelme

Examples

```
#The following stencil defines a neighbourhood that
#includes the next pixel to the left (delta_x = -1) and the next pixel to the right (delta_x = 1)
stencil <- data.frame(dx=c(-1,1),dy=c(0,0))
im <- as.cimg(function(x,y) x+y,w=100,h=100)
get.stencil(im,stencil,x=50,y=50)

#A larger neighbourhood that includes pixels upwards and
#downwards of center (delta_y = -1 and +1)
stencil <- stencil.cross()
im <- as.cimg(function(x,y) x,w=100,h=100)
get.stencil(im,stencil,x=5,y=50)
```

get_gradient *Compute image gradient.*

Description

Compute image gradient.

Usage

```
get_gradient(im, axes = "", scheme = 3L)
```

Arguments

im	an image
axes	Axes considered for the gradient computation, as a C-string (e.g "xy").
scheme	= Numerical scheme used for the gradient computation: 1 = Backward finite differences 0 = Centered finite differences 1 = Forward finite differences 2 = Using Sobel masks 3 = Using rotation invariant masks 4 = Using Deriche recursive filter. 5 = Using Van Vliet recursive filter.

Value

a list of images (corresponding to the different directions)

See Also

imgradient

get_hessian *Return image hessian.*

Description

Return image hessian.

Usage

```
get_hessian(im, axes = "")
```

Arguments

im	an image
axes	Axes considered for the hessian computation, as a character string (e.g "xy").

grab *Select image regions interactively*

Description

These functions let you select a shape in an image (a point, a line, or a rectangle) They either return the coordinates of the shape (default), or the contents. In case of lines contents are interpolated. Note that grabLine does not support the "pixset" return type. Note that you need X11 library to use these functions.

Usage

```
grabLine(im, output = "coord")

grabRect(im, output = "coord")

grabPoint(im, output = "coord")
```

Arguments

im	an image
output	one of "im","pixset","coord","value". Default "coord"

Value

Depending on the value of the output parameter. Either a vector of coordinates (output = "coord"), an image (output = "im"), a pixset (output = "pixset"), or a vector of values (output = "value"). grabLine and grabPoint support the "value" output mode and not the "im" output.

Author(s)

Simon Barthelme

See Also

display

Examples

```
##Not run: interactive only
##grabRect(boats)
##grabRect(boats,TRUE)
```

grayscale *Convert an RGB image to grayscale*

Description

This function converts from RGB images to grayscale

Usage

```
grayscale(im, method = "Luma", drop = TRUE)
```

Arguments

im	an RGB image
method	either "Luma", in which case a linear approximation to luminance is used, or "XYZ", in which case the image is assumed to be in sRGB color space and CIE luminance is used.
drop	if TRUE returns an image with a single channel, otherwise keep the three channels (default TRUE)

Value

a grayscale image (spectrum == 1)

Examples

```
grayscale(boats) %>% plot
#In many pictures, the difference between Luma and XYZ conversion is subtle
grayscale(boats,method="XYZ") %>% plot
grayscale(boats,method="XYZ",drop=FALSE) %>% dim
```

grow *Grow/shrink a pixel set*

Description

Grow/shrink a pixel set through morphological dilation/erosion. The default is to use square or rectangular structuring elements, but an arbitrary structuring element can be given as input. A structuring element is a pattern to be moved over the image: for example a 3x3 square. In "shrink" mode, a element of the pixset is retained only if and only the structuring element fits entirely within the pixset. In "grow" mode, the structuring element acts like a neighbourhood: all pixels that are in the original pixset *or* in the neighbourhood defined by the structuring element belong the new pixset.

Usage

```
grow(px, x, y = x, z = x, boundary = TRUE)

shrink(px, x, y = x, z = x, boundary = TRUE)
```

Arguments

px	a pixset
x	either an integer value, or an image/pixel set.
y	width of the rectangular structuring element (if x is an integer value)
z	depth of the rectangular structuring element (if x is an integer value)
boundary	are pixels beyond the boundary considered to have value TRUE or FALSE (default TRUE)

Functions

- `shrink()`: shrink pixset using erosion

Examples

```
#A pixel set:
a <- grayscale(boats) > .8
plot(a)
#Grow by a 8x8 square
grow(a,8) %>% plot
#Grow by a 8x2 rectangle
grow(a,8,2) %>% plot
#Custom structuring element
el <- matrix(1,2,2) %>% as.cimg
all.equal(grow(a,el),grow(a,2))
#Circular structuring element
px.circle(5) %>% grow(a,.) %>% plot
#Sometimes boundary conditions matter
im <- imfill(10,10)
px <- px.all(im)
shrink(px,3,bound=TRUE) %>% plot(main="Boundary conditions: TRUE")
shrink(px,3,bound=FALSE) %>% plot(main="Boundary conditions: FALSE")
```

---

gsdim *Grayscale dimensions of image*

Description

Shortcut, returns the dimensions of an image if it had only one colour channel

Usage

```
gsdim(im)
```

Arguments

im	an image

Value

returns c(dim(im)[1:3],1)

Author(s)

Simon Barthelme

Examples

```
imnoise(dim=gsdim(boats))
```

---

haar *Compute Haar multiscale wavelet transform.*

Description

Compute Haar multiscale wavelet transform.

Usage

```
haar(im, inverse = FALSE, nb_scales = 1L)
```

Arguments

im	an image
inverse	Compute inverse transform (default FALSE)
nb_scales	Number of scales used for the transform.

Examples

```
#Image compression: set small Haar coefficients to 0
hr <- haar(boats,nb=3)
mask.low <- threshold(abs(hr),"75%")
mask.high <- threshold(abs(hr),"95%")
haar(hr*mask.low,inverse=TRUE,nb=3) %>% plot(main="75% compression")
haar(hr*mask.high,inverse=TRUE,nb=3) %>% plot(main="95% compression")
```

highlight *Highlight pixel set on image*

Description

Overlay an image plot with the contours of a pixel set. Note that this function doesn't do the image plotting, just the highlighting.

Usage

```
highlight(px, col = "red", ...)
```

Arguments

px	a pixel set
col	color of the contours
...	passed to the "lines" function

Author(s)

Simon Barthelme

See Also

colorise, another way of highlighting stuff

Examples

```
#Select similar pixels around point (180,200)
px <- px.flood(boats,180,200,sigma=.08)
plot(boats)
#Highlight selected set
highlight(px)
px.flood(boats,18,50,sigma=.08) %>% highlight(col="white",lwd=3)
```

hough_circle *Circle detection using Hough transform*

Description

Detects circles of known radius in a pixset. The output is an image where the pixel value at (x,y) represents the amount of evidence for the presence of a circle of radius r at position (x,y). NB: in the current implementation, does not detect circles centred outside the limits of the pixset.

Usage

```
hough_circle(px, radius)
```

Arguments

px	a pixset (e.g., the output of a Canny detector)
radius	radius of circle

Value

a histogram of Hough scores, with the same dimension as the original image.

Author(s)

Simon Barthelme

Examples

```
im <- load.example('coins')
px <- cannyEdges(im)
#Find circles of radius 20
hc <- hough_circle(px,20)
plot(hc)
#Clean up, run non-maxima suppression
nms <- function(im,sigma) { im[dilate_square(im,sigma) != im] <- 0; im}
hc.clean <- isoblur(hc,3) %>% nms(50)
#Top ten matches
df <- as.data.frame(hc.clean) %>%
dplyr::arrange(desc(value)) %>% head(10)
with(df,circles(x,y,20,fg="red",lwd=3))
```

---

hough_line *Hough transform for lines*

Description

Two algorithms are used, depending on the input: if the input is a pixset then the classical Hough transform is used. If the input is an image, then a faster gradient-based heuristic is used. The method returns either an image (the votes), or a data.frame. In both cases the parameterisation used is the Hesse normal form (theta,rho), where a line is represented as the set of values such that cos(theta)*x + sin(theta)*y = rho. Here theta is an angle and rho is a distance. The image form returns a histogram of scores in (rho,theta) space, where good candidates for lines have high scores. The data.frame form may be more convenient for further processing in R: each line represents a pair (rho,theta) along with its score. If the 'shift' argument is true, then the image is assumed to start at x=1,y=1 (more convenient for plotting in R). If false, the image begins at x=0,y=0 and in both cases the origin is at the top left.

Usage

```
hough_line(im, ntheta = 100, data.frame = FALSE, shift = TRUE)
```

Arguments

im	an image or pixset
ntheta	number of bins along theta (default 100)
data.frame	return a data.frame? (default FALSE)
shift	if TRUE, image is considered to begin at (x=1,y=1).

Value

either an image or a data.frame

Author(s)

Simon Barthelme

Examples

```
#Find the lines along the boundary of a square
px <- px.square(30,80,80) %>% boundary
plot(px)
#Hough transform
hough_line(px,ntheta=200) %>% plot

df <- hough_line(px,ntheta=800,data.frame=TRUE)
#Plot lines with the highest score
plot(px)
with(subset(df,score > quantile(score,.9995)),nfline(theta,rho,col="red"))

plot(boats)
df <- hough_line(boats,ntheta=800,data=TRUE)
```

---

idply *Split an image along axis, map function, return a data.frame*

Description

Shorthand for imsplit followed by purrr::map_df

Usage

```
idply(im, axis, fun, ...)
```

Arguments

im	image
axis	axis for the split (e.g "c")
fun	function to apply
...	extra arguments to function fun

Examples

```
idply(boats,"c",mean) #mean luminance per colour channel
```

---

iiply *Split an image, apply function, recombine the results as an image*

Description

This is just imsplit followed by purrr::map followed by imappend

Usage

```
iiply(im, axis, fun, ...)
```

Arguments

im	image
axis	axis for the split (e.g "c")
fun	function to apply
...	extra arguments to function fun

Examples

```
##' #Normalise colour channels separately, recombine
iiply(boats,"c",function(v) (v-mean(v))/sd(v)) %>% plot
```

---

ilply *Split an image along axis, apply function, return a list*

Description

Shorthand for imsplit followed by purrr::map

Usage

```
ilply(im, axis, fun, ...)
```

Arguments

im	image
axis	axis for the split (e.g "c")
fun	function to apply
...	extra arguments for function fun

Examples

```
parrots <- load.example("parrots")
ilply(parrots,"c",mean) #mean luminance per colour channel
```

`im2cimg` *Convert an image in spatstat format to an image in cimg format*

Description

as.cimg.im is an alias for the same function

Usage

```
im2cimg(img)
```

Arguments

`img`	a spatstat image

Value

a cimg image

Author(s)

Simon Barthelme

`imager` *imager: an R library for image processing, based on CImg*

Description

CImg by David Tschumperle is a C++ library for image processing. It provides most common functions for image manipulation and filtering, as well as some advanced algorithms. imager makes these functions accessible from R and adds many utilities for accessing and working with image data from R. You should install ImageMagick if you want support for image formats beyond PNG and JPEG, and ffmpeg if you need to work with videos (in which case you probably also want to take a look at experimental package imagerstreams on github). Package documentation is available at http://dahtah.github.io/imager/.

imager.combine *Combining images*

Description

These functions take a list of images and combine them by adding, multiplying, taking the parallel min or max, etc. The max. in absolute value of (x1,x2) is defined as x1 if (|x1| > |x2|), x2 otherwise. It's useful for example in getting the most extreme value while keeping the sign. "parsort","parrank" and "parorder" aren't really reductions because they return a list of the same size. They perform a pixel-wise sort (resp. order and rank) across the list. parvar returns an unbiased estimate of the variance (as in the base var function). parsd returns the square root of parvar.

Usage

```
add(x, na.rm = FALSE)

wsum(x, w, na.rm = FALSE)

average(x, na.rm = FALSE)

mult(x, na.rm = FALSE)

parmax(x, na.rm = FALSE)

parmax.abs(x)

parmin.abs(x)

parmin(x, na.rm = FALSE)

enorm(x)

parmed(x, na.rm = FALSE)

parvar(x, na.rm = FALSE)

parsd(x, na.rm = FALSE)

parall(x)

parany(x)

equal(x)

which.parmax(x)

which.parmin(x)
```

```
parsort(x, increasing = TRUE)

parorder(x, increasing = TRUE)

parrank(x, increasing = TRUE)
```

Arguments

x	a list of images
na.rm	ignore NAs (default FALSE)
w	weights (must be the same length as the list)
increasing	if TRUE, sort in increasing order (default TRUE)

Functions

- add(): Add images
- wsum(): Weighted sum of images
- average(): Average images
- mult(): Multiply images (pointwise)
- parmax(): Parallel max over images
- parmax.abs(): Parallel max in absolute value over images,
- parmin.abs(): Parallel min in absolute value over images,
- parmin(): Parallel min over images
- enorm(): Euclidean norm (i.e. sqrt(A^2 + B^2 + ...))
- parmed(): Median
- parvar(): Variance
- parsd(): Std. deviation
- parall(): Parallel all (for pixsets)
- parany(): Parallel any (for pixsets)
- equal(): Test equality
- which.parmax(): index of parallel maxima
- which.parmin(): index of parallel minima
- parsort(): pixel-wise sort
- parorder(): pixel-wise order
- parrank(): pixel-wise rank

Author(s)

Simon Barthelme

See Also

imsplit,Reduce

Examples

```
im1 <- as.cimg(function(x,y) x,50,50)
im2 <- as.cimg(function(x,y) y,50,50)
im3 <- as.cimg(function(x,y) cos(x/10),50,50)
l <- imlist(im1,im2,im3)
add(l) %>% plot #Add the images
average(l) %>% plot #Average the images
mult(l) %>% plot #Multiply
wsum(l,c(.1,8,.1)) %>% plot #Weighted sum
parmax(l) %>% plot #Parallel max
parmin(l) %>% plot #Parallel min
parmed(l) %>% plot #Parallel median
parsd(l) %>% plot #Parallel std. dev
#parsort can also be used to produce parallel max. and min
(parsort(l)[[1]]) %>% plot("Parallel min")
(parsort(l)[[length(l)]]) %>% plot("Parallel max")
#Resize boats so the next examples run faster
im <- imresize(boats,.5)
#Edge detection (Euclidean norm of gradient)
imgradient(im,"xy") %>% enorm %>% plot
#Pseudo-artistic effects
l <- map_il(seq(1,35,5),~ boxblur(im,.))
parmin(l) %>% plot
average(l) %>% plot
mult(l) %>% plot
#At each pixel, which colour channel has the maximum value?
imsplit(im,"c") %>% which.parmax %>% table
#Same thing using parorder (ties are broken differently)!!!
imsplit(im,"c") %>% { parorder(.)[[length(.)]] } %>% table
```

---

imager.replace *Replace part of an image with another*

Description

These replacement functions let you modify part of an image (for example, only the red channel). Note that cimg objects can also be treated as regular arrays and modified using the usual [] operator.

Usage

```
channel(x, ind) <- value

R(x) <- value

G(x) <- value
```

```
B(x) <- value

frame(x, ind) <- value
```

Arguments

x	an image to be modified
ind	an index
value	the image to insert

Functions

- `channel(x, ind) <- value`: Replace image channel
- `R(x) <- value`: Replace red channel
- `G(x) <- value`: Replace green channel
- `B(x) <- value`: Replace blue channel
- `frame(x, ind) <- value`: Replace image frame

See Also

imdraw

Examples

```
boats.cp <- boats
#Set the green channel in the boats image to 0
G(boats.cp) <- 0
#Same thing, more verbose
channel(boats.cp,2) <- 0
#Replace the red channel with noise
R(boats.cp) <- imnoise(width(boats),height(boats))
#A new image with 5 frames
tmp <- imfill(10,10,5)
#Fill the third frame with noise
frame(tmp,3) <- imnoise(10,10)
```

---

imager.subset *Array subset operator for cimg objects*

Description

Internally cimg objects are 4D arrays (stored in x,y,z,c mode) but often one doesn't need all dimensions. This is the case for instance when working on grayscale images, which use only two. The array subset operator works like the regular array [] operator, but it won't force you to use all dimensions. There are easier ways of accessing image data, for example imsub, channels, R, G, B, and the like.

Arguments

x	an image (cimg object)
drop	if true return an array, otherwise return an image object (default FALSE)
...	subsetting arguments

See Also

imsub, which provides a more convenient interface, autocrop, imdraw

Examples

```
im <- imfill(4,4)
dim(im) #4 dimensional, but the last two ones are singletons
im[,1,,] <- 1:4 #Assignment the standard way
im[,1] <- 1:4 #Shortcut
as.matrix(im)
im[1:2,]
dim(boats)
#Arguments will be recycled, as in normal array operations
boats[1:2,1:3,] <- imnoise(2,3) #The same noise array is replicated over the three channels
```

---

imappend *Combine a list of images into a single image*

Description

All images will be concatenated along the x,y,z, or c axis.

Usage

```
imappend(imlist, axis)
```

Arguments

imlist	a list of images (all elements must be of class cimg)
axis	the axis along which to concatenate (for example 'c')

See Also

imsplit (the reverse operation)

Examples

```
imappend(list(boats,boats),"x") %>% plot
imappend(list(boats,boats),"y") %>% plot
purrr::map(1:3, ~imnoise(100,100)) %>% imappend("c") %>% plot
boats.gs <- grayscale(boats)
purrr::map(seq(1,5,l=3),function(v) isoblur(boats.gs,v)) %>% imappend("c") %>% plot
#imappend also works on pixsets
imsplit(boats > .5,"c") %>% imappend("x") %>% plot
```

`imchange` *Modify parts of an image*

Description

A shortcut for modifying parts of an image, using imeval syntax. See doc for imeval first. As part of a pipe, avoids the creating of intermediate variables.

Usage

```
imchange(obj, where, fo, env = parent.frame())
```

Arguments

`obj`	an image or imlist
`where`	where to modify. a pixset, or a formula (in imeval syntax) that evaluates to a pixset.
`fo`	a formula (in imeval syntax) used to modify the image part
`env`	evulation environment (see imeval)

Value

a modified image

Author(s)

Simon Barthelme

See Also

imeval

Examples

```
#Set border to 0:
imchange(boats,px.borders(boats,10),~ 0) %>% plot
#Eq. to
im <- boats
im[px.borders(im,10)] <- 0
#Using formula syntax
imchange(boats,~ px.borders(.,10),~ 0)
#Replace with grayscale ramp
imchange(boats,~ px.borders(.,10),~ xs) %>% plot
#Kill red channel in image
imchange(boats,~ c==1,~ 0) %>% plot
#Shit hue by an amount depending on eccentricity
load.example("parrots") %>%
  RGBtoHSL %>%
  imchange(~ c==1,~ .+80*exp(-(rho/550)^2) ) %>%
  HSLtoRGB %>%
  plot
```

---

imcoord *Coordinates as images*

Description

These functions return pixel coordinates for an image, as an image. All is made clear in the examples (hopefully)

Usage

```
Xc(im)

Yc(im)

Zc(im)

Cc(im)
```

Arguments

im	an image

Value

another image of the same size, containing pixel coordinates

Functions

- `Xc()`: X coordinates
- `Yc()`: Y coordinates
- `Zc()`: Z coordinates
- `Cc()`: C coordinates

See Also

as.cimg.function, pixel.grid

Examples

```
im <- imfill(5,5) #An image
Xc(im) #An image of the same size, containing the x coordinates of each pixel
Xc(im) %>% imrow(1)
Yc(im) %>% imrow(3) #y is constant along rows
Yc(im) %>% imcol(1)
#Mask bits of the boats image:
plot(boats*(Xc(boats) < 100))
plot(boats*(dnorm(Xc(boats),m=100,sd=30))) #Gaussian window
```

---

imdirac *Generates a "dirac" image, i.e. with all values set to 0 except one.*

Description

This small utility is useful to examine the impulse response of a filter

Usage

```
imdirac(dims, x, y, z = 1, cc = 1)
```

Arguments

`dims`	a vector of image dimensions, or an image whose dimensions will be used. If dims has length < 4 some guesswork will be used (see examples and ?as.cimg.array)
`x`	where to put the dirac (x coordinate)
`y`	y coordinate
`z`	z coordinate (default 1)
`cc`	colour coordinate (default 1)

Value

an image

Author(s)

Simon Barthelme

Examples

```
#Explicit settings of all dimensions
imdirac(c(50,50,1,1),20,20)
imdirac(c(50,50),20,20) #Implicit
imdirac(c(50,50,3),20,20,cc=2) #RGB
imdirac(c(50,50,7),20,20,z=2) #50x50 video with 7 frames
#Impulse response of the blur filter
imdirac(c(50,50),20,20) %>% isoblur(sigma=2)  %>% plot
#Impulse response of the first-order Deriche filter
imdirac(c(50,50),20,20) %>% deriche(sigma=2,order=1,axis="x")  %>% plot
##NOT RUN, interactive only
##Impulse response of the blur filter in space-time
##resp <- imdirac(c(50,50,100),x=25,y=25,z=50)  %>%  isoblur(16)
###Normalise to 0...255 and play as video
##renorm(resp) %>% play(normalise=FALSE)
```

---

imdraw *Draw image on another image*

Description

Draw image on another image

Usage

```
imdraw(im, sprite, x = 1, y = 1, z = 1, opacity = 1)
```

Arguments

im	background image
sprite	sprite to draw on background image
x	location
y	location
z	location
opacity	transparency level (default 1)

Author(s)

Simon Barthelme

See Also

imager.combine, for different ways of combining images

Examples

```
im <- load.example("parrots")
boats.small <- imresize(boats,.5)
#I'm aware the result is somewhat ugly
imdraw(im,boats.small,x=400,y=10,opacity=.7) %>% plot
```

`imeval` *Evaluation in an image context*

Description

imeval does for images what "with" does for data.frames, namely contextual evaluation. It provides various shortcuts for pixel-wise operations. imdo runs imeval, and reshapes the output as an image of the same dimensions as the input (useful for functions that return vectors). imeval takes inspiration from purrr::map in using formulas for defining anonymous functions using the "." argument. Usage is made clear (hopefully) in the examples. The old version of imeval used CImg's internal math parser, but has been retired.

Usage

```
imeval(obj, ..., env = parent.frame())

imdo(obj, form)
```

Arguments

`obj`	an image, pixset or imlist
`...`	one or more formula objects, defining anonymous functions that will be evaluated with the image as first argument (with extra contextual variables added to the evaluation context)
`env`	additional variables (defaults to the calling environment)
`form`	a single formula

Functions

- `imdo()`: run imeval and reshape

Author(s)

Simon Barthelme

See Also

imchange, which modifies specific parts of an image

Examples

```
## Computing mean absolute deviation
imeval(boats, ~ mean(abs(.-median(.))))
##Equivalent to:
mean(abs(boats-median(boats)))
##Two statistics
imeval(boats,mad=  ~ mean(abs(.-median(.))),sd=  ~ sd(.))
##imeval can precompute certain quantities, like the x or y coord. of each pixel
imeval(boats,~ x) %>% plot
##same as Xc(boats) %>% plot
## Other predefined quantities:
##w is width, h is height
imeval(boats,~ x/w) %>% range
##It defines certain transformed coordinate systems:
##Scaled x,y,z
## xs=x/w
## ys=y/h
##Select upper-left quadrant (returns a pixset)
imeval(boats,~ xs<.5 & ys < .5) %>% plot
##Fade effect
imeval(boats,~ xs*.) %>% plot
## xc and yc are another set of transformed coordinates
## where xc=0,yc=0 is the image center
imeval(boats,~ (abs(xc)/w)*.) %>% plot

##rho, theta: circular coordinates. rho is distance to center (in pix.), theta angle
##Gaussian mask with sd 10 pix.
blank <- imfill(30,30)
imeval(blank,~ dnorm(rho,sd=w/3)) %>% plot(int=FALSE)
imeval(blank,~ theta) %>% plot
##imeval is made for interactive use, meaning it
##accesses the environment it got called from, e.g. this works:
f <- function()
{
  im1 <- imfill(3,3,val=1)
   im2 <- imfill(3,3,val=3)

  imeval(im1,~ .+im2)
}
f()
##imeval accepts lists as well
map_il(1:3, ~ isoblur(boats,.)) %>%
   imeval(~ xs*.) %>%
   plot

##imeval is useful for defining pixsets:
##here, all central pixels that have value under the median
grayscale(boats) %>%
    imeval(~ (. > median(.)) & rho < 150) %>%
    plot
##other abbreviations are defined:
##s for imshift, b for isoblur, rot for imrotate.
```

```
##e.g.
imeval(boats, ~ .*s(.,3)) %>% plot

#The rank function outputs a vector
grayscale(boats) %>% rank %>% class
#Auto-reshape into an image
grayscale(boats)  %>% imdo(~ rank(.)) %>% plot
#Note that the above performs histogram normalisation

#Also works on lists
imsplit(boats,"c") %>% imdo( ~ rank(.)) %>% imappend("c") %>% plot
```

`imfill` *Create an image of custom size by filling in repeated values*

Description

This is a convenience function for quickly creating blank images, or images filled with a specific colour. See examples. If val is a logical value, creates a pixset instead.

Usage

```
imfill(x = 1, y = 1, z = 1, val = 0, dim = NULL)
```

Arguments

`x`	width (default 1)
`y`	height (default 1)
`z`	depth (default 1)
`val`	fill-in values. Either a single value (for grayscale), or RGB values for colour, or a character string for a colour (e.g. "blue")
`dim`	dimension vector (optional, alternative to specifying x,y,z)

Value

an image object (class cimg)

Author(s)

Simon Barthelme

Examples

```
imfill(20,20) %>% plot #Blank image of size 20x20
imfill(20,20,val=c(1,0,0)) %>% plot #All red image
imfill(20,20,val="red") %>% plot #Same, using R colour name
imfill(3,3,val=FALSE) #Pixset
imfill(dim=dim(boats)) #Blank image of the same size as the boats image
```

imgradient *Compute image gradient*

Description

Light interface for get_gradient. Refer to get_gradient for details on the computation.

Usage

```
imgradient(im, axes = "xy", scheme = 3)
```

Arguments

im	an image of class cimg
axes	direction along which to compute the gradient. Either a single character (e.g. "x"), or multiple characters (e.g. "xyz"). Default: "xy"
scheme	numerical scheme (default '3', rotation invariant)

Value

an image or a list of images, depending on the value of "axes"

Author(s)

Simon Barthelme

Examples

```
grayscale(boats) %>% imgradient("x") %>% plot
imgradient(boats,"xy") #Returns a list
```

imhessian *Compute image hessian.*

Description

Compute image hessian.

Usage

```
imhessian(im, axes = c("xx", "xy", "yy"))
```

Arguments

im	an image
axes	Axes considered for the hessian computation, as a character string (e.g "xy" corresponds to d/(dx*dy)). Can be a list of axes. Default: xx,xy,yy

Value

an image, or a list of images

Examples

```
imhessian(boats,"xy") %>% plot(main="Second-derivative, d/(dx*dy)")
```

`iminfo` *Return information on image file*

Description

This function calls ImageMagick's "identify" utility on an image file to get some information. You need ImageMagick on your path for this to work.

Usage

```
iminfo(fname)
```

Arguments

`fname`	path to a file

Value

a list with fields name, format, width (pix.), height (pix.), size (bytes)

Author(s)

Simon Barthelme

Examples

```
## Not run:
someFiles <- dir("*.png") #Find all PNGs in directory
iminfo(someFiles[1])
#Get info on all files, as a data frame
info <- purrr::map_df(someFiles,function(v) iminfo(v) %>% as.data.frame)

## End(Not run)
```

imlap *Compute image Laplacian*

Description

The Laplacian is the sum of second derivatives, approximated here using finite differences.

Usage

```
imlap(im)
```

Arguments

im	an image

Examples

```
imlap(boats) %>% plot
```

imlist *Image list*

Description

An imlist object is simply a list of images (of class cimg). For convenience, some generic functions are defined that wouldn't work on plain lists, like plot, display and as.data.frame DEPRECATION NOTE: in v0.30 of imager, the original behaviour of the "imlist" function was to take a list and turn it into an image list. This behaviour has now been changed to make "imlist" be more like "list". If you wish to turn a list into an image list, use as.imlist.

Usage

```
imlist(...)
```

Arguments

...	images to be included in the image list

See Also

plot.imlist, display.imlist, as.data.frame.imlist

Examples

```
imlist(a=imfill(3,3),b=imfill(10,10))
imsplit(boats,"x",6)
imsplit(boats,"x",6) %>% plot
```

`imnoise` *Generate (Gaussian) white-noise image*

Description

A white-noise image is an image where all pixel values are drawn IID from a certain distribution. Here they are drawn from a Gaussian.

Usage

```
imnoise(x = 1, y = 1, z = 1, cc = 1, mean = 0, sd = 1, dim = NULL)
```

Arguments

`x`	width
`y`	height
`z`	depth
`cc`	spectrum
`mean`	mean pixel value (default 0)
`sd`	std. deviation of pixel values (default 1)
`dim`	dimension vector (optional, alternative to specifying x,y,z,cc)

Value

a cimg object

Author(s)

Simon Barthelme

Examples

```
imnoise(100,100,cc=3) %>% plot(main="White noise in RGB")
imnoise(100,100,cc=3) %>% isoblur(5) %>% plot(main="Filtered (non-white) noise")
imnoise(dim=dim(boats)) #Noise image of the same size as the boats image
```

implot *Plot objects on image using base graphics*

Description

This function lets you use an image as a canvas for base graphics, meaning you can use R functions like "text" and "points" to plot things on an image. The function takes as argument an image and an expression, executes the expression with the image as canvas, and outputs the result as an image (of the same size).

Usage

```
implot(im, expr, ...)
```

Arguments

im	an image (class cimg)
expr	an expression (graphics code to execute)
...	passed on to plot.cimg, to control the initial rendering of the image (for example the colorscale)

Value

an image

Author(s)

Simon Barthelme

See Also

plot, capture.plot

Examples

```
## Not run:
b.new <- implot(boats,text(150,50,"Boats!!!",cex=3))
plot(b.new)
#Draw a line on a white background
bg <- imfill(150,150,val=1)
implot(bg,lines(c(50,50),c(50,100),col="red",lwd=4))%>%plot
#You can change the rendering of the initial image
im <- grayscale(boats)
draw.fun <- function() text(150,50,"Boats!!!",cex=3)
out <- implot(im,draw.fun(),colorscale=function(v) rgb(0,v,v),rescale=FALSE)
plot(out)

## End(Not run)
```

imrep *Replicate images*

Description

Kinda like rep, for images. Copy image n times and (optionally), append.

Usage

```
imrep(x, n = 1, axis = NULL)
```

Arguments

x	an image
n	number of replications
axis	axis to append along (one of NULL, "x","y","z","c"). Default: NULL

Value

either an image or an image list

Author(s)

Simon Barthelme

Examples

```
#Result is a list
imrep(boats,3) %>% plot
#Result is an image
imrep(boats,3,"x") %>% plot
#Make an animation by repeating each frame 10x
#map_il(1:5,~ isoblur(boats,.) %>% imrep(10,"z")) %>%
#                       imappend("z") %>% play
```

imrotate *Rotate an image along the XY plane.*

Description

If cx and cy aren't given, the default is to centre the rotation in the middle of the image. When cx and cy are given, the algorithm used is different, and does not change the size of the image.

Usage

```
imrotate(im, angle, cx, cy, interpolation = 1L, boundary = 0L)
```

Arguments

im	an image
angle	Rotation angle, in degrees.
cx	Center of rotation along x (default, image centre)
cy	Center of rotation along y (default, image centre)
interpolation	Type of interpolation. One of 0=nearest,1=linear,2=cubic.
boundary	Boundary conditions. One of 0=dirichlet, 1=neumann, 2=periodic

See Also

imwarp, for flexible image warping, which includes rotations as a special case

Examples

```
imrotate(boats,30) %>% plot
#Shift centre to (20,20)
imrotate(boats,30,cx=20,cy=20) %>% plot
```

---

imsharpen *Sharpen image.*

Description

The default sharpening filter is inverse diffusion. The "shock filter" is a non-linear diffusion that has better edge-preserving properties.

Usage

```
imsharpen(im, amplitude, type = "diffusion", edge = 1, alpha = 0, sigma = 0)
```

Arguments

im	an image
amplitude	Sharpening amplitude (positive scalar, 0: no filtering).
type	Filtering type. "diffusion" (default) or "shock"
edge	Edge threshold (shock filters only, positive scalar, default 1).
alpha	Window size for initial blur (shock filters only, positive scalar, default 0).
sigma	Window size for diffusion tensor blur (shock filters only, positive scalar, default 0).

Examples

```
layout(t(1:2))
plot(boats,main="Original")
imsharpen(boats,150)  %>% plot(main="Sharpened")
```

imshift *Shift image content.*

Description

Shift image content.

Usage

```
imshift(
  im,
  delta_x = 0L,
  delta_y = 0L,
  delta_z = 0L,
  delta_c = 0L,
  boundary_conditions = 0L
)
```

Arguments

im	an image
delta_x	Amount of displacement along the X-axis.
delta_y	Amount of displacement along the Y-axis.
delta_z	Amount of displacement along the Z-axis.
delta_c	Amount of displacement along the C-axis.
boundary_conditions	can be: - 0: Zero border condition (Dirichlet). - 1: Nearest neighbors (Neumann). - 2: Repeat Pattern (Fourier style).

Examples

```
imshift(boats,10,50) %>% plot
```

imsplit *Split an image along a certain axis (producing a list)*

Description

Use this if you need to process colour channels separately, or frames separately, or rows separately, etc. You can also use it to chop up an image into blocks. Returns an "imlist" object, which is essentially a souped-up list.

Usage

```
imsplit(im, axis, nb = -1)
```

Arguments

im	an image
axis	the axis along which to split (for example 'c')
nb	number of objects to split into. if nb=-1 (the default) the maximum number of splits is used, i.e. split(im,"c") produces a list containing all individual colour channels.

See Also

imappend (the reverse operation)

Examples

```
im <- as.cimg(function(x,y,z) x+y+z,10,10,5)
imsplit(im,"z") #Split along the z axis into a list with 5 elements
imsplit(im,"z",2) #Split along the z axis into two groups
imsplit(boats,"x",-200) %>% plot #Blocks of 200 pix. along x
imsplit(im,"z",2) %>% imappend("z") #Split and reshape into a single image
#You can also split pixsets
imsplit(boats > .5,"c") %>% plot
```

---

imsub *Select part of an image*

Description

imsub selects an image part based on coordinates: it allows you to select a subset of rows, columns, frames etc. Refer to the examples to see how it works

Usage

```
imsub(im, ...)

subim(im, ...)
```

Arguments

im	an image
...	various conditions defining a rectangular image region

Details

subim is an alias defined for backward-compatibility.

Value

an image with some parts cut out

Functions

- `subim()`: alias for imsub

Author(s)

Simon Barthelme

Examples

```
parrots <- load.example("parrots")
imsub(parrots,x < 30) #Only the first 30 columns
imsub(parrots,y < 30) #Only the first 30 rows
imsub(parrots,x < 30,y < 30) #First 30 columns and rows
imsub(parrots, sqrt(x) > 8) #Can use arbitrary expressions
imsub(parrots,x > height/2,y > width/2)  #height and width are defined based on the image
#Using the %inr% operator, which is like %in% but for a numerical range
all.equal(imsub(parrots,x %inr% c(1,10)),
  imsub(parrots,x >= 1,x <= 10))
imsub(parrots,cc==1) #Colour axis is "cc" not "c" here because "c" is an important R function
##Not run
##imsub(parrots,x+y==1)
##can't have expressions involving interactions between variables (domain might not be square)
```

`imwarp` *Image warping*

Description

Image warping consists in remapping pixels, ie. you define a function M(x,y,z) -> (x',y',z') that displaces pixel content from (x,y,z) to (x',y',z'). Actual implementations rely on either the forward transformation M, or the backward (inverse) transformation M^-1. In CImg the forward implementation will go through all source (x,y,z) pixels and "paint" the corresponding pixel at (x',y',z'). This will result in unpainted pixels in the output if M is expansive (for example in the case of a scaling M(x,y,z) = 5*(x,y,z)). The backward implementation will go through every pixel in the destination image and look for ancestors in the source, meaning that every pixel will be painted. There are two ways of specifying the map: absolute or relative coordinates. In absolute coordinates you specify M or M^-1 directly. In relative coordinates you specify an offset function D: M(x,y) = (x,y) + D(x,y) (forward) M^-1(x,y) = (x,y) - D(x,y) (backward)

Usage

```
imwarp(
  im,
  map,
  direction = "forward",
  coordinates = "absolute",
  boundary = "dirichlet",
  interpolation = "linear"
)
```

Arguments

im	an image
map	a function that takes (x,y) or (x,y,z) as arguments and returns a named list with members (x,y) or (x,y,z)
direction	"forward" or "backward" (default "forward")
coordinates	"absolute" or "relative" (default "relative")
boundary	boundary conditions: "dirichlet", "neumann", "periodic". Default "dirichlet"
interpolation	"nearest", "linear", "cubic" (default "linear")

Details

Note that 3D warps are possible as well. The mapping should be specified via the "map" argument, see examples.

Value

a warped image

Author(s)

Simon Barthelme

See Also

warp for direct access to the CImg function

Examples

```
im <- load.example("parrots")
#Shift image
map.shift <- function(x,y) list(x=x+10,y=y+30)
imwarp(im,map=map.shift) %>% plot
#Shift image (backward transform)
imwarp(im,map=map.shift,dir="backward") %>% plot

#Shift using relative coordinates
map.rel <- function(x,y) list(x=10+0*x,y=30+0*y)
imwarp(im,map=map.rel,coordinates="relative") %>% plot

#Scaling
map.scaling <- function(x,y) list(x=1.5*x,y=1.5*y)
imwarp(im,map=map.scaling) %>% plot #Note the holes
map.scaling.inv <- function(x,y) list(x=x/1.5,y=y/1.5)
imwarp(im,map=map.scaling.inv,dir="backward") %>% plot #No holes

#Bending
map.bend.rel <- function(x,y) list(x=50*sin(y/10),y=0*y)
imwarp(im,map=map.bend.rel,coord="relative",dir="backward") %>% plot #No holes
```

im_split *Split an image along a certain axis (producing a list)*

Description

Split an image along a certain axis (producing a list)

Usage

```
im_split(im, axis, nb = -1L)
```

Arguments

im	an image
axis	the axis along which to split (for example 'c')
nb	number of objects to split into. if nb=-1 (the default) the maximum number of splits is used ie. split(im,"c") produces a list containing all individual colour channels

See Also

imappend (the reverse operation)

index.coord *Linear index in internal vector from pixel coordinates*

Description

Pixels are stored linearly in (x,y,z,c) order. This function computes the vector index of a pixel given its coordinates

Usage

```
index.coord(im, coords, outside = "stop")
```

Arguments

im	an image
coords	a data.frame with values x,y,z (optional), c (optional)
outside	what to do if some coordinates are outside the image: "stop" issues error, "NA" replaces invalid coordinates with NAs. Default: "stop".

Value

a vector of indices (NA if the indices are invalid)

Author(s)

Simon Barthelme

See Also

coord.index, the reverse operation

Examples

```
im <- as.cimg(function(x,y) x+y,100,100)
px <- index.coord(im,data.frame(x=c(3,3),y=c(1,2)))
im[px] #Values should be 3+1=4, 3+2=5
```

---

inpaint *Fill-in NA values in an image*

Description

Fill in NA values (inpainting) using a Gaussian filter, i.e. replace missing pixel values with a weighted average of the neighbours.

Usage

```
inpaint(im, sigma)
```

Arguments

im	input image
sigma	std. deviation of the Gaussian (size of neighbourhood)

Value

an image with missing values filled-in.

Author(s)

Simon Barthelme

Examples

```
im <- boats
im[sample(nPix(im),1e4)] <- NA
inpaint(im,1) %>% imlist(im,.) %>%
   setNames(c("before","after")) %>% plot(layout="row")
```

`interact` *Build simple interactive interfaces using imager*

Description

To explore the effect of certain image manipulations, filter settings, etc., it's useful to have a basic interaction mechanism. You can use shiny for that, but imager provides a lightweight alternative. The user writes a function that gets called every time a user event happens (a click, a keypress, etc.). The role of the function is to process the event and output an image, which will then be displayed. You can exit the interface at any time by pressing Esc. See examples for more. This feature is experimental!!! Note that you need X11 library to use this function.

Usage

```
interact(fun, title = "", init)
```

Arguments

`fun`	a function that takes a single argument (a list of user events) and returns an image to be plotted. The image won't be rescaled before plotting, so make sure RGB values are in [0,1].
`title`	a title for the window (default "", none)
`init`	initial image to display (optional)

Value

an image, specifically the last image displayed

Author(s)

Simon Barthelme

Examples

```
#Implement a basic image gallery:
#press "right" and "left" to view each image in a list
gallery <- function(iml)
{
    ind <- 1
    f <- function(state)
   {
        if (state$key=="arrowleft")
        {
            ind <<- max(ind-1,1)
        }
        if (state$key=="arrowright")
        {
            ind <<- min(ind+1,length(iml))
```

```
        }
        iml[[ind]]
    }
    interact(f)
}
##Not run (interactive only)
##map_il(1:10,~ isoblur(boats,.)) %>% gallery
```

`interp` *Interpolate image values*

Description

This function provides 2D and 3D (linear or cubic) interpolation for pixel values. Locations need to be provided as a data.frame with variables x,y,z, and c (the last two are optional).

Usage

```
interp(im, locations, cubic = FALSE, extrapolate = TRUE)
```

Arguments

`im`	the image (class cimg)
`locations`	a data.frame
`cubic`	if TRUE, use cubic interpolation. If FALSE, use linear (default FALSE)
`extrapolate`	allow extrapolation (to values outside the image)

Examples

```
loc <- data.frame(x=runif(10,1,width(boats)),y=runif(10,1,height(boats))) #Ten random locations
interp(boats,loc)
```

`is.cimg` *Checks that an object is a cimg object*

Description

Checks that an object is a cimg object

Usage

```
is.cimg(x)
```

Arguments

`x`	an object

Value

logical

`is.imlist` *Check that an object is an imlist object*

Description

Check that an object is an imlist object

Usage

```
is.imlist(x)
```

Arguments

`x`	an object

Value

logical

`is.pixset` *Check that an object is a pixset object*

Description

Check that an object is a pixset object

Usage

```
is.pixset(x)
```

Arguments

`x`	an object

Value

logical

isoblur *Blur image isotropically.*

Description

Blur image isotropically.

Usage

```
isoblur(im, sigma, neumann = TRUE, gaussian = TRUE, na.rm = FALSE)
```

Arguments

im	an image
sigma	Standard deviation of the blur (positive)
neumann	If true, use Neumann boundary conditions, Dirichlet otherwise (default true, Neumann)
gaussian	Use a Gaussian filter (actually van Vliet-Young). Default: 0th-order Deriche filter.
na.rm	if TRUE, ignore NA values. Default FALSE, in which case the whole image is NA if one of the values is NA (following the definition of the Gaussian filter)

See Also

deriche,vanvliet,inpaint,medianblur

Examples

```
isoblur(boats,3) %>% plot(main="Isotropic blur, sigma=3")
isoblur(boats,10) %>% plot(main="Isotropic blur, sigma=10")
```

label *Label connected components.*

Description

The algorithm of connected components computation has been primarily done by A. Meijster, according to the publication: 'W.H. Hesselink, A. Meijster, C. Bron, "Concurrent Determination of Connected Components.", In: Science of Computer Programming 41 (2001), pp. 173–194'.

Usage

```
label(im, high_connectivity = FALSE, tolerance = 0)
```

Arguments

im	an image
high_connectivity	4(false)- or 8(true)-connectivity in 2d case, and between 6(false)- or 26(true)-connectivity in 3d case. Default FALSE
tolerance	Tolerance used to determine if two neighboring pixels belong to the same region.

Examples

```
imname <- system.file('extdata/parrots.png',package='imager')
im <- load.image(imname) %>% grayscale
#Thresholding yields different discrete regions of high intensity
regions <- isoblur(im,10) %>% threshold("97%")
labels <- label(regions)
layout(t(1:2))
plot(regions,"Regions")
plot(labels,"Labels")
```

---

liply *Apply function to each element of a list, then combine the result as an image by appending along specified axis*

Description

This is just a shortcut for purrr::map followed by imappend

Usage

```
liply(lst, fun, axis, ...)
```

Arguments

lst	a list
fun	function to apply
axis	which axis to append along (e.g. "c" for colour)
...	further arguments to be passed to fun

Examples

```
build.im <- function(size) as.cimg(function(x,y) (x+y)/size,size,size)
liply(c(10,50,100),build.im,"y") %>% plot
```

load.dir *Load all images in a directory*

Description

Load all images in a directory and return them as an image list.

Usage

```
load.dir(path, pattern = NULL, quiet = FALSE)
```

Arguments

path	directory to load from
pattern	optional: file pattern (ex. *jpg). Default NULL, in which case we look for file extensions png,jpeg,jpg,tif,bmp.
quiet	if TRUE, loading errors are quiet. If FALSE, they are displayed. Default FALSE

Value

an image list

Author(s)

Simon Barthelme

Examples

```
path <- system.file(package="imager") %>% paste0("/extdata")
load.dir(path)
```

load.example *Load example image*

Description

Imager ships with five test pictures and a video. Two (parrots and boats) come from the [Kodak set](http://r0k.us/graphics/kodak/). Another (birds) is a sketch of birds by Leonardo, from Wikimedia. The "coins" image comes from scikit-image. The Hubble Deep field (hubble) is from Wikimedia. The test video ("tennis") comes from [xiph.org](https://media.xiph.org/video/derf/)'s collection.

Usage

```
load.example(name)
```

Arguments

name	name of the example

Value

an image

Author(s)

Simon Barthelme

Examples

```
load.example("hubble") %>% plot
load.example("birds") %>% plot
load.example("parrots") %>% plot
```

---

load.image *Load image from file or URL*

Description

PNG, JPEG and BMP are supported via the readbitmap package. You'll need to install ImageMagick for other formats. If the path is actually a URL, it should start with http(s) or ftp(s).

Usage

```
load.image(file)
```

Arguments

file	path to file or URL

Value

an object of class 'cimg'

Examples

```
#Find path to example file from package
fpath <- system.file('extdata/Leonardo_Birds.jpg',package='imager')
im <- load.image(fpath)
plot(im)
#Load the R logo directly from the CRAN webpage
#load.image("https://cran.r-project.org/Rlogo.jpg") %>% plot
```

load.video *Load a video using ffmpeg*

Description

You need to have ffmpeg on your path for this to work. This function uses ffmpeg to split the video into individual frames, which are then loaded as images and recombined. Videos are memory-intensive, and load.video performs a safety check before loading a video that would be larger than maxSize in memory (default 1GB)

Usage

```
load.video(
  fname,
  maxSize = 1,
  skip.to = 0,
  frames = NULL,
  fps = NULL,
  extra.args = "",
  verbose = FALSE
)
```

Arguments

fname	file to load
maxSize	max. allowed size in memory, in GB (default max 1GB).
skip.to	skip to a certain point in time (in sec., or "hh:mm::ss" format)
frames	number of frames to load (default NULL, all)
fps	frames per second (default NULL, determined automatically)
extra.args	extra arguments to be passed to ffmpeg (default "", none)
verbose	if TRUE, show ffmpeg output (default FALSE)

Value

an image with the extracted frames along the "z" coordinates

Author(s)

Simon Barthelme

See Also

save.video, make.video

Examples

```
fname <- system.file('extdata/tennis_sif.mpeg',package='imager')
##Not run
## load.video(fname) %>% play
## load.video(fname,fps=10) %>% play
## load.video(fname,skip=2) %>% play
```

`magick` *Convert a magick image to a cimg image or image list and vice versa*

Description

The magick library package stores its data as "magick-image" object, which may in fact contain several images or an animation. These functions convert magick objects into imager objects or imager objects into magick objects. Note that cimg2magick function requires magick package.

Usage

```
magick2imlist(obj, alpha = "rm", ...)

magick2cimg(obj, alpha = "rm", ...)

cimg2magick(im, rotate = TRUE)
```

Arguments

`obj`	an object of class "magick-image"
`alpha`	what do to with the alpha channel ("rm": remove and store as attribute, "flatten": flatten, "keep": keep). Default: "rm"
`...`	ignored
`im`	an image of class cimg
`rotate`	determine if rotate image to adjust orientation of image

Value

an object of class cimg or imlist

an object of class "magick-image"

Author(s)

Jan Wijffels, Simon Barthelme

Shota Ochi

See Also

flatten.alpha, rm.alpha

`make.video` *Make/save a video using ffmpeg*

Description

You need to have ffmpeg on your path for this to work. This function uses ffmpeg to combine individual frames into a video. save.video can be called directly with an image or image list as input. make.video takes as argument a directory that contains a sequence of images representing individual frames to be combined into a video.

Usage

```
make.video(
  dname,
  fname,
  pattern = "image-%d.png",
  fps = 25,
  extra.args = "",
  verbose = FALSE
)

save.video(im, fname, ...)
```

Arguments

`dname`	name of a directory containing individual files
`fname`	name of the output file. The format is determined automatically from the name (example "a.mpeg" will have MPEG format)
`pattern`	pattern of filename for frames (the default matches "image-1.png", "image-2.png", etc.. See ffmpeg documentation for more).
`fps`	frames per second (default 25)
`extra.args`	extra arguments to be passed to ffmpeg (default "", none)
`verbose`	if TRUE, show ffmpeg output (default FALSE)
`im`	an image or image list
`...`	extra arguments to save.video, passed on to make.video

Functions

- `save.video()`: Save a video using ffmpeg

Author(s)

Simon Barthelme

See Also

load.video

Examples

```
## Not run
## iml <- map_il(seq(0,20,l=60),~ isoblur(boats,.))
## f <- tempfile(fileext=".avi")
## save.video(iml,f)
## load.video(f) %>% play
## #Making a video from a directory
## dd <- tempdir()
## for (i in 1:length(iml)) {
## png(sprintf("%s/image-%i.png",dd,i));
## plot(iml[[i]]); dev.off() }
## make.video(dd,f)
## load.video(f) %>% play
```

---

map_il *Type-stable map for use with the purrr package*

Description

Works like purrr::map, purrr::map_dbl and the like but ensures that the output is an image list.

Usage

```
map_il(...)

map2_il(...)

pmap_il(...)
```

Arguments

...	passed to map

Value

an image list

Functions

- `map2_il()`: Parallel map (two values)
- `pmap_il()`: Parallel map (multiple values)

Author(s)

Simon Barthelme

Examples

```
#Returns a list
imsplit(boats,"x",2) %>% purrr::map(~ isoblur(.,3))
#Returns an "imlist" object
imsplit(boats,"x",2) %>% map_il(~ isoblur(.,3))
#Fails if function returns an object that's not an image
try(imsplit(boats,"x",2) %>% map_il(~ . > 2))
#Parallel maps
map2_il(1:3,101:103,~ imshift(boats,.x,.y))
pmap_il(list(x=1:3,y=4:6,z=7:9),function(x,y,z) imfill(x,y,z))
```

`medianblur` *Blur image with the median filter. In a window of size n x n centered at pixel (x,y), compute median pixel value over the window. Optionally, ignore values that are too far from the value at current pixel.*

Description

Blur image with the median filter.

In a window of size n x n centered at pixel (x,y), compute median pixel value over the window. Optionally, ignore values that are too far from the value at current pixel.

Usage

```
medianblur(im, n, threshold = 0)
```

Arguments

`im`	an image
`n`	Size of the median filter.
`threshold`	Threshold used to discard pixels too far from the current pixel value in the median computation. Can be used for edge-preserving smoothing. Default 0 (include all pixels in window).

See Also

isoblur, boxblur

Examples

```
medianblur(boats,5) %>% plot(main="Median blur, 5 pixels")
medianblur(boats,10) %>% plot(main="Median blur, 10 pixels")
medianblur(boats,10,8) %>% plot(main="Median blur, 10 pixels, threshold = 8")
```

mirror *Mirror image content along specified axis*

Description

Mirror image content along specified axis

Usage

```
mirror(im, axis)
```

Arguments

im	an image
axis	Mirror axis ("x","y","z","c")

Examples

```
mirror(boats,"x") %>% plot
mirror(boats,"y") %>% plot
```

mutate_plyr *Mutate a data frame by adding new or replacing existing columns.*

Description

This function copied directly from plyr, and modified to use a different name to avoid namespace collisions with dplyr/tidyverse functions.

Usage

```
mutate_plyr(.data, ...)
```

Arguments

.data	the data frame to transform
...	named parameters giving definitions of new columns.

Details

This function is very similar to transform but it executes the transformations iteratively so that later transformations can use the columns created by earlier transformations. Like transform, unnamed components are silently dropped.

Mutate seems to be considerably faster than transform for large data frames.

nfline *Plot a line, Hesse normal form parameterisation*

Description

This is a simple interface over abline meant to be used along with the Hough transform. In the Hesse normal form (theta,rho), a line is represented as the set of values (x,y) such that cos(theta)*x + sin(theta)*y = rho. Here theta is an angle and rho is a distance. See the documentation for hough_lines.

Usage

```
nfline(theta, rho, col, ...)
```

Arguments

theta	angle (radians)
rho	distance
col	colour
...	other graphical parameters, passed along to abline

Value

nothing

Author(s)

Simon Barthelme

Examples

```
#Boring example, see ?hough_lines
plot(boats)
nfline(theta=0,rho=10,col="red")
```

pad *Pad image with n pixels along specified axis*

Description

Pad image with n pixels along specified axis

Usage

```
pad(im, nPix, axes, pos = 0, val)
```

Arguments

im	the input image
nPix	how many pixels to pad with
axes	which axes to pad along
pos	-1: prepend 0: center 1: append
val	colour of the padded pixels (default 0 in all channels). Can be a string for colour images, e.g. "red", or "black".

Value

a padded image

Author(s)

Simon Barthelme

Examples

```
pad(boats,20,"xy") %>% plot
pad(boats,20,pos=-1,"xy") %>% plot
pad(boats,20,pos=1,"xy") %>% plot
pad(boats,20,pos=1,"xy",val="red") %>% plot
```

---

patchstat *Return image patch summary*

Description

Patches are rectangular image regions centered at cx,cy with width wx and height wy. This function provides a fast way of extracting a statistic over image patches (for example, their mean). Supported functions: sum,mean,min,max,median,var,sd, or any valid CImg expression. WARNINGS: - values outside of the image region are considered to be 0. - widths and heights should be odd integers (they're rounded up otherwise).

Usage

```
patchstat(im, expr, cx, cy, wx, wy)
```

Arguments

im	an image
expr	statistic to extract. a string, either one of the usual statistics like "mean","median", or a CImg expression.
cx	vector of x coordinates for patch centers
cy	vector of y coordinates for patch centers
wx	vector of patch widths (or single value)
wy	vector of patch heights (or single value)

Value

a numeric vector

See Also

extract_patches

Examples

```
im <- grayscale(boats)
#Mean of an image patch centered at (10,10) of size 3x3
patchstat(im,'mean',10,10,3,3)
#Mean of image patches centered at (10,10) and (20,4) of size 2x2
patchstat(im,'mean',c(10,20),c(10,4),5,5)
#Sample 10 random positions
ptch <- pixel.grid(im) %>% dplyr::sample_n(10)
#Compute median patch value
with(ptch,patchstat(im,'median',x,y,3,3))
```

---

patch_summary_cimg *Extract a numerical summary from image patches, using CImg's mini-language Experimental feature.*

Description

Extract a numerical summary from image patches, using CImg's mini-language Experimental feature.

Usage

```
patch_summary_cimg(im, expr, cx, cy, wx, wy)
```

Arguments

im	an image
expr	a CImg expression (as a string)
cx	vector of x coordinates for patch centers
cy	vector of y coordinates for patch centers
wx	vector of coordinates for patch width
wy	vector of coordinates for patch height

Examples

```
#Example: median filtering using patch_summary_cimg
#Center a patch at each pixel
im <- grayscale(boats)
patches <- pixel.grid(im)  %>% dplyr::mutate(w=3,h=3)
#Extract patch summary
out <- dplyr::mutate(patches,med=patch_summary_cimg(im,"ic",x,y,w,h))
as.cimg(out,v.name="med") %>% plot
```

`periodic.part` *Compute the periodic part of an image, using the periodic/smooth decomposition of Moisan (2011)*

Description

Moisan (2011) defines an additive image decomposition im = periodic + smooth where the periodic part shouldn't be too far from the original image. The periodic part can be used in frequency-domain analyses, to reduce the artifacts induced by non-periodicity.

Usage

```
periodic.part(im)
```

Arguments

`im`	an image

Value

an image

Author(s)

Simon Barthelme

References

L. Moisan, Periodic plus Smooth Image Decomposition,J. Math. Imaging Vision, vol. 39:2, pp. 161-179, 2011

Examples

```
im <- load.example("parrots") %>% subim(x <= 512)
layout(t(1:3))
plot(im,main="Original image")
periodic.part(im) %>% plot(main="Periodic part")
#The smooth error is the difference between
#the original image and its periodic part
(im-periodic.part(im)) %>% plot(main="Smooth part")
```

permute_axes *Permute image axes*

Description

By default images are stored in xyzc order. Use permute_axes to change that order.

Usage

```
permute_axes(im, perm)
```

Arguments

im	an image
perm	a character string, e.g., "zxyc" to have the z-axis come first

Examples

```
im <- array(0,c(10,30,40,3)) %>% as.cimg
permute_axes(im,"zxyc")
```

pixel.grid *Return the pixel grid for an image*

Description

The pixel grid for image im gives the (x,y,z,c) coordinates of each successive pixel as a data.frame. The c coordinate has been renamed 'cc' to avoid conflicts with R's c function. NB: coordinates start at (x=1,y=1), corresponding to the top left corner of the image, unless standardise == TRUE, in which case we use the usual Cartesian coordinates with origin at the center of the image and scaled such that x varies between -.5 and .5, and a y arrow pointing up

Usage

```
pixel.grid(im, standardise = FALSE, drop.unused = TRUE, dim = NULL)
```

Arguments

im	an image
standardise	If TRUE use a centered, scaled coordinate system. If FALSE use standard image coordinates (default FALSE)
drop.unused	if TRUE ignore empty dimensions, if FALSE include them anyway (default TRUE)
dim	a vector of image dimensions (optional, may be used instead of "im")

Value

a data.frame

Examples

```
im <- as.cimg(array(0,c(10,10))) #A 10x10 image
pixel.grid(im) %>% head
pixel.grid(dim=dim(im)) %>% head #Same as above
pixel.grid(dim=c(10,10,3,2)) %>% head
pixel.grid(im,standardise=TRUE) %>% head
pixel.grid(im,drop.unused=FALSE) %>% head
```

---

pixset *Pixel sets (pixsets)*

Description

Pixel sets represent sets of pixels in images (ROIs, foreground, etc.). From an implementation point of view, they're just a thin layer over arrays of logical values, just like the cimg class is a layer over arrays of numeric values. Pixsets can be turned back into logical arrays, but they come with a number of generic functions that should make your life easier. They are created automatically whenever you run a test on an image (for example im > 0 returns a pixset).

Usage

```
pixset(x)
```

Arguments

x	an array of logical values

Examples

```
#A test on an image returns a pixset
boats > 250
#Pixsets can be combined using the usual Boolean operators
(boats > 230) & (Xc(boats) < width(boats)/2)
#Subset an image using a pixset
boats[boats > 250]
#Turn a pixset into an image
as.cimg(boats > 250)
#Equivalently:
(boats > 250) + 0
```

play *Play a video*

Description

A very basic video player. Press the space bar to pause and ESC to close. Note that you need X11 library to use this function.

Usage

```
play(vid, loop = FALSE, delay = 30L, normalise = TRUE)
```

Arguments

vid	A cimg object, to be played as video
loop	loop the video (default false)
delay	delay between frames, in ms. Default 30.
normalise	if true pixel values are rescaled to 0...255 (default TRUE). The normalisation is based on the *first frame*. If you don't want the default behaviour you can normalise by hand. Default TRUE.

plot.cimg *Display an image using base graphics*

Description

If you want to control precisely how numerical values are turned into colours for plotting, you need to specify a colour scale using the colourscale argument (see examples). Otherwise the default is "gray" for grayscale images, "rgb" for colour. These expect values in [0..1], so the default is to rescale the data to [0..1]. If you wish to over-ride that behaviour, set rescale=FALSE. See examples for an explanation. If the image is one dimensional (i.e., a simple row or column image), then pixel values will be plotted as a line.

Usage

```
## S3 method for class 'cimg'
plot(
  x,
  frame,
  xlim = c(1, width(x)),
  ylim = c(height(x), 1),
  xlab = "x",
  ylab = "y",
  rescale = TRUE,
```

```
  colourscale = NULL,
  colorscale = NULL,
  interpolate = TRUE,
  axes = TRUE,
  main = "",
  xaxs = "i",
  yaxs = "i",
  asp = 1,
  col.na = rgb(0, 0, 0, 0),
  ...
)
```

Arguments

x	the image
frame	which frame to display, if the image has depth > 1
xlim	x plot limits (default: 1 to width)
ylim	y plot limits (default: 1 to height)
xlab	x axis label
ylab	y axis label
rescale	rescale pixel values so that their range is [0,1]
colourscale, colorscale	an optional colour scale (default is gray or rgb)
interpolate	should the image be plotted with antialiasing (default TRUE)
axes	Whether to draw axes (default TRUE)
main	Main title
xaxs	The style of axis interval calculation to be used for the x-axis. See ?par
yaxs	The style of axis interval calculation to be used for the y-axis. See ?par
asp	aspect ratio. The default value (1) means that the aspect ratio of the image will be kept regardless of the dimensions of the plot. A numeric value other than one changes the aspect ratio, but it will be kept the same regardless of dimensions. Setting asp="varying" means the aspect ratio will depend on plot dimensions (this used to be the default in versions of imager < 0.40)
col.na	which colour to use for NA values, as R rgb code. The default is "rgb(0,0,0,0)", which corresponds to a fully transparent colour.
...	other parameters to be passed to plot.default (eg "main")

See Also

display, which is much faster, as.raster, which converts images to R raster objects

Examples

```
plot(boats,main="Boats")
plot(boats,axes=FALSE,xlab="",ylab="")

#Pixel values are rescaled to 0-1 by default, so that the following two plots are identical
plot(boats)
plot(boats/2,main="Rescaled")
#If you don't want that behaviour, you can set rescale to FALSE, but
#then you need to make sure values are in [0,1]
try(plot(boats,rescale=FALSE)) #Error!
try(plot(boats/255,rescale=FALSE)) #Works
#You can specify a colour scale if you don't want the default one.
#A colour scale is a function that takes pixels values and return an RGB code,
#like R's rgb function,e.g.
rgb(0,1,0)
#Let's switch colour channels
cscale <- function(r,g,b) rgb(b,g,r)
plot(boats/255,rescale=FALSE,colourscale=cscale)
#Display slice of HSV colour space
im <- imfill(255,255,val=1)
im <- list(Xc(im)/255,Yc(im)/255,im) %>% imappend("c")
plot(im,colourscale=hsv,rescale=FALSE,
     xlab="Hue",ylab="Saturation")
#In grayscale images, the colourscale function should take in a single value
#and return an RGB code
boats.gs <- grayscale(boats)
#We use an interpolation function from package scales
cscale <- scales::gradient_n_pal(c("red","purple","lightblue"),c(0,.5,1))
plot(boats.gs,rescale=FALSE,colourscale=cscale)
#Plot a one-dimensional image
imsub(boats,x==1) %>% plot(main="Image values along first column")
#Plotting with and without anti-aliasing:
boats.small <- imresize(boats,.3)
plot(boats.small,interp=TRUE)
plot(boats.small,interp=FALSE)
```

`plot.imlist` *Plot an image list*

Description

Each image in the list will be plotted separately. The layout argument controls the overall layout of the plot window. The default layout is "rect", which will fit all of your images into a rectangle that's as close to a square as possible.

Usage

```
## S3 method for class 'imlist'
plot(x, layout = "rect", ...)
```

Arguments

x	an image list (of type imlist)
layout	either a matrix (in the format defined by the layout command) or one of "row","col" or "rect". Default: "rect"
...	other parameters, to be passed to the plot command

Author(s)

Simon Barthelme

Examples

```
imsplit(boats,"c") #Returns an image list
imsplit(boats,"c") %>% plot
imsplit(boats,"c") %>% plot(layout="row")
imsplit(boats,"c") %>% plot(layout="col")
imsplit(boats,"x",5) %>% plot(layout="rect")
```

---

px.flood *Select a region of homogeneous colour*

Description

Select pixels that are similar to a seed pixel. The underlying algorithm is the same as the bucket fill (AKA flood fill). Unlike with the bucket fill, the image isn't changed, the function simply returns a pixel set containing the selected pixels.

Usage

```
px.flood(im, x, y, z = 1, sigma = 0, high_connexity = FALSE)
```

Arguments

im	an image
x	X-coordinate of the starting point of the region to flood
y	Y-coordinate of the starting point of the region to flood
z	Z-coordinate of the starting point of the region to flood
sigma	Tolerance concerning neighborhood values.
high_connexity	Use 8-connexity (only for 2d images, default FALSE).

Details

Old name: selectSimilar (deprecated)

See Also

bucketfill

Examples

```
#Select part of a sail
px <- px.flood(boats,x=169,y=179,sigma=.2)
plot(boats)
highlight(px)
```

---

px.na *A pixset for NA values*

Description

A pixset containing all NA pixels

Usage

```
px.na(im)
```

Arguments

im	an image

Value

a pixset

Examples

```
im <- boats
im[1] <- NA
px.na(im)
```

px.remove_outer *Remove all connected regions that touch image boundaries*

Description

All pixels that belong to a connected region in contact with image boundaries are set to FALSE.

Usage

```
px.remove_outer(px)
```

Arguments

px	a pixset

Value

a pixset

Author(s)

Simon Barthelme

Examples

```
im <- draw_circle(imfill(100,100),c(0,50,100),c(50,50,50),radius=10,color=1)
plot(im)
as.pixset(im) %>% px.remove_outer %>% plot
```

RasterPackage *Convert a RasterLayer/RasterBrick to a cimg image/image list*

Description

The raster library stores its data as "RasterLayer" and "RasterBrick" objects. The raster package can store its data out-of-RAM, so in order not to load too much data the "maxpixels" argument sets a limit on how many pixels are loaded.

Usage

```
## S3 method for class 'RasterLayer'
as.cimg(obj, maxpixels = 1e+07, ...)

## S3 method for class 'RasterStackBrick'
as.imlist(obj, maxpixels = 1e+07, ...)
```

Arguments

obj	an object of class "RasterLayer"
maxpixels	max. number of pixels to load (default 1e7)
...	ignored

Author(s)

Simon Barthelme, adapted from the image method for RasterLayer by Robert J Hijmans

---

renorm *Renormalise image*

Description

Pixel data is usually expressed on a 0...255 scale for displaying. This function performs a linear renormalisation to range min...max

Usage

```
renorm(x, min = 0, max = 255)
```

Arguments

x	numeric data
min	min of the range
max	max of the range

Author(s)

Simon Barthelme

Examples

```
renorm(0:10)
renorm(-5:5) #Same as above
```

`resize` *Resize image*

Description

If the dimension arguments are negative, they are interpreted as a proportion of the original image.

Usage

```
resize(
  im,
  size_x = -100L,
  size_y = -100L,
  size_z = -100L,
  size_c = -100L,
  interpolation_type = 1L,
  boundary_conditions = 0L,
  centering_x = 0,
  centering_y = 0,
  centering_z = 0,
  centering_c = 0
)
```

Arguments

`im`	an image
`size_x`	Number of columns (new size along the X-axis).
`size_y`	Number of rows (new size along the Y-axis).
`size_z`	Number of slices (new size along the Z-axis).
`size_c`	Number of vector-channels (new size along the C-axis).
`interpolation_type`	Method of interpolation: -1 = no interpolation: raw memory resizing. 0 = no interpolation: additional space is filled according to boundary_conditions. 1 = nearest-neighbor interpolation. 2 = moving average interpolation. 3 = linear interpolation. 4 = grid interpolation. 5 = cubic interpolation. 6 = lanczos interpolation.
`boundary_conditions`	Border condition type.
`centering_x`	Set centering type (only if interpolation_type=0).
`centering_y`	Set centering type (only if interpolation_type=0).
`centering_z`	Set centering type (only if interpolation_type=0).
`centering_c`	Set centering type (only if interpolation_type=0).

See Also

See imresize for an easier interface.

`resize_doubleXY` *Resize image uniformly*

Description

Resize image by a single scale factor. For non-uniform scaling and a wider range of options, see resize.

Usage

```
resize_doubleXY(im)

resize_halfXY(im)

resize_tripleXY(im)

imresize(im, scale = 1, interpolation = 3)
```

Arguments

`im`	an image
`scale`	a scale factor
`interpolation`	interpolation method to use (see doc for resize). Default 3, linear. Set to 5 for cubic, 6 for Lanczos (higher quality).

Value

an image

Functions

- `resize_doubleXY()`: Double size
- `resize_halfXY()`: Half size
- `resize_tripleXY()`: Triple size
- `imresize()`: resize by scale factor

Author(s)

Simon Barthelme

References

For double-scale, triple-scale, etc. uses an anisotropic scaling algorithm described in: http://www.scale2x.it/algorithm.html. For half-scaling uses what the CImg doc describes as an "optimised filter", see resize_halfXY in CImg.h.

See Also

resize

Examples

```
im <- load.example("parrots")
imresize(im,1/4) #Quarter size
map_il(2:4,~ imresize(im,1/.)) %>% imappend("x") %>% plot
```

RGBtoHSL *Colour space conversions in imager*

Description

All functions listed here assume the input image has three colour channels (spectrum(im) == 3)

Usage

```
RGBtoHSL(im)

RGBtoXYZ(im)

XYZtoRGB(im)

HSLtoRGB(im)

RGBtoHSV(im)

HSVtoRGB(im)

RGBtoHSI(im)

HSItoRGB(im)

RGBtosRGB(im)

sRGBtoRGB(im)

RGBtoYCbCr(im)

YCbCrtoRGB(im)

RGBtoYUV(im)

YUVtoRGB(im)

LabtoRGB(im)
```

```
RGBtoLab(im)

LabtoXYZ(im)

XYZtoLab(im)

LabtosRGB(im)

sRGBtoLab(im)
```

Arguments

im	an image

Functions

- RGBtoHSL(): RGB to HSL conversion
- RGBtoXYZ(): CIE RGB to CIE XYZ (1931) conversion, D65 white point
- XYZtoRGB(): CIE XYZ to CIE RGB (1931) conversion, D65 white point
- HSLtoRGB(): HSL to RGB conversion
- RGBtoHSV(): RGB to HSV conversion
- HSVtoRGB(): HSV to RGB conversion
- RGBtoHSI(): RGB to HSI conversion
- HSItoRGB(): HSI to RGB conversion
- RGBtosRGB(): RGB to sRGB conversion
- sRGBtoRGB(): sRGB to RGB conversion
- RGBtoYCbCr(): RGB to YCbCr conversion
- YCbCrtoRGB(): YCbCr to RGB conversion
- RGBtoYUV(): RGB to YUV conversion
- YUVtoRGB(): YUV to RGB conversion
- LabtoRGB(): Lab to RGB (linear)
- RGBtoLab(): RGB (linear) to Lab
- LabtoXYZ(): Lab to XYZ
- XYZtoLab(): XYZ to Lab
- LabtosRGB(): Lab to sRGB
- sRGBtoLab(): sRGB to Lab

rm.alpha *Remove alpha channel and store as attribute*

Description

Remove alpha channel and store as attribute

Usage

```
rm.alpha(im)
```

Arguments

im	an image with 4 RGBA colour channels

Value

an image with only three RGB channels and the alpha channel as attribute

Author(s)

Simon Barthelme

See Also

flatten.alpha

Examples

```
#An image with 4 colour channels (RGBA)
im <- imfill(2,2,val=c(0,0,0,0))
#Remove fourth channel
rm.alpha(im)
attr(rm.alpha(im),"alpha")
```

rotate_xy *Rotate image by an arbitrary angle, around a center point.*

Description

Rotate image by an arbitrary angle, around a center point.

Usage

```
rotate_xy(im, angle, cx, cy, interpolation = 1L, boundary_conditions = 0L)
```

Arguments

im	an image
angle	Rotation angle, in degrees.
cx	X-coordinate of the rotation center.
cy	Y-coordinate of the rotation center.
interpolation	Interpolation type. 0=nearest | 1=linear | 2=cubic
boundary_conditions	Boundary conditions. 0=dirichlet | 1=neumann | 2=periodic

Examples

```
rotate_xy(boats,30,200,400) %>% plot
rotate_xy(boats,30,200,400,boundary=2) %>% plot
```

---

save.image *Save image*

Description

You'll need ImageMagick for formats other than PNG and JPEG.

Usage

```
save.image(im, file, quality = 0.7)
```

Arguments

im	an image (of class cimg)
file	path to file. The format is determined by the file's name
quality	(JPEG only) default 0.7. Higher quality means less compression.

Value

nothing

See Also

save.video

Examples

```
#Create temporary file
tmpF <- tempfile(fileext=".png")
#Save boats image
save.image(boats,tmpF)
#Read back and display
load.image(tmpF) %>% plot
```

`split_connected` *Split pixset into connected components*

Description

Compute connected components (using "label"), then split into as many sets as there are components. Useful for segmentation

Usage

```
split_connected(px, ...)
```

Arguments

`px`	a pixset
`...`	further arguments passed to label

Value

a list of pixsets

Author(s)

Simon Barthelme

See Also

label

Examples

```
px <- isoblur(grayscale(boats),5) > .75
plot(px)
spl <- split_connected(px)
plot(spl[[1]])
px <- isoblur(grayscale(boats),5) > .75
plot(px)
spl <- split_connected(px)
plot(spl[[1]])
```

squeeze *Remove empty dimensions from an array*

Description

Works just like Matlab's squeeze function: if anything in dim(x) equals one the corresponding dimension is removed

Usage

```
squeeze(x)
```

Arguments

x	an array

Examples

```
A <- array(1:9,c(3,1,3)) #3D array with one flat dimension
A %>% squeeze #flat dimension removed
```

stencil.cross *A cross-shaped stencil*

Description

Returns a stencil corresponding to all nearest-neighbours of a pixel

Usage

```
stencil.cross(z = FALSE, cc = FALSE, origin = FALSE)
```

Arguments

z	include neighbours along the z axis
cc	include neighbours along the cc axis
origin	include center pixel (default false)

Value

a data.frame defining a stencil

Author(s)

Simon Barthelme

See Also

get.stencil

`threshold` *Threshold grayscale image*

Description

Thresholding corresponding to setting all values below a threshold to 0, all above to 1. If you call threshold with thr="auto" a threshold will be computed automatically using kmeans (ie., using a variant of Otsu's method). This works well if the pixel values have a clear bimodal distribution. If you call threshold with a string argument of the form "XX%" (e.g., "98%"), the threshold will be set at percentile XX. Computing quantiles or running kmeans is expensive for large images, so if approx == TRUE threshold will skip pixels if the total number of pixels is above 10,000. Note that thresholding a colour image will threshold all the colour channels jointly, which may not be the desired behaviour! Use iiply(im,"c",threshold) to find optimal values for each channel separately.

Usage

```
threshold(im, thr = "auto", approx = TRUE, adjust = 1)
```

Arguments

`im`	the image
`thr`	a threshold, either numeric, or "auto", or a string for quantiles
`approx`	Skip pixels when computing quantiles in large images (default TRUE)
`adjust`	use to adjust the automatic threshold: if the auto-threshold is at k, effective threshold will be at adjust*k (default 1)

Value

a pixset with the selected pixels

Author(s)

Simon Barthelme

Examples

```
im <- load.example("birds")
im.g <- grayscale(im)
threshold(im.g,"15%") %>% plot
threshold(im.g,"auto") %>% plot
threshold(im.g,.1) %>% plot
#If auto-threshold is too high, adjust downwards or upwards
#using "adjust"
threshold(im,adjust=.5) %>% plot
threshold(im,adjust=1.3) %>% plot
```

vanvliet *Young-Van Vliet recursive Gaussian filter.*

Description

The Young-van Vliet filter is a fast approximation to a Gaussian filter (order = 0), or Gaussian derivatives (order = 1 or 2).

Usage

```
vanvliet(im, sigma, order = 0L, axis = "x", neumann = FALSE)
```

Arguments

im	an image
sigma	standard deviation of the Gaussian filter
order	the order of the filter 0,1,2,3
axis	Axis along which the filter is computed. One of 'x', 'y', 'z', 'c'
neumann	If true, use Neumann boundary conditions (default false, Dirichlet)

References

From: I.T. Young, L.J. van Vliet, M. van Ginkel, Recursive Gabor filtering. IEEE Trans. Sig. Proc., vol. 50, pp. 2799-2805, 2002. (this is an improvement over Young-Van Vliet, Sig. Proc. 44, 1995)

Boundary conditions (only for order 0) using Triggs matrix, from B. Triggs and M. Sdika. Boundary conditions for Young-van Vliet recursive filtering. IEEE Trans. Signal Processing, vol. 54, pp. 2365-2367, 2006.

Examples

```
vanvliet(boats,sigma=2,order=0) %>% plot("Zeroth-order Young-van Vliet along x")
vanvliet(boats,sigma=2,order=1) %>% plot("First-order Young-van Vliet along x")
vanvliet(boats,sigma=2,order=1) %>% plot("Second-order Young-van Vliet along x")
vanvliet(boats,sigma=2,order=1,axis="y") %>% plot("Second-order Young-van Vliet along y")
```

warp *Warp image*

Description

Warp image

Usage

```
warp(im, warpfield, mode = 0L, interpolation = 1L, boundary_conditions = 0L)
```

Arguments

im	an image
warpfield	Warping field. The (x,y,z) fields should be stacked along the colour coordinate.
mode	Can be 0=backward-absolute | 1=backward-relative | 2=forward-absolute | 3=forward-relative
interpolation	Can be <tt> 0=nearest | 1=linear | 2=cubic </tt>.
boundary_conditions	Boundary conditions. Can be <tt> 0=dirichlet | 1=neumann | 2=periodic </tt>.

See Also

imwarp for a user-friendly interface

Examples

```
#Shift image via warp
warp.x <- imfill(width(boats),height(boats),val=5)
warp.y <- imfill(width(boats),height(boats),val=20)
warpfield <- list(warp.x,warp.y) %>% imappend("c")
warp(boats,warpfield,mode=1) %>% plot
```

---

watershed *Compute watershed transform.*

Description

The watershed transform is a label propagation algorithm. The value of non-zero pixels will get propagated to their zero-value neighbours. The propagation is controlled by a priority map. See examples.

Usage

```
watershed(im, priority, fill_lines = TRUE)
```

Arguments

im	an image
priority	Priority map.
fill_lines	Sets if watershed lines must be filled or not.

Examples

```
#In our initial image we'll place three seeds
#(non-zero pixels) at various locations, with values 1, 2 and 3.
#We'll use the watershed algorithm to propagate these values
imd <- function(x,y) imdirac(c(100,100,1,1),x,y)
im <- imd(20,20)+2*imd(40,40)+3*imd(80,80)
layout(t(1:3))
plot(im,main="Seed image")
#Now we build an priority map: neighbours of our seeds
#should get high priority.
#We'll use a distance map for that
p <- 1-distance_transform(sign(im),1)
plot(p,main="Priority map")
watershed(im,p) %>% plot(main="Watershed transform")
```

---

where *Return locations in pixel set*

Description

Return locations in pixel set

Usage

```
where(x)
```

Arguments

x	a pixset

Examples

```
#All pixel locations with value greater than .99
where(boats > .99)
```

%inr% *Check that value is in a range*

Description

A shortcut for x >= a | x <= b.

Usage

```
x %inr% range
```

Arguments

x	numeric values
range	a vector of length two, of the form c(a,b)

Value

a vector of logicals 1:10

Author(s)

Simon Barthelme

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