collageradiomics

Release 0.2

BrIC Laboratory

Jul 19, 2023

CONTENTS:

CoLlAGe captures subtle anisotropic differences in disease pathologies by measuring entropy of co-occurrences of voxel-level gradient orientations on imaging computed within a local neighborhood.

CoLlAGe is based on the hypothesis that disruption in tissue microarchitecture can be quantified on imaging by measuring the disorder in voxel-wise gradient orientations. CoLlAGe involves assigning every image voxel a 'disorder value' associated with the co-occurrence matrix of gradient orientations computed around every voxel.

Details on extraction of CoLlAGe features are included in [1]. After feature extraction, the subsequent distribution or different statistics such as mean, median, variance etc can be computed and used in conjunction with a machine learning classifier to distinguish similar appearing pathologies. The feasibility of CoLlAGe in distinguishing cancer from treatment confounders/benign conditions and characterizing molecular subtypes of cancers has been demonstrated in the context of multiple challenging clinical problems.

CHAPTER

ONE

HELPFUL LINKS

Instructions: README

RadxTools Website: https://radxtools.github.io

Original Paper: Co-occurrence of Local Anisotropic Gradient Orientations (CoLlAGe): A new radiomics descriptor

CHAPTER

TWO

CODE DOCUMENTATION

2.1 Notes

The **attributes** below represent the public output intended to be available to consumers of this module.

class collageradiomics.**Collage**(*img_array*, *mask_array*, *svd_radius=5*, *verbose_logging=False*, *cooccurence_angles=[0.0, 0.7853981633974483, 1.5707963267948966, 2.356194490192345, 3.141592653589793, 3.9269908169872414, 4.71238898038469, 5.497787143782138]*, *difference_variance_interpretation=DifferenceVarianceInterpretation.XMinusYVariance*, *haralick_window_size=-1*, *num_unique_angles=64*)

Bases: object

This is the main object in the Collage calculation system. Usage: create a Collage object and then call the *execute()* function.

Parameters

- **image_array** (*numpy.ndarray*) – image to run collage upon
- **mask_array** (*numpy.ndarray*) – mask that correlates with the image
- **svd_radius** (*int, optional*) – radius of svd. Defaults to 5.
- **verbose_logging** (*bool, optional*) – This parameter is now ignored. Please use the python logging module.
- **cooccurence_angles** (*list, optional*) – list of angles to use in the cooccurence matrix. Defaults to [x*numpy.pi/4 for x in range(8)]
- **difference_variance_interpretation** (DifferenceVarianceInterpretation, *optional*) – Feature 10 has two interpretations, as the variance of **|x-y|** or as the variance of P(**|x-y|**).].Defaults to DifferenceVarianceInterpretation.XMinusYVariance.
- **haralick_window_size** (*int, optional*) – size of rolling window for texture calculations. Defaults to -1.
- **num_unique_angles** (*int, optional*) – number of bins to use for the texture calculation. Defaults to 64.

Attributes

collage_output
Array representing collage upon the mask within the full images.

cooccurence_angles
Iterable of angles that will be used in the cooccurence matrix.

difference_variance_interpretation
Feature 10 has two interpretations, as the variance of |x-y| or as the variance of P(|x-y|).].

haralick_window_size
Number of pixels around each pixel to calculate a haralick texture.

img_array
The original image.

is_3D
Whether we are using 3D collage calculations (True) or 2D (False)

mask_array
Array passed into Collage.

num_unique_angles
Number of bins to use for texture calculations.

svd_radius
SVD radius is used to calculate the pixel radius for the dominant angle calculation.

verbose_logging
This parameter is now ignored.

Methods

execute()	Begins haralick calculation.
get_single_feature_output(which_feature)	Output a single collage output feature.

property collage_output

Array representing collage upon the mask within the full images. If the input was 2D, the output will be height×width×13 where "13" is the number of haralick textures. If the input was 3D, the output will be height×width×depth×13x2 where "2" is the primary angle (element 0) or the secondary angle (element 1)

The output will have numpy.nan values everywhere outside the masked region.

Getter
Returns array the same shape as the original image with collage in the mask region.

Type
numpy.ndarray

property cooccurence_angles

Iterable of angles that will be used in the cooccurence matrix.

Getter
Returns the Iterable of cooccurence angles.

Setter
Sets the angles to be used in the cooccurence matrix.

Type
int

property difference_variance_interpretation

Feature 10 has two interpretations, as the variance of |x-y| or as the variance of P(|x-y|).]. Defaults to DifferenceVarianceInterpretation.XMinusYVariance.

Getter
Returns requested variance interpretation.

Setter
Sets requested variance interpretation.

Type
DifferenceVarianceInterpretation

`execute()`

Begins haralick calculation.

Returns
An image at original size that only has the masked section filled in with collage calculations.

Return type
numpy.ndarray

`get_single_feature_output(which_feature)`

Output a single collage output feature. If this was a 3D calculation, the output will be of size height×width×depth×2 where the "2" represents the collage calculation from the primary angle (0) or secondary angle (1).

param which_feature
Either an integer from 0 to 12 (inclusive) or a HaralickFeature enum value

:type which_feature HaralickFeature

`property haralick_window_size`

Number of pixels around each pixel to calculate a haralick texture.

Getter
Returns requested number of pixels.

Setter
Sets requested number of pixels.

Type
int

`property img_array`

The original image.

Getter
Returns the original image array.

Setter
Sets the original image array.

Type
np.ndarray

`property is_3D`

Whether we are using 3D collage calculations (True) or 2D (False)

`property mask_array`

Array passed into Collage.

Getter
Returns the original mask array.

Setter
Sets the original mask array.

Type
np.ndarray

property num_unique_angles

Number of bins to use for texture calculations. Defaults to 64.

Getter
Returns requested number of unique angles to bin into.

Type
int

property svd_radius

SVD radius is used to calculate the pixel radius for the dominant angle calculation.

Getter
Returns the SVD radius.

Setter
Sets the SVD radius.

Type
int

property verbose_logging

This parameter is now ignored. Please use the python logging module.

Getter
Returns True if on.

Setter
Turns verbose logging off or on.

Type
bool

class collageradiomics.**DifferenceVarianceInterpretation**(*value*)

Bases: Enum

Feature 10 has two interpretations, as the variance of **|x-y|** or as the variance of P(**|x-y|**). See: https://ieeexplore.ieee.org/document/4309314

Parameters
Enum (DifferenceVarianceInterpretation) – Enumeration Helper For Haralick Features

ProbabilityXMinusYVariance = 1

XMinusYVariance = 0

class collageradiomics.**HaralickFeature**(*value*)

Bases: IntEnum

Enumeration Helper For Haralick Features

Parameters
IntEnum (HaralickFeature) – Enumeration Helper For Haralick Features

AngularSecondMoment = 0

Contrast = 1

Correlation = 2

DifferenceEntropy = 9

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DifferenceVariance = 8

Entropy = 7

InformationMeasureOfCorrelation1 = 10

InformationMeasureOfCorrelation2 = 11

MaximalCorrelationCoefficient = 12

SumAverage = 4

SumEntropy = 6

SumOfSquareVariance = 3

SumVariance = 5
```

CHAPTER

THREE

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PYTHON MODULE INDEX

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