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regionprops

Measure properties of image regions

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Syntax

```
stats = regionprops(BW,properties)
stats = regionprops(CC,properties)
stats = regionprops(L,properties)
stats = regionprops(___,I,properties)
stats = regionprops(output,___)
stats = regionprops(gpuarrayImg,___)
```

Description

example

`stats = regionprops(BW,properties)` returns measurements for the set of properties specified by `properties` for each 8-connected component (object) in the binary image, `BW`. `stats` is struct array containing a struct for each object in the image. You can use `regionprops` on contiguous regions and discontiguous regions (see Algorithms).

Note

To return measurements of a 3-D volumetric image, consider using `regionprops3`. While `regionprops` can accept 3-D images, `regionprops3` calculates more statistics for 3-D images than `regionprops`.

For all syntaxes, if you do not specify the `properties` argument, `regionprops` returns the `'Area'`, `'Centroid'`, and `'BoundingBox'` measurements.

`stats = regionprops(CC,properties)` returns measurements for the set of properties specified by `properties` for each connected component (object) in `CC`. `CC` is a structure returned by `bwconncomp`.

`stats = regionprops(L,properties)` returns measurements for the set of properties specified by `properties` for each labeled region in the label matrix `L`.

`stats = regionprops(___,I,properties)` returns measurements for the set of properties specified by `properties` for each labeled region in the image `I`. The first input to `regionprops` (`BW`, `CC`, or `L`) identifies the regions in `I`. The size of the first input must match the size of the image, that is, `size(I)` must equal `size(BW)`, `CC.ImageSize`, or `size(L)`.

example

`stats = regionprops(output,___)` returns measurements for a set of properties, where `output` specifies the type of return value. `regionprops` can return measurements in a `struct` or a `table`.

example

`stats = regionprops(gpuarrayImg,___)` performs the measurements on a GPU. `gpuarrayImg` can be a 2-D binary image (`logical` gpuArray) or a gpuArray label matrix. The connected component structure (`CC`) returned by `bwconncomp` is not supported on the GPU.

When run on a GPU, `regionprops` does not support the following properties: `'ConvexArea'`, `'ConvexHull'`, `'ConvexImage'`, `'EulerNumber'`, `'FilledArea'`, `'FilledImage'`, and `'Solidity'`.

Examples

collapse all

Calculate Centroids and Superimpose Locations on Image

Read binary image into workspace.

```
BW = imread('text.png');
```

Calculate centroids for connected components in the image using `regionprops`.

```
s = regionprops(BW,'centroid');
```

Concatenate structure array containing centroids into a single matrix.

```
centroids = cat(1, s.Centroid);
```

Display binary image with centroid locations superimposed.

```
imshow(BW)
hold on
plot(centroids(:,1),centroids(:,2), 'b*')
hold off
```

Calculate Centroids and Superimpose Locations on Image on GPU

Read binary image into a gpuArray.

```
BW = gpuArray(imread('text.png'));
```

Calculate the centroids of objects in the image.

```
s  = regionprops(BW,'centroid');
```

Plot the centroids on the image.

```
centroids = cat(1, s.Centroid);
imshow(BW)
hold on
plot(centroids(:,1), centroids(:,2), 'b*')
hold off
```

Estimate Center and Radii of Circular Objects and Plot Circles

Estimate the center and radii of circular objects in an image and use this information to plot circles on the image. In this example, `regionprops` returns the information it calculates in a table.

Read an image into workspace.

```
a = imread('circlesBrightDark.png');
```

Turn the input image into a binary image.

```
bw = a < 100;
imshow(bw)
title('Image with Circles')
```

Calculate properties of regions in the image and return the data in a table.

```
stats = regionprops('table',bw,'Centroid',...
    'MajorAxisLength','MinorAxisLength')
```

```
stats=4x3 table
        Centroid        MajorAxisLength    MinorAxisLength
    ________________    _______________    _______________

     256.5     256.5    834.46             834.46         
       300       120    81.759             81.759         
    330.47    369.83    111.78             110.36         
       450       240    101.72             101.72         
```

Get centers and radii of the circles.

```
centers = stats.Centroid;
diameters = mean([stats.MajorAxisLength stats.MinorAxisLength],2);
radii = diameters/2;
```

Plot the circles.

```
hold on
viscircles(centers,radii);
hold off
```

Input Arguments

collapse all

`BW` — Input binary image
logical array of any dimension

Input binary image, specified as a logical array of any dimension.

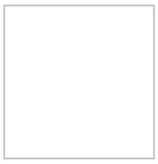
Data Types: `logical`

`properties` — Type of measurement
comma-separated list of strings or character vectors | cell array of strings or character vectors | `'all'` | `'basic'`

Type of measurement, specified as a comma-separated list of strings or character vectors, a cell array of strings or character vectors, or as `'all'` or `'basic'`. Property names are case-insensitive and can be abbreviated. When used with code generation, `regionprops` does not support cell arrays of strings or character vectors.

The following tables list all the properties that provide shape measurements. The properties listed in the Pixel Value Measurements table are valid only when you specify a grayscale image. If you specify `'all'`, `regionprops` computes all the shape measurements and, for grayscale images, the pixel value measurements as well. If you specify `'basic'`, or do not specify the `properties` argument, `regionprops` computes only the `'Area'`, `'Centroid'`, and `'BoundingBox'` measurements. You can calculate the following properties on N-D inputs: `'Area'`, `'BoundingBox'`, `'Centroid'`, `'FilledArea'`, `'FilledImage'`, `'Image'`, `'PixelIdxList'`, `'PixelList'`, and `'SubarrayIdx'`.

Shape Measurements

Property Name	Description	N-D Support	GPU Support	Code Generation
`'Area'`	Actual number of pixels in the region, returned as a scalar. (This value might differ slightly from the value returned by `bwarea`, which weights different patterns of pixels differently.) To find the equivalent to the area of a 3-D volume, use the `'Volume'` property of `regionprops3`.	Yes	Yes	Yes
`'BoundingBox'`	Smallest rectangle containing the region, returned as a 1-by-`Q*2` vector, where `Q` is the number of image dimensions. For example, in the vector `[ul_corner width]`, `ul_corner` specifies the upper-left corner of the bounding box in the form `[x y z ...]`. `width` specifies the width of the bounding box along each dimension in the form `[x_width y_width ...]`. `regionprops` uses `ndims` to get the dimensions of label matrix or binary image, `ndims(L)`, and `numel` to get the dimensions of connected components, `numel(CC.ImageSize)`.	Yes	Yes	Yes
`'Centroid'`	Center of mass of the region, returned as a 1-by-*`Q`* vector. The first element of `Centroid` is the horizontal coordinate (or *x*-coordinate) of the center of mass. The second element is the vertical coordinate (or *y*-coordinate). All other elements of `Centroid` are in order of dimension. This figure illustrates the centroid and bounding box for a discontiguous region. The region consists of the white pixels; the green box is the bounding box, and the red dot is the centroid. 	Yes	Yes	Yes
`'ConvexArea'`	Number of pixels in `'ConvexImage'`, returned as a scalar.	2-D only	No	No
`'ConvexHull'`	Smallest convex polygon that can contain the region, returned as a *p*-by-2 matrix. Each row of the matrix contains the *x*- and *y*-coordinates of one vertex of the polygon.	2-D only	No	No
	Image that specifies the convex hull, with all pixels within the hull filled in (set to `on`), returned as a binary image (`logical`). The image is the size of the			

Property Name	Description	N-D Support	GPU Support	Code Generation
`'ConvexImage'`	bounding box of the region. (For pixels that the boundary of the hull passes through, `regionprops` uses the same logic as `roipoly` to determine whether the pixel is inside or outside the hull.)	2-D only	No	No
`'Eccentricity'`	Eccentricity of the ellipse that has the same second-moments as the region, returned as a scalar. The eccentricity is the ratio of the distance between the foci of the ellipse and its major axis length. The value is between 0 and 1. (0 and 1 are degenerate cases. An ellipse whose eccentricity is 0 is actually a circle, while an ellipse whose eccentricity is 1 is a line segment.)	2-D only	Yes	Yes
`'EquivDiameter'`	Diameter of a circle with the same area as the region, returned as a scalar. Computed as `sqrt(4*Area/pi)`.	2-D only	Yes	Yes
`'EulerNumber'`	Number of objects in the region minus the number of holes in those objects, returned as a scalar. This property is supported only for 2-D label matrices. `regionprops` uses 8-connectivity to compute the Euler number measurement. To learn more about connectivity, see Pixel Connectivity.	2-D only	No	Yes
`'Extent'`	Ratio of pixels in the region to pixels in the total bounding box, returned as a scalar. Computed as the `Area` divided by the area of the bounding box.	2-D only	Yes	Yes
`'Extrema'`	Extrema points in the region, returned as an 8-by-2 matrix. Each row of the matrix contains the *x*- and *y*-coordinates of one of the points. The format of the vector is `[top-left top-right right-top right-bottom bottom-right bottom-left left-bottom left-top]`. This figure illustrates the extrema of two different regions. In the region on the left, each extrema point is distinct. In the region on the right, certain extrema points (e.g., `top-left` and `left-top`) are identical.	2-D only	Yes	Yes
`'FilledArea'`	Number of `on` pixels in `FilledImage`, returned as a scalar.	Yes	No	Yes
`'FilledImage'`	Image the same size as the bounding box of the region, returned as a binary (`logical`) array. The `on` pixels correspond to the region, with all holes filled in, as shown in this figure.	Yes	No	Yes
`'Image'`	Image the same size as the bounding box of the region, returned as a binary (`logical`) array. The `on` pixels correspond to the region, and all other pixels are `off`.	Yes	Yes	Yes
	Length (in pixels) of the major axis of the ellipse that has the same	2-D		

Property Name	Description	N-D Support	GPU Support	Code Generation
`'MajorAxisLength'`	normalized second central moments as the region, returned as a scalar.	only	Yes	Yes
`'MinorAxisLength'`	Length (in pixels) of the minor axis of the ellipse that has the same normalized second central moments as the region, returned as a scalar.	2-D only	Yes	Yes
`'Orientation'`	Angle between the *x*-axis and the major axis of the ellipse that has the same second-moments as the region, returned as a scalar. The value is in degrees, ranging from -90 degrees to 90 degrees. This figure illustrates the axes and orientation of the ellipse. The left side of the figure shows an image region and its corresponding ellipse. The right side shows the same ellipse with the solid blue lines representing the axes. The red dots are the foci. The orientation is the angle between the horizontal dotted line and the major axis.	2-D only	Yes	Yes
`'Perimeter'`	Distance around the boundary of the region. returned as a scalar. `regionprops` computes the perimeter by calculating the distance between each adjoining pair of pixels around the border of the region. If the image contains discontiguous regions, `regionprops` returns unexpected results. This figure illustrates the pixels included in the perimeter calculation for this object.	2-D only	Yes	Yes
`'PixelIdxList'`	Linear indices of the pixels in the region, returned as a *p*-element vector.	Yes	Yes	Yes
`'PixelList'`	Locations of pixels in the region, returned as a *p*-by-`Q` matrix. Each row of the matrix has the form `[x y z ...]` and specifies the coordinates of one pixel in the region.	Yes	Yes	Yes
`'Solidity'`	Proportion of the pixels in the convex hull that are also in the region, returned as a scalar. Computed as `Area/ConvexArea`.	2-D only	No	No
`'SubarrayIdx'`	Elements of `L` inside the object bounding box, returned as a cell array that contains indices such that `L(idx{:})` extracts the elements.	Yes	Yes	No

The pixel value measurement properties in the following table are valid only when you specify a grayscale image, `I`.

Pixel Value Measurements

Property Name	Description	N-D Support	GPU Support	Code Generation
`'MaxIntensity'`	Value of the pixel with the greatest intensity in the region, returned as a scalar.	Yes	Yes	Yes
`'MeanIntensity'`	Mean of all the intensity values in the region, returned as a scalar.	Yes	Yes	Yes
`'MinIntensity'`	Value of the pixel with the lowest intensity in the region, returned as a scalar.	Yes	Yes	Yes
`'PixelValues'`	Number of pixels in the region, returned as a *p*-by-1 vector, where *p* is the number of pixels in the region. Each element in the vector contains the value of a pixel in the region.	Yes	Yes	Yes
`'WeightedCentroid'`	Center of the region based on location and intensity value, returned as a *p*-by-`Q` vector of coordinates. The first element of `WeightedCentroid` is the horizontal coordinate (or *x*-coordinate) of the weighted centroid. The second element is the vertical coordinate (or *y*-coordinate). All other elements of `WeightedCentroid` are in order of dimension.	Yes	Yes	Yes

Data Types: `char` | `string` | `cell`

`CC` — Connected components
structure

Connected components, specified as a structure returned by `bwconncomp`.

Data Types: `struct`

`L` — Label matrix
real, nonsparse, numeric array

Label matrix, specified as a real, nonsparse, numeric array. `L` can have any numeric class and any dimension. `regionprops` treats negative-valued pixels as background and rounds down input pixels that are not integers. Positive integer elements of `L` correspond to different regions. The set of elements of `L` equal to 1 corresponds to region `1`. The set of elements of `L` equal to 2 corresponds to region `2`, and so on.

Data Types: `single` | `double` | `int8` | `int16` | `int32` | `uint8` | `uint16` | `uint32`

`I` — Image to be measured
grayscale image

Image to be measured, specified as a grayscale image.

Data Types: `single` | `double` | `int8` | `int16` | `int32` | `int64` | `uint8` | `uint16` | `uint32`

`output` — Return type
`'struct'` (default) | `'table'`

Return type, specified as either of the following values:

Value	Description
`'struct'`	Returns an array of structures with length equal to the number of objects in `BW`, `CC.NumObjects`, or `max(L(:))`. The fields of the structure array denote different properties for each region, as specified by `properties`. If you do not specify this argument, `regionprops` returns a struct by default.
`'table'`	Returns a MATLAB table with height (number of rows) equal to the number of objects in `BW`, `CC.NumObjects`, or `max(L(:))`. The variables (columns) denote different properties for each region, as specified by `properties`. To learn more about MATLAB tables, see `table`. Not supported on a GPU.

Data Types: `char`

`gpuarrayImg` — Input image

2D `logical gpuArray` | label matrix `gpuArray`

Input image, specified as a 2-D `logical gpuArray` or label matrix `gpuArray`.

Data Types: `single` | `double` | `int8` | `int16` | `int32` | `uint8` | `uint16` | `uint32`

Output Arguments

collapse all

`stats` — Measurement values
`struct` array (default) | `table`

Measurement values, returned as an array of structs or a table. The number of structs in the array, or the number of rows in the table, corresponds to the number of objects in `BW`, `CC.NumObjects`, or `max(L(:))`. The fields of each struct, or the variables in each row, denote the properties calculated for each region, as specified by `properties`.

When run on a GPU, `regionprops` can only return struct arrays.

Tips

- The function `ismember` is useful with `regionprops`, `bwconncomp`, and `labelmatrix` for creating a binary image containing only objects or regions that meet certain criteria. For example, these commands create a binary image containing only the regions whose area is greater than 80 and whose eccentricity is less than 0.8.

  ```
  cc = bwconncomp(BW);
  stats = regionprops(cc, 'Area','Eccentricity');
  idx = find([stats.Area] > 80 & [stats.Eccentricity] < 0.8);
  BW2 = ismember(labelmatrix(cc), idx);
  ```

- The comma-separated list syntax for structure arrays is useful when you work with the output of `regionprops`. For a field that contains a scalar, you can use this syntax to create a vector containing the value of this field for each region in the image. For instance, if `stats` is a structure array with field `Area`, then the following expression:

  ```
  stats(1).Area, stats(2).Area, ..., stats(end).Area
  ```

  is equivalent to:

  ```
  stats.Area
  ```

  Therefore, you can use these calls to create a vector containing the area of each region in the image. `allArea` is a vector of the same length as the structure array `stats`.

  ```
  stats = regionprops(L, 'Area');
  allArea = [stats.Area];
  ```

- The functions `bwlabel`, `bwlabeln`, and `bwconncomp` all compute connected components for binary images. `bwconncomp` replaces the use of `bwlabel` and `bwlabeln`. It uses less memory and is sometimes faster than the other functions.

Function	Input Dimension	Output Form	Memory Use	Connectivity
`bwlabel`	2-D	Label matrix with double-precision	High	4 or 8
`bwlabeln`	N-D	Double-precision label matrix	High	Any
`bwconncomp`	N-D	`CC` struct	Low	Any

  The output of `bwlabel` and `bwlabeln` is a double-precision label matrix. To compute a label matrix using a more memory-efficient data type, use the `labelmatrix` function on the output of `bwconncomp`:

  ```
  CC = bwconncomp(BW);
  L = labelmatrix(CC);
  ```

  If you are measuring components in a binary image with default connectivity, it is no longer necessary to call `bwlabel` or `bwlabeln` first. You can pass the binary image directly to `regionprops`, which then uses the memory-efficient `bwconncomp` function to compute the connected components automatically. To specify nondefault connectivity, call `bwconncomp` and pass the result to `regionprops`.

  ```
  CC = bwconncomp(BW, CONN);
  S = regionprops(CC);
  ```

- Most of the measurements take little time to compute. However, the following measurements can take longer, depending on the number of regions in `L`:
  - `'ConvexHull'`
  - `'ConvexImage'`
  - `'ConvexArea'`
  - `'FilledImage'`
- Computing certain groups of measurements takes about the same amount of time as computing just one of them. `regionprops` takes advantage of intermediate computations useful to each computation. Therefore, it is fastest to compute all the desired measurements in a single call to `regionprops`.

Algorithms

Contiguous regions are also called *objects*, *connected components*, or *blobs*. A label matrix containing contiguous regions might look like this:

```
1 1 0 2 2 0 3 3
1 1 0 2 2 0 3 3
```

Elements of `L` equal to 1 belong to the first contiguous region or connected component; elements of `L` equal to 2 belong to the second connected component; and so on.

Discontiguous regions are regions that might contain multiple connected components. A label matrix containing discontiguous regions might look like this:

```
1 1 0 1 1 0 2 2
1 1 0 1 1 0 2 2
```

Elements of `L` equal to 1 belong to the first region, which is discontiguous and contains two connected components. Elements of `L` equal to 2 belong to the second region, which is a single connected component.

Extended Capabilities

C/C++ Code Generation
Generate C and C++ code using MATLAB® Coder™.

Usage notes and limitations:

- This function supports the generation of C code using MATLAB® Coder™. Note that if you choose the generic `MATLAB Host Computer` target platform, the function generates code that uses a precompiled, platform-specific shared library. Use of a shared library preserves performance optimizations but limits the target platforms for which code can be generated. For more information, see Understand Code Generation with Image Processing Toolbox.
- Supports only 2-D input images or label matrices.
- Specifying the output type `'table'` is not supported.
- Passing a cell array of properties is not supported. Use a comma-separated list instead.
- All properties are supported except `'ConvexArea'`, `'ConvexHull'`, `'ConvexImage'`, `'Solidity'`, and `'SubarrayIdx'`.

See Also

`bwconncomp` | `bwlabel` | `bwlabeln` | `ismember` | `labelmatrix` | `regionprops3` | `watershed`

Introduced before R2006a

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