Object and Feature Detection

Janani Ravi

CO-FOUNDER, LOONYCORN

www.loonycorn.com

Overview

Deep learning algorithms and AI rely on images and videos as input

Proper choice of features is key

Image descriptors to summarize important features

Denoising images before feature extraction

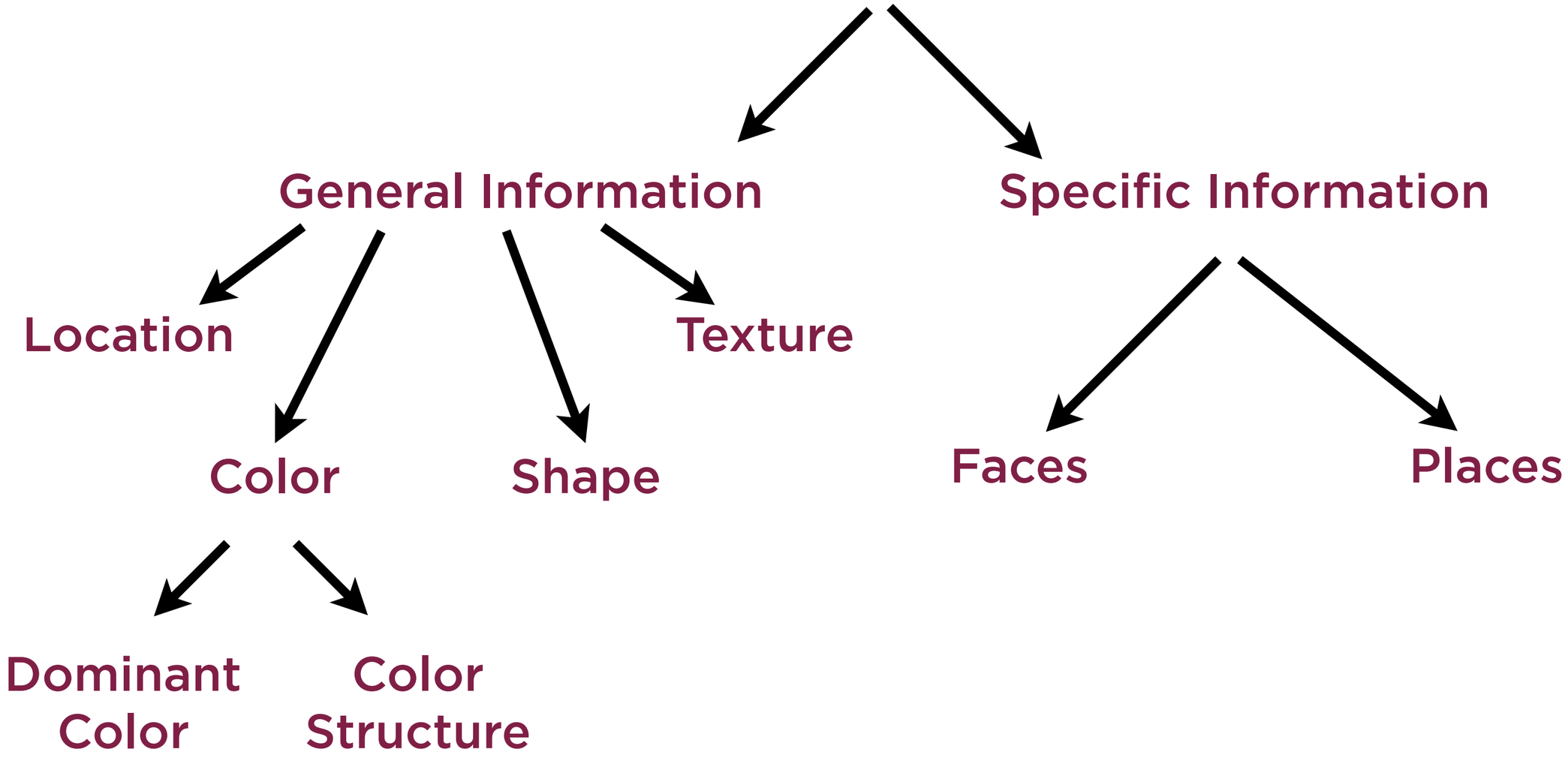
Process images to fill holes and highlight peaks

Image Descriptor

Image Descriptor

Descriptions of the key features of images.

Image Descriptors



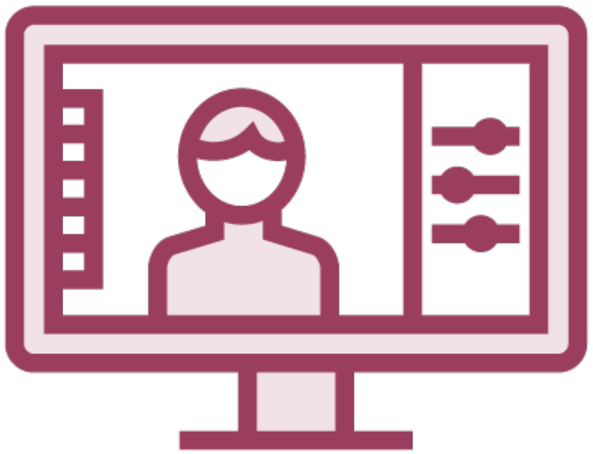


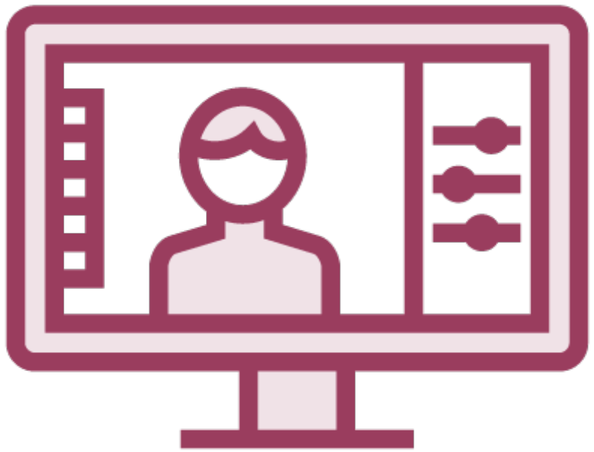
Image Descriptors

Scale Invariant Feature Transform (SIFT)

DAISY descriptors

*S*cale *I*nvariant *F*eature *T*ransform (SIFT)

Feature detection algorithm used to detect and describe features in images in a manner robust to translation, scaling and rotation



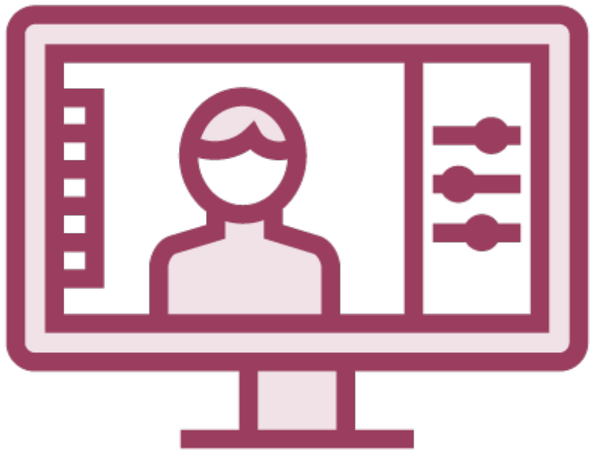
SIFT

Start with corpus of reference images

Analyze and store descriptors

For new images, compare to corpus

Find matches with corpus database



SIFT

Invariant to scale and rotation

Robust against changes in illumination, noise and viewpoint

Highly distinctive

Robust to partial occlusion

SIFT

Scale Invariant Feature Detection

Convert images to large number of feature vectors

Cluster Identification

Given a fresh image, use Hough Transform to find all keys in corpus that this image matches

Outlier Detection

Eliminate all feature vectors that are too far from original image

Feature Matching and Indexing

Efficiently store those feature vectors for fast key-based lookup

Model Verification

Minimize least square distance from original image and its feature vectors

Demo

Feature extraction using DAISY descriptors

DAISY Descriptor

Feature selection algorithm, conceptually similar to SIFT, but faster and works with lower dimensionality feature vectors.

DAISY Algorithm

Also used for feature extraction

Dimensionality reduction

- Robust normalization
- Followed by PCA (Principal Components Analysis)

Demo

Feature description using HOG (Histogram of Oriented Gradients)

Histogram of Oriented Gradients

Feature descriptor used for object detection.

HOG

Image Normalization

Eliminate effects of illumination and shadows

Compute Gradients

Use simple first order gradients to find contour, silhouette and texture

Compute Histograms

Group cell histograms into larger, spatially connected blocks; aggregate into HOG by voting

Block Normalization

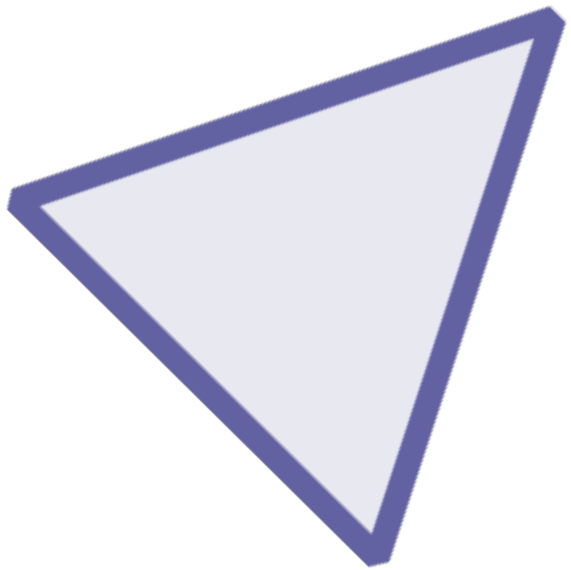
Divide each histogram block by L-1 norm or L-2 norm to normalize

Object Recognition

Use histogram blocks as feature vectors in your preferred ML algorithm

Demo

Corner detection

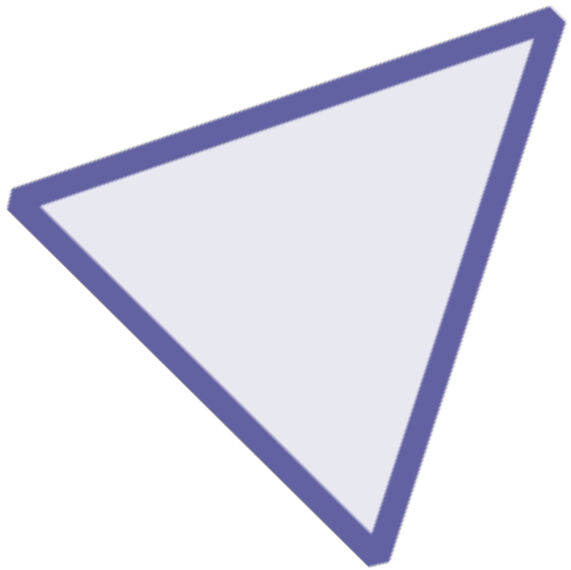


Corner Detection

Interest point = Point with well-defined position that can be clearly defined

Types of interest points

- Corners: Intersection of two edges
- Intensity maxima/minima
- Line endings



Corner Detection

Find cornerness measure for each pixel

- Low self-similarity, different from nearby points

Apply threshold to suppress weak corners

Remaining points are marked as corners

Noise

Random variations in images due to lighting variations, camera electronics, surface reflectance and lens.

Denoising

Process of removing noise from images, usually through the use of filters.

Filters for Denoising

Total variation filter

Bilateral filter

Wavelet denoising filter

Total Variation Filter

Based on the principle that signals with noise have high total variation

Reducing total variation brings image closer to original

Bilateral Filter

Edge-preserving and noise reducing filter

Depends on differences in color intensity, depth distance

Wavelet Denoising Filter

Transform image using wavelet transform

Concentrates signal and image features into a few large magnitude coefficients

Shrinks noise, preserves important features

Preserves image quality

Demo

Image denoising

Morphological Reconstruction

A useful but little-known method for extracting meaningful information about shapes in an image.

Morphological Reconstruction

Extract marked objects

Find bright regions surrounded by dark

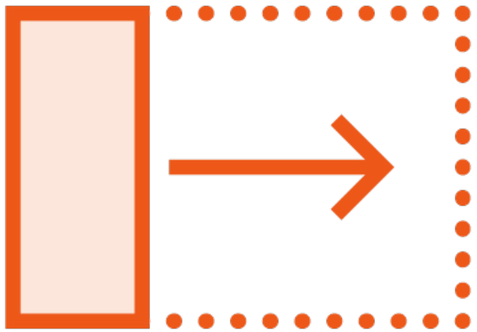
Remove objects

Fill holes

Basic Morphological Operations

Erosion

Shrink connected sets

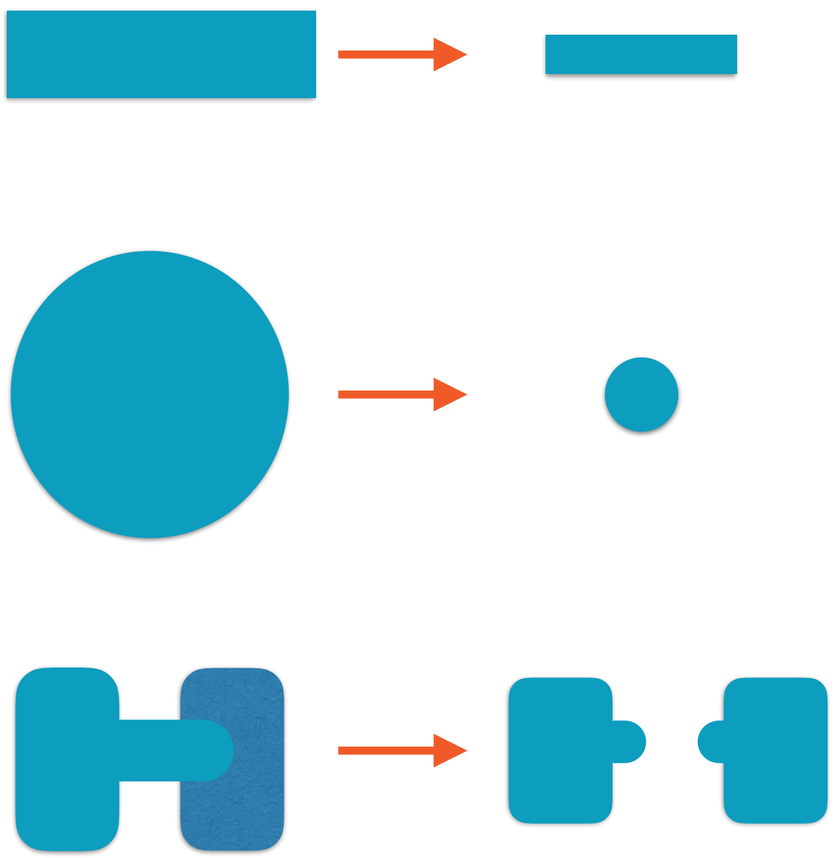


Dilation

Expand connected sets

Both dilation and erosion involve the use of a mask known as a Structural Element

Erosion



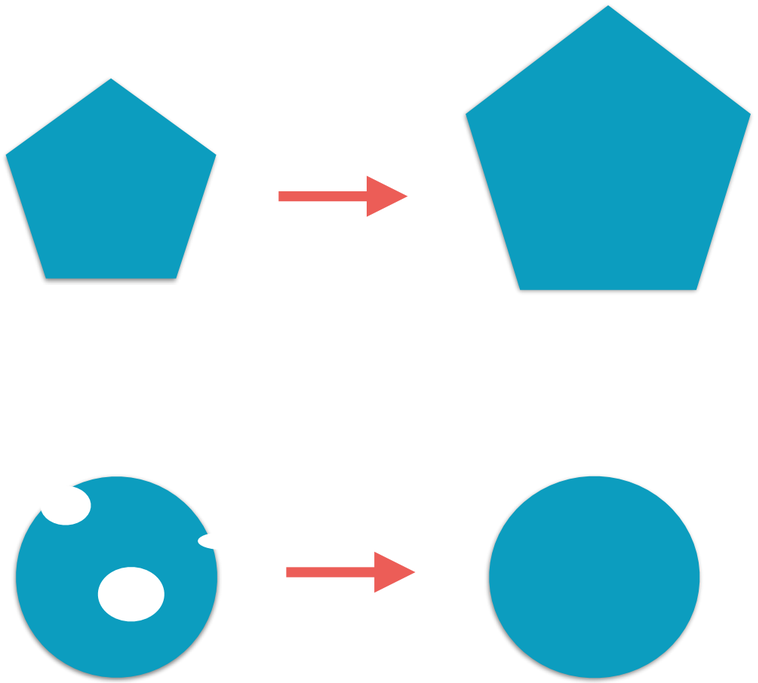
Shrinks objects

- Removes pixels from boundaries

Can be used for

- Shrinking features
- Removing bridges, branches, small protrusions

Dilation



Expands objects

- Adds pixels to boundaries

Can be used for

- Growing features
- Filling holes and gaps

Demo

Dilation and erosion

Summary

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