Segmentation and Transformation

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Overview

Thresholding for converting grayscale images to binary

Image segmentation to find meaningful regions

RAGs, Watershed algorithms

Structural Similarity Index to measure distance between images

Thresholding

Thresholding

A method used to create a binary image from a grayscale image; more generally a way to tag pixels with one of a finite set of labels

Thresholding

Algorithm to classify pixels into different categories

Segment objects from the background

“Black or white”

“Foreground or background”

Two Kinds of Thresholding

Histogram-based

Assume properties for the histogram of pixel intensities

Local

Consider neighboring pixels while processing one pixel

Histogram-based

Assume properties for the histogram of pixel intensities

Global: Create histogram of all pixel intensities, then look for peaks

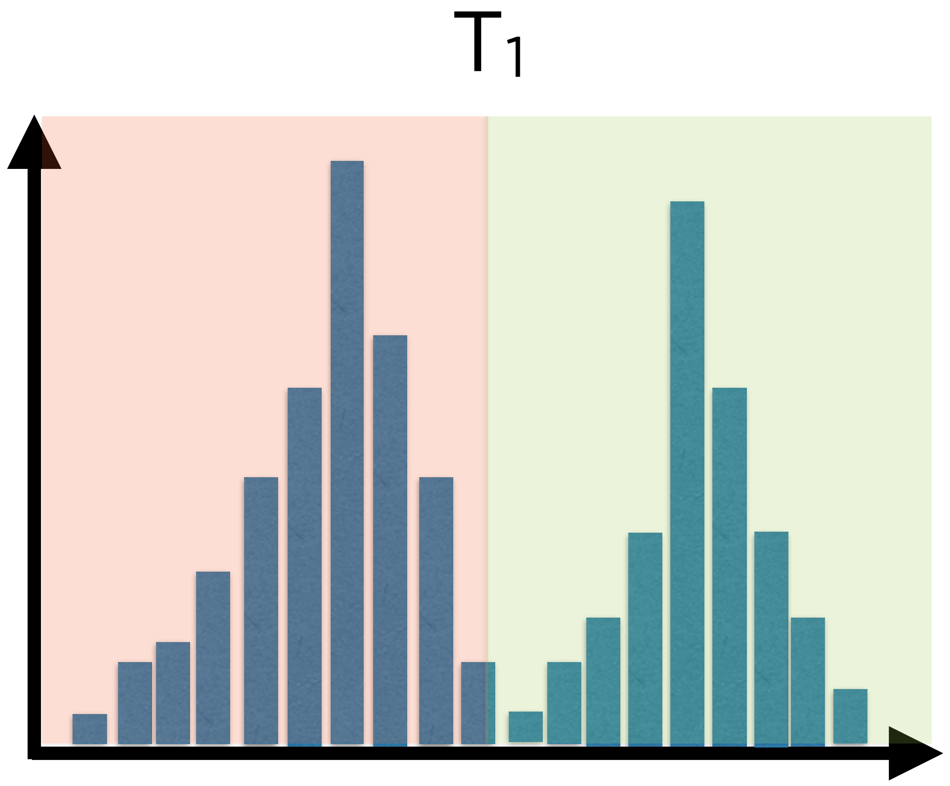
- Fast and efficient
- Ignores relationships

Local

Consider neighboring pixels while processing one pixel

Local: For each pixel, only consider intensities of neighbors

- Slower to compute
- Captures relationships between pixels

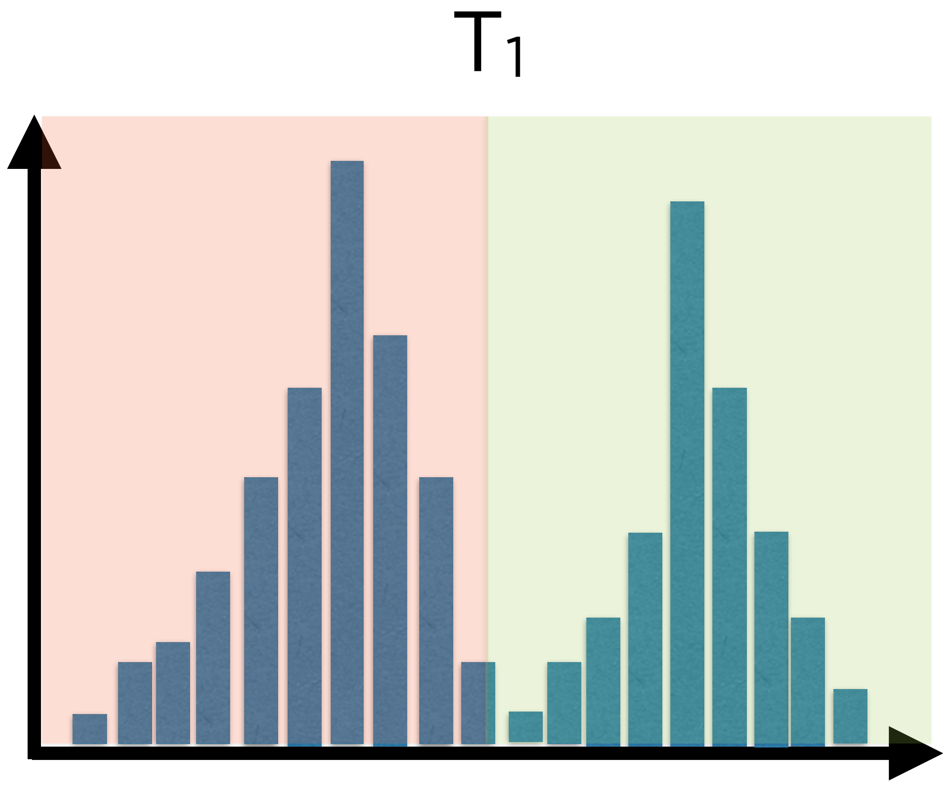


Global Thresholding

Global thresholding algorithms involve plotting histogram of all pixel values

Peaks in histograms correspond to the different labels

Global Thresholding



Bi-modal histogram: Binary image

Obvious application for clustering algorithm

Demo

Global and local thresholding

Segmentation

Image Segmentation

Partitioning an image into meaningful sets of pixels

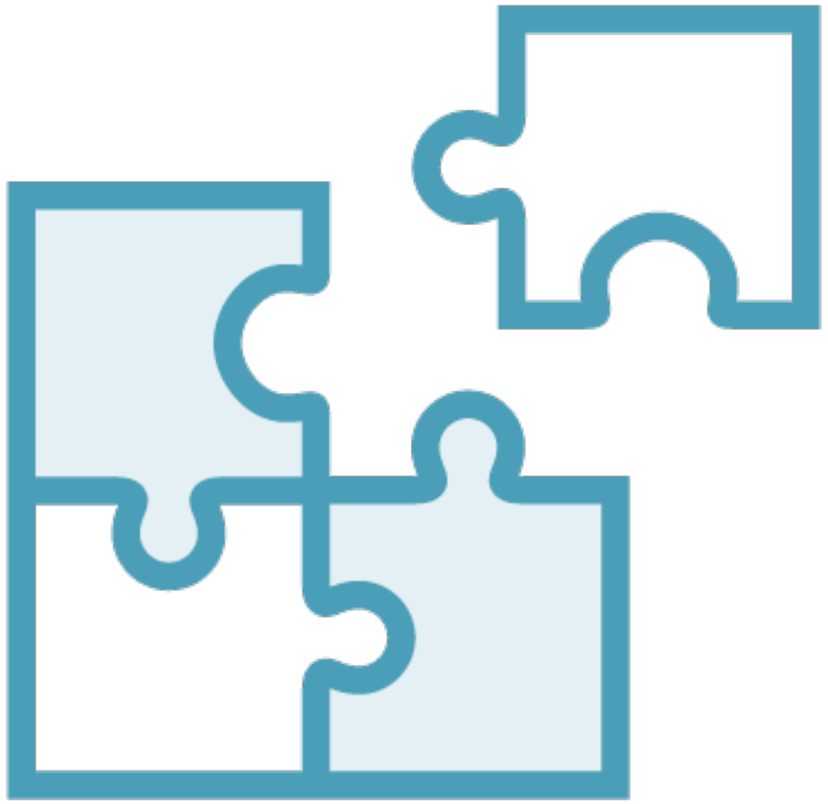
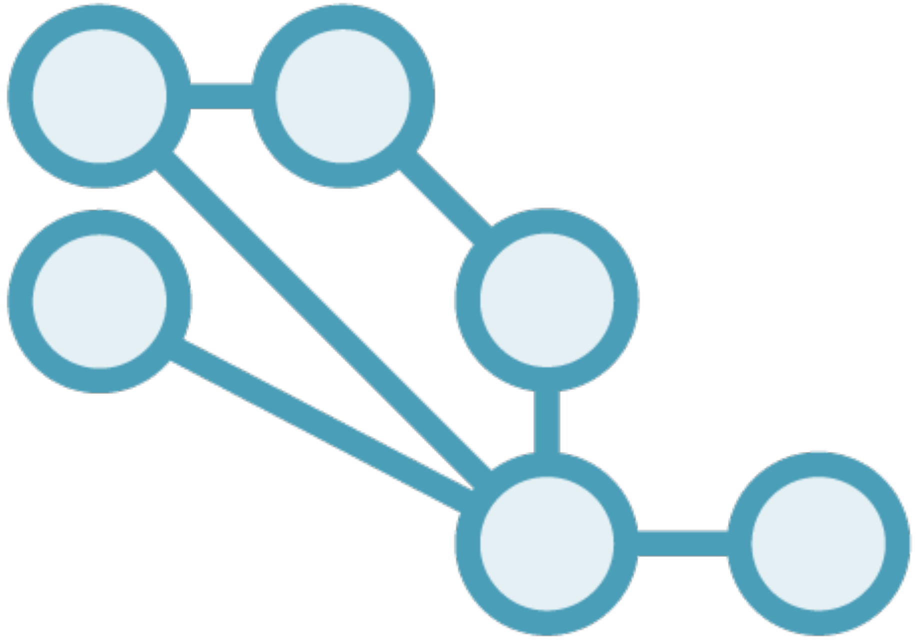


Image Segmentation

Object detection and tagging

Find pixels with similarities in

- color
- intensity
- texture
- contours



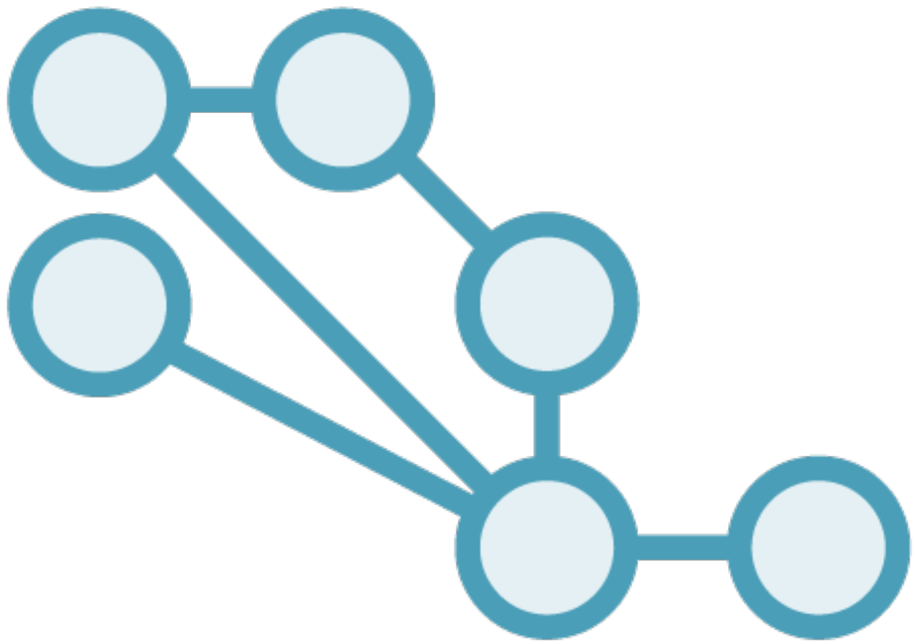
Region Adjacency Graphs (RAGs)

Data structure used in segmentation

Each region in image is represented as a graph node

Edges defined between regions

Weight of edge = Difference between average colors of pixels in each region

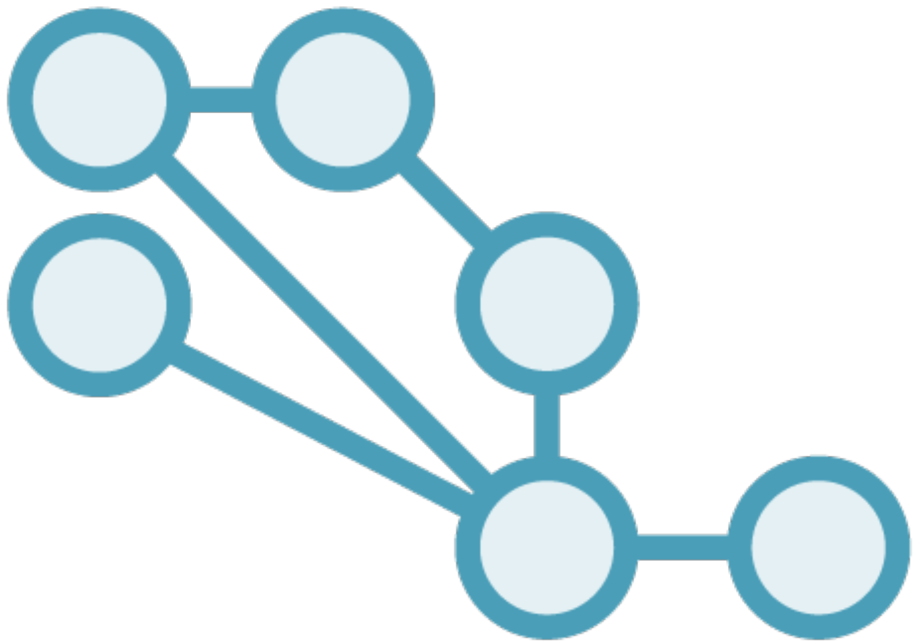


Region Adjacency Graphs (RAGs)

Weight of edge signifies difference between regions

Similar regions: weight of edge is small

Dissimilar regions: weight of edge is large



Region Adjacency Graphs (RAGs)

Progressively merge adjacent regions of similar color

Need threshold to define similar

Continue until no adjacent regions are similar

Demo

Image segmentation using RAGs

Watershed

Watershed

In image processing, this refers to a transformation that treats a grayscale image as a topographical map and finds lines between pixels of equal brightness. These lines are then used to segment the image into regions.

Watershed Algorithms

Watershed by flooding

Watershed by topographic distance

Watershed by drop of water principle

Watershed Algorithms

- Watershed by flooding
- Watershed by topographic distance
- Watershed by drop of water principle

Watershed by Flooding

A water source placed in each regional minimum

Will flood that region

Barriers are where different water sources meet

Compact Watershed

Smart choice of initial seeds

Mitigates problem of very uneven region sizes

Demo

Watershed algorithms

Demo

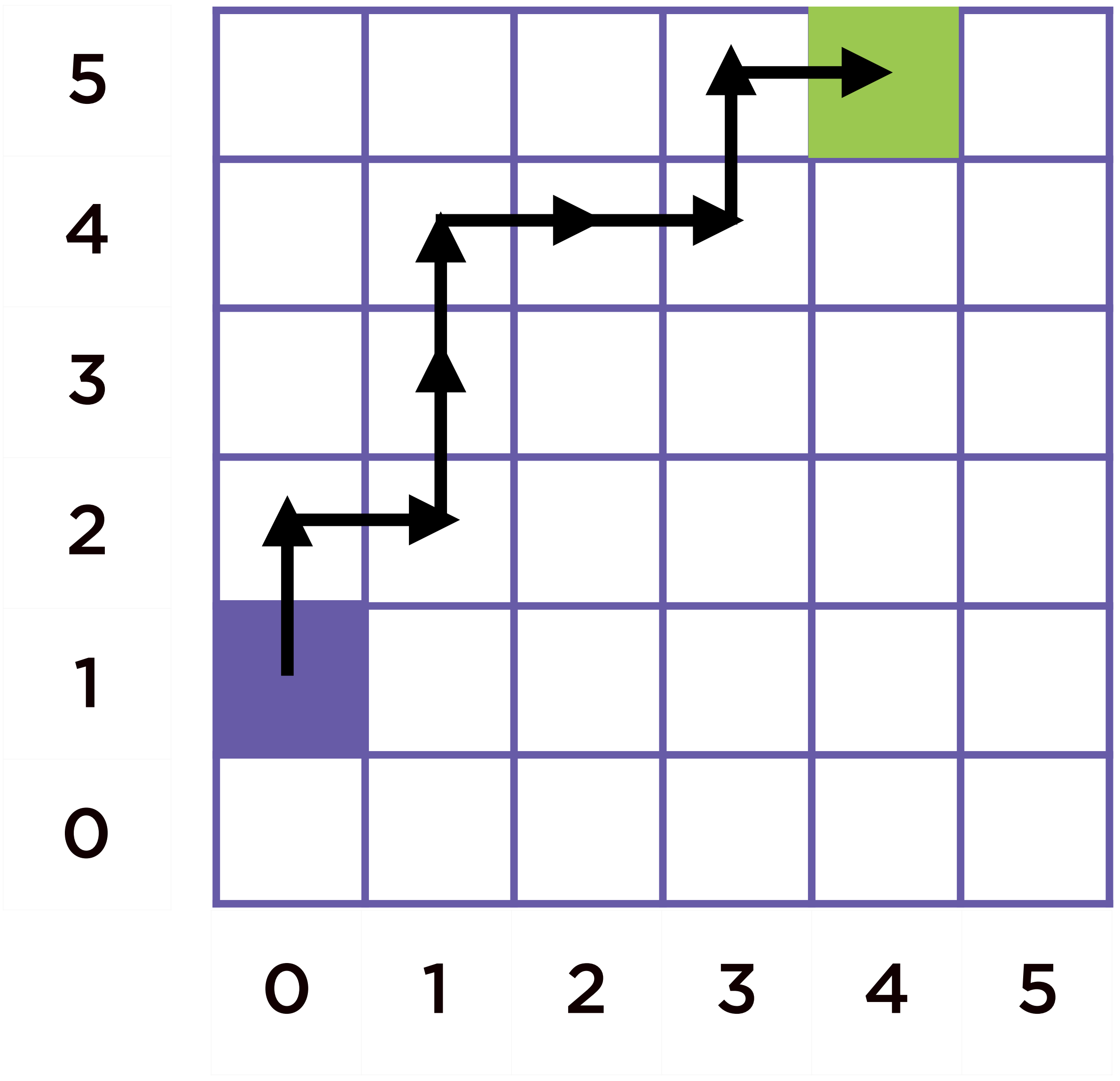
Transformation algorithms

Structural Similarity Index

Distance Measures

L1 distance

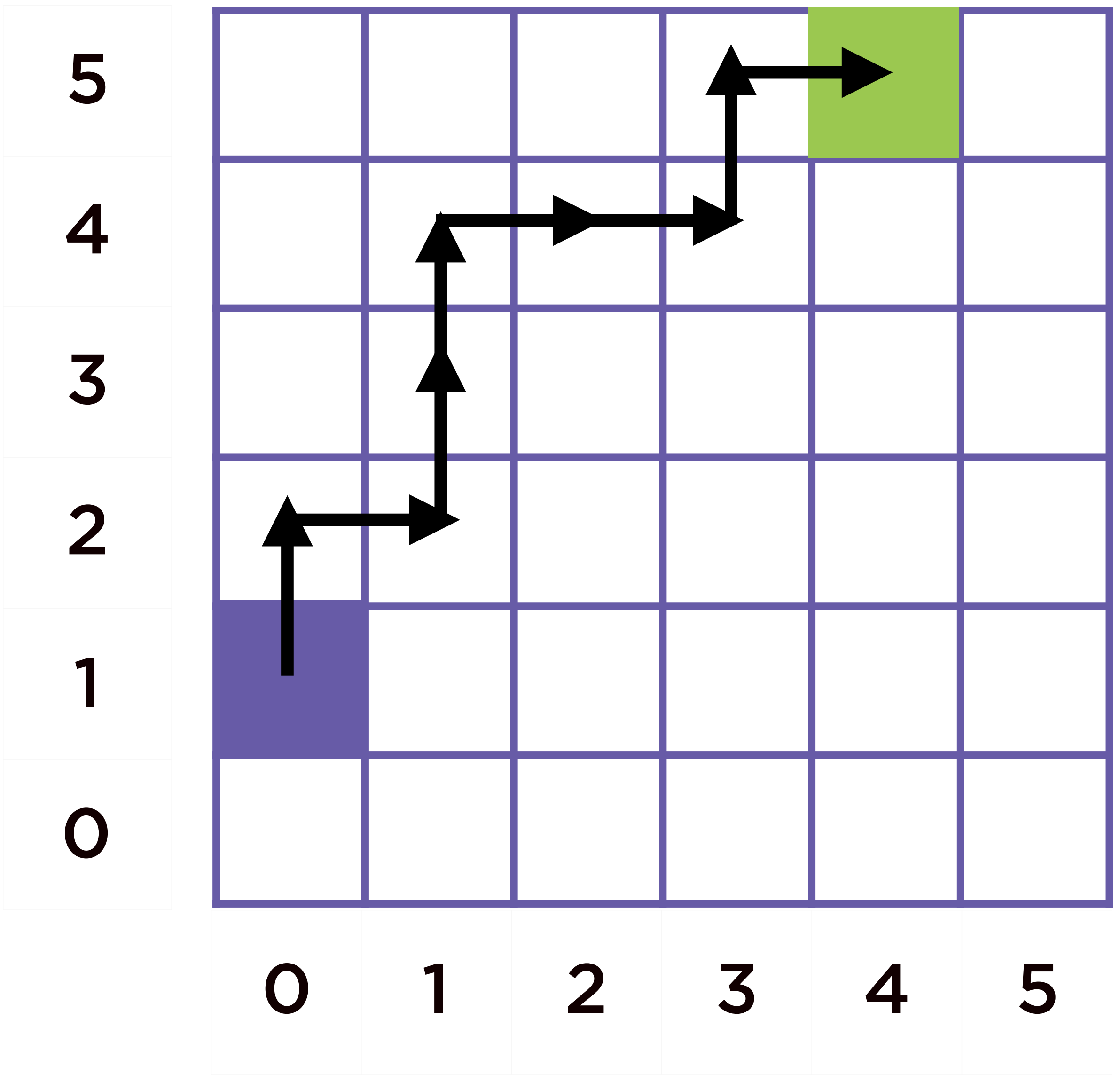
L2 distance



$|5\text{-}1| + |4\text{-}0| = 8$

Absolute values of x and y coordinates considered

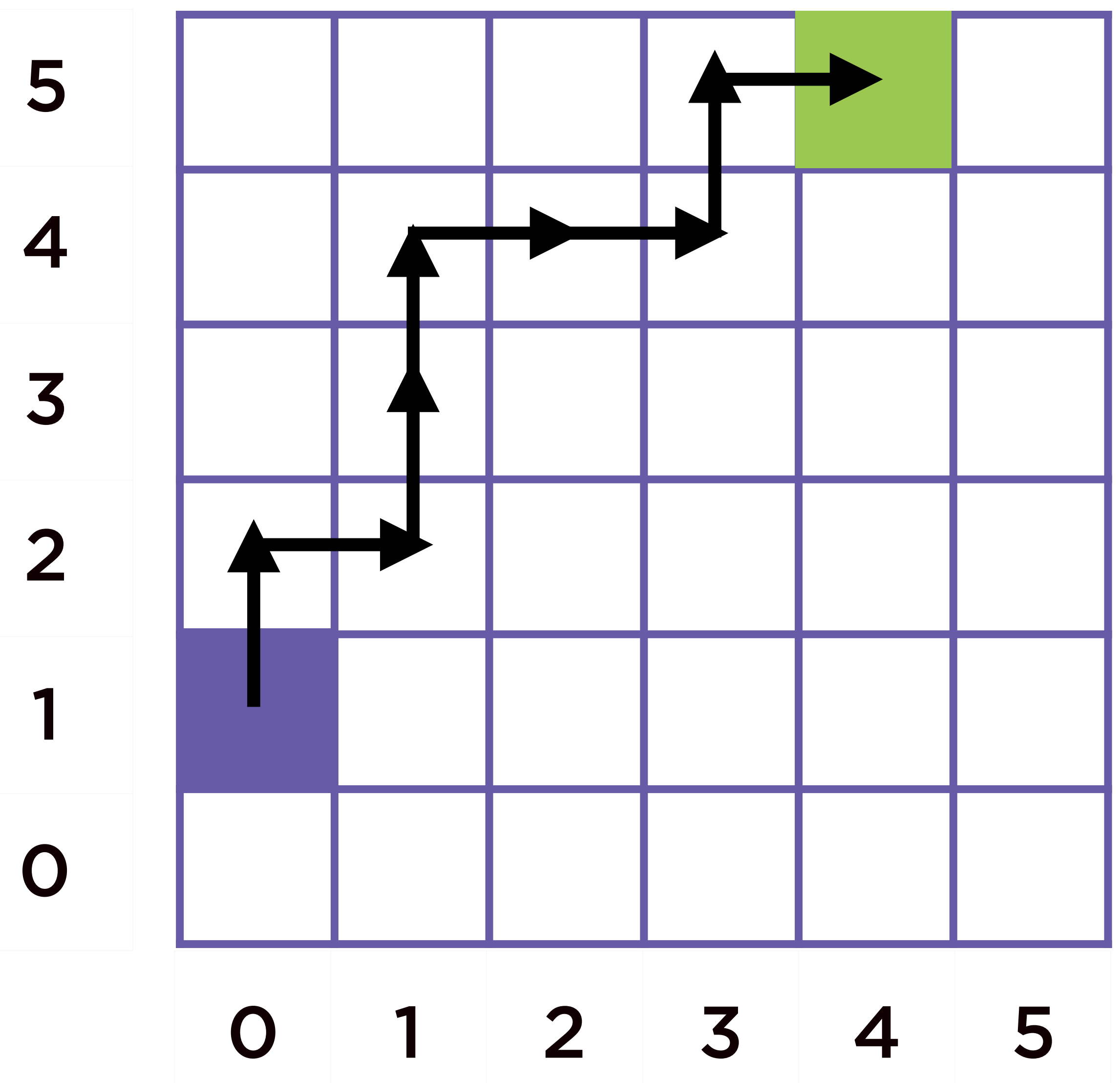
L1 Distance



$(5\text{-}1)^2 + (4\text{-}0)^2 = 32$

Square of the distance between coordinates

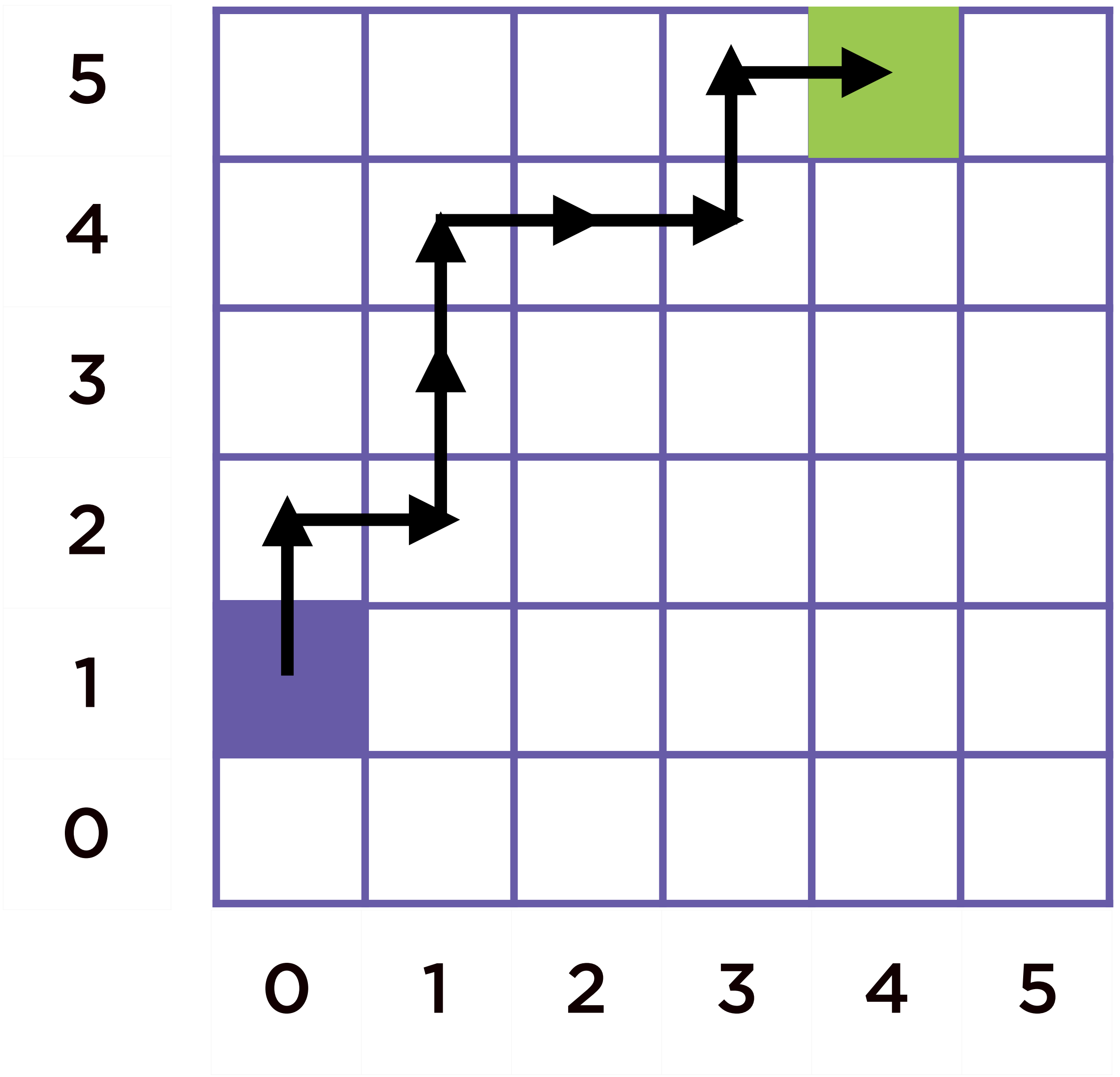
L2 Distance



L2 Distance / N

Find across all data points

Mean Square Error



MSE distance does not account for structural similarities between images

Structural Similarity Index

Structural Similarity Index

Given images A and B

```
SSIM(A, B) = L(A, B).C(A, B).S(A, B)
```

Where L = Luminance
C = Contrast
S = Structure

Structural Similarity Index

`-1 ≤ SSIM ≤ 1`

SSIM = 1 implies exact similarity

Demo

Compare MSE and SSIM when determining how similar images are

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Introduction to Machine Learning

Understanding Machine Learning with Python

Building Machine Learning Models in Python with scikit-learn

Python Packages for Data Science

Pandas Fundamentals

Introduction to Data Visualization in Python

Building Data Visualizations Using Plotly