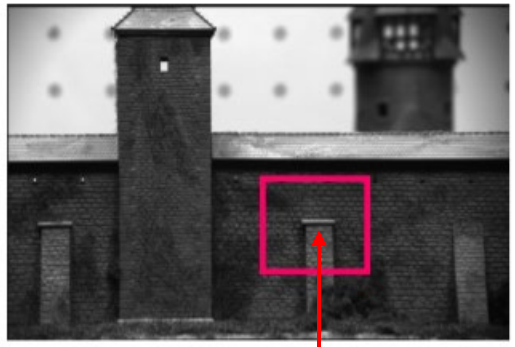
Template Matching

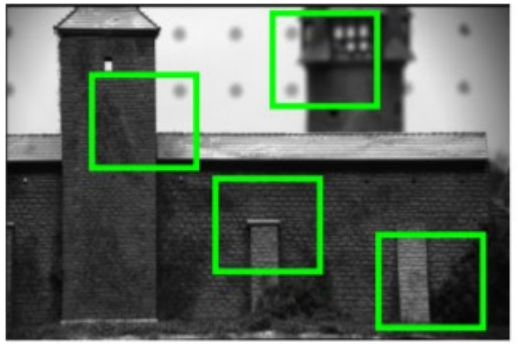
Adapted from R. Collins

Template Matching

Problem Statement: locate an object described by a template f(x,y) in the image g(x,y).



f(x,y)

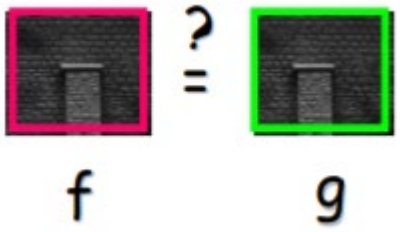


g(x,y)

Template Matching

1. Need an appearance similarity measure
2. Need a search strategy to find location with highest similarity. Simplest approach is exhaustive search

Comparing Windows:



- Some possible measures

$$\sum_{[i,j]\in R} |f(i,j) - g(i,j)|$$

$$SSD = \sum_{[i,j]\in R} (f(i,j) - g(i,j))^2$$

$$C_{fg} = \sum_{[i,j]\in R} f(i,j)g(i,j)$$

Most popular

Correlation-based Comparison

- We can think of correlation as comparing a template with each local image patch
- Cross correlation can be implemented by filtering the image using the template as the filter.

Image Patch 1

0	0	0
0	1	0
0	1	1

Image Patch 2

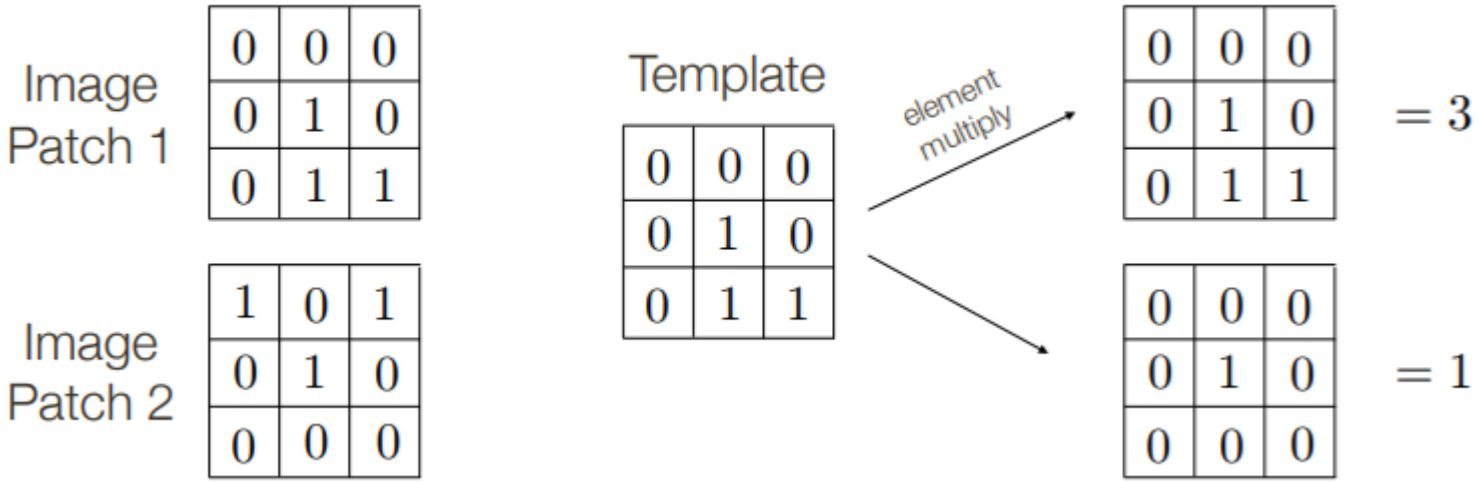
1	0	1
0	1	0
0	0	0

Template

0	0	0
0	1	0
0	1	1

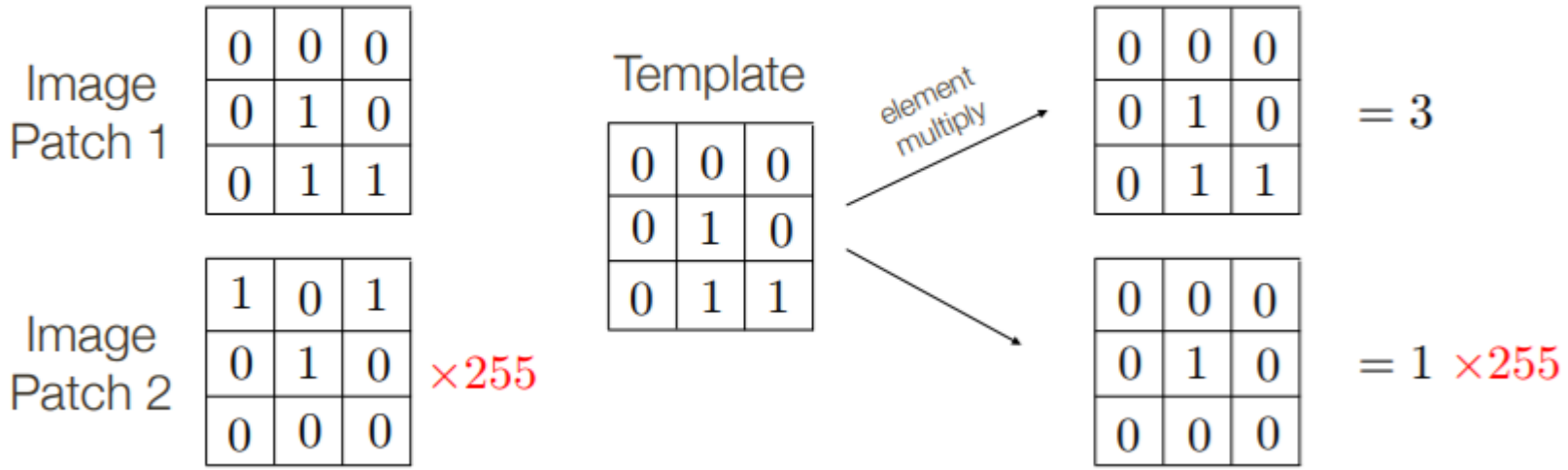
Correlation-based Comparison

- We can think of correlation as comparing a template with each local image patch
- Applying a filter can be interpreted as computing the dot product between the filter and the local image patch



Correlation-based Comparison

- However, the dot product may be large simply because the image region is bright. We need to normalize the result in some way.

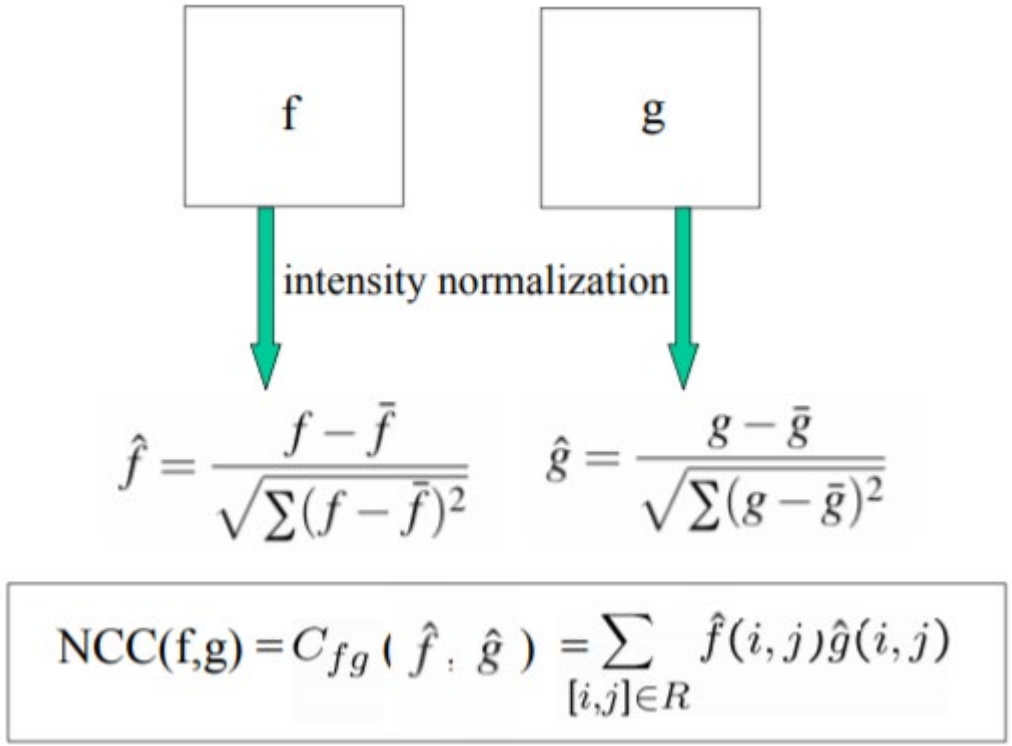


Better:

- Subtract off the mean value of the template and divide by the std dev
- Normalize the pixels in the windows by subtracting the mean of the patch intensities and dividing by the std dev

$$\hat{f} = \frac{f - \bar{f}}{\sqrt{\sum (f - \bar{f})^2}} \qquad \hat{g} = \frac{g - \bar{g}}{\sqrt{\sum (g - \bar{g})^2}}$$

Normalized Cross Correlation



Score values range from 1 (perfect match) to -1 (completely anti-correlated)

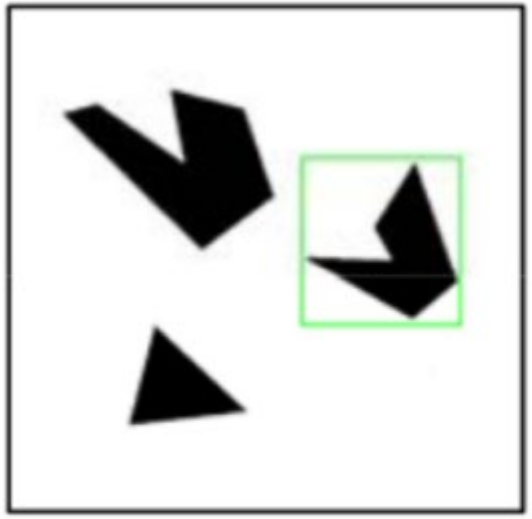
Template matching – Toy Example

Scene

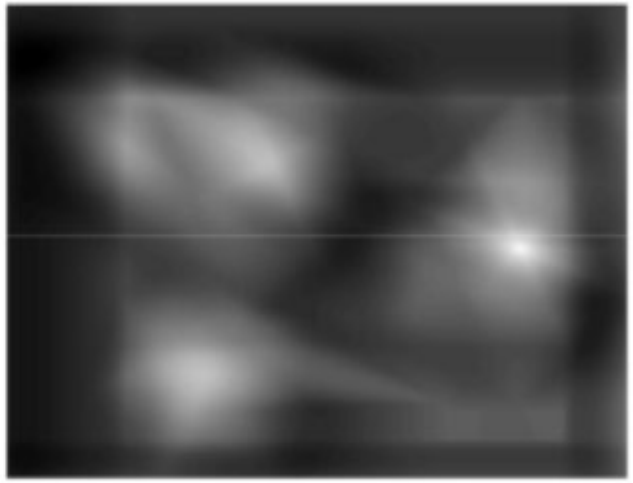
Template (mask)

Template matching – Toy Example

- Cross correlation with a filter can be viewed as comparing a little "picture" of what you want to find against all local regions in the image.
- For this reason, it is sometimes called "matched filtering"



Detected template



Correlation map

In MATLAB, use normxcorr2()