THE UNIVERSITY OF BRITISH COLUMBIA

CPSC 425: Computer Vision

Image Credit: https://docs.adaptive-vision.com/4.7/studio/machine_vision_guide/TemplateMatching.html

Lecture 6: Template Matching

(unless otherwise stated slides are taken or adopted from **Bob Woodham, Jim Little** and **Fred Tung**)

Template Matching

How can we find a part of one image that matches another?

or,

How can we find instances of a pattern in an image?

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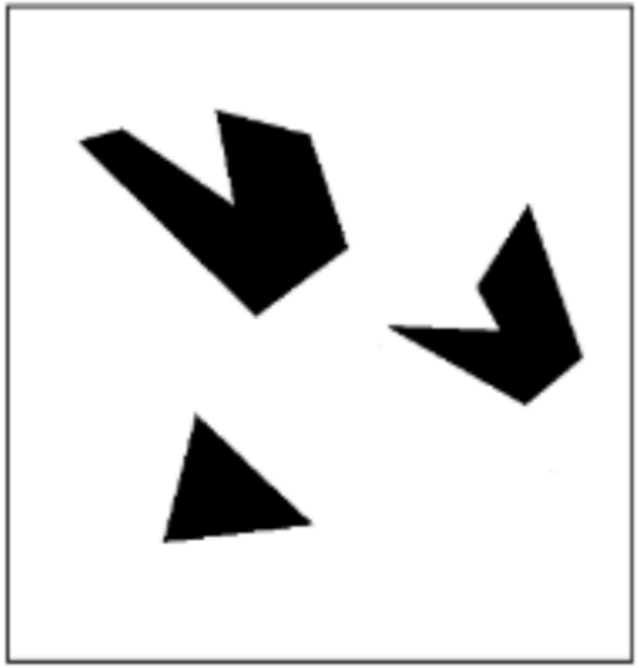
How can we find instances of a pattern in an image?

Key Idea: Use the pattern as a **template**

Template Matching



Scene

Template (mask)

A toy example

Slide Credit: Kristen Grauman

Template Matching

We can think of convolution/**correlation** as comparing a template (the filter) with each local image patch.

— Consider the filter and image patch as vectors.

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Template

0	0	0
0	1	0
0	1	1

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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

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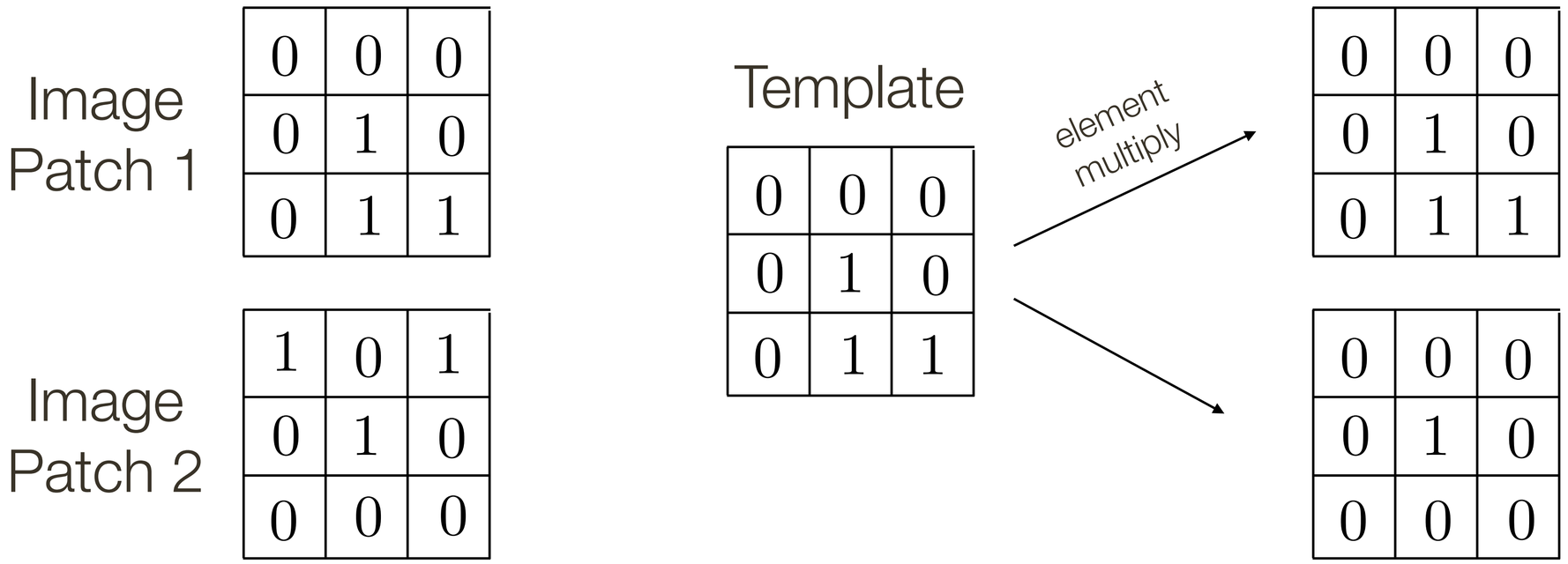

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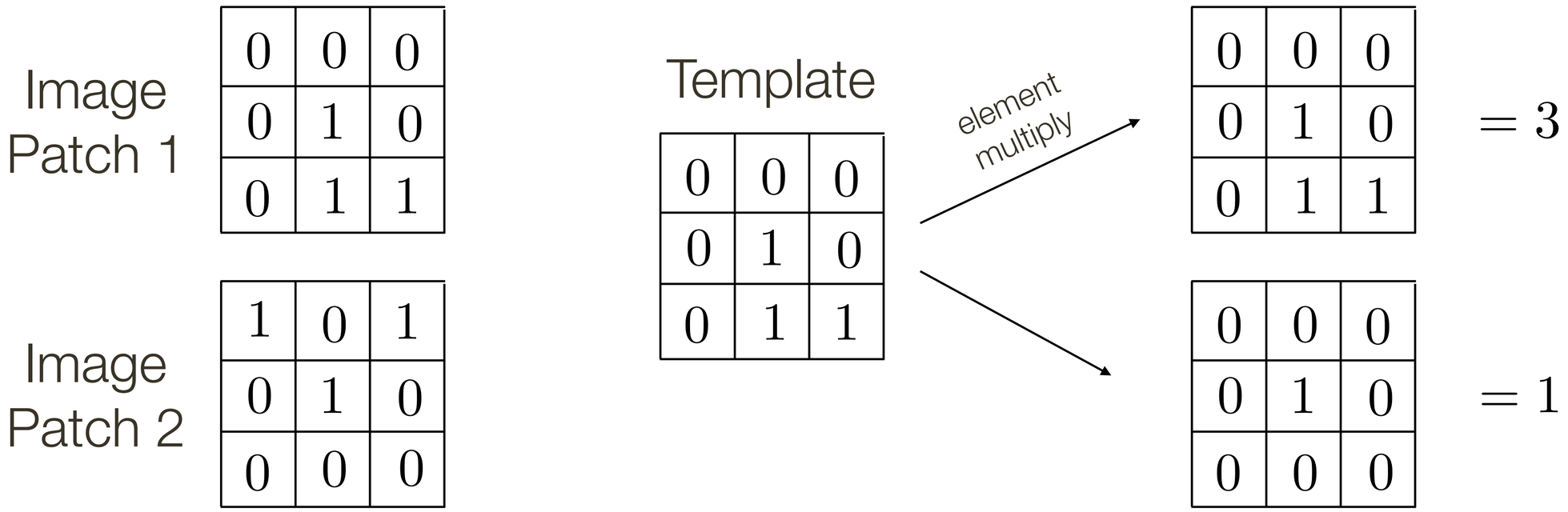

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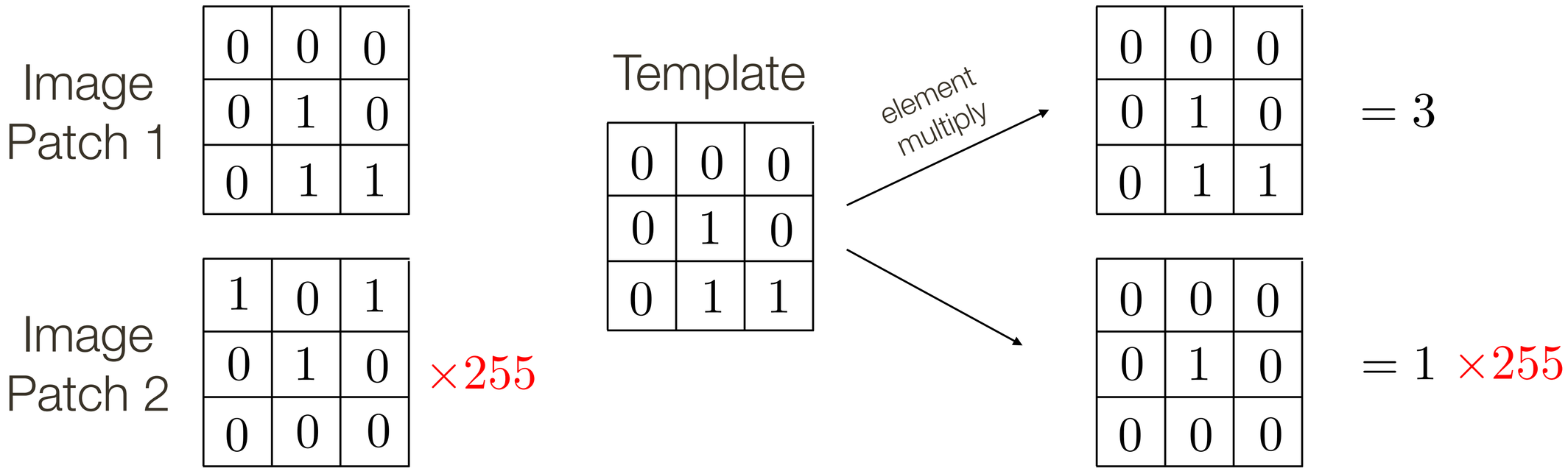

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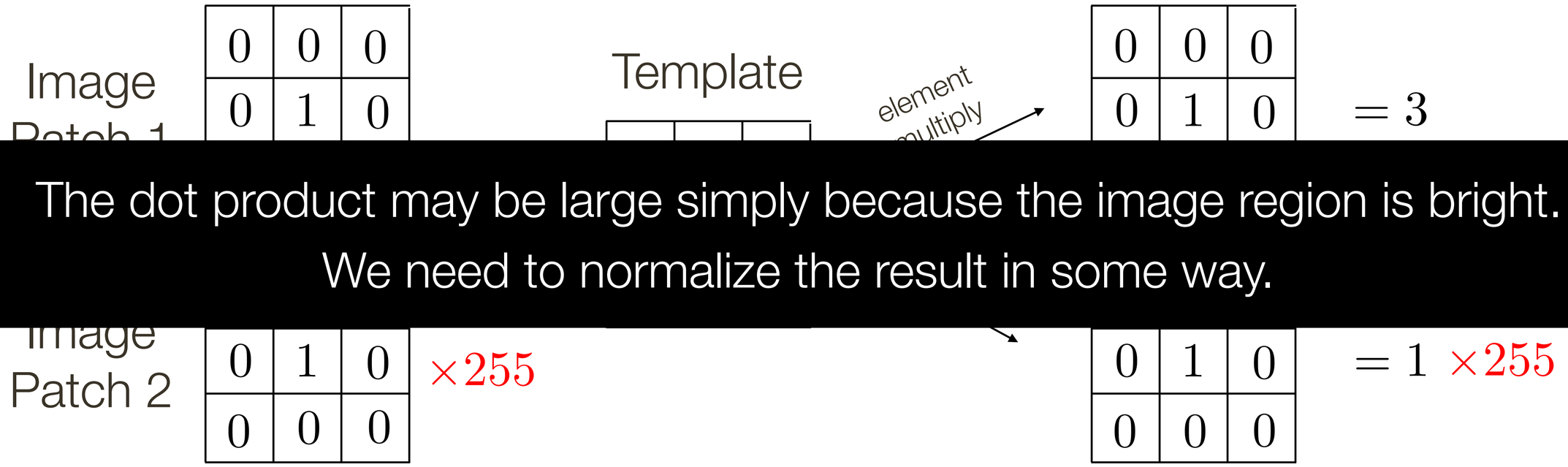


The dot product may be large simply because the image region is bright.

We need to normalize the result in some way.

Template Matching

Let a and b be vectors. Let θ be the angle between them. We know

$$\cos\theta = \frac{a \cdot b}{|a||b|} = \frac{a \cdot b}{\sqrt{(a \cdot a)(b \cdot b)}} = \frac{a}{|a|}\frac{b}{|b|}$$

where · is dot product and | | is vector magnitude

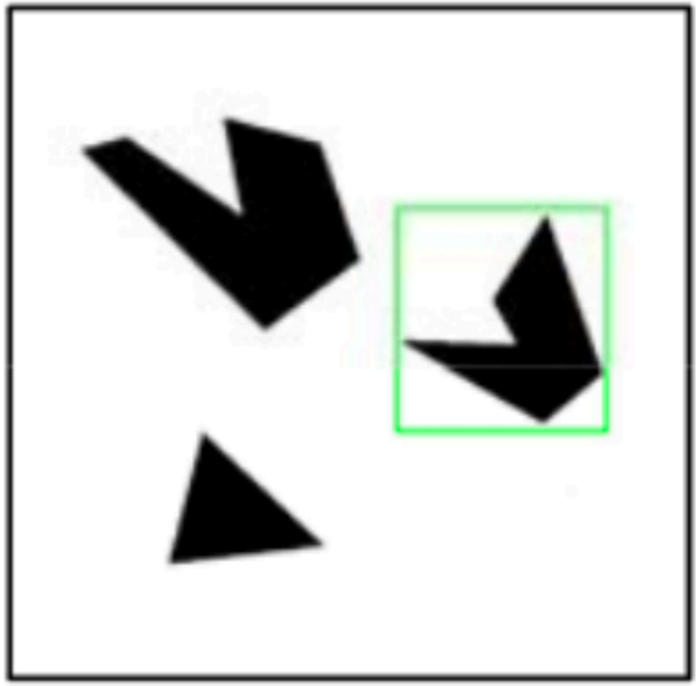
Correlation is a dot product

Correlation measures similarity between the filter and each local image region

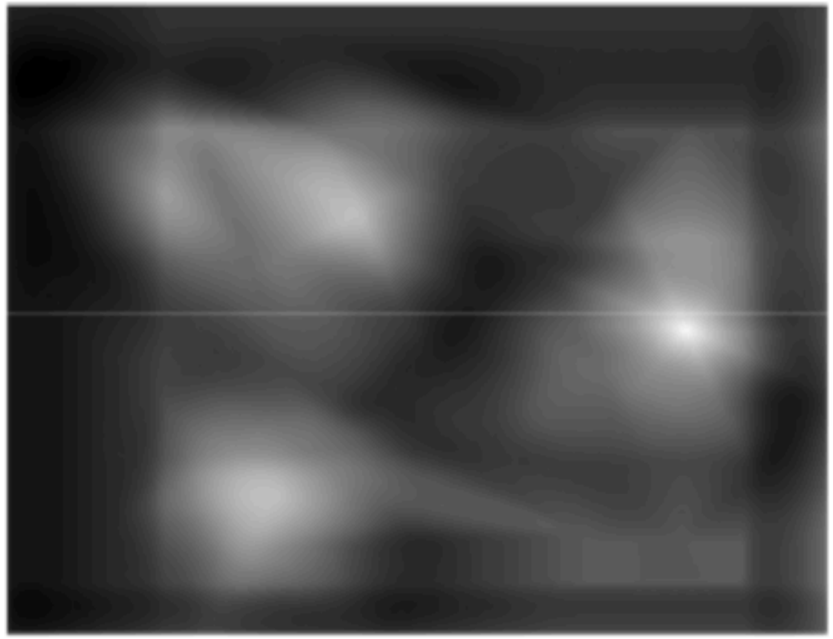
Normalized correlation varies between –1 and 1

Normalized correlation attains the value 1 when the filter and image region are identical (up to a scale factor)

Template Matching



Detected template



Correlation map

Slide Credit: Kristen Grauman

Template Matching

Linear filtering the entire image computes the entire set of dot products, one for each possible alignment of filter and image

Important Insight:

— filters look like the pattern they are intended to find

— filters find patterns they look like

Linear filtering is sometimes referred to as **template matching**