

Lab Nov 6st

template matching

- Problem
 - Noise spikes ruin detection

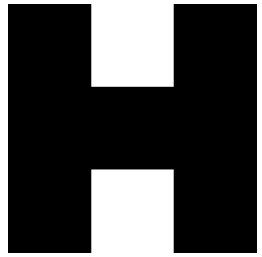
template matching

- Problem
 - Noise spikes ruin detection
- One solution
 - Normalize regions involved
 - Now, intensity distribution (balance between pixels in a window) matters, not absolute value

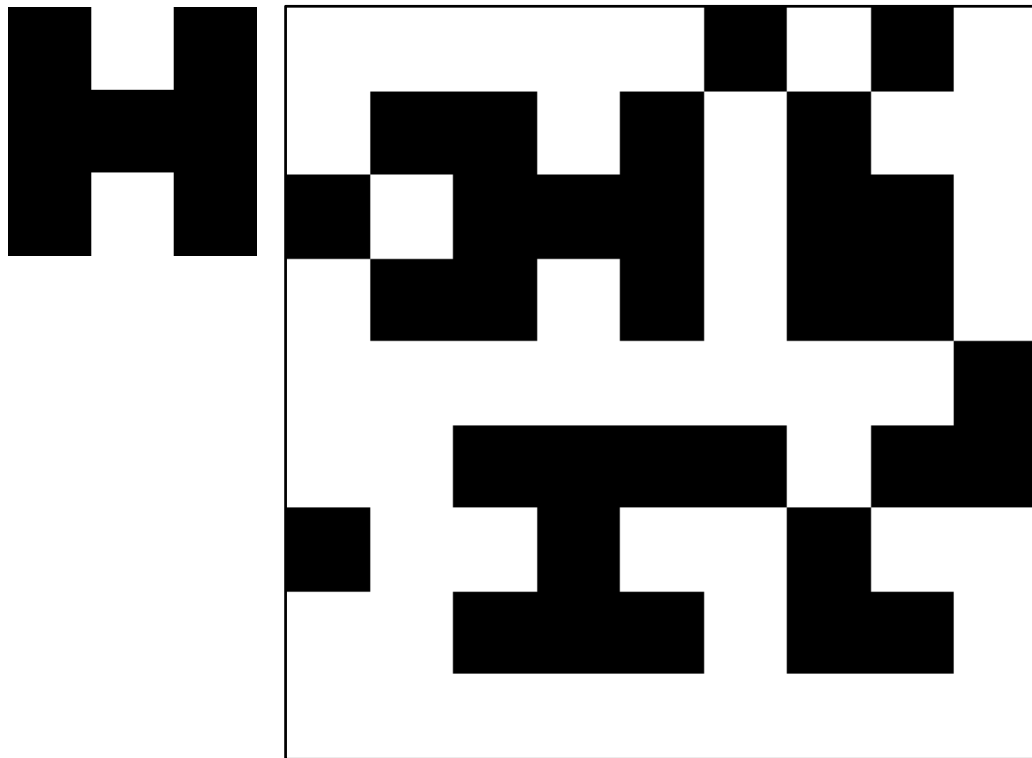
template matching

- Problem
 - Noise spikes ruin detection
- One solution
 - Normalize regions involved
 - Now, intensity distribution (balance between pixels in a window) matters, not absolute value
 - Normalized cross-correlation

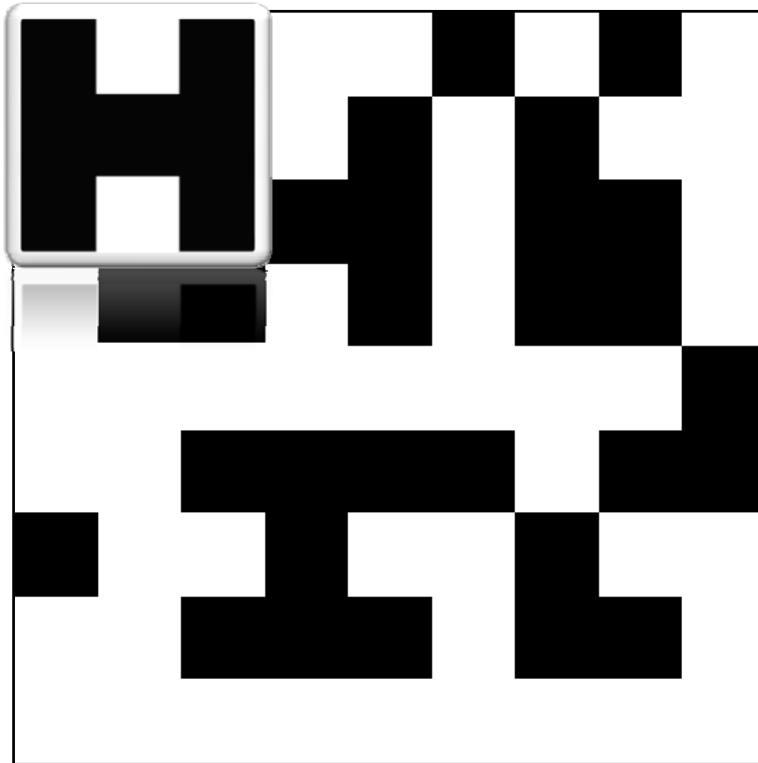
move template over image



move template over image

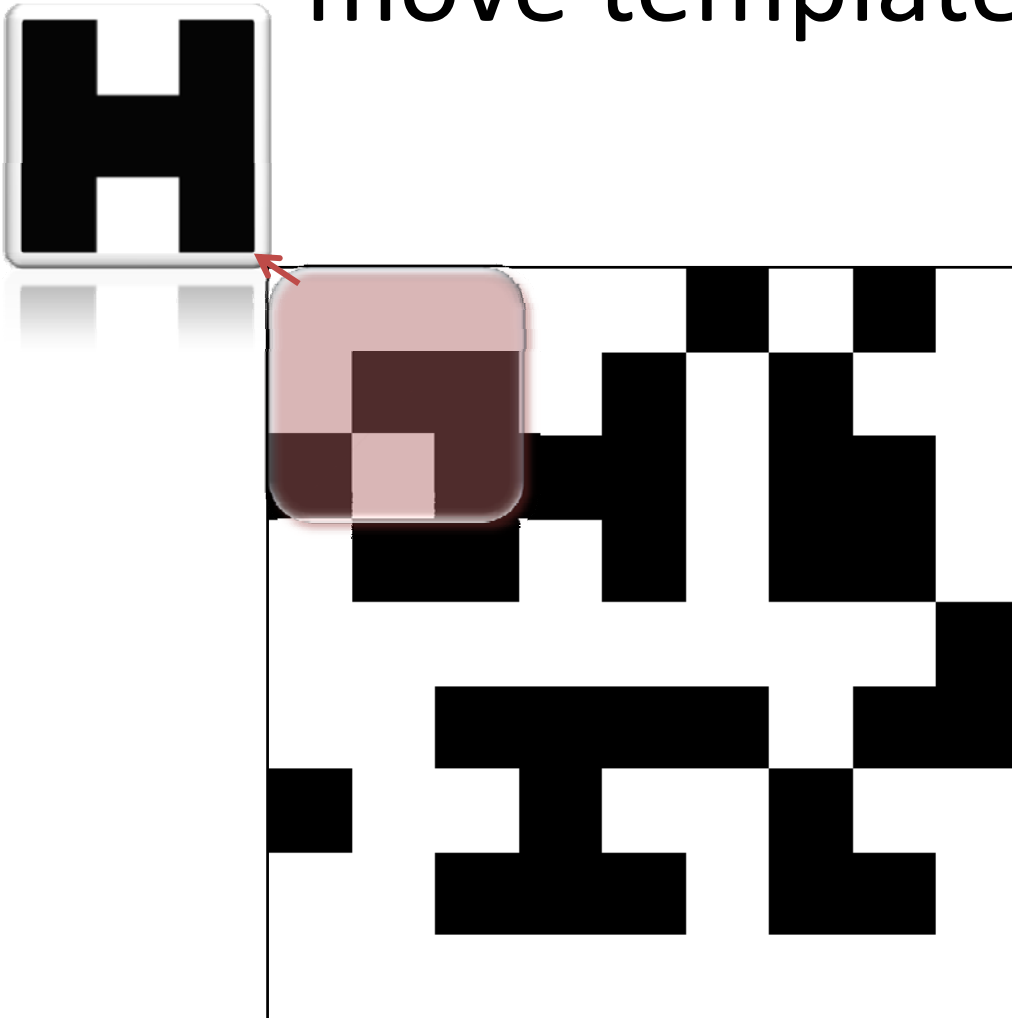


move template over image



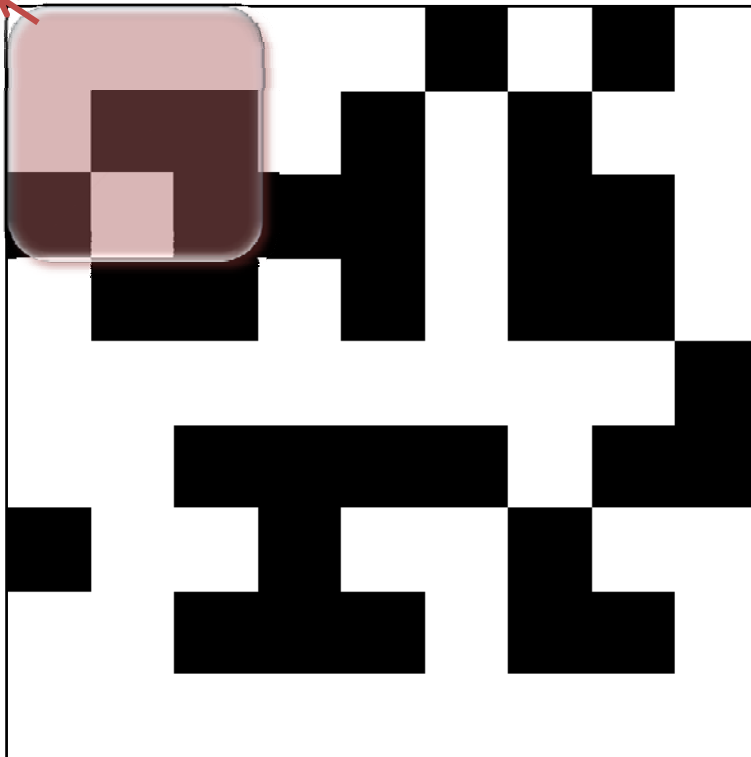
Calculate similarity at this point

move template over image



Calculate similarity at this point

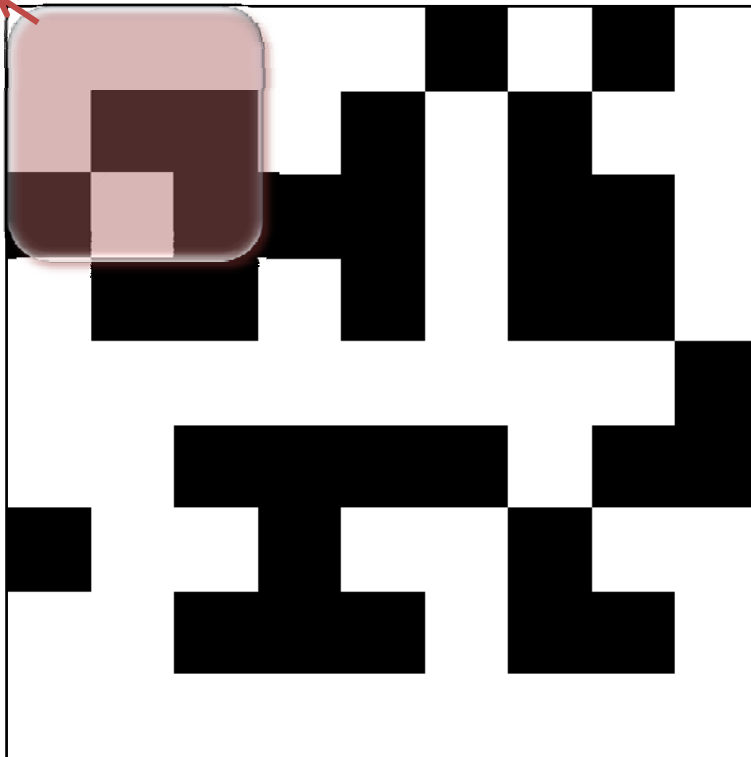
move template over image



Before comparing,
Normalize the regions

Calculate similarity at this point

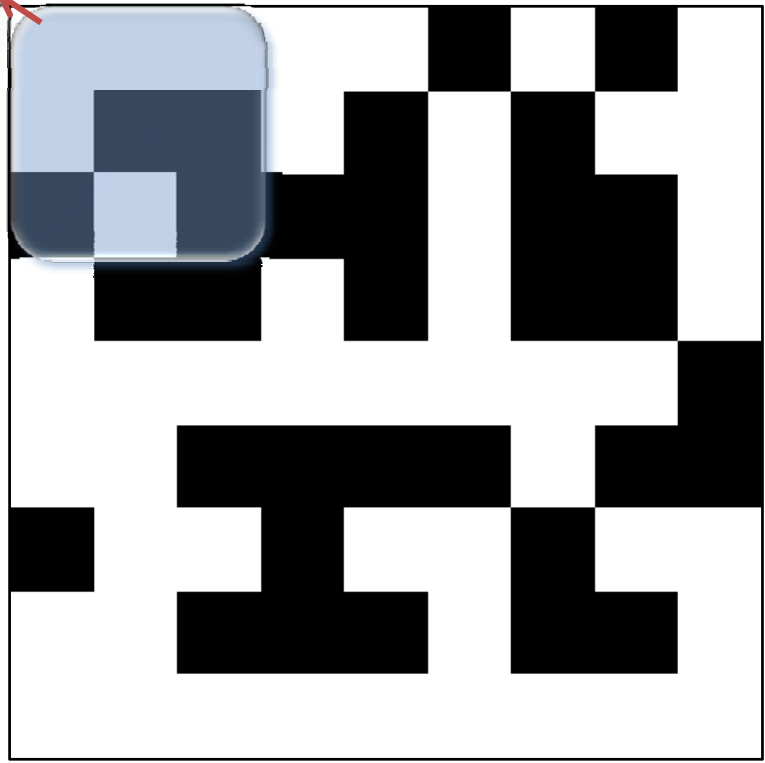
move template over image



Before comparing,
Normalize the regions

Calculate similarity at this point

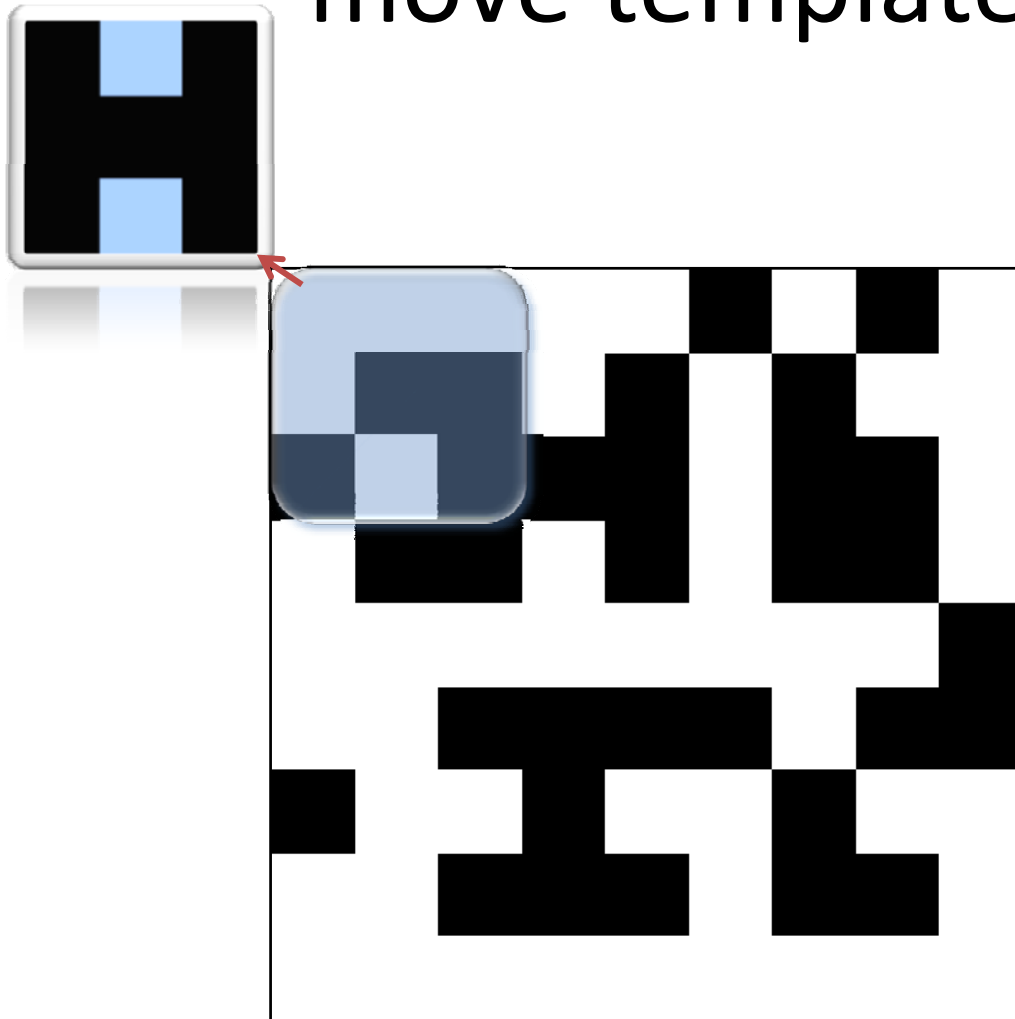
move template over image



Before comparing,
Normalize the regions

Calculate similarity at this point

move template over image

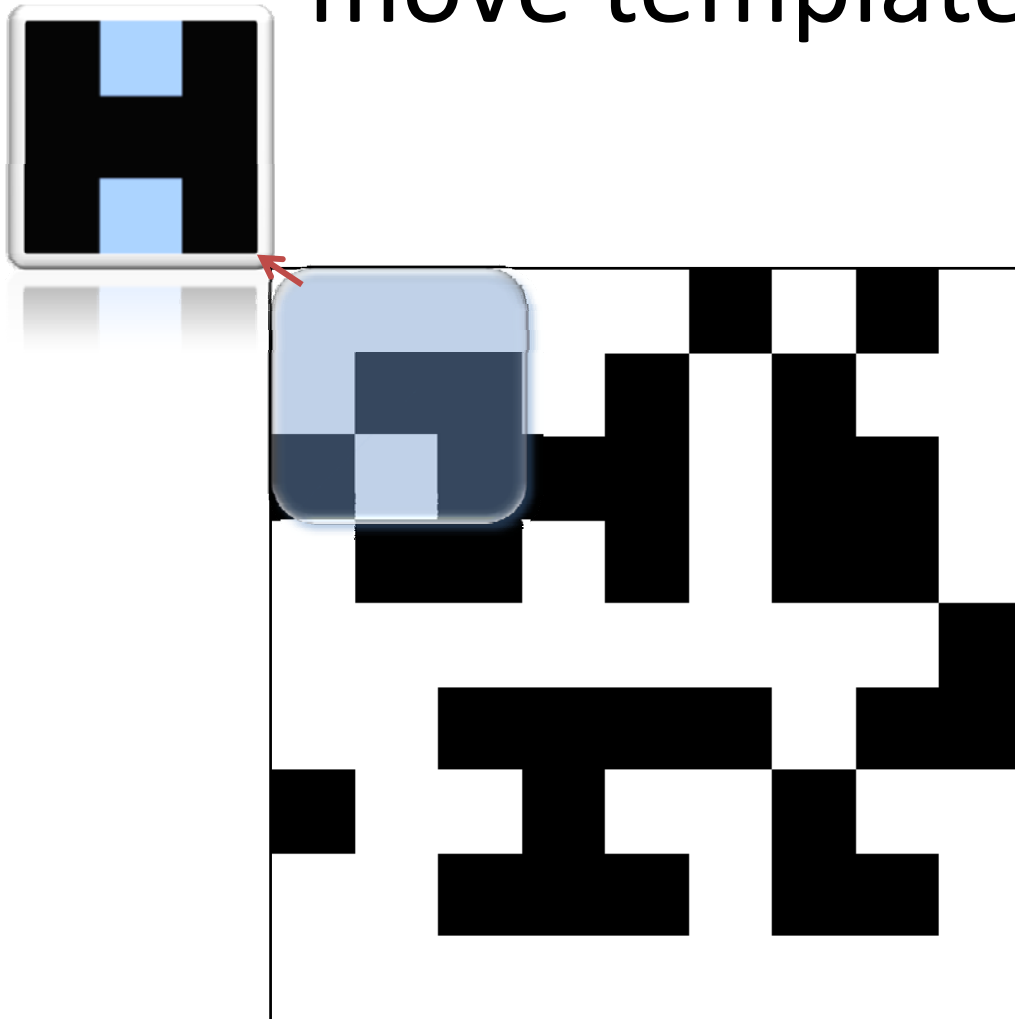


Before comparing,
Normalize the regions

Then do the correlation

Calculate similarity at this point

move template over image



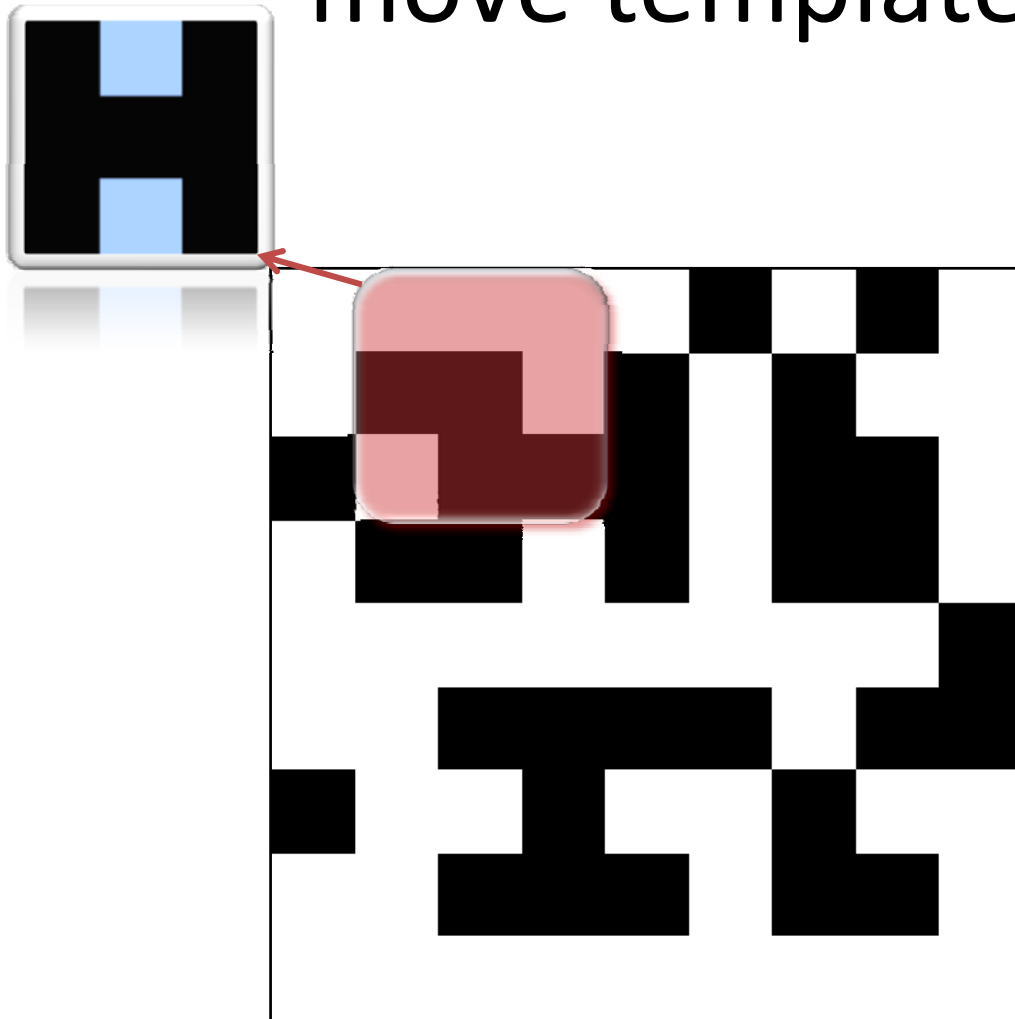
Before comparing,
Normalize the regions

Then do the correlation

However...when moving...

Calculate similarity at this point

move template over image



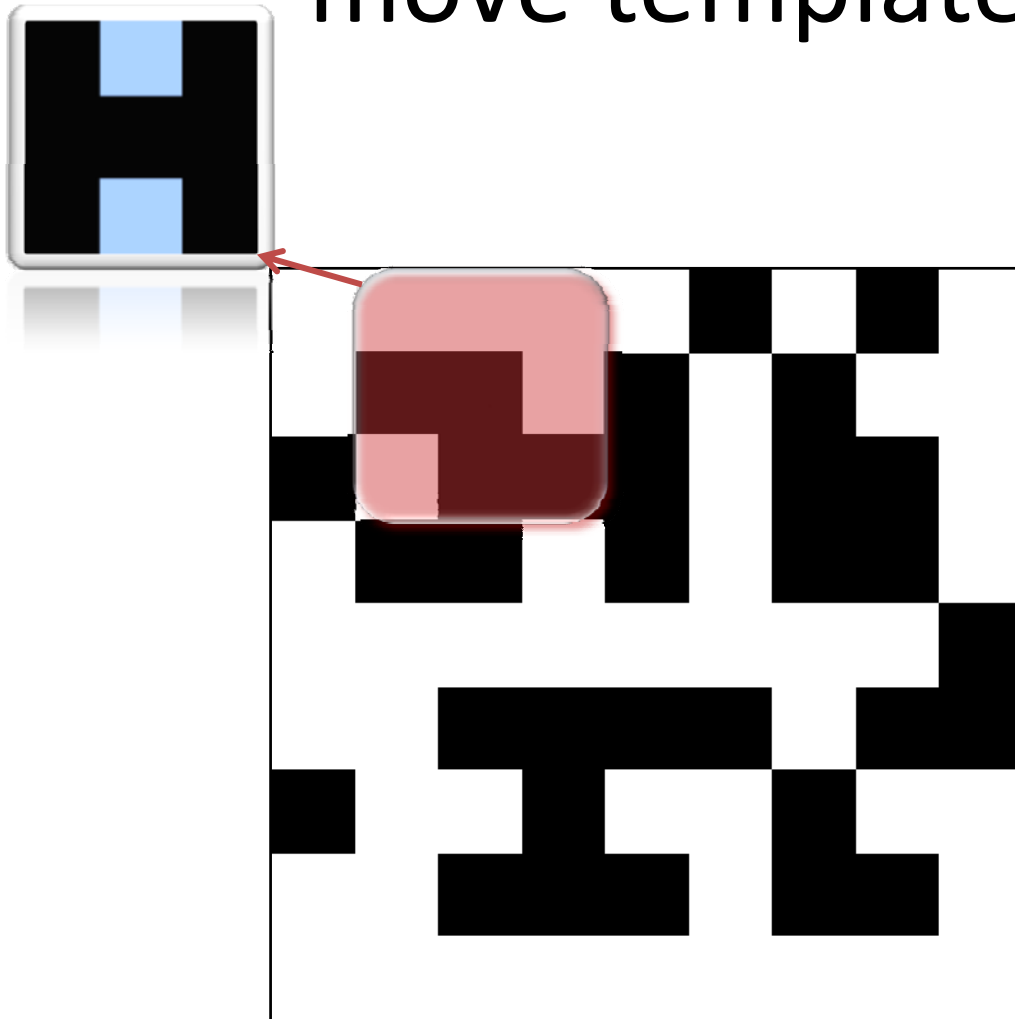
Before comparing,
Normalize the regions

Then do the correlation

However...when moving...

Calculate similarity at this point

move template over image



Before comparing,
Normalize the regions

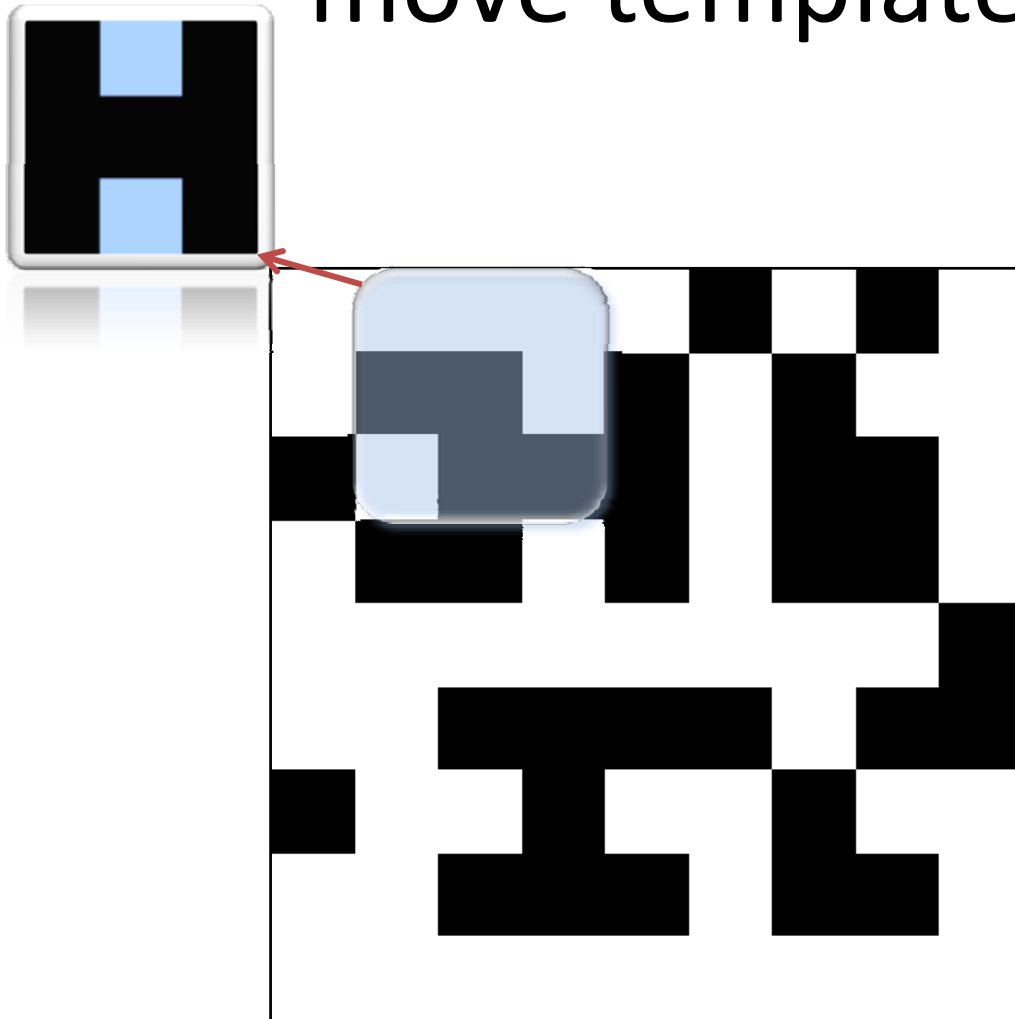
Then do the correlation

However...when moving...

Have to renormalize image
region

Calculate similarity at this point

move template over image



Before comparing,
Normalize the regions

Then do the correlation

However...when moving...

Have to renormalize image
region

Calculate similarity at this point

how to normalize

- Goal
 - Given template t image region r
 - $\text{crosscorrelate}(t,r) \rightarrow 1$ as match improves.
 - so, $\text{crosscorrelate}(t,t) = 1$
 - To do this, use variant of standard deviation

how to normalize

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$$T_n = T \cdot \frac{1}{\sqrt{\sum_{i=\Omega} (i)^2}}$$

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 - Given template t image region r
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 - so, $\text{crosscorrelate}(t,t) = 1$
 - To do this, use variant of standard deviation

$$T_n = T \cdot \frac{1}{\sqrt{\sum_{i=\Omega} (i)^2}}$$

$$R_n = R \cdot \frac{1}{\sqrt{\sum_{i=\Omega} (i)^2}}$$

Lets try one

- **Template** $\sigma = \sum_{\Omega} (i)^2 = \frac{1}{\sqrt{\sigma}}$ adjusted

1	1	1
1	0	0
1	1	1

- **Image region**

3	3	3
3	0	1
3	2	2

Lets try one

- **Template** $\sigma = \sum_{\Omega} (i)^2 = \frac{1}{\sqrt{\sigma}} =$ **adjusted**

1	1	1
1	0	0
1	1	1

7

- **Image region**

3	3	3
3	0	1
3	2	2

Lets try one

- **Template** $\sigma = \sum_{\Omega} (i)^2 = \frac{1}{\sqrt{\sigma}} =$ **adjusted**

1	1	1
1	0	0
1	1	1

7

$$\frac{1}{\sqrt{7}}$$

- **Image region**

3	3	3
3	0	1
3	2	2

Lets try one

- Template

1	1	1
1	0	0
1	1	1

$$\sigma = \sum_{\Omega} (i)^2 = 7$$
$$\frac{1}{\sqrt{\sigma}} = \frac{1}{\sqrt{7}}$$

adjusted

$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$
$\frac{1}{\sqrt{7}}$	0	0
$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$

- Image region

3	3	3
3	0	1
3	2	2

Lets try one

- Template

1	1	1
1	0	0
1	1	1

$$\sigma = \sum_{\Omega} (i)^2 = 7$$
$$\frac{1}{\sqrt{\sigma}} = \frac{1}{\sqrt{7}}$$

adjusted

$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$
$\frac{1}{\sqrt{7}}$	0	0
$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$

- Image region

3	3	3
3	0	1
3	2	2

54

Lets try one

- Template

1	1	1
1	0	0
1	1	1

$$\sigma = \sum_{\Omega} (i)^2 = \frac{1}{\sqrt{\sigma}} = 7 \frac{1}{\sqrt{7}}$$

adjusted

$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$
$\frac{1}{\sqrt{7}}$	0	0
$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$

- Image region

3	3	3
3	0	1
3	2	2

$$54 \frac{1}{\sqrt{54}} = \frac{1}{3\sqrt{6}}$$

Lets try one

- Template

1	1	1
1	0	0
1	1	1

$$\sigma = \sum_{\Omega} (i)^2 = \frac{1}{\sqrt{\sigma}} = \frac{1}{\sqrt{7}}$$

7

adjusted

$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$
$\frac{1}{\sqrt{7}}$	0	0
$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$

- Image region

3	3	3
3	0	1
3	2	2

$$54 \quad \frac{1}{\sqrt{54}} = \frac{1}{3\sqrt{6}}$$

$\frac{1}{\sqrt{6}}$	$\frac{1}{\sqrt{6}}$	$\frac{1}{\sqrt{6}}$
$\frac{1}{\sqrt{6}}$	0	$\frac{1}{3\sqrt{6}}$
$\frac{1}{\sqrt{6}}$	$\frac{2}{3\sqrt{6}}$	$\frac{2}{3\sqrt{6}}$

Lets try one... cross correlate

- **Template**

$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$
$\frac{1}{\sqrt{7}}$	0	0
$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$

- **Image**

$\frac{1}{\sqrt{6}}$	$\frac{1}{\sqrt{6}}$	$\frac{1}{\sqrt{6}}$
$\frac{1}{\sqrt{6}}$	0	$\frac{1}{3\sqrt{6}}$
$\frac{1}{\sqrt{6}}$	$\frac{2}{3\sqrt{6}}$	$\frac{2}{3\sqrt{6}}$

- **element-wise**

Lets try one... cross correlate

- **Template**

$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$
$\frac{1}{\sqrt{7}}$	0	0
$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$	$\frac{1}{\sqrt{7}}$

- **Image**

$\frac{1}{\sqrt{6}}$	$\frac{1}{\sqrt{6}}$	$\frac{1}{\sqrt{6}}$
$\frac{1}{\sqrt{6}}$	0	$\frac{1}{3\sqrt{6}}$
$\frac{1}{\sqrt{6}}$	$\frac{2}{3\sqrt{6}}$	$\frac{2}{3\sqrt{6}}$

- **element-wise**

$$5 \cdot \frac{1}{\sqrt{42}} + 2 \cdot \frac{2}{3\sqrt{42}} = .97725$$