1(a) $r(m,s) = \frac{1}{n}\sum_i \left(\frac{(s_i - \bar{s})(m_i - \bar{m})}{\sigma_s \sigma_m} \right)$

$$r(m, as+b) = \frac{1}{n}\sum_i \left(\frac{[as_i + b - \frac{1}{n}\sum_i (as_i + b)](m_i - \bar{m})}{\sigma_s \sigma_m} \right)$$

$$= \frac{1}{n}\sum_i \left(\frac{[as_i + b - a\frac{1}{n}\sum_i (s_i) + \frac{nb}{n}](m_i - \bar{m})}{\sigma_s \sigma_m} \right)$$

$$= \frac{1}{n}\sum_i \left(\frac{(as_i + b - a\bar{s} + b)(m_i - \bar{m})}{\sigma_s \sigma_m} \right)$$

$$= \frac{1}{n}\sum_i \left(\frac{a(s_i - \bar{s})(m_i - \bar{m})}{\sigma_s \sigma_m} \right)$$

$$= \frac{1}{n}\sum_i \left(\frac{a(s_i - \bar{s})(m_i - \bar{m})}{a\sigma_s \sigma_m} \right) \quad \{ \text{because } \sigma' s = a \cdot \sigma_s \}$$

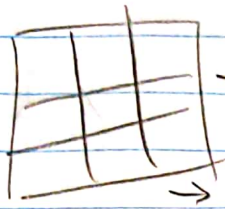
$$= r(m,s)$$

1(b) Useful for image analysis, especially template matching, under different lighting conditions.

1(c) Use it as a score to determine if the location and template matches. When NCC = 1, they are perfect match. When NCC = -1, they are an inverted match.

1(d) It is useful as it suggests that the image is not biased towards 1 or -1. This is good for template matching.

Q.2



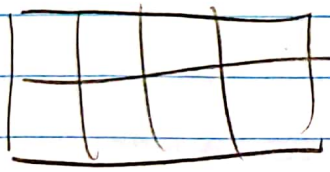
→ Compactness : $\frac{8^2}{9} = 7.1$

→ Second moment : $E_{min} = \frac{12}{2} - 0 - 0 = 6$

$E_{max} = \frac{12}{2} + 0 + 0 = 6$

$\frac{E_{min}}{E_{max}} = 1$

→ $\frac{\mu}{\sigma} = 5.828$



→ compactness $= \frac{8^2}{8} = 8$

→ second moment :

$E_{min} = \frac{12}{2} - \frac{(10-2)}{2}\left(\frac{8}{\sqrt{8^2+0^2}}\right) - 0$

$= 6 - 4 = 2$

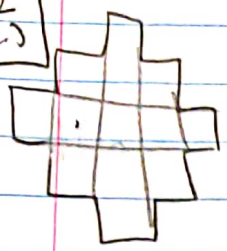
$E_{max} = \frac{12}{2} + \frac{(10-2)}{2}(1) + 0$

$= 6 + 4 + 0 = 10$

$\frac{E_{min}}{E_{max}} = \frac{2}{10} = \frac{1}{5}$

→ $\frac{\mu}{\sigma} = 2.618$

Q.2 (cont.)



→ compactness: $\frac{8^2}{13} = 4.923$

→ $E_{min} = 14 - 0 + 0 = 14$

$E_{max} = 14 + 0 + 0 = 14$

$\frac{E_{min}}{E_{max}} = 1$

→ $\frac{M}{\sigma} = \frac{\frac{1}{8}(8+4\sqrt{2})}{\sqrt{\frac{1}{8}(16+8) - \left[\frac{1}{8}(8+4\sqrt{2})\right]^2}} = 5.828$

→ compactness = $\frac{10^2}{10} = 10$

→ $E_{min} = 20.625 - 20.625$

$= 0$

$E_{max} = 41.25 + 41.25$

$= 82.5$

$\frac{E_{min}}{E_{max}} = 0$

→ $\frac{M}{\sigma} = 1.768$

Q.3

		true	
		Cat	Dog
hypo	Cat	64	24
	Dog	36	56

$acc = \frac{64+56}{180} = 0.67$

$prec = \frac{64}{88} = 0.7272$

$recall = \frac{64}{100} = 0.640$