$$CC = \frac{\sum (x-\bar{x})(y-\bar{y})}{\left[\sum (x-\bar{x})^2 \sum (y-\bar{y})^2\right]^{1/2}}$$

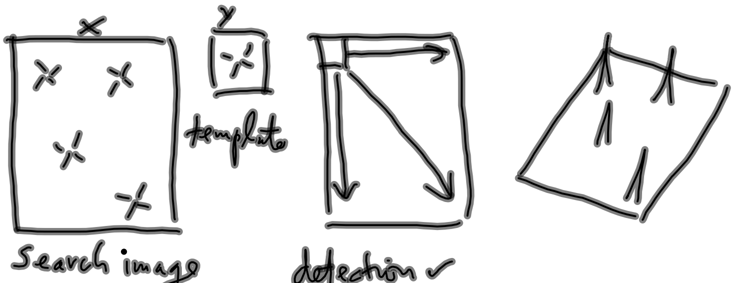
Sample Corr. Coeff.

27-1

X : Left image

Y : Right image

$-1 \to +1$



detection ✓

location ✓

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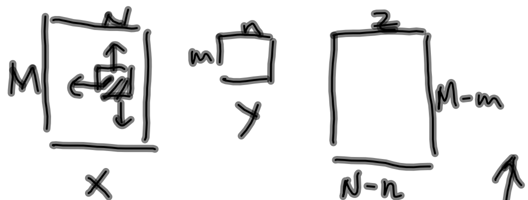

xbar = sumx / (m*n)

ybar = sumy / (m*n)

27-2

```
For I = 1 : M-m
  for J = 1 : N-n
    sumx = 0
    sumy = 0
    for i = 1:m
      for j = 1:n
        ii = I + i - 1
        jj = J + j - 1
        sumx = sumx + X(ii, jj)
        sumy = sumy + Y(i, j)
      end
    end
```

```
num = 0
denx = 0
deny = 0
for i = 1:m
  for j = 1:n
    ii = I + i - 1
    jj = J + j - 1
```

(init Z @ begin.
Z = zeros(M-m, N-n))

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27-3

```
num = num + (x(ii,jj) - xbar)*(y(i,j) - ybar)
denx = denx + (x(ii,jj) - xbar)^2
deny = deny + (y(i,j) - ybar)^2
end
end
cc = num/sqrt(denx * deny)
Z(I,J) = cc ;
end
end
```

follow with threshold operation

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motivation

27-4

- need to do CC (SD)
- can implement fast CC as convolution in FD ⟸
- need to understand convolution & relation to CC
  - response to impulse (LS)
  - response to complicated signal rep as collection of impulses

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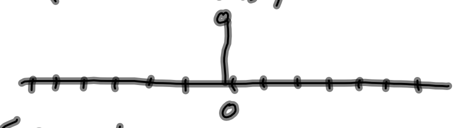
<u>Linear Systems</u> ref. Signals + systems Oppenheim + willsky 27.5

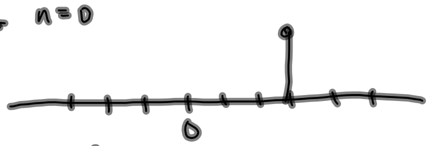
<u>discrete</u> (vs. continuous)

$\delta(n)$

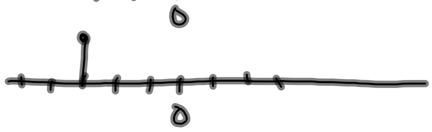


$$\delta(n) = \begin{cases} 0 & n \neq 0 \\ 1 & n = 0 \end{cases}$$

$\delta(n-3)$



$\delta(n+3)$



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linearity 27.6

$$\left.\begin{array}{l} I_1 \to O_1 \\ I_2 \to O_2 \end{array}\right\} \quad I_1 + I_2 \to O_1 + O_2$$

output of a sum = sum of outputs

$kI \to kO$

LTI linear time invariant

LTI systems posess property of <u>Superposition</u>

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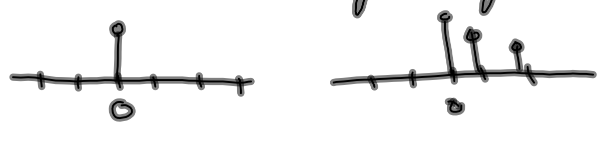
27.7

if input is linear combination of set of basic signals, then output will be superposition of the responses to those basic signals

$$x(n) = \sum_{k=-\infty}^{+\infty} x(k) \underline{\delta(n-k)}$$ sifting property of unit impulse

$\delta(n) \longrightarrow h(n)$ impulse response



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27-8

$$\boxed{y(n) = \sum_{k=-\infty}^{+\infty} x(k)\, h(n-k)}$$

assume zero mean data

$\bar{x}, \bar{y} = 0$

convolution sum or superposition sum

<u>convolution:</u>
- two functions
- time reverse
- slide it by first one
- multiply + add
- TD, SD

<u>cross correlation</u>

<u>no time reversal</u>

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27.9

$$x(n) = \sum_{k=-\infty}^{+\infty} x(k)\,\delta(n-k)$$

$$y(n) = \sum_{k=-\infty}^{+\infty} x(k)\,h(n-k)$$

assume $h(n-k)$ only nonzero for
$n-k = 0, 1, 2$

$$y(n) = x(n-2)\,h(2) + x(n-1)\,h(1) + x(n)\,h(0)$$

$(k=n-2)$

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27.10

$x(n-2)\,h(0)$	$x(n-2)\,h(1)$	$x(n-2)\,h(2)$	
	$x(n-1)\,h(0)$	$x(n-1)\,h(1)$	$x(n-1)\,h(2)$
		$x(n)\,h(0)$	...

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