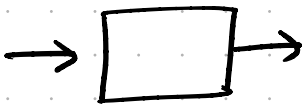
Convolution Properties.

Mathematical Properties.

- Convolution is the order in which two signals are makes difference; the result is

IF  THEN 

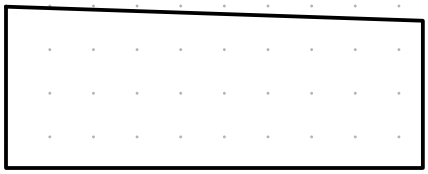
IF $y[n] = \sum_{k=-\infty}^{\infty} x[k] \cdot h[n-k]$

let. $l =$ $\Rightarrow k =$

THEN

↓

for a sum the order doesn't matter



It is possible to convolve 3 or more signals?

→

$x[n]$ want to convolve with both $h_1[n]$ $h_2[n]$

Convolve two of the signals to produce an intermediate signal

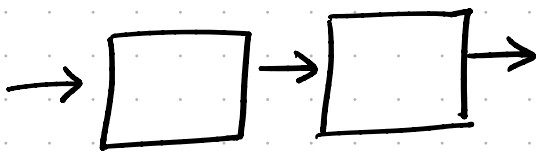
intermediate signal

then we convole the intermediate signal to the third signal

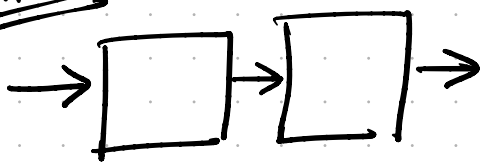
What should be the order of $h_1[n]$ $h_2[n]$

- convolution is → used in system theory to describe how systems behave

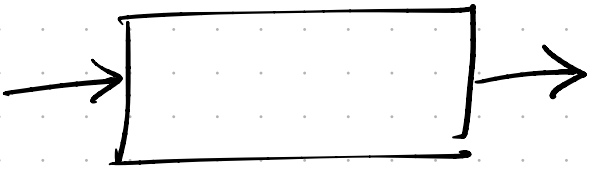
IF



THEN



ALSO



$$(x[n] * h_1[n]) * h_2[n] =$$

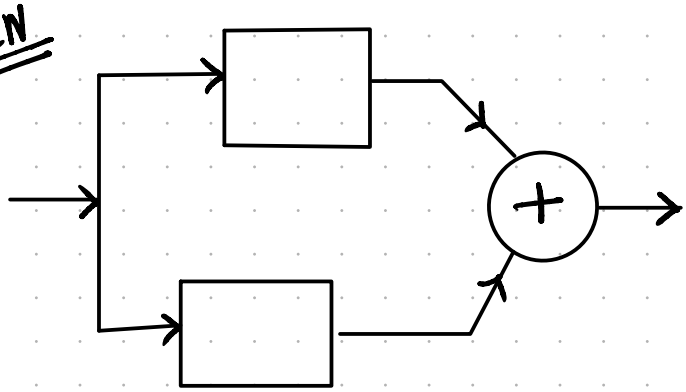
Example → allows us to make bandpass filters as a sum of multiple high, low pass filters.

- Convolution is → describes the operation in parallel system with added output.

$$x[n] * (h_1[n] + h_2[n]) =$$

IF

THEN



Test if a linear Time Invariant is or not

↓

Do not get an output prior to the input that caused it ( )

LTI system is iff

To See

$$y[n] = \sum_{k=-\infty}^{\infty} h[k] \cdot x[n-k]$$

Thus $h[n<0] = 0$.

- LTI systems is stable. or bounded input results in bounded output

iff

implies →

as

also

if $x[n]$ is finite duration $g[n] \rightarrow$

as $n \rightarrow$

Finite Impulse Response (FIR

If over finite range

AND

Then

system is a

↓

when you apply an to the system

you get an impulse response/ an output

that is only for a

amount of time

so the response to the impulse is only for

a

- System has
- easy to achieve

↓ just need the coefficients of the system to be

Infinite Impulse Response

if h[n] has range

- System has memory
  - → if you have an input to the system, the effect of that system is there forever and it never goes away.
  - harder to achieve

Why do we use recursion/feedbacks in digital systems?

Recursion gives us where

we have to think more about

↓

It gives us a compact & better description of the system

Example cummulative sum of $x[n]$ starting at $n=0$

$y[n] =$ system with an that is a

Issues →

Efficient Recursive Formulation

$y[n] =$

Linear Constant Coefficient Difference Equation

$$y[n] = -a_1 y[n-1] - a_2 y[n-2] - \cdots + b_0 x[n] + b_1 x[n-1]$$

a's are → co-efficients

b's are → co-efficients.

$y[n]$

If a's and b's are constants.

Determining Impulse Response of a Linear Constant Co-Efficient Difference Equation

To determine $h[n]$:

1. Apply to existing system

2. Assume

Example **Cumulative Sum**

$$y[n] = \begin{cases} 0 & , n<0 \\ y[n-1] + x[n] & , n \geq 0 \end{cases}$$

So,

$h[n] =$

Thus, $h[0] =$

$h[1] =$

$h[2] =$

on

FIR vs IIR via Difference Equation

Find $h[n]$ when a's $= 0$

Then $y[n] =$

Find impulse Response $h[n]$

- Apply Impulse to it

- If a's $= 0$ & no feedback
- else

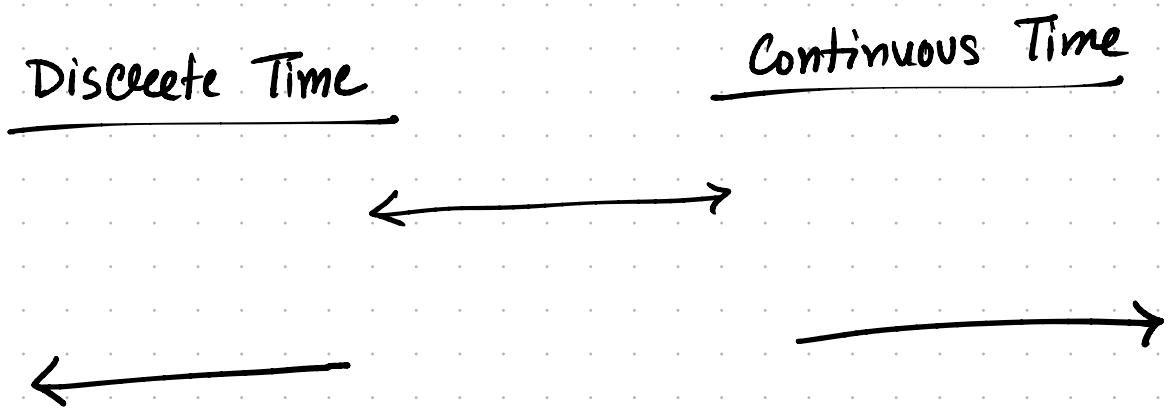
Solving Difference Equation

↳ we are not going to solve in the

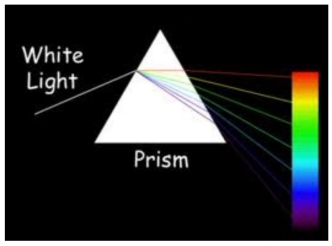
but look into the

Why do the frequency transforms?

– Direct (time domain) solution to difference equation is

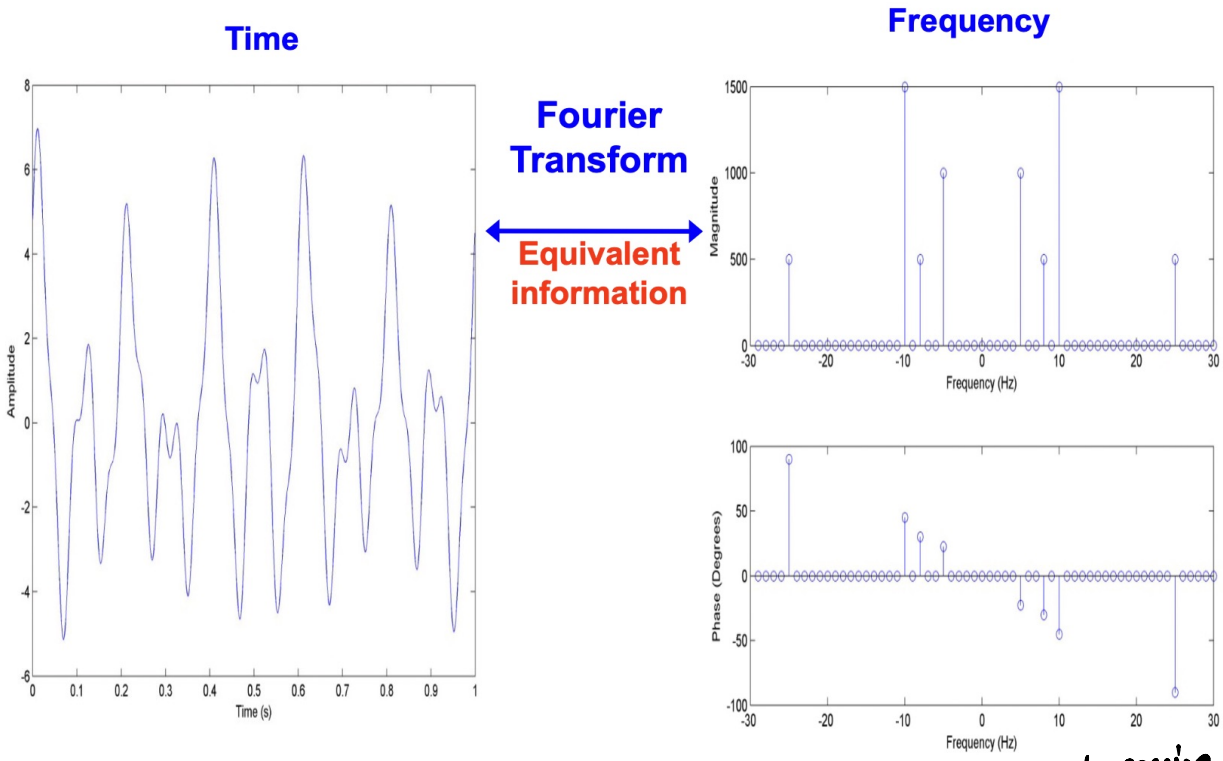


#Analogy of light through Prism



- Prism separates light into its component colors
  - Each color is an electromagnetic wave of distinct frequency
- Combinations of component colors give other colors
  - (100% Red) + (100% Green) = Yellow
  - (100% Red) + (50% Green) = Orange

#Time Domain vs Frequency Domain



Time Domain

- good for occurring at specific information

Frequency domain

- good for localizing information occurring at specific