Three-Steps of Linear Convolution

- For any given n, how to obtain

$$g(n) = \sum_{k=-\infty}^{\infty} h(k)\, f\,(n-k)$$

  - Step 1: time reversal of either signal (e.g., $f(k) \rightarrow f(-k)$)
  - Step 2: shift $f(-k)$ by n samples to obtain $f(n-k)$
  - Step 3: multiply $h(k)$ and $f(n-k)$ for each k and then take the summation over k

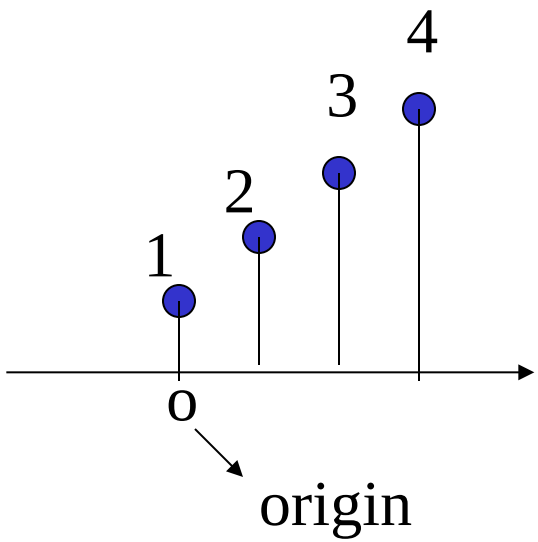
Note

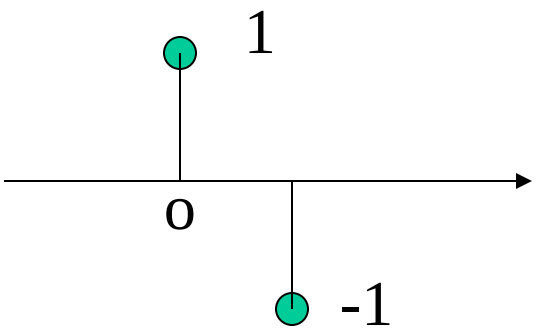
You need to change variable n to get the whole sequence.

1D Linear Convolution

f(n)=[1 2 3 4]

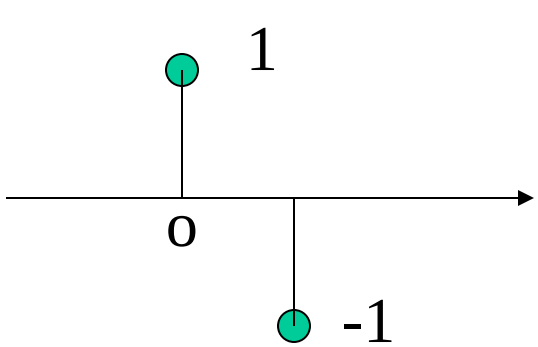
h(n)=[1 –1]

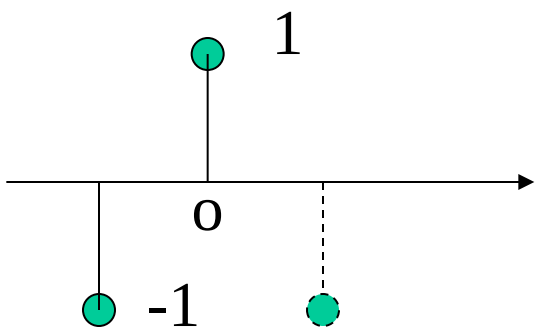




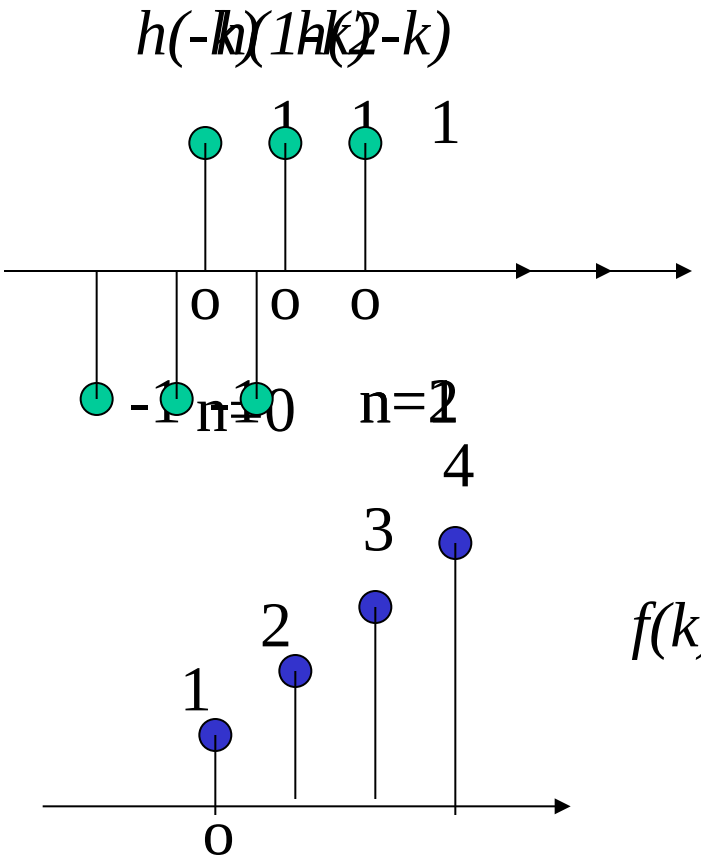
Step 1:Time Reversal

$h(k)=[1\ -1]$ ⟶ $h(-k)=[-1\ 1]$



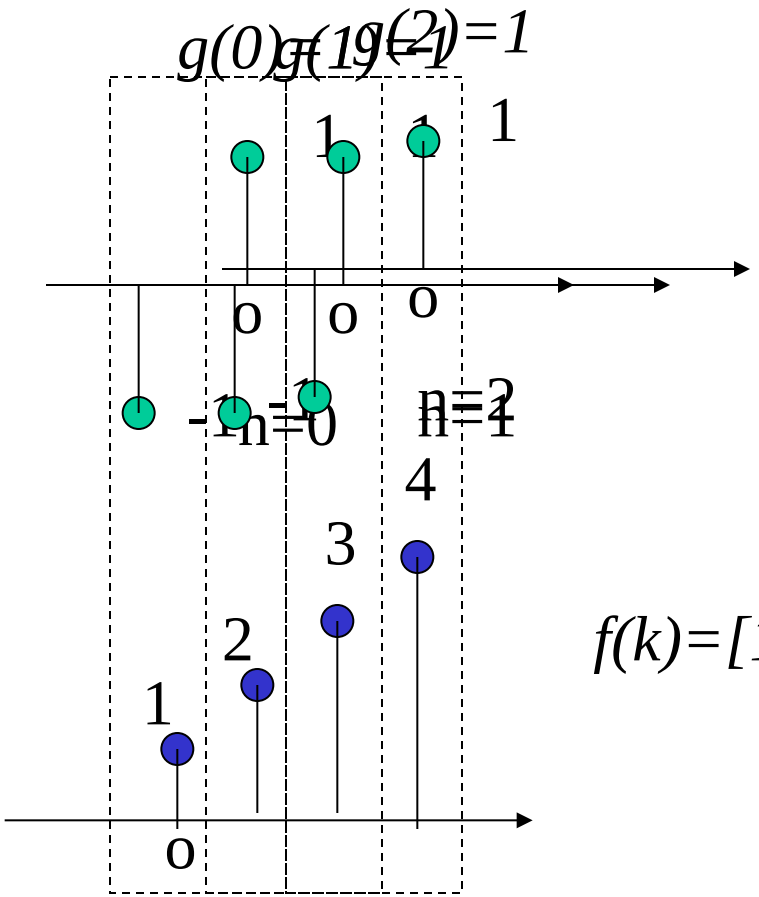


Step 2: Shift



f(k)=[1 2 3 4]

Step3: Multiply-and-Add

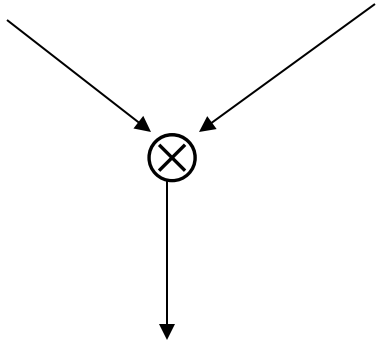


f(k)=[1 2 3 4]

Final Result

f(n)=[1 2 3 4]

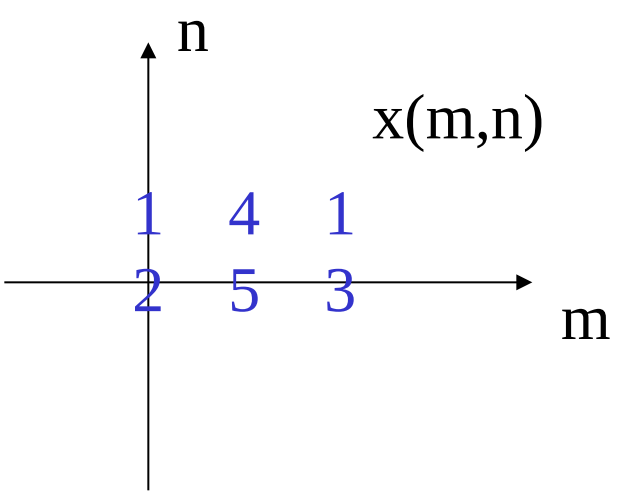
h(n)=[1 –1]

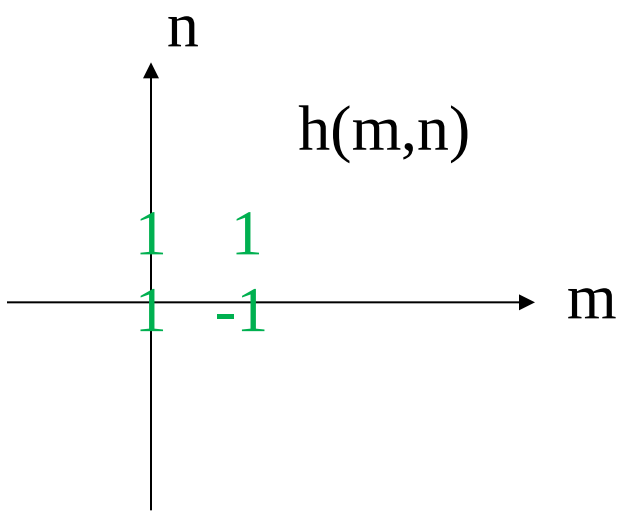


g(n)=[1 1 1 1 -4]

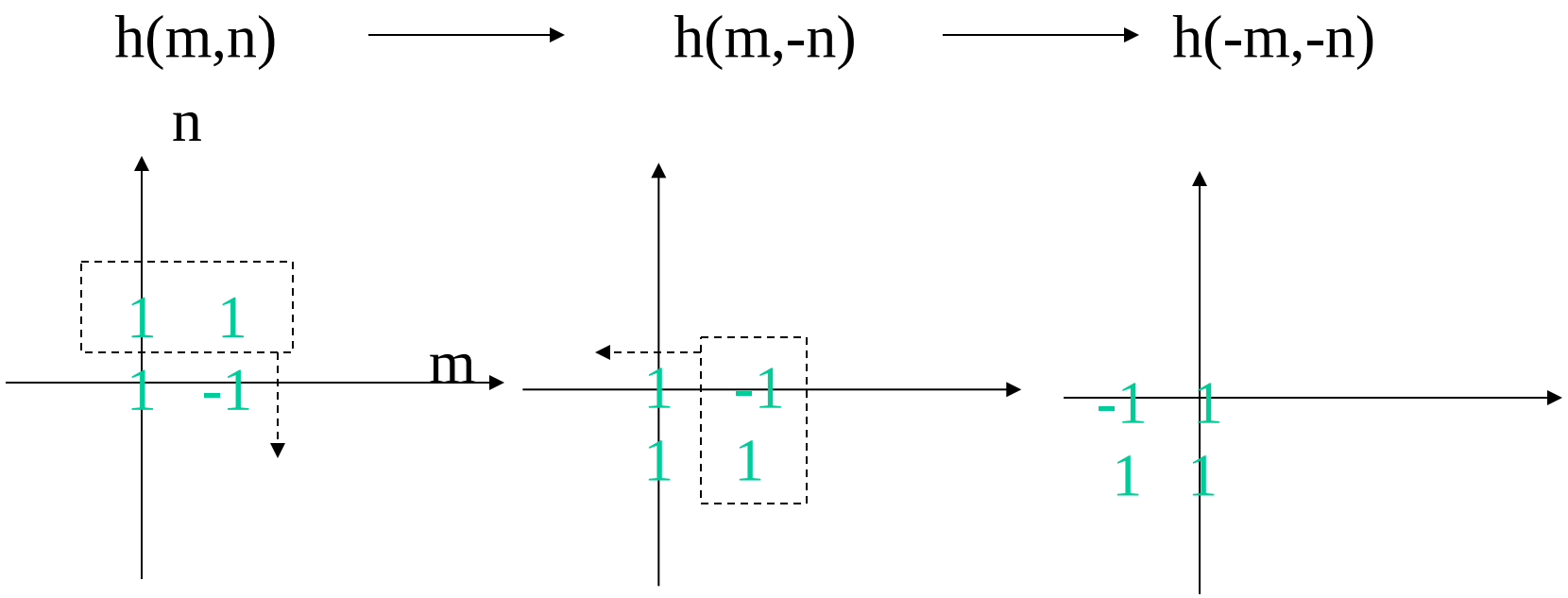
If the lengths of two input signals are N_1 and N_2 respectively, the length of the output signal will be N_1+N_2-1.

2D Linear Convolution

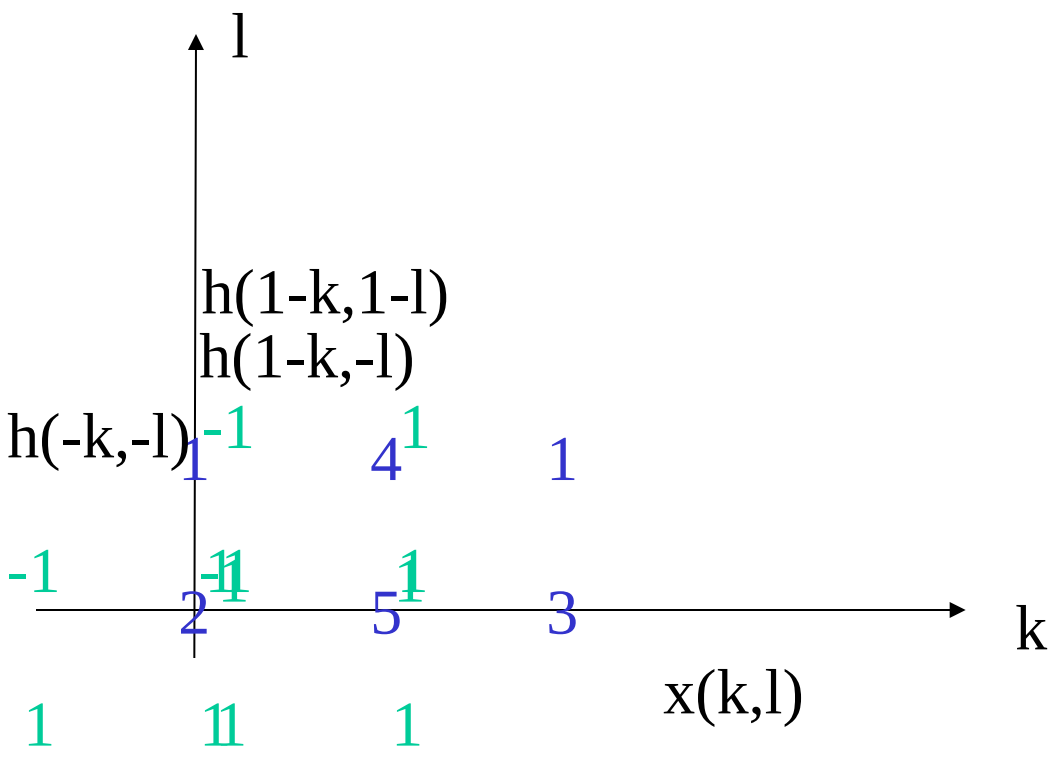




Step 1:Time Reversal



Step 2: Shift



Step3: Multiply-and-Add