PROBLEM:

Evaluate the "running" average:

$$y[n] = \frac{1}{L} \sum_{k=0}^{L-1} x[n-k]$$

for a specific input signal—a signal that turns on at $n = 0$. This is called the *unit step* signal, and is usually denoted by $u[n]$.

$$x[n] = u[n] = \begin{cases} 0 & \text{for } n < 0 \\ 1 & \text{for } n \geq 0 \end{cases}$$

(a) Make a plot of $u[n]$ before working out the answer for $y[n]$.

(b) Now compute the numerical values of $y[n]$ over the range $-5 \leq n \leq 10$, assuming that $L = 5$.

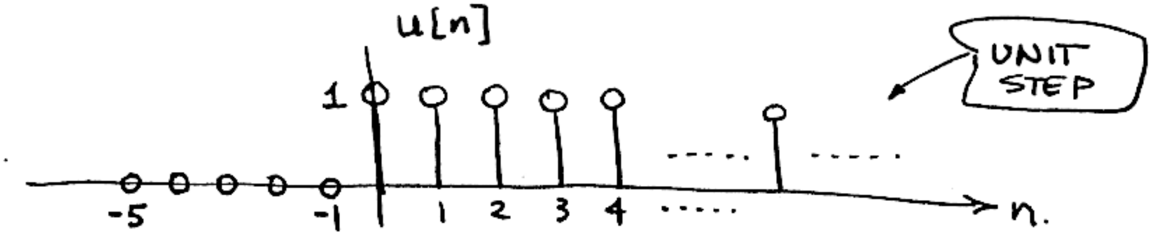
(c) Make a sketch of the output for both over the range $-5 \leq n \leq 10$, assuming that $L = 5$. Use MATLAB if necessary, but learn to do it by hand also.

(d) Finally, derive a general formula for $y[n]$ that will apply for any length L and for the index range $n \geq 0$.

McClellan, Schafer and Yoder, *Signal Processing First*, ISBN 0-13-065562-7.

SOLUTION

(a)



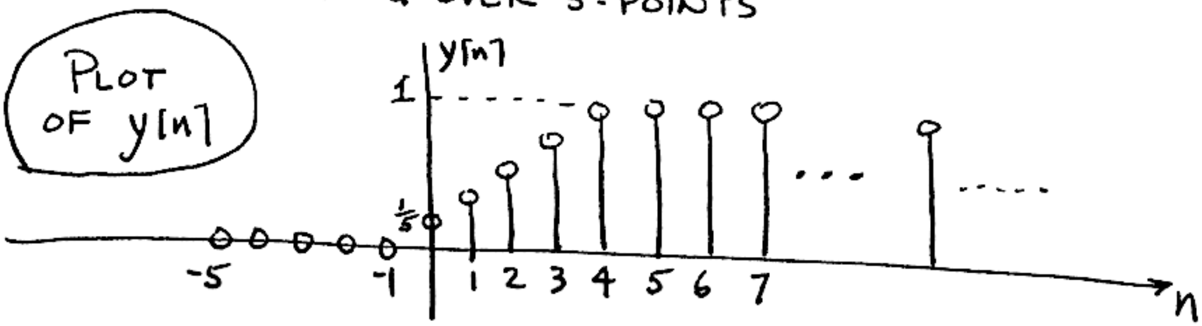
(b) $L=5 \Rightarrow$ avg. 5 points

Make table:

n	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
$x[n]=u[n]$	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
$y[n]$	0	0	0	0	0	$\frac{1}{5}$	$\frac{2}{5}$	$\frac{3}{5}$	$\frac{4}{5}$	1	1	1	1	1	1	1

AVG OVER 5-POINTS

(c)



(d) General Formula:

We need a "piecewise" definition

$$y[n] = \begin{cases} 0, & \text{for } n<0 \\ \frac{1}{5}(n+1), & \text{for } 0 \le n < 4 \\ 1, & \text{for } n \ge 4 \end{cases}$$