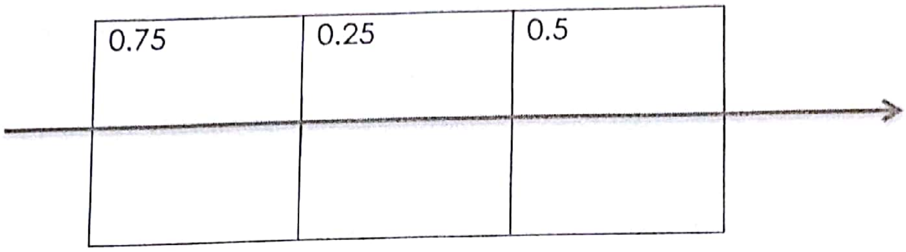
3. **Image-Order Volume Visualization**
Consider the following ray through a pixel into a volume in which the scalar data are all in [0,1]. One particular ray moves through the following 3 cells:



Suppose the transfer function we use is simply $I(s) = (1 - s, 0, s, s)$
Suppose the distance the ray traveled through each cell is 1

a. What is the color produced by a Maximum Intensity Projection?

max = 3/4

$I(3/4) = (1/4, 0, 3/4, 3/4)$

b. What is the color produced by an Average Intensity Projection?

avg = 1/2

$I(1/2) = (1/2, 0, 1/2, 1/2)$

c. How would the color be produced by compositing with the Over operator? Just write out an expression, don't do the computation.

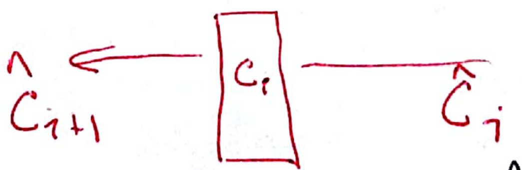
$(1/4, 0, 3/4, 3/4)$ over $\big((3/4, 0, 1/4, 1/4)$ over $(1/2, 0, 1/2, 1/2)\big) =$

$3/4\,(1/4, 0, 3/4) + 1/4\,(5/8)\big(1/4\,(3/4, 0, 1/4) + 3/4 \cdot 1/2\,(1/2, 0, 1/2)\big)$

> **Pre-multiplied alpha**
> Suppose we use pre- multiplied alpha. A color (r,g,b) and an alpha value α is stored as (αr, αg, αb, α). Compositing of two colors with alpha values can be accomplished using the over operator: C_A over $C_B = C_A + (1-\alpha_A)C_B$

4. Derive a set of expressions using pre-multiplied alpha that allows front to back volume rendering. What advantage in terms of optimizations does this expression have? Can this be done with post-multiplied alpha?

$$\hat{C}_{i+1} = \hat{C}_i + (1 - \hat{A}_i)\, C_i$$



$$\hat{A}_{i+1} = \hat{A}_i + (1 - \hat{A}_i)\, A_i$$