Arithmetic Coding
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Exercise - encoding

Multimedia Technology

Tutorial 2, section 1a

Arithmetic Coding

An information source produces the symbols A, B, C and $ (terminal symbol).

Construct the interval table and encode the string AABC$ with a decimal number using arithmetic coding (calculate the probabilities from the string).

Calculate the probabilities from the string: AABC$

In the given string AABC$, we have 5 symbols, and A appears twice, thus A = 0.4.
Similarly for the rest of the symbols we have the following probabilities:

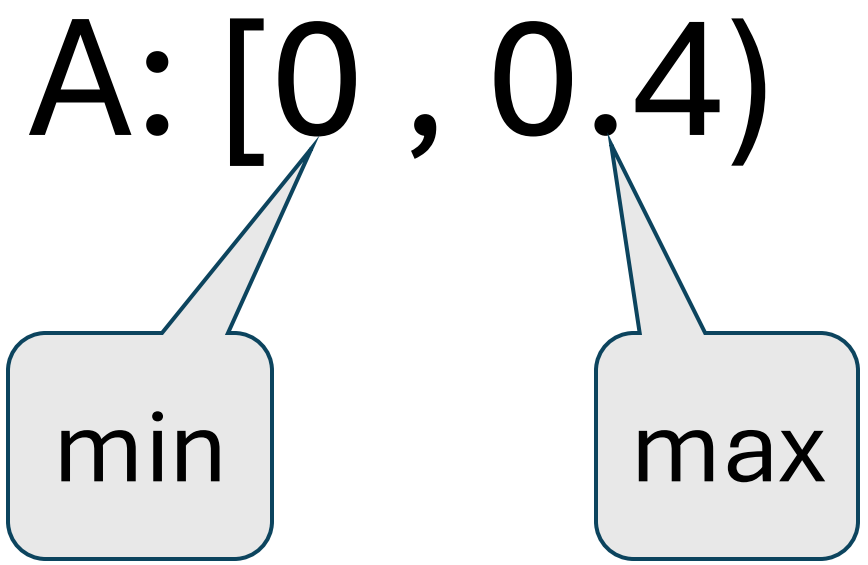
A = 0.4 ==> A: [0 , 0.4)

B = 0.2 ==> B: [0.4 , 0.6)

C = 0.2 ==> C: [0.6 , 0.8)

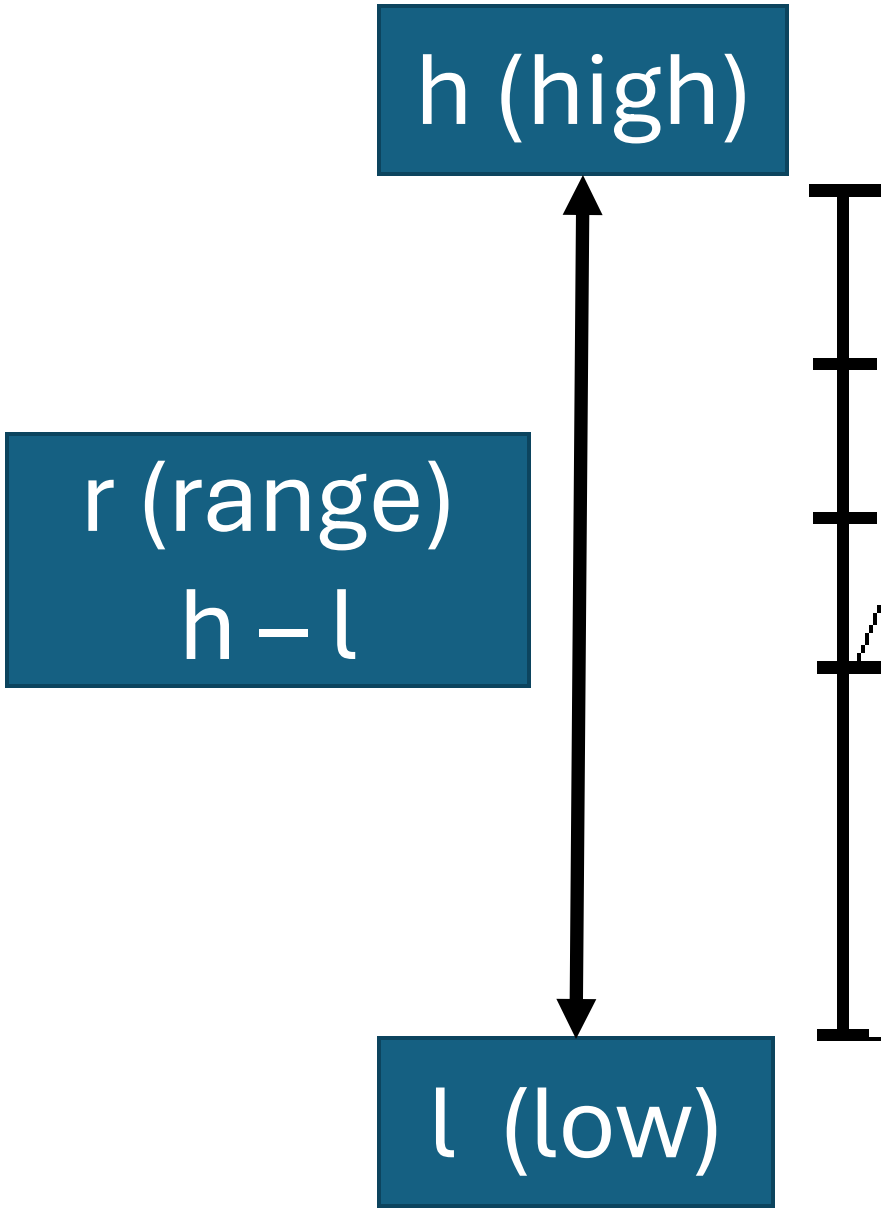
$ = 0.2 ==> $: [0.8 , 1)

min and max



min: start point of the interval assigned to the symbol based on its probability
max: end point of the interval assigned to the symbol based on its probability

high, low, range



low and high: current bounds of the interval that represents the encoded message up to the current symbol

range: width of current interval before refining it with the next symbol

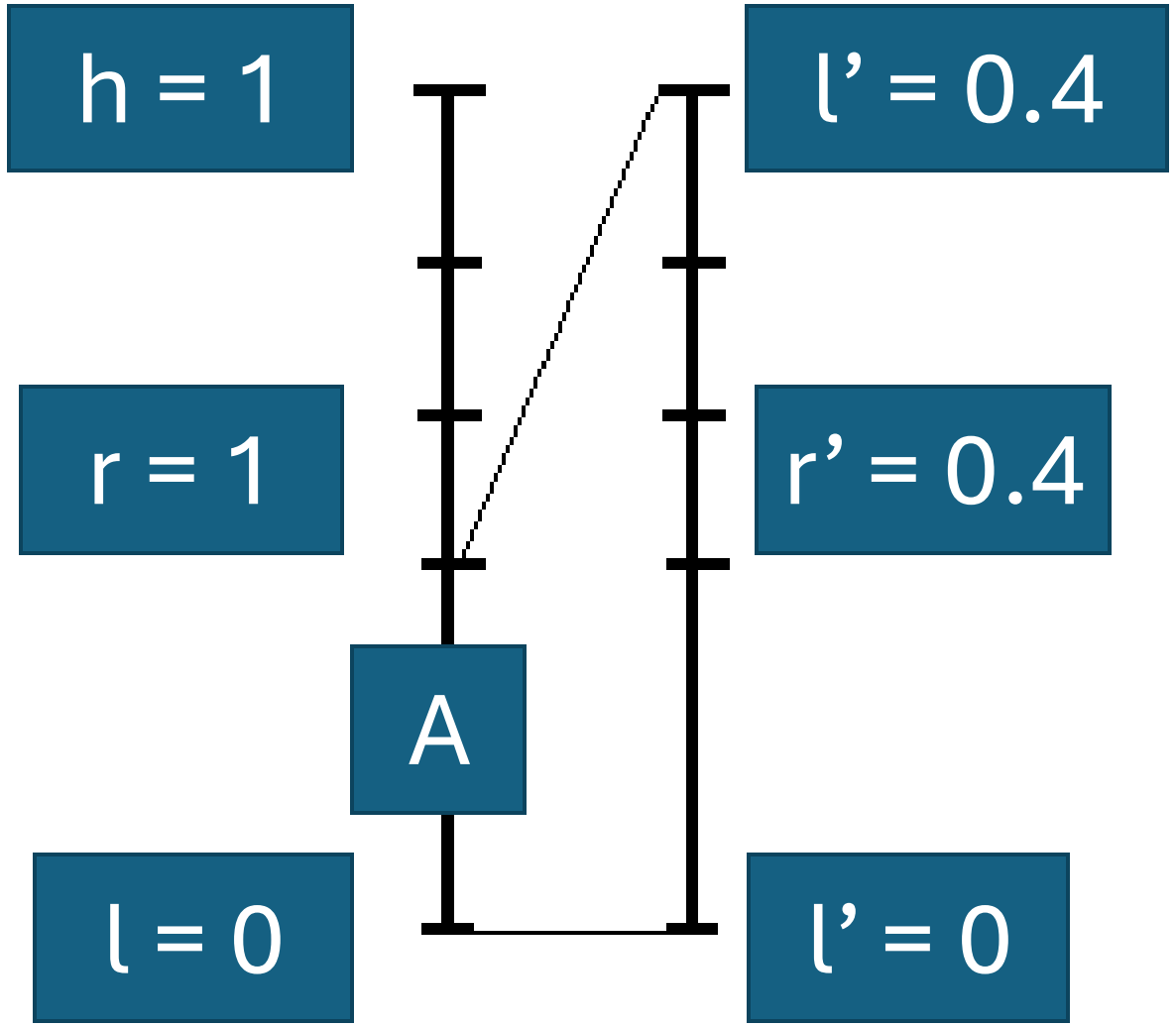
- We encode the string AABC$ by refining the range for each symbol sequentially.

A

$h' = l + r*max$

$l' = l + r*min$

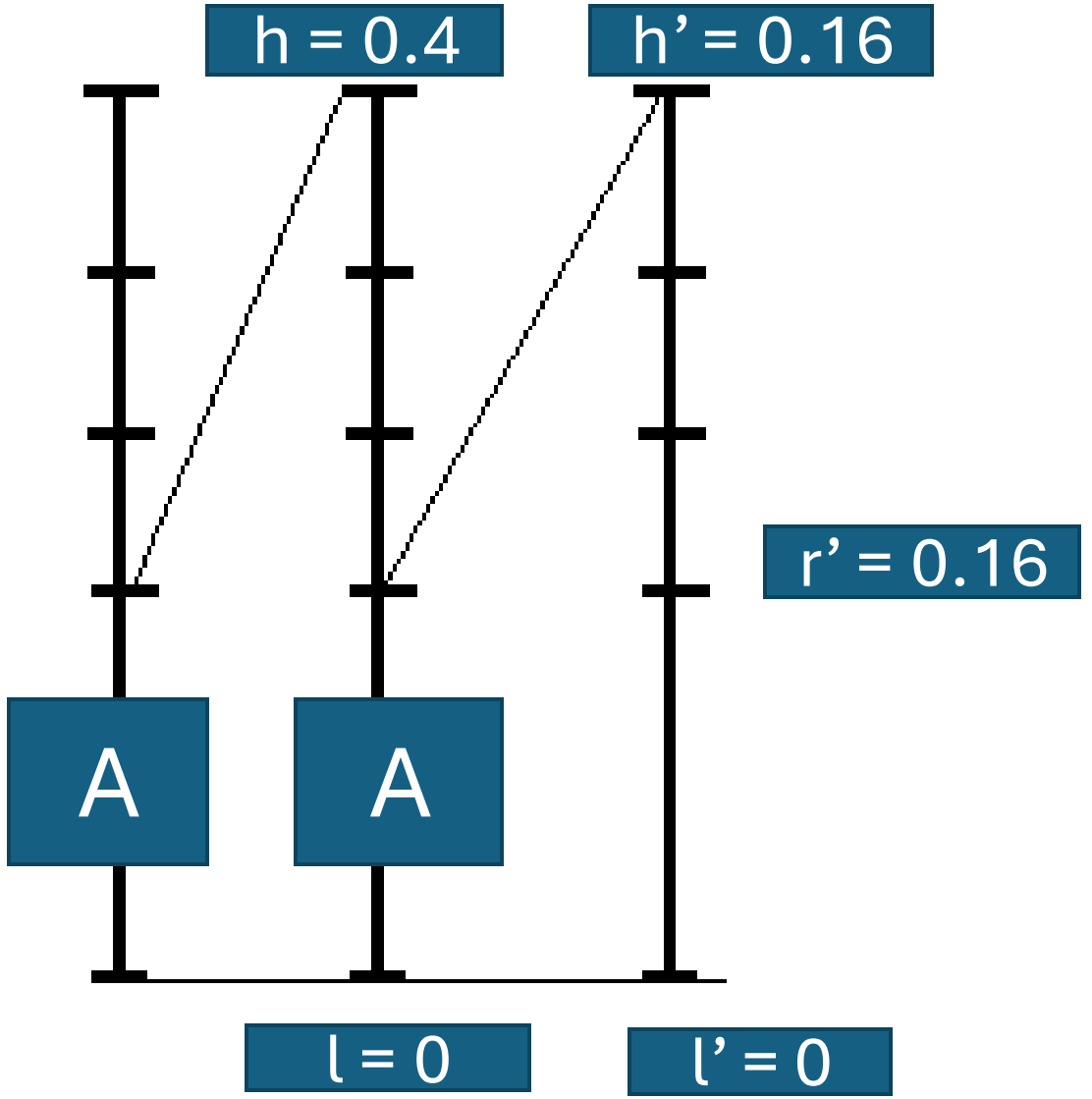
- h = 1
- l = 0
- r = 1 (range)
- h’ = 0 + 1*0.4 = 0.4
- l’ = 0 + 1* 0 = 0
- r’ = H’ – L’ = 0.4 – 0 = 0.4



A

$$h' = l + r*max$$
$$l' = l + r*min$$

- h = 0.4
- l = 0
- r = 0.4
- h’ = 0 + 0.4*0.4 = 0.16
- l’ = 0 + 0.4* 0 = 0
- r’ = h’ – l’ = 0.16 – 0 = 0.16

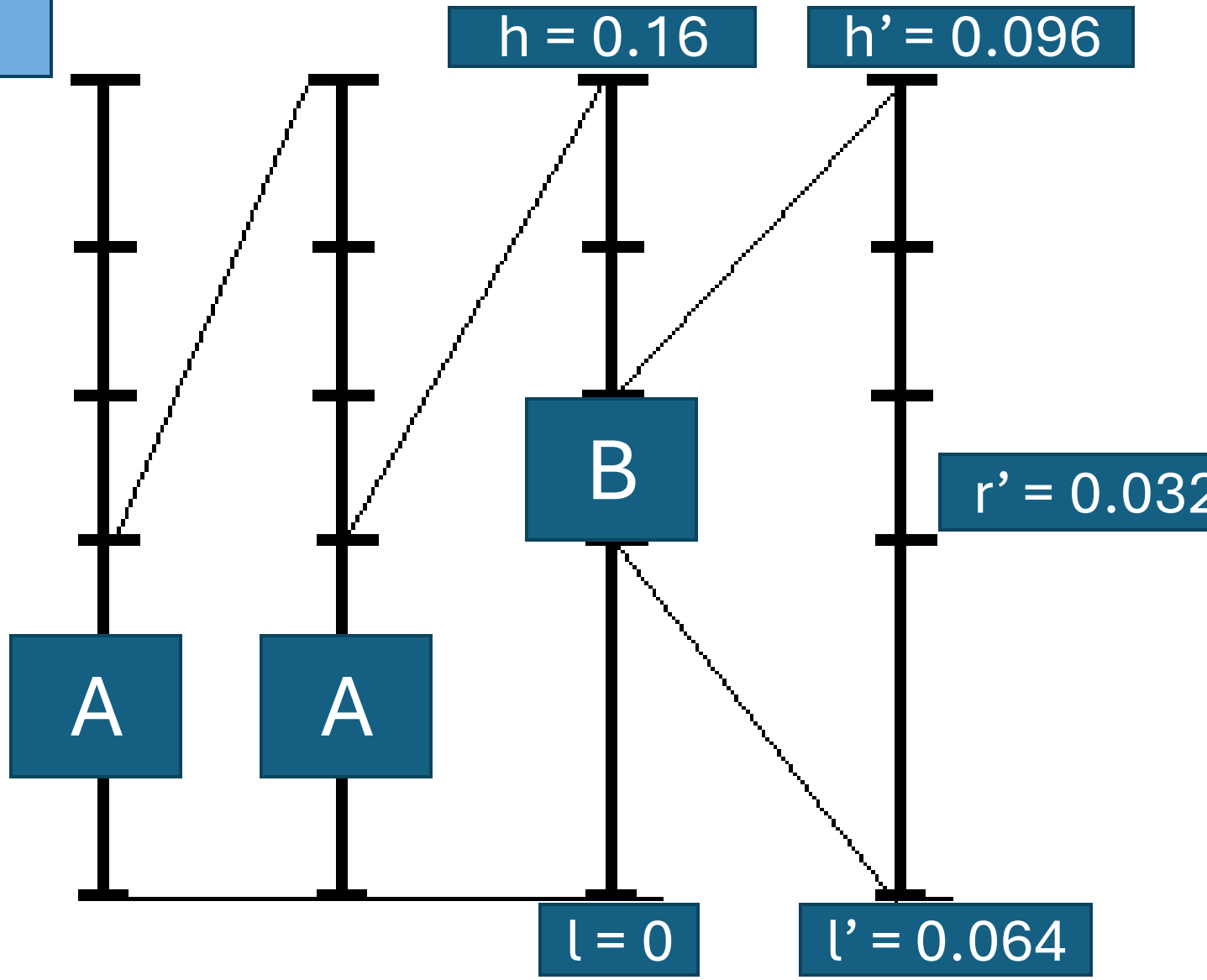


B

$h' = l + r*max$

$l' = l + r*min$

- h = 0.16
- l = 0
- r = 0.16
- h’ = 0 + 0.16*0.6 = 0.096
- l’ = 0 + 0.16*0.4 = 0.064
- r’ = h’ – l’ = 0.096 – 0.064
  = 0.032

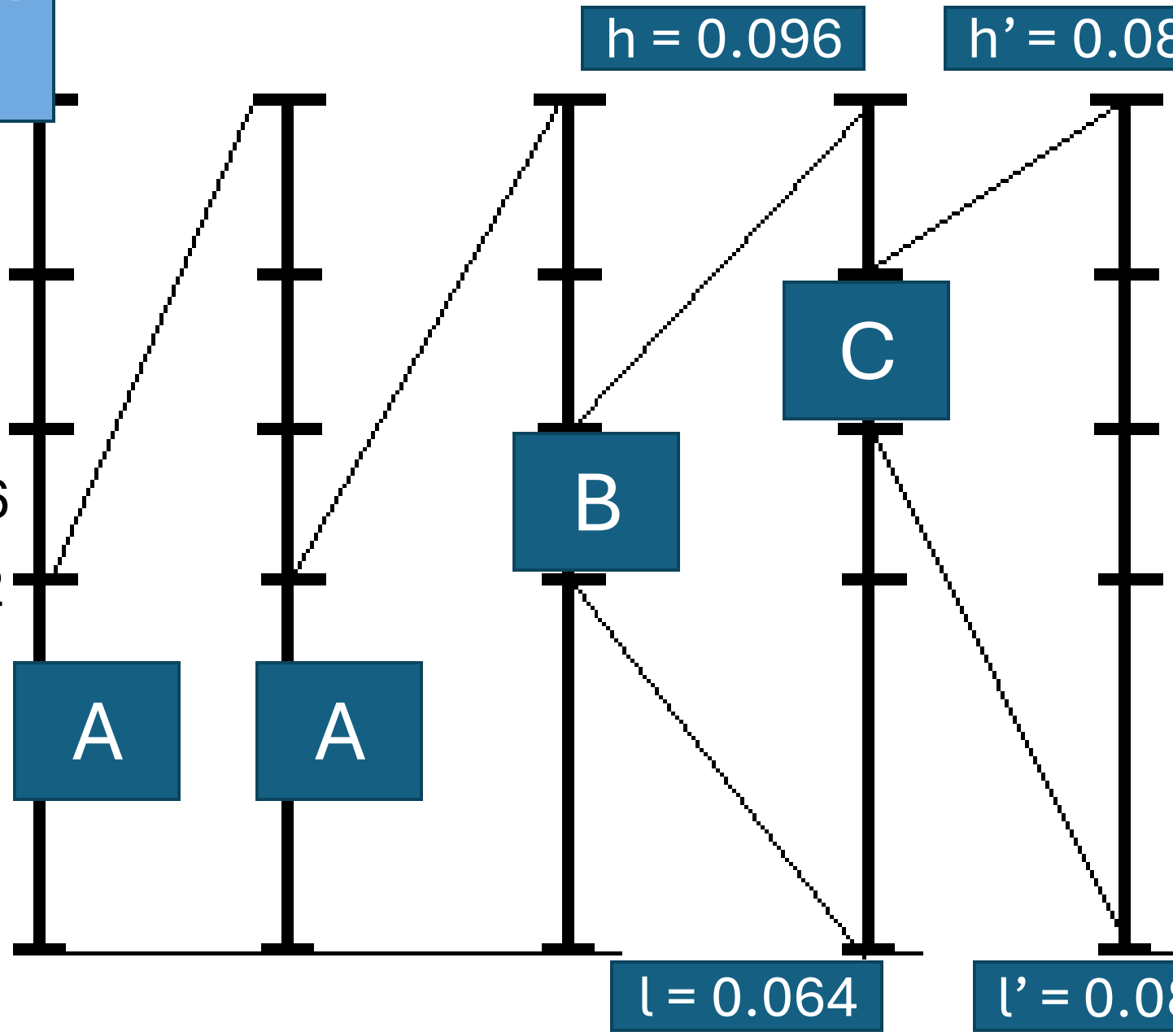


C

$h' = l + r*max$

$l' = l + r*min$

- h = 0.096
- l = 0.064
- r = 0.032
- h’ = 0.064 + 0.032*0.8 = 0.0896
- l’ = 0.064 + 0.032*0.6 = 0.0832
- r’ = h’ – l’ = 0.0896 – 0.0832
  = 0.0064



$

$$h' = l + r*max$$
$$l' = l + r*min$$

- h = 0.0896
- l = 0.0832
- r = 0.0064
- h’ = 0.0832 + 0.0064*1 = 0.08960
- l’ = 0.0832 + 0.0064*0.8 = 0.08832
- Answer:

Any number within the range: 0.08960 ~ 0.08832

- <u>Simplest decimal within the interval: 0.089</u>