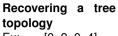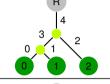**(a)**

Recovering a tree topology
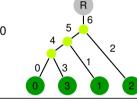
Ex: $v = [0, 2, 0, 4]$

Step 1
$v[1] = [0]$
Initial tree:
2 leaves: 0, 1
1 internal node
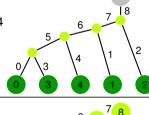1 extra root (R)

Step 2
$v[2] = 2$
Split branch 2
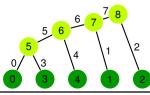yield leaf 2

Step 3
$v[3] = 0$
Split branch 0
yield leaf 3

Step 4
$v[4] = 5$
Split branch 4
yield leaf 4

Final
Remove the
extra root.
Name the
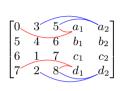ancestors.

(b)

Apply branch lengths

Ex:

$$\boldsymbol{m} = \begin{bmatrix} 0 & 2 & 0 & 4 \\ a_1 & b_1 & c_1 & d_1 \\ a_2 & b_2 & c_2 & d_2 \end{bmatrix}$$

Step 1
Append BLs to
the ancestry matrix
$BL(0, 5) = a_1$
$BL(3, 5) = a_2$
...
$BL(7, 8) = d_1$
$BL(2, 8) = d_2$

$$\begin{bmatrix} 0 & 3 & 5 & a_1 & a_2 \\ 5 & 4 & 6 & b_1 & b_2 \\ 6 & 1 & 7 & c_1 & c_2 \\ 7 & 2 & 8 & d_1 & d_2 \end{bmatrix}$$

Step 3
Annotate the tree