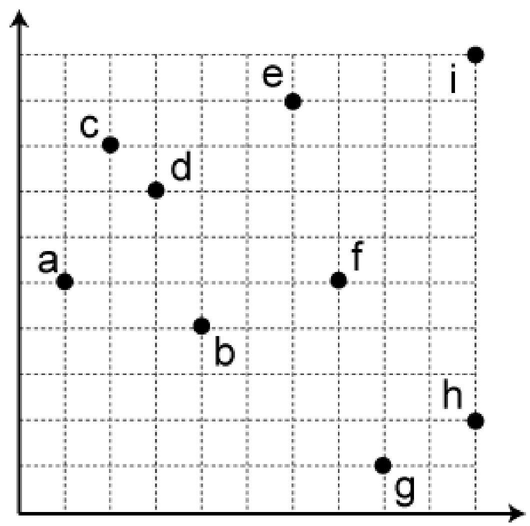
L-Shaped RST Routing

- Perform L-RST using node *b* as the root
  - First step: build a separable MST
  - Prim with $w(i,j) = (D(i,j), -|y(i) - y(j)|, -\max\{x(i), x(j)\})$

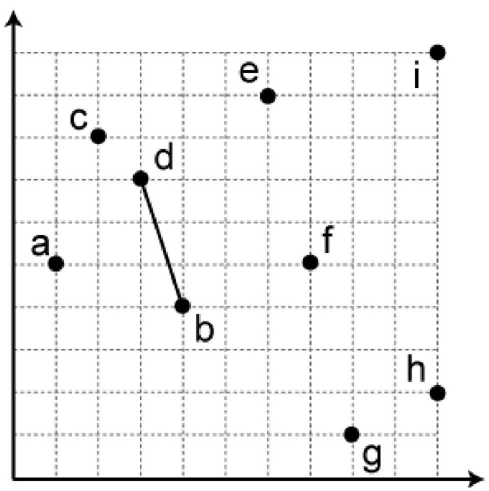


First Iteration

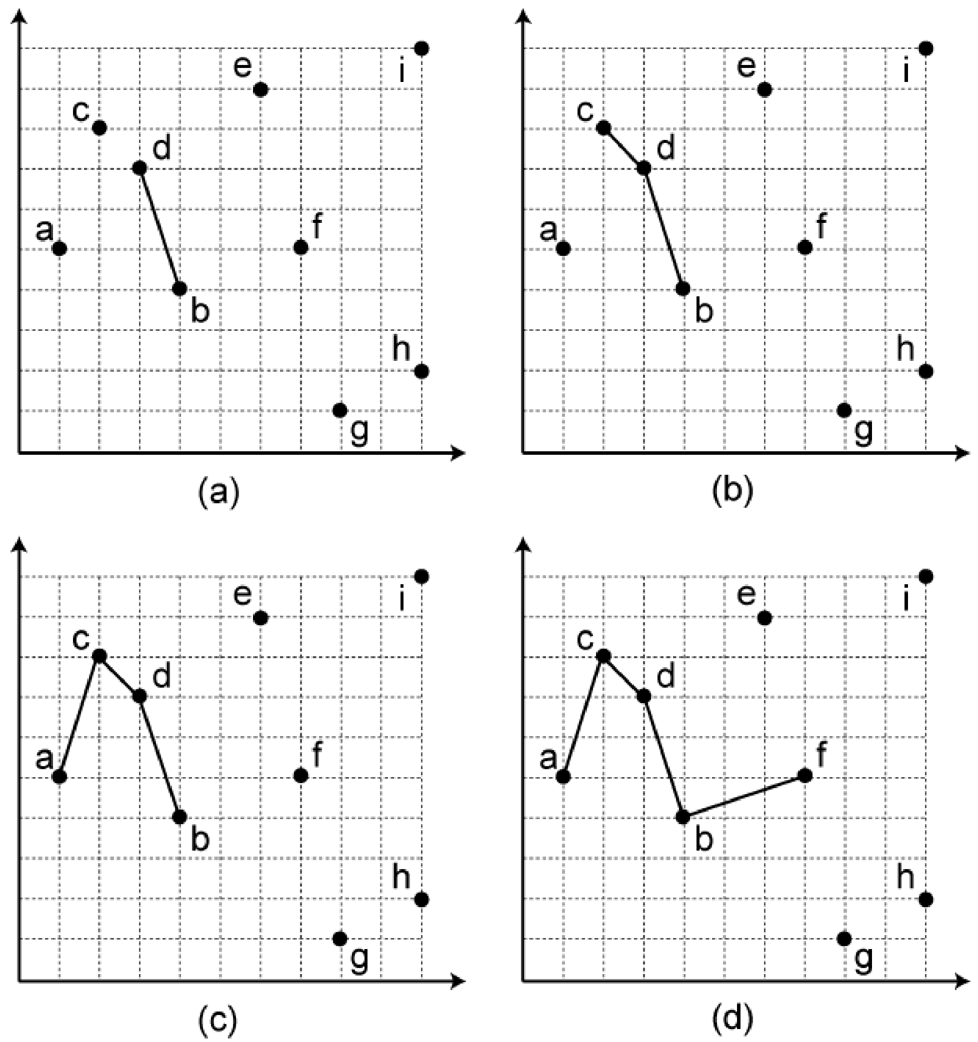
We initially set our separable MST $T = \{b\}$. T contains three nearest neighbors: a, d, and f. These nodes can connect to T via the following edges (sorted based on their weights):

- $(b, d) = (4, -3, -4)$
- $(b, f) = (4, -1, -7)$
- $(b, a) = (4, -1, -4)$

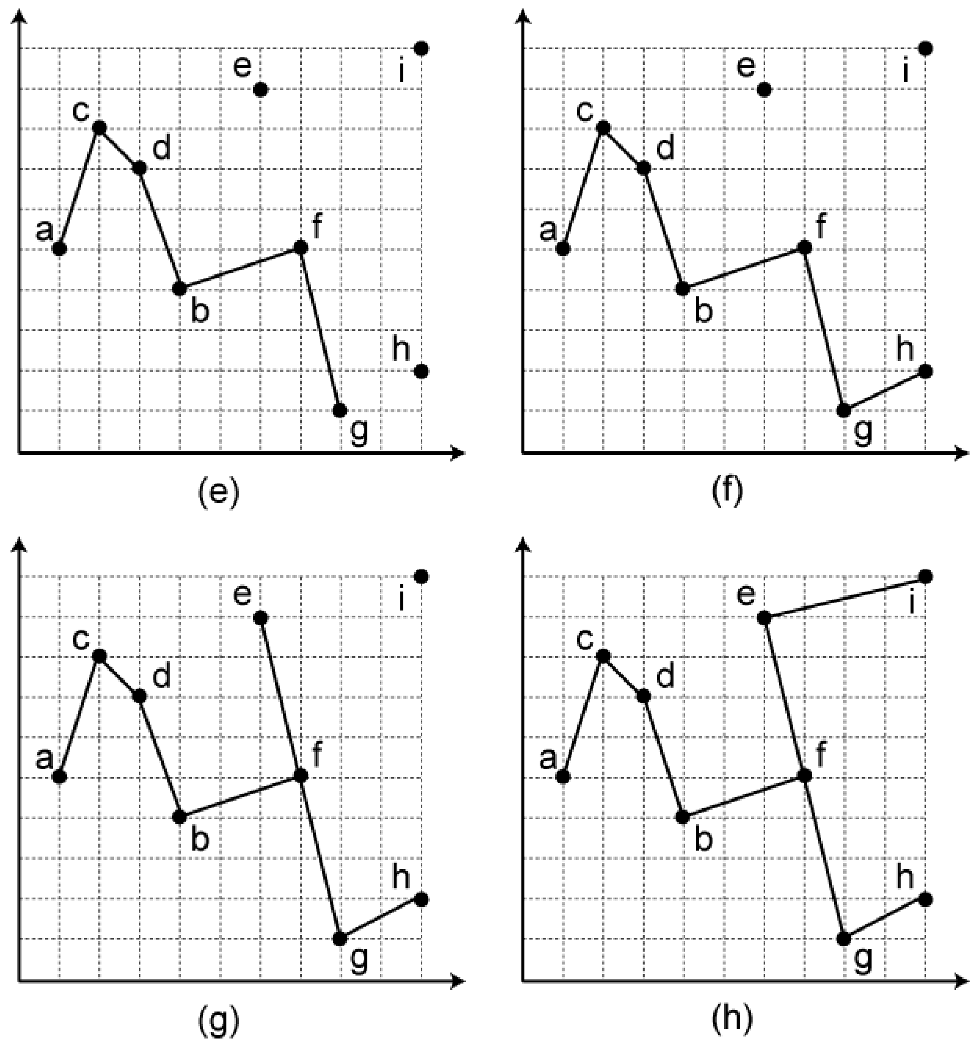
Thus, we add (b, d) to T based on this lexicographical order.



Separable MST Construction

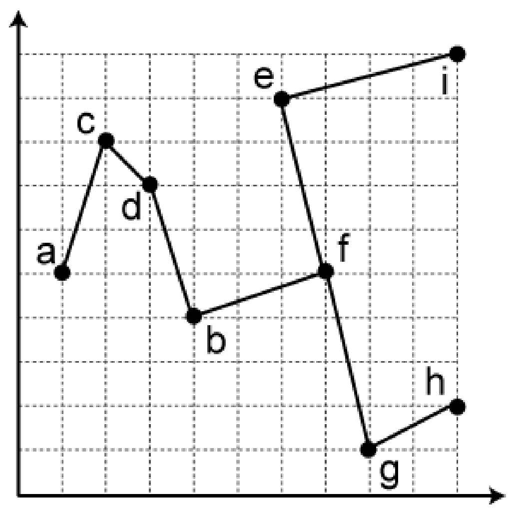


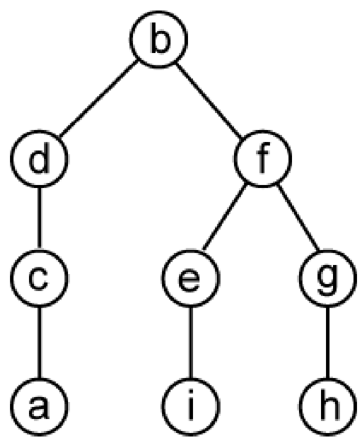
Separable MST Construction (cont)



Constructing a Rooted Tree

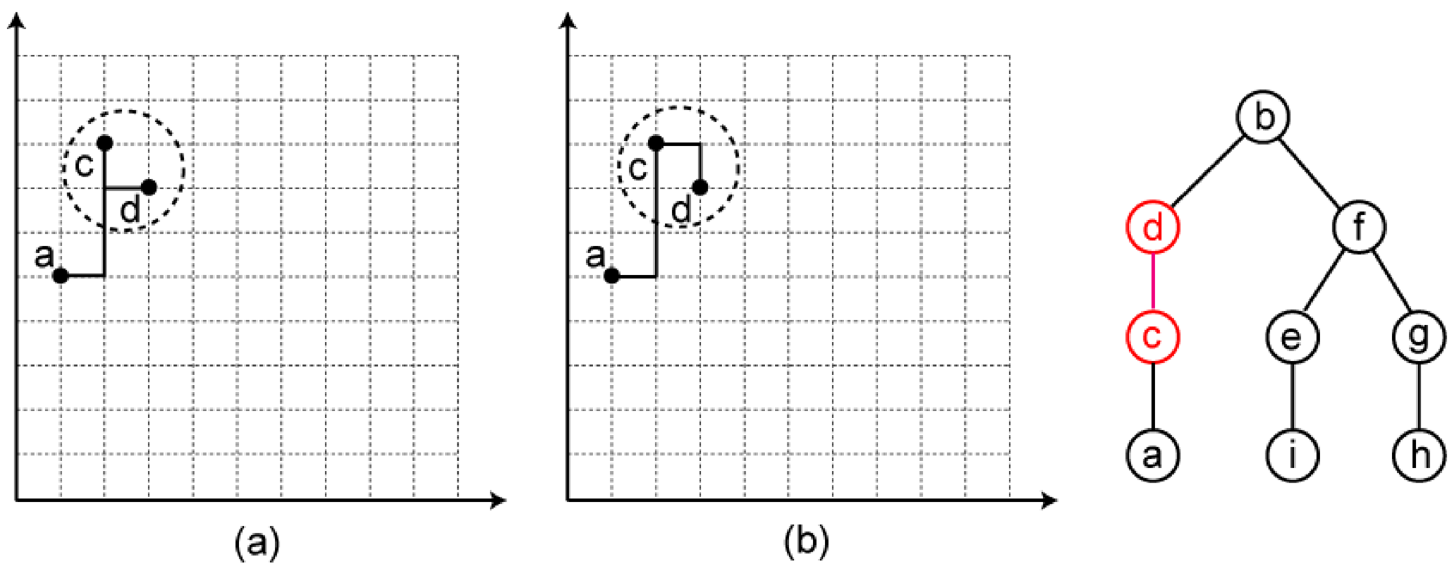
- Node *b* is the root node
  - Based on the separable MST (initial wirelength = 32)
  - Bottom-up traversal is performed on this tree during L-RST routing





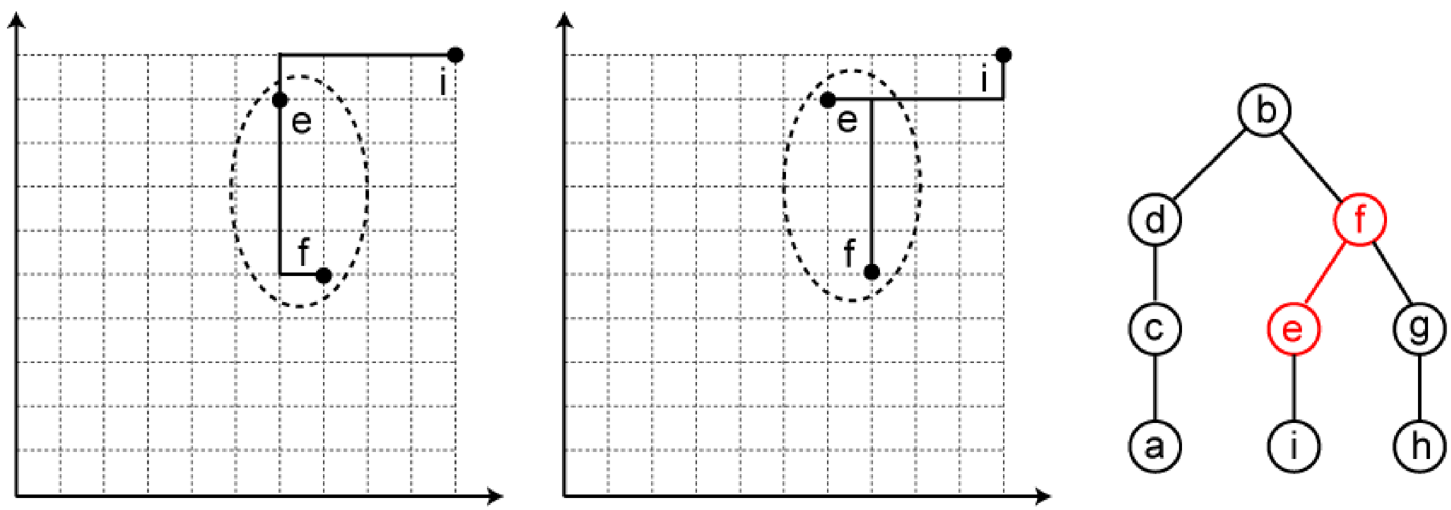
Partial L-RST for Node C

- $\Phi_l(c)$: (c, d) is fixed to lower-L. Figure (a) shows $\Phi_l(c)$. We assign lower-L to (c, a) in order to maximize the overlap in T_c^S. Thus, $Z(\Phi_l(c)) = 1$.
- $\Phi_u(c)$: (c, d) is fixed to upper-L. Figure (b) shows $\Phi_u(c)$. The orientation of (c, a) is irrelevant because no overlap occurs in T_c^S. Thus, $Z(\Phi_u(c)) = 0$.



Partial L-RST for Node E

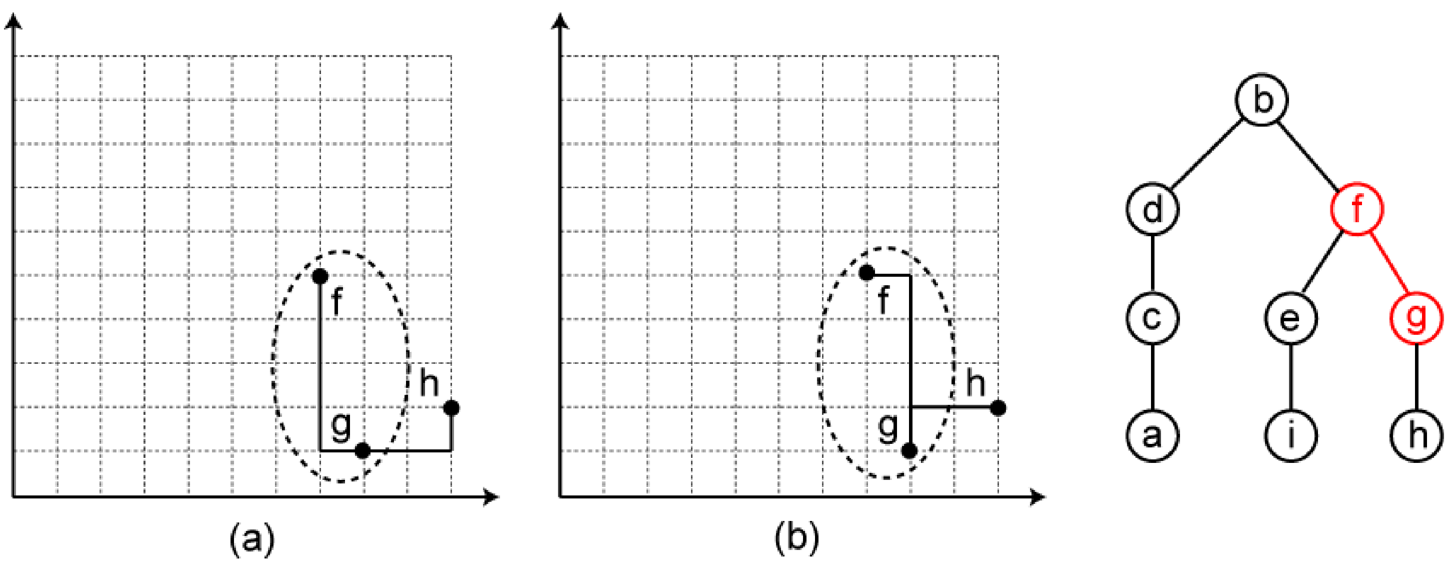
- $\Phi_l(e)$: (e, f) is fixed to lower-L. Figure (a) shows $\Phi_l(e)$. The orientation of (e, i) is irrelevant because no overlap occurs in T_e^S. Thus, $Z(\Phi_l(e)) = 0$.
- $\Phi_u(e)$: (e, f) is fixed to upper-L. Figure (b) shows $\Phi_u(e)$. We assign lower-L to (e, i) in order to maximize the overlap in T_e^S. Thus, $Z(\Phi_u(e)) = 1$.

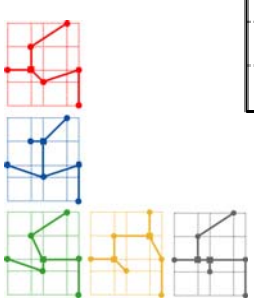


(a) (b)

Partial L-RST for Node G

- $\Phi_l(g)$: (g, f) is fixed to lower-L. Figure (a) shows $\Phi_l(g)$. The orientation of (g, h) is irrelevant because no overlap occurs in T_g^S. Thus, $Z(\Phi_l(g)) = 0$.
- $\Phi_u(g)$: (g, f) is fixed to upper-L. Figure (b) shows $\Phi_u(g)$. We assign upper-L to (g, h) in order to maximize the overlap in T_g^S. Thus, $Z(\Phi_u(g)) = 1$.

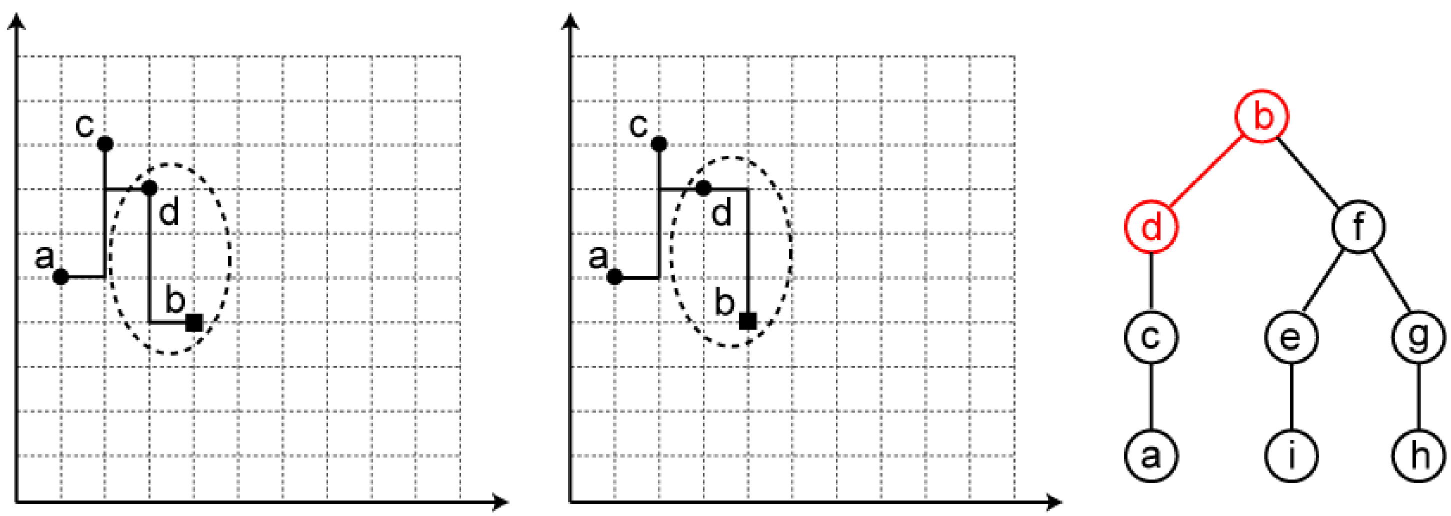




Partial L-RST for Node D

- $\Phi_l(d)$: (d, b) is fixed to lower-L. Figure (a) shows $\Phi_l(d)$. There is no overlap in T_d^S, but we choose lower-L for (d, c) because $Z(\Phi_l(c)) > Z(\Phi_u(c))$ from Part (a). Thus,

$$\begin{aligned} Z(\Phi_l(d)) &= Z(T_d^S) + \max\{Z(\Phi_l(c)), Z(\Phi_u(c))\} \\ &= 0 + \max\{1, 0\} = 1 \end{aligned}$$

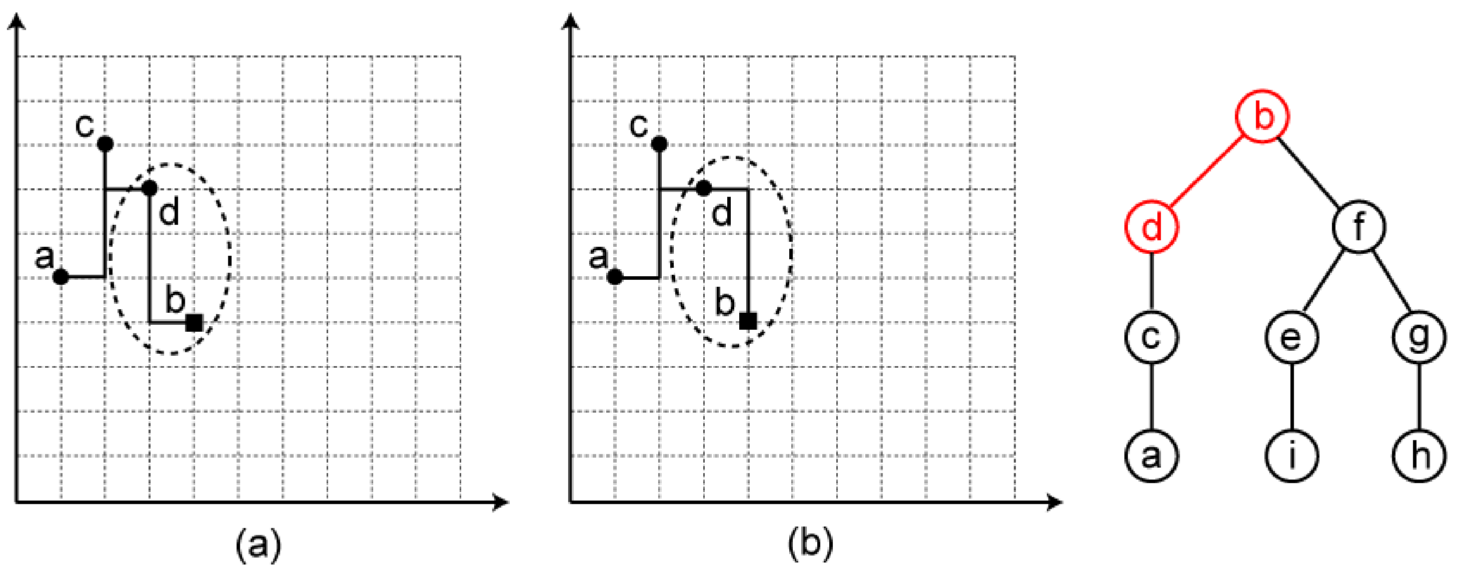


(a) (b)

Partial L-RST for Node D (cont)

- $\Phi_u(d)$: (d, b) is fixed to upper-L. Figure (b) shows $\Phi_u(d)$. There is no overlap in T_d^S, but we choose lower-L for (d, c) because $Z(\Phi_l(c)) > Z(\Phi_u(c))$ from Part (a). Thus,

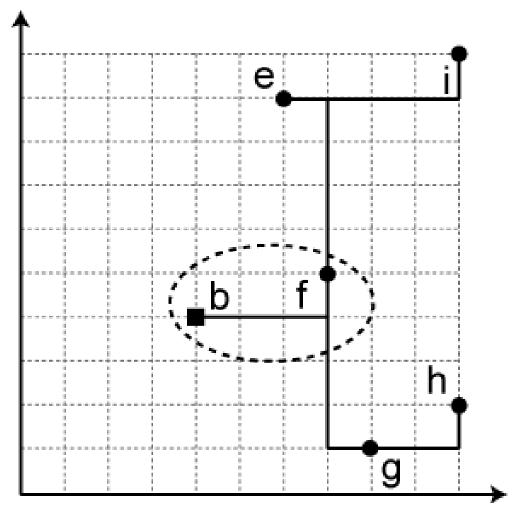
$$\begin{aligned} Z(\Phi_u(d)) &= Z(T_d^S) + \max\{Z(\Phi_l(c)), Z(\Phi_u(c))\} \\ &= 0 + \max\{1, 0\} = 1 \end{aligned}$$



Partial L-RST for Node F

- $\Phi_l(f)$: (f, b) is fixed to lower-L. Since f has two children e and g, we consider the following 4 cases:

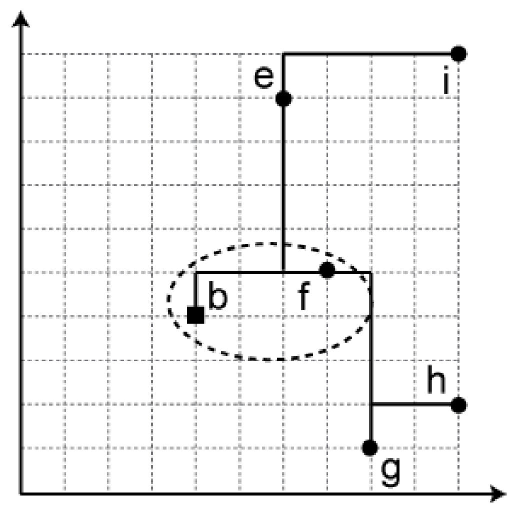
$$Z(\Phi_l(f)) = Z(T_f^S) + Z(\Phi_l(e)) + Z(\Phi_l(g))$$
$$= 1 + 0 + 0 = 1$$
$$Z(\Phi_l(f)) = Z(T_f^S) + Z(\Phi_l(e)) + Z(\Phi_u(g))$$
$$= 0 + 0 + 1 = 1$$
$$Z(\Phi_l(f)) = Z(T_f^S) + Z(\Phi_u(e)) + Z(\Phi_l(g))$$
$$= 1 + 1 + 0 = 2$$ **best case**
$$Z(\Phi_l(f)) = Z(T_f^S) + Z(\Phi_u(e)) + Z(\Phi_u(g))$$
$$= 0 + 1 + 1 = 2$$



Partial L-RST for Node F (cont)

- $\Phi_u(f)$: (f, b) is fixed to upper-L. We again consider the following 4 cases to compute the total amount of overlap in $\Phi_u(f)$:

$$Z(\Phi_u(f)) = Z(T_f^S) + Z(\Phi_l(e)) + Z(\Phi_l(g))$$
$$= 1 + 0 + 0 = 1$$
$$Z(\Phi_u(f)) = Z(T_f^S) + Z(\Phi_l(e)) + Z(\Phi_u(g))$$
$$= 1 + 0 + 1 = 2$$ **best case**
$$Z(\Phi_u(f)) = Z(T_f^S) + Z(\Phi_u(e)) + Z(\Phi_l(g))$$
$$= 0 + 1 + 0 = 1$$
$$Z(\Phi_u(f)) = Z(T_f^S) + Z(\Phi_u(e)) + Z(\Phi_u(g))$$
$$= 0 + 1 + 1 = 2$$



Processing the Root Node

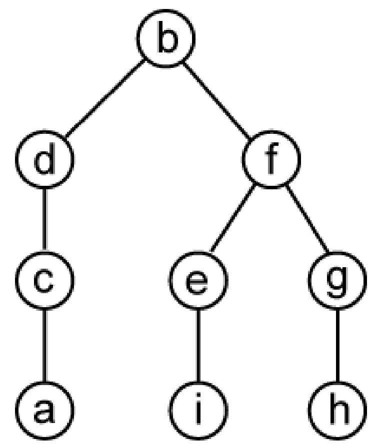
b has two children d and f. Since b is the root node, we examine the following 4 cases and choose the best solution (no additional partial L-RST construction is necessary):

$$Z(\Phi(b)) = Z(T_b^S) + Z(\Phi_l(d)) + Z(\Phi_l(f))$$
$$= 0 + 1 + 2 = 3$$

$$Z(\Phi(b)) = Z(T_b^S) + Z(\Phi_l(d)) + Z(\Phi_u(f))$$
$$= 0 + 1 + 2 = 3$$

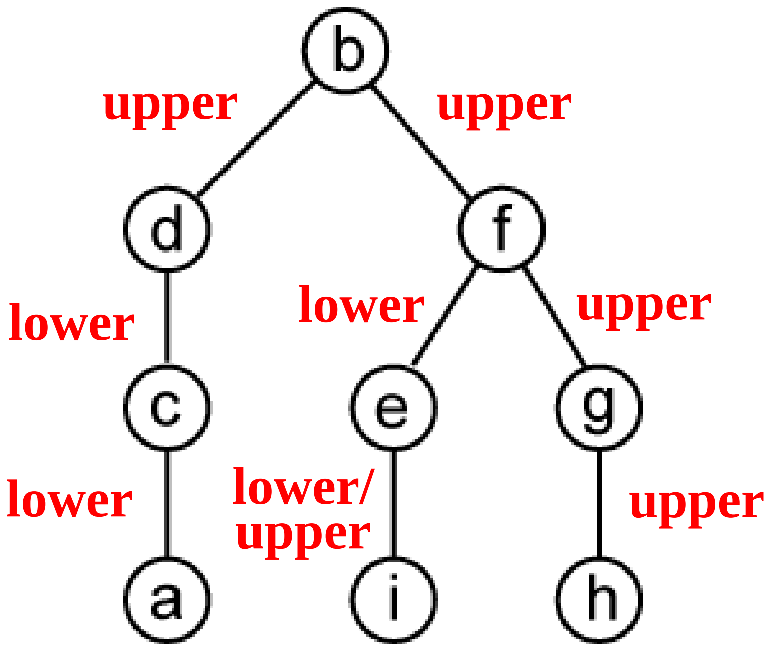
$$Z(\Phi(b)) = Z(T_b^S) + Z(\Phi_u(d)) + Z(\Phi_l(f))$$
$$= 0 + 1 + 2 = 3$$

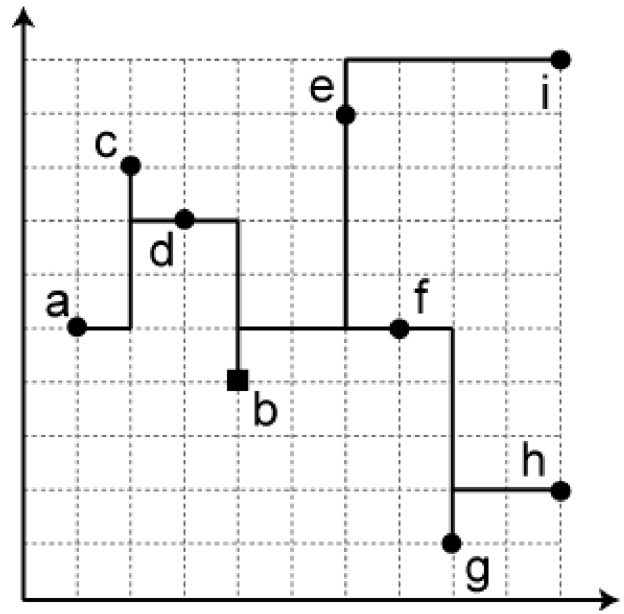
$$Z(\Phi(b)) = Z(T_b^S) + Z(\Phi_u(d)) + Z(\Phi_u(f))$$
$$= 1 + 1 + 2 = 4$$ **best case**



Top-down Traversal

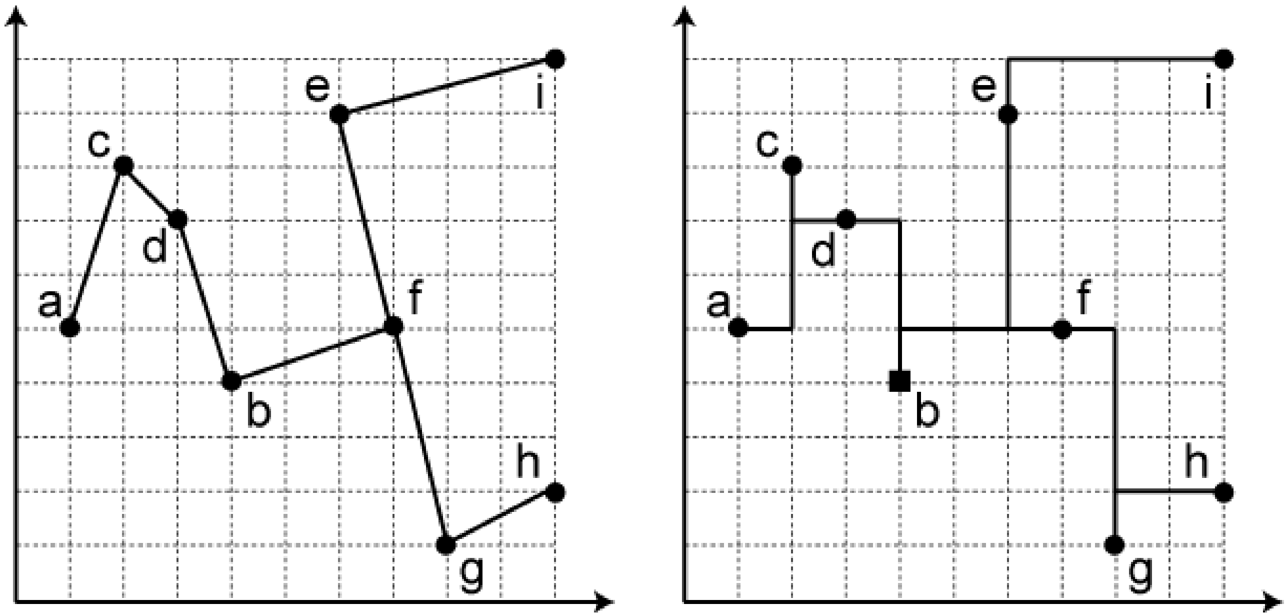
- In order to obtain the final tree





Final Tree

- Wirelength reduction
  - Initial wirelength − total overlap = 32 − 4 = 28



Stable Under Rerouting

- Steiner points are marked X
  - Wirelength does not reduce after rerouting