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

(a)  
(b)  
(c)  
(d)
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, $Z(\Phi_u(e)) = 1$. 

![Diagram of L-RST algorithm](image)
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, $Z(\Phi_u(g)) = 1$. 

![Diagrams showing L-RST for Node G](image-url)
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,

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

\[
Z(\Phi_u(d)) = Z(T_d^S) + \max\{Z(\Phi_l(c)), Z(\Phi_u(c))\} \\
= 0 + \max\{1, 0\} = 1
\]
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:

\[
Z(\Phi_l(f)) = Z(T_f^S) + Z(\Phi_l(e)) + Z(\Phi_l(g)) \\
= 1 + 0 + 0 = 1 \\
Z(\Phi_l(f)) = Z(T_f^S) + Z(\Phi_l(e)) + Z(\Phi_u(g)) \\
= 0 + 0 + 1 = 1 \\
Z(\Phi_l(f)) = Z(T_f^S) + Z(\Phi_u(e)) + Z(\Phi_l(g)) \\
= 1 + 1 + 0 = 2 \quad \text{best case} \\
Z(\Phi_l(f)) = Z(T_f^S) + Z(\Phi_u(e)) + Z(\Phi_u(g)) \\
= 0 + 1 + 1 = 2
\]
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 $\Phi_u(f)$:

$$Z(\Phi_u(f)) = Z(T^S_f) + Z(\Phi_l(e)) + Z(\Phi_l(g))$$

$$= 1 + 0 + 0 = 1$$

$$Z(\Phi_u(f)) = Z(T^S_f) + Z(\Phi_l(e)) + Z(\Phi_u(g))$$

$$= 1 + 0 + 1 = 2 \text{ best case}$$

$$Z(\Phi_u(f)) = Z(T^S_f) + Z(\Phi_u(e)) + Z(\Phi_l(g))$$

$$= 0 + 1 + 0 = 1$$

$$Z(\Phi_u(f)) = Z(T^S_f) + Z(\Phi_u(e)) + Z(\Phi_u(g))$$

$$= 0 + 1 + 1 = 2$$
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):

\[
Z(\Phi(b)) = Z(T^S_b) + Z(\Phi_l(d)) + Z(\Phi_l(f)) \\
= 0 + 1 + 2 = 3
\]

\[
Z(\Phi(b)) = Z(T^S_b) + Z(\Phi_l(d)) + Z(\Phi_u(f)) \\
= 0 + 1 + 2 = 3
\]

\[
Z(\Phi(b)) = Z(T^S_b) + Z(\Phi_u(d)) + Z(\Phi_l(f)) \\
= 0 + 1 + 2 = 3
\]

\[
Z(\Phi(b)) = Z(T^S_b) + Z(\Phi_u(d)) + Z(\Phi_u(f)) \\
= 1 + 1 + 2 = 4 \quad \text{best case}
\]
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