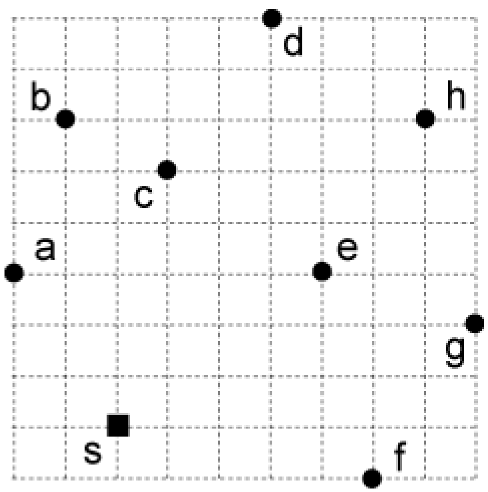
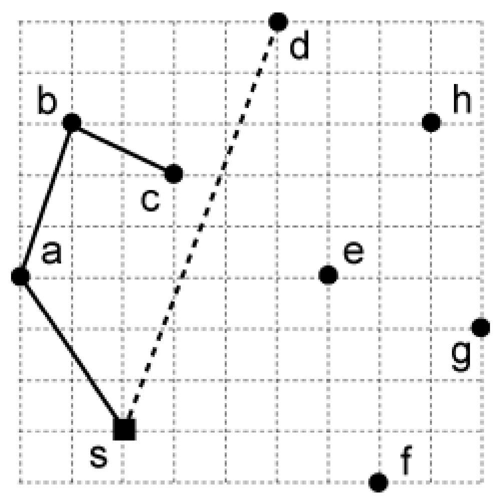
Bounded Radius Routing

- Perform bounded PRIM algorithm
  - Under $\varepsilon = 0$, $\varepsilon = 0.5$, and $\varepsilon = \infty$
  - Compare radius and wirelength
  - Radius = 12 for this net



BPRIM Under $\varepsilon = 0$

- Example
  - Edges connecting to nearest neighbors = (c,d) and (c,e)
    - We choose (c,d) based on lexicographical order
  - s-to-d path length along T = 12+5 > 12 (= radius bound)
  - First appropriate edge found = (s,d)

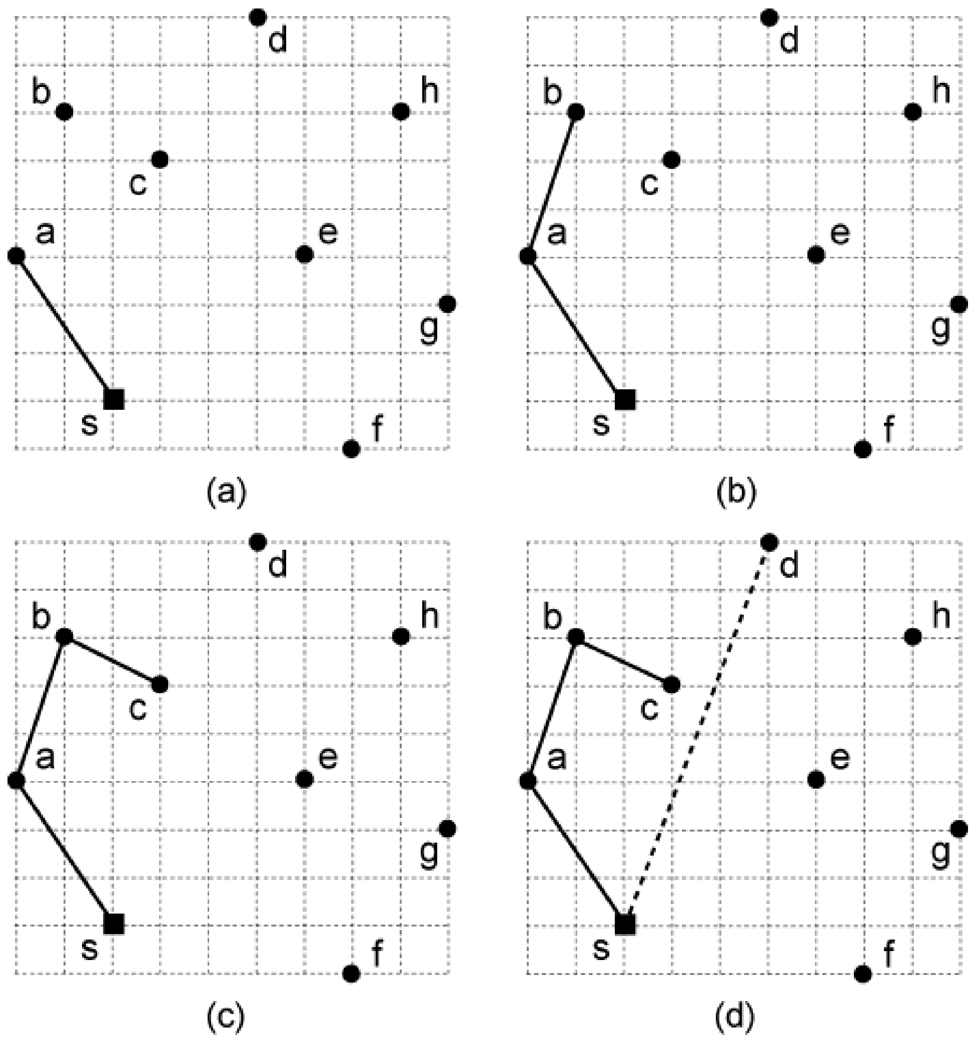


BPRIM Under $\varepsilon = 0$ (cont)

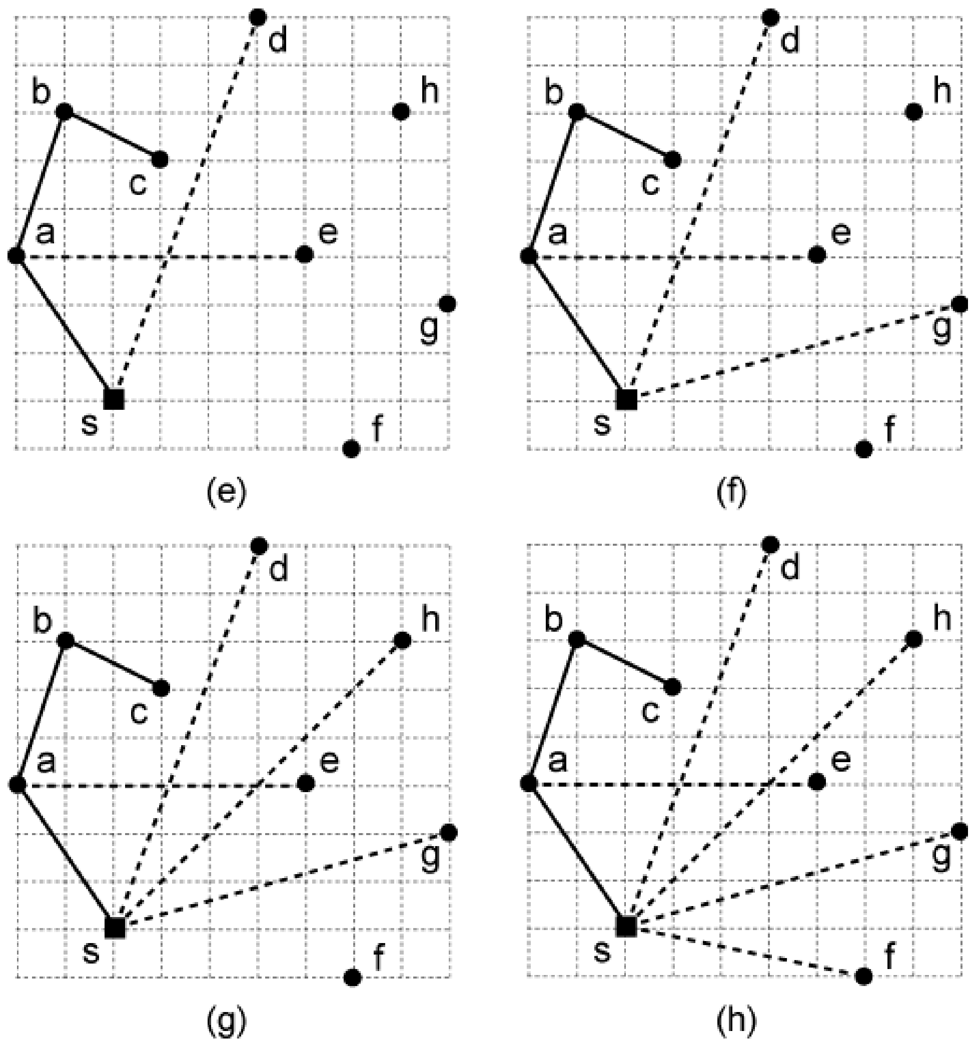
- Radius bound = 12

edges connecting to nearest neighbors		s-to-y path length along T	first feasible appr-edge
min $dist(x, y)$	chosen	$dist_T(s, x) + dist(x, y)$ of chosen edge	appropriate edge
(s, a)	(s, a)	$0 + 5$	-
(a, b)	(a, b)	$5 + 4$	-
(b, c)	(b, c)	$9 + 3$	-
(c, d), (c, e)	(c, d)	$12 + 5$	(s, d)
(c, e), (d, h)	(c, e)	$12 + 5$	(a, e)
(e, g)	(e, g)	$11 + 4$	(s, g)
(d, h), (e, h), (e, f), (g, f)	(d, h)	$11 + 5$	(s, h)
(e, f), (g, f)	(e, f)	$11 + 5$	(s, f)
	ties broken lexicographically	should be ≤ 12; otherwise appropriate used	

BPRIM Under $\varepsilon = 0$ (cont)



BPRIM Under $\varepsilon = 0$ (cont)



BPRIM Under $\varepsilon = 0.5$

- Radius bound = 18

edges connecting to nearest neighbors

s-to-y path length along T

first feasible appr-edge

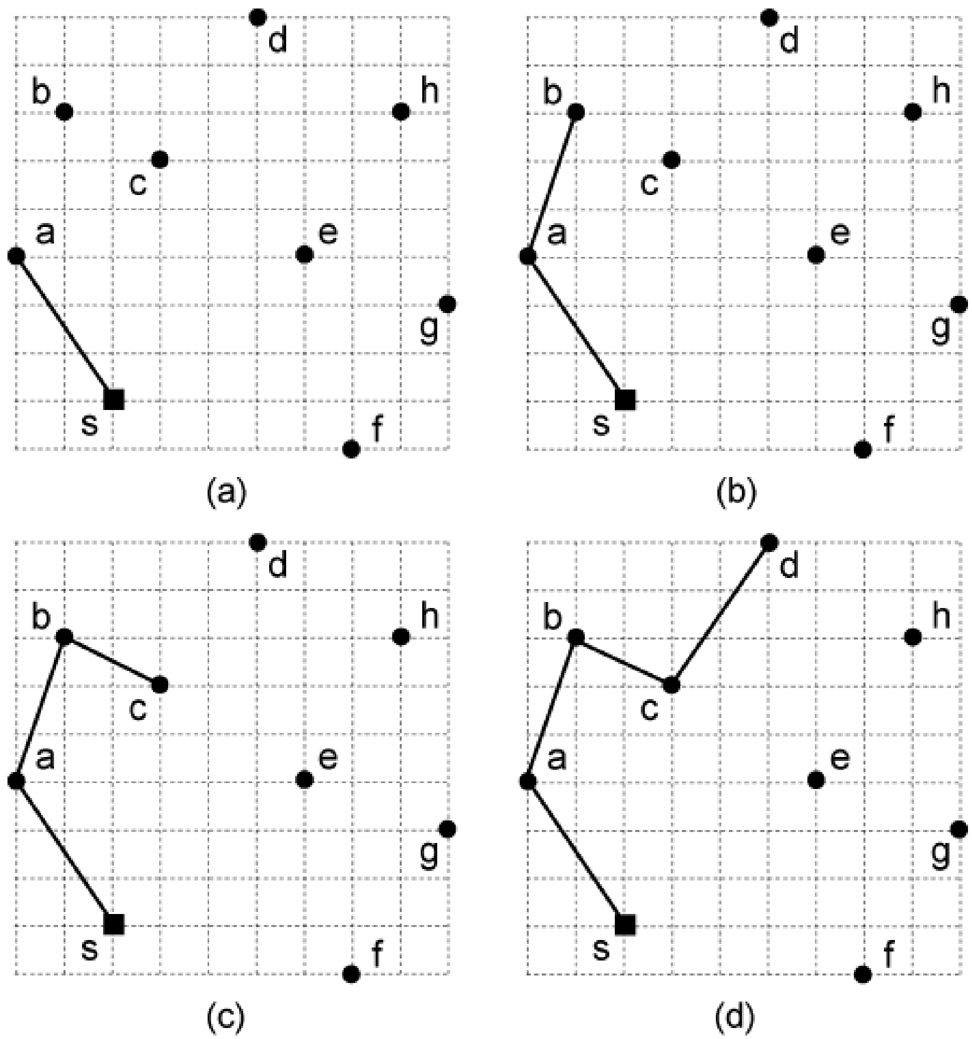
min $dist(x, y)$	chosen	$dist_T(s, x) + dist(x, y)$ of chosen edge	appropriate edge
(s, a)	(s, a)	$0 + 5$	-
(a, b)	(a, b)	$5 + 4$	-
(b, c)	(b, c)	$9 + 3$	-
(c, d), (c, e)	(c, d)	$12 + 5$	-
(c, e), (d, h)	(c, e)	$12 + 5$	-
(e, g)	(e, g)	$17 + 4$	(s, g)
(d, h), (e, h), (g, h), (e, f), (g, f)	(d, h)	$17 + 5$	(s, h)
(e, f), (g, f)	(e, f)	$17 + 5$	(s, f)

ties broken lexicographically

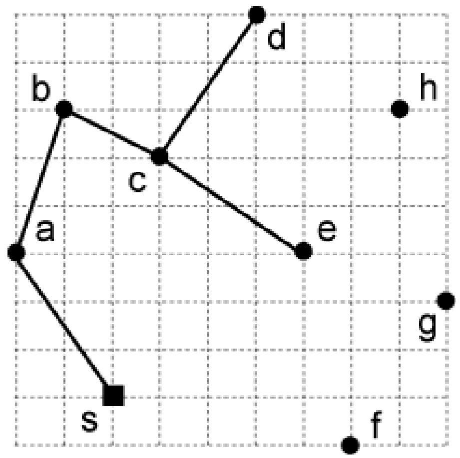
should be ≤ 18; otherwise appropriate used

should be ≤ 12

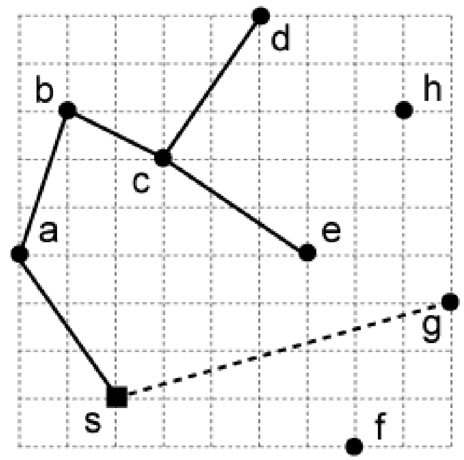
BPRIM Under $\varepsilon = 0.5$ (cont)



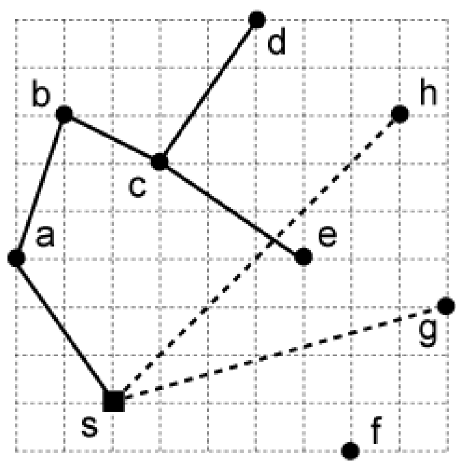
BPRIM Under $\varepsilon = 0.5$ (cont)



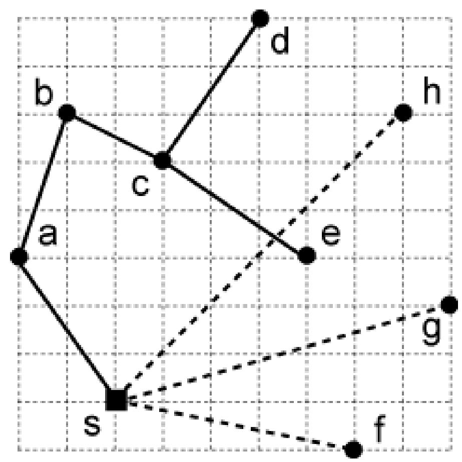
(e)



(f)



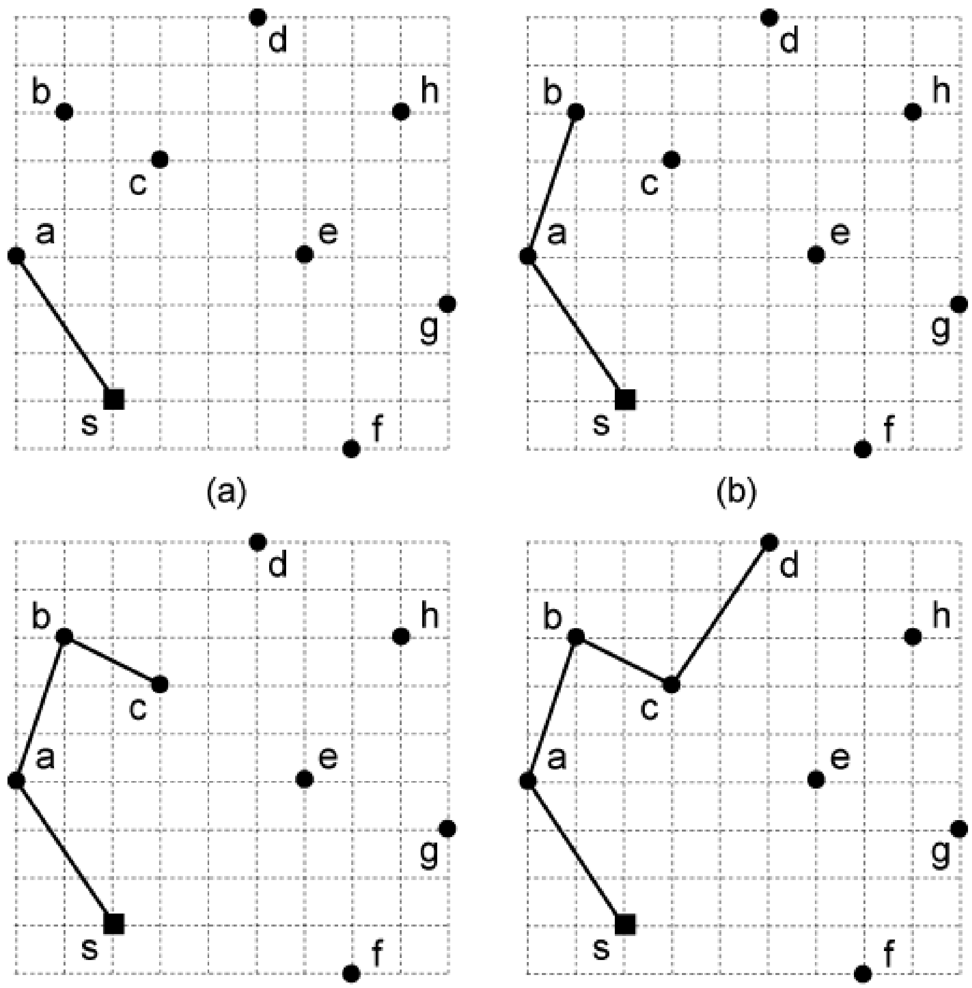
(g)



(h)

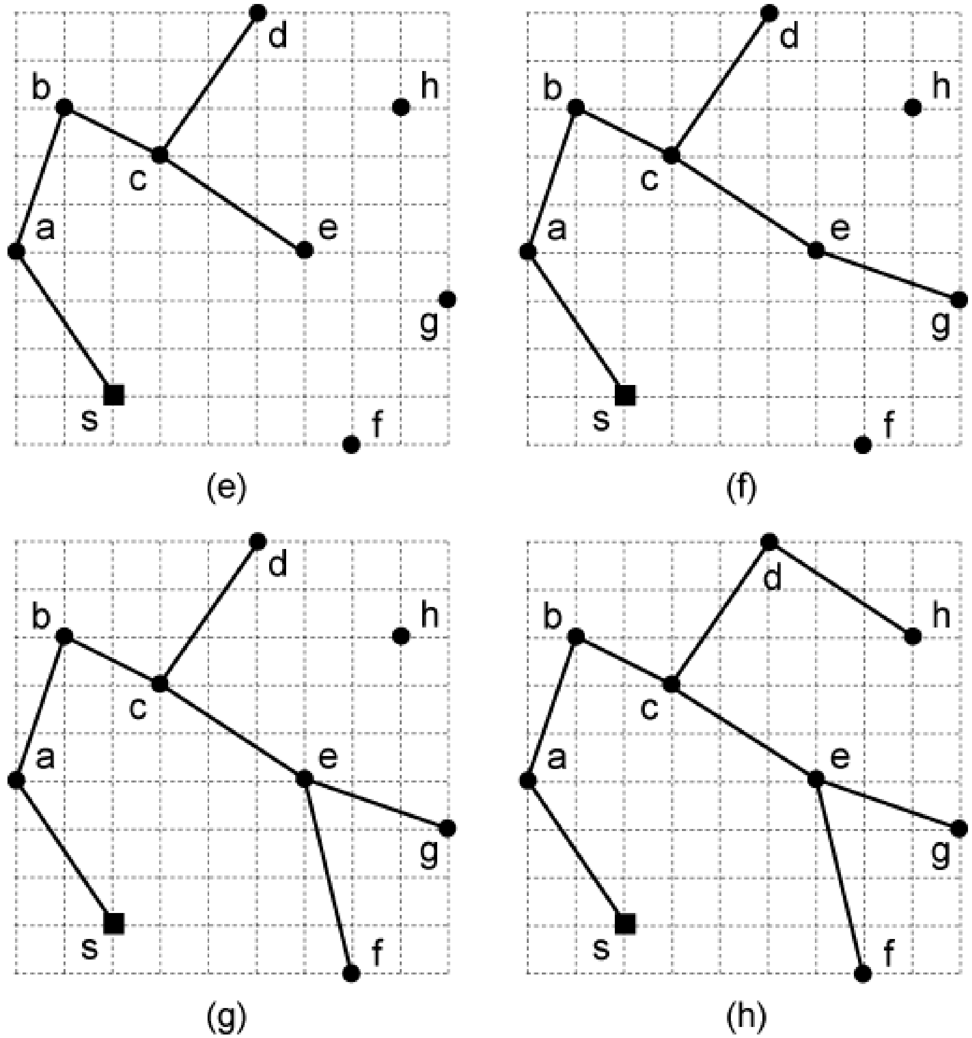
BPRIM Under $\varepsilon = \infty$

Radius bound = ∞
= regular PRIM



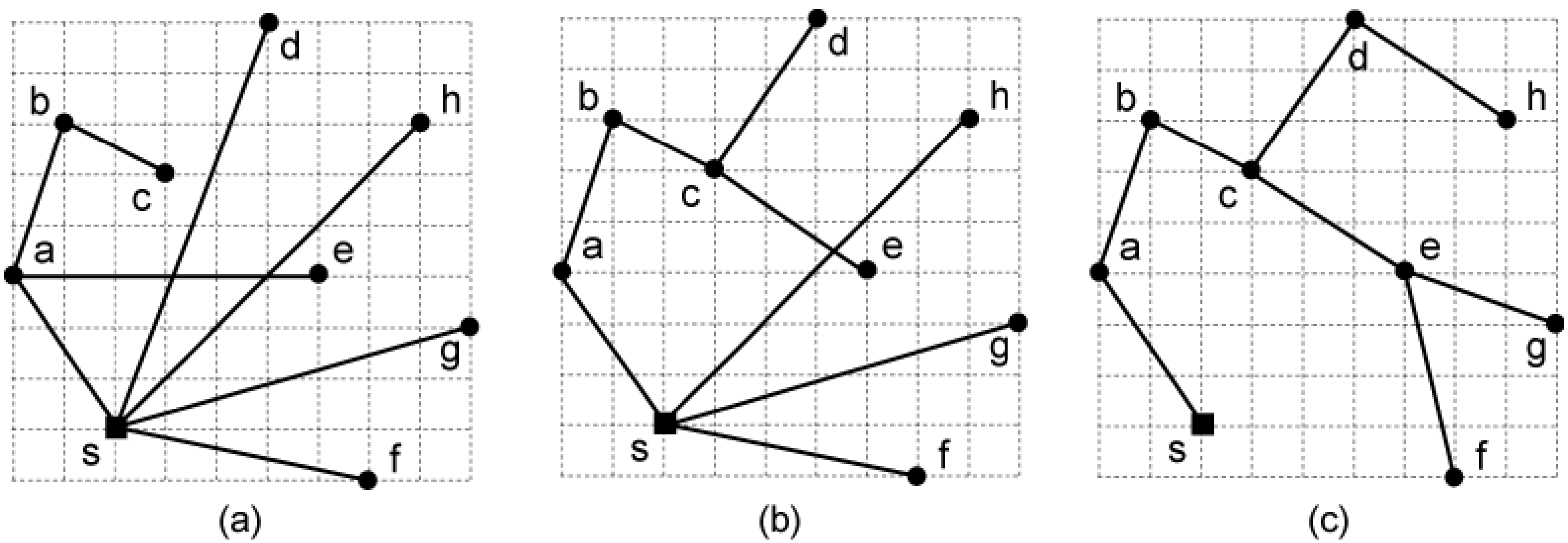
(a)
(b)
(c)
(d)

BPRIM Under $\varepsilon = \infty$ (cont)



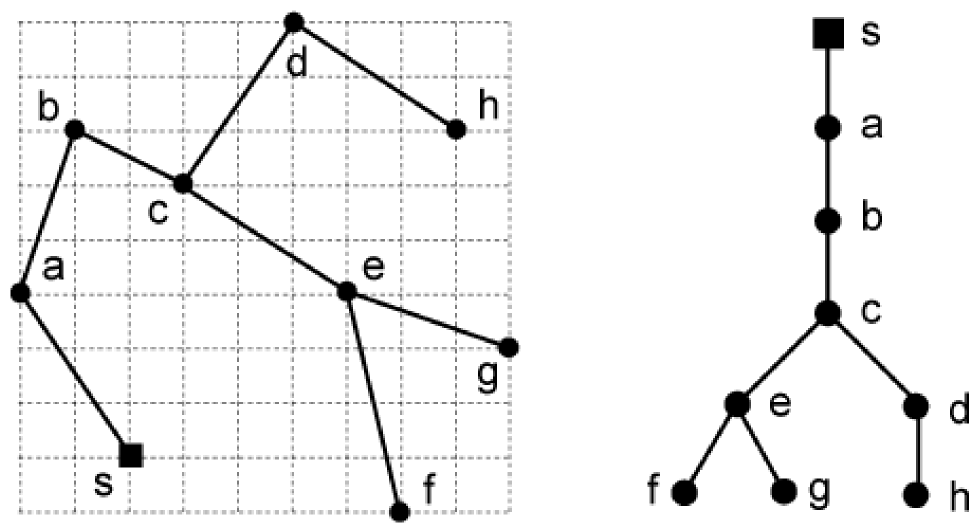
Comparison

- As the bound increases (12 → 18 → ∞)
  - Radius value increases (12 →17 → 22)
  - Wirelength decreases (56 → 49 → 36)



Bounded Radius Bounded Cost

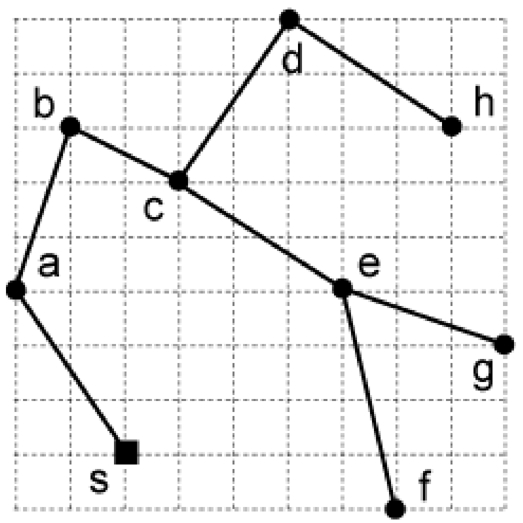
- Perform BRBC under $\varepsilon = 0.5$
  - ε defines both radius and wirelength bound
  - Perform DFS on rooted-MST
  - Node ordering $L = \{s, a, b, c, e, f, e, g, e, c, d, h, d, c, b, a, s\}$
  - We start with Q = MST



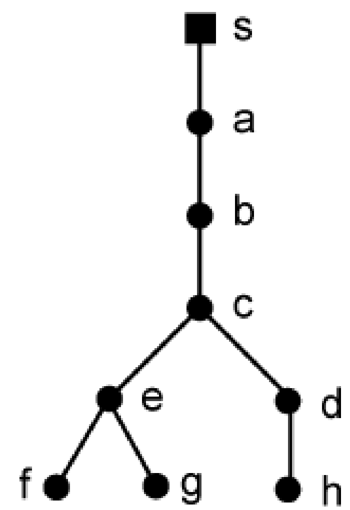
(a) (b)

MST Augmentation

- Example: visit a via (s,a)
  - Running total of the length of visited edges, $S = 5$
  - Rectilinear distance between source and a, $dist(s,a) = 5$
  - We see that $\varepsilon \cdot dist(s,a) = 0.5 \cdot 5 < S$
  - Thus, we reset S and add (s,a) to Q (note (s,a) is already in Q)



(a)

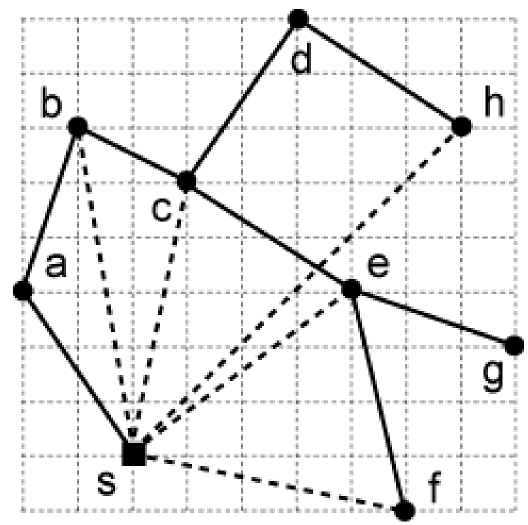


(b)

MST Augmentation (cont)

edge	L_i	$\epsilon \cdot dist(s, L_i)$	S	reset S?
(s, a)	a	$0.5 \cdot 5$	5	yes
(a, b)	b	$0.5 \cdot 7$	4	yes
(b, c)	c	$0.5 \cdot 6$	3	yes
(c, e)	e	$0.5 \cdot 7$	5	yes
(e, f)	f	$0.5 \cdot 6$	5	yes
(f, e)	e	$0.5 \cdot 7$	5	yes
(e, g)	g	$0.5 \cdot 9$	4	no
(g, e)	e	$0.5 \cdot 7$	8	yes
(e, c)	c	$0.5 \cdot 6$	5	yes
(c, d)	d	$0.5 \cdot 11$	5	no
(d, h)	h	$0.5 \cdot 12$	10	yes
(h, d)	d	$0.5 \cdot 11$	5	no
(d, c)	c	$0.5 \cdot 6$	10	yes
(c, b)	b	$0.5 \cdot 7$	3	no
(b, a)	a	$0.5 \cdot 5$	7	yes
(a, s)	s	$0.5 \cdot 0$	5	yes

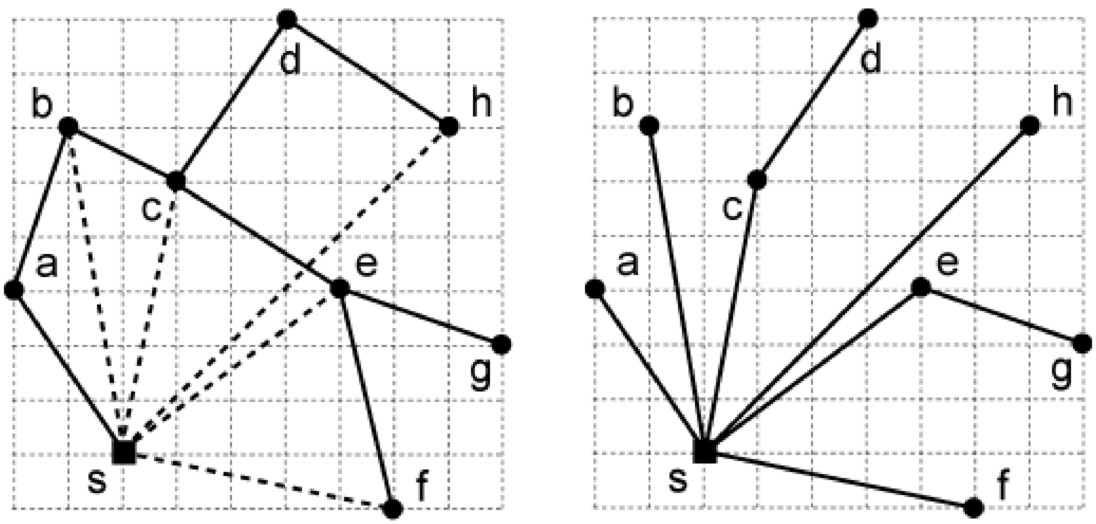
visit nodes based on L



dotted edges are added

Last Step: SPT Computation

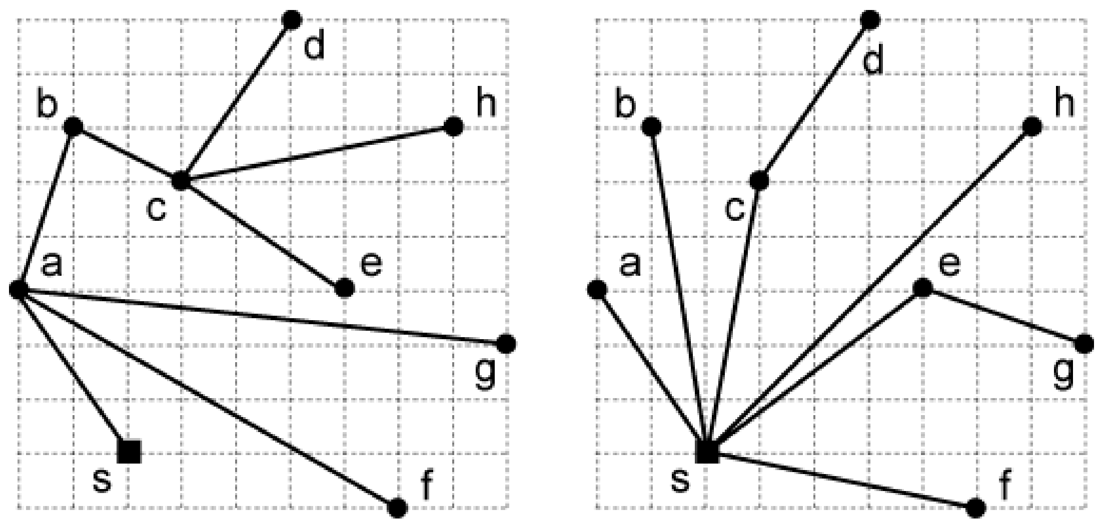
- Compute rooted shortest path tree on augmented *Q*



(a) (b)

BPRIM vs BRBC

- Under the same $\varepsilon = 0.5$
  - BPRIM: radius = 18, wirelength = 49
  - BRBC: radius = 12, wirelength = 52
  - BRBC: significantly shorter radius at slight wirelength increase



(a) (b)