## Prim's Algorithm Demo

- Prim's algorithm
- lazy implementation
- eager implementation

Robert Sedgewick I Kevin Wayne
https://algs4.cs.princeton.edu

## Prim's Algorithm Demo

- Prim's algorithm
- lazy implementation

Algorithms

- eager implementation

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## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

an edge-weighted graph

0-7 0.16
2-3 $\quad 0.17$
1-7 0.19
0-2 0.26
5-7 0.28
1-3 0.29
1-5 0.32
2-7 $\quad 0.34$
4-5 0.35
1-2 0.36
4-7 0.37
0-4 0.38
6-2 0.40
3-6 0.52
6-0 0.58
6-4 0.93

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- Repeat until $V$ - 1 edges.

edges with exactly
one endpoint in T
(sorted by weight)
in MST $\longrightarrow 0-7 \quad 0.16$
0-2 0.26
0-4 0.38
6-0 0.58


## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
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MST edges
0-7

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edges with exactly
one endpoint in T
(sorted by weight)
in MST $\longrightarrow$ 1-7 0.19
0-2 0.26
5-7 0.28
2-7 0.34
4-7 0.37
0-4 0.38
6-0 0.58

MST edges
0-7

## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
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MST edges
0-7 1-7

## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

edges with exactly
one endpoint in $T$
(sorted by weight)



## MST edges

0-7 1-7

## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


MST edges
0-7 $\quad 1$-7 $0-2$

## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

edges with exactly
one endpoint in T
(sorted by weight)

in MST $\longrightarrow$ 2-3 0.17
5-7 0.28
1-3 0.29
1-5 0.32
4-7 0.37
0-4 0.38
6-2 0.40
6-0 0.58


## MST edges

$$
\begin{array}{lll}
0-7 & 1-7 & 0-2
\end{array}
$$

## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


MST edges
0-7 $\quad 1-7 \quad 0-2 \quad 2-3$

## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
min weight edge with exactly one endpoint in $T$


$$
\text { in MST } \longrightarrow \begin{array}{cc}
5-7 & 0.28 \\
1-5 & 0.32 \\
4-7 & 0.37 \\
0-4 & 0.38 \\
6-2 & 0.40 \\
3-6 & 0.52 \\
& 6-0
\end{array} 0.58
$$

MST edges

$$
\begin{array}{llll}
0-7 & 1-7 & 0-2 & 2-3
\end{array}
$$

## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


MST edges

$$
\begin{array}{lllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7
\end{array}
$$

## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
min weight edge with exactly one endpoint in $T$



## MST edges

$$
\begin{array}{lllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7
\end{array}
$$

edges with exactly
one endpoint in $T$
(sorted by weight)
in MST $\longrightarrow 4-5 \quad 0.35$
4-7 0.37
0-4 0.38
6-2 0.40
3-6 0.52
6-0 0.58

## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


MST edges

$$
\begin{array}{llllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7 & 4-5
\end{array}
$$

## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


MST edges

$$
\begin{array}{llllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7 & 4-5
\end{array}
$$

## Prim's algorithm demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


MST edges

$$
\begin{array}{lllllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7 & 4-5 & 6-2
\end{array}
$$

## Prim's Algorithm Demo

## Algorithms

- Prim's algorithm
- lazy implementation
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## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

an edge-weighted graph


## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.



## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
add to $P Q$ all edges incident to 0



## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 0-7 and add to MST

edges on PQ (sorted by weight)

0-7 0.16
0-2 0.26
0-4 0.38
6-0 0.58

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

edges on PQ (sorted by weight)

0-2 0.26
0-4 0.38
6-0 0.58

## MST edges <br> 0-7

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
add to $P Q$ all edges incident to 7
no need to add 0-7

edges on PQ (sorted by weight)
* 1-7 0.19

0-2 0.26

* 5-7 0.28
* 2-7 0.34
* 4-7 0.37

0-4 0.38
6-0 0.58

$$
\begin{aligned}
& \text { MST edges } \\
& 0-7
\end{aligned}
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 1-7 and add to MST


0-2 0.26
5-7 0.28
2-7 0.34
4-7 0.37
0-4 0.38
6-0 0.58

## MST edges 0-7

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

edges on PQ (sorted by weight)

0-2 0.26
5-7 0.28
2-7 0.34
4-7 0.37
0-4 0.38
6-0 0.58

> MST edges
> $0-7 \quad 1-7$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
add to $P Q$ all edges incident to 1

edges on PQ (sorted by weight)

| $0-2$ | 0.26 |
| ---: | ---: |
| $5-7$ | 0.28 |
| $* 1-3$ | 0.29 |
| $* 1-5$ | 0.32 |
| $2-7$ | 0.34 |
| $* 1-2$ | 0.36 |
| $4-7$ | 0.37 |
| $0-4$ | 0.38 |
| $6-0$ | 0.58 |

MST edges
0-7 1-7

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete edge 0-2 and add to MST

edges on PQ (sorted by weight)
$0-2 \quad 0.26$
5-7 0.28
1-3 0.29
1-5 0.32
2-7 0.34
1-2 0.36
4-7 0.37
0-4 0.38
6-0 0.58


## MST edges

0-7 1-7

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

1-2 and 2-7 becomes obsolete
(lazy implementation leaves on PQ)


MST edges
0-7 $\quad 1-7 \quad 0-2$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

$$
\text { no need to add either } 1-2 \text { or } 2-7
$$

add to $P Q$ all edges incident to 2

$$
\text { (because both endpoints are in } \mathrm{T} \text { ) }
$$



$$
\begin{aligned}
& \text { MST edges } \\
& 00-7 \quad 1-7 \quad 0-2
\end{aligned}
$$

edges on PQ (sorted by weight)

$$
* 2-3 \quad 0.17
$$

$$
5-7 \quad 0.28
$$

$$
1-3 \quad 0.29
$$

$$
1-5 \quad 0.32
$$

$$
2-7 \quad 0.34
$$

$$
1-2 \quad 0.36
$$

$$
4-7 \quad 0.37
$$

$$
0-4 \quad 0.38
$$

$$
\text { * 6-2 } 0.40
$$

$$
6-0 \quad 0.58
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 2-3 and add to MST

edges on PQ (sorted by weight)
* 2-3 0.17

5-7 0.28
1-3 0.29
1-5 0.32
2-7 0.34
1-2 0.36
4-7 0.37
0-4 0.38

* 6-2 0.40

6-0 0.58

$$
\begin{aligned}
& \text { MST edges } \\
& 0-7 \quad 1-7 \quad 0-2
\end{aligned}
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

edges on PQ (sorted by weight)

5-7 0.28
1-3 0.29
1-5 0.32
2-7 0.34
1-2 0.36
4-7 0.37
0-4 0.38
6-2 0.40
6-0 0.58

MST edges

$$
\begin{array}{llll}
0-7 & 1-7 & 0-2 & 2-3
\end{array}
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
add to $P Q$ all edges incident to 3

edges on PQ
(sorted by weight)

$$
\begin{array}{ll}
5-7 & 0.28
\end{array}
$$

$$
0.29
$$

$$
1-5 \quad 0.32
$$

$$
2-7 \quad 0.34
$$

$$
1-2 \quad 0.36
$$

$$
4-7 \quad 0.37
$$

$$
0-4 \quad 0.38
$$

$$
6-2 \quad 0.40
$$

$$
\text { * 3-6 } 0.52
$$

MST edges

$$
6-0 \quad 0.58
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 5-7 and add to MST

edges on PQ (sorted by weight)

5-7 0.28
1-3 0.29
1-5 0.32
2-7 0.34
1-2 0.36
4-7 0.37
0-4 0.38
6-2 0.40
3-6 0.52
6-0 0.58

$$
\begin{aligned}
& \text { MST edges } \\
& 0-7 \quad 1-7
\end{aligned} \quad 0-2 \quad 2-3 .
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

edges on PQ (sorted by weight)

| $1-3$ | 0.29 |
| :--- | :--- |
| $1-5$ | 0.32 |
| $2-7$ | 0.34 |
| $1-2$ | 0.36 |
| $4-7$ | 0.37 |
| $0-4$ | 0.38 |
| $6-2$ | 0.40 |
| $3-6$ | 0.52 |
| $6-0$ | 0.58 |

MST edges

$$
\begin{array}{lllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7
\end{array}
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
add to $P Q$ all edges incident to 5

edges on PQ (sorted by weight)

1-3 0.29
1-5 0.32
2-7 0.34
4-5 0.35
1-2 0.36
4-7 0.37
0-4 0.38
6-2 $\quad 0.40$
3-6 0.52
6-0 0.58

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 1-3 and discard obsolete edge

edges on PQ (sorted by weight)

1-3 0.29
1-5 0.32
2-7 0.34
4-5 0.35
1-2 0.36
4-7 0.37
0-4 0.38
6-2 0.40
3-6 0.52
6-0 0.58

$$
\begin{aligned}
& \text { MST edges } \\
& 0-7 \quad 1-7
\end{aligned} \begin{aligned}
& 0-2
\end{aligned} \quad 2-3 \quad 5-7 .
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 1-5 and discard obsolete edge

edges on PQ (sorted by weight)

1-5 0.32
2-7 0.34
4-5 0.35
1-2 0.36
4-7 0.37
0-4 0.38
6-2 0.40
3-6 0.52
6-0 0.58

MST edges

$$
\begin{array}{lllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7
\end{array}
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 2-7 and discard obsolete edge

edges on PQ (sorted by weight)
2-7 0.34

4-5 0.35
1-2 0.36
4-7 0.37
0-4 0.38
6-2 0.40
3-6 0.52
6-0 0.58

## MST edges

$$
\begin{array}{lllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7
\end{array}
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 4-5 and add to MST

edges on PQ (sorted by weight)

4-5 0.35
1-2 0.36
4-7 0.37
0-4 0.38
6-2 0.40
3-6 0.52
6-0 0.58

MST edges

$$
\begin{array}{lllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7
\end{array}
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

edges on PQ (sorted by weight)

1-2 0.36
4-7 0.37
0-4 0.38
6-2 0.40
3-6 0.52
6-0 0.58

MST edges
0-7 $\quad 1-7 \quad 0-2 \quad 2-3 \quad 5-7 \quad 4-5$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
add to $P Q$ all edges incident to 4

edges on PQ (sorted by weight)

1-2 0.36
4-7 0.37
0-4 0.38
6-2 0.40
3-6 0.52
6-0 0.58

* 6-4 0.93

MST edges
0-7 $\quad 1-7 \quad 0-2 \quad 2-3 \quad 5-7 \quad 4-5$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 1-2 and discard obsolete edge

edges on PQ (sorted by weight)

1-2 0.36
4-7 0.37
0-4 0.38
6-2 0.40
3-6 0.52
6-0 0.58
6-4 0.93

MST edges

$$
\begin{array}{llllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7 & 4-5
\end{array}
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 4-7 and discard obsolete edge

edges on PQ (sorted by weight)

4-7 0.37
0-4 0.38
6-2 $\quad 0.40$
3-6 0.52
6-0 0.58
6-4 0.93

MST edges

$$
\begin{array}{llllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7 & 4-5
\end{array}
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 0-4 and discard obsolete edge

edges on PQ (sorted by weight)

0-4 0.38
6-2 0.40
3-6 0.52
6-0 0.58
6-4 0.93

MST edges

$$
\begin{array}{llllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7 & 4-5
\end{array}
$$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 6-2 and add to MST

edges on PQ (sorted by weight)
$6-2 \quad 0.40$
3-6 0.52
6-0 0.58
6-4 0.93

MST edges
0-7 $\quad 1-7 \quad 0-2 \quad 2-3 \quad 5-7 \quad 4-5$

## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
delete 6-2 and add to MST


```
MST edges
0-7 1-7 0-2 2-3 5-7 4-5
```


## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.
stop since $\mathbf{V}$ - 1 edges

edges on PQ (sorted by weight)

```
MST edges
0-7 1-7 0-2 2-3
```


## Prim's algorithm: lazy implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


$$
\begin{aligned}
& \text { MST edges } \\
& 0-7 \\
& 1-7
\end{aligned} \quad 0-2 \quad 2-3 \quad 5-7 \quad 4-5 \quad 6-2 .
$$

## Prim's Algorithm Demo

## Algorithms

## - Prim's algorithm

- lazy implementation
- eager implementation

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## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

an edge-weighted graph


## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.



## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


$\rightarrow$| $\vee$ | edgeTo[] | distTo[] |
| :---: | :---: | :---: |
| 0 | - | - |


| 7 | $0-7$ | 0.16 |
| :--- | :--- | :--- |
| 2 | $0-2$ | 0.26 |
| 4 | $0-4$ | 0.38 |
| 6 | $6-0$ | 0.58 |

vertices on PQ (sorted by weight)
found connections to $7,2,4$, and 6 (add to PQ)

## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.



## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


> MST edges
> $0-7$

## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.



## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


> MST edges
> $0-7 \quad 1-7$

## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


> MST edges
> $0-7 \quad 1-7$

## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.



## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


MST edges
0-7 1-7

## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


MST edges

$$
\begin{array}{lll}
0-7 & 1-7 & 0-2
\end{array}
$$

## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.



## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


$$
\begin{aligned}
& \text { MST edges } \\
& 0-7 \quad 1-7 \quad 0-2 \quad 2-3
\end{aligned}
$$

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already a better

$$
\begin{array}{llllc}
\text { MST edges } & & \text { connection to } 6 \\
\mathbf{0 - 7} & \mathbf{1 - 7} & \mathbf{0 - 2} & \mathbf{2 - 3} & \text { (discard) }
\end{array}
$$

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$$
\begin{aligned}
& \text { MST edges } \\
& 0-7 \quad 1-7
\end{aligned} \quad 0-2 \quad 2-3 .
$$

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$$
\begin{aligned}
& \text { MST edges } \\
& 0-7 \\
& 1-7
\end{aligned} \quad 0-2 \quad 2-3 \quad 5-7 .
$$

## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.

> a better connection to 4 (decrease key of vertex 4 )

MST edges

$$
\begin{array}{lllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7
\end{array}
$$

| $v$ | edgeTo[] | distTo[] |
| :---: | :---: | :---: |
| 0 | - | - |
| 7 | $0-7$ | 0.16 |
| 1 | $1-7$ | 0.19 |
| 2 | $0-2$ | 0.26 |
| 3 | $2-3$ | 0.17 |
| $\rightarrow 5$ | $5-7$ | 0.28 |
|  |  | 0.37 |
| 4 | $4-7$ | 0.35 |
| 6 | $6-2$ | 0.40 |

## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
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MST edges
0-7

## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


MST edges

$$
\begin{array}{llllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7 & 4-5
\end{array}
$$

## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
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## Prim's algorithm: eager implementation demo

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$$
\begin{aligned}
& \text { MST edges } \\
& 0-0-7 \\
& 1-7
\end{aligned} \quad 0-2 \quad 2-3 \quad 5-7 \quad 4-5 .
$$

## Prim's algorithm: eager implementation demo

- Start with vertex 0 and greedily grow tree $T$.
- Add to $T$ the min weight edge with exactly one endpoint in $T$.
- Repeat until $V$ - 1 edges.


MST edges

$$
\begin{array}{lllllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7 & 4-5 & 6-2
\end{array}
$$

## Prim's algorithm: eager implementation demo

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| $v$ | edgeTo[] | distTo[] |
| :---: | :---: | :---: |
| 0 | - | - |
| 7 | $0-7$ | 0.16 |
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| 3 | $2-3$ | 0.17 |
| 5 | $5-7$ | 0.28 |
| 4 | $4-5$ | 0.35 |
| 6 | $6-2$ | 0.40 |

MST edges

$$
\begin{array}{lllllll}
0-7 & 1-7 & 0-2 & 2-3 & 5-7 & 4-5 & 6-2
\end{array}
$$

