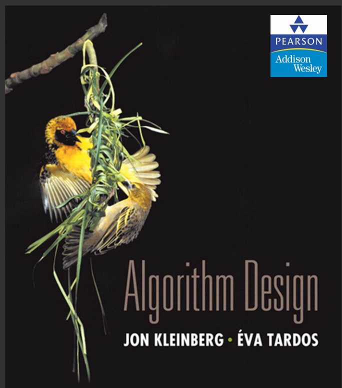


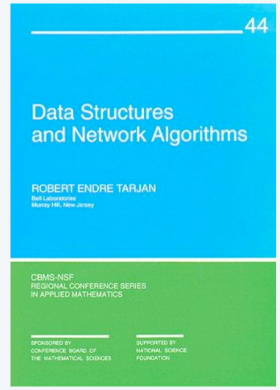

# 4. Greedy Algorithms II

- *red-rule blue-rule demo*
- *Prim's algorithm demo*
- *Kruskal's algorithm demo*
- *reverse-delete algorithm demo*
- *Boruvka's algorithm demo*

Lecture slides by Kevin Wayne

http://www.cs.princeton.edu/~wayne/kleinberg-tardos

Last updated on 1/15/20 9:35 AM




Section 6.1

# 4. Greedy Algorithms II

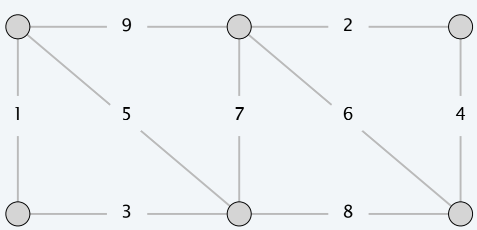


## Red-rule blue-rule demo

Red rule. Let $C$ be a cycle with no red edges. Select an uncolored edge of $C$ of max weight and color it red.

Blue rule. Let $D$ be a cutset with no blue edges. Select an uncolored edge in $D$ of min weight and color it blue.

**the input graph**

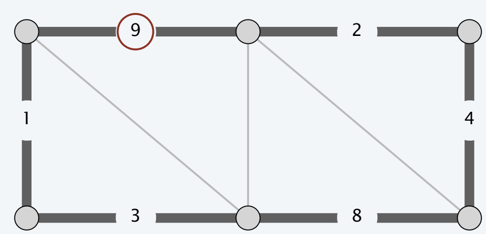





## Red-rule blue-rule demo

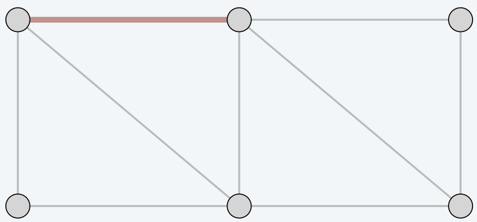
Red rule. Let $C$ be a cycle with no red edges. Select an uncolored edge of $C$ of max weight and color it red.

**apply the red rule to the cycle**



## Red-rule blue-rule demo

current set of red and blue edges

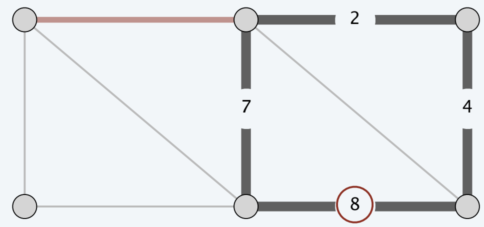




## Red-rule blue-rule demo

Red rule. Let $C$ be a cycle with no red edges. Select an uncolored edge of $C$ of max weight and color it red.

apply the red rule to the cycle

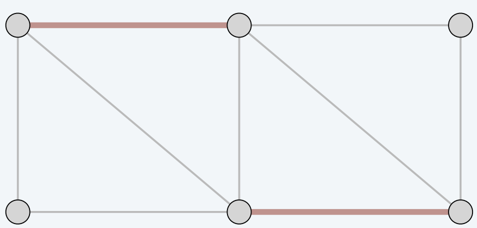





## Red-rule blue-rule demo

Red rule. Let $C$ be a cycle with no red edges. Select an uncolored edge of $C$ of max weight and color it red.

current set of red and blue edges

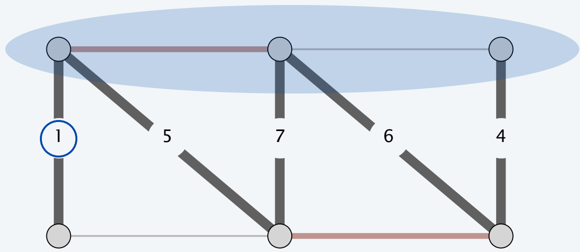




## Red-rule blue-rule demo

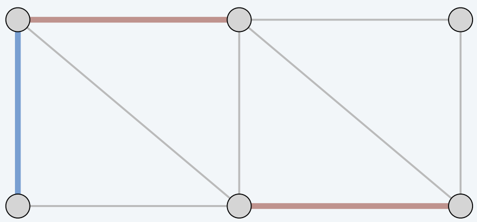
Blue rule. Let $D$ be a cutset with no blue edges. Select an uncolored edge in $D$ of min weight and color it blue.

apply the blue rule to the cutset



## Red-rule blue-rule demo

**current set of red and blue edges**

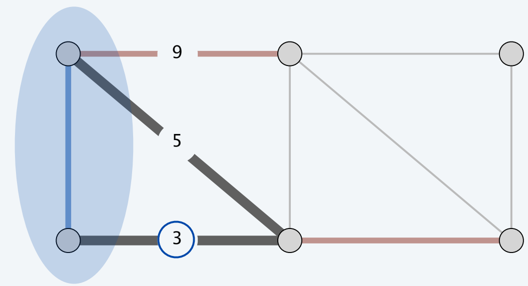




## Red-rule blue-rule demo

Blue rule. Let $D$ be a cutset with no blue edges. Select an uncolored edge in $D$ of min weight and color it blue.

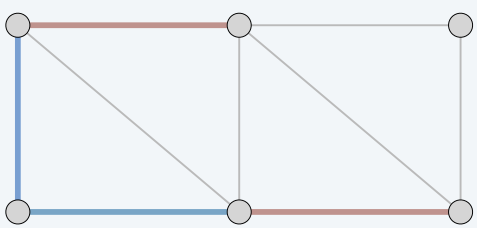
**apply the blue rule to the cutset**






## Red-rule blue-rule demo

**current set of red and blue edges**

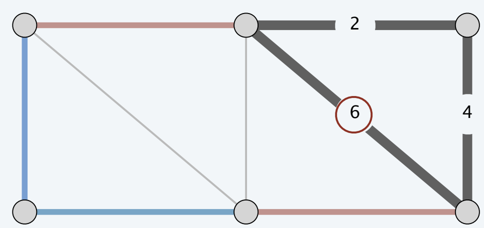




## Red-rule blue-rule demo

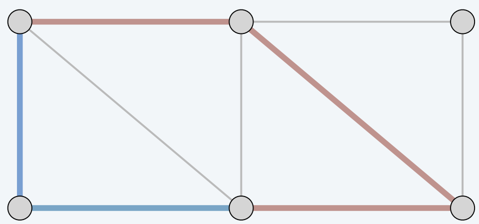
Red rule. Let $C$ be a cycle with no red edges. Select an uncolored edge of $C$ of max weight and color it red.

**apply the red rule to the cycle**



## Red-rule blue-rule demo

**current set of red and blue edges**

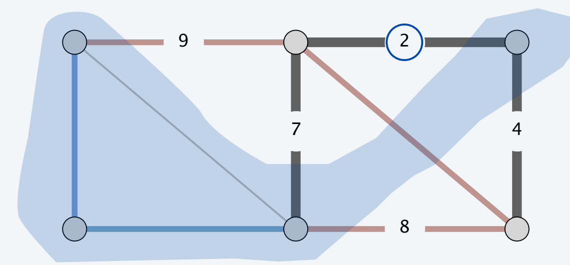




## Red-rule blue-rule demo

Blue rule. Let $D$ be a cutset with no blue edges. Select an uncolored edge in $D$ of min weight and color it blue.

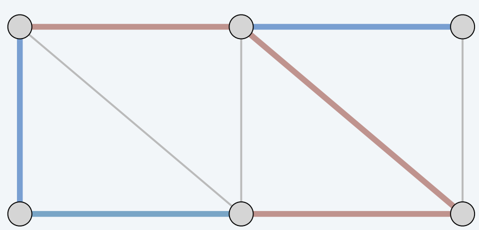
**apply the blue rule to the cutset**






## Red-rule blue-rule demo

**current set of red and blue edges**

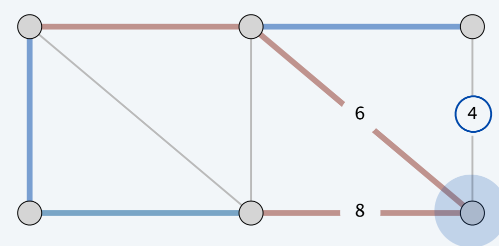




## Red-rule blue-rule demo

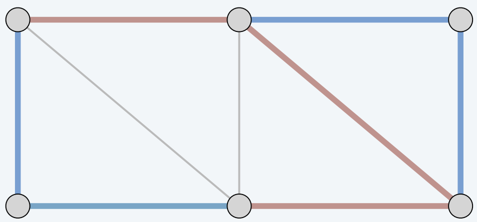
Blue rule. Let $D$ be a cutset with no blue edges. Select an uncolored edge in $D$ of min weight and color it blue.

**apply the blue rule to the cutset**



## Red-rule blue-rule demo

**current set of red and blue edges**

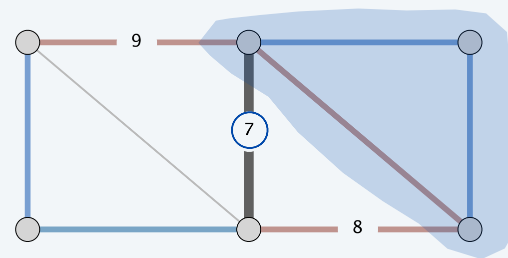




## Red-rule blue-rule demo

Blue rule. Let $D$ be a cutset with no blue edges. Select an uncolored edge in $D$ of min weight and color it blue.

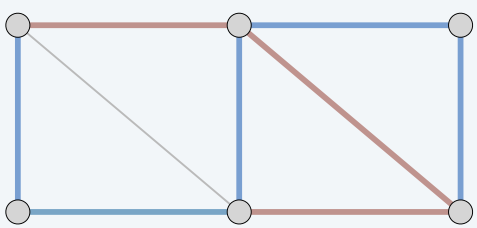
**apply the blue rule to the cutset**






## Red-rule blue-rule demo

**current set of red and blue edges**

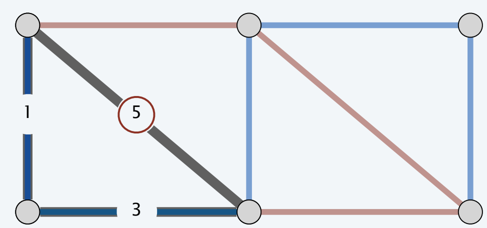




## Red-rule blue-rule demo

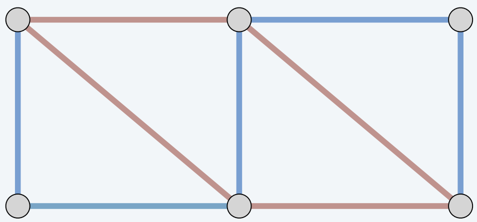
Blue rule. Let $D$ be a cutset with no blue edges. Select an uncolored edge in $D$ of min weight and color it blue.

**apply the red rule to the cycle**



## Red-rule blue-rule demo

current set of red and blue edges

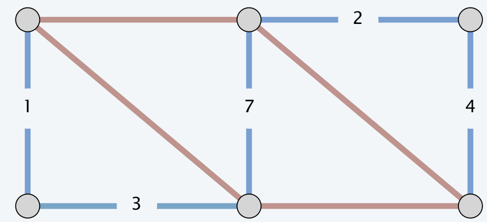




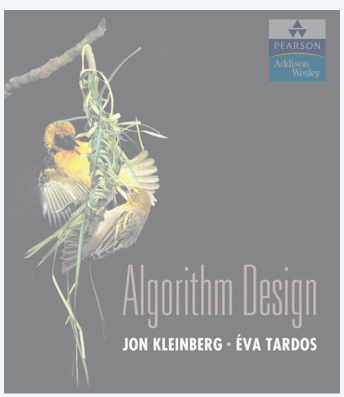
## Red-rule blue-rule demo

Greedy algorithm. Upon termination, the blue edges form a MST.

a minimum spanning tree






SECTION 4.5

## 4. GREEDY ALGORITHMS II

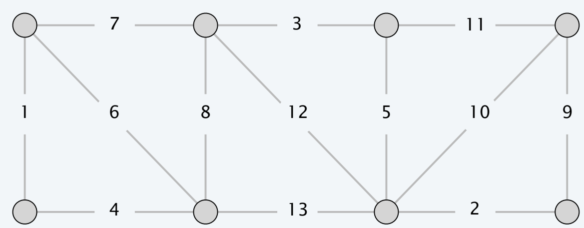


## Prim's algorithm demo

Initialize $S = \{ s \}$ for any node $s$, $T = \varnothing$.

Repeat $n - 1$ times:

- Add to $T$ a min-weight edge with exactly one endpoint in $S$.
- Add the other endpoint to $S$.



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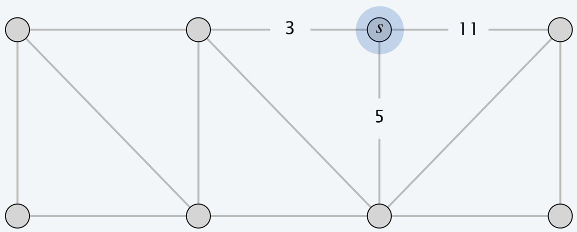




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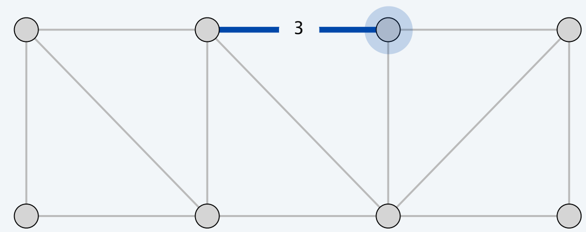




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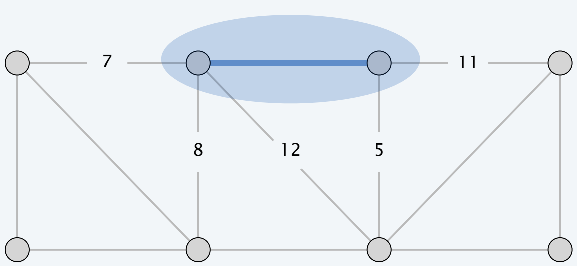




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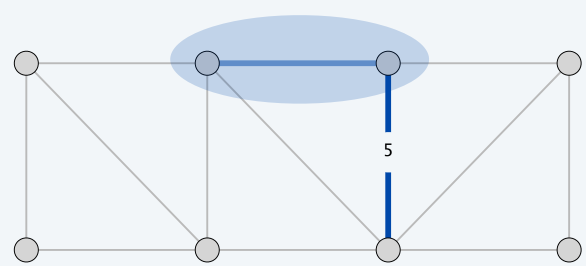

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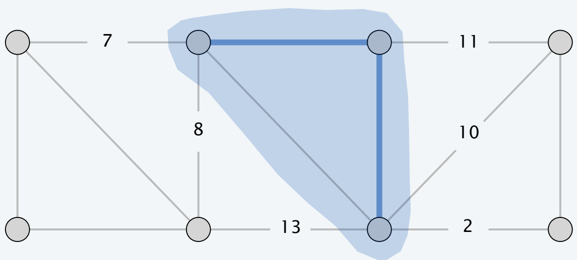




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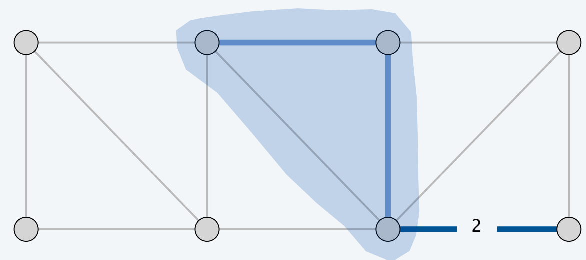




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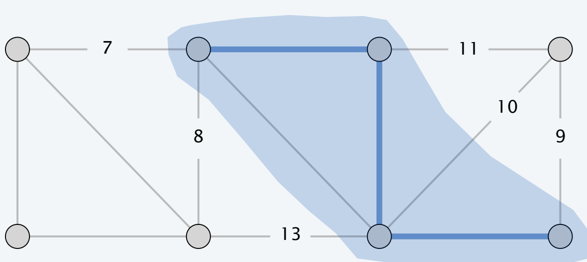




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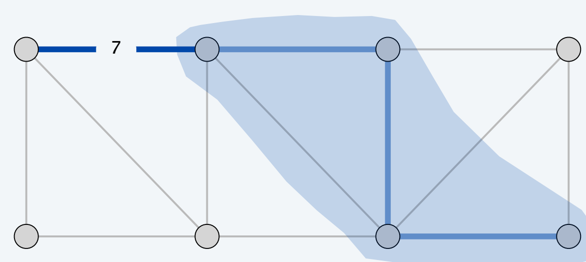

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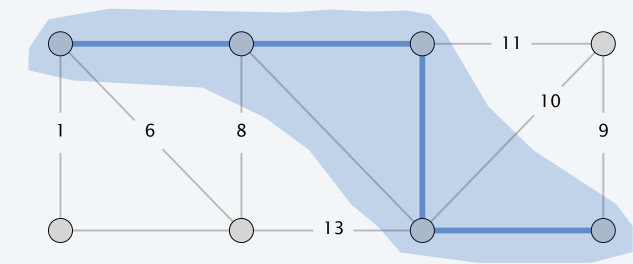




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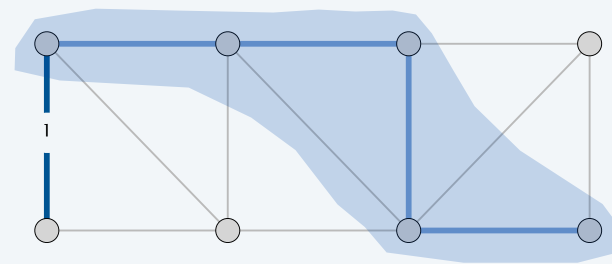




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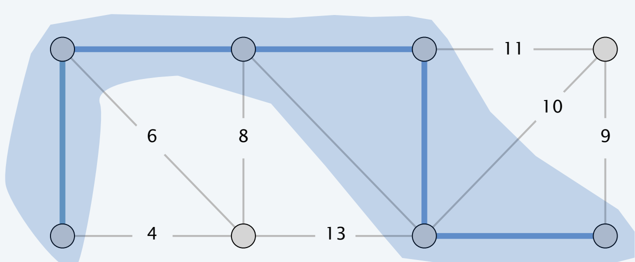




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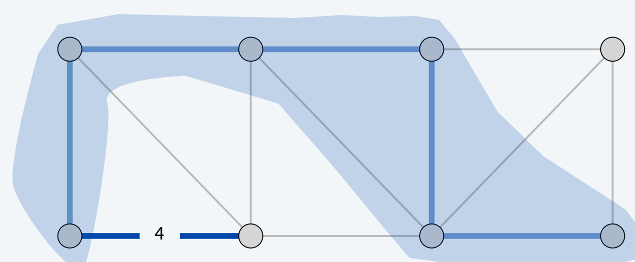

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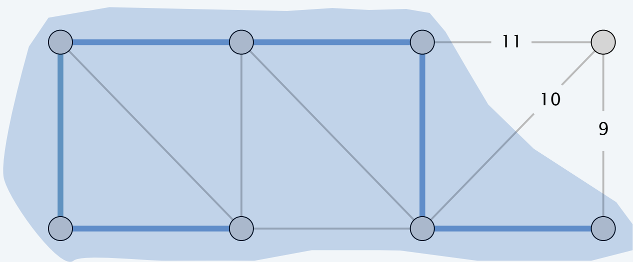




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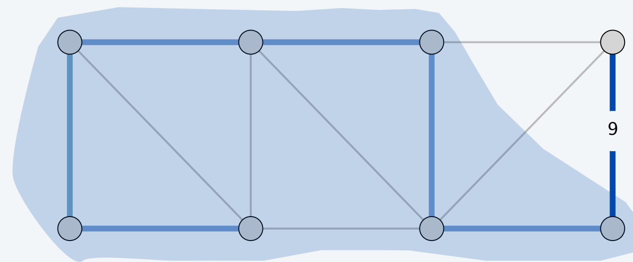




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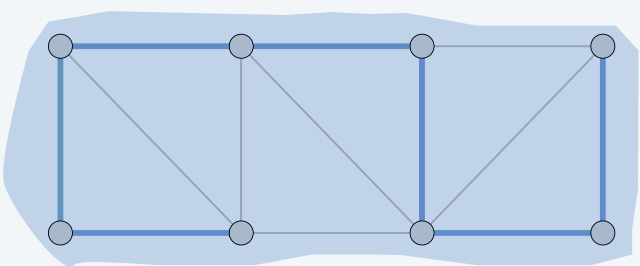



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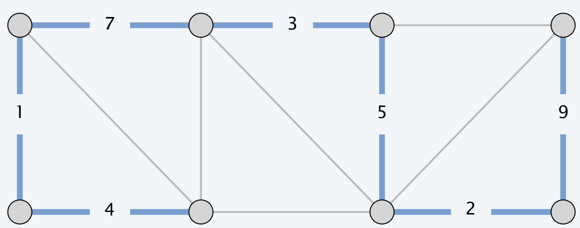
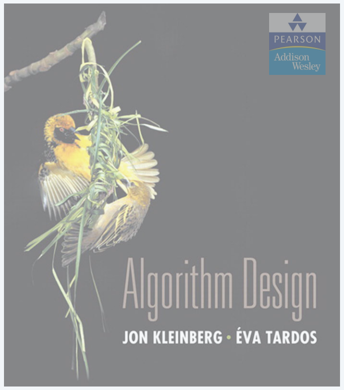





SECTION 4.5

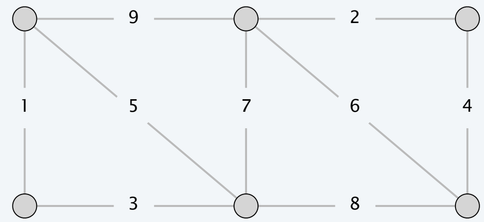
# 4. GREEDY ALGORITHMS II

- red-rule blue-rule demo
- Prim's algorithm demo
- *Kruskal's algorithm demo*
- reverse-delete algorithm demo
- Boruvka's algorithm demo

## Kruskal's algorithm demo

Consider edges in ascending order of weight:

- Add to $T$ unless it would create a cycle.



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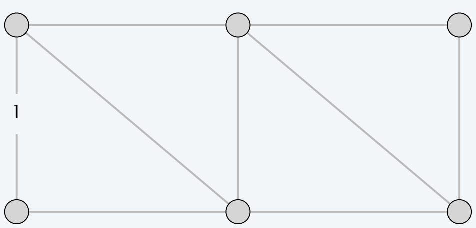




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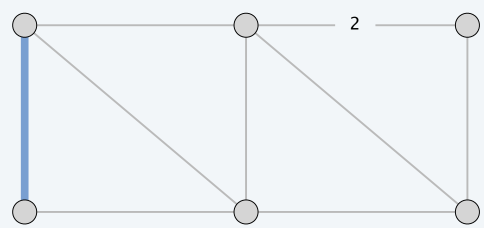

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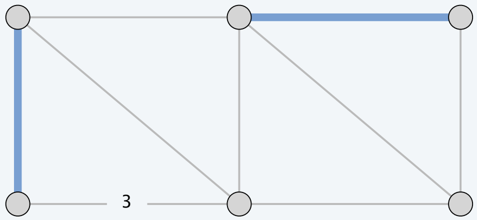




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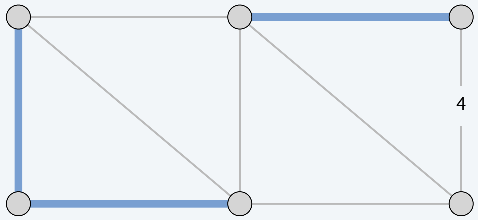




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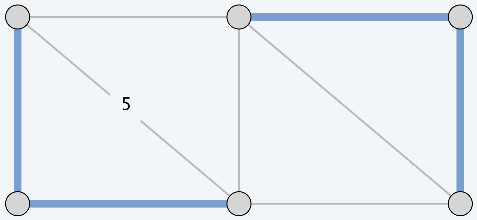




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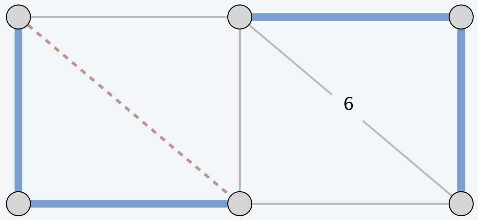

## Kruskal's algorithm demo

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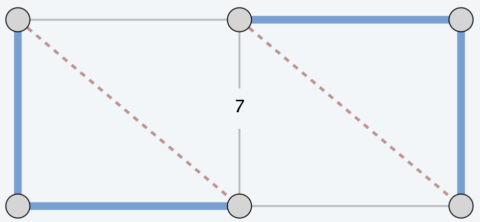




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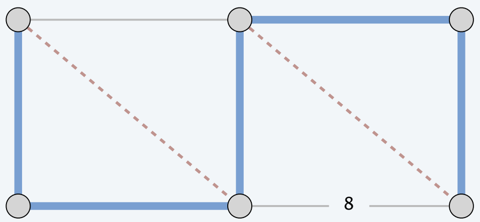




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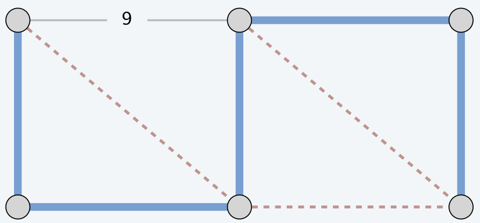




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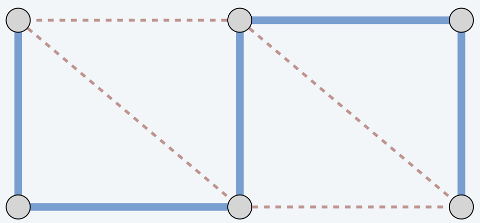

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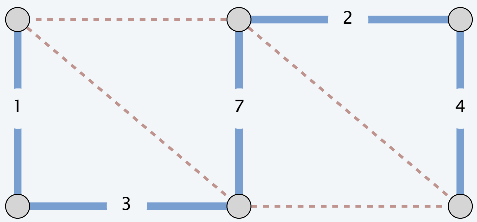
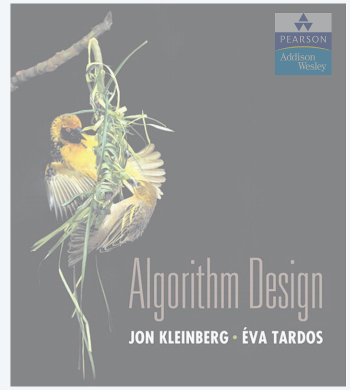
Consider edges in ascending order of weight:

- Add to $T$ unless it would create a cycle.






SECTION 4.5

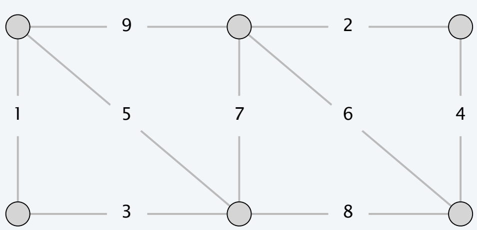
## 4. GREEDY ALGORITHMS II



## Reverse-delete algorithm demo

Start with all edges in $T$ and consider them in descending order of weight:

- Delete edge from $T$ unless it would disconnect $T$.

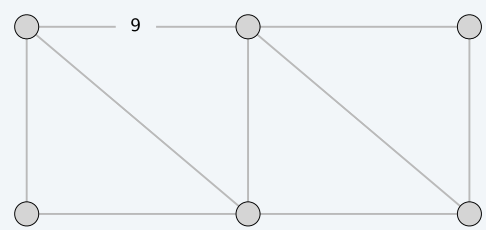





## Reverse-delete algorithm

Start with all edges in $T$ and consider them in descending order of weight:

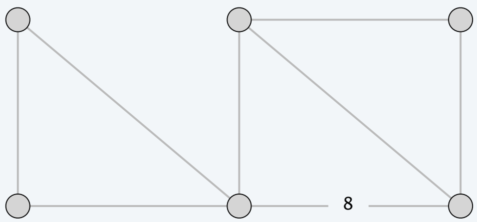
- Delete edge from $T$ unless it would disconnect $T$.



## Reverse-delete algorithm

Start with all edges in $T$ and consider them in descending order of weight:

- Delete edge from $T$ unless it would disconnect $T$.

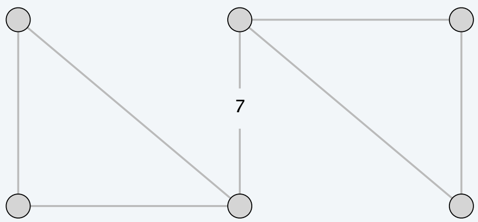





## Reverse-delete algorithm

Start with all edges in $T$ and consider them in descending order of weight:

- Delete edge from $T$ unless it would disconnect $T$.

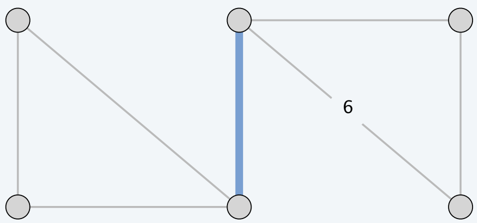





## Reverse-delete algorithm

Start with all edges in $T$ and consider them in descending order of weight:

- Delete edge from $T$ unless it would disconnect $T$.

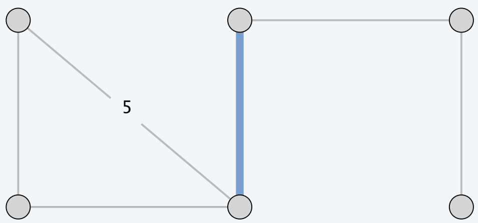





## Reverse-delete algorithm

Start with all edges in $T$ and consider them in descending order of weight:

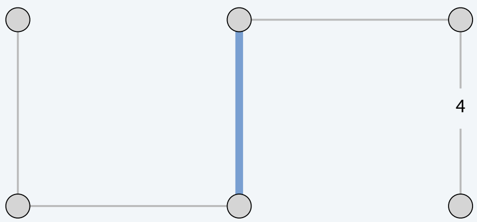
- Delete edge from $T$ unless it would disconnect $T$.



## Reverse-delete algorithm

Start with all edges in $T$ and consider them in descending order of weight:

- Delete edge from $T$ unless it would disconnect $T$.

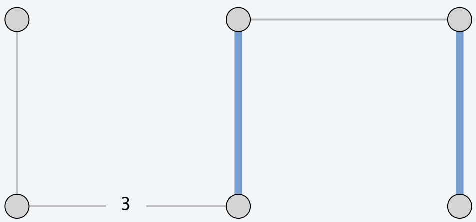





## Reverse-delete algorithm

Start with all edges in $T$ and consider them in descending order of weight:

- Delete edge from $T$ unless it would disconnect $T$.

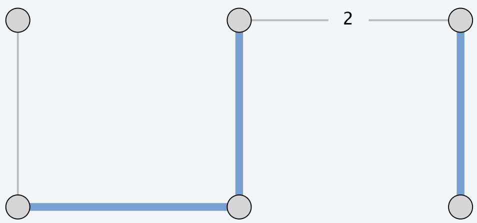





## Reverse-delete algorithm

Start with all edges in $T$ and consider them in descending order of weight:

- Delete edge from $T$ unless it would disconnect $T$.

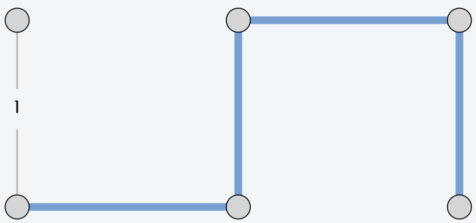





## Reverse-delete algorithm

Start with all edges in $T$ and consider them in descending order of weight:

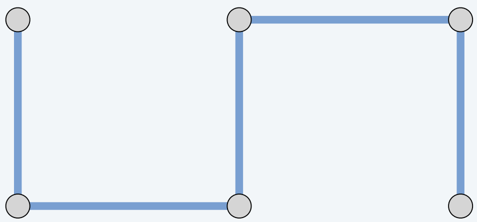
- Delete edge from $T$ unless it would disconnect $T$.



## Reverse-delete algorithm

Start with all edges in $T$ and consider them in descending order of weight:

- Delete edge from $T$ unless it would disconnect $T$.

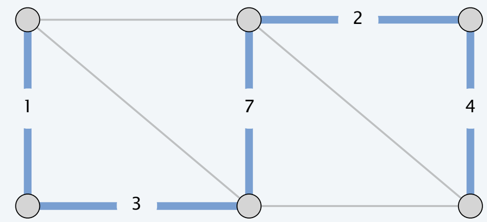




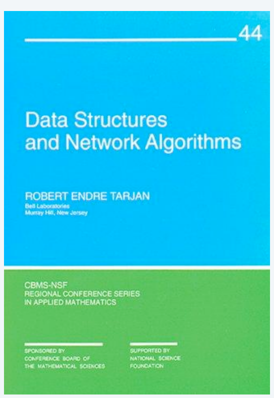
## Reverse-delete algorithm

Start with all edges in $T$ and consider them in descending order of weight:

- Delete edge from $T$ unless it would disconnect $T$.






SECTION 6.2

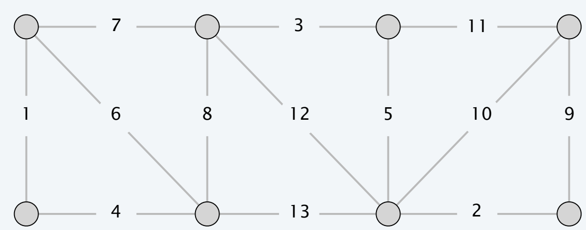
## 4. GREEDY ALGORITHMS II

- *red-rule blue-rule demo*
- *Prim's algorithm demo*
- *Kruskal's algorithm demo*
- *reverse-delete algorithm demo*
- ***Boruvka's algorithm demo***

## Borůvka's algorithm demo

Repeat until only one tree.

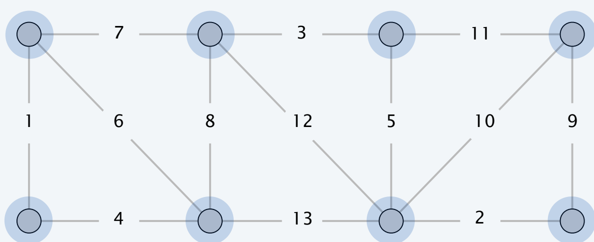
- Apply blue rule to cutset corresponding to each blue tree.
- Color all selected edges blue.



## Borůvka's algorithm demo

Repeat until only one tree.

- Apply blue rule to cutset corresponding to each blue tree.
- Color all selected edges blue.

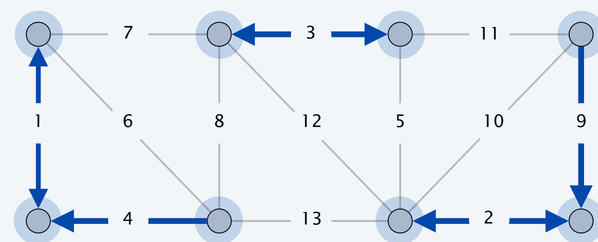





## Borůvka's algorithm demo

Repeat until only one tree.

- Apply blue rule to cutset corresponding to each blue tree.
- Color all selected edges blue.

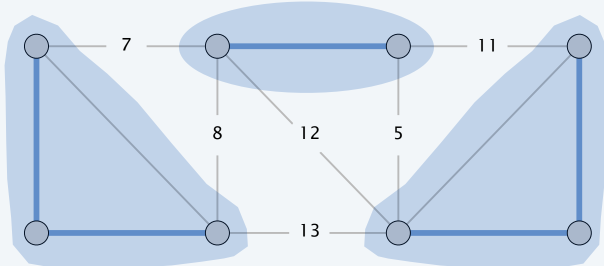





## Borůvka's algorithm demo

Repeat until only one tree.

- Apply blue rule to cutset corresponding to each blue tree.
- Color all selected edges blue.

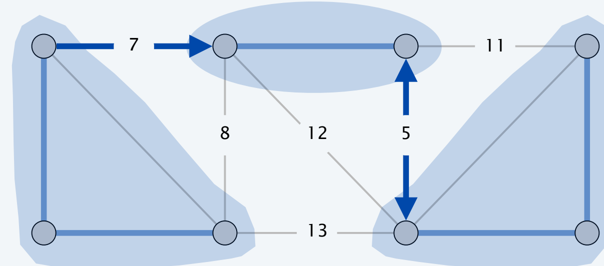





## Borůvka's algorithm demo

Repeat until only one tree.

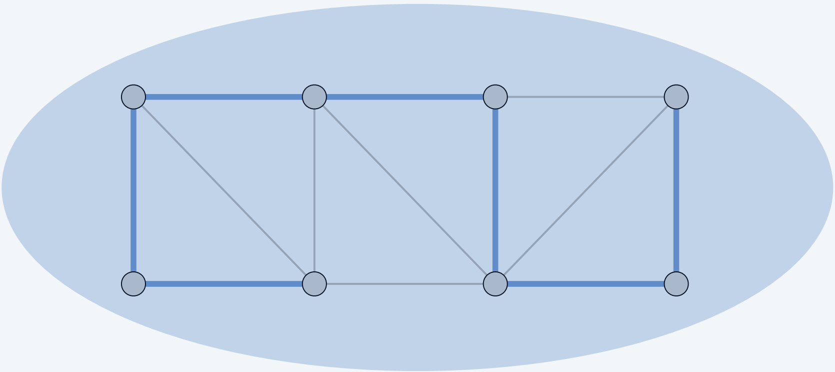
- Apply blue rule to cutset corresponding to each blue tree.
- Color all selected edges blue.



## Borůvka's algorithm demo

Repeat until only one tree.

- Apply blue rule to cutset corresponding to each blue tree.
- Color all selected edges blue.





## Borůvka's algorithm demo

Repeat until only one tree.

- Apply blue rule to cutset corresponding to each blue tree.
- Color all selected edges blue.