4.1 Breadth-First Search

click to begin demo
Breadth-first search

Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.

Graph $G$
Repeat until queue is empty:
• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.

Breadth-first search

add 0 to queue
Breadth-first search

Repeat until queue is empty:
• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.

dequeue 0
Repeat until queue is empty:

- Remove vertex \( v \) from queue.
- Add to queue all unmarked vertices adjacent to \( v \) and mark them.
Breadth-first search

Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.

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**Queue and edgeTo[v] table**

<table>
<thead>
<tr>
<th>queue</th>
<th>v</th>
<th>edgeTo[v]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>–</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>5</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diagram**

- ** dequeue 0 **

- Graph with vertices 0, 1, 2, 3, 4, 5 and edges connecting them.
Repeat until queue is empty:

• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.
Breadth-first search

Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.
Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.
Breadth-first search

Repeat until queue is empty:

• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.

Breadth-first search

dequeue 2
Breadth-first search

Repeat until queue is empty:
• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.

<table>
<thead>
<tr>
<th>queue</th>
<th>( v )</th>
<th>edgeTo[( v )]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**dequeue 2**
Repeat until queue is empty:
• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.

Breadth-first search

dequeue 2
Breadth-first search

Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.
Breadth-first search

Repeat until queue is empty:
• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.

2 done
Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.

Breadth-first search
dequeue 1
Breadth-first search

Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.

dequeue 1
Breadth-first search

Repeat until queue is empty:
• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.
Repeat until queue is empty:
- Remove vertex $v$ from queue.
- Add to queue all unmarked vertices adjacent to $v$ and mark them.
Breadth-first search

Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.

dequeue 5
Breadth-first search

Repeat until queue is empty:
• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.

dequeue 5
Breadth-first search

Repeat until queue is empty:
• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.

dequeue 5
Breadth-first search

Repeat until queue is empty:
• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.

5 done
Breadth-first search

Repeat until queue is empty:
- Remove vertex $v$ from queue.
- Add to queue all unmarked vertices adjacent to $v$ and mark them.

dequeue 3
Breadth-first search

Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.

dequeue 3
Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.

dequeue 3
Breadth-first search

Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.

dequeue 3
Breadth-first search

Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.

3 done
Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.

Breadth-first search
dequeue 4
Breadth-first search

Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.

**Dequeue 4**
Repeat until queue is empty:
• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.

**Breadth-first search**

dequeue 4
Repeat until queue is empty:
• Remove vertex $v$ from queue.
• Add to queue all unmarked vertices adjacent to $v$ and mark them.

<table>
<thead>
<tr>
<th>queue</th>
<th>$v$</th>
<th>edgeTo[$v$]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>–</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

4 done
Repeat until queue is empty:
• Remove vertex \( v \) from queue.
• Add to queue all unmarked vertices adjacent to \( v \) and mark them.

Breadth-first search

done