Graph Implementation #1: Edge List
- HashTable storage of our vertex set
- List storage of our edge set
- O(1) runtime: insertVertex
- O(m) runtime: removeVertex, areAdjacent, and incidentEdges

Graph Implementation #2: Adjacency Matrix

Operations on an Adjacency Matrix:
- insertVertex(K key):
- removeVertex(Vertex v):
- areAdjacent(Vertex v1, Vertex v2):
- incidentEdges(Vertex v):

Graph Implementation #3: Adjacency List

Operations on an Adjacency List:
- insertVertex(K key):
- removeVertex(Vertex v):
- areAdjacent(Vertex v1, Vertex v2):
- incidentEdges(Vertex v):
Running Times of Classical Graph Implementations

<table>
<thead>
<tr>
<th></th>
<th>Edge List</th>
<th>Adj. Matrix</th>
<th>Adj. List</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Space</strong></td>
<td>n+m</td>
<td>n+m</td>
<td>n^2</td>
</tr>
<tr>
<td><strong>insertVertex</strong></td>
<td>1</td>
<td>n</td>
<td>1</td>
</tr>
<tr>
<td><strong>removeVertex</strong></td>
<td>m</td>
<td>n</td>
<td>deg(v)</td>
</tr>
<tr>
<td><strong>insertEdge</strong></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>removeEdge</strong></td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>incidentEdges</strong></td>
<td>m</td>
<td>n</td>
<td>deg(v)</td>
</tr>
<tr>
<td><strong>areAdjacent</strong></td>
<td>m</td>
<td>1</td>
<td>( \min(\text{deg}(v),\text{deg}(w)) )</td>
</tr>
</tbody>
</table>

How do the algorithms compare?

...is one always better?

Graph Traversal

**Objective:** Visit every vertex and every edge in the graph.

**Purpose:** Search for interesting sub-structures in the graph.

We've seen traversal before – this is only slightly different:

<table>
<thead>
<tr>
<th>BST</th>
<th>Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="BST Diagram" /></td>
<td><img src="image2" alt="Graph Diagram" /></td>
</tr>
</tbody>
</table>

**CS 225 – Things To Be Doing:**

1. Topic list for Programming Exam C available; starts Tuesday 4/17
2. lab_puzzles ongoing; due Sunday, April 15th
3. MP6 due on Monday, April 16th
4. Daily POTDs are ongoing!