**Graphs: Introduction**

Graphs are the most generalized data structure in this course. Many seemingly unrelated real-world networks (WWW, powerline, airline, citation, language, food webs, economics, metabolic, protein, social) can be expressed as mathematical graphs, and therefore solved.

Graphs are generalized trees; alternatively, trees are graphs with restrictions on how the nodes are connected. Trees are well-understood but there are graph theorems still waiting to be discovered.

In mathematics and computer science, a *graph* is a set of *vertices* (or nodes) which are connected by links (or *edges*). Graphs may be *directed*, meaning the edges connect in one direction, shown by the arrows. If the graph is drawn without arrows, the graph is *undirected*, meaning that the edges connect in both directions. One of the fundamental questions about graphs is the question of *reachability*. For example:

1. If you start at 0, is 1 reachable? Y/N
2. If you start at 0, is 2 reachable? Y/N
3. If you start at 2, is 0 reachable? Y/N
4. If you start at 2, is 2 reachable? Y/N

Vocabulary:

* *Reachability*: refers to the ability to get from one vertex (the *source*) to another (the *target*) by following a path within the graph.
* *Path*: a path is a sequence of vertices connected by edges. In a directed graph, the path goes from the *source* vertex to the *target* vertex.
* *Neighbors*: the neighbors of a source vertex are all the vertices reachable by traveling along one (1) edge. In graph problems, the neighbors are given, and you calculate the paths.
* *Loop*: a loop is an edge that connects a vertex to itself. In the diagram above, 2 has a loop.
* *Cycle*: a cycle in a directed graph is a path that begins and ends at the same vertex. The *length* of the cycle is the number of edges.

The kinds of questions that we will be asking:

1. How many vertices are in the graph above?
2. How many edges are in the graph above?
3. List the neighbors of 0.
4. List the neighbors of 3.
5. Is there a path from source 2 to target 0?