2019-11-12 Graph Search & DFS Trees

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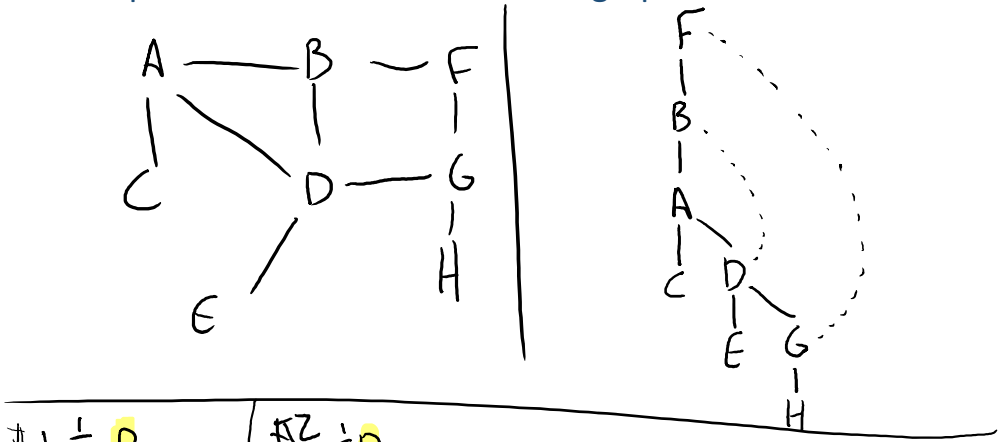
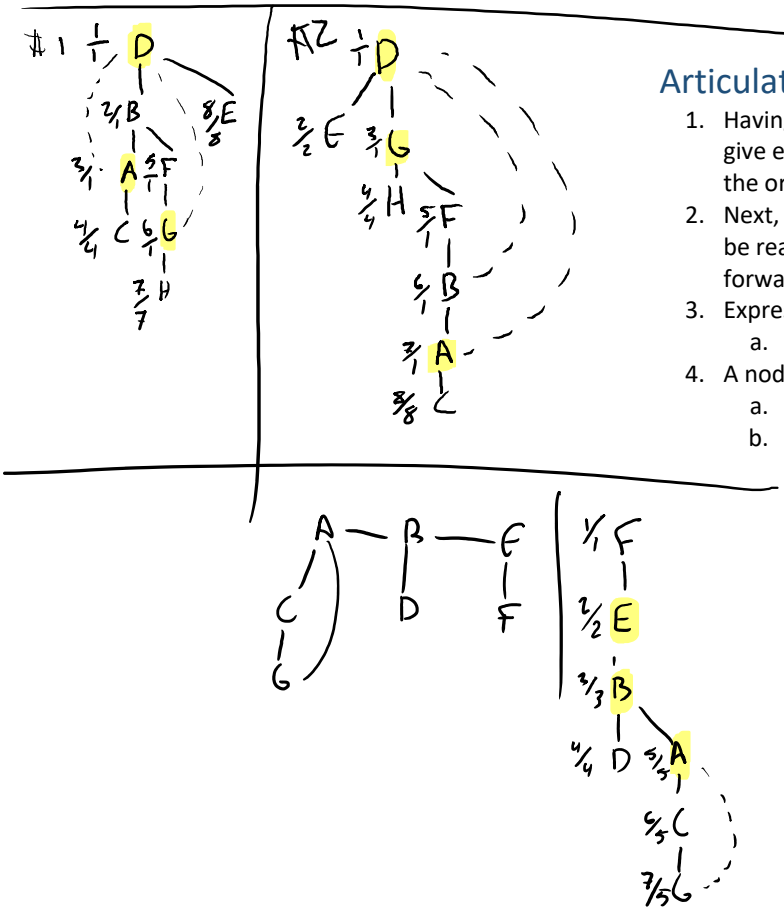
DFS trees allow us to find articulation points in a graph

- A node is an articulation point if its removal results in a disconnected graph
- Power grid: taking a given power station down leaves a group unpowered
- Network analysis: What servers are critical for maintaining connectivity
- Social: Who are the "influencers" that connect disparate groups?
- Military: What bridge must we hold?

- DFS articulation trees can have any arbitrary node as its root.
- Unused graph edges are marked as "back edges" (on paper, dotted lines)

Example DFS tree constructed on a graph





Articulation Point Algorithm

1. Having constructed a DFS tree w/ back edges, give each node in the tree an "ID" based on the order in which it was visited (root -> #1)
2. Next, find the lowest ID of the node that can be reached in the tree by taking zero or more forward (solid) edges, and **up to one** back edge (dotted line)
3. Express this as a fraction with step #1 numerator, step #2 denominator
    a. I.e. ID / LOW ID VALUE
4. A node is an articulation point
    a. if and only if it is a root and has more than two children OR
    b. When the node's direct child(ren) have a LOW VALUE >= its ID value