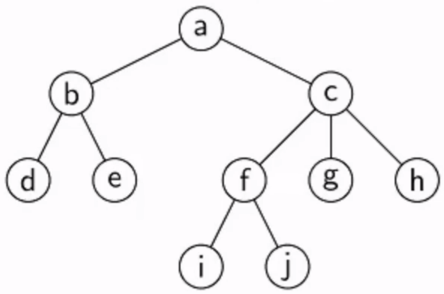
Idea

- DFS explores the graph, starting at the last visited vertex having unvisited neighbors.
  - **Special case**: G is a tree $\Rightarrow$ DFS-Order = pre-order



  - Maintain Stack ST that contains all visited but not yet satured nodes.
  - Rest similar to BFS

  Question: What is the pre-order for this tree?

  a b d e c f i j g h

Pseudo-Code

- DFS(G) /* G given as adjacency list F */
for all $u \in V$
    state(u)=new
    pre(u)=nil
for all $u \in V$ /* loop not necessary for connected graphs */
    if state(u)==new
        DEPTH(u)

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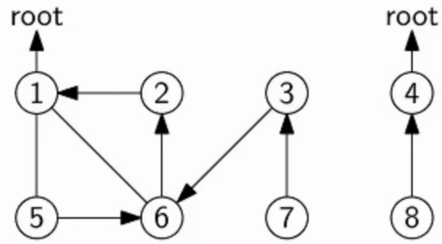
state(u)=visited; write(u)
for all $v \in F[u]$ /* test all neighbors of u */
    if state(v)==new
        pre(v)=u
        DEPTH(v) $\leftarrow$ recursion can be replaced by stack
state(u)=saturated

Example:



F:

1	2	3	4	5	6	7	8
2	1	6	8	1	1	3	4
5	6	7		6	2		
6					3		
					5		

Further Observations:

- The pre-pointers form a set of trees (DFS-forest);
- every call of DEPTH in the main programm (not in the recursion) results in a new root and tree.
- For connected graphs there is only one root and tree.

Properties

- time complexity
  - DEPTH ist called exactly once per node (only for new nodes, that are immediately marked as "visited").
  - A call of DEPTH(v) takes $O(\text{degree}(v))$ time
  - $\Rightarrow$ $\Theta(n+m)$ time in total
- space complexity
  - $\Theta(n+m)$ space in total
  - correctness
    - vertex that is set to visited:
      - put on stack
      - when removed from stack, all neighbors are considered
    - $\Rightarrow$ every vertex set to visited exactly once