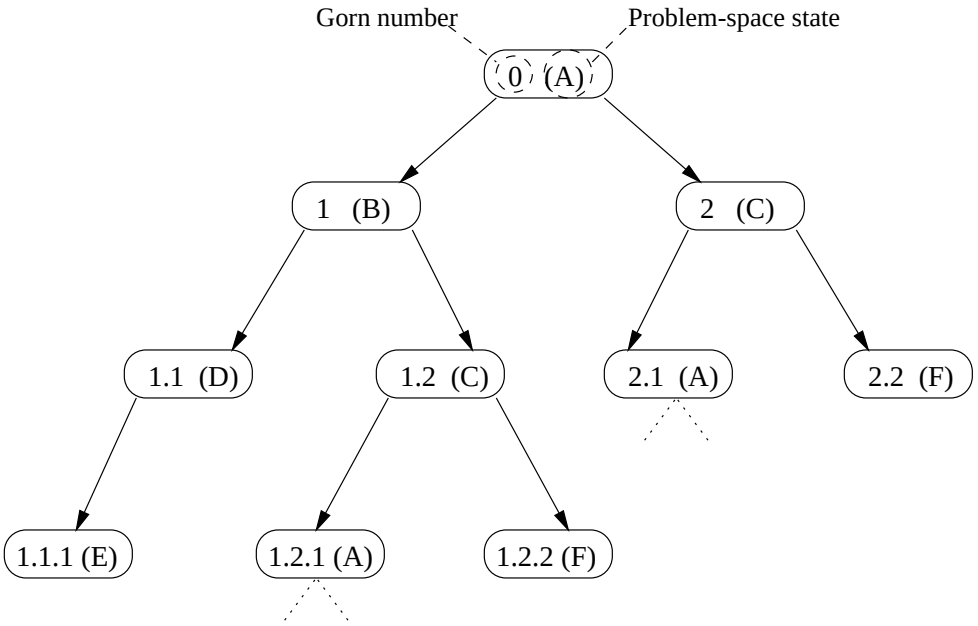
CS/ENGRI 172, Fall 2003: Computation, Information, and Intelligence
9/8/03: Solving Problems - Path Trees and Search

Problem Solving: Find a valid, finite path in the problem space leading from the initial state to a goal state.

Example problem space
Let our states be A, B, C, D, E, F, R, and S. The initial state is A, and for now we will not specify a goal state. The operators are as follows:

α_1: A $\rightarrow$ B γ_1: C $\rightarrow$ A
α_2: A $\rightarrow$ C γ_2: C $\rightarrow$ F
β_1: B $\rightarrow$ D δ_1: D $\rightarrow$ E
β_2: B $\rightarrow$ C ρ_1: R $\rightarrow$ S

This problem specification induces the following path tree (with goal state and operator labels omitted):



"Systematic" Search Algorithms

Depth-first Search (DFS):

1. Mark node 0 visited.
2. Choose the *deepest* visited node n.
   - **(a)** If n corresponds to a problem-space goal state, declare success and **stop**;
   - **(b)** otherwise, if n corresponds to a repeated problem-space state or is childless, remove it and all its descendants;
   - **(c)** otherwise, mark n's least-Gorn-numbered unvisited child as visited.
3. If the tree still has nodes, repeat step 2.
4. If the entire tree has been removed, declare failure.

Breadth-first Search (BFS):

1. Mark node 0 touched.
2. Choose the *highest* touched node n *with untouched children*.
   - **(a)** If n corresponds to a problem-space goal state, declare success and **stop**;
   - **(b)** otherwise, if n corresponds to a repeated problem-space state or is childless, delete it and all its descendants;
   - **(c)** otherwise, mark n's least-Gorn-numbered untouched child as touched.
3. If the tree still has nodes, repeat step 2.
4. If the entire tree has been deleted, declare failure.

Note: we're using "visited" and "removed" for DFS and "touched" and "deleted" for BFS to faciliate lecture notation.

Both DFS and BFS will visit all of the nodes in a (finite) tree, just in different orders.