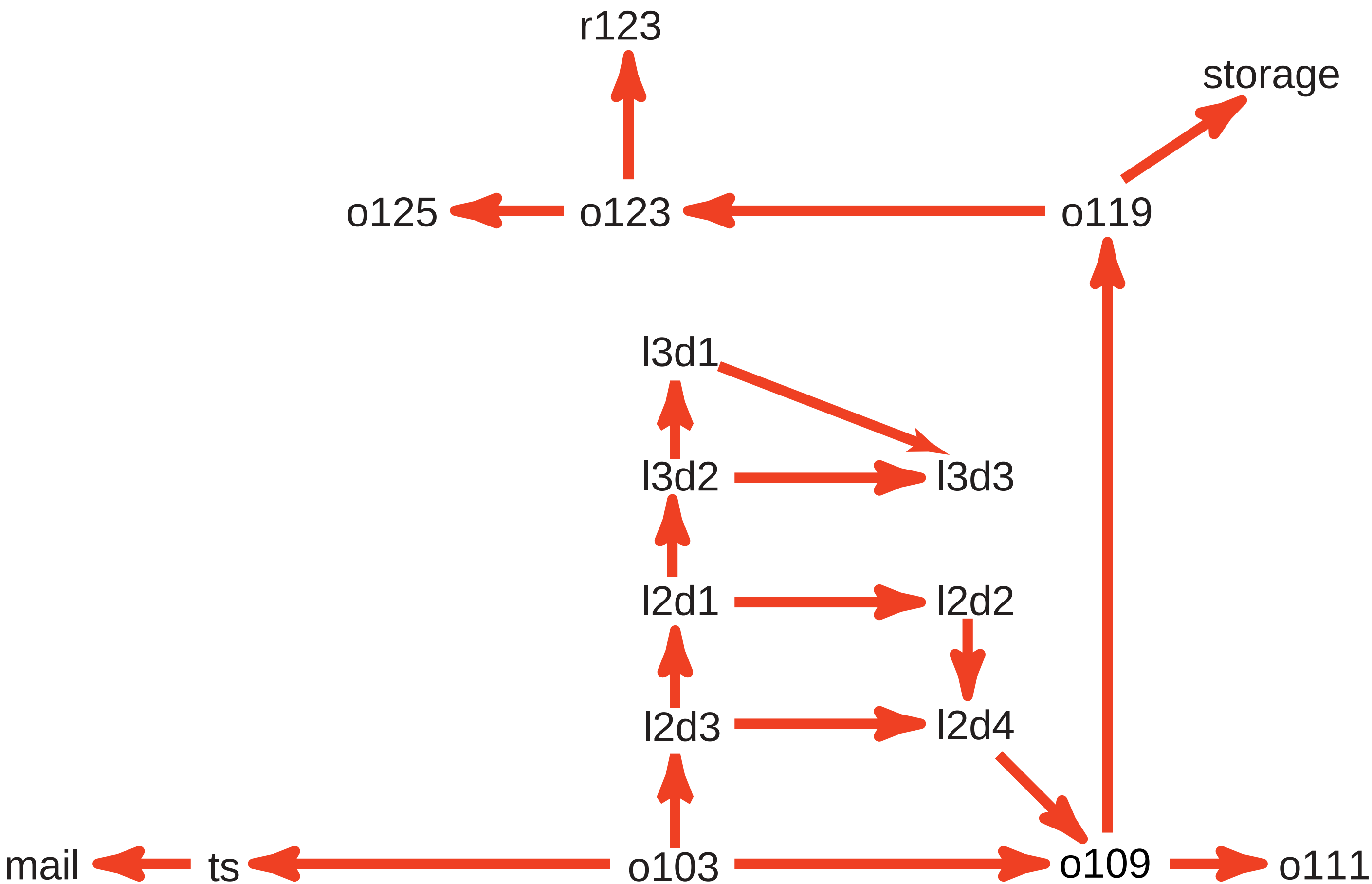
Searching

- Often we are not given an algorithm to solve a problem, but only a specification of what is a solution — we have to search for a solution.
- Search is a way to implement don't know nondeterminism.
- So far we have seen how to convert a semantic problem of finding logical consequence to a search problem of finding derivations.

Search Graphs

- A graph consists of a set N of nodes and a set A of ordered pairs of nodes, called arcs.
- Node n_2 is a neighbor of n_1 if there is an arc from n_1 to n_2. That is, if $\langle n_1, n_2 \rangle \in A$.
- A path is a sequence of nodes $\langle n_0, n_1, \ldots, n_k \rangle$ such that $\langle n_{i-1}, n_i \rangle \in A$.
- Given a set of start nodes and goal nodes, a solution is a path from a start node to a goal node.

Example Graph for the Delivery Robot



Search Graph for SLD Resolution

$a \leftarrow b \wedge c.$

$a \leftarrow h.$

$b \leftarrow k.$

$d \leftarrow p.$

$f \leftarrow p.$

$g \leftarrow f.$

$h \leftarrow m.$

$a \leftarrow g.$

$b \leftarrow j.$

$d \leftarrow m.$

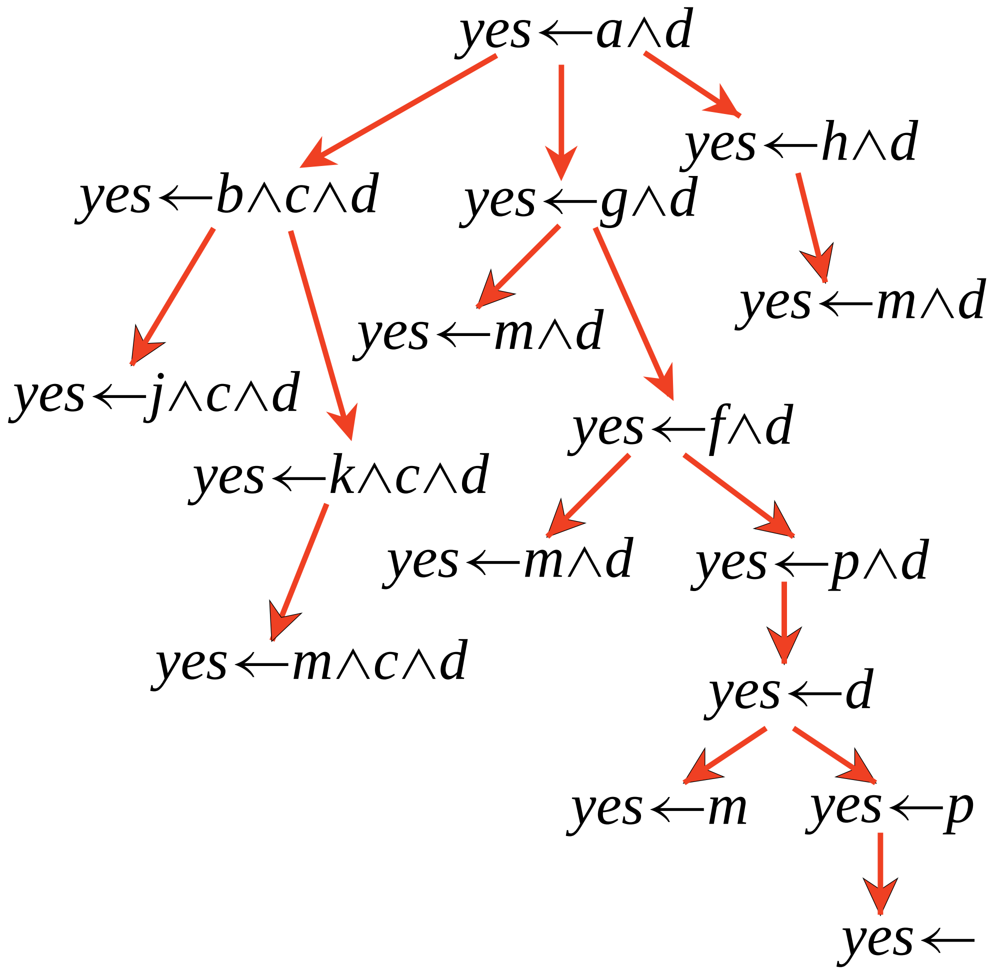
$f \leftarrow m.$

$g \leftarrow m.$

$k \leftarrow m.$

$p.$

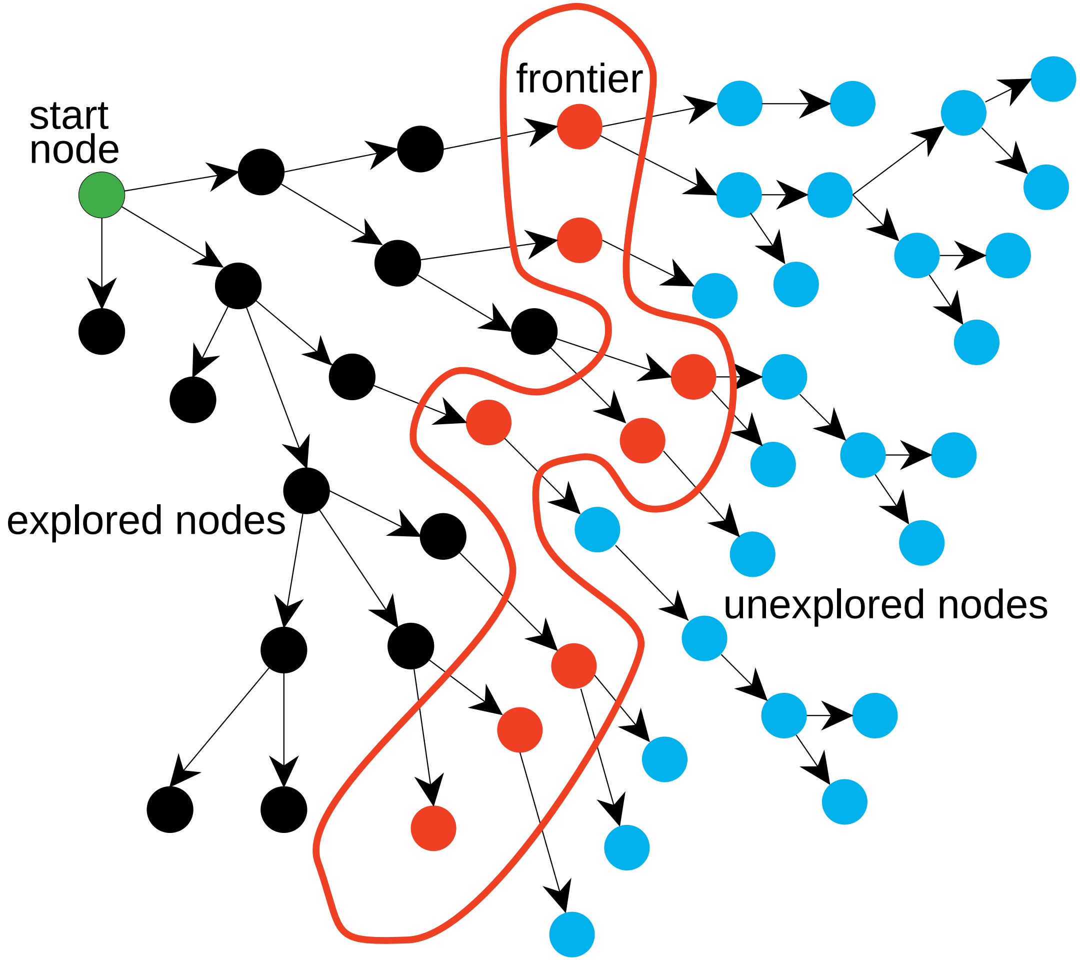
$?a \wedge d$



Graph Searching

- Generic search algorithm: given a graph, start nodes, and goal nodes, incrementally explore paths from the start nodes.
- Maintain a frontier of paths from the start node that have been explored.
- As search proceeds, the frontier expands into the unexplored nodes until a goal node is encountered.
- The way in which the frontier is expanded defines the search strategy.

Problem Solving by Graph Searching



Graph Search Algorithm

Input: a graph,

a set of start nodes,

Boolean procedure $goal(n)$ that tests if n is a goal node

$frontier := \{\langle s \rangle : s \text{ is a start node}\}$;

while *frontier* is not empty:

select and **remove** path $\langle n_0, \ldots, n_k \rangle$ from *frontier*;

if $goal(n_k)$

return $\langle n_0, \ldots, n_k \rangle$;

for every neighbor n of n_k

add $\langle n_0, \ldots, n_k, n \rangle$ to *frontier*;

end while

- We assume that after the search algorithm returns an answer, it can be asked for more answers and the procedure continues.
- Which value is selected from the frontier at each stage defines the search strategy.
- The *neighbors* defines the graph.
- *is_goal* defines what is a solution.