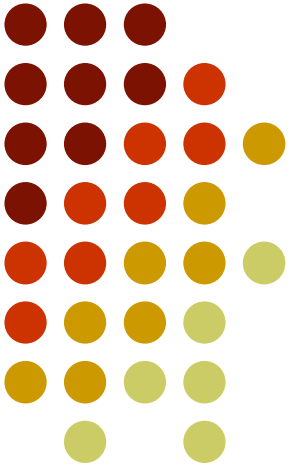
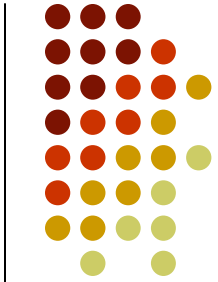
Prolog in AI
Towers of Hanoi, Searching

CS171: Expert Systems



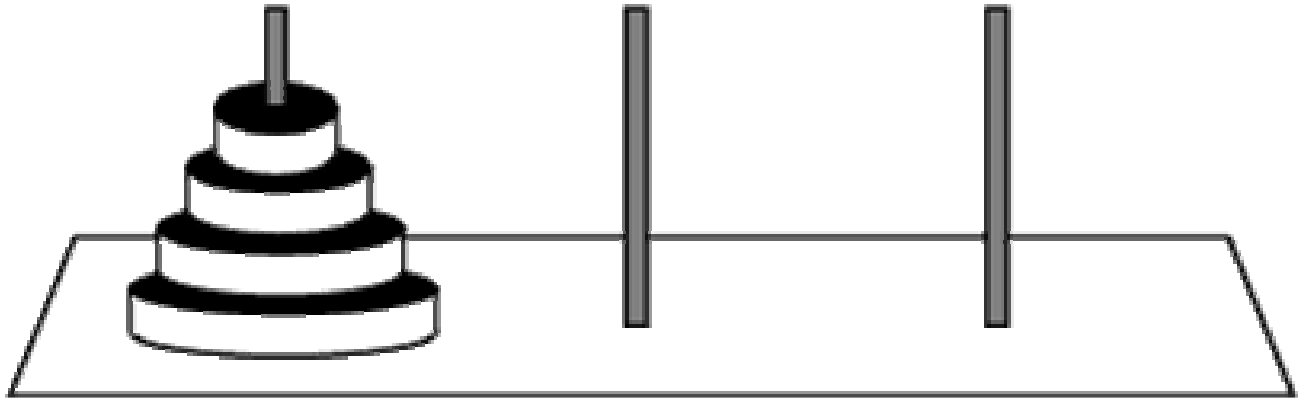
Topics:



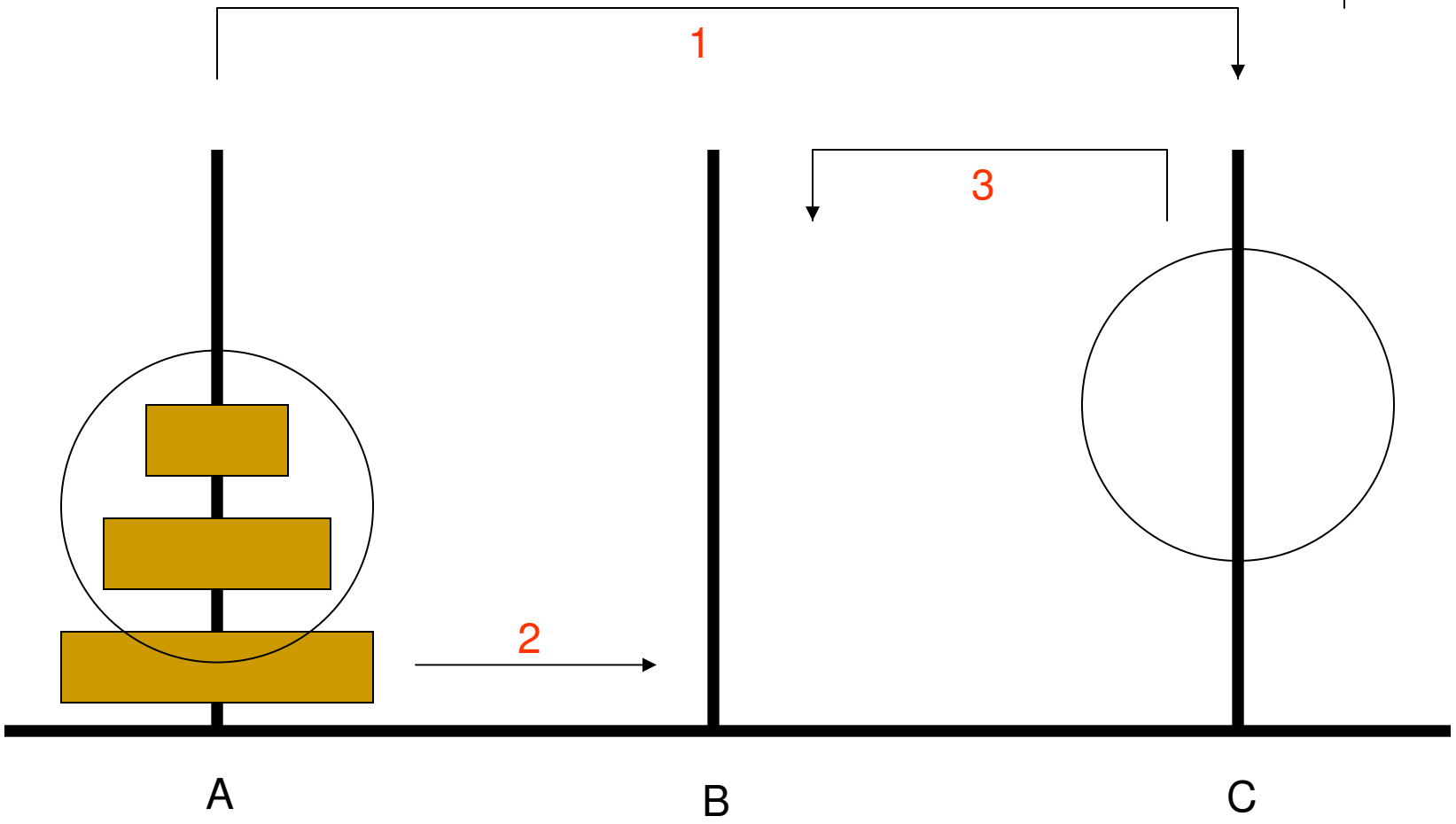
- Towers of Hanoi
- Searching a maze
- Searching directed graphs

Towers of Hanoi

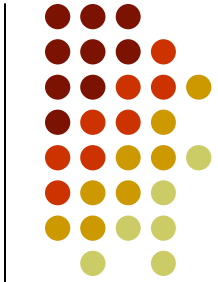
- Stack of *n* disks arranged from largest on the bottom to smallest on top placed on a rod
- Two empty rods: goal and an auxiliary rod
- Minimum number of moves to move the stack from one rod



Towers of Hanoi

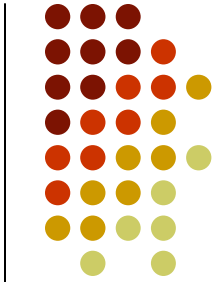


Towers of Hanoi



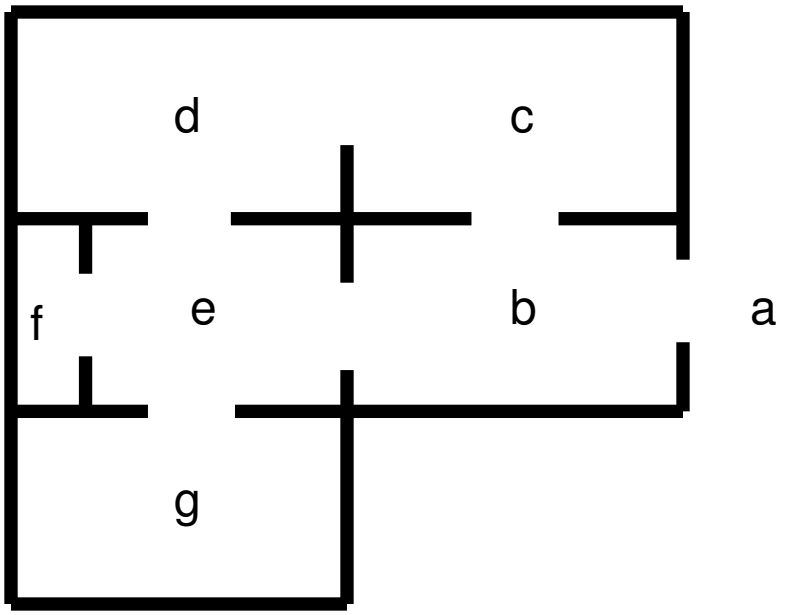
```
hanoi(N) :- move(N, left, centre, right).

move(0, _, _, _) :- !.
move(N, A, B, C) :- M is N-1,
     move(M, A, C, B),          % 1
     inform(A, B),              % 2
     move(M, C, B, A).          % 3
inform(X,Y) :-
     write([move, disk, from, X,  to, Y]), nl.
```

Searching a maze



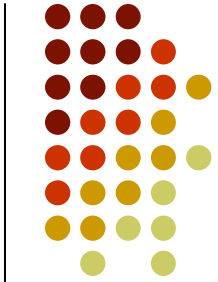
- Let's say we have a simple maze like the one below:

door(a, b).
door(b, e).
door(b, c).
door(d, e).
door(c, d).
door(e, f).
door(g, e).



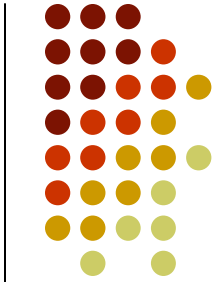
- Goal is to find a path from a room to another room.

Searching a maze



- Since door(a, b) is the same as door(b ,a), the maze can be modeled with an undirected graph.
- Using the standard approach: we are either in the goal room (base case), or we have to pass through a door to get closer to the goal room (recursive case).
- To avoid going in circles (b-c-d-e or a-b-a-b), we need to remember where “we have been so far” (does this phrase sound familiar?)

Searching a maze



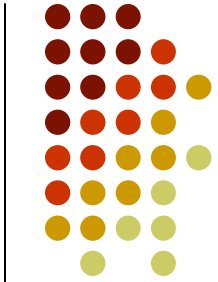
- So, the solution would be something in the lines of:

```
go(X, X, T).
go(X, Y, T):- door(X, Z),
        not(member(Z, T)), go(Z, Y, [Z|T]).
go(X, Y, T):- door(Z, X),
        not(member(Z, T)), go(Z, Y, [Z|T]).
```

- Or, using the semicolon (logical or):

```
go(X, Y, T):- (door(X, Z) ; door(Z, X)),
        not(member(Z, T)), go(Z, Y, [Z|T]).
        go(Z, Y, [Z|T]).
```

Searching a maze



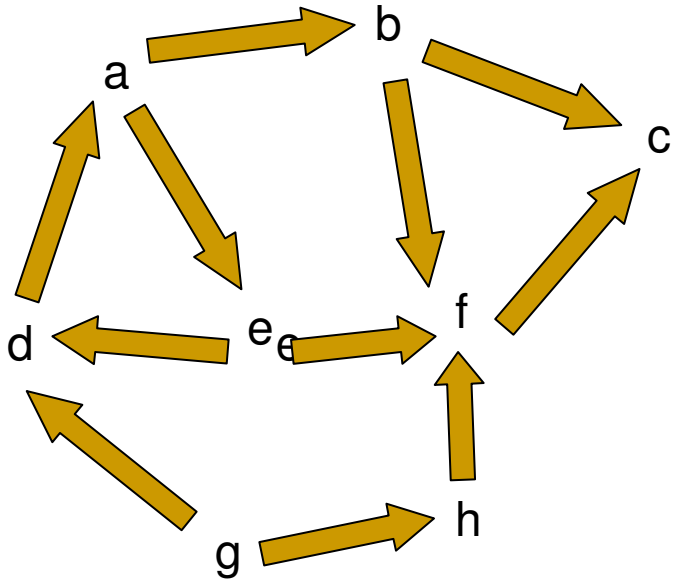
- Let's add a twist to the story: in one of the rooms (we do not know exactly which one), there is phone which is ringing. We need to get to the room in which the phone is, and pick it up (this actually sound like an AI problem :-).
- So, we ask the question:

  ?- go(a, X, [ ]), phone(X).
- This follows the "generate and test" paradigm: we first generate a solution to the problem of how to get the room, then check if the phone is in the room.

Searching a graph

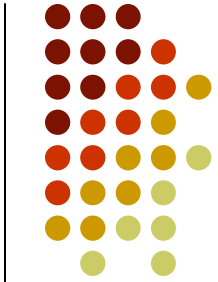
- Let's say we have a directed graph as the one below:

```
edge(g, h).
edge(g, d).
edge(e, d).
edge(h, f).
edge(e, f).
edge(a, e).
edge(a, b).
edge(b, f).
edge(b, c).
edge(f, c).
edge(d, a).
```



- Again, goal is to find a path from a node to another node.

Searching a graph



- The simplest solution is:

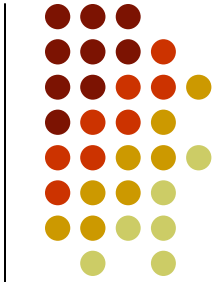
```
cango(X, X).
cango(X, Y):- edge(X, Z), cango(Z, Y).
```

or

```
cango(X, Y):- edge(X, Y).
cango(X, Y):- cango(Z, Y), edge(X, Z).
```

- However, the graph has loops (a-e-d), so Prolog might never be able to resolve this.

Searching a graph



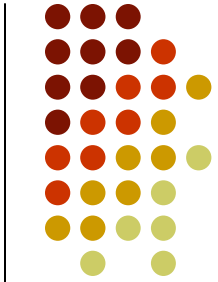
- We can use a solution similar to the maze search. However, let's say we are also interested in the route from X to Y:

```
route(Start, Dest, Route):-
        go(Start, Dest, [ ], R),
        rev(R, [ ], Route).

go(X, X, T, [X|T]).
go(Place, Dest, T, R):- edge(Place, Next),
        not(member(Next, T)),
        go(Next, Dest, [Place|T], R).
```

Searching a graph

- This algorithm performs breadth-first search.
- You can of course make this more complex by adding weights to the edges.
- Searching is actually a big topic in AI:
  - breadth-first search
  - depth-first search
  - best-first search (uses a heuristic do decide what is the “best” way to go)
  - A* search (uses the sum of the path so far and the heuristic to estimate the path left)

Reference



- Clocksin, W.F., and Mellish C.S. *Programming in Prolog*. 4th edition. New York: Springer-Verlag. 1994.