Computation, Information, and Intelligence (ENGRI/CS/INFO/COGST 172), Spring 2007
1/24/07: **Lecture aid — Intro to problem solving and problem-space specifications**

Agenda: problem solving as our first AI topic; a simple example of the explicit-enumeration method of specifying a problem space (this is a warm-up to implicit specifications, which we'll start next time)
Announcements:

- The second prelim is on Friday April 6 (*not* 16); apologies for the typo in the Course Description and Policies handout of 1/22/07 and thanks to alert readers for pointing that out.
- Reminder: Non-freshmen need permission to enroll in the course, even if already registered (students without permission will be dropped by the roster). If you need an application form or have a completed one to drop off, please see me after class. (All freshmen are permitted to enroll regardless of prior experience with COM S 100; the Courses of Study had outdated information about this.)

I. Definition: problem-space specification To specify a problem space is to define for it, in order, the following four components:

A. The set of *states* (also known as the *state set*). The state set must contain at least one state. (The intent is that the states in the set represent all the distinct situations one is willing to have taken under consideration, and that each state sums up all of the relevant information about its associated situation.)

B. The *initial state*, which must be one of the states in the state set. (The intent is that the initial state correspond to the beginning situation.)

C. The set of *goal states*. The goal states must be selected from among the states in the state set, but there can be zero, one, or many of them. (The goal states are intended to correspond to the desired or acceptable outcome(s).)

D. The set of *operators*. There must be at least one operator in the set, and, for each operator, one must indicate (perhaps implicitly) which states it is applicable to and which *single* state is reached (transitioned to) when it is applied to each such state. (The intent is that the operator set represent all distinct allowable acts in terms of how they affect the current state.)

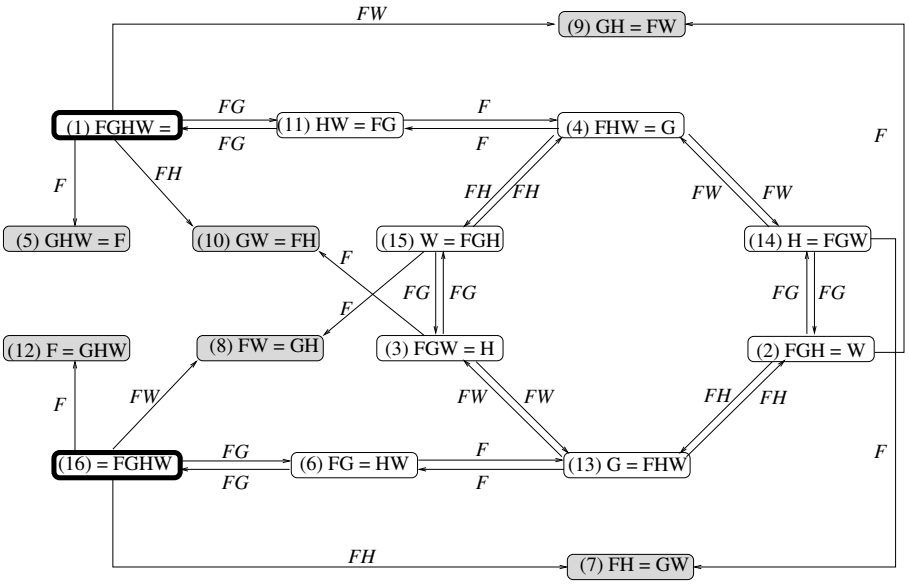
Problem-space specifications are required to be **well-defined**: it must be clear *from the state and operator specifications alone* — as opposed to knowledge about the problem, common sense, or other external factors — what the states are, what the operators are, which operators apply in which states, and which state results from the application of an operator.

II. The farmer puzzle (Alcuin, c. 800, *Propositio de homine et capra et lupo*) A farmer has three items of merchandise — a wolf, a goat, and a roughly goat-sized bale of hay — on a riverbank, and wishes to transport everything to the other side using a boat. Only the farmer can row the boat; the boat can hold at most the farmer and one of the items. The wolf will eat the goat if they are on the same bank without the farmer there; likewise, the goat will eat the bale of hay if they are on the same bank without the farmer there. Can the farmer get all three of the goods to the other side of the river intact?

For the sake of argument, we allow the farmer to leave an eater/eatee pair unattended, although this is obviously undesirable; and we only consider the farmer's actions.

(OVER)

III. A problem-space specification for the farmer puzzle by explicit enumeration



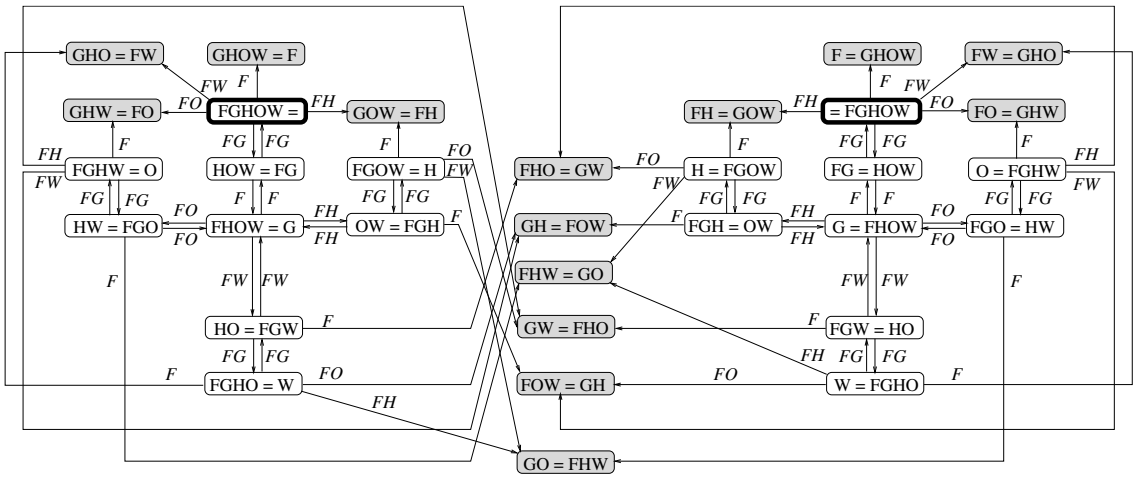
A. The states are given as boxes
B. The initial state is (1)
C. There is one goal state, (16)
D. The actions are given as arrows

Notes: Shading, bold outlines, and arrow labels are visual aids, not part of the specification

IV. Definition: legal and complete A specification is *legal and complete* if it satisfies both of the following conditions:

- (legality) Only action sequences that are allowed by the problem statement are represented.
- (completeness) All solutions to the problem are represented as paths from the initial state to a goal state.

V. A problem-space specification for the "plus oats" variant



A. The states are given as boxes. B. The initial state is FGHOW=. C. The goal state is =FGHOW. D. The actions are given by arrows.