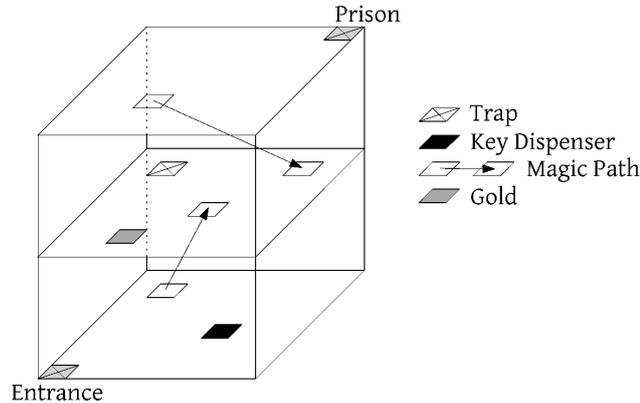


2 Artificial Intelligence (sbh11)

This question addresses the *state-variable representation* for *planning problems*. Evil Robot has found himself in a new cave. This cave is 3-dimensional, with locations on a $10 \times 10 \times 10$ grid. An example cave is:



Arbitrary locations can be connected by Magic Paths transporting the user instantly from one place to another, and these are the only means of vertical travel. Magic Paths can only be traversed in one direction. Some locations contain traps that transport the victim to a prison at location $(10, 10, 10)$.

Escape from the prison back to the entrance at $(1, 1, 1)$ is possible if a key has been obtained. Some locations contain key dispensers. One location contains some gold, and Evil Robot’s aim is to find it.

- (a) Describe the elements of the state-variable representation. [5 marks]
- (b) Give examples of how the following three elements of Evil Robot’s cave problem can be represented in the state-variable representation: the locations of the traps and key dispensers, obtaining a key, and escape from the prison. [5 marks]
- (c) Movement is achieved using actions `goLeft`, `goRight`, `goForward` and `goBack`. We wish to use a single action description for each. However the cave is surrounded by walls and not all locations have the same effect when moved into. Explain how *rigid relations* can be used to obtain precisely four action descriptions with the desired behaviour. Make sure you account for the fact that it should not be possible to escape from the prison just by moving. [5 marks]
- (d) One of the advantages of the state-variable representation is that planning problems can easily be translated into a form solvable by a *constraint satisfaction solver*. Briefly describe how your `goRight` action would be modelled as part of a constraint satisfaction problem. [5 marks]