Artificial Intelligence
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Lecture – 10
Uninformed Search: Notion of a State (Part – 1)

Let us get started on the very first topic, which is search, we will only talk about the philosophy of search today, so what is our goal, right, the topic is search but why are we interested in search, let us first think about that particular question. So, our goal is to solve every problem in the world, okay, you suddenly get a problem in your mind and is there an AI algorithm that you can give this problem to.

And the AI algorithm at least can in principle attempted that is our goal because you know if you have a brain, there is a fundamental, some algorithms running there, that algorithm should be able to deal with all kinds of problems, right. In fact, I remembered there was a very beautiful quote, not quote but a thought that somebody shared with me, he said that if a person is good at one thing and they are good at another thing, this is a good chance that they are just generally smart people and they will be good at many, many things.

So, I have seen many people who are really good at one thing and they have become good at one thing by shear practice wrote and teaching, by teaching is an learning from a teacher and that is okay, you know I am not taking any credit away from them, they have worked hard at what they do but then you will find some people who are just naturally intelligent, right, you give them a new kind of problem.

And they will able to observe it, analyse it and quickly give you some insights in it which many other people will not be able to do and I would say that we are interested in that goal that allows someone to be intelligent or good at many different feels, think that it may not have you know seen and learned for a very long periods of time and that is something what AI people, AI researchers also motivated by.

Is there one AI algorithm that can solve all problems and that is where this whole notion of search started, right but before we get to search which is the algorithm, there asked a very important question, well if there is one algorithm that can solve every problem that means, every problem in the world can be convert and this is one algorithm, so it will take one input obviously, if this AI algorithm was taking many different inputs, then it will not be one algorithm.

In one of my senior mentors used to say that do not think about the algorithm, think about the input and the output that will tell you a lot about what is going on in the world, it is actually, a beautiful thought, you will not appreciated today but you just note it down, when you have a discussion with someone and you are not able to figure out what is the problem they are trying to solve, just ask them, okay we want to build a computational box, tell me what will be the input and what will be the output.

And notice that if there is not enough clarity in the air, the other person will become confused in answering this question, do not think about how, think about what was in and what comes out first, I want to save the world computationally from you know hunger, okay, great, we want to build in computational system, what will go in and what will come out, now you can say all the data about hunger will go in, all the extra surplus of restaurants will go in.

And you know output would be how to distribute food from one restaurant to nearby poor person, I am okay with that now, there is some clarity here but before that there is no clarity, so think about the input and the output. So the folk said, I guess they did not say it that way but when we post factor rationalise it, understand it and construct it, reconstruct it, they said that we want to build one algorithm.

This algorithm is expected to solve all the problems in the world but because there is one algorithm, it can only have one input that means, technically we should have a way to convert all the problems into the world of the world in one input representation, does it make sense, they should be one uniform way to convert any problem; computational problem into that representation.

So, the question is what is that representation, is there a one single representation that can; if that can; that I can convert any computational problem into and then I have this uniform representation, so I can give it to the AI system and that AI system can solve it for me, if so what is that representation and this led to a lot of thought and they came up with first a fundamental concept of a state.

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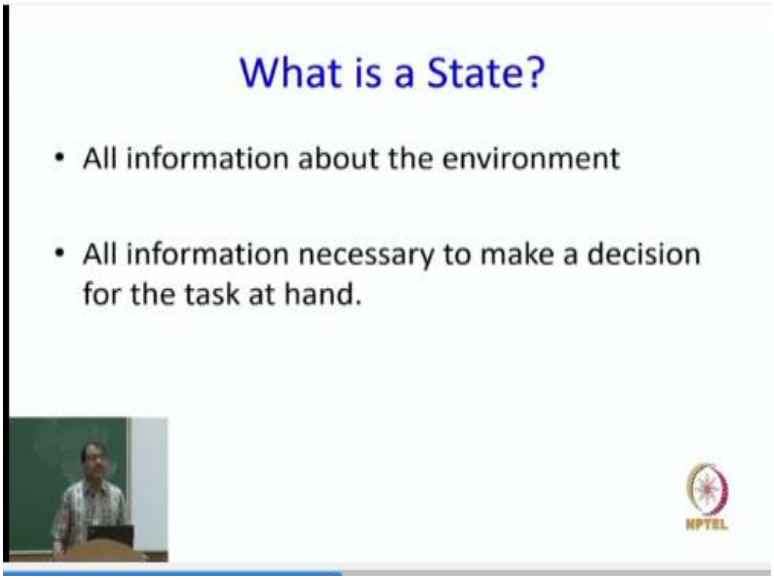

They said that in my general representation of the problem, I will have a state, what is a state and you will get more and more appreciation of what is the state as you go forward in the field of AI but for now, let us just say that all information about the environment could technically go into the state, in fact all information about the environment and all information about me, how I think about anything can go into the state.

But then this may become prohibitively huge for example, you want to make a plan from; for going from this point to that point, in this context it does not matter what class is going on in the neighbouring room but technically, what class is going on in the neighbouring room is also part of the state but then you will say, oh, whether it has rained in New York today is also the part of the state.

And who is the Prime Minister of India is still part of the state but you know that is not relevant if I want to move from this point to this point, so therefore the world you more you have many,

many, many, many, many things but when we create a computational problem, we abstracted out and we said we will put in the state what is important for us to make the next decision for the task at hand.

So, if our task is navigation, we will put our location, current xy coordinates maybe we will put the neighbouring obstacles, maybe we will put all the obstacles in this room, we will put you know, where you are sitting, where you are sitting, which street you are sitting that way you will know how far the distance to humans is etc., etc., all of that makes sense but you know whether it rained in New York or not, we will not worry about because you we not expect the robot to be able to fly to New York.

And even then that should become part of the state for a different problem there, right so that is a first issue, we will define a set of states and we will put any information relevant to the decision mechanism in that state, okay.

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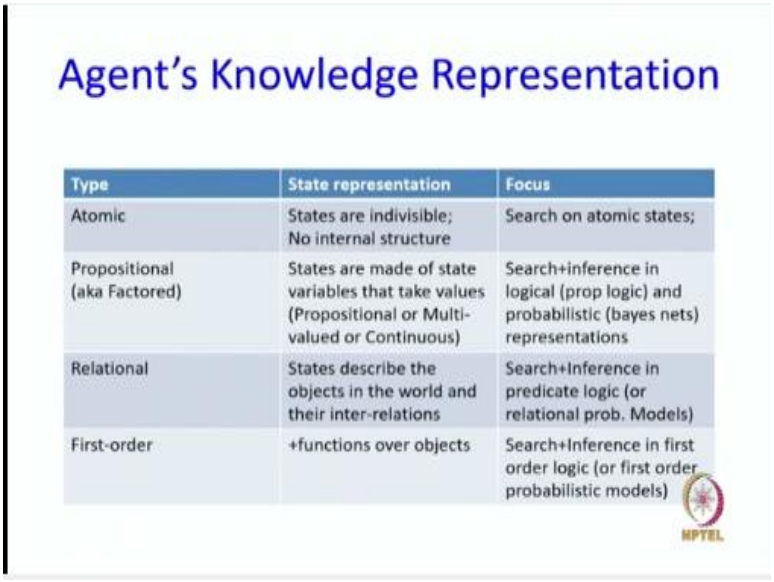

Then the next question is; how would we represent the state, okay and this slide we will keep coming back to and we will understand it more and more and more over time but there are many views. One view is that every unique state is a number, so Vishwajeet is sitting on chair number 1 and Harish is sitting on chair number 15 and so on and so forth that forms a state now, I will call it state number 237.

And if Vishwajeet stop sitting at chair number 1 and start sitting in chair number 35, we will start calling it state number 3997 and each different state will be a different number for me and I will not go inside it as to where Vishwajeet was sitting in state number 237 and where he is sitting in state number 3997, then that way of looking at world will be called an atomic state. So, in the atomic state representation, states are indivisible, there is no internal structure in the states, okay.

Whereas, we could define state variables like the seat where the Vishwajeet is sitting, the seat where Harish is sitting and now the value for seat where Vishwajeet is sitting could be seat 1 in one state and seat 35 in the other state, there we can look at 2 states and say, okay states we are going inside the states, state is not just a number, it is made of state variable, state variables can take values and now we can compare 2 states and say oh, only Vishwajeet moved.

The fact that you can compare 2 states and figure out what changed is not possible in the atomic state world but it is possible in the propositional state world, then people develop this further and said, oh why propositional we can go first order, so the world comprises of objects and relations so, the object would be chairs and the object would be people and the relations would be people x, person x is sitting on chair y and sitting would be a relationship.

And we will describe the world in terms of objection relations and so a particular manifestation of you know which relations are true in the world will create a state, right. So, this is the atomic agent view, the propositional agent view, the relational agent view and if you have function of objects and that is the first order view. So, there is full theory here of how do I represent the state.

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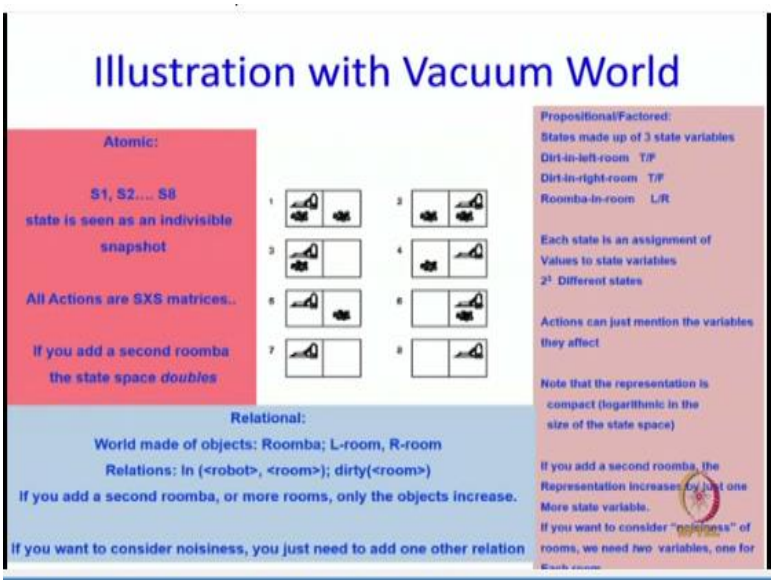

Let us quickly look at an example; suppose, I have 2 rooms, there can be dirt in 2 rooms and I can have a single vacuum cleaner robot and this vacuum cleaner robot is in one of the 2 rooms, then I have 8 states whether there is dirt in the 1st, dirt in the 2nd and where the vacuum cleaner is, if I call them state 1, 2, 3, 4, 5, 6, 7, 8 that will be the atomic view, right. If I say that my state has 3 propositions Boolean dirt in the left room true, false, dirt in the right room true, false, Roomba in the room true, false, vacuum cleaner is bought.

And 3 values like true, true false, false, false true they make a state that will be call as the propositional view and relational view would be that I have roombas, I have rooms and I have a relation in robot room, dirty room and then that would create my world then that will be called as relational view. So, based on this we can define a state space and a more interesting representation for the search problem; for the problem.

So, now I have not defined the right way to represent a new problem, I have only defined that there is some notion of the state, so from in the next class, I will first give you a general representation for an atomic agent's input.

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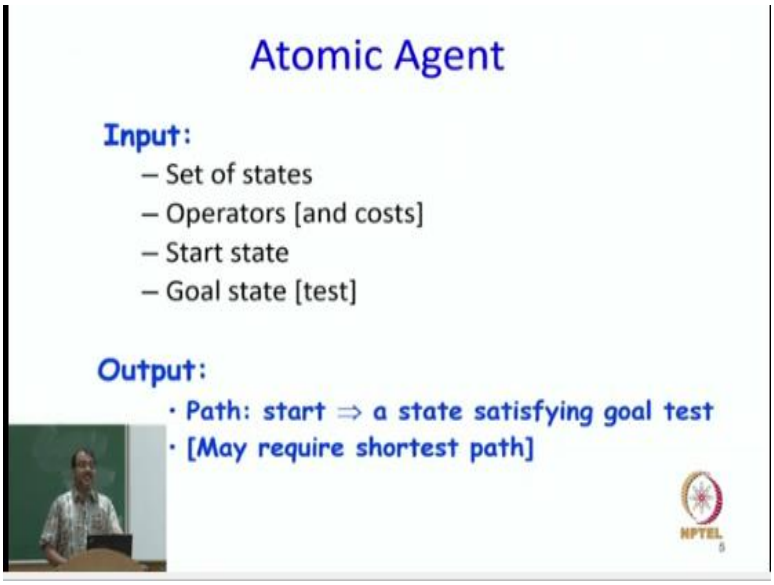

What input would it take which is set of states, operators, start test and goal test and what output is expected from the agent which is a path from the start to the goal, we will first crystallise this idea and having crystallised this, we will then get into the various algorithms to achieve this and for the next week; week and a half, we will only work on algorithms to achieve this, so this is a good point to stop and we will meet tomorrow, thanks.