Artificial Intelligence: Search Methods for Problem Solving
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Lecture – 16
Introduction (2013)
Epiphemona in Computers

But Hofstadter says that, we have to introduce a notion of what he calls as downward causality, which means the causality is from a higher level to a lower level. Even though the laws of physics can explain going from particle level to ensembles of particle level, he says that is not useful for us we have to think about how.

So, for example, if I want to drink a cup of tea, then I am thinking at a level about cup of tea and so on and so forth and this level of thinking which is operate which is happening with this concepts at this level of abstraction is eventually driving at one level you might say my muscles or my nerve cells or something at even lower level you might say the very fundamental particles which make up my hand.

For example, in such a manner that my hand eventually reaches out for the cup of tea and pick it up and you know take a sip from it essentially. So, the causality is from our level of reasoning to the lower level where things are actually happening.

Now, physics of course, does not have a notion of causality, that is why Kant's even when he was talking about human categories was saying that space and causality are given to us that we accept we have to start working with those things essentially.

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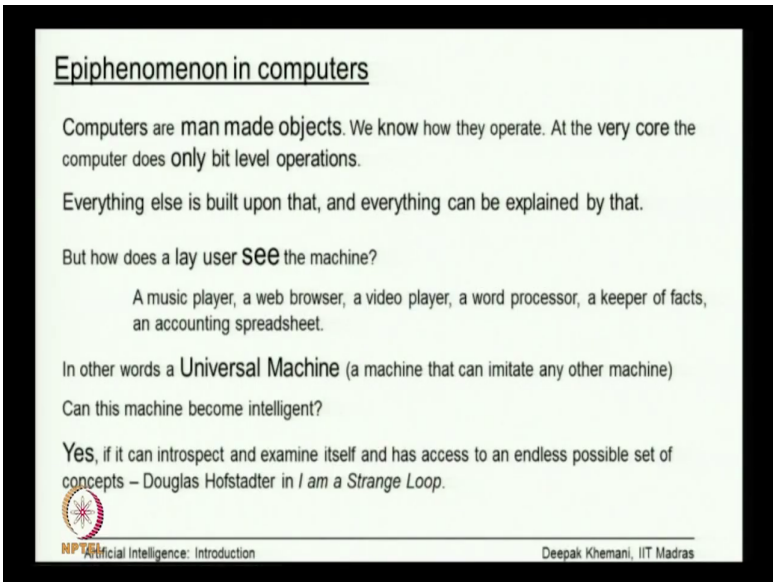

So, these things are called epiphenomenon. So, things like pressure for example, in a balloon we talk of pressure, but what is really happening that lower level activities you know molecules of different kinds of molecules in air, nitrogen, hydrogen, carbon dioxide everything they are moving around randomly and you know impinging upon the surface of the in inner surface of the balloon and this cumulative activity or the epiphenomenon of pressure is felt essentially.

Likewise, in our human brains there are these billions of neurons which are firing away in some fashion, we are not tend to think of our brain in that fashion. I tend to think of my brain in saying oh I want to have this cup of tea which is operating at a very higher level essentially. So, cannot a machine operate at the epiphenomena level like this and that we feel is necessary for machines to be intelligent.

So, we have run through this. So, computers are man made objects we know how they operate. So, its easy for us to explain for example, if you type something in a word processor in principle somebody can say that at the lowest level these are the kind of micro level operations which were taking place, but we do not do that of course, which we as human beings tend to think of machines as doing high level things. So, how do we see a machine? Computer as a music player or a web browser or a game or any of these many things that a machine can do.

So, the important thing is what many people have called starting with Turing is there is a universal machine. The computer just like us is a universal machine if you want to call yourself a universal machine and a universal machine is a machine which not only of course, a simple machine can do only what it is designed to do, but a universal machine can imitate other machines and do what they were doing. So, they are flexible in that nature.

Can such a machine be intelligent? Hofstadter? So, I come back to Hofstadter he says that if this machine can introspect and examine its own behavior, then it is possible for it to become intelligent essentially. So, he is going one more step from Newell and Simon. Simon and Newell they said that if you can create symbolic representations and create algorithms which will work on the representation that is sufficient to necessary and sufficient to create intelligent behavior.

Now you can see that is at one level of. So, there are these layers and layers that one has to talk about. In computers we have bit level representation, we have machine code, assembly language, higher level languages, higher level data structures representations objects all kinds of things. So, now, keep going higher likewise in the real world out there.

So, Newell and Simon said that one level of representation which is makes this calls at the symbol level is enough, but now Hofstadter is going one step further he is saying that in addition to that you need this capability to introspect essentially. So, if you read his book it quite a interesting book to read I am a strange loop, he sort of goes to a long detailed

argument of how Godel discovered this idea of self reference in Russell and Whiteheads Principia Mathematica.

And this in spite of the fact that Russell and Whitehead went out to formalize everything and they wanted to keep away self referential structure. So, they had layered logical representation or type logical representation where self reference would not be possible. A same type of an argument element could not be an argument to a sentence in that same language essentially.

But Godel constructed this very elaborately or he gave us this very elaborate mechanism of how to construct a sentence. So, there is these two levels at which things are operating upon one is this level of number theory, which is Principia Mathematica is all about, but there is also this level of encoding things into this number theory and then encoding sentences like I am lying or something like that essentially or this sentence is not true and things like that.

So, Hofstadter is saying that if a machine can have this capacity to introspect and reason about its own actions which means also reason about other peoples actions, then it can in principle be intelligent.

So, let us talk about intelligent agents for a moment, its a very popular term nowadays. So, these are programs we will talk of intelligent is an programs which are persistent which means like the operating system for example, if you leave your machine on that is exist all the time essentially. They are autonomous which means that nobody is saying that run this program run this routine or call this sub routine or something like that.

They are proactive if they see an opportunity in the environment they sense a environment they will go after it essentially and they are goal directed which means that you know they have goals of course, its goals may not be self generated they could be given by the creator essentially.

So, just like we have the secret agents and the governments are supposed to have who have all these properties they are persistent autonomous and proactive, but they carry out the bidding of their government essentially.

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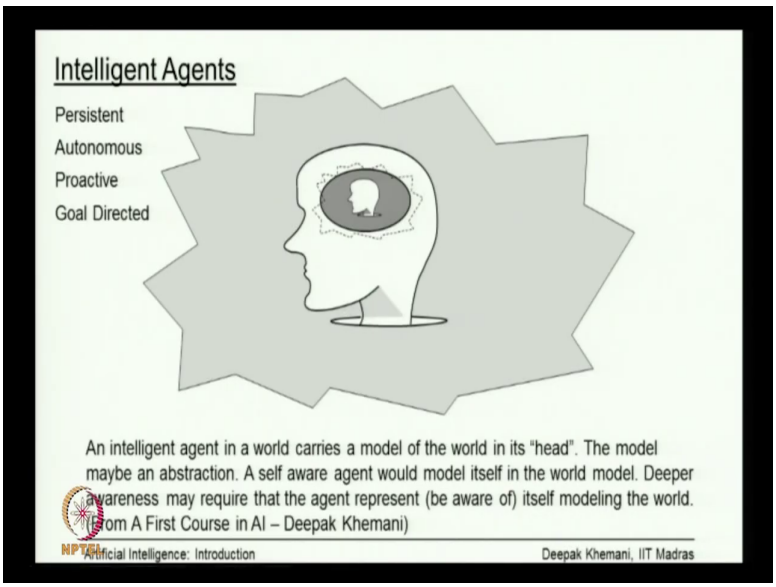

So, this is a rough diagram of what an intelligent agent should be like. So, as an the. So, that white figure head is supposed to be the agent and the thing inside that is what is in the head of the agent and what is in the head of the agent is a model of the world out there and model of the world should contain itself which means it can introspect on itself and obviously, you would might ask the question as to it that if the model of the agent has a world in which the agent is there then in that agents head also I should create a model of the world.

So, there is an infinite level of nesting which is possible in principle. So, there are these kind of very curious loops which can form ok.

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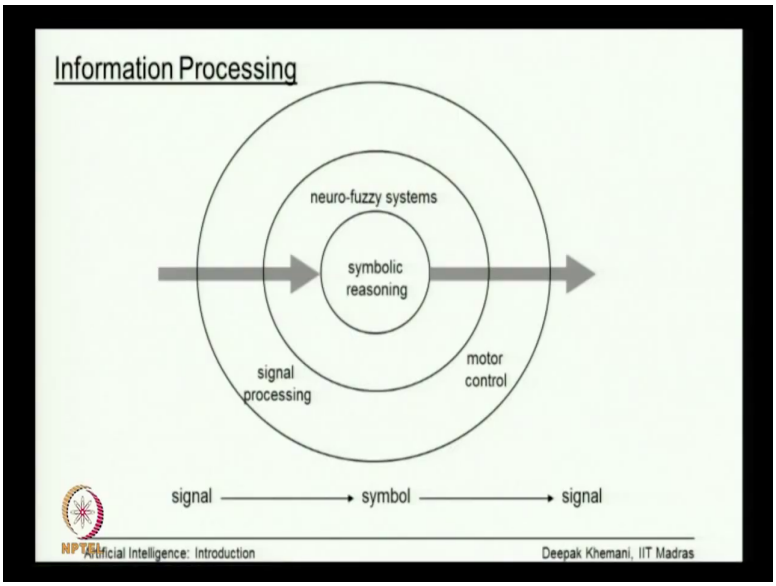

So, we are slowly coming towards moving away from history and coming to what we want to do. If you want to build an intelligent agent which interacts with the real world then you have to have at least these layers of different kinds of reasoning.

One is the outermost layer is what we can call as signal processing, which means you are receiving signal sound waves, light waves or whatever from the world and the innermost layer is symbolic reasoning which is what this classical AIs what all about that you can create symbol systems and reason with them and you may have and this is my interpretation of this

whole thing that an intermediate layer of neuro fuzzy systems which serve the purpose of converting signals into symbols essentially.

So, for example, if I am speaking and what I am creating is a signal which is you know sound waves of a particular pattern, but your brain is converting these sound waves into linguistic entities essentially. So, you are recognizing words out of these sound waves from this signals you are extracting symbols essentially.

So, if I say the word apple, it may be certain sound wave which is meaningless in itself just like neural activity in our head is meaningless in itself, but you can process it to understand at a higher level to stand for a symbol apple. So, a neural networks are particularly good at doing this kind of things. So, you must have heard about fact that character recognition, if I were to draw the letter A on a hand written characters.

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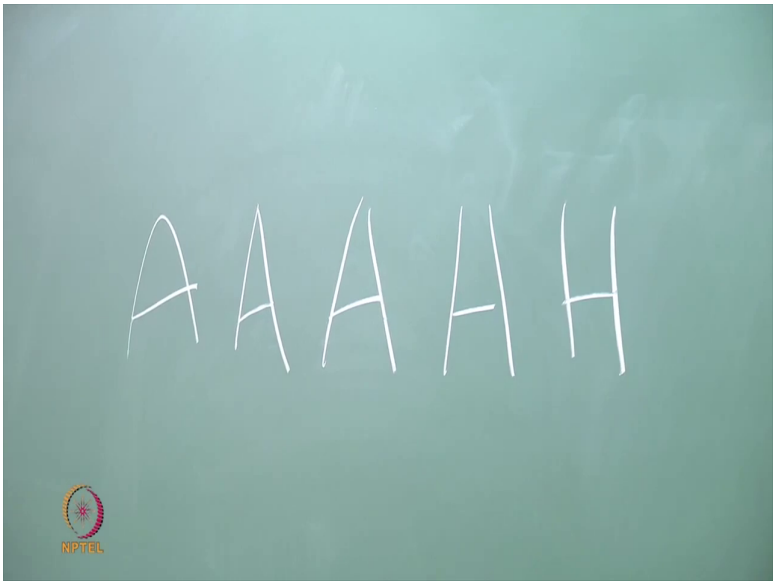

So, if I write A like this, if I write A like this, if I write A like this we have no difficulty in recognizing that these are A and neural networks are also pretty good at this sort of a thing. But at some point you know you may start getting a doubt about whether I am writing an A or whether I am writing an H and its very difficult to describe rules to say that this sequence of segments forms A, this sequence of segments forms H and so on.

Whereas, the learning system which will learn these characters in context of other letters around them will eventually learn to recognize the character A for example. So, neural networks are very good at this sort of a thing, but if you want to do give an explanation of let us say the Pythagoras theorem what is the Pythagoras theorem and how do we prove it, then neural networks are not really very good at that kind of a thing for that we need this symbol manipulation ability which everybody is from Simon to Hofstadter is saying is necessary for intelligent behavior essentially.

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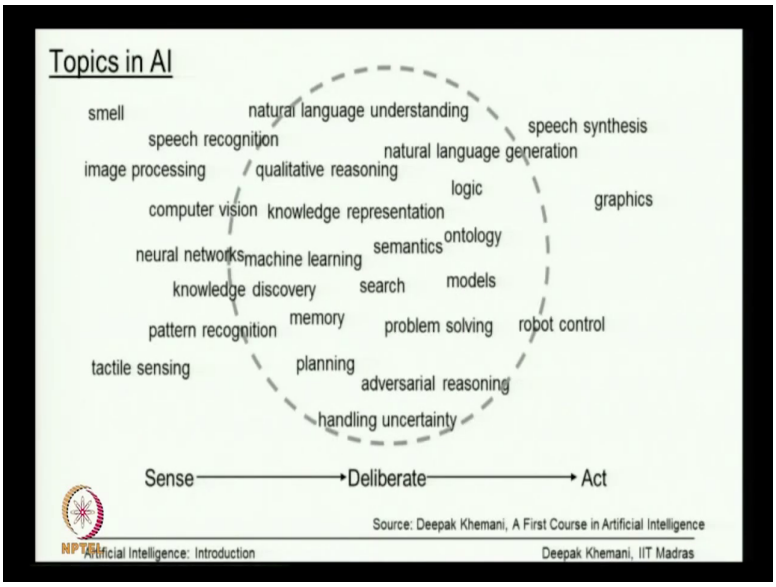

So, these are topics that one can identify if you look at AI in general this is not the topics of this course, if you look at the enterprise of AI then we have all kinds of topics here knowledge representations, semantics, ontology, models, search, memory, machine learning, problem solving, planning, adversarial reasoning, qualitative reasoning, natural language understanding and all kinds of topics.

So, on the left what I have drawn in this figure? Are the sensing kind of activities, signal to symbol kind of activities, speech processings, image processing, video processing, computer vision, neural networks, pattern recognition, touch sensors and that kind of thing on the right hand side its a opposite from symbol to signal. So, we have motor control of if you want to build robots, you have to eventually make the robot do what the robot is thinking about doing.

So, if the robot is thinking about going from place A to place B, it must do something to make the physical movement possible. So, we need actuators and things like that at that (Refer Time: 12:54) essentially. So, these are the topics of AI and the circle basically this figure is taken from a book, this circle roughly kind of describe what is there in the book.

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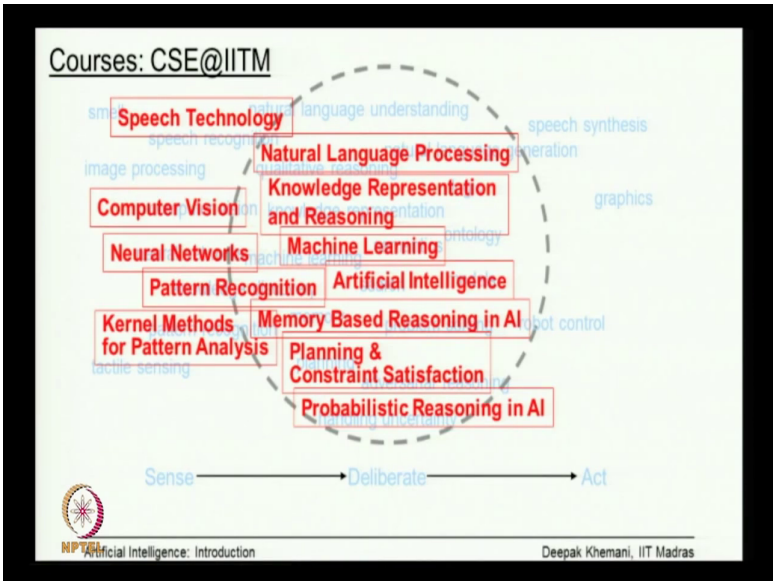

So, of course, we are doing this course on AI which we are doing here, but in our department there is a whole lot of courses which cover these areas and I just want to give you some idea of the kind of courses that we offer. The first four courses that will come our courses which I am personally involved with, but the rest of the courses you know mostly my colleagues are handling.

So, we start with this course which is AI which kind of covers some of this stuff inside this thing here, then planning and constraint satisfaction these are names of courses. So, this will

be offered next semester for example, both these courses will be offered next semester knowledge representation reasoning as well. Then there are other courses which my colleagues teach the machine learning which is being offered now, pattern recognition is also being offered now I think.

Natural language processing as well is being offered at this moment, probabilistic reasoning is not been offered at this moment very often I think Dr. Ravindran offers it as a self study course, then we have computer vision I am not quite sure which semester may be this semester its being offered. Speech technology, Kernel methods which is I think next semester digital video processing computer graphics.

We do not have so, much on the output side. So, you can see our department is not very wrong in things like robotics. So, we do not really offer courses in that so, that. So, there I imagine mechanical department may be offering some courses. So, in terms of assignment I might have mentioned this earlier, one assignment is going to be on game playing.

So, I will try to do game playing not in this order, but a little bit earlier than this order, may be after heuristic search or something like that. So, that you can get going and we will decide which game and you have to implement a algorithm for. And your programs will play against each other that kind of stuff and another assignment would be implementation of some of these algorithms.

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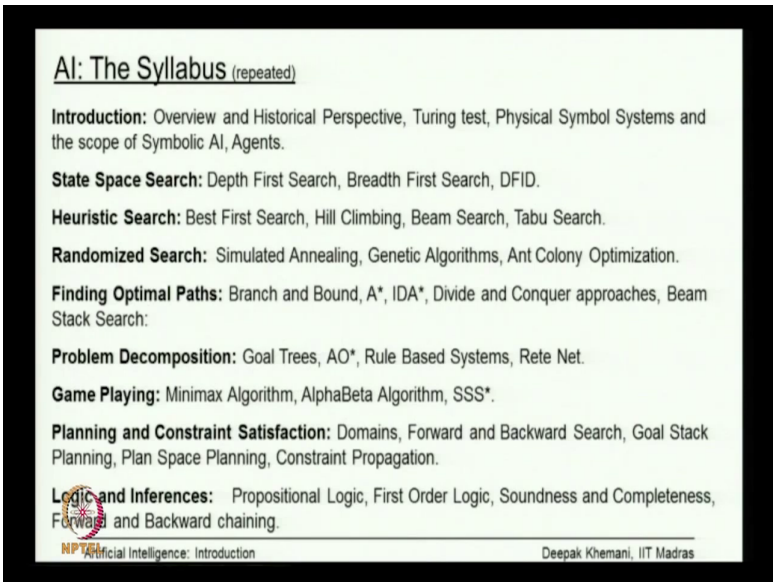

So, we will. So, the assign some algorithm and you should implement that we will go into the details as we go along course ok. So, the text book as I said is this text book which I have just written and everything that I am teaching is from there and vice versa in the sense it what is there is what I teach.

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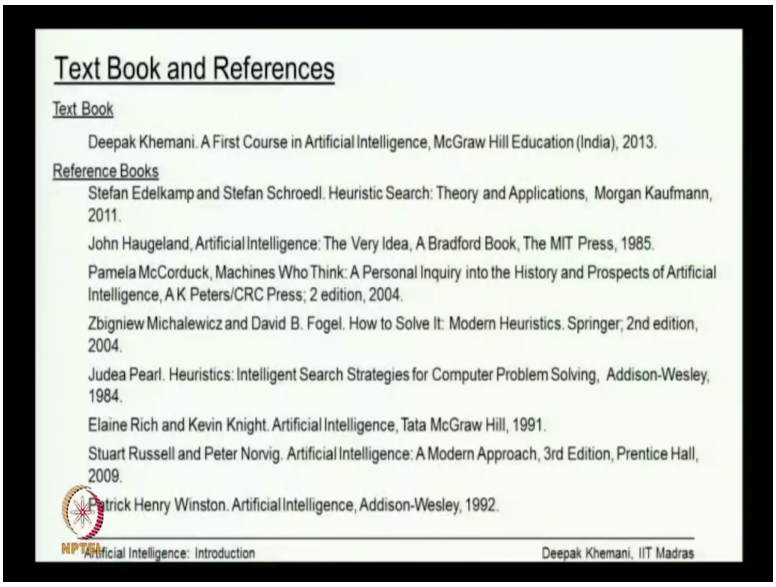

So, we will use that as a text book and then there is a host of other reference books that I will point to as and when needed is essentially. So, already from these reference books we have in some sense finished with two of them which is Pamela McCordick's machines who think and John Haugelands AI the very idea artificial intelligence the very idea, but some of these other books we will refer too as and when the time comes essentially.

So, we will stop here and next on Friday when we meet we will have a qualitative shift and start devising algorithms for simple search that we just mentioned essentially.

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State Space Search