

**Artificial Intelligence: Search Methods for Problem Solving**  
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**Lecture – 10**  
**Introduction (2013)**  
**Reasoning = Computation**

Talking about our standard source of meaning which is a dictionary. So, if you want to look up a meaning of a word, you go and look up a dictionary. How does the dictionary give us meaning essentially? Because dictionary is only describing words in terms of other words essentially. When you give examples, also you are giving examples in terms of other words. Where does the meaning originate from? I mean, is there a fundamental source of meaning essentially?


This is a kind of difficulty which Hobbes faces. Where does meaning come from essentially? We also not able to say were where is the meaning comes from. See first the people before him that the motion of an apple is because you see an apple and that is what it means essentially ok; but when we talk about language and thought and symbols, we have this difficulty of saying where does the meaning come from essentially.

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**Reasoning = Computation**


In *De Corpore* Hobbes first describes the view that reasoning is computation early in chapter one. "By reasoning", he says "I understand computation. And to compute is *to collect the sum of many things added together at the same time, or to know the remainder when one thing has been taken from another*. To reason therefore is the same as *to add or to subtract*" (Hobbes 1655, 1.2).

Stanford Encyclopedia of Philosophy  
<http://plato.stanford.edu/entries/hobbes/>



**Thomas Hobbes**  
Born 5 April 1588  
Westport near Malmesbury,  
Wiltshire, England

Hobbes was influenced by Galileo. Just as geometry could represent motion, thinking could be done by manipulation of mental symbols



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As a question that we do not we have not yet answered today essentially. This is the picture of Thomas Hobbes in the 16th century. His book called *De Corpore* Hobbes first describes the view that reasoning is computation. So, he is saying reasoning is computation. By reasoning, he says I understand computation and to compute these two, collect the sum of many things added together at the same time or so, this is very archaic language essentially or to know the remainder when one thing has been taken from another. To reason therefore, is same as to add or to subtract. So, again like Leibniz said an adding, subtracting arithmetic is similar to other kinds of, reasoning is similar to this kind of process essentially.

So, this code I have taken from this source which is the Stanford Encyclopedia of Philosophy and as we have just mentioned Thomas was influenced by Galileo; just says geometry could

represent motion thinking could be done by manipulation of mental symbols essentially. Does a name Hobbes ring a bell?

Student: Calvin and Hobbes.

Calvin and Hobbes right. In fact, Hobbes was named after Thomas Hobbes; the Bill Watterson.

Student: (Refer Time: 02:40).


The author of Calvin and Hobbes, named him after Thomas Hobbes that is why he is such a philosophical character.

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Thoughts = Symbols

**René Descartes** (1596 –1650)

Animals were wonderful *machines*.  
Human beings were too,  
except that they possessed a *mind*.




Born 31 March 1596  
La Haye en Touraine,  
Kingdom of France

Galileo: Motion → Geometry  
Descartes:      Geometry → Algebra

Everything is "applied math"  
... even "thought" ↓

Descartes: Thoughts themselves are symbolic representations



Source: [http://en.wikipedia.org/wiki/Ren%C3%A9\\_Descartes](http://en.wikipedia.org/wiki/Ren%C3%A9_Descartes)  
John Haugeland: *AI the Very Idea*

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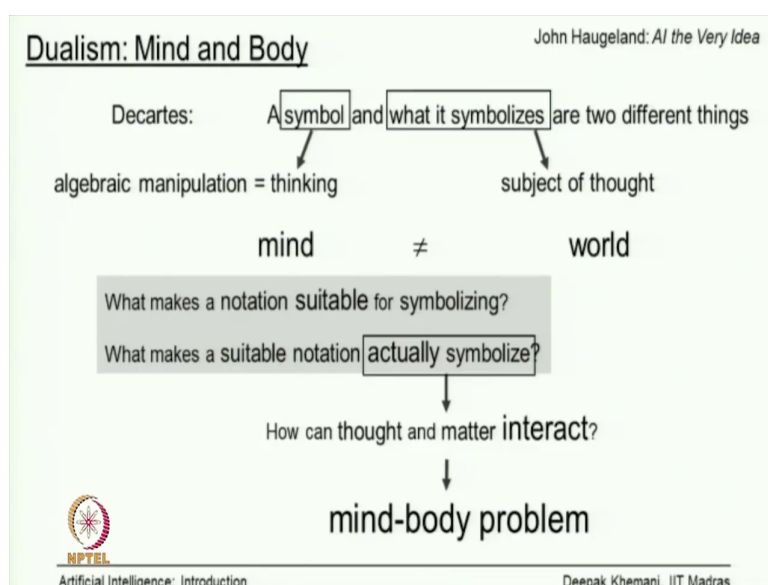
When we come to Rene Descartes again another great thinker from the middle times, we know him for many things including the Cartesian coordinates are named after Descartes. Here come, remember that all this thing was going on this talking statues, moving things and so on and so forth and it had become sort of acceptable in Europe to talk about these machines as being like us in some sense essentially.

So, Descartes in fact, goes on to say that animals are wonderful machines. He just makes this next step that they are they are not like machines, they are machines essentially and then, he says human beings were to except for that they possess something called the mind essentially.

We will come to this Decartes Decartes problems in a moment. So, just as Galileo said that motion can be expressed in geometry, Descartes that the geometry could be expressed in algebra. Descartes is a one who invented this so called coordinate geometry and that kind of thing.

But he went further, he says that even thought can be expressed in the language of mathematics and thoughts themselves are symbolic representations. So, you can see he is building upon what Hobbes has said. Hobbes said thoughts are symbols and now, he is saying that thoughts are symbolic representation that we operate upon essentially.

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But this is something which is new which Descartes brought brings in the notion of the mind and the body. So, Descartes is what we call as a dualist or belongs to this thinker which say that you know mind and body are two separate things. So, we often call it the mind body dualism.

So, as oppose to dualism, there are schools of thought which are monist in nature which believe that there is only one kind of thing ok. So, for the first time Descartes is saying there are two different kinds of things in this world; one is this material world which he calls a body and the other is a mental world which he calls as a mind.

And he says that there are two different kinds of things; the material world of course, would obey the laws of physics and things like that and we will see later that you know philosopher said that mental world also should obey such laws and so on.

But they are different world. Mind, the world of mind is separate and the world of body is separate and this is opposed to other kinds of philosophies or other kinds of views in philosophy is the that there is only one kind of thing.

So, there is a world of idealism which says that there is only the world of ideas. So, for example, in India, we say there is everything is Maya, we say right. There is everything is the world of ideas and matter is basically a construct that comes out of our ideas essentially. It is very complicated to think about; but maybe you can reflect upon that a little bit.

As oppose to idealism, the other world is materialism which says that everything is matter and the whole world is matter and matter interacts in a certain way and ideas and minds and all this kind of stuff thing they emerge out of this essentially, somehow essentially. So, there are different viewpoints about what the world is like there and Descartes was a dualist. He said that mind and body are two separate things and he says that a symbol and what it symbolizes are two different things.

So, if I say chalk as a symbol, it is a compound symbol made up of these letters. So, but its nevertheless the symbol. So, chalk is a symbol and this thing that I am holding in my hand is what it symbolizes essentially. So, this notion that chalk, the symbol chalk is separate and then, we have this problem that a symbol is amenable to algebraic manipulation.

So, you can do thinking what we called as thinking is basically symbol manipulation which you can manipulate symbols and the subject of thought is a world, the real world out there what it symbolizes and they are different things; the mind is different and the body is different essentially. Of course, he had to answer questions like you know because see the body or the material world obeys laws of physics and the mind of course, it was not clear how it operated; but it was separate.

So, he had to answer questions like this when what makes a notation or a symbol notation suitable for symbolizing and secondly, what makes a suitable notation actually symbolize. See this problem has occurred because he has separated the world of the mind and the body. He says the mind is one thing and the body is another thing.

A symbol is one thing and what it symbolizes another thing. So, the question is what makes a notation suitable for symbolizing now, that is a question that we are addressing now, when we write algorithms, when we talk about knowledge representation. Then, we are addressing this issue as you know what is this how do you represent, how do you create a domain model for example, how do you represent the world so that you can you know compute upon that essentially.

That is a easier part, but the more difficult part is what makes a suitable notion actually symbolize essentially, which means that if it is to be meaningful in nature. Then, the world of symbols or the world of thought should be connected in some ways to the material world or the world of matter.

Because they cannot be independent of each other, they can they are not different worlds that are you know operating independently. Our world of thoughts is sort of enclose synchrony to the world of matter essentially. If we raise our hands, if we think about raising our hands, we actually raise our hands essentially that kind of. How does the interaction take place between the world of thought and the world of matter? So, the question is how can thought and matter interact?

Because you know the world of thought is different; matter of course, behave sort of obeys the laws of physics, what about the world? The world the world of thought is not made of matter, it is a different world. How can it interact with matter that is a question that he could never answer, the mind, body problem essentially or the mind body dualism essentially.

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**The Paradox of Mechanical Reason**  
John Haugeland: *AI the Very Idea*

IF  
Reasoning is the manipulation of meaningful symbols according to rational rules

THEN  
Who is manipulating the symbols?

It can be either mechanical or meaningful but how can it be both?  
How can a mechanical manipulator pay attention to meaning?

↓

faculty of will?  
transcendental ego?  
or  
the homunculus? A little man?

For some more recent thoughts on this question see  
Hofstadter: *Godel, Escher, Bach*  
Hofstadter & Dennet: *The Mind's I*  
Hofstadter: *I am a Strange Loop*

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So, this brings us to what we can call as a paradox of mechanical reason. This term is by John Haugeland in his book and a paradox is that if reasoning is a manipulation of meaningful symbols according to rational rules, so remember that we are talking about manipulating symbols like Leibniz says there are well defined ways of manipulating these ideas, it is not like you are doing it randomly. So, according to well defined rules. So, if reasoning is a manipulation of symbols according to this national rule, who is manipulating the symbols?

Because this question of meaningful manipulation has come into it that. Our thoughts cannot independent of the real world essentially. They have to be connected to that essentially. So, if a fast bowler is running up and bowling, thinking of bowling and in swinger or something, he better be able to produce a real in swinger, if he is worth his salt.



How is his thoughts related to the real world essentially? Who is manipulating the symbols essentially? The difficult question to answer because what people say is that it can either be mechanical, according to some fixed set of rules or it can be meaningful; but how can it be both. You cannot have a mechanical system being meaningful at the same time and by meaningful, we mean paying attention to the meaning of what is happening.

How can a mechanical manipulator pay attention to meaning essentially? So, remember that that they are not talking about AI or any such things, they are talking about human cognition, they are talking about human minds, how human minds operate essentially.

So, they are trying to analyse that essentially and Descartes has said that there is a world of the mind which is symbol processing and then, there is a world of the body which is a real world made up of physical matter. But they are closely tied together. So, when I am thinking about some real world in a meaningful fashion. So, if I got two pieces on a table let us say a cake and a sandwich, I am thinking about them and I have to decide should I pick up one of them.

I am thinking about some real things in the world in a meaningful fashion. My thoughts about this cake and a sandwich are about real things and I am making some decisions should I eat this or should I not eat this or something like that and so, this meaningfulness, where does that come from essentially.

How can a mechanical manipulator pay attention to me? It is a question I would ask you to ponder over a little bit and see whether you know maybe like Penrose said human beings are special, there is something special happening in our brains which allows us to do this or like Rafter said that there are some instincts that we have which we cannot automate essentially; but of course, I believe I take the opposite view.

So, this led to a lot of debate in his time. This is we are talking about Descartes, still Rene Descartes and his mind, body dualism and some people attribute the fact that you know go it is said that Descartes who also gave us a phrase cogito ergo sum I think therefore, I am his. Apparently, he is claimed to have a proof of that God exists essentially.

And the proof is tied to the fact that there is this difficulty about how do symbols, how do symbols get manipulated in a meaningful fashion essentially. But his contemporaries of course, did not accept any such thing and they would in fact, mock him about you know this idea of ah.

So, you can imagine a little bit like the Chinese room which we have not discussed in detail; but just imagine that your brain is like a Chinese room full of symbols and there is somebody manipulating those symbols according to some rules. Whose that somebody that is a question that we are asking hm.

So, people would mock at Descartes and say oh there is a little man sitting in your head who is doing manipulating the symbols. But the problem is as you can imagine, this explanation does not work because the next question that you would ask is how does the little man operate? So, little man has a little brain in his little body, which has little symbols inside his head and who is manipulating those symbols. So, there comes an infinite regress essentially and people say that this is what led to Descartes claim that he can prove that god exists essentially.

But in the real world, what was happening as so this question to who people philosophers have tried various kinds of explanations something called the faculty of will which we cannot quite define or transcendental ego or as I said, the people used to mock him and say there is a Humunculus. Remember the Humunculus was made by paracelsus, a little man sitting inside his head essentially.

So, that is a that is a fundamental question one has to answer which say that if you are in modern day world going to write programs which will operate according to the algorithms that you are putting into those programs, how can they be doing meaningful things essentially?

So, its roughly equal to that essentially or I might say that if I were to implement a neural network, which is I know that the structure of a neuron how it operates and so on and so forth and I am just connecting together hundreds of thousands of neurons, how can that ever do meaningful things like character recognition. Of course, we know that it can be done,

character recognition it can be done; but the fundamental question is that is that intelligent or is it doing something that we have asked it to do.

In fact, Ada Lovelace had said that the computer can only do what it is instructed to do and nothing more than that, which is of course true at a very fundamental level. So, some recent thoughts on who is doing this manipulation of thinking, there are some very interesting books and for those of your interested, I would recommend them all of three have a common author called Douglas Hofstadter, who is in the Indiana university, his famous book called Godel, Escher, Bach and he and Dennet, wrote a series of, collected a series of articles called The Mind's I and more recently, he is written a book called I am a Strange Loop essentially.

So, he is trying to Hofstadter is also trying to answer this question I mean instead of saying who he is saying what is this notion of I that I have as a as a human being that I have essentially; I or you essentially.

So, if I talk of you as a person, what do I really mean; what is that you essentially? So, I say that my body, my mind my hands, my eyes, my feet, my whatever. What is this I which is saying my essentially that is a question which Hofstadter is trying to answer and he sort of uses a combination of emergent behaviour and self-referential loops which we do not have time to get into here essentially. But I would recommend one of these books, they are quite easy to read and quite engrossing.

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Concepts and Categories