Artificial Intelligence: Search Methods for Problem Solving
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Lecture - 08
Introduction (2013)
Machines with Gears and Wheels

So, let us move onto more useful things, mechanical arithmetic can we make machines which will do arithmetic for us. So, Pascal of course, you are familiar with as students of science in various places Pascal's name has appeared, not least as a programming language name of a programming language.

So, he invented a mechanical calculator using something called lantern gears, which we will not go into and he tried out 50 different prototypes before, presenting his machine in 1645 to the public. It was called Pascaline or arithmetic machine or Pascal's calculator. And it could add and subtract two numbers that was its limit of his mental abilities and multiply and divide by repetition essentially.

There is a image of Pascaline from one of the museums. And he received the rights to produce this machine and sell it in France, but it was not something which was commercially viable for him essentially. So, as this article says the cost and complexity of producing the Pascaline was too much for him essentially and production ceased in a year. But this a real machine which could add, subtract and multiply two numbers.

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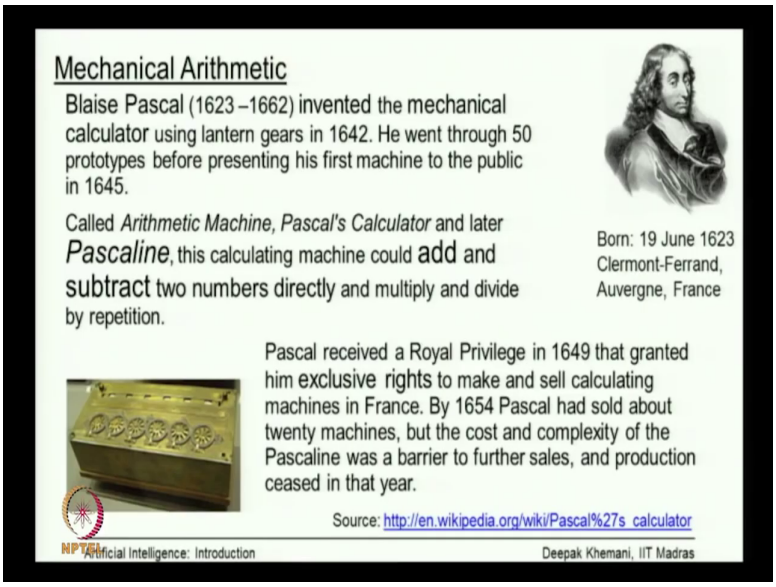

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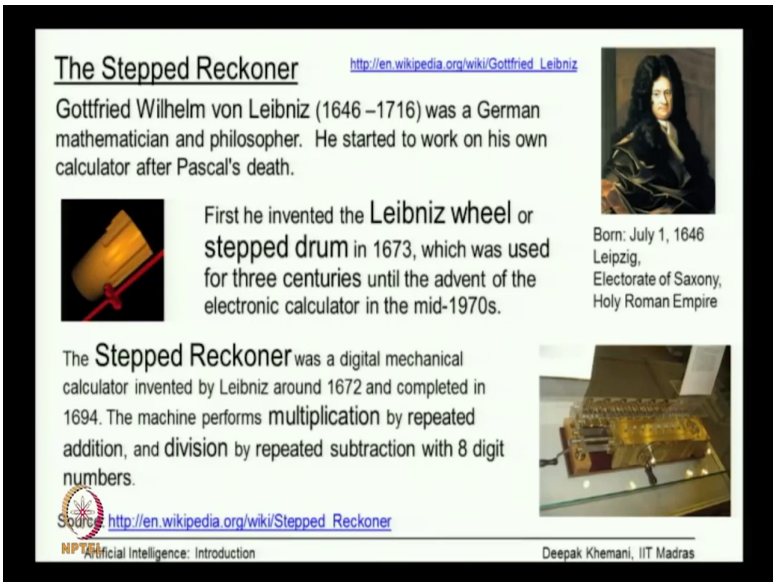

So, you can see we already looking at the advent of calculating machines. So, all these are famous names you must have encountered them for example, Leibniz we know as an inventor of the calculus. So, this was sort of multifaceted people they did all kind of things in those days. So, he was a German philosopher and mathematician he started to work on his own calculator after Pascal's death.

So, he invented something which is called as a Leibniz wheel or a stepped drum, which could do counting in some sense. So, here is a image from the Wikipedia site. So, you can see there is a gear in the red colour fixed to a rod and depending upon and there is a step set of teeth in the orange cylinder. So, depending an upon where this gear is it would be rotated some number of times dependent upon how many of those teeth it encountered essentially.

So, if it was on the lower part it would count 0 or 1, if it was raised to the extreme right then, it would be stuck by let us say 9 or 10 teeth and it would count up to 10. So, its a small counting device that he invented. So, all these machines in those time were mechanical in nature its called the stepped drum. And as you can see from this quote it was used for three centuries until the advent of the electronic calculator, which came only much later in life. In fact, in the last century and he build this machine called the stepped reckoner.

So, the stepped reckoner the step name comes from the kind of drum it uses the stepped drum. It was a digital mechanical calculator invented by Leibniz around 1672 and completed in 1694, it could perform multiplication by repeated addition and division by repeated subtraction and it could operate with 8 digit number. So, if you multiply 2 8 bit 8 digit numbers it would give you a 16 digit answer so, that was its precession. So, to speak and image of the stepped reckoner from one of the museums essentially.

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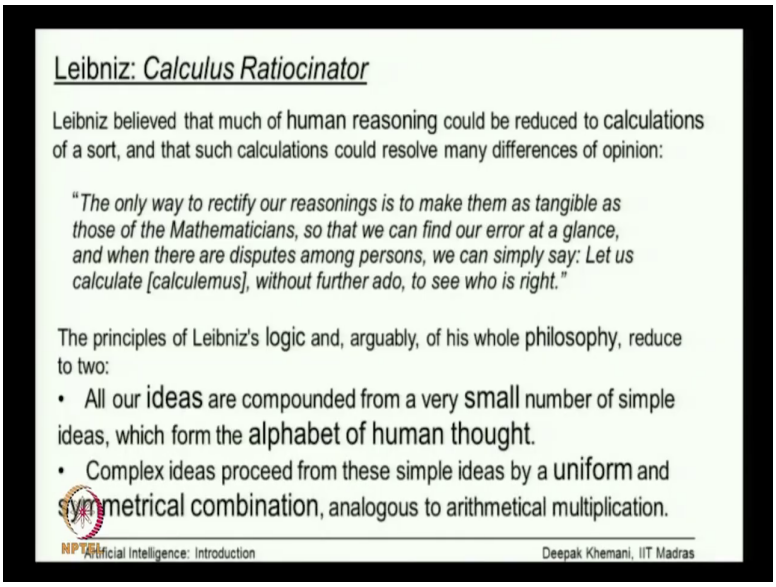

So, Leibniz of course, was as I said a multifaceted person. He believed that much of human reasoning could be reduced to calculations of a sort ok. So, we are moving towards AI in some sense that can we have machines automate on which think, and which can do reasoning and you know including things like arithmetic. But, he is going beyond arithmetic he is saying that human reasoning could be reduced to calculations of a sort and such calculations could resolve many differences of opinion essentially.

So, here is a quote from Leibniz he says the only way to rectify our reasoning's and mind this language is not modern language its slightly old language. The only way to rectify our reasoning's is to make them as tangible as those of the mathematicians. So, that we can find our error at a glance and when there is a dispute among people persons, we can simply say let us calculate without further ado to see who is right essentially.

The motivation behind devising logic is the same essentially. And we will see that logic also evolve from similar background, but this idea that arguments can be settled by calculation. So, you do not have to fight or something like that also go goes back to those times essentially.

Of course, if you tell this to the UP government they would not believe it essentially saying. So, these are the general principles of his logic and in fact, his whole philosophy and they are that all our ideas are compounded from a very small number of simple ideas, which form the alphabet of human thought essentially ok.

So, very significant step he is making essentially, he is saying that everything that, we think about is essentially combinations of some small set of simple things. Remember in those days physics or science had still not discovered the notion of an atom, all those ideas came much later essentially. And Leibniz is talking about the fact that there are small number of simple ideas, which combined and form complex ideas to form new ideas essentially.

And this is an idea which sort of carries forward to present, their knowledge representation as well. There have been approaches to knowledge representation, which says that we will work with a small number of primitive concepts and derive all other concepts from those concept essentially.

So, its a very significant idea. So, the alphabet of human thought. And secondly, complex ideas proceed from these simple ideas, by a uniform and symmetrical combinations analogous to arithmetical multiplication.

So, what it he means by uniform and symmetric combination is that there is a well defined way of doing things essentially. The well defined mechanical way of just like you have algorithms for adding or doing long division or multiplication, you have algorithms for combining smaller ideas into more complex ones essentially.

So, there are two things he is saying one is that everything all ideas are made up of a finite set of simple ideas and then, there is a uniform way of combining ideas it to form more complex ideas essentially. And remember this was in the 17th century.

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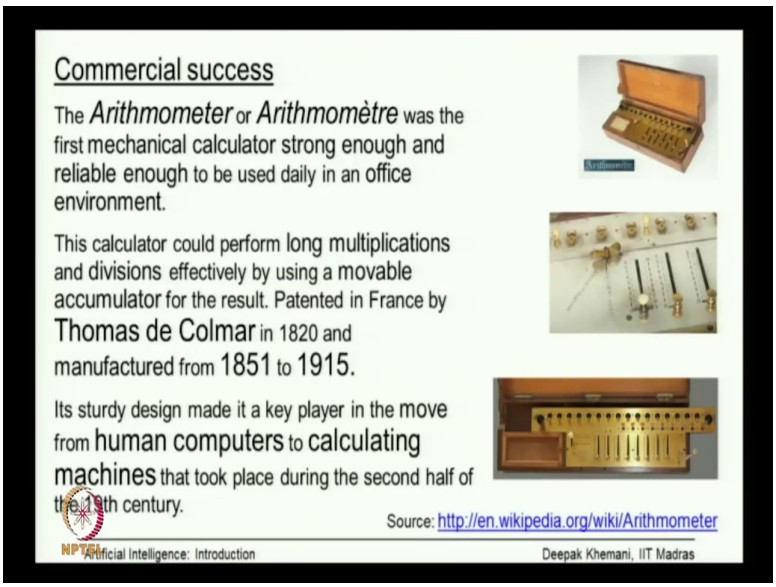

The first commercial success of a mechanical calculator was in 1820, Thomas de Colmar from France he built this machine. And it was strong and sturdy enough to withstand daily use in the office environment essentially.

So, if you look at the last paragraph. So, these are some of the images which are of those real machines and as you can see in the second paragraph, they were manufactured from 1851 to 1915. So, not even 100 years ago you might have found people using such a machine to do arithmetic essentially. The last paragraph says that its sturdy design made it a key player in the

move from human computers to calculating machines that took place during the second half of the nineteenth century.

So, I want to draw your attention to the phase human computers. Before, our computers, digital computers or mechanical computers that we will see in a moment were invented the word computation was essentially applied to human beings. The human beings computed things and they were called computers essentially. And this is a term that we will see again later or sometime.

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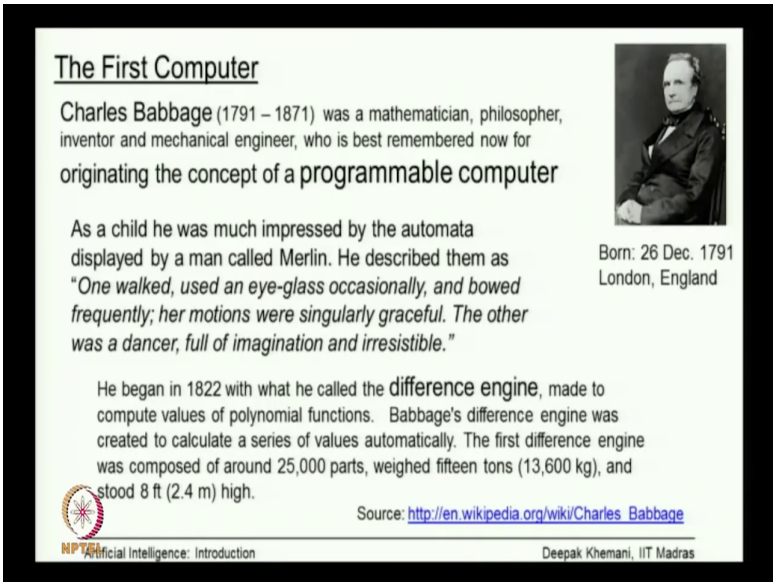

That brings us to the first computer. So, you all familiar with Charles Babbage I presume 18th century he was a mathematician, philosopher, inventor, mechanical engineer, best remembered for his idea of the programmable computer. All the machines that we have seen so, far were not programmable, they could do arithmetic for example, and that was about it essentially

Charles Babbage take this to the next step. So, he as a child was fascinated by the same automata the kind of talking heads, moving, figures that we talked about and he this is the quote from what he said about some statues that he saw displayed by a man called Merlin.

And he described them as saying they are these two feminine figures, he says one walked used an eye glass occasionally and bowed frequently her motions were singularly graceful. And he says the other was a dancer full of imagination, I do not know how he got that and irresistible essentially. So, this was the general fascination which talking moving figures that you know was pushing all these ideas forward essentially.

So, in 1822 he began building what is called as a difference engine, you must have heard the term, it was designed to compute polynomial functions more than addition and multiplication. The first engine was composed of 25000 parts weighed about 13600 kilograms and was 8 feet tall.

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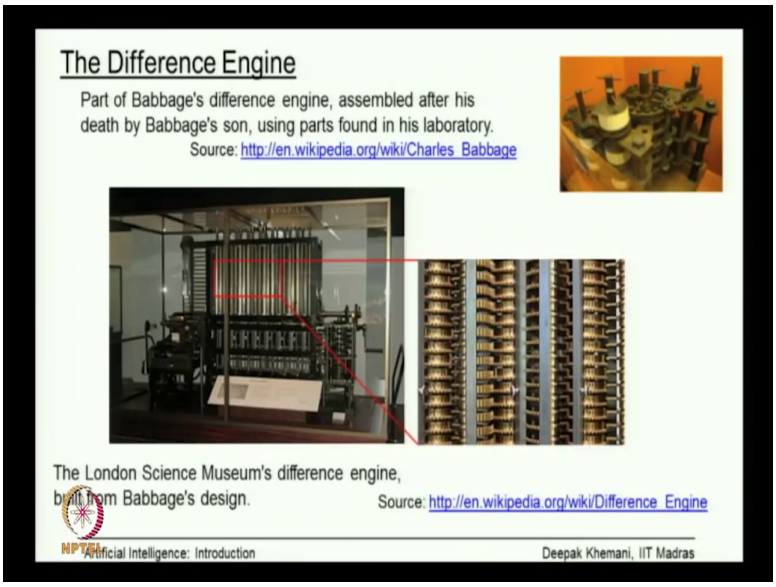

Here is an image of a difference engine on the bottom you can see, on the bottom left you can see an image which is there in the London science museum. And on its right is a small enlargement of the gear system that it was using. And on the top is a part of a difference engine assemble after his death by his son, using parts found in his lab essentially. So, that is a original Babbage engine whereas, what here is a recreation modern recreation of the difference engine that you can see, but these are working machines.

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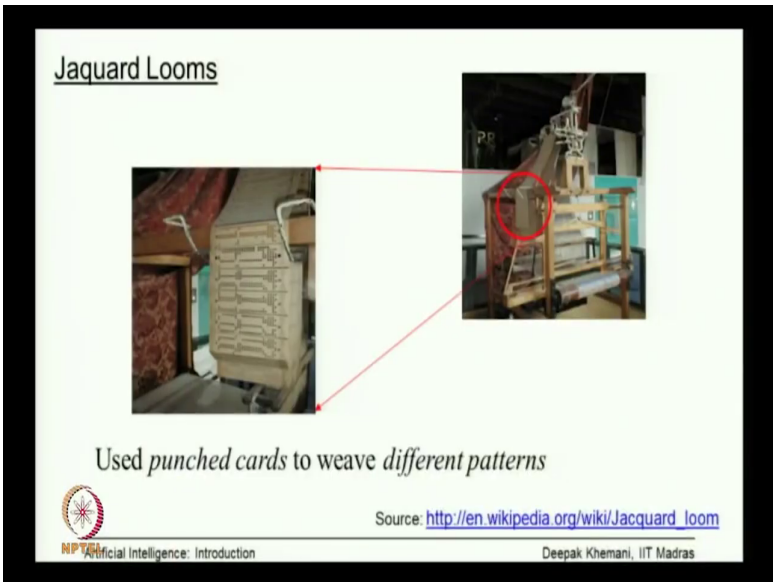

One place where Babbage got some ideas was from this so, called jacquard looms essentially. So, why is a computer are different machine from the rest of the machines because, it is programmable. And how is it programmable? Because we have this idea of a stored program. We can plug in a program and run that program then, we can plug in a different program and run the different program (Refer Time: 11:54).

So, the stored program which can be input the idea came from this jacquard looms, which is the kind of punched cards that you see here on the left, which is an enlargement of the figure on the right, which were used to create designs in fabric essentially. So, these looms were create to use to create this pattern fabrics and the pattern could be controlled by this punch card. So, this idea of punch cards is what Babbage took from there and he created what is known as the analytic engine.

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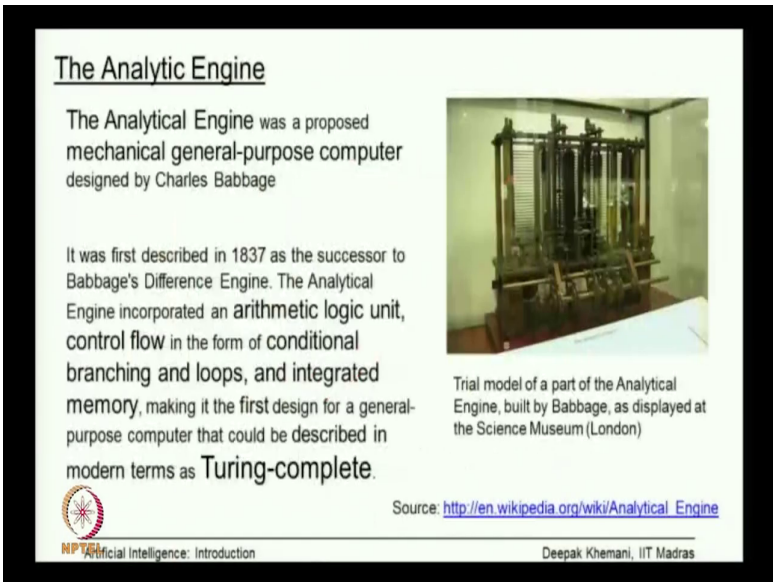

It was a proposed he did not actually built it.

Student: Yeah.

Mechanical general purpose computer designed by Charles Babbage. First described in 1837, it had an arithmetic and logic unit control flow all modern terms in computer science. In the form of conditional and branching loops and integrated memory. And it was the first machine which in the modern sense could be set to be Turing complete essentially, which means it is equivalent to a Turing machine.

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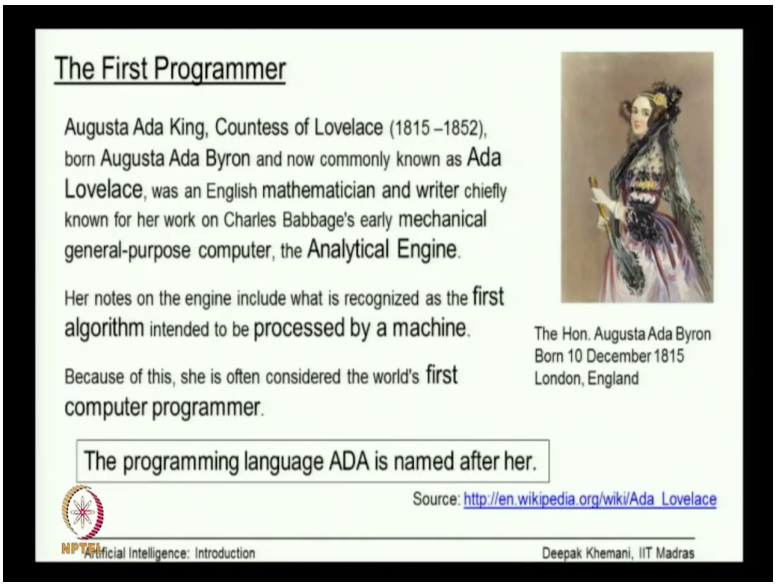

The first programmer was his accomplice or collaborator Augusta Ada King, she was a daughter of Lord Byron, who was a poet she is now known as Ada Lovelace was a English mathematician and writer chiefly known for the work that she did along with Babbage essentially.

So, her notes include what can be called as a first algorithm, which is processed by a machine and because of this she is often called as a first programmer. And the programming language Ada, that you might have heard about promoted by the US department of defence is named after her essentially.

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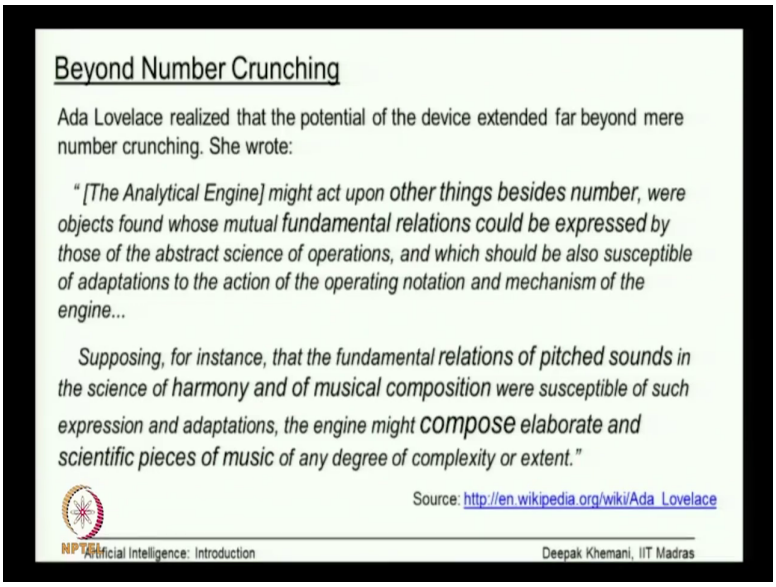

So, she went beyond number crunching again like Leibniz, she realized that the potential of the device extended far more beyond number crunching. And she wrote and this is the quotation that the analytical might act upon other things besides number, were objects found whose mutual fundamental relations could be expressed by those of the abstract science of operations and so on.

And then in particular she talks about generating music, she says that supposing that the fundamental relations of pitched sounds and the science of harmony and musical composition were susceptible of such expressions. The engine might compose elaborate and scientific pieces of music to any degree of complexity essentially.

So, even then Babbage was just designing this analytic engine, which was not even built and she was imagining that such a machine could compose music essentially. Because, nowadays we know it can be done.

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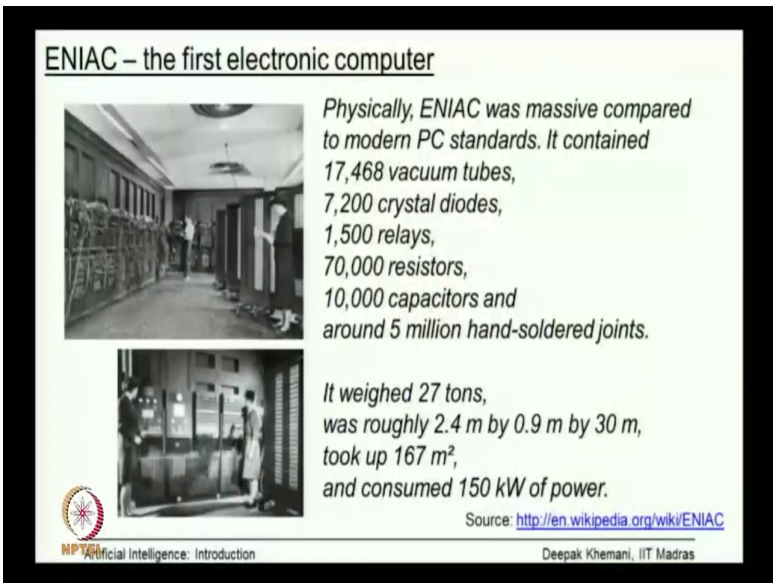

And finally, in this study of mechanical history, we look at this first electronic machine which was built called the ENIAC you must be familiar with it. But, you can just see the size of ENIAC 17000 vacuum tubes 7200 crystal diodes and so on and so forth 27 tons it occupied a full room essentially. It was not even as powerful as a small computer that you have on a smart phone nowadays essentially, but that was a first electronic machine essentially.

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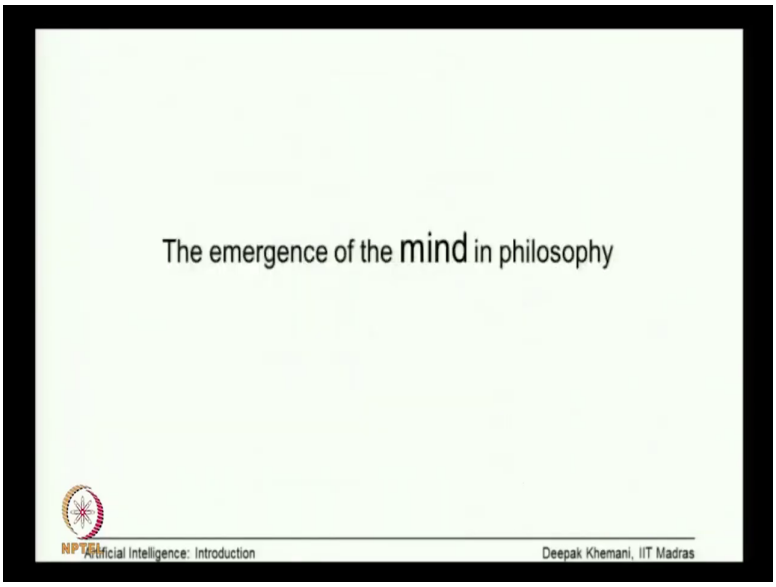

So, with that we come to the end of the first part, which is the mechanical side of this thing. So, we will take a small break and come back with the second question, which is this notion of mind and philosophy how did the notion of mind come back in philosophy. So, we will stop for a while and then we will start in about three or four minutes essentially.

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The Notion of Mind in Philosophy