Knowledge Representation

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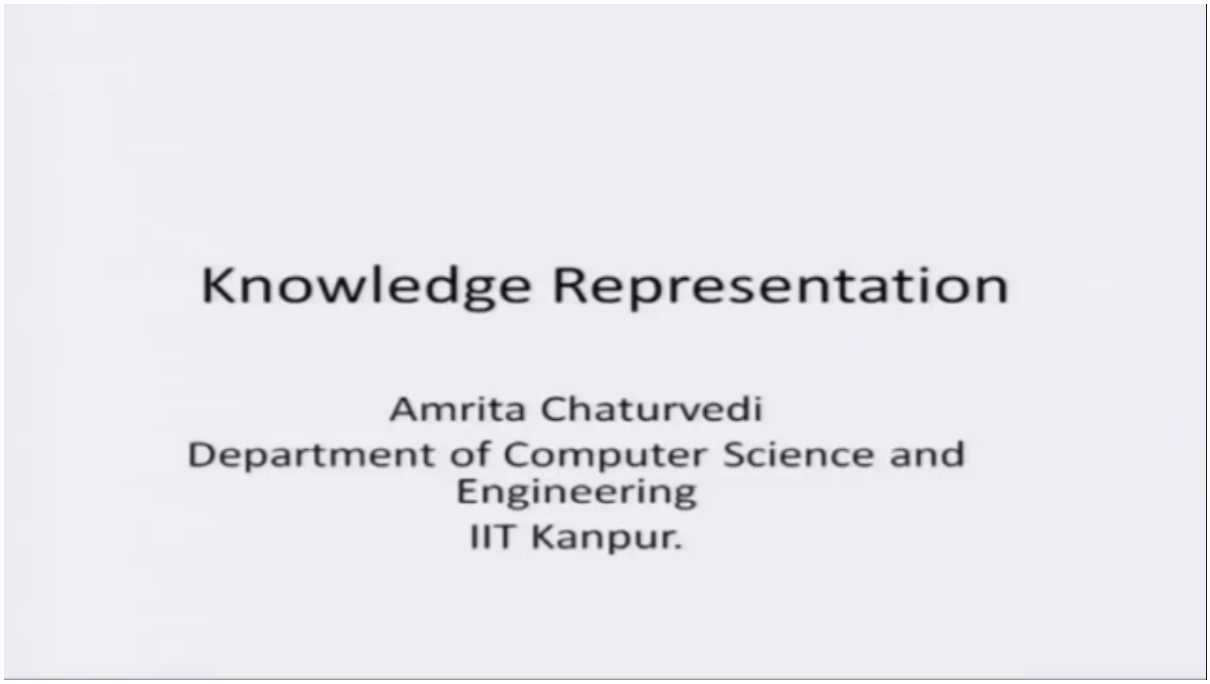

Hello, everyone. Welcome to this video of Knowledge Representation. I am Amrita Chaturvedi from the Department of Computer Science and Engineering at IIT Kanpur.

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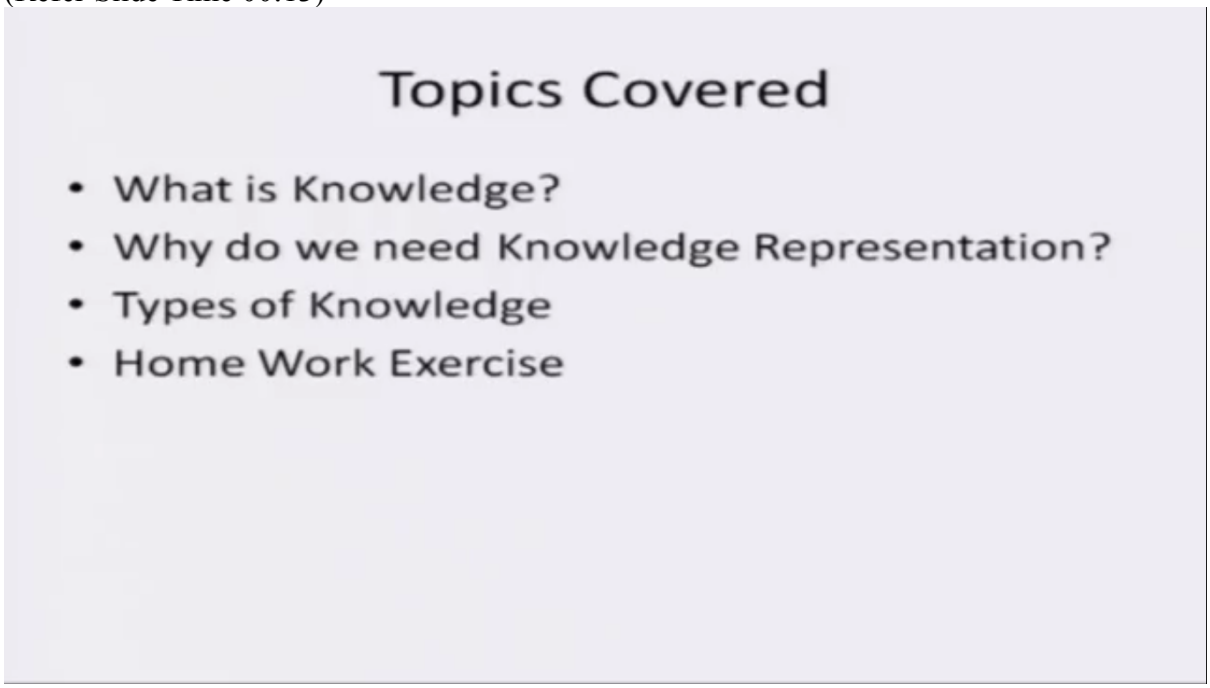

The topics that will be covered in today's video are what is knowledge, why do we need knowledge representation, the different types of human knowledge and finally, some homework exercise for you to do.

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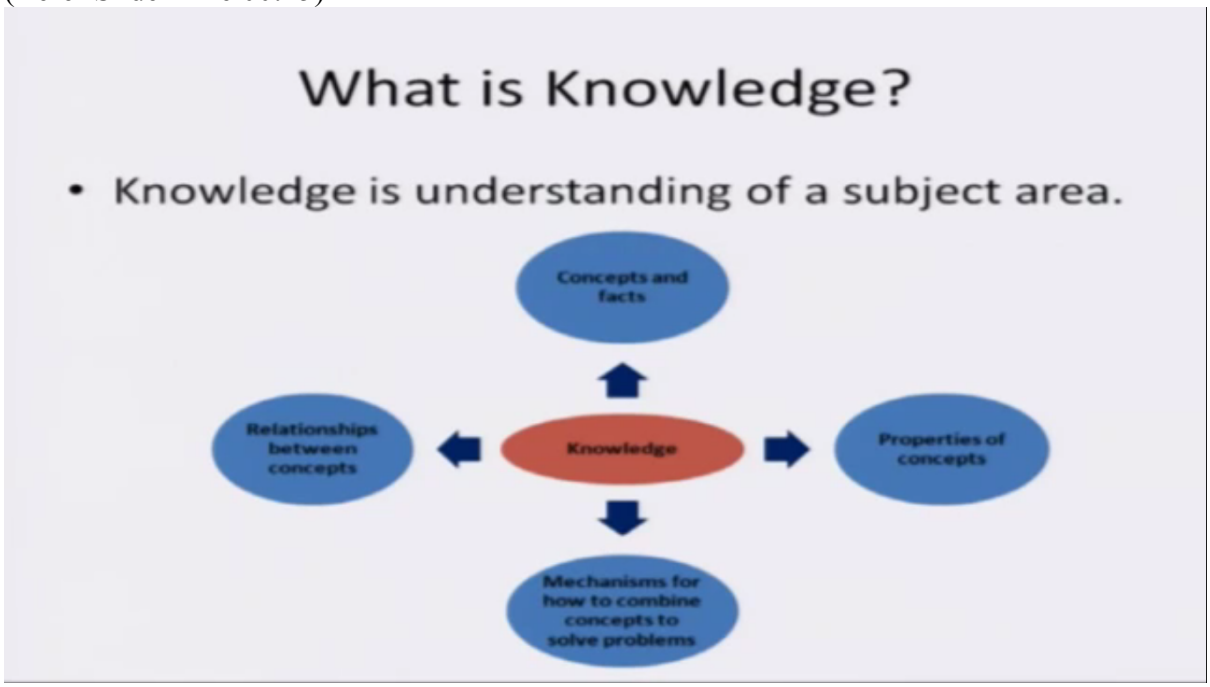

First of all, what is knowledge? Knowledge is understanding of a subject area. Knowledge is the fact, a condition of knowing something.

Now how do we know things? We know them in the form of mental images, concepts, facts, their properties, and relationship between them and also the mechanisms for how to combine the concepts to solve problems.

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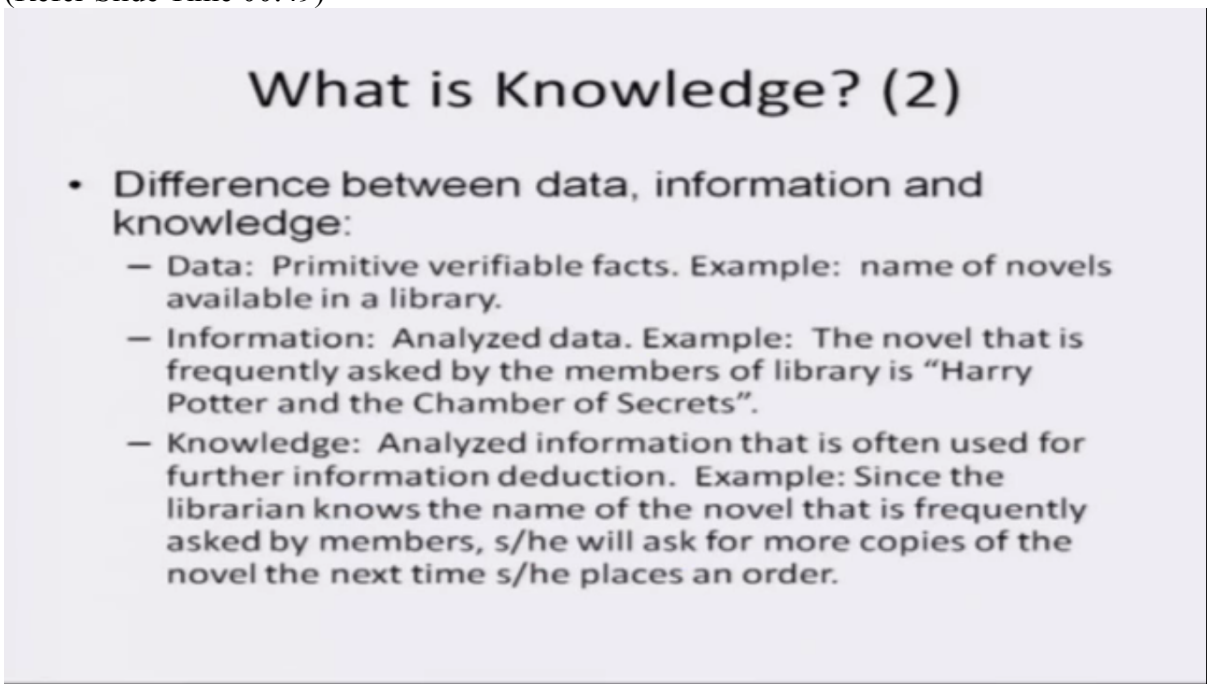

The basic difference between data, information and knowledge: Data is primitive verifiable fact. For example, name of novels available in a library. Information is refined and analyzed data. For example, the novel that is frequently asked by members of library is Harry Potter and the Chamber of Secrets. Now information adds some more value and sense to the data. It enables one to answer some question in a particular context.

What is knowledge? Knowledge is further refined and analyzed information that is often used for further information deduction. For example, now continuing the previous example, since the librarian knows the name of the novel that is frequently asked by members that is Harry Potter and the Chamber of Secrets, she will ask for more copies of the novel the next time she places an order so that all the different requests of the members of the library are fulfilled.

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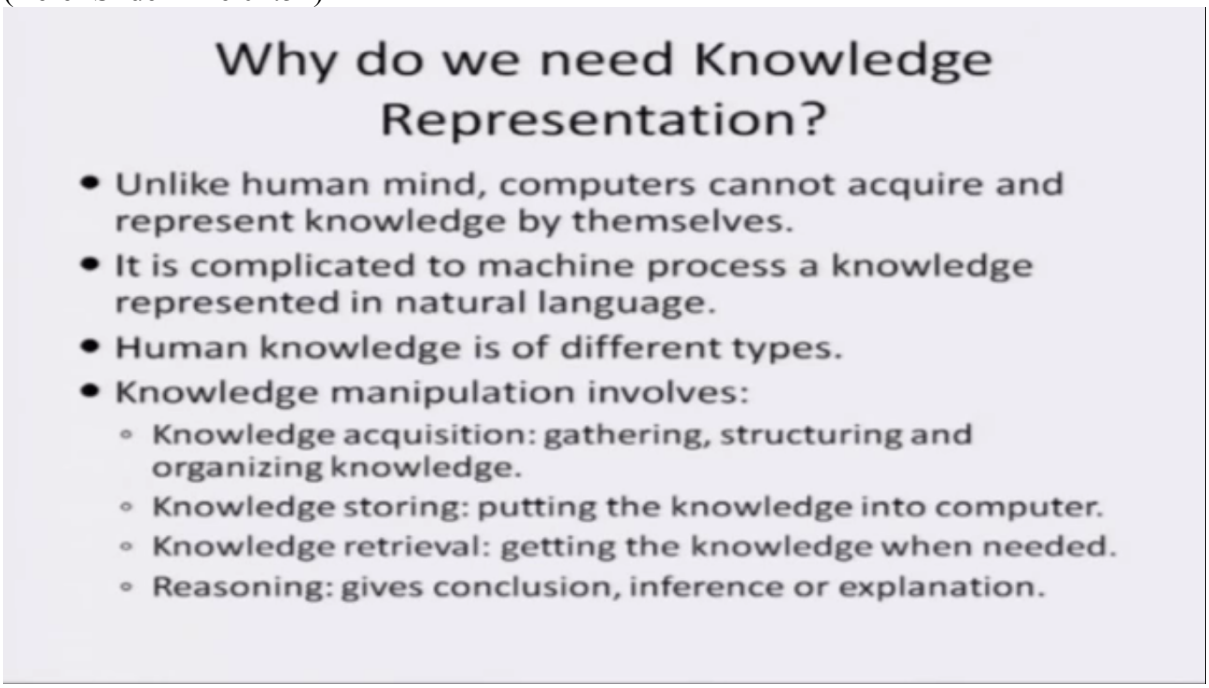

Why do we need knowledge representation? We human beings can directly perceive and acquire knowledge in the form of mental images, objects, properties and the relationships.

For example, consider a person who has never had any experience with a handheld device say a smartphone and she happens to take that device into her hand. She plays with it for a while and memorizes her experience of the device along with its essential features.

Now her -- the brain of the person will automatically store all the essential features of the device and retrieve that knowledge the next time she takes that device into her hand. Not only that, if the person has already had an experience with some desktop or a laptop computer, she may very easily get along with the device by automatically reasoning the possible features of the device.

Now this capability is not there with the computers. They rely on human beings to put knowledge into their memory. We, therefore, have to decide -- design some suitable

knowledge representation techniques that can represent the knowledge into the computer memory.

It is complicated to machine process our knowledge represented in natural language. Human language is of different types. Therefore, it is essential to suitably design some knowledge representation techniques to efficiently represent the human knowledge into the computer memory.

Knowledge manipulation involves these activities: first of all, knowledge acquisition. It is the process of gathering, structuring and organizing knowledge of a particular topic or a domain in order to prepare it to be put into the computer memory. Knowledge storing is the process of putting the knowledge into the computer in a suitably encoded format. Knowledge retrieval is the inverse process of getting the knowledge back whenever it is needed. Reasoning, this is the most important part of knowledge representation. It includes deriving new knowledge from the existing knowledge by means of an intelligent program. The newly derived knowledge is known as conclusion, inference or explanation.

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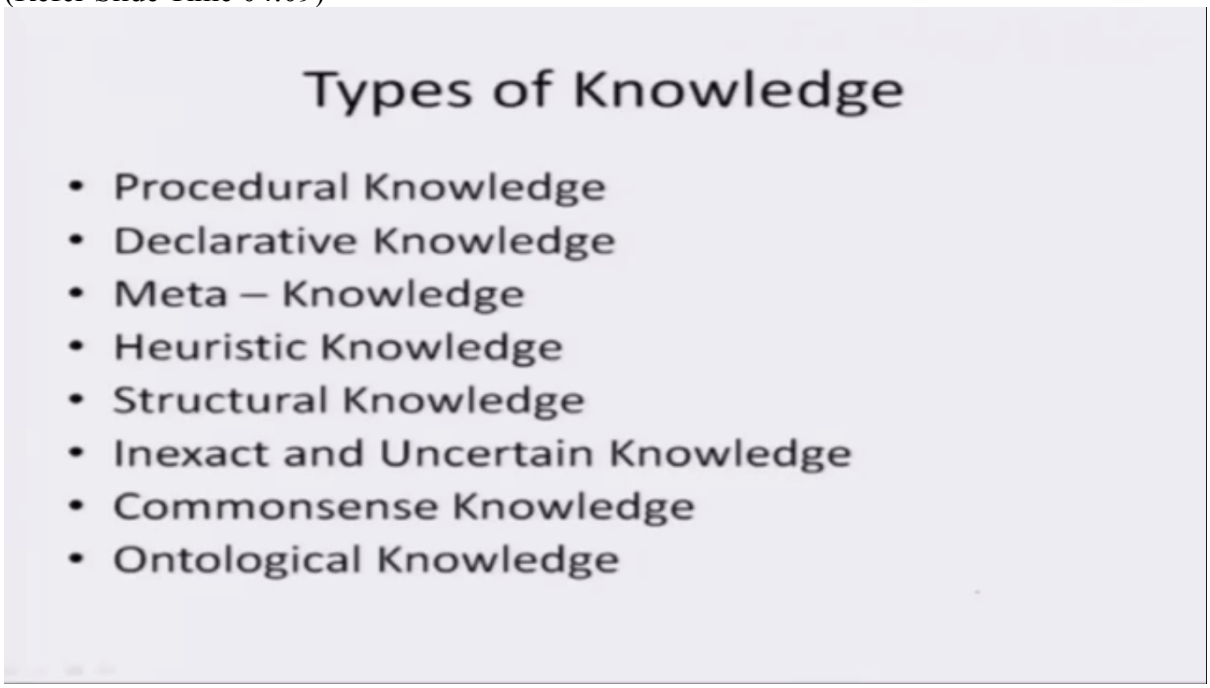

The different types of human knowledge are procedural, declarative, meta-knowledge, heuristic, structural, inexact and uncertain knowledge, commonsense knowledge and ontological knowledge. We will be discussing each one of them very briefly.

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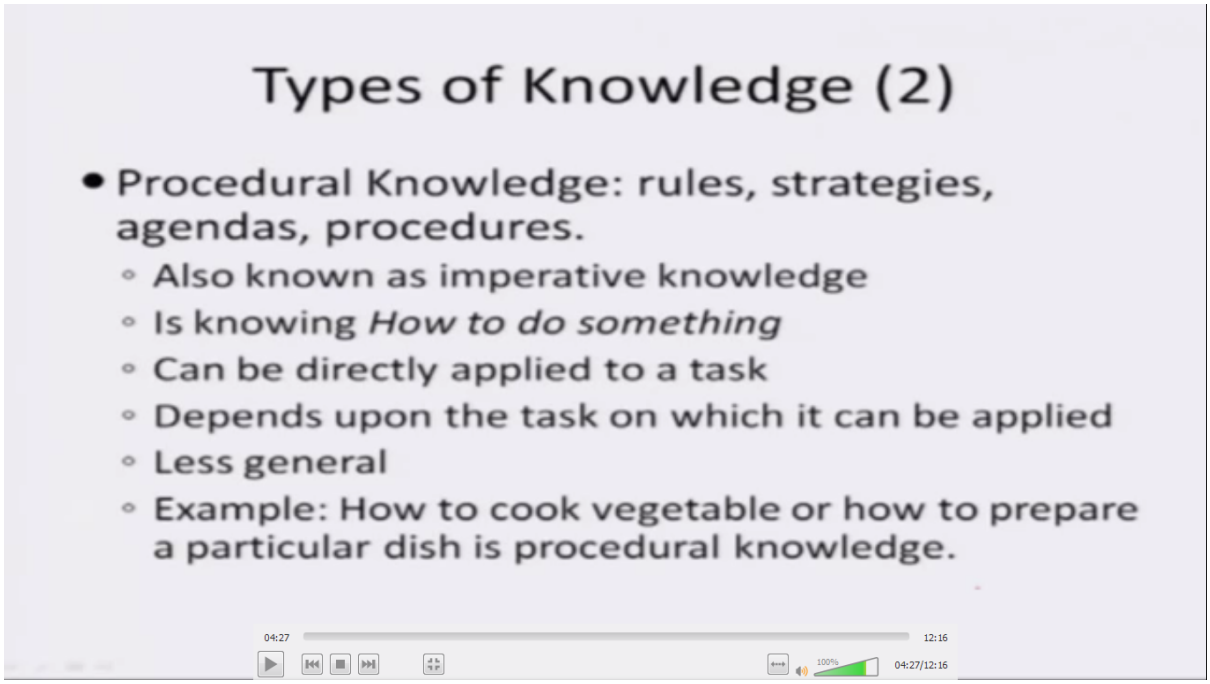

First of all, the procedural knowledge. It includes rules, strategies, agendas and procedures. It is also known as imperative knowledge. It is actually knowing how to do something or a particular task. It can be directly applied to a task. It also depends upon the task on which it can be applied. For example, how to cook vegetable or how to prepare a particular dish is procedural knowledge.

Now the sequence of steps that are required to be done to cook a vegetable are very much task dependent. They cannot be applied to do some other task, for example, bake a cake, for instance. So this knowledge is very much task dependent and hence is less general.

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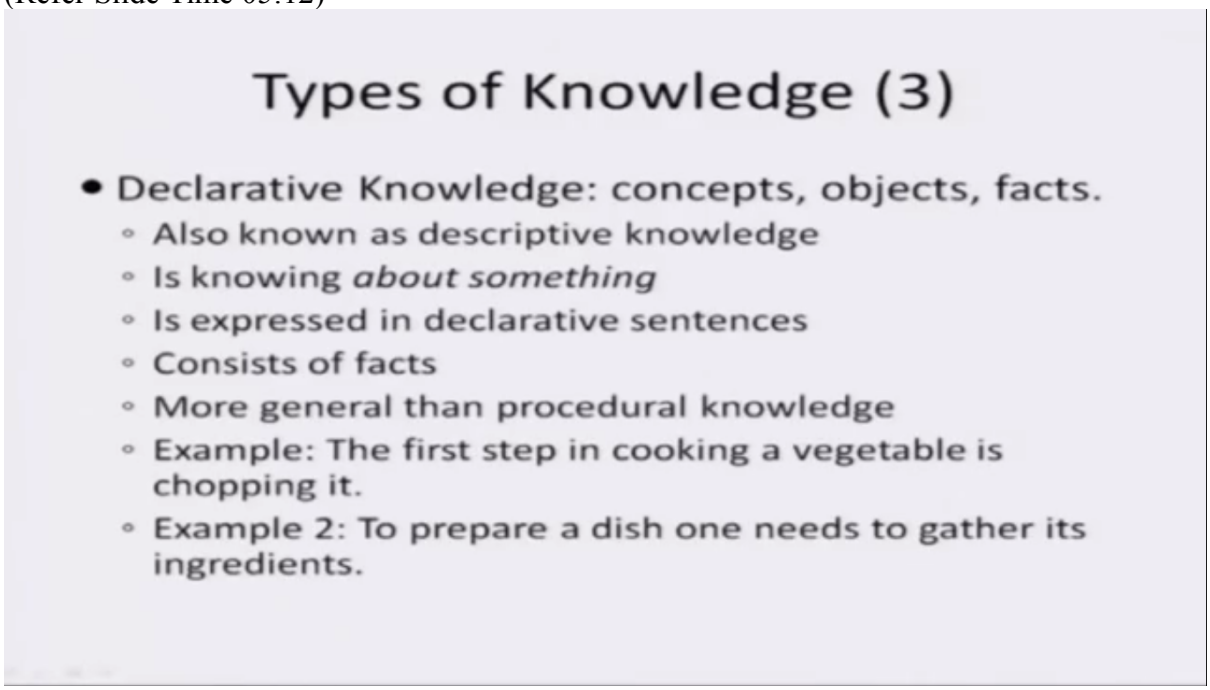

Declarative knowledge. It includes concepts, objects and facts. It is also known as descriptive knowledge. It is knowing about something. It is expressed in declarative sentences and is actually a collection of facts. It is more general than procedural knowledge.

For example, the first step in cooking a vegetable is chopping it. Now this statement is general enough to be applied to cook any vegetable.

Another example is to prepare a dish, one needs to gather its ingredients. Again, this is general enough to prepare any dish and therefore declarative knowledge is more general than procedural knowledge.

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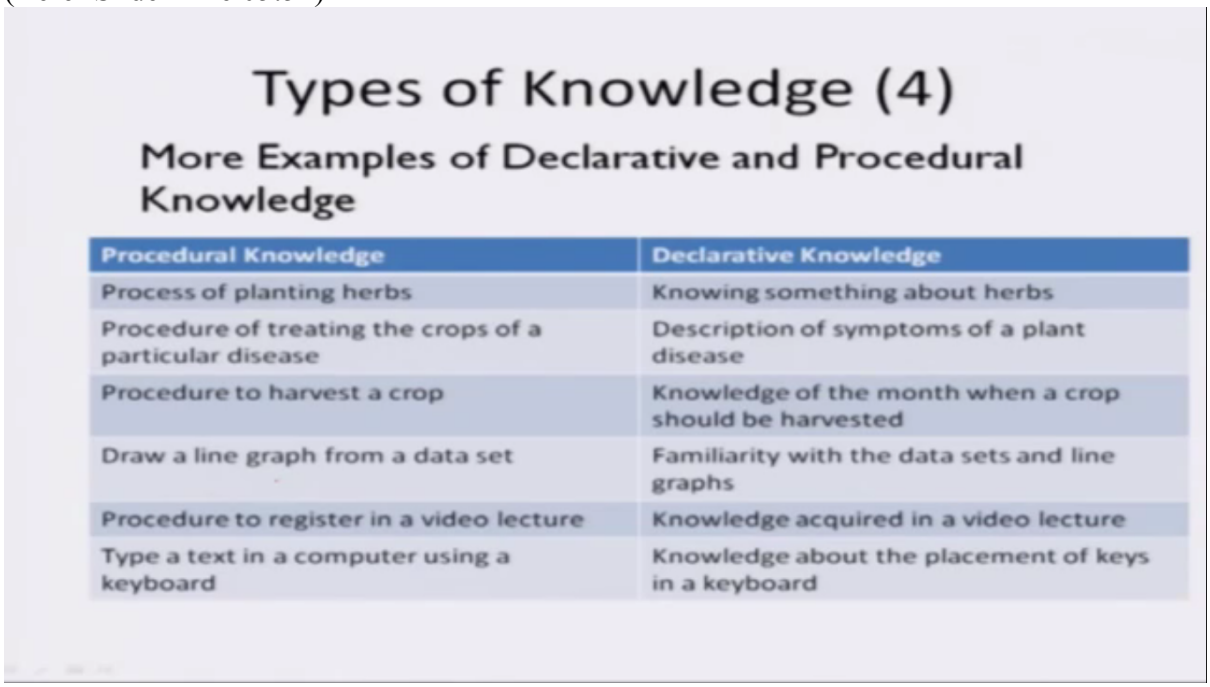

To understand more clearly the difference between declarative and procedural knowledge, let us see some more examples.

For example, process of planting herbs. This is a sequence of steps, for example, collecting the different seeds, sowing them into the soil and then watching them appropriately. Since it consists of a sequence of actions, this is procedural knowledge. But knowing about herbs, this is a collection of facts and hence is declarative knowledge.

Procedure of treating the crops of a particular disease, now this treatment process is a step by step process and hence is procedural knowledge. But description of symptoms of a plant disease is a collection of facts and is therefore declarative knowledge.

Procedure to harvest a crop, this is a sequence of actions to be done and is therefore procedural knowledge. But knowledge of the month when a crop should be harvested is a fact and is therefore declarative knowledge.

Draw a line from a dataset. This includes a set of actions, for example, plot the data points onto the graph and then join the points with a line. Since this is a sequence of action, this is

procedural knowledge. But familiarity with the datasets and line graphs, this is a collection of fact and hence is declarative knowledge.

Procedure to register in a video, this includes sequence of actions to be done to register oneself in a video lecture and is therefore procedural knowledge. But knowledge acquired in a video lecture is a collection of facts and is therefore declarative knowledge.

Type a text in a computer using keyboard involves a sequence of actions of typing into the character -- into the keyboard and is therefore procedural knowledge. But knowledge about the placement of keys in a keyboard is declarative knowledge.

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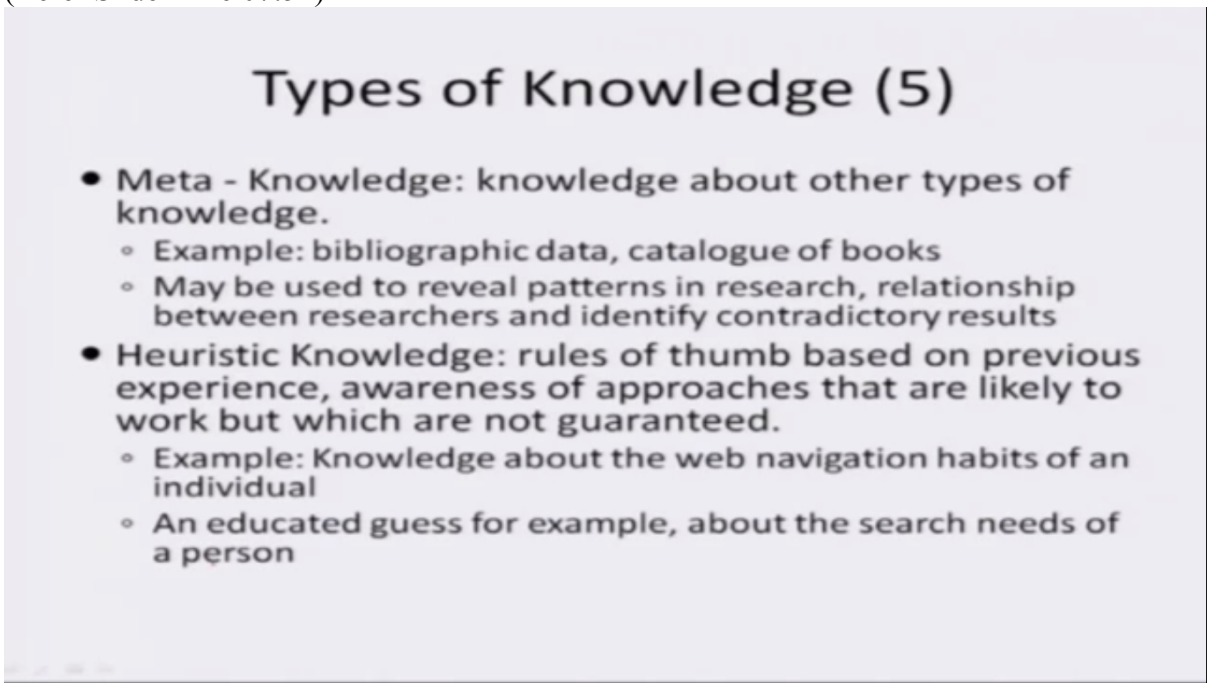

Now meta-knowledge. It is knowledge about other types of knowledge. It establishes relationship between different pieces of knowledge and also enables one to use that knowledge. For example, bibliographic data, catalogue of books. Now the relationship established in bibliographic data can be used to reveal patterns in research, relationship between researchers and also identify contradictory results in researches.

Heuristic knowledge involves rules of thumb of first principles that guide the problem-solving process based on previous experience, individual intuition and skills, and deep understanding of the problem domain. However, the problem-solving based on heuristic knowledge is not guaranteed to be successful. For example, knowledge about the web navigation habits of an individual, an educated guess about the search needs of a person.

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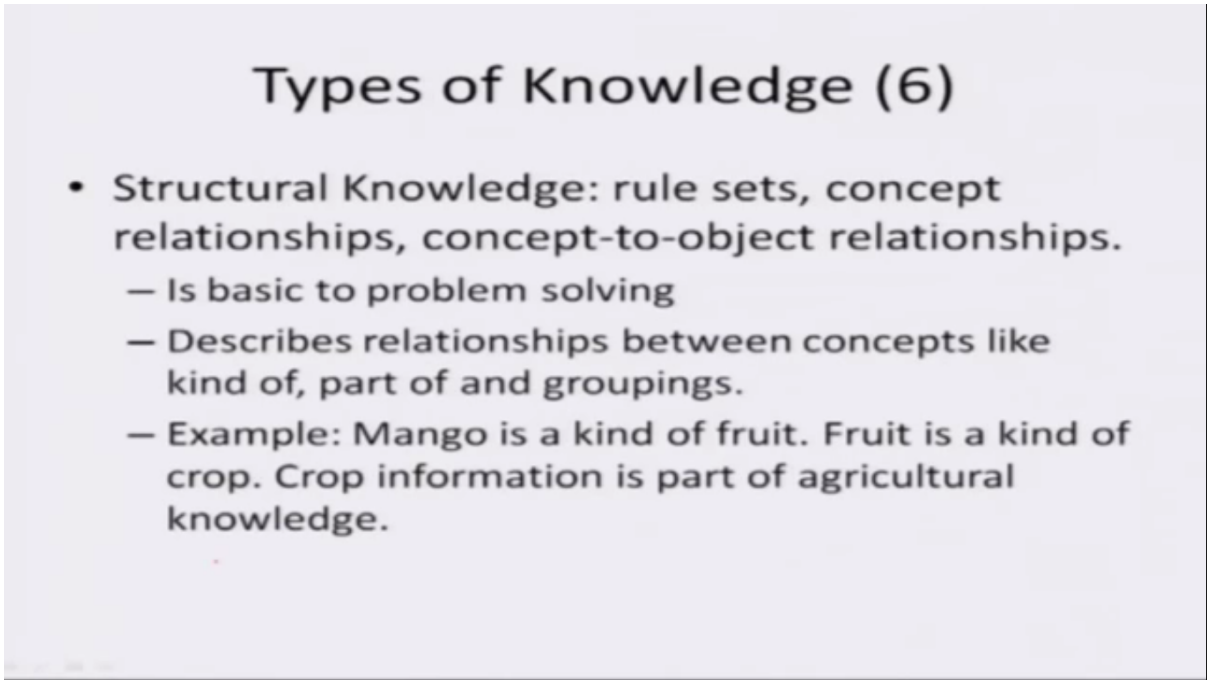

Structural knowledge. It includes rule sets, concept relationships, concept-to-object relationships. It is basic to problem solving and describes relationships between concepts like kind of, part of and other relationships that may enable one to group the concepts.

For example, mango is a kind of fruit. Here mango and fruit are concepts and kind of is a relationship. Fruit is a kind of crop. Here fruit and crop are concepts and kind of is a relationship. Crop information is part of agricultural knowledge. Here crop information and agricultural knowledge are concepts and part of is the relationship.

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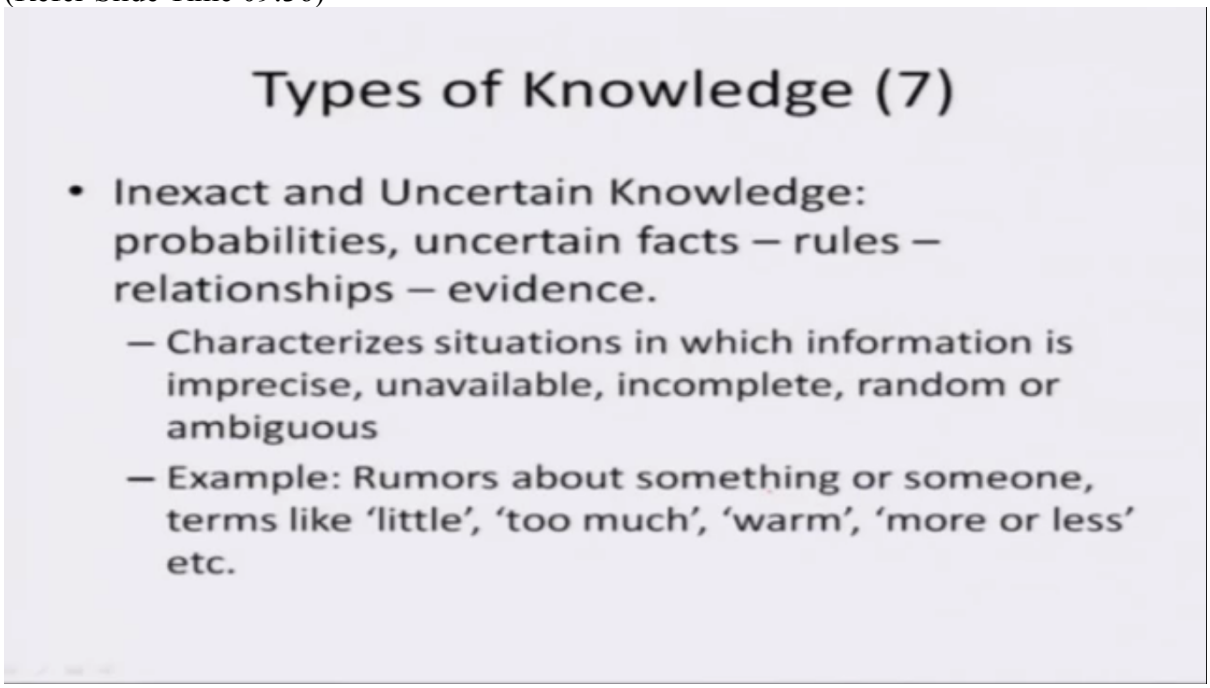

Inexact and uncertain knowledge. It includes probabilities, uncertain facts, rules, relationships and evidence. It characterizes situations in which information is imprecise, unavailable,

incomplete, random or ambiguous. For example, rumors about something or someone, terms like little, too much, warm, more or less etc.

For example, I may say that this glass of milk is a little hot. This statement does not tell anything about the temperature of the glass of milk. I may say that this room is more or less spacious. It does not give any information about the dimensions of the room. Also if I say that the news is more or less correct, this shows that I'm not sure whether the news is correct or not. All these are examples of inexact and uncertain knowledge.

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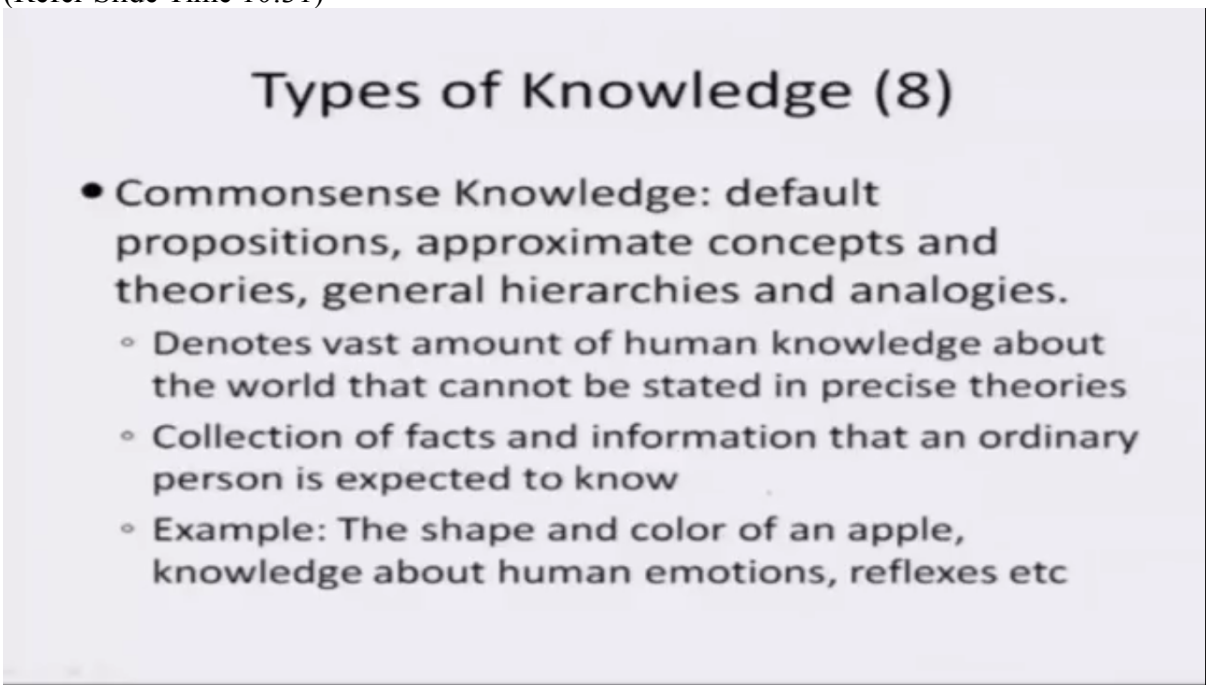

Commonsense knowledge. It is default propositions, approximate concepts, theories, general hierarchies and analogies. It denotes the vast amount of human knowledge that is acquired by experience and that cannot be stated in precise theories.

Collection of facts and information that an ordinary person is expected to know. For example, the shape and color of an apple, knowledge about human emotions, reflexes etc. For example, whenever you see a person, you can very easily say whether that person is happy, sad or angry. So this knowledge about the human emotions is deeply ingrained in our minds and hence is commonsense knowledge.

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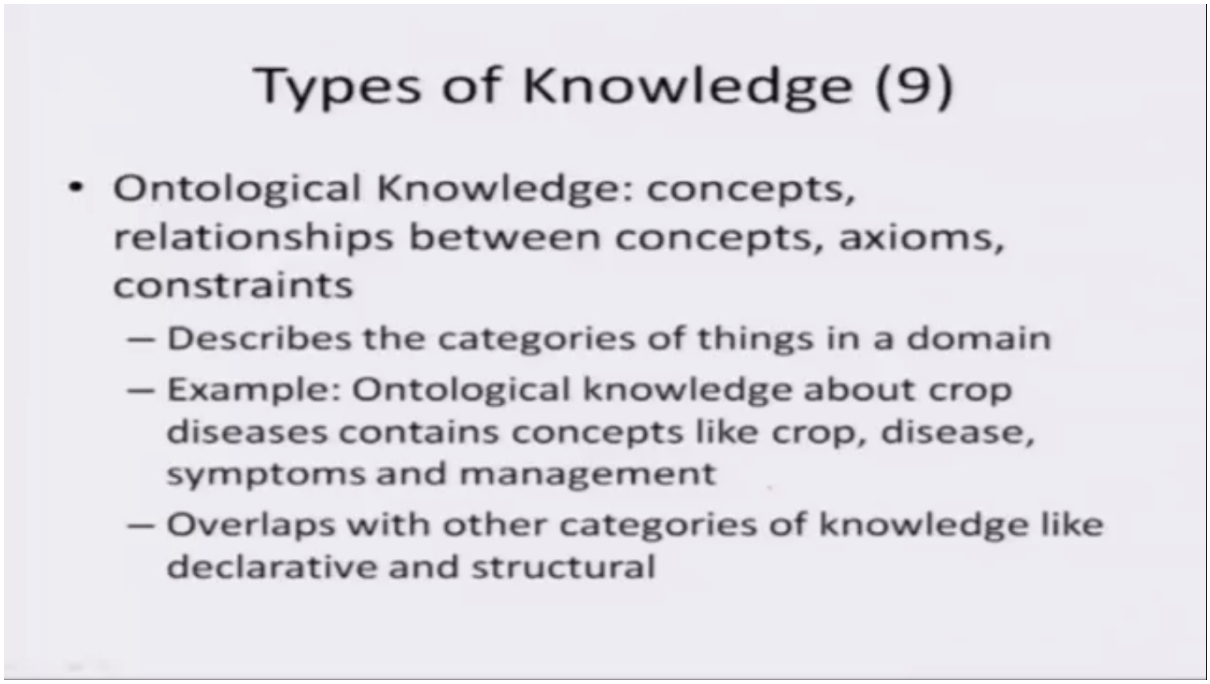

Ontological knowledge. It includes concepts, relationships between concepts, axioms and constraints. It describes the categories of things in a domain. For example, ontological knowledge about crop diseases contains concepts like crop, disease, symptoms and management.

It overlaps with other categories of knowledge like declarative and structural. Ontological knowledge is therefore both declarative and structural.

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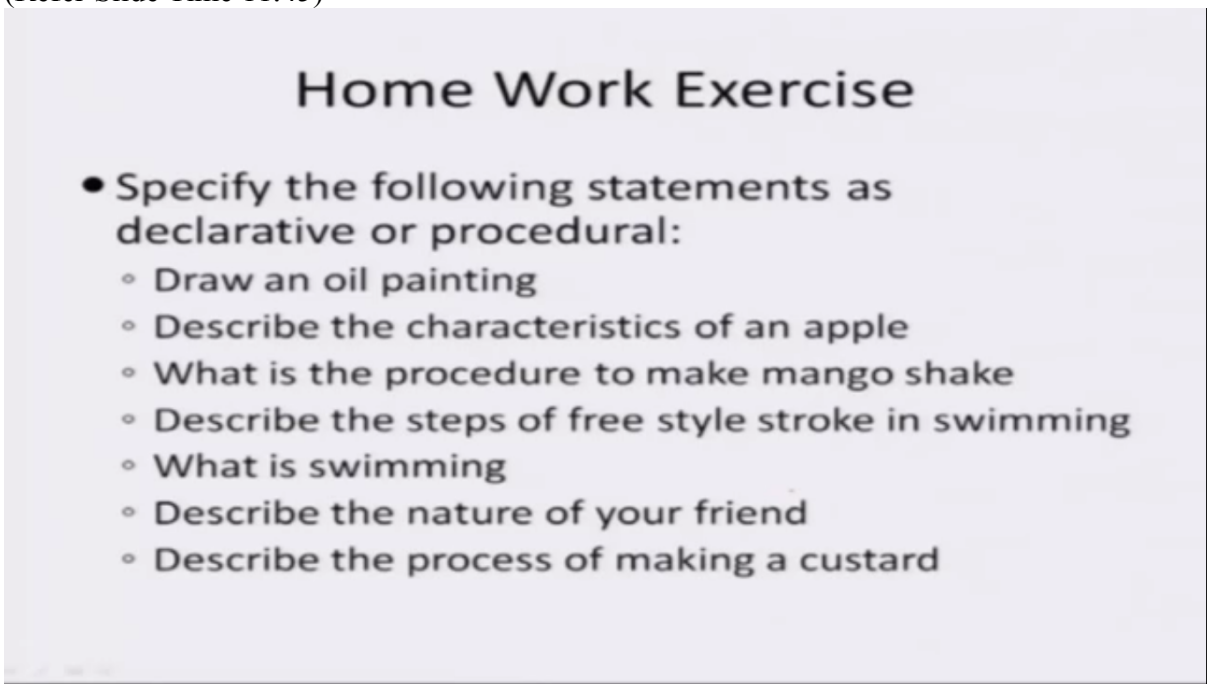

These are some homework exercise for you to do. Specify the following statements as declarative or procedural: draw an oil painting, describe the characteristics of an apple, what is the procedure to make mango shake, describe the steps of freestyle stroke in swimming,

what is swimming, describe the nature of your friend, describe the process of making a custard.

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That will be all for today. Thank you so much for attending this lecture.