INDIAN INSTITUTE OF TECHNOLOGY MADRAS

सिद्धिर्भवति कर्मजा

IIT Madras

ONLINE DEGREE

Computational Thinking
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Introduction to Complex Data Types

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Records and Lists

So, far what we have seen is basically some basic data types the basic data types where a Boolean which has true and false values, integers which have negative 0 or positive values and the character data type and we saw subtypes of this, various subtypes of this and then we made this data type called strings which was the sequence of characters and then we saw lot of subtypes of the strings data type.

Now, I am going to introduce two more complex or some ways of putting together all these data types together in a kind of a package, or a bundle. So, we have two ways of bundling.

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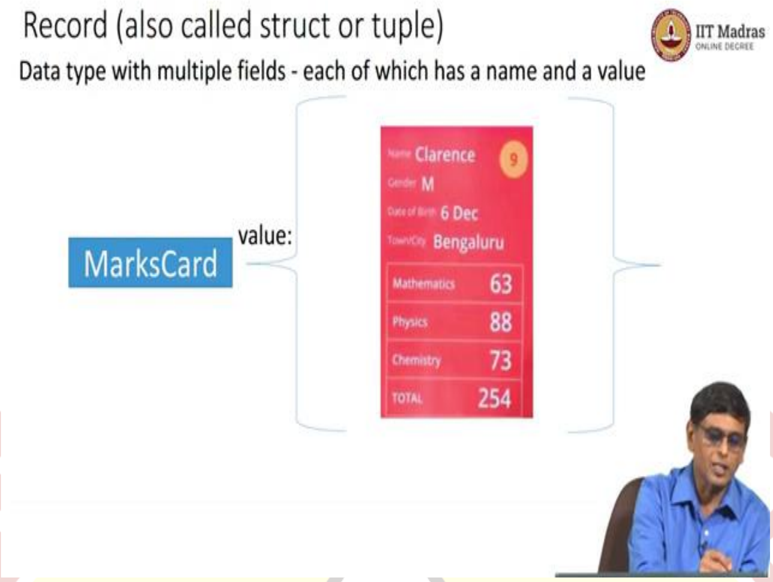

Record (also called struct or tuple)

Data type with multiple fields - each of which has a name and a value

And one way of bundling is what is called a record, so sometimes in some programming languages it is called struct, in C and C++ it is called struct, or sometimes it may be called a class, or it might in mathematics we like to call it a tuple but, the record basically is just a data set or basically data item which has a number of elements and these elements are called fields.

So, for example we saw the marks card so, if you look at the marks card what I have shown in the figure here it had basically this number 9 which is the sequence number it had a name, it had a gender, it had a date of birth, city and the various marks, so this has these fields. These are the fields of this marks card.

So, how do we represent the entire marks card as one data item? How do you represent, what is the data type of this marks card? So, the value, the valid values the range of values or the valid values that the marks card can take is not, cannot be, you cannot write it down independent of the values that, the fields can take.

So, you are basically trying to define what are the fields in this particular data item, and what are the values that fields can take. So, it is enough to basically write down all the fields and the data types of those fields. And that is what I have attempted to do, for this particular card.

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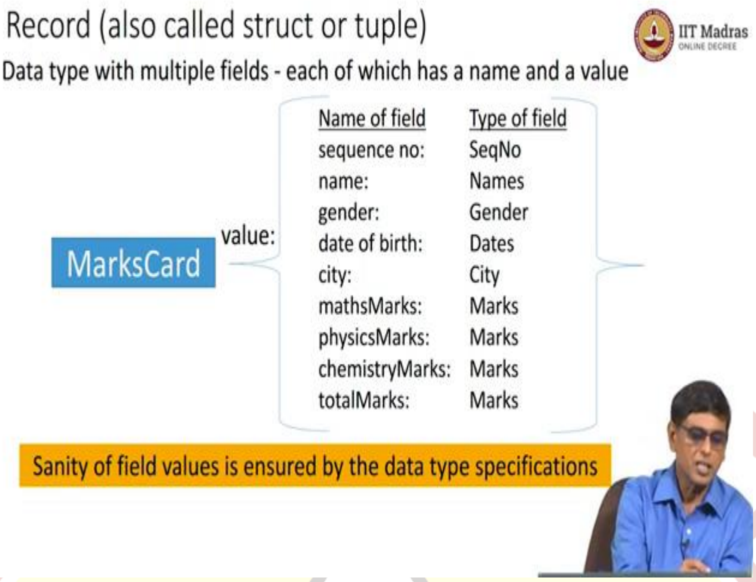

Record (also called struct or tuple)

Data type with multiple fields - each of which has a name and a value

MarksCard value:

Name of field	Type of field
sequence no:	SeqNo
name:	Names
gender:	Gender
date of birth:	Dates
city:	City
mathsMarks:	Marks
physicsMarks:	Marks
chemistryMarks:	Marks
totalMarks:	Marks

Sanity of field values is ensured by the data type specifications

So, if you recall we had the sequence number and we have already defined the correct type of data type for sequence number which was SeqNo, so I can write sequence number, sequence number data type, name is of the names data type, gender is of the gender data type, date of birth is of the dates data type, cities of the city data type and these marks are of the marks data type. So, basically the marks card is a record, it is a record data type which contains various fields, and each of these fields has a specific data type.

So, the values for each of these fields is constrained by the kind of data type that you are defining for that particular field. So, the sanity of this card, the marks card is ensured because, you have defined the fields data types, so that is how the sanity is ensured.

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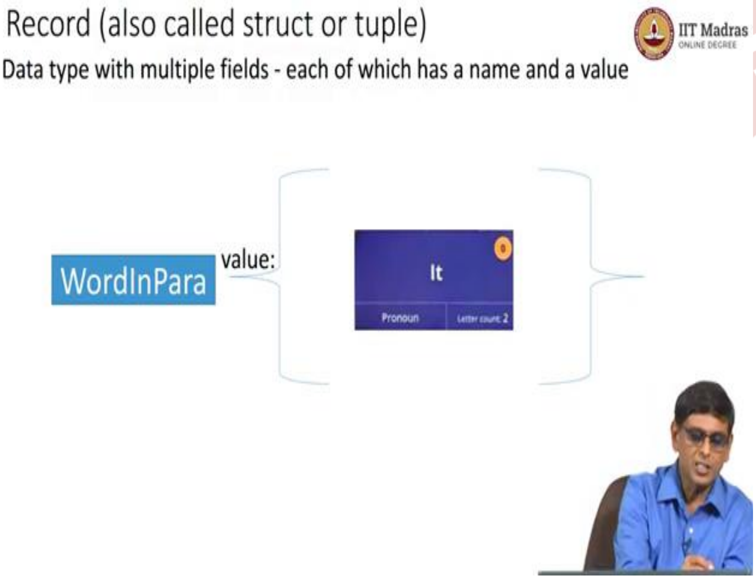

Record (also called struct or tuple)

Data type with multiple fields - each of which has a name and a value

WordInPara value:

Now we can look at the second data type that we had which is the words which are, words in the paragraph that we had, for example we had this word called It, which is the pronoun, it had two letters and we had the sequence number 0. So, there are clearly 1 2 3 4 fields in this data type, this is a record with 4 fields, and what are those 4 fields?

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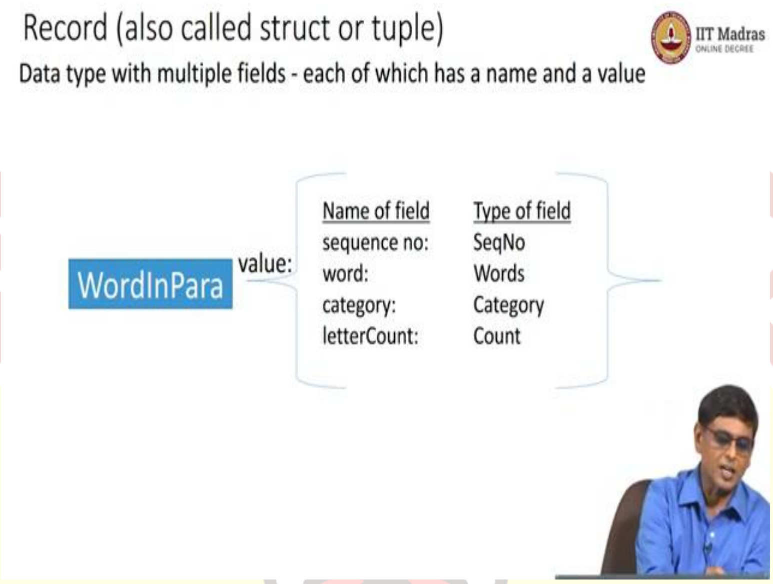

Record (also called struct or tuple)

Data type with multiple fields - each of which has a name and a value

WordInPara value:

Name of field	Type of field
sequence no:	SeqNo
word:	Words
category:	Category
letterCount:	Count

Sequence number is obviously of sequence number type the word which is in the card is of the words data type. The category which is pronoun proposition and so on is of the category data type and the letter count is of a count data type. So, we have already defined the sub types that we need for writing the data type for all the fields in this card.

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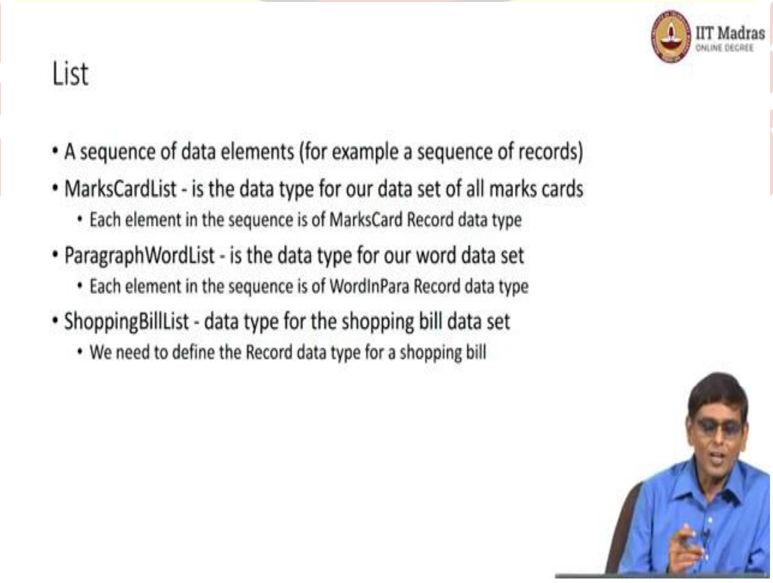

List

- A sequence of data elements (for example a sequence of records)
- MarksCardList - is the data type for our data set of all marks cards
    - Each element in the sequence is of MarksCard Record data type
- ParagraphWordList - is the data type for our word data set
    - Each element in the sequence is of WordInPara Record data type
- ShoppingBillList - data type for the shopping bill data set
    - We need to define the Record data type for a shopping bill

Finally, if we look at the, set of all the marks cards, if I add the bunch of all the marks cards, is there a data type that can basically, that can represent that? Now, because I can write for one card I can write a record, but for the entire list, or the entire set of cards I need something else.

So, sequence of data elements is called a list, so you can make the list which list is basically, is the sequence of just like a string basically the sequence of characters so a string is also in principle of list. So, the sequence of data elements is a list, for example a sequence of records, so a marks card list is just a sequence of marks card record data types.

A paragraph word list is just a sequence of WordInPara record data type. So, the set of all the marks cards, is a marks card list, the set of all the words in the paragraph is a paragraph word list and similarly the set of all shopping bills, is the shopping bill list. Of course I have not told you what the record data type for the shopping bill is. So, let us look at that.

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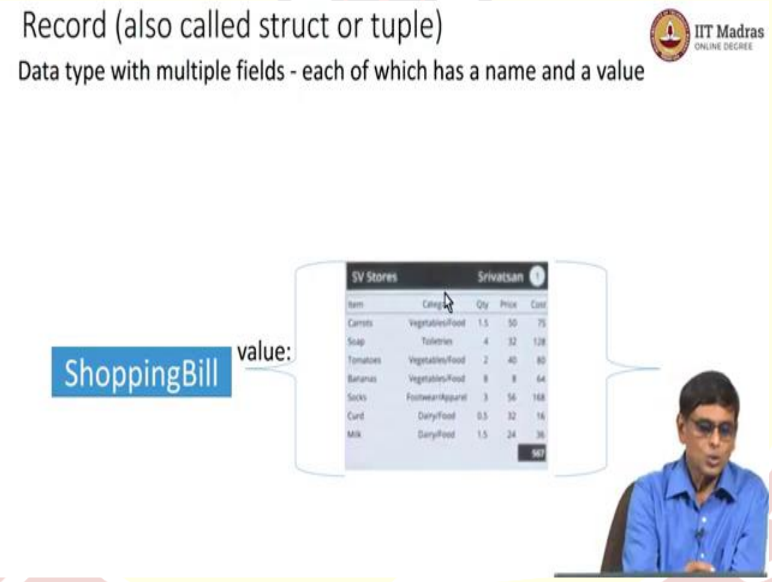

Record (also called struct or tuple)

Data type with multiple fields - each of which has a name and a value

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Item	Categ	Qty	Price	Cost
Carrots	Vegetables/Food	1.5	50	75
Soap	Toiletries	4	32	128
Tomatoes	Vegetables/Food	2	40	80
Bananas	Vegetables/Food	8	8	64
Socks	Footwear/Apparel	3	56	168
Curd	Dairy/Food	0.5	32	16
Milk	Dairy/Food	1.5	24	36
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How do we do the record for the shopping bill? Now, if you look at the shopping bill again it looks like you have the name of the shop, you have the name of the customer you have a sequence number and you have a total amount. Besides that you also have a list of items. Now, the complication comes because of the list of items, this is the name, this is also a name , this is the sequence number and this is an amount. So, all of these I can capture but, this again I do not know how many items will be there in this list.

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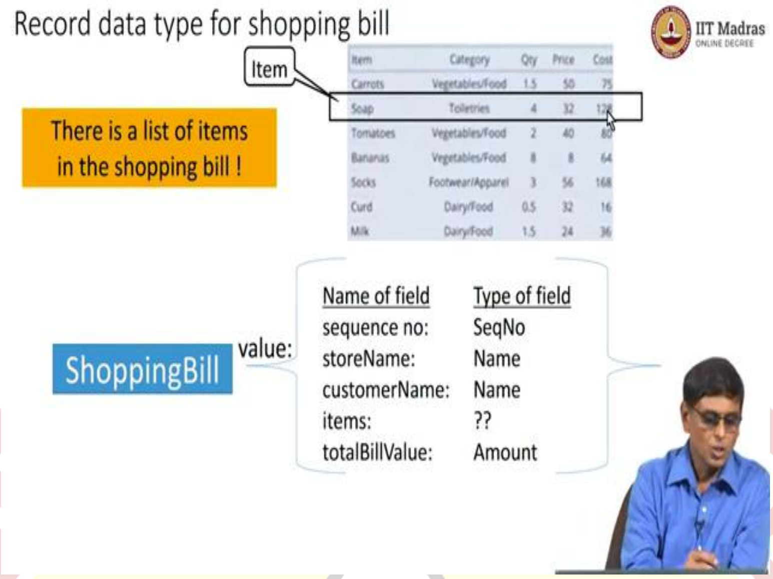

Record data type for shopping bill

Item	Category	Qty	Price	Cost
Carrots	Vegetables/Food	1.5	50	75
Soap	Toiletries	4	32	128
Tomatoes	Vegetables/Food	2	40	80
Bananas	Vegetables/Food	8	8	64
Socks	Footwear/Apparel	3	56	168
Curd	Dairy/Food	0.5	32	16
Milk	Dairy/Food	1.5	24	36

Item

There is a list of items in the shopping bill !

ShoppingBill value:

Name of field	Type of field
sequence no:	SeqNo
storeName:	Name
customerName:	Name
items:	??
totalBillValue:	Amount

So, let me take a first pass, at making this record so, I have the sequence number which is sequence number data type, store name which is the name data type, customer name which is the name data type, total bill value which is an amount data type. And then there are items in the shopping bill whose data type I do not know how to define?

Why don't I know how to define? Because I do not know how many, there may be many elements in it, that is why I do not know how to define it. But, it looks like because, there are a sequence of elements there, it looks like it is a list, so something like a list should be put here. Now, when you say list, it has to be a list of something, so what is it a list of, it has to be a list of these items, one row is an item, we have a list of such items.

So, if we take one item and make a record data type out of it, then it will be a list of that record. So, what does one item look like? It has basically the item name, it has a category name, it has quantity, it has price, and it has the cost.

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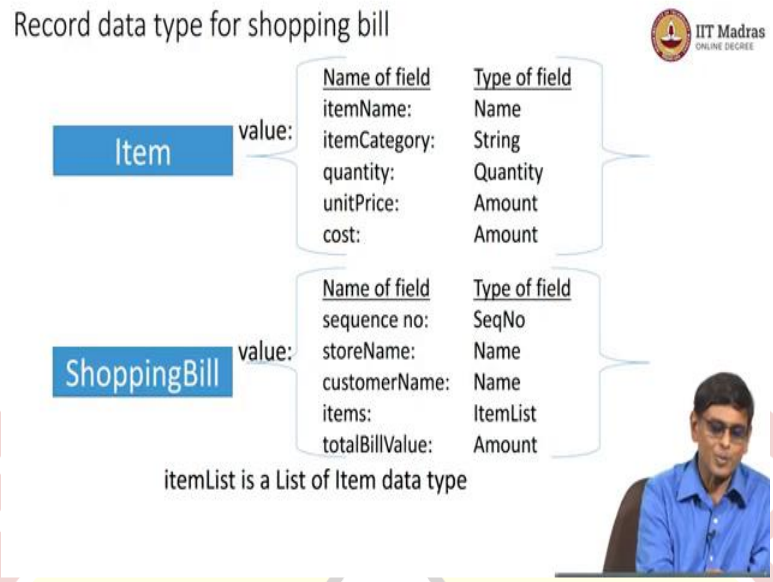

Record data type for shopping bill

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Item value:

Name of field	Type of field
itemName:	Name
itemCategory:	String
quantity:	Quantity
unitPrice:	Amount
cost:	Amount

ShoppingBill value:

Name of field	Type of field
sequence no:	SeqNo
storeName:	Name
customerName:	Name
items:	ItemList
totalBillValue:	Amount

itemList is a List of Item data type

So, I can try and define the data type for that. So, I have the item name which is of the name data type, item category which is string data type, quantity which is quantity data type, unit price which is an amount and cost which is also an amount and once I have defined a data type for an item then I can go back here, and fill this as a list of items. Item list is just a list of item data type.

So, in this way I have basically created a record data type for shopping bill. So, note that the record data type for shopping bill contains a number of fields, one of those fields is a list, that list basically is a list of records, so basically it is a record of a list which contains a field which is the list of another record which is item, which in turn has a number of fields.

So, it is a little bit more involved data type, and as we go long we will be seeing such hierarchy of data types that we can build. Which is basically putting together basic data types to create more, complex data types then working through those complex data types to do, solving our problems.

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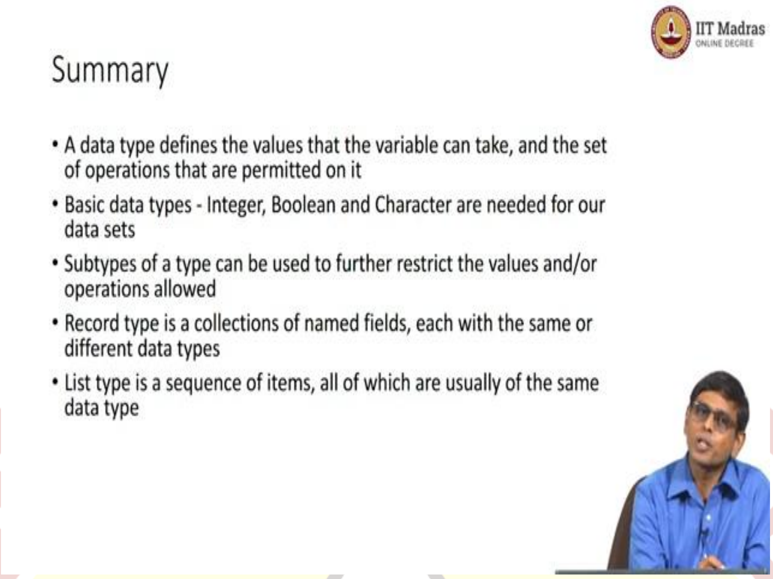

Summary

- A data type defines the values that the variable can take, and the set of operations that are permitted on it
- Basic data types - Integer, Boolean and Character are needed for our data sets
- Subtypes of a type can be used to further restrict the values and/or operations allowed
- Record type is a collections of named fields, each with the same or different data types
- List type is a sequence of items, all of which are usually of the same data type

So to summarize, a data type defines values that a variable can take, and the set of operations that are permitted on it. The basic data types that we saw were integer, Boolean, and character that is what we saw for our data sets that what we needed for our data sets.

The subtypes, of a type basically are used to further restrict the values or operations that can be performed on a data type. A record type is a collection of named fields, each of those fields may have the same or could be different data types. For example, when we saw the marks card data type, it had basically different fields, all the fields had very different values but, the marks if we look Physics, Maths, Chemistry and total marks, they were all of the same data type but all the other fields name and date and all had different other types of data types.

But list if you take the list data type, typically the data type of all the elements in the list are usually the same because, it is not necessary you could also make a list of different data types, but usually most of the times, we will see list in which all the elements in the list are all of the same data type. So, list is just a sequence of elements all of which have the same data type.

So, with that we end this lecture on data types and how to use the data types to constrain the values and to constrain the operations that can be performed on them.