GALGOTIAS UNIVERSITY

## School of Computing Science and Engineering

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# PL/SQL Composite data type - Collections (Associative array, VARRAY and Nested Tables )

A composite data type stores values that have internal components and internal components can be either scalar or composite.

Internal components can be of same data type and different data type.

PL/SQL allows us to define two kinds of composite data types:

1. Collection - The internal components must have the same data type and access each element of a collection variable by its unique index, **Syntax: variable_name(index).**

2. Record - The internal components can have different data types and access each field of a record variable by its name, **Syntax: variable_name.field_name**.

# Collections in PL/SQL

Oracle provides three types of collections.

1. Index-by Table(associative array),
2. Nested Tables, and
3. VARRAY.

All these collections are like a single dimension array. Syntax of collection declaration:-

```
TYPE  type  IS  -- type is collection variable name, a valid identifier
{  assoc_array_type_def
|  varray_type_def
|  nested_table_type_def
}  ;
```

# Collection can be created in following ways:

**1.** Defines a collection type and then declare a variable of that type.

**2.** Use %TYPE to declare a collection variable of the same type as a previously declared collection variable.

# Associate array(Indexed Tables):-

- Associative array is a set of **key-value pairs** and each key should be unique index.
- The data type of index can be either a string type or PLS_INTEGER.
- Indexes are stored in sort order, not creation order.
- Syntax of associative array type creation :

```
TYPE type IS {
--assoc_array_type_def
TABLE OF datatype [ NOT NULL ]
INDEX BY { PLS_INTEGER | BINARY_INTEGER | VARCHAR2 ( v_size ) |
data_type } };
```

- On combining both collection declaration and associate table type declaration, create associative array and store key value pairs and perform various operation on it.
- Create TYPE of associative array named as address and then create a variable employee_address of TYPE address.

```
DECLARE
--Associative array type indexed by BINARY_NUMBER
TYPE address IS TABLE OF VARCHAR2(200) INDEX BY BINARY_INTEGER
--Associative array variable of type address
employees_address address;
BEGIN
employees_address('01') := 'Hyderabad, INDIA';
employees_address('02') := 'Banglore, INDIA’;
employees_address('03') := 'NY, USA’;

--Collection operations
-- FIRST and NEXT gives first and next element of collection
```

```
DBMS_OUTPUT.PUT_LINE('FIRST and LAST ELEMENT key of collection are '
|| employees_address.FIRST  || ' and '  || employees_address.LAST);
--COUNT()method gives total no of elements in collection
DBMS_OUTPUT.PUT_LINE('Total no of elements in collection ‘
|| employees_address.COUNT);
--EXISTS check for existence of key
IF employees_address.EXISTS(02)  THEN
      employees_address.DELETE(02);
END  IF;
DBMS_OUTPUT.PUT_LINE('Total no of elements in collection after delete ‘
|| employees_address.COUNT);
END;
```

```
==========Sample output===========
FIRST and LAST ELEMENT key of collection are 1 and 3
Total no of elements in collection 3
Total no of elements in collection after delete 2
```

- **VARRAY**:- It is variable-size array and element counts in it can vary from 0 to declared maximum size.

Characteristics of VARRAY:-

- Elements of VARRAY can be accessed by variable_name(index).VARRY index starts from 1 (lowest_index = 1) and it can go up to maximum size of VARRAY.
- As contrast to associative array, **it can be persisted in database table** and order of elements (indexes and element order) remain stable.

- VARRAY has constructor support as contrast to Associative array that does not support collection constructor.
- VARRAY is stored as a single object in a column in database table.(if size of object is more than 4KB then it is stored separately but in same namespace).

# VARRAY creation and its initialization:-

Syntax:

varray_type_def with collection

```
-- size_limit: upper limit of VARRAY(maximum that many elements can be stored)
TYPE type IS { VARRAY | [ VARYING ] ARRAY } ( size_limit )
OF datatype [ NOT NULL ]
```

Consider following sample program which creates a VARRY to store address information of employees and initialize it with constructor.

Here ADDRESS is VARRAY type with upper limit of container 3 and using constructor collection of type ADDRESS created is returned to emp_address.

```
DECLARE
-- VARRAY type declaration of type VARCHAR, upperlimit 3
TYPE ADDRESS IS VARRAY(3) OF VARCHAR2(45);
-- varray variable initialized with constructor of type ADDRESS
emp_address ADDRESS := ADDRESS('HYD,IND', 'NY,USA','BANG,IND’);
BEGIN
DBMS_OUTPUT.PUT_LINE('VARRAY elements count is ‘
        || emp_address.COUNT);
DBMS_OUTPUT.PUT_LINE('Address display - Iteration over VARRAY’);
        --emp_address.FIRST= 1 and emp_address.LAST = 3
```

```
FOR i IN emp_address.FIRST..emp_address.LAST LOOP
      DBMS_OUTPUT.PUT_LINE(i || '. address is ' || emp_address(i));
END LOOP;
DBMS_OUTPUT.PUT_LINE('Modify emp_address VARRAY ‘);
emp_address(1)  := 'Sydney, AUS’;
DBMS_OUTPUT.PUT_LINE('Accessing VARRAY based on index, modified
address is ‘      ||emp_address(1)); -- notice modified value here.
--emp_address.DELETE(2);--Delete operation on VARRAY is not allowed.
END;
```

```
======Sample output=======

VARRAY elements count is 3
Address display - Iteration over VARRAY
1. address is HYD,IND
2. address is NY,USA
3. address is BANG,IND
Modify emp_address VARRAY
Accessing VARRAY based on index, modified address is Sydney, AUS
```

# Where do we use VARRAY:-

If we have prior info of maximum number of elements and we want sequential access of collection.

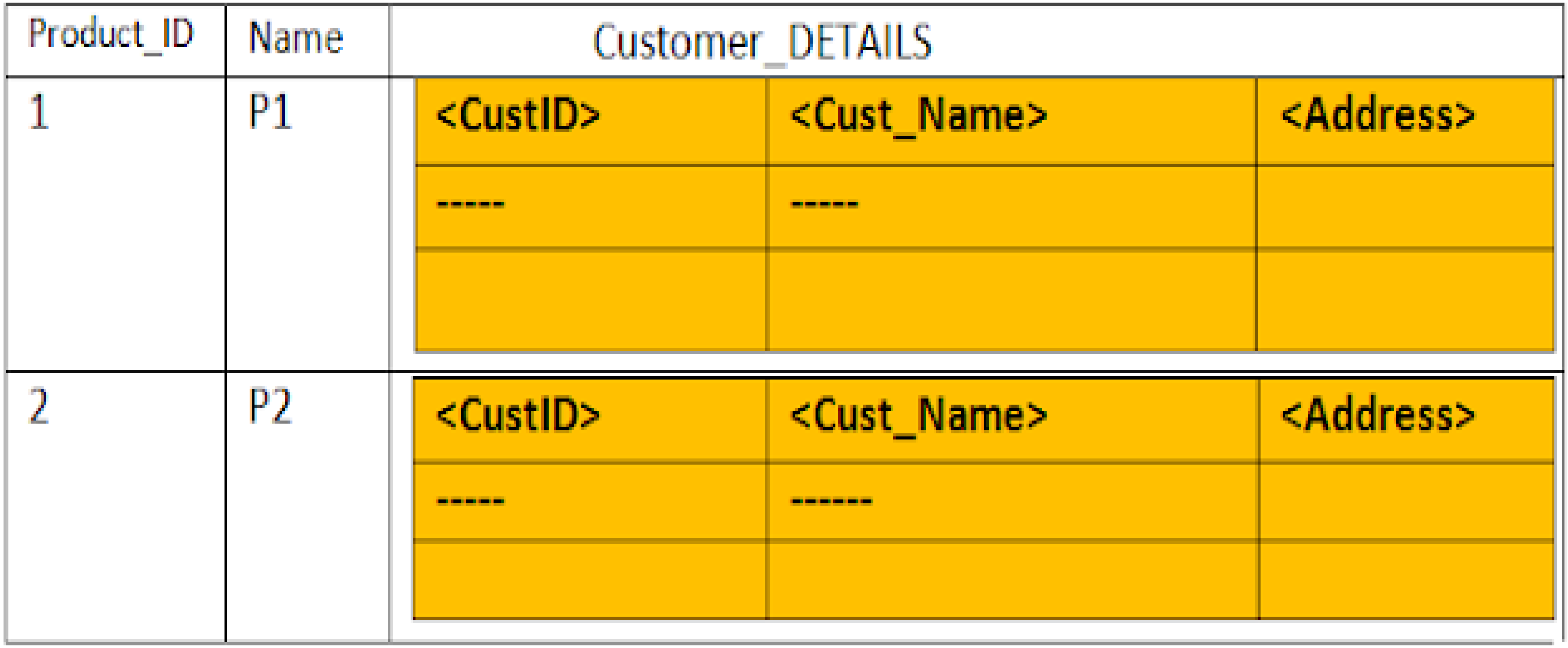
It is not good idea to use VARRAY when collection size is very large, because VARRAY is retrieved at once from database.

## Nested Tables:-

- It is a table (with rows and columns) that is stored in database table as data of a column in no particular order.
- When that table is retrieved form database in PL/SQL context, PL/SQL indexes all rows starting from 1 and based on index we can access each row of nested table using method: nested_table_var(index).

- Following diagram shows how Nested tables is stored in database table.
- Highlighted inner table in CUSTOMER_DETAILS column refers to Nested table type and stored as part of column data.

Product table in database with a column of NESTED TABLE type (CUSTOMER DETAILS):



| Product_ID | Name | Customer_DETAILS | | |
|---|---|---|---|---|
| 1 | P1 | <CustID> | <Cust_Name> | <Address> |
| | | ----- | ----- | |
| | | | | |
| 2 | P2 | <CustID> | <Cust_Name> | <Address> |
| | | ----- | ------ | |
| | | | | |

# Nested table creation and its initialization:-

Syntax:

(nested_table_type_def with collection ):

```
TYPE type IS {TABLE OF datatype [ NOT NULL ] }
```

# Where do we use Nested tables:-

Nested table finds it's usage when index values are not consecutive, maximum number of elements storage is not fixed.

# Nested Tables

A nested table is like a one-dimensional array with an arbitrary number of elements. However, a nested table differs from an array in the following aspects –

- An array has a declared number of elements, but a nested table does not. The size of a nested table can increase dynamically.
- An array is always dense, i.e., it always has consecutive subscripts. A nested array is dense initially, but it can become sparse when elements are deleted from it.

# Syntax:

```
TYPE type_name IS TABLE OF element_type [NOT NULL];

table_name type_name;
```

- This declaration is similar to the declaration of an **index-by** table, but there is no **INDEX BY** clause.
- A nested table can be stored in a database column. It can further be used for simplifying SQL operations where you join a single-column table with a larger table. An associative array cannot be stored in the database.

```
DECLARE
   TYPE names_table IS TABLE OF VARCHAR2(10);
   TYPE grades IS TABLE OF INTEGER;
   names names_table;
   marks grades;
   total integer;
BEGIN
   names := names_table('Kavita', 'Pritam', 'Ayan', 'Rishav', 'Aziz');
   marks:= grades(98, 97, 78, 87, 92);
   total := names.count;
   dbms_output.put_line('Total '|| total || ' Students');
   FOR i IN 1 .. total LOOP
      dbms_output.put_line('Student:'||names(i)||', Marks:' || marks(i));
   end loop;
END;
/
```

```
Total 5 Students
Student:Kavita, Marks:98
Student:Pritam, Marks:97
Student:Ayan, Marks:78
Student:Rishav, Marks:87
Student:Aziz, Marks:92

PL/SQL procedure successfully completed.
```

# Collection Methods

PL/SQL provides the built-in collection methods that make collections easier to use. The following table lists the methods and their purpose

**EXISTS(n)**
Returns TRUE if the nth element in a collection exists; otherwise returns FALSE.

**COUNT**
Returns the number of elements that a collection currently contains.

**LIMIT**
Checks the maximum size of a collection.

**FIRST**
Returns the first (smallest) index numbers in a collection that uses the integer subscripts.

**LAST**
Returns the last (largest) index numbers in a collection that uses the integer subscripts.

**PRIOR(n)**
**Returns the index number that precedes index n in a collection.**

**NEXT(n)**
**Returns the index number that succeeds index n.**

**EXTEND**
**Appends one null element to a collection.**

**EXTEND(n)**
**Appends n null elements to a collection.**

**EXTEND(n,i)**
**Appends n copies of the $i^{th}$ element to a collection.**

TRIM

Removes one element from the end of a collection.

TRIM(n)

Removes n elements from the end of a collection.

DELETE

Removes all elements from a collection, setting COUNT to 0.

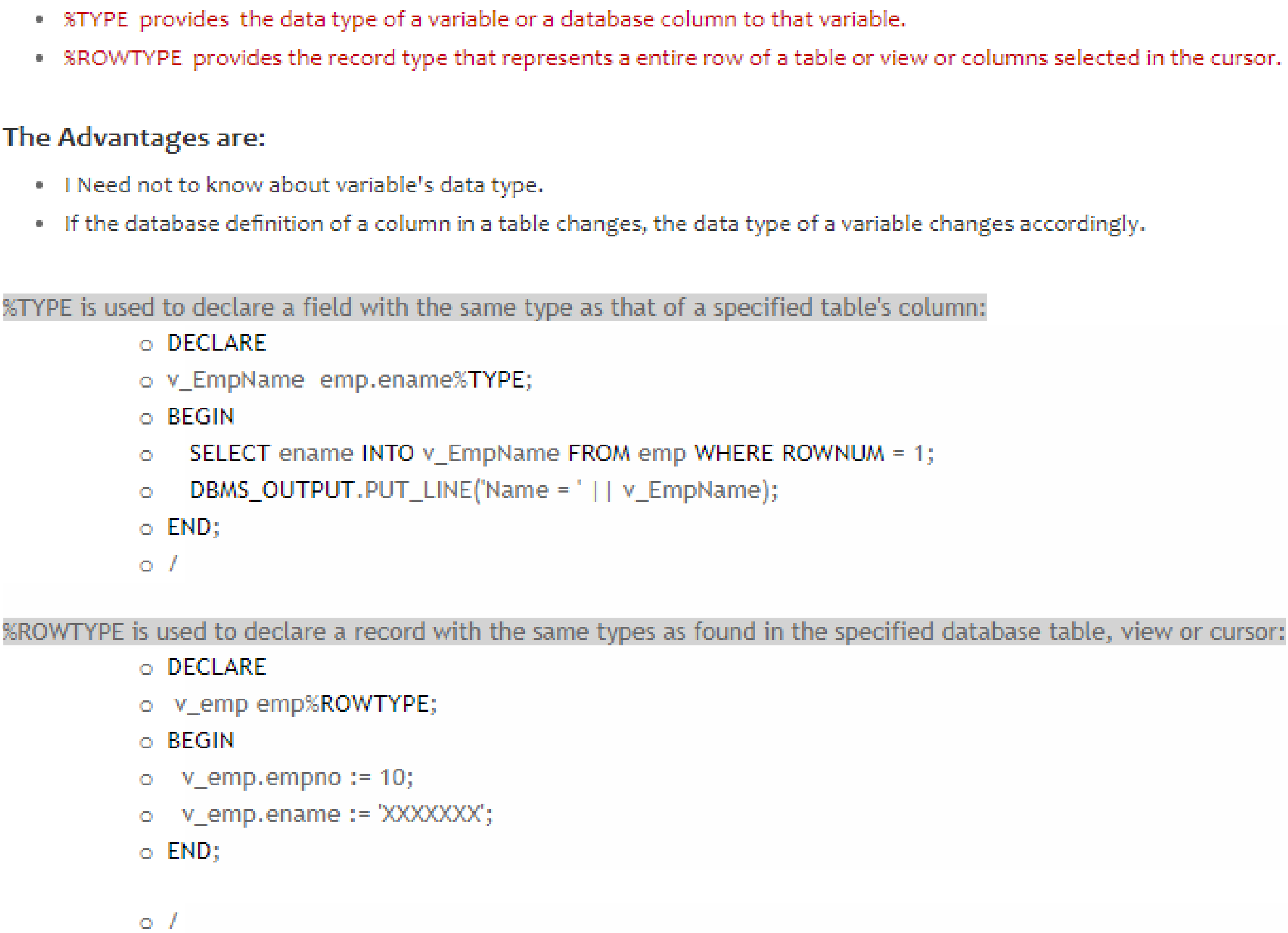
DELETE(n)

Removes the nth element from an associative array with a numeric key or a nested table. If the associative array has a string key, the element corresponding to the key value is deleted. If n is null, DELETE(n) does nothing.

DELETE(m,n)

Removes all elements in the range m..n from an associative array or nested table. If m is larger than n or if m or n is null, DELETE(m,n)does nothing.

## %TYPE Vs. %RowType



- %TYPE provides the data type of a variable or a database column to that variable.
- %ROWTYPE provides the record type that represents a entire row of a table or view or columns selected in the cursor.

The Advantages are:

- I Need not to know about variable's data type.
- If the database definition of a column in a table changes, the data type of a variable changes accordingly.

%TYPE is used to declare a field with the same type as that of a specified table's column:

```
DECLARE
v_EmpName  emp.ename%TYPE;
BEGIN
   SELECT ename INTO v_EmpName FROM emp WHERE ROWNUM = 1;
   DBMS_OUTPUT.PUT_LINE('Name = ' || v_EmpName);
END;
/
```

%ROWTYPE is used to declare a record with the same types as found in the specified database table, view or cursor:

```
DECLARE
 v_emp emp%ROWTYPE;
BEGIN
  v_emp.empno := 10;
  v_emp.ename := 'XXXXXXX';
END;

/
```

# Thank You