Introduction to Computers and Programming

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Reading: FK pp. 367-384, 415-420, 214-217

Lecture 16
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Structured data types

- So far:
  - **scalar** (single value) data types
  - structured data type: **array**
- **records:** data structure that collects together into one unit several related items of data
  - Name, phone number, sex, age, and weight
  - Day number, month name, and year number
  - ...

Arrays

- Access elements using Indices
  - Single Dimension arrays A(I)
  - Two dimensional arrays A(I,J)
  - N dimensional array A(i_1, i_2,..,i_n)
- Loops can be used to access control to elements.

```
for I in 1 .. N loop
   Get (A(I));
end loop;
```

```
for I in 1 .. M loop
   for J in 1 .. N loop
      Put (B(I,J));
   end loop;
end loop;
```

Records

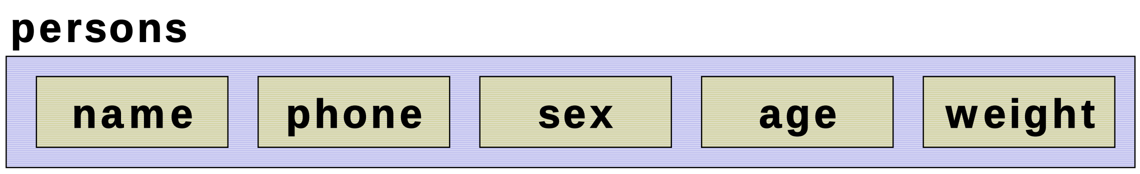
- To use records we need to know:

1. How to **design** a record
2. How to **declare** record types and variables
3. How to **use** a record

1. Designing Records

- To design a record:
  - **identify** the items of data that are relevant in this application
  - use a **data structure diagram** to show the relevant information
    - decide on **names** for the overall structure, and for the individual fields
  - determine the **data types** of the fields

Example1 Fitness club



```
name   : names;     -- string sub-type
phone  : phones;    -- string sub-type
sex    : sexes;     -- enumerated type
age    : ages;      -- integer sub-range
weight : weights;   -- float sub-type
```

2. Declaring records

- Form of declaration:

```
-- declaration of record data type
type record_type_name is record
    field_name_1 : field_type_1;
    field_name_2 : field_type_2;
    -- various fields in the record
end record;
```

2. Declaring records

- Example - positional aggregate:

```
average_male : constant persons :=
  (“Mr.  A Average            “,
   “          “,
   male, 25, 72.5);
```

- Example - named aggregate:

```
average_female : constant persons :=
  (name   => ”Ms. A Average      “,
   phone  => ”         “,
   sex    => female,
   age    => 21,
   weight => 62.0);
```

3. Using records

- To refer to an entire record variable (for assignment, parameter, comparison, etc) just use its name

- To refer to a field of a record, use
  record_name.field_name

  - `average_male.weight`
    `average_female.name`

3. Using records

- Assignment
  - You can assign one record variable to another of identical type
    - that_person := this_person;

- Input
  - You cannot read an entire record variable in a single operation. You must read **each field separately**.

  - To input a record variable use a procedure:
    - Prompt for and get each field in turn

CQ 1

1. My_First_Record contains contents of My_Second_Record
2. Program will not compile
3. Program gives a run-time error
4. Don't know

3. Using records

- Output
  - You cannot display an entire record variable in a single operation. You must **display each field separately**.
  - To display a record variable use a procedure:
    - Describe and display each field in turn

3. Using records

- **Comparisons**
  - You can compare one record variable to another of identical type using “=" or “/=" operators
    - `if this_person = that_person then`
  - You should use a function to compare specific fields

    -
      ```
      function is_heavier_than(a_person,
        another_person : persons ) return BOOLEAN is

      begin -- is_heavier_than
        return a_person.weight > another_person.weight;
      end is_heavier_than;
      ```
  - To use this function:

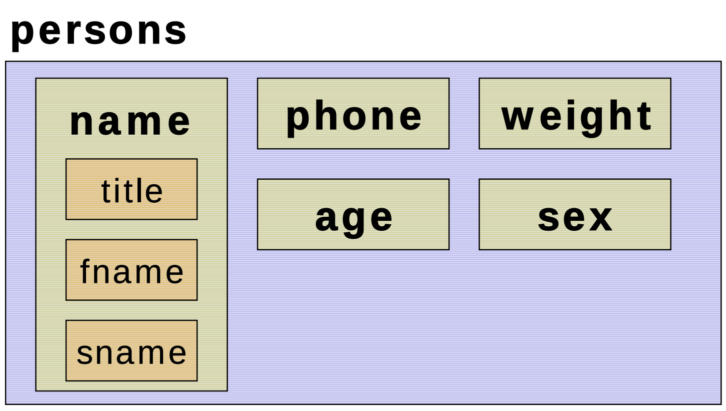
    -
      ```
      if is_heavier_than(this_person, that_person) then
        PUT(this_person.name); PUT_LINE(" is heavier.");
      else
        PUT(that_person.name); PUT_LINE(" is heavier.");
      end if;
      ```

CQ 2

1. Displays garbage
2. Program will not compile
3. Program gives a run-time error
4. Displays
   John Doe
   25
   Detroit Mi
5. Don’t know

Hierarchical records

- The components of a record can be **any** type, including another record



text_io

- Text_IO
  - Page line character
    - set_col : go to nominated column in output file
    - new_line: go to next line of output
    - set_line: go to nominated line in output file
    - new_page: go to next page of output
    - skip_line: go to start of next line in input
    - skip_page: go to start of next page of inputs
    - page: what page number are we up to in the file?
    - line: what line number are we up to on the page?
    - col: what character position are we up to on the line?

example

-
  ```
  SET_LINE (2);
  SET_COL (30);
  PUT ("Student Results Report");
  SET_LINE (4);
  SET_COL ( 5); PUT ("Student name");
  SET_COL (35); PUT ("Assignments");
  SET_COL (50); PUT ("Exams");
  SET_COL (65); PUT ("Average");
  SET_LINE (6);
  ```

Line length

- For output files
  - set_line_length for lines
  - set_page_length for pages
- set_line_length
  - EOL generated automatically when limit reached
  - Default is 0

  -
    ```
    SET_LINE_LENGTH (30);
    for i in 1 .. 20 loop
       PUT (i**2, width => 5);
    end loop;
    ```

```
'    1    4    9   16   25   36'
'   49   64   81  100  121  144'
'  169  196  225  256  289  324'
'  361  400'
```

Files

- Files need to be:
  - Declared
    - File variable set up

      `Open (Inf, In_File, File_Name(1..Name_Length));`
  - Created/opened/reset
    - Disk file linked to file variable
    - File opened for I/O

      `Mode is (In_File, Out_File, Append_File);`
  - Used for I/O
    - PUT, GET, etc

      `Put_Line (Outf, Line (1..Line_Length));`
  - Closed
    - After I/O finished

CQ 3

In the program, what is changed in the file

1. this is without putline –
   Where does this line go?

2. this is without putline - Where does this line go?

3. This is a copy - do not replicate this is without putline -
   Where does this line go?

4. None of the Above

reset

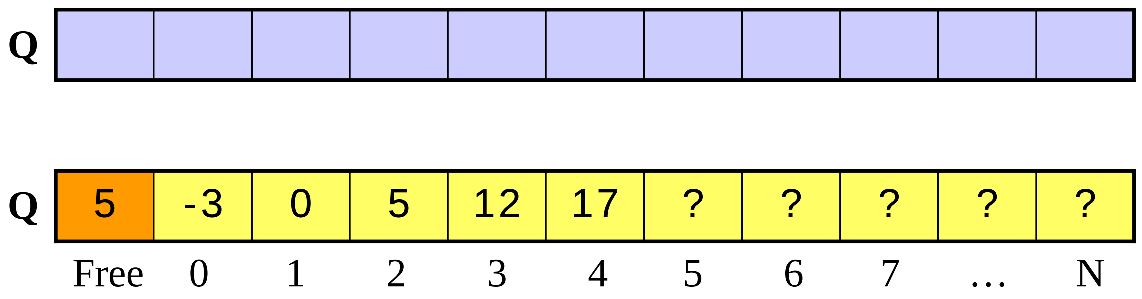
- Need to process a file twice. RESET procedure:
  - Go back to beginning
  - (optionally) change mode
  - File must be open already

```
-- read file twice
   open (filevar, in_file, filename);
    --code to read from the file
   reset (filevar);
   --code to read the file all over again
   close (filevar);
```

File position functions

- END_OF_FILE
  - Next character is EOF
  - Next character is combination of EOL, EOP, EOF
- END_OF_LINE
  - Next character is EOL or EOF
- END_OF_PAGE
  - Next character is combination of EOL and EOP
  - Next character is EOF
- **`if`** `END_OF_PAGE (infile)` **`then`** …
  `while not` `END_OF_FILE` **`loop`** …

Example2 Priority Queue



- Data structure that stores items so that retrieval of 'highest priority' item can be done efficiently.
- Highest priority have lower values
- Operations: PUT, GET, EMPTY