**Example 7: How many counties in the US have a higher population density than the state of New Jersey?**

Of course this question is contrived so that the solution will illustrate a 3-level nesting of structures – in this case, a conditional statement inside a While inside a For loop. It will also illustrate a simple use of an array. We will use the divide-and-conquer method to break the problem into three relatively simple parts, which we will then combine. We will assume that some clerk has access to data on all 50 states, showing the population and area of each county in the state.

For the convenience of the clerk, it would be good to refer to states by name, so we will start by building the names of the states into the program:

Declare String Array StateNames[51] // We will only use entries numbered 1 through 50

Set StateNames[1] = “Alabama” //Note 1

Set StateNames[2] = “Alaska”

……………….

Set StateNames[49] = “Wisconsin”

Set StateNames[50] = “Wyoming”

Our strategy is to go through the states, and for each state go through its list of counties. In each county, we have to divide the population by the area to get the density, then compare the quotient with the population density of New Jersey, which is 1012.1 persons per square mile. (Note 2)

At this point, we can develop an initial Variables Table:

|  |  |  |
| --- | --- | --- |
| **Name** | **Data Type** | **Usage** |
| StateNames | Array[51] of String | Names of US States |
| J | Integer | Used for counting states |
| Dense CountiesCount | Integer | Number of high-density counties found |
| Population | Integer | Population of one county |
| Area | Float | Area of one county |
| Density | Float | Density of one county |
| JerseyDensity | Float Constant | 1020.1 prsons/Sq.Mi. in New Jersey |

**Step 1: Deal with the States**

Since we know already how many states there are, we will use a For loop

Begin Program

Declare J as Integer

Declare DenseCountiesCount as Integer

Set DenseCountiesCount = 0 // Every time we fine a high-density county, we add 1 to this.

For (J = 1; J <= 50; J = J + 1)

*Instruct the clerk to enter data for state StateNames[j] and process it*

End For

Write “There are “ + DenseCountiesCount + “ counties with population densities greater than that of New Jersey.”

End Program

**Step 2: Deal with one State**

We have to go through the list of counties, but we don’t know how many there are (most likely, no two states are the same) so we will use a While loop with a sentinel, as we have done before. Here is what we need in the yellow area:

Declare Population as Integer

Declare Area, Density as Float

Write “Enter the population and area of a “ + StateNames[J] + “ county”

Input Population, Area

While (Population > 0)

*Deal with the data for this county*

Write “Enter the population and area of a county, or zero and zero if finished”

Input Population, Area

End While

**Step 3: Deal with one County**

Now we forget about loops for a while, and just deal with the data we have for some unknown county.

Set Density = Population/Area

If (Density > JerseyDensity)

Set DenseCountiesCount = DenseCountiesCount + 1

End If

**Step 5: Assemble the Program**

First, we insert the results of Step 3 in place of the blue-highlighted line in Step 2:

Declare Population as Integer

Declare Area, Density as Float

Write “Enter the population and area of a county, or zero and zero if finished”

Input Population, Area

While (Population > 0)

Set Density = Population/Area

If (Density > 1210.1)

Set DenseCountiesCount = DenseCountiesCount + 1

EndIf

Write “Enter the population and area of a county, or zero and zero if finished”

Input Population, Area

End While

(Continued on next page)

Then, we insert all of the above in place of the yellow line in Step 1, and pick up the initial declarations:

Declare String Array StateNames[51] // We will only use entries numbered 1 through 50

Set StateNames[1] = “Alabama” //Note 1

Set StateNames[2] = “Alaska”

……………….

Set StateNames[49] = “Wisconsin”

Set StateNames[50] = “Wyoming”

Declare JerseyDensity as Float

Set JerseyDensity = 1210.1

Declare J as Integer

Declare DenseCountiesCount as Integer

Set DenseCountiesCount = 0 // Every time we fine a high-density county, we add 1 to this.

For (J = 1; J <= 50; J = J + 1)

Declare Population as Integer

Declare Area, Density as Float

Write “Enter the population and area of a “ + StateNames[J] + “ county”

Input Population, Area

While (Population > 0)

Set Density = Population/Area

If (Density > 1210.1)

Set DenseCountiesCount = DenseCountiesCount + 1

EndIf

Write “Enter the population and area of a county, or zero and zero if finished”

Input Population, Area

End While

End for

Write “There are “ + DenseCountiesCount + “ counties with population densities greater than that of New Jersey.”

End Program

**Note 1:** This is a very common use of arrays. For instance, any program that has to deal with calendar issues would contain an array of month names, and another array containing the number of days in each month.

**Note 2:** Source: Wikipedia article “List\_of\_U.S.\_states\_by\_population\_density”