Laboratory Assignment № 4

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Place Value Decomposition of Non-negative Integers

Learning Objectives

1. Using Loops,
2. More on Decision Statements, and
3. More on Writing Interactive Programs

In this week's lab, you will write an interactive program that uses loops. A loop is a control structure that allows a program to condition the iterative execution of a code segment on a logical expression. When using loops ensure that the loop makes the desired number of iterations. A good programming habit, especially when writing large programs or programs with challenging control structures, is to program incrementally.

Definition 1. Every digit in a number has a **place value**. A place value can be defined as the value represented by a digit in a number on the basis of its position in the number. The place values of the digits in a number can be represented by powers of 10. The place values of the digits in a whole number from the least to most significant digit are the ones, tens, hundreds, thousands, ten thousands, hundred thousands, etc. For example, $13547 = 1 \times 10^4 + 3 \times 10^3 + 5 \times 10^2 + 4 \times 10 + 7$ and $5000010 = 5 \times 10^6 + 1 \times 10$.

Definition 2. A **palindromic integer** is an integer whose digits when read left-to-right or right-to-left give the same number. Every positive one-digit number is palindromic. 1025201 is palindromic but 1035031 is not palindromic.

The *Digitizer* Program

Write a program *Digitizer* that decomposes a positive integer into the sum of the product of its digits and their place values and determines whether the number is palindromic. The place values will be expressed as powers of 10. For the tens place, 10 rather than 10^1 will be used as the place value. Also, 10^0 will not be explicitly stated as the units place value. In this decomposition scheme, zero digits will not be given in the representation except for the number 0. Your program should not use standard Java Math class methods nor should it use Strings or String class methods.

- **Preliminary Version** : Prompts the user for a non-negative integer. If the user enters a negative integer, the program displays an error message. If the user enters a one-digit number, the program displays the place value decomposition of the number along with a message indicating that the number is palindromic, as shown in the sample run.
- **Second Version**: Modify the program so that it also handles a two-digit number: the program displays the place value decomposition of the number and a message indicating whether the number is palindromic or not.
- **Third Version**: Modify the program so that it gives the place value decomposition of integers with three or more digits.
- **Final Version**: Modify the program so that it also determines whether an integer with three or more digits is palindromic or not.

Programming Tips

To generate the digits from least-to-most-significant, an alternating sequence of integer modulo 10 and division by 10 operations are carried out. You may also need to peel of the digits from most-to-least-significant. This will require finding the place value of the most significant digit of the integer. To determine the place value of the most significant digit of an integer that has three or more digits:

1. Begin with a place value of 100.
2. Repeat the following until the number divided by the place value is less than 10: increase the place value to the next higher place value and again check if the number divided by the place value is less than 10.

To determine the digits of a positive integer from most-to-least-significant:

1. Initialize remaining digits to the number.
2. The current left-most digit is remaining digits divided by its place value.
3. Update the remaining digits to the current remaining digits integer modulo the place value.
4. Update the place value to the next lower place value.
5. Repeat 2-4 until only two digits, the units and tens digits, are left. The two least significant digits are handled in unique ways since their place values as powers of 10 are handled differently.

Additional Requirements

1. Do not use any String variable, String concatenation or standard Java library String class methods in this program.
2. Do not use standard Java Math library methods in this program.

Remove all Netbeans auto-generated comments. Write header comments using the following Javadoc documentation template:

```
/**
 * Explain the purpose of this class; what it does <br>
 * CSC 1350 Lab # 4
 * @author YOUR NAME
 * @since DATE THE CLASS WAS WRITTEN
 */
```

Here are sample program interactions:

Listing 1: Sample Run

```
1 Enter a non-negative integer -> -25
2 Error: Input must be a non-negative integer.
```

Listing 2: Sample Run

```
1 Enter a non-negative integer -> 9
2 9 = 9
3 9 is a palindrome.
```

Listing 3: Sample Run

```
1 Enter a non-negative integer -> 99
2 99 = 9 x 10 + 9
3 99 is a palindrome.
```

Listing 4: Sample Run

```
1 Enter a non-negative integer -> 80
2 80 = 8 x 10
3 80 is not a palindrome.
```

Listing 5: Sample Run

```
1 Enter a non-negative integer -> 78
2 78 = 7 x 10 + 8
3 78 is not a palindrome.
```

Listing 6: Sample Run

```
Enter a non-negative integer -> 10100101
10100101 = 1 x 10^7 + 1 x 10^5 + 1 x 10^2 + 1
10100101 is a palindrome.
```

Listing 7: Sample Run

```
Enter a non-negative integer -> 12344321
12344321 = 1 x 10^7 + 2 x 10^6 + 3 x 10^5 + 4 x 10^4 + 4 x 10^3 + 3 x 10^2 + 2 x 10 + 1
12344321 is a palindrome.
```

Listing 8: Sample Run

```
Enter a non-negative integer -> 10101010
10101010 = 1 x 10^7 + 1 x 10^5 + 1 x 10^3 + 1 x 10
10101010 is not a palindrome.
```

Listing 9: Sample Run

```
Enter a non-negative integer -> 12345321
12345321 = 1 x 10^7 + 2 x 10^6 + 3 x 10^5 + 4 x 10^4 + 5 x 10^3 + 3 x 10^2 + 2 x 10 + 1
12345321 is not a palindrome.
```

Listing 10: Sample Run

```
Enter a non-negative integer -> 102030201
102030201 = 1 x 10^8 + 2 x 10^6 + 3 x 10^4 + 2 x 10^2 + 1
102030201 is a palindrome.
```

Listing 11: Sample Run

```
Enter a non-negative integer -> 102030201
102030201 = 1 x 10^8 + 2 x 10^6 + 3 x 10^4 + 2 x 10^2 + 1
102030201 is a palindrome.
```

Listing 12: Sample Run

```
Enter a non-negative integer -> 102030203
102030203 = 1 x 10^8 + 2 x 10^6 + 3 x 10^4 + 2 x 10^2 + 3
102030203 is not a palindrome.
```

Listing 13: Sample Run

```
Enter a non-negative integer -> 123454321
123454321 = 1 x 10^8 + 2 x 10^7 + 3 x 10^6 + 4 x 10^5 + 5 x 10^4 + 4 x 10^3 + 3 x 10^2 + 2 x 10 + 1
123454321 is a palindrome.
```

Submitting Your Work for Grading

Using windows explorer, navigate your way through your netbeansprojects folder and find *Digitizer.java*, your source code for the program. Right-click the file and create a compressed (zipped) folder containing a copy of the file. Rename the zip file *PAWSID_lab04.zip*, where *PAWSID* is the prefix of your LSU/Tiger email address - the characters left of the @ sign. Double-click the zip file to verify that your program file is in the zip file. If the zip file does not contain your source file, repeat the steps. Upload the zip file to the digital dropbox on Moodle.