COMPSCI 119
Extra Credit Lab #2
Bar Codes
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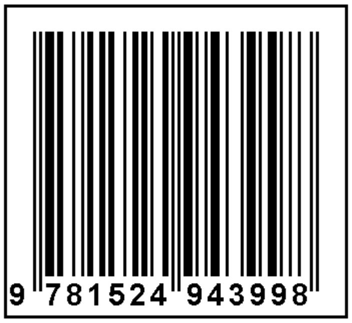
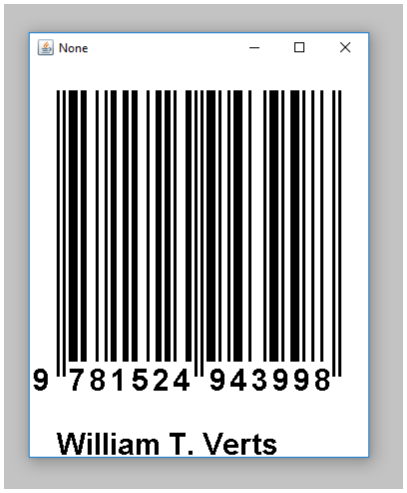
<u>Introduction and Background</u>

In this assignment you are to create bar codes from user input. There are two common bar codes in use today, UPC-A and EAN-13, as well as many alternative codes that we need not consider here. The 12-digit Universal Product Code (UPC) has been in use on most commercial products in America since the 1970s. The 13-digit European Article Number (EAN) is a *superset* of UPC, which means that EAN-13 has the same configuration and layout as UPC-A and generates the same code as UPC in the case where the leading digit is 0. Since they are so closely allied, we will consider only the EAN-13 code here (that is, if you can generate EAN-13, you can also generate UPC-A for free). Here Is a valid EAN-13 bar code (the code for the Computer Science Companion book) shown as a traditional bar code on the left and as the expected output from your JES program on the right (with your name instead of mine):





9 781524 943998

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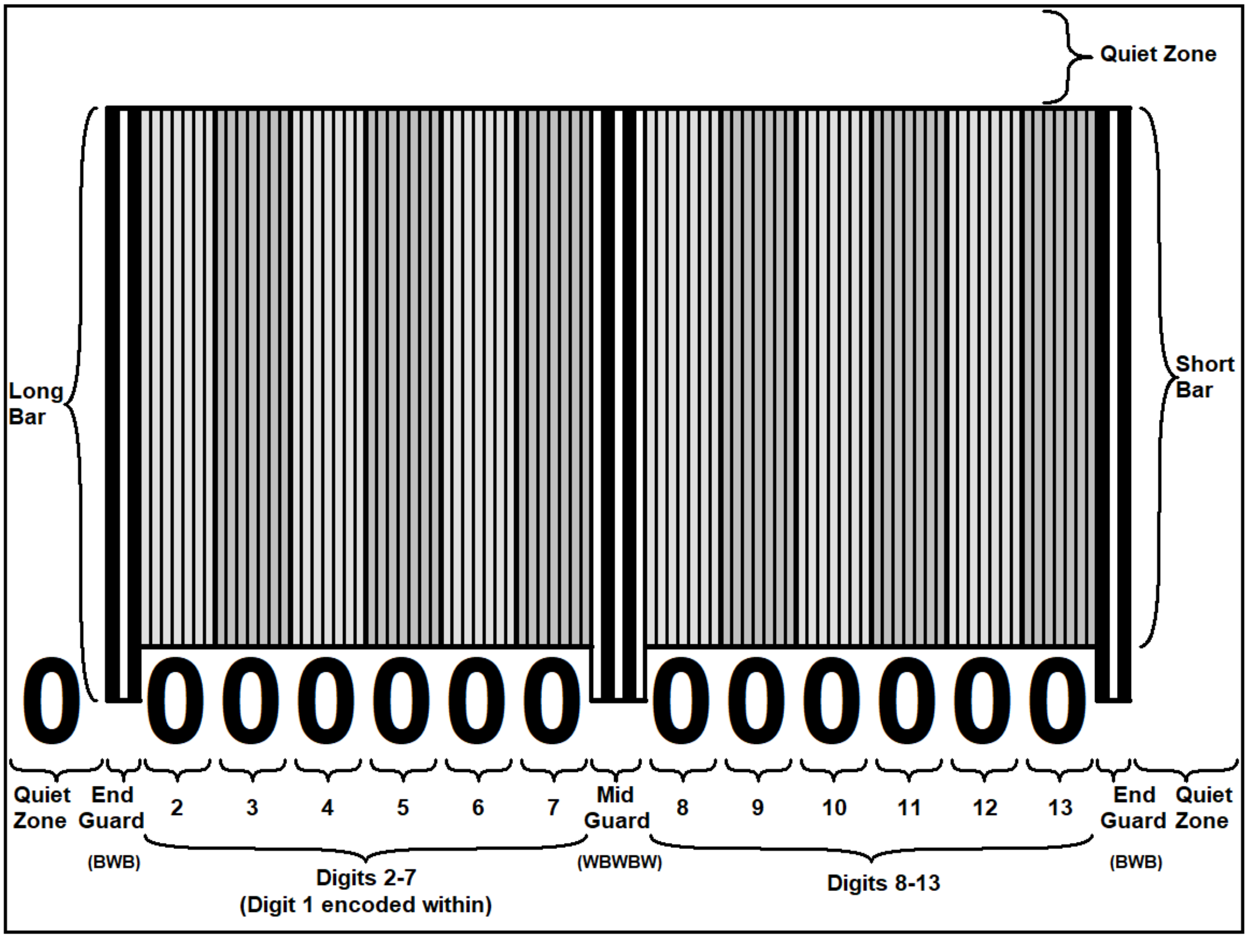
The purpose of your Python program is to let a user enter any number containing up to 13 digits, such as 9781524943998, and then draw out the bar code and text as shown here on the right. If the number contains fewer than 13 digits, enough 0s will be appended to the left to make a total of 13.

Layout of EAN-13 Bar Codes

UPC-A and EAN-13 codes have exactly 95 vertical stripes: some long and some shorter, some black and some white. At both the left and right ends of the code are three-stripe guard bars that are always in the order black-white-black. In the middle is a five-stripe guard bar that is always in the order white-black-white-black-white. Between the left and middle guard bars are the stripes for six digits, each digit consisting of seven stripes each. Similarly, there are six more digits of seven stripes each between the middle and right guard bars. Thus, the width of the bar code as painted is 3 + (6×7) + 5 + (6×7) + 3 = 95 stripes. Around the outside of the complete bar code is an additional "quiet zone" that is at least 9 stripes wide; this is to ensure that a scanner isn't confused trying to find the start or end of the code.



There isn't a specific digit position for the leftmost of the 13 digits; that digit is encoded in a distributed fashion within the region for the left six digits (this is due to the UPC-A code being reverse-engineered to hold 13 digits instead of 12, and yet maintain backwards compatibility with UPC-A).

Setting Sizes

The bar code is thus 9{quiet zone} + 95{bar code} + 9{quiet zone} = **113 stripes wide**. There is a lot of flexibility on the height of a bar code, so we can start with the same height as the width. In this assignment, however, we will triple the size of the bottom quiet zone to allow space for your name, so the bar code height will be **131 stripes tall**. At minimum, each stripe will be exactly one pixel wide. For this assignment you will enter a **scale factor** to determine the stripe width, in pixels. For example, if the scale factor is 3 then each stripe will be 3 pixels wide, and the canvas will be therefore 3×113=339 pixels wide by 3×131=393 pixels tall.

The length of a **long bar** is 95 stripes, and the length of a **short bar** is 90 stripes. These values must also be multiplied by the scale factor to get their corresponding lengths in pixels.

The **text size** is 10 points times the scale factor. Use the following JES functions to draw the text (the call to **`makeStyle`** can be done once at the top of the program):

```
          MyStyle = makeStyle(sanSerif, bold, textsize)
          addTextWithStyle(Canvas, X, Y, "text", MyStyle, color)
```

When drawing text in JES, location <X,Y> forms the lower left pixel coordinate of the text.

Selecting Digit Patterns

The process for figuring out the white and black stripes for each digit is a little complicated. In the Python lists **`L_Code`**, **`G_Code`**, and **`R_Code`** below, each list contains ten strings of seven **`W`** or **`B`** characters each, indicating a white or black stripe, respectively. These lists are used to paint the actual stripes onto the canvas. The **`L_Group`** and **`R_Group`** lists each contain ten strings of six **`L`**, **`G`**, or **`R`** characters, and determine whether the stripe codes of some digit value are to be pulled from **`L_Code`**, **`G_Code`**, or **`R_Code`**, respectively, based on the left-most pf the 13 digits. Type these five lists into your program at the top of the code. Notice the \ at the end of the first line of each list; this is to allow the lists to extend onto the next line.

```
L_Group   = ["LLLLLL",  "LLGLGG",  "LLGGLG",  "LLGGGL",  "LGLLGG",  \
             "LGGLLG",  "LGGGLL",  "LGLGLG",  "LGLGGL",  "LGGLGL"]

R_Group   = ["RRRRRR",  "RRRRRR",  "RRRRRR",  "RRRRRR",  "RRRRRR",  \
             "RRRRRR",  "RRRRRR",  "RRRRRR",  "RRRRRR",  "RRRRRR"]

L_Code    = ["WWWBBWB", "WWBBWWB", "WWBWWBB", "WBBBBWB", "WBWWWBB", \
             "WBBWWWB", "WBWBBBB", "WBBBWBB", "WBBWBBB", "WWWBWBB"]

G_Code    = ["WBWWBBB", "WBBWWBB", "WWBBWBB", "WBWWWWB", "WWBBBWB", \
             "WBBBWWB", "WWWWBWB", "WWBWWWB", "WWWBWWB", "WWBWBBB"]

R_Code    = ["BBBWWBW", "BBWWBBW", "BBWBBWW", "BWWWWBW", "BWBBBWW", \
             "BWWBBBW", "BWBWWWW", "BWWWBWW", "BWWBWWW", "BBBWBWW"]
```

If a particular bar code digit is 7, for example, and if we happen to know the code is to be pulled from **`R_Code`**, then **`R_Code[7]`** is **BWWWBWW**, indicating that the stripes to be painted for that digit are black-white-white-white-black-white-white.

An Example

So, how do we know if a particular digit-pattern is to be pulled from `L_Code`, `G_Code`, or `R_Code`? The answer depends on whether we are painting a digit in the left group of six or in the right group of six, and it also depends on the first (leftmost) digit. This information is encoded in the lists `L_Group` and `R_Group`.

Let's use as an example the EAN-13 code for the Computer Science Companion: 9781524943998. We first divide it into three fields: 9-781524-943998.

The left most digit is 9, so we look up `L_Group[9]` and `R_Group[9]`. `L_Group[9]` is `"LGGLGL"` and `R_Group[9]` is `"RRRRRR"` (yes, they all are – that isn't a mistake). The left group of six digits, 781524, will use **LGGLGL**, and the right group of six digits, 943998, will use **RRRRRR** to figure out which black-and-white stripe codes to use. This is shown below:

For 781524: `L_Code[7]`, `G_Code[8]`, `G_Code[1]`, `L_Code[5]`, `G_Code[2]`, `L_Code[4]`

For 943998: `R_Code[9]`, `R_Code[4]`, `R_Code[3]`, `R_Code[9]`, `R_Code[9]`, `R_Code[8]`

Once this information is known, the bar code can be created from the following stripes:

Left guard bar	**BWB**	(long)
`L_Code[7]`	**WBBBWBB**	
`G_Code[8]`	**WWWBWWB**	
`G_Code[1]`	**WBBWWBB**	
`L_Code[5]`	**WBBWWWB**	
`G_Code[2]`	**WWBBWBB**	
`L_Code[4]`	**WBWWWBB**	
Mid guard bar	**WBWBW**	(long)
`R_Code[9]`	**BBBWBWW**	
`R_Code[4]`	**BWBBBWW**	
`R_Code[3]`	**BWWWWBW**	
`R_Code[9]`	**BBBWBWW**	
`R_Code[9]`	**BBBWBWW**	
`R_Code[8]`	**BWWBWWW**	
Right guard bar	**BWB**	(long)

Each black stripe can be painted using some number of calls to the JES `addLine` function, based on the scale factor. That is, if the scale factor is 3, then each black stripe will be three calls to `addLine` with successive X coordinates.

More Details on the Process

1. Ask the user for a 13-digit integer (this has to be done as a string, because Python integers aren't big enough). Convert the string into a list of 13 integers, where each integer is in the range [0…9].

2. Ask the user for a scale (1-10). This represents the width of a stripe, in pixels (that is, at **`Scale`**=1 a stripe is one pixel wide; at **`Scale`**=5 a stripe is five pixels wide).

3. Determine the width and height of the canvas, based on the number of needed stripes and the **`Scale`** value. Similarly, determine the length of the long and short lines. Create the canvas.

4. Based on the first of the 13 digits, determine from **`L_Group`** and **`R_Group`** the code patterns to use.

5. Paint the left guard pattern with long lines.

6. Paint digits 2-7 as a series of black and white stripes with short lines, with the patterns picked from **`L_Code`** and **`G_Code`**.

7. Paint the middle guard pattern with long lines.

8. Paint digits 8-13 as a series of black and white stripes with short lines, with the patterns picked from **`R_Code`**.

9. Paint the right guard pattern with long lines.

10. Paint the digit text underneath the stripes. (You may wish to paint each digit as you are painting the stripes.)

11. Paint your name at the bottom.

When your program is complete, try it with the code for the Companion, as well as other EAN-13 and UPC-A codes that you find. If you want to try a 12-digit UPC-A code, remember to prefix it with a 0 character (that is, a UPC-A code such as 123456789012 should be entered as EAN-13 code 0123456789012). Test your program with different scale factors as well.

Submit this program using the on-line form as Lab Assignment #12.