

## Analyzing Numerical Data: Estimating Large Numbers

### I.A Student Activity Sheet 3: Not Enough Numbers

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#### Telephone Numbers

During the past few years, there have been several statements of the form: “It is conceivable that we may run out of area codes and telephone numbers within the next 10 years.” The shortage of phone numbers is due to the proliferating use of cell phones, pagers, and fax machines. In the next few problems, you will estimate the number of possible telephone numbers in North America. The assignment of telephone numbers is coordinated by the North American Numbering Plan Administration ([www.nanpa.com](http://www.nanpa.com)). (NANPA actually covers only the United States and its territories, Canada, and the Caribbean. Mexico is not included.)

A telephone number in the form  $NYZ-ABC-XXXX$  has three sections:

<b>NYZ</b>	<b>ABC</b>	<b>XXXX</b>
area code	exchange code	station code

Before 1995, all area codes had the form  $NYZ$ , where  $N$  was any digit from 2 to 9 (2-9),  $Y$  was 0 or 1, and  $Z$  was 1-9 if  $Y$  was 0 or  $Z$  was 2-9 if  $Y$  was 1. The restrictions on  $N$  saved 0 for *call operator* and 1 for long-distance calls. In addition, codes such as 800 and 911 were (and still are) used for special purposes.

The restriction that  $Y = 0$  or 1 was removed in 1995 because all possible area codes had been assigned. Today  $N$  is 2-9,  $Y$  is 0-8, and  $Z$  is 0-9; the exception to these rules are codes of the form  $37Z$  and  $96Z$ , which are being reserved for future use. Area codes where  $Y = Z$  are called *easily recognizable codes* and are often assigned to special services such as 800 and 877.

1. How many area codes were possible before 1995?

$8 [2-9] \cdot 1 \cdot 9 [1-9] = 72$  possible area codes for  $NOZ$  and  $8 [2-9] \cdot 1 \cdot 8 [2-9] = 64$  possible area codes for  $N1Z$  — a total of 136.

2. According to the post-1995 rules, how many area codes are possible today?

$8 \cdot 9 \cdot 10 - 20 [37Z \text{ and } 96Z] = 700$

There are, in fact, a few other restrictions that reduce the number of available area codes to 681. As of September 2008, 377 area codes have been assigned.

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3. The 7-digit numbers in a given area code have the form **ABC-XXXX**, where **X**, **B**, and **C** can be any digit 0-9 and **A** is restricted to 2-9. There are two other restrictions:
- **B** and **C** cannot both equal 1 since these values are designated for other purposes such as 911 (emergency) and 411 (information), and
  - 555-0100 through 555-0199 are reserved for fictional uses such as in television shows or movies.

According to these conditions, how many 7-digit numbers are possible in a single area code?

$$8 \cdot 10^6 - 8 \cdot 1 \cdot 1 \cdot 10^4 [\mathbf{B} = \mathbf{C} = 1] - 100 [\text{fictional numbers}] = 7,919,900$$

4. Using your answers to the previous questions, determine how many 10-digit numbers are possible in North America.

$$700 \cdot 7,919,900 = 5,543,930,000$$

Your answer is an upper estimate because there are some other restrictions and reserved numbers.