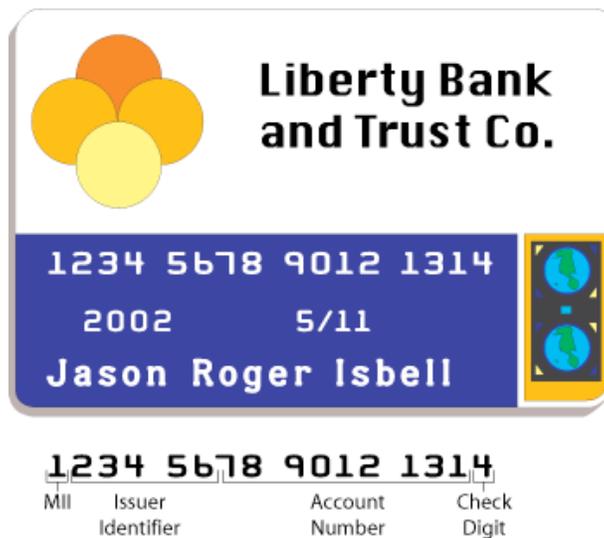## Analyzing Numerical Data: Validating Identification Numbers
I.D Student Activity Sheet 13: Credit Card Numbers

Identification numbers are present everywhere in society. Today's identification numbers are more sophisticated than those introduced years earlier (for example, Social Security numbers). Today's numbers have a check digit to partially ensure that they have been correctly scanned or entered into a computer.

Credit cards have 16-digit numbers, of which the first 15 digits identify the credit card and the sixteenth digit is the check digit. The following figure shows the significance of the digits:

MII stands for *major industry identifier*; *4* and *5* indicate "Banking and Financial." VISA cards begin with *4* and MasterCard cards with *5*.

1. MasterCard numbers begin with 51, 52, 53, 54, or 55. What is the maximum number of credit cards that MasterCard can issue?

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A **check digit** is used to help validate credit card numbers. The credit card companies use the Codabar method to determine the check digit. This method consists of the following steps:

- Add the digits in the odd-numbered positions and double this total.
- Add the *number* of odd-position digits that are more than 4 to the total.
- Add the even-position digits.
- Choose a check digit that makes this calculation total a number whose final digit is 0.

Libraries, shipping/receiving companies, and blood banks also use the Codabar method.

2. Show that the check digit (*d*) for the VISA card 4162 0012 3456 789*d* is 3.

3. What is the check digit (*d*) for the MasterCard number 5424 9813 2720 008*d*?

4. Show that 4128 0012 4389 0110 is an invalid VISA credit card number.

   If someone made a single-digit error when entering this invalid number, can you tell which digit is incorrect? Why or why not?

   Change one digit in this invalid number so the resulting number is valid.

5. The following is another way to explain the Codabar method:

- If a digit is in an even-numbered position, add it to the total.
- If a digit is in an odd-numbered position, multiply it by 2. If the product is equal to or greater than 10, subtract 9 from the product. Add this difference to the total.
- After the first 15 digits have been processed, choose the check digit so that the sum of the 16 digits ends in 0.

   Explain why both methods yield the same check digit.

6. Suppose you entered *8* instead of *9* when recording the credit card number 4001 2560 01<u>9</u>6 4310. Explain why the Codabar method will detect this error.

   Do you think the Codabar method will detect all such single-digit errors using a method similar to the one for showing all such errors are detected for UPC numbers? Either write *Yes* or give several examples of numbers with an error that will not be detected.

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7. The Codabar method detects 98% of all transposition errors. There is one pair of numbers, however, that when transposed will not be detected by the Codabar method. Find this pair of numbers and explain why this transposition error will go undetected. (*Hint:* There are several cases to consider depending on the positions of the transposed digits.)

8. REFLECTION: In what ways is the Codabar method like the activities you explored in Section C, "Indices Using Weighted Sums and Averages"?

9. EXTENSION

- The European Article Numbering Code (EAN 13) is the worldwide standard. Conduct research on how the EAN 13 number is calculated and what types of errors this method detects. Prepare a report and presentation about your findings.
- The International Standard Book Numbers (ISBNs) used to identify books have a check-digit scheme that detects all single-digit and transposition errors. Conduct research on how the ISBN number is calculated and why this method detects all single-digit and transposition errors. Prepare a report and presentation about your findings.
- In a vehicle identification number (VIN), the check digit comes in the middle of the number instead of at the end. Conduct research on how the VIN is calculated and what types of errors this method detects. Prepare a report and presentation about your findings.
- Retailers use Universal Product Codes (UPC) to identify products. Conduct research on the meaning of various digits in the UPC number and how check digits are determined. Prepare a report and presentation about your findings.
- Imagine that you are employed by a company that does not have an identification code number for its employees and products. Prepare a report discussing various numbering alternatives and make a recommendation. Include a check digit in your code number. Indicate how successful your method of determining the check digit will be in detecting single-digit and transposition errors. The company can be your school.