

LECTURE 13:

EXAMPLES OF SIMPLE CODES IN THE REAL WORLD

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US POSTAL SERVICE MONEY ORDER

- The number is 11 digits (each between 1 and 9).
- The 11th digit is the sum of the first 10, mod 9.
- Example: $(0+2+5+4+3+7+5+0+5+9) \bmod 9 = 40 \bmod 9 = 4$

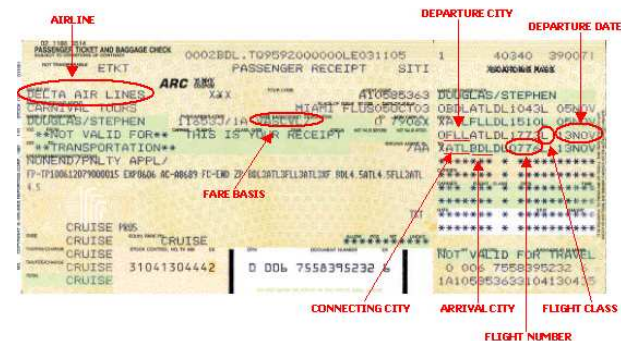


COMMON CODES TO PREVENT HUMAN ERRORS

- Many numbers which have to be read and retyped by humans are designed to include some error correction coding, usually in the form of a single extra “check digit”.
- A common scheme is to make the “check digit” equal to the sum of the other digits, mod something.
- Examples include:
 - Money Orders, Bank Cheques, Traveller’s Cheques
 - UPC Symbols, ISBN/ISSN Numbers, VIN Numbers
 - Credit Cards, Driver’s Licenses, Social Security Numbers
 - Airline Tickets, Courier Tracking Numbers, ...

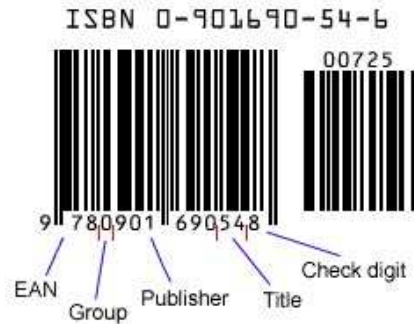
AIRLINE TICKETS

- The numbers are different lengths, but the whatever number is obtained by dropping the last digit must be congruent to the last digit, mod 7.
- Example: $3104130444 \bmod 7 = 2$



INTERNATIONAL STANDARD BOOK NUMBERS (ISBN) 4

- Each book has a 10 digit ISBN, whose weighted sum must be equal to 0 mod 11. The weighting of the first digit is 10, the second digit 9, and so forth, weighting the last digit by 1.
- Example: $10*0+9*9+8*0+7*1+6*6+5*9+4*0+3*5+2*4+6=198 = 11*18$



CREDIT CARDS 6

- Credit card numbers are 16 digits long (VISA starts with 4, AMEX with 34 or 37, Mastercard with 51-55) and obey the check: $2*\text{sum-of-odd-positions} + \text{sum-of-even-positions} + \text{number-of-odd-positions} > 4 = 0 \text{ mod } 10$
- Example: $2*(4+8+2+2+7+1+1+7) + 9+8+4+2+2+2+1+5 + 3 = 2*32+33+3 = 100 = 10*10$



BANK IDENTIFICATION NUMBERS 5

- Each bank has a 9 digit identification number.
- The weighted sum of the first 8 digits must be equal to the last digit, mod 10. The weighting used is [7,3,9,7,3,9,7,3].
- Example: $7*1+3*2+9*1+7*0+3*3+9*1+6*7+7*3 = 103$



UNIVERSAL PRODUCT CODES (UPC) 7

- Many commercial items have a UPC, consisting of a category code, manufacturer's ID (5 digits), product ID (5 digits) and check digit.
- The sum of the even digits plus 3 times the sum of the odd digits must be equal to 0 mod 10.
- Example: $3+4+0+1+7+5 + 3*(0+9+0+0+9+2) = 80$

