# Lecture 14:

# Real World Examples

November 2, 2005

## 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) mod 9 = 40 mod 9 = 4

## Common Codes to Prevent Human Errors

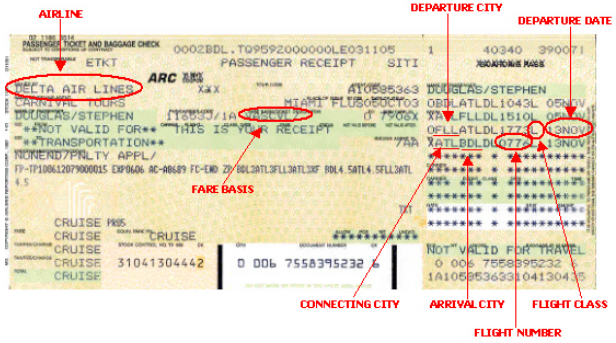


- Many numbers that have to be read and retyped by people include some error correction coding, ususally in the form of a single check digit.
- A common scheme is to make the check digit equal to the sum of the other digits, mod somthing.
- Examples include:
  - Money Orders, Bank Cheques, Traveller's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

## Airline Tickets

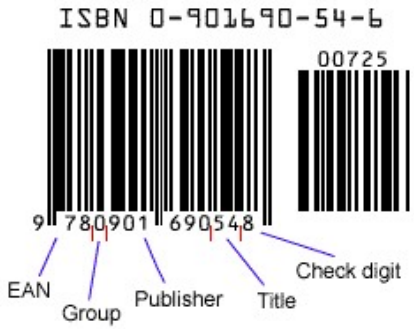


- The numbers are different lengths, but the whatever number is obtained by dropping the last digit must be congruent to the last digit, mod 7.
- Example: 3104130444 mod 7 = 2



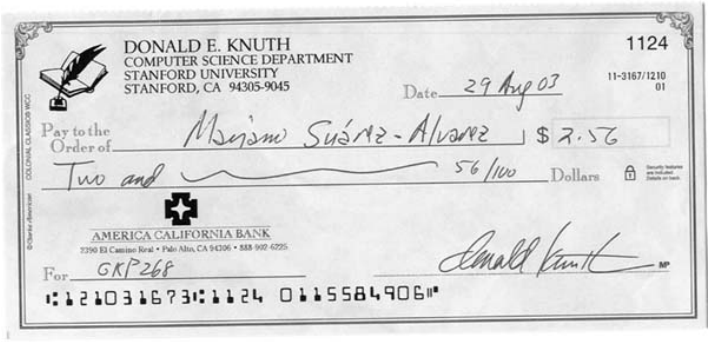
## International Standard Book Numbers (ISBN) 4

- 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




## 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




## Credit Cards 6

- Credit card numbers are 16 digits long (VISA stars with 4, AMEX with 34 or 37, Mastercard with 51-55) and obey the check: `2*sum-of-odd-positions + sum-of-even-positions + number-of-odd-positions>4 = 0 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

## 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