Programming Design In-class Practices

Digital Systems

Ling-Chieh Kung

Department of Information Management
National Taiwan University

Problem 1: base conversion (with pencil)

- Convert the following base-r value $(x)_r$ into base-10 values. Consider all of them are unsigned integers.
  - $(110011)_2$.
  - $(13702)_8$.
  - $(3DA)_{16}$.
- Convert the following base-10 value $(x)_{10}$ into base-r values. Consider all of them are unsigned integers.
  - $x = 652, r = 2$.
  - $x = 9527, r = 8$.
  - $x = 98652, r = 16$.

Problem 2: base conversion

- Convert a base-10 value $(x)_{10}$ into its base-r value $(y)_r$. Output only the most significant digit of y.
- Input: $x \in \{1, 2, \ldots, 10000\}$, a white space, and then $r \in \{2, 3, \ldots, 8\}$.
- Output: The most significant digit of y.

Input: **20 2** Output: **1**	Input: **20 3** Output: **2**	Input: **9527 8** Output: **2**

  - $(20)_{10} = (10100)_2; (20)_{10} = (202)_3; (9527)_{10} = (22467)_8.$

Problem 3: complements (with pencil)

- For each of the following 1-byte base-2 integer, express its negation with signed magnitude, 1's complement, and 2's complement.
  - 01010011.
  - 11010011.
  - 00000000.

Problem 4: subtraction (with pencil)

- Consider two 1-byte base-2 integers $x = 00110110$ and $y = 00010011$. For each of the following expression, find its value by using 2's complement.
  - $x + y$.
  - $x - y$.
  - $y - x$.
  - $-x - y$.

Problem 5: overflow (with pencil)

- For each of the following pairs of 1-byte base-2 integers x and y, determine whether overflow occurs when we do $x + y$, $x - y$, $-x + y$, and $-x - y$.
  - $x = 00110110$ and $y = 00010011$.
  - $x = 01110110$ and $y = 00010011$.
  - $x = 10101110$ and $y = 01010011$.
  - $x = 10101110$ and $y = 11010011$.

Problem 6: time flies

- Given a time moment labeled as h:m:s, determine the time moment h':m':s' after x seconds.
  - E.g., if now it is 11:12:5, then it will be 13:18:45 after 7600 seconds.
- Input: $h \in \{0,1,2,\ldots,11\}$, $m \in \{0,1,\ldots,59\}$, $s \in \{0,1,\ldots,59\}$, and $x \in \{1,2,\ldots,10000\}$. Two consecutive values are separated by a white space.
- Output: the new time moment h', m', and s'. Two consecutive values should be separated by one colon.

Input:
```
11 12 5 7600
```

Output:
```
13:18:45
```

Input:
```
11 12 5 1
```

Output:
```
11:12:6
```

Input:
```
1 59 59 2
```

Output:
```
2:0:1
```

Problem 7: leap year

- Given a positive integer $y \in \{1, 2, \ldots, 3000\}$ as the A.D. year number, determine whether it is a leap year.
  - A year (typically) is a leap year if its year number is a multiple of 4.
  - However, it is (typically) considered as an ordinary year if its year number is a multiple of 100.
  - However, it is considered as a leap year if its year number is a multiple of 400.
- E.g., 1992 is a leap year, 1900 is not, and 2000 is.

Problem 7: leap year

- Input: $y \in \{1, 2, \ldots, 3000\}$.
- Output: 1 is that year represented by y is a leap year and 0 otherwise.

Input: **1992** Output: **1**	Input: **1900** Output: **0**	Input: **2000** Output: **1**