CSCI 1540 Fundamental Computing with C++

Tutorial 2

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Outline

- **Assignment 2**
- **Exercise**

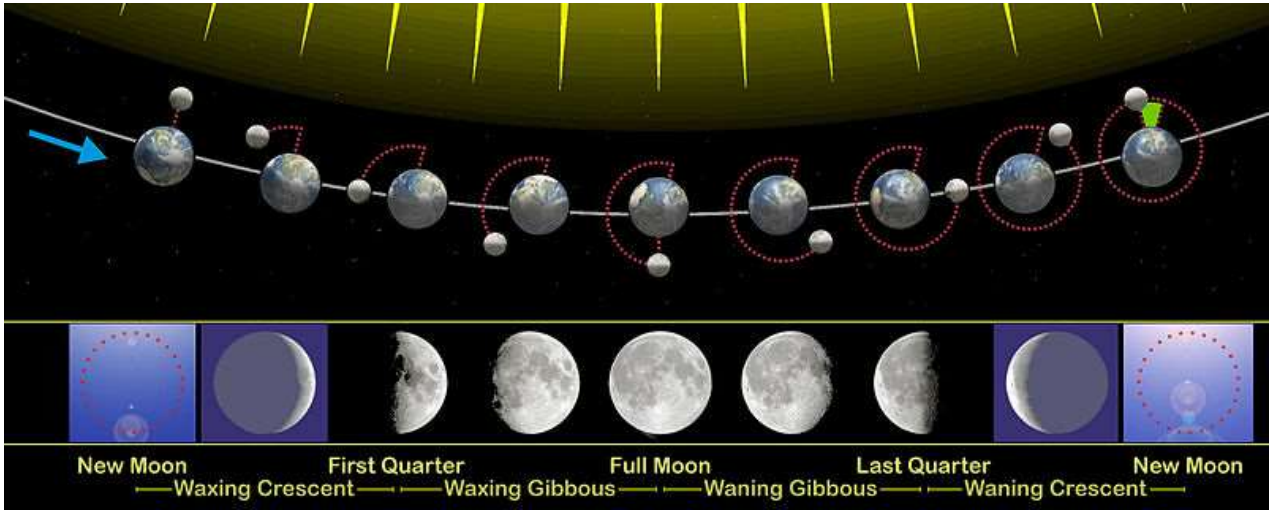
Assignment 2: Lunar New Year

- Due : 20:00, Tue 2 Oct 2019.

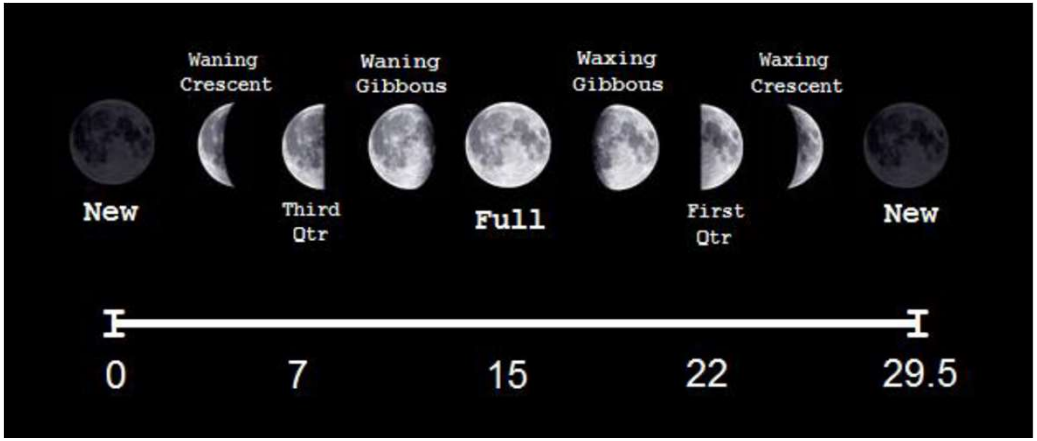
- estimate the date of Lunar New Year (LNY / Chinese New Year / Spring Festival)

```
Enter a year: 2019↵
LNY of 2019 is around: Tue, 5 Feb 2019
```

The date should be printed in the format "ddd, d mmm y", where ddd is the three-letter abbreviation for day of the week (e.g., Tue), d is the day of the month, mmm is the three-letter abbreviation for month (e.g., Feb), and y is the year.



The New Moon (when the sun does not illuminate any of the moon's surface we see on Earth) repeats every 29.53 days.



The easiest way to calculate the current phase of the moon is to compare it to a known time when it was new (e.g., HKT 02:13, 6 Jan 2000), and determine how many cycles it has passed through.

Julian day numbers

Julian day numbers are a system of counting days since a specific day (January 1, 4713 BC).

$$a = \left\lfloor \frac{14 - m}{12} \right\rfloor$$
$$b = m + 12a - 3$$
$$c = y + 4800 - a$$
$$j = d + \left\lfloor \frac{153b + 2}{5} \right\rfloor + 365c + \left\lfloor \frac{c}{4} \right\rfloor - \left\lfloor \frac{c}{100} \right\rfloor + \left\lfloor \frac{c}{400} \right\rfloor - 32045$$

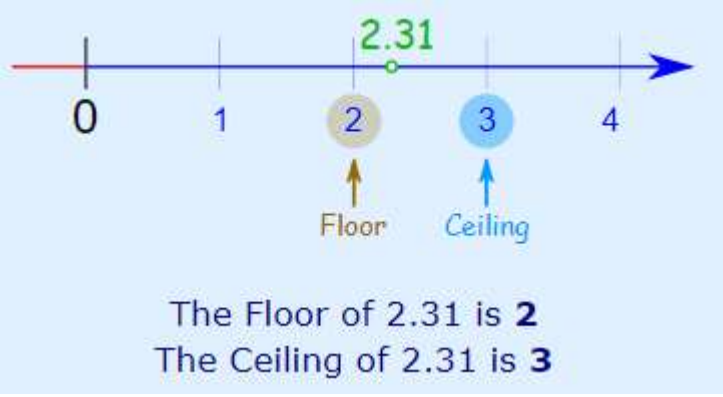
Given a year number y, m=1, and d=21 (meaning 21 Jan) :

Julian day numbers

$$a = \left\lfloor \frac{14 - m}{12} \right\rfloor$$
$$b = m + 12a - 3$$
$$c = y + 4800 - a$$
$$j = d + \left\lfloor \frac{153b + 2}{5} \right\rfloor + 365c + \left\lfloor \frac{c}{4} \right\rfloor - \left\lfloor \frac{c}{100} \right\rfloor + \left\lfloor \frac{c}{400} \right\rfloor - 32045$$
$$k = \frac{j - 2451551.0923611}{29.530587981}$$
$$n = \lfloor 29.530587981 \times (\lceil k \rceil - k) \rfloor$$

$\lfloor x \rfloor$ Floor Function: the greatest integer that is less than or equal to **x**.

$\lceil x \rceil$ Ceiling Function: the least integer that is greater than or equal to **x.**



- Given a year number y, m=1, and d=21 :

$$a = \left\lfloor \frac{14 - m}{12} \right\rfloor$$
$$b = m + 12a - 3$$
$$c = y + 4800 - a$$
$$j = d + \left\lfloor \frac{153b + 2}{5} \right\rfloor + 365c + \left\lfloor \frac{c}{4} \right\rfloor - \left\lfloor \frac{c}{100} \right\rfloor + \left\lfloor \frac{c}{400} \right\rfloor - 32045$$
$$k = \frac{j - 2451551.0923611}{29.530587981}$$
$$n = \lfloor 29.530587981 \times (\lceil k \rceil - k) \rfloor$$

- Example: y=2061:

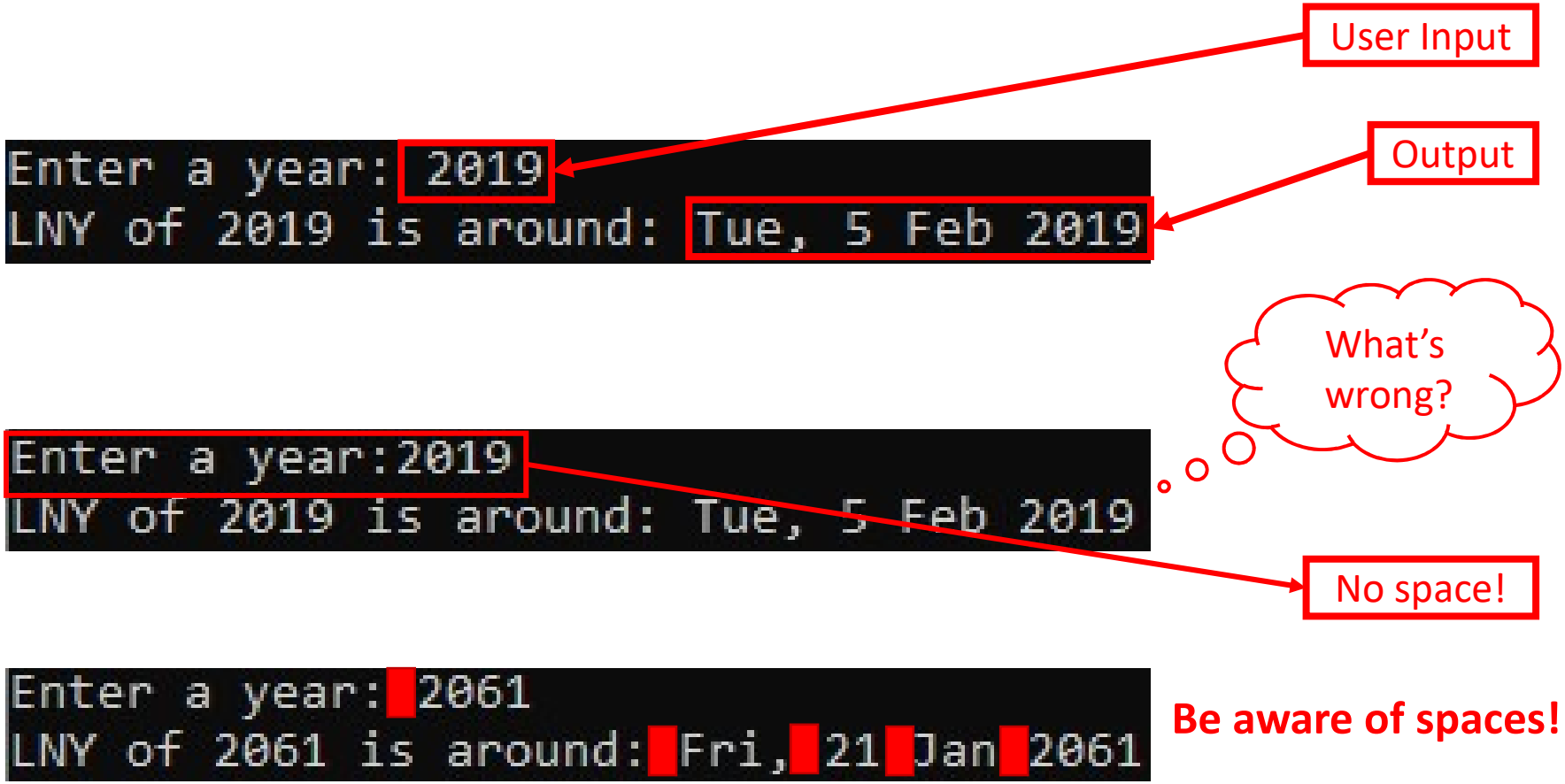
$$a = \left\lfloor \frac{14 - 1}{12} \right\rfloor = 1$$
$$b = 1 + 12 \times 1 - 3 = 10$$
$$c = 2061 + 4800 - 1 = 6860$$
$$j = 21 + \left\lfloor \frac{153 \times 10 + 2}{5} \right\rfloor + 365 \times 6860 + \left\lfloor \frac{6860}{4} \right\rfloor - \left\lfloor \frac{6860}{100} \right\rfloor + \left\lfloor \frac{6860}{400} \right\rfloor - 32045$$
$$= 21 + 306 + 2503900 + 1715 - 68 + 17 - 32045 = 2473846$$
$$k = \frac{2473846 - 2451551.0923611}{29.530587981} = \frac{22294.9076389}{29.530587981} = 754.976760139167$$
$$n = \lfloor 29.530587981 \times (755 - 754.976760139167) \rfloor = \lfloor 0.68628675501781 \rfloor = 0$$

Therefore, LNY of year 2061 is around 0 day after 21 Jan. That is, 21 Jan. Also, $((j + n) \bmod 7) + 1 = ((2473846 + 0) \bmod 7) + 1 = 4 + 1 = 5$. So, 21 Jan 2061 is Friday.

Program Specification

- The output should be the **100% same** with sample output (i.e., same text, same symbols, same letter case, same number of spaces, etc.)
- Otherwise, it will be considered as ***wrong***, even if you have computed the correct result.

Sample Output



The date should be printed in the format "ddd, d mmm y", where ddd is the three-letter abbreviation for day of the week (e.g., Tue), d is the day of the month, mmm is the three-letter abbreviation for month (e.g., Feb), and y is the year.

Real-time Demonstration

You can also run the sample program on blackboard

Compare your program outputs and sample program outputs!

Hints

- Variables needed in program:
  - Storing Input:

```
int y
```

  - Storing intermediate values:

```
int a, b, c, j, n,
double k
```

  - Use if-else statement to output the “ddd” and “mmm”

```
if (m == 1)
    cout << " Jan ";
if (m == 2)
    cout << " Feb ";
```

Program hints

- How to implement $\lfloor x \rfloor$, $\lceil x \rceil$ and mod in the C++?
  - For $\lfloor x \rfloor$, just let `n=(int)(x)` and if x, y are all integers, to calculate z=$\left\lfloor \frac{x}{y} \right\rfloor$, `z=x/y` can work. E.g. `19/10=1`.
  - For mod, use operator `%`. E.g. `19%10=9`.
  - For $\lceil x \rceil$, you can write `z = ceil(x).` Be careful that you need to add `#include <cmath>` at the beginning of your program.

Program Hints

- Test your program!
  - use some self-thought numbers (including some extreme cases)
  - work out the a, b, c, j, k, n by hand
  - verify with program output.

Others

- Program file: Iny.cpp
- Please insert your personal information (SID, email, name)
- Please insert some suitable comments. (tell me what your codes are now doing)
- Free of errors and warnings.
- No Plagiarism !

Outline

- **Assignment 2**
- **Exercise**

Exercise: Introduction

Computus:

- **Computus** : the calculation of the Easter Day in the Christian calendar.

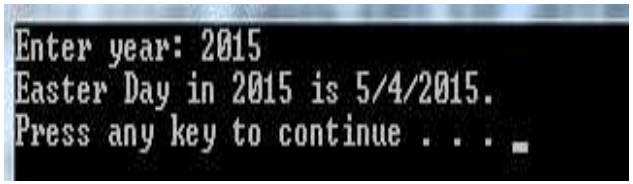
An algorithm to calculate the Easter Day for a particular $year$

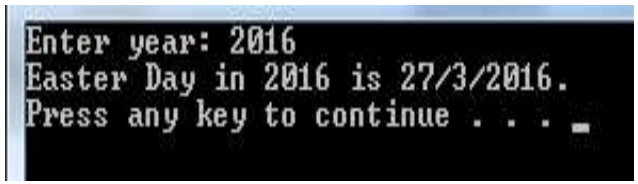
$$a = year \bmod 19$$
$$b = \left\lfloor \frac{year}{100} \right\rfloor$$
$$c = year \bmod 100$$
$$d = \left\lfloor \frac{b}{4} \right\rfloor$$
$$e = b \bmod 4$$
$$f = \left\lfloor \frac{b+8}{25} \right\rfloor$$
$$g = \left\lfloor \frac{b-f+1}{3} \right\rfloor$$
$$h = (19a + b - d - g + 15) \bmod 30$$
$$i = \left\lfloor \frac{c}{4} \right\rfloor$$
$$k = c \bmod 4$$
$$L = (32 + 2e + 2i - h - k) \bmod 7$$
$$m = \left\lfloor \frac{a + 11h + 22L}{451} \right\rfloor$$
$$month = \left\lfloor \frac{h + L - 7m + 114}{31} \right\rfloor$$
$$day = \big((h + L - 7m + 114) \bmod 31\big) + 1$$

Exercise: Introduction

Computus:

- **Computus** : the calculation of the Easter Day in the Christian calendar.
- **Goal**: write a program to calculate the Easter Day for some given years
- Examples:





Step 1: Input

Inputs: the year you want to calculate the Easter Day

cin use “cin” to read in the input

- *The region of the input year*

The program will obtain a year as user input. You can assume that the input year is always integers greater than 1582 (when the Gregorian calendar was first adopted).

Step 2: Computation

-- Define each variable first and then assign them.

$$a = year \bmod 19$$
$$b = \left\lfloor \frac{year}{100} \right\rfloor$$
$$c = year \bmod 100$$
$$d = \left\lfloor \frac{b}{4} \right\rfloor$$
$$e = b \bmod 4$$
$$f = \left\lfloor \frac{b+8}{25} \right\rfloor$$
$$g = \left\lfloor \frac{b-f+1}{3} \right\rfloor$$
$$h = (19a + b - d - g + 15) \bmod 30$$
$$i = \left\lfloor \frac{c}{4} \right\rfloor$$
$$k = c \bmod 4$$
$$L = (32 + 2e + 2i - h - k) \bmod 7$$
$$m = \left\lfloor \frac{a + 11h + 22L}{451} \right\rfloor$$
$$month = \left\lfloor \frac{h + L - 7m + 114}{31} \right\rfloor$$
$$day = \big((h + L - 7m + 114) \bmod 31\big) + 1$$

Step 2: Computation

The operators used in C++ (an example using year 2023)

- modulo operation : %

  year mod 19 → year % 19 = 2023 % 19 = 9;

- floor operation : /

  $b = \left\lfloor \frac{year}{100} \right\rfloor$ → b = year / 100 = 2023 / 100 = 20;

- With the same way.

  c = year mod 100 → c = year % 100 = 2023 % 100 = 23;

  $d = \left\lfloor \frac{b}{4} \right\rfloor$ → d = b / 4= 20 / 4 = 5;

Step 2: Computation

- modulo operation : % floor operation : /
- a = 9; b = 20; c = 23; d = 5;

e = b mod 4 → e = b % 4 = 20 % 4 = 0;

$f = \left\lfloor \frac{b+8}{25} \right\rfloor$ → f = (b + 8) / 25= 28 / 25 = 1;

$g = \left\lfloor \frac{b-f+1}{3} \right\rfloor$ → g = (b – f + 1) / 4 = 20 / 4 = 5;

$h = (19a + b - d - g + 15) \bmod 30$

→ h = (19a + b – d – g + 15) % 30 = 196 % 30 = 16;

$i = \left\lfloor \frac{c}{4} \right\rfloor$ → i = c / 4= 23 / 4 = 5;

k= c mod 4 → k = c % 4 = 23 % 4 = 3;

Step 2: Computation

- modulo operation : % floor operation : /

a = 9; b = 20; c = 23; d = 5; e = 0; f = 1; g = 5; h = 16; i = 5; k = 3;

$$L = (32 + 2e + 2i - h - k) \bmod 7$$

→ L = (32 + 2e +2i – h - k) % 7 = 23 % 7 = 2;

$$m = \left\lfloor \frac{a + 11h + 22L}{451} \right\rfloor$$

→ m = (a + 11h + 22L) / 451 = 229 / 451 = 0;

$$month = \left\lfloor \frac{h + L - 7m + 114}{31} \right\rfloor$$

→ month = (h + L – 7m + 114) / 31 = 132 / 31 = 4;

$$day = \left((h + L - 7m + 114) \bmod 31\right) + 1$$

→ day = ((h + L – 7m + 114) % 31) + 1 = (132 % 31) + 1 = 9;

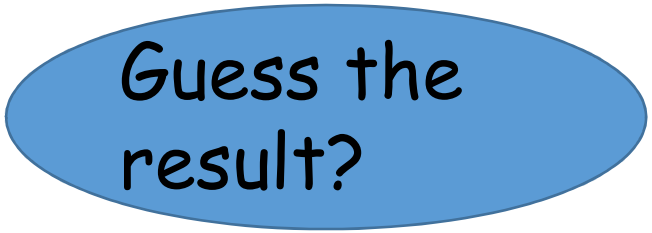
Step 2: Computation

Integer division

/ could only get the integer part of the result and omit the decimals.

For example,

7/2 + 5



Step 3: Output

Outputs: cout use “cout” to print out

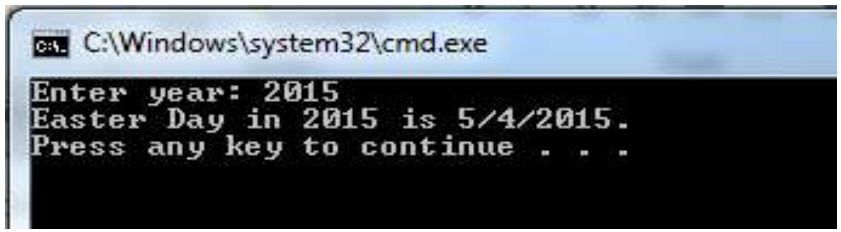
- *The output date format*

The program output is the date of the Easter Day of the input year, in the format d/m/y.

Sample Codes

```
#include <iostream>
using namespace std;

int main()
{
// Declare variables
	int year, month, day;
	int a, b, c, d, e, f, g, h, i, k, L, m;

// Prompt the user to enter a 'year' and store
the value in variable 'year’
	cout<<"Enter year: ";
	cin>>year;

// Follow the assigned algorithm
	a = year % 19;
	b = year / 100;
	c = year % 100;
	d = b / 4;
	e = b % 4;
	f = (b + 8) / 25;
	g = (b - f + 1) / 3;
	h = (19 * a + b - d - g + 15) % 30;
	i = c / 4;
	k = c % 4;
	L = (32 + 2 * e + 2 * i - h - k) % 7;
	m = (a + 11 * h + 22 * L) / 451;

	month = (h + L - 7 * m + 114) / 31;
	day = ((h + L - 7 * m + 114) % 31) + 1;

// Print out the result
	cout<<“Easter Day in ” << year << “ is ”
<< day << “/” << month << ”/” << year << “.”;

	return 0;
}
```

Output Samples




Thanks!