homework 1 Time Conversion

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question description:

2022/9/19 10:00 to `UTC` to `BDS` time then to `GPS` time.

found a interesting that can solve this: leap second

some definitions

- `UT`, universal time, time scales based on rotation of earth
- `UT0`, solar time form astronomical observations
- `UT1`, `UT0` corrected for polar motion based on measurements
- `LT`, local time, 24 time zone according to longitude
- `ET`, ephemeris time, time associated with any ephemeris
- `TAI`, international atomic time, uniform and accurate time
- `UTC`, universal time coordinated; `UT` is not precise, while `TAI` has a problem that earth loses 1 day every 8000 years;
  will be adjusted on the last second of Jun 30th or Dec 31st every year;
- `GPST`, `GPS` time, `TAI`
- `BDS`, `BeiDou` time, `TAI`

time conversion

There is a transform chart according to the definitions and some formulas.

$$\mathrm{TAI} = \begin{cases} \mathrm{GPST} + 19.0\mathrm{s} \\ \mathrm{UTC} + \text{leap second} \\ \mathrm{BDT} + 33.0\mathrm{s} \\ \mathrm{TT} - 32.184\mathrm{s} \end{cases}$$

and local time + `time zone leap` = `UTC`, for China, `time zone leap` is 8 hours.

to be advised, `leap second` is $37.0s$ currently;

it's easy to get the answer with input `10:00 2022-9-19`, but it's a little complicated to realize a random time conversion.

we need:

- a fully time add and subtraction function, `params` including year, month, day, hour, min, sec; and the data type needs to be considered;
- `GPST`, `BDT` and `TT` is easy to complete. However, `leap second` is different by years and months. So we need a `leep time` judge function;

So we got 2 key points;

parameters

if I give a string like '2022091910000000' to program, then splitting it, converting `string` to `int` and `double` ;

reachable, but complex;

use year, month, day, hour, min, and sec instead;

headers

```
//
// Created by hazyparker on 22-9-19.
//

#ifndef HOMEWORK1_TIMECONVERSION_H
#define HOMEWORK1_TIMECONVERSION_H

// this is a header for class TimeConversion
// to compose time converting from local time to different time

// include libs
#include <vector>
#include <iostream>
#include <tuple>

using namespace std;

typedef vector< vector<int> > Vec2int;
typedef tuple<int, int, int, int, int, double> Time;

class TimeConversion {
private:
    // define time parameters
    Time local_time;
    Time gps_time;
    Time bds_time;
    Time utc_time;
    Time ia_time;

    // define leap second table, table from
    // https://en.wikipedia.org/wiki/Leap_second
    Vec2int leap_sec_vec;

public:
    /**
     * construction function
     * @param mYear
     * @param mMonth
     * @param mDay
     * @param mHour
     * @param mMin
     * @param mSec
     */
    TimeConversion(int mYear, int mMonth, int mDay,
                   int mHour, int mMin, double mSec);
```

```
    /**
     * compose add ans subtraction operation to known time spot
     * @param time_origin; time spot for input
     * @param delta; bias of few seconds
     * @param sign; true means positive add, false means negative subtraction
     * @return the result time, in the data type of tuple(type defined before)
     */
    static Time TimeAddSubtraction(Time &time_origin, double sec, bool sign);

    /**
     * judge if this year is a leap year
     * @param year
     * @return true or false, is or not
     */
    static bool isLeapYear(int year);

    /**
     * local time to UTC time
     */
    void LT2UTC();

    /**
     * local time to GPS time
     */
    void LT2GPS();

    /**
     * local time to BDS time
     */
    void LT2BDS();

    static void Show(Time &time);

    /**
     * show all time
     */
    void ShowAllTime();
};


#endif //HOMEWORK1_TIMECONVERSION_H
```

results

for `2022-9-19-10:00:00`

```
$/home/hazyparker/project/SJTU-MAI-
SpaceEngineering/1_Courses/NavigationPrinciple/homework1/cmake-build-
debug/homework1
  local time, 2022- 9-19, 10:0:0
     IA time, 2022- 9-19,  2:0:37
    GPS time, 2022- 9-19,  2:0:18
    BDS time, 2022- 9-19,  2:0:4
    UTC time, 2022- 9-19,  2:0:0
 GPS in week, 2228 weeks and 93618 seconds
 BDS in week, 872 weeks and 93604 seconds
```

for `2012-3-1-7:00:00`

```
$/home/hazyparker/project/SJTU-MAI-
SpaceEngineering/1_Courses/NavigationPrinciple/homework1/cmake-build-
debug/homework1
  local time, 2012- 3- 1,  7:0:0
     IA time, 2012- 2-29, 23:0:35
    GPS time, 2012- 2-29, 23:0:16
    BDS time, 2012- 2-29, 23:0:2
    UTC time, 2012- 2-29, 23:0:0
 GPS in week, 1677 weeks and 255616 seconds
 BDS in week, 321 weeks and 342002 seconds
```