Calculating n^{th} day of the Date in a Calendar Year
Cariño's nd-Algorithm

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Abstract. This study is an algorithm of calculating n^{th} day of the Date in a Year for any given Date in Gregorian & Julian calendar using simplified formula. It consists of ten algebraic (6 for Julian) expression, eight of which are integer function by substituting the year, month and day. This formula will calculate the n^{th} day which gives a number from 1 to 366 that determines the exact n^{th} day in a given Date. This algorithm has no condition even during leap-year and 400-year cycle.

1 Introduction

1.1 This algorithm is devised using basic mathematics, without any condition or modification to the formula, it will provide a direct substitution to the formula.

1.2 For any calendar date, m denotes for month, d for day and y for year; m is the number of months in the calendar year, i.e., $m = 1$ for the month of January, $m = 2$ for the month of February and $m = 12$ for the last month of the year which is December; d on the other hand, is the day in a given calendar date, i.e., 1 until 31. Lastly, y is the calendar year in either Gregorian & Julian calendar.

2 The Formula

Formula for Gregorian calendar in original form,

$$nd = 31m - 31 + d - \left\lfloor\frac{3m}{7}\right\rfloor - 2\left\lfloor\frac{m+7}{10}\right\rfloor + \left\lfloor\frac{12y+m-3}{48}\right\rfloor - \left\lfloor\frac{y-1}{4}\right\rfloor - \left\lfloor\frac{12y+m-3}{1200}\right\rfloor + \left\lfloor\frac{12y+m-13}{1200}\right\rfloor + \left\lfloor\frac{12y+m-3}{4800}\right\rfloor - \left\lfloor\frac{12y+m-13}{4800}\right\rfloor$$

where

- nd is the n^{th} day of the Date (0 to 366)
- m is the month (1 = January, 2 = February, ………, 12 = December)
- d is the day of the month

- y is the Gregorian year

3 Simplified Formula

3.1 Original form,

$$nd = 31m - 31 + d - \left\lfloor\frac{3m}{7}\right\rfloor - 2\left\lfloor\frac{m+7}{10}\right\rfloor + \left\lfloor\frac{12y+m-3}{48}\right\rfloor - \left\lfloor\frac{y-1}{4}\right\rfloor - \left\lfloor\frac{12y+m-3}{1200}\right\rfloor + \left\lfloor\frac{12y+m-13}{1200}\right\rfloor + \left\lfloor\frac{12y+m-3}{4800}\right\rfloor - \left\lfloor\frac{12y+m-13}{4800}\right\rfloor$$

3.2 Simplified form,

$$nd = 31m - 31 + d - \left\lfloor\frac{3m}{7}\right\rfloor - 2\left\lfloor\frac{m+7}{10}\right\rfloor + \left\lfloor\frac{a}{48}\right\rfloor - \left\lfloor\frac{y-1}{4}\right\rfloor - \left\lfloor\frac{a}{1200}\right\rfloor + \left\lfloor\frac{b}{1200}\right\rfloor + \left\lfloor\frac{a}{4800}\right\rfloor - \left\lfloor\frac{b}{4800}\right\rfloor$$

where

- $a = 12y + m - 3$
- $b = a - 10$

4 Examples

Several examples are presented/shown to illustrate the algorithm.

4.1 January 1, 1583, first New Year of Gregorian calendar.

$m = 1, \quad d = 1, \quad y = 1583$

$a = 12y + m - 3 = 12(1583) + 1 - 3 = 18994$

$b = a - 10 = 18994 - 10 = 18984$

$$nd = 31(1) - 31 + 1 - \left\lfloor\frac{3(1)}{7}\right\rfloor - 2\left\lfloor\frac{1+7}{10}\right\rfloor + \left\lfloor\frac{18994}{48}\right\rfloor - \left\lfloor\frac{1583-1}{4}\right\rfloor - \left\lfloor\frac{18994}{1200}\right\rfloor + \left\lfloor\frac{18984}{1200}\right\rfloor + \left\lfloor\frac{18994}{4800}\right\rfloor - \left\lfloor\frac{18984}{4800}\right\rfloor$$

$$= 31 - 31 + 1 - \left\lfloor\frac{3}{7}\right\rfloor - 2\left\lfloor\frac{8}{10}\right\rfloor + \left\lfloor\frac{18994}{48}\right\rfloor - \left\lfloor\frac{1582}{4}\right\rfloor - \left\lfloor\frac{18994}{1200}\right\rfloor + \left\lfloor\frac{18984}{1200}\right\rfloor + \left\lfloor\frac{18994}{4800}\right\rfloor - \left\lfloor\frac{18984}{4800}\right\rfloor$$

$$= 31 - 31 + 1 - \lfloor 0.43\rfloor - 2\lfloor 0.8\rfloor + \lfloor 395.71\rfloor - \lfloor 395.5\rfloor - \lfloor 15.83\rfloor + \lfloor 15.82\rfloor + \lfloor 3.96\rfloor - \lfloor 3.96\rfloor$$

$$= 31 - 31 + 1 - 0 - 0 + 395 - 395 - 15 + 15 + 3 - 3$$

$$= \mathbf{1}$$

So, January 1, 1583 is the 1st day of year 1583

4.2 March 1, 1900, latest centennial that is not a leap-year

$m = 3, \quad d = 1, \quad y = 1900$

$a = 12y + m - 3 = 12(1900) + 3 - 3 = 22800$

$b = a - 10 = 22800 - 10 = 22790$

$$nd = 31(3) - 31 + 1 - \left\lfloor\frac{3(3)}{7}\right\rfloor - 2\left\lfloor\frac{3+7}{10}\right\rfloor + \left\lfloor\frac{22800}{48}\right\rfloor - \left\lfloor\frac{1900-1}{4}\right\rfloor - \left\lfloor\frac{22800}{1200}\right\rfloor + \left\lfloor\frac{22790}{1200}\right\rfloor + \left\lfloor\frac{22800}{4800}\right\rfloor - \left\lfloor\frac{22790}{4800}\right\rfloor$$

$$= 93 - 31 + 1 - \left\lfloor\frac{9}{7}\right\rfloor - 2\left\lfloor\frac{10}{10}\right\rfloor + \left\lfloor\frac{22800}{48}\right\rfloor - \left\lfloor\frac{1899}{4}\right\rfloor - \left\lfloor\frac{22800}{1200}\right\rfloor + \left\lfloor\frac{22790}{1200}\right\rfloor + \left\lfloor\frac{22800}{4800}\right\rfloor - \left\lfloor\frac{22790}{4800}\right\rfloor$$

$$= 93 - 31 + 1 - \lfloor 1.29\rfloor - 2\lfloor 1\rfloor + \lfloor 475\rfloor - \lfloor 474.75\rfloor - \lfloor 19\rfloor + \lfloor 18.99\rfloor + \lfloor 4.75\rfloor - \lfloor 4.75\rfloor$$

$$= 93 - 31 + 1 - 1 - 2 + 475 - 474 - 19 + 18 + 4 - 4$$

$$= 60$$

So, March 1, 1900 is the 60th day of year 1900

5 The Algorithms

- $a = 12y + m - 3$
- $b = a - 10$

5.1 Gregorian Calendar:

$$nd = 31m - 31 + d - \left\lfloor\frac{3m}{7}\right\rfloor - 2\left\lfloor\frac{m+7}{10}\right\rfloor + \left\lfloor\frac{a}{48}\right\rfloor - \left\lfloor\frac{y-1}{4}\right\rfloor - \left\lfloor\frac{a}{1200}\right\rfloor + \left\lfloor\frac{b}{1200}\right\rfloor + \left\lfloor\frac{a}{4800}\right\rfloor - \left\lfloor\frac{b}{4800}\right\rfloor$$

5.2 Julian Calendar:

$$nd = 31m - 31 + d - \left\lfloor\frac{3m}{7}\right\rfloor - 2\left\lfloor\frac{m+7}{10}\right\rfloor + \left\lfloor\frac{a}{48}\right\rfloor - \left\lfloor\frac{y-1}{4}\right\rfloor$$

5.3 Common year with 365days:

$$nd = 31m - 31 + d - \left\lfloor\frac{3m}{7}\right\rfloor - 2\left\lfloor\frac{m+7}{10}\right\rfloor$$

6 Counter Checking

For the counter checking of result, use the paper entitled "*Calculating Number of Days Passed Since the Introduction of Gregorian Calendar*" [1]. Where $nd = dp_f - dp_i;\ dp_f\ is\ December\ 31\ of\ the\ previous\ year;\ dp_i\ is\ the\ given\ Date.$

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References

1 http://vixra.org/pdf/1801.0177v2.pdf
2 https://en.wikipedia.org/wiki/Gregorian_calendar
3 https://en.wikipedia.org/wiki/Julian_calendar