A mondate Apology

The following sentence is found throughout the insurance industry:

A: “The value of insured losses as of December 31, 2015 by accident year is …”

The following sentence is found throughout the casualty actuarial literature:

B: “The age in months (or years) of accident year losses as of December 31, 2015 is …”

These two sentences are difficult to model in R. The mondate package was written to implement a working model of sentences A and B.

First, some insurance terminology.

Definition: An accident year is a twelve-month interval of time during which insurance events occur.

Definition: An “as of” date AOD is an instant of time recording the last time at which can occur events that influence an insurance company’s financial statements dated AOD.

Example: ABC Ins. Co.’s actuary Ed uses data as of 12/31/2015 to estimate ABC’s 12/31/2015 IBNR. This work occurs during the month of January 2016. ABC closes the books during February using Ed’s estimates. It is understood throughout the accounting community that Ed’s estimates are deemed to have taken effect as of 12/31/2015. They did not “occur” during 2016 in the sense of having an impact on changes between ABC’s accounting statements as of 12/31/2015 and 12/31/2016.

Definition: The “age” of event E as of AOD is the quantity AOD – time(E).

Note that units are not mentioned in the definition of “age”. This is because the use case’s frame of reference should determine the appropriate “unit.” As noted in sentence B indicates, a months is frequently the appropriate unit for actuarial analysis.

Sentences A and B can be modeled by base R, but with difficulty. First the easy one.

Sentence A

It is well known that international standards (ISO 8601) say that a day begins at time zero that day. Although ISO realizes that it is possible to define a day as ending at midnight 24:00:00, they also realize that midnight one day is the same as time zero 00:00:00 the following day and chose the latter approach for reasons that are not well documented. Base R follows that standard and represents an instant of time as the number of seconds that have transpired since the beginning of 1970.

On the other hand, in the accounting world, when ABC’s auditors consider all 2016 financial decisions impacting 12/31/2015 financial statements to have occurred “as of 12/31/2015”, it seems natural to consider those decisions to have taken place at “the end of the day 12/31/2015” not “the beginning of the day 1/1/2016”, although those two phrases *represent the same point in time*.

In the base R environment the “name” for the instant in time separating 2015 from 2016 is “2016-01-01 00:00:00”, or just “2016-01-01”. One way to implement the phrase “as of 12/31/2015” is by the following algorithm:

* Find the day corresponding to “12/31/2015”: as.Date(“2015-12-31”)
* Add one day: as.Date(“2015-12-31”) + 1

(I told you this one was easy! On the other hand, who wants to have to worry about having to do that calculation all the time?)

Sentence B

It is well known that a month is comprised if different numbers of days depending on the instant of time beginning the month. The same goes for “year”. On the other hand, the beginning and ending instants of any given month/year are intuitively well defined. Following that intuition, any pair of such instants are commonly referred to as a being one month apart. Using the terminology above, if one were to consider the distance between any two month-end “as of dates” in units of months, it is reasonable to think of those quantities as always being integers. For any as of date not coinciding with a month-end, if one were to define the month-time of that date, it would be reasonable to measure it as the month-time of the preceding month-end plus the proportion of the month to have transpired by the end of that date. That is the definition of a “month date” in the mondate package.

Definition: Let t represent the time as which event E occurs. Then “mondate(t)” equals the (potentially fractional) number of months since the end of 1999.

Example 1: mondate(asof(“1/31/2000”)) = 1

Example 2: mondate(asof(“2/14/2001”)) = 13.5 because the end of the 14th day is halfway through February 2001 (not a leap year).

Conversely, given any real number t, it is straightforward to find the time “YYYYMMDD HH:MM:SS.zzzzz” that is t months away from the end of 1999 by first counting whole months, then counting into the next month (if necessary) the number of days and seconds corresponding that month per the fractional value of t.

[footnote: It is not difficult to see that some months in the mondate world “last longer” than others if one were to think in terms of days. Perhaps a little known fact is that the last half of the year always “lasts longer” than the first half because the second half contains 184 days, the first half 181 or 182 depending on leap day.]

This gives rise to the following definitions:

Definition: The number of months between times t1 and t2 is mondate(t2)-mondate(t1).

Defintion: the number of years between times t1 and t2 equals the number of months divided by 12.

Case Study:

ABC Ins. Co. started on 1/1/2010 to write earthquake insurance in California. As claims are made, ABC defines the occurrence date of a claim claim to be the date of the earthquake, and stores that date in an ISO-8601 compliant object (“POSIXt”). ABC has had good luck so far – only 20 claims have been made. Here are their occurrence dates and their know values as of 12/31/2015:

data …

To complete Sentence B, we need one more definition:

Definition: The age of accident year AY as of AOD is AOD – AY-01-01.

The accident year age of the 20 claims is the vector

mondate(“2015-12-31”) – year(occurrenceDate)-01-01