

Let  $F_{29}$  be the event that a person is born on **F**ebruary **29**th, and let  $L$  be the event that that a person is born on a **L**eap year.

As a practical approximation, there are 485 leap years in 2 millennia = 2000 years, so, the probability of being born in a leap year, given a frequentist interpretation of probability, is  $P(L) = \frac{485}{2000}$  (This is a bit of a simplification, since the probability is a little bit larger than this as we've assumed equal chance of years here – see solution 2 which does not make this assumption). We can use Baye's theorem to determine the solution. According to Baye's theorem:

$$P(F_{29}|L) = \frac{P(L|F_{29})P(F_{29})}{(L)} \tag{1}$$

Rearranging terms in (1), we can easily solve for  $P(F_{29})$  using:

$$P(F_{29}) = \frac{P(F_{29}|L)P(L)}{(L|F_{29})} \tag{2}$$

We know  $P(L) = \frac{485}{2000}$ , assuming a person is equally likely to be born in any given year. Further  $P(L|F_{29}) = 1$ , since a person is born on a leap year with probability 1 if they were born on February 29th (by definition of a leap year). If we assume that a person is equally likely to be born on any given day within a leap year, then  $P(F_{29}|L) = \frac{1}{366}$ . Using these calculations in (2) above, we have:

$$P(F_{29}) = \frac{P(F_{29}|L)P(L)}{(L|F_{29})} \tag{3}$$

$$= \frac{\left(\frac{1}{366}\right)\left(\frac{485}{2000}\right)}{1} \tag{4}$$

$$= \frac{485}{732000} \tag{5}$$

$$= \frac{97}{146400} \tag{6}$$

$$\approx 0.0006625683 \tag{7}$$

To be more precise you could follow this logic: there are 485 years in a 2 millennia. So, in 2 millennia, there are  $485(366) + (2000 - 485)(365) = 730485$  total days. Of those, days, February 29th occurs in 485 of them (the leap years), so the probability is:  $\frac{485}{730485} = \frac{97}{146097} \approx 0.0006639424$ . This second solution is a closer approximation to the "true" probability of being born on February 29th, since it is not subject to as much rounding error as that in (4), but both answers are appropriate.