# K2013 implementation in R

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## K2013

We are given the following from Finanstilsynet:

```r
#The weights given by finanstilsynet
w <- function(x, G){
  #male: G = "M"
  #female: G = "F"
  #x: age in calender year t,
  if (G == "M"){
    return (min(2.671548-0.172480*x + 0.001485*x**2, 0))
  }
  else {
    return(min(1.287968-0.101090*x+ 0.000814*x**2,0))
  }
}

mu_kol_2013 <- function(x, G){
  #male
  if (G == "M"){
    return((0.241752+0.004536*10**(0.051*x))/1000)
  }
  #female
  else {
    return((0.085411+0.003114*10**(0.051*x))/1000)
  }
}

#0:alie, 1: dead
mu_K13 <- function(x, G, Y = 2022){
  return(mu_kol_2013(x, G)*(1 + w(x, G)/100)^{(Y-2013)})
}
```

The survival probability is given by:

$$p_{**}^x(t,s) = \exp\left(-\int_t^s \mu_{K13}(x+u, Y+u)du\right)$$

One way to solve this is to use the Trapezoidal rule:

$$\begin{aligned}\int_t^s f(u;x,Y)du &= \sum_{k=1}^{N} \frac{f(u_{k+1};x,Y) - f(u_k;x,Y)}{2}\Delta u_k \\ &= \sum_{k=1}^{N} \frac{\mu_{K13}(x+u_{k-1}, Y+u_{k-1}) - \mu_{K13}(x+u_k, Y+u_k)}{2}\Delta u_k\end{aligned}$$

We will evaluate the integral yearly, giving us $\Delta u_k = 1 \implies N = (s-t)$:

```r
#trapizodal rule:
p_surv <- function(x, G, t, s, Y){

  if (t == s){
    return(1)
  }

  ages  <- seq(x + t, x + s, by = 1) #x= 24 gives, 24,25,25, ...
  years <- seq(Y, Y + (s-t), by = 1) #Y= 2022 gives, 2022,2023, ...

  N <- (s-t)
  s1 <- 0
  for (k in 1:N){
    s1 <- s1 + 0.5*(mu_K13(x = ages[k]   , G = G, Y = years[k]) +
                    mu_K13(x = ages[k+1], G = G, Y = years[k+1])
                    )
  }
  ans <- exp(-s1)
  return(ans)
}

#24 year old man, surviving the next 10 years, given that we are in 2022:
p_surv(24, "M", 0, 10, 2022)
```

```
## [1] 0.9967247
```