

# GLOSSARY OF TERMS - SURVIVAL MODELS

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## Deterministic Approach (where you know exactly how many persons will die at each age)

### Life table functions

$l_x$  :- the number of persons alive aged  $x$  in a life table. For example, we might have  $l_0=100$ ,  $l_1=90$ ,  $l_2=82$ ,  $l_3=75$ , etc. which would mean that out of 100 births, 90 persons are alive at exact age 1, 82 alive at exact age 2, 75 alive at exact age 3 etc.

$d_x$  :- the number of persons who die aged  $x$  last birthday. In the above example,  $d_0=10$ ,  $d_1=8$ ,  $d_2=7$  etc.

$p_x$  :- the probability that a person aged exactly  $x$  survives one year to exactly age  $(x+1)$  i.e. the probability of surviving one year. Example,  $p_0=90/100=.9$ ,  $p_1=82/90=.9111$ ,  $p_2=75/82=.9146$ , etc. Hence  $p_x = l_{x+1}/l_x$ .

$q_x$  :- the probability that a person aged exactly  $x$  dies before exact age  $(x+1)$ ,  $q_x = (1-p_x)$  i.e. the probability of dying in the next year. Example,  $q_0=10/100=.1$ ,  $q_1=8/90=.0889$ ,  $q_2=7/82=.0854$ . Hence  $q_x = d_x/l_x$ .

${}_t p_x$  :- the probability that a person aged exactly  $x$  lives for another  $t$  years to exact age  $(x+t)$ . Hence  ${}_t p_x = l_{x+t}/l_x$ .

${}_t q_x$  :- the probability that a person aged exactly  $x$  dies before exact age  $(x+t)$ . Hence  ${}_t q_x = 1 - {}_t p_x = (l_x - l_{x+t})/l_x$ .

${}_m|{}_n q_x$  :- the probability that a person aged exactly  $x$  dies between exact ages  $(x+n)$  and  $(x+m+n)$ . Hence  ${}_m|{}_n q_x = (l_{x+n} - l_{x+m+n})/l_x$ . The period  $m$  is sometimes referred to as the deferred period.

$\mu_x$ , force of mortality :-  $\mu_x = -\frac{1}{l_x} \frac{dl_x}{dx}$ . Hence  $\mu_x$  represents the instantaneous rate at which people are dying. If  $x$  is fixed and  $t$  is the variable then  $\mu_{x+t} = -\frac{1}{l_{x+t}} \frac{dl_{x+t}}{dt}$ . By integration of this equation it can

be seen that  $l_{x+t} = l_x e^{-\int_{s=0}^{s=t} \mu_{x+s} ds}$  and therefore that  ${}_t p_x = e^{-\int_{s=0}^{s=t} \mu_{x+s} ds}$

**Assumption of uniform of distribution of deaths between exact ages  $x$  and  $(x+1)$  :-** The  $d_x$  deaths between ages  $x$  and  $(x+1)$  are assumed uniformly spread across the year of age. Hence  $l_{x+t} = l_x - t d_x$  for  $0 \leq t \leq 1$ .

**Assumption of constant force of mortality between exact ages  $x$  and  $(x+1)$  :-** The force of mortality between ages  $x$  and  $(x+1)$  is assumed constant ( $\mu_x$ , say). Hence,  $l_{x+t} = l_x e^{-\mu_x t}$  for  $0 \leq t \leq 1$ .

# Terms Of Survival

**Jicheng Xie**



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