

Project L7

Instructions to the candidate

- (i) Read the attached document, which describes the background to this project. You will also be given an additional piece of information later on in the day.
- (ii) Build a model that uses the 1985 population, mortality and fertility data to project the male and female rabbit populations to the end of each year from 1986 to 2005. You should document all assumptions made.
- (iii) Illustrate these projections using a suitable chart.
- (iv) Compare the projected populations as at 2005 with the 2005 population survey information provided. **You are not required to perform any statistical tests.** By repeating the calculations performed in (ii), determine an adjustment that could be made to fertility rates in order for the projections to reconcile more closely to the 2005 population survey data. You may assume that the same adjustment may be made to all of the fertility rates given.
- (v) Illustrate the comparisons as at 2005 between original projections, adjusted projections and population survey data using a suitable chart.
- (vi) Repeat the above as appropriate using the additional information given to you later in the day. Include the results in the chart produced in (v).
- (vii) Prepare a set of five or six pages of summary with visual aids capturing the main features and results. You should cover the following:
 - data, approach and assumptions used
 - initial projection of rabbit populations
 - adjustment to fertility rates and comparison of the result with the 2005 population survey
 - results from using the additional information
 - conclusions, including any reservations on the model and suggested next steps

END

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Background

The city of Actuopolis has a large common, one corner of which is inhabited by a colony of rabbits. A population survey of these rabbits was taken on 31 December 1985, estimating the population split by age to be:

<i>Age last birthday</i>	<i>Male</i>	<i>Female</i>
0 – 2	12,000	13,000
3 – 4	6,000	5,000
5 – 6	4,000	5,000
7 – 8	1,000	2,000
9+	<u>0</u>	<u>250</u>
Total rabbits	23,000	25,250

Around the same time, a local scientist published his research on the mortality and fertility rates experienced by this rabbit population. From studying the colony for several years, he noted that the rabbits exhibited some features similar to human lives, including lower female mortality rates at higher ages and higher male mortality rates at younger ages. However, he also observed higher mortality rates in younger females related to reproduction. He produced the following table of estimated mortality rates:

<i>Age exact (x)</i>	<i>Male q_x</i>	<i>Female q_x</i>
0 – 1	0.3	0.2
2 – 4	0.3	0.4
5 – 6	0.4	0.4
7	0.6	0.4
8	1.0	0.6
9 +	1.0	1.0

The scientist found it more difficult to estimate fertility rates. However, he concluded that the number of baby rabbits born in a year to each female of reproductive age was estimated to be 3.0 for female rabbits aged from 2 to 4 last birthday and 2.0 for those aged from 5 to 7. Older and younger rabbits are not able to reproduce.

You have been asked to perform a projection of the estimated rabbit population at the end of each year from 1986 to 2005 using the above data, separately for males and females.

A further population survey was performed on 31 December 2005, estimating the population split to be:

<i>Age last birthday</i>	<i>Male</i>	<i>Female</i>
0 – 2	35,000	40,000
3 – 5	10,000	10,000
6+	<u>2,000</u>	<u>2,000</u>
Total rabbits	47,000	52,000

You have also been asked to compare this population survey data with the projected year end 2005 rabbit population based on the 1985 data. Some doubts have been cast on the scientist's estimates regarding fertility rates, given the secrecy with which these rabbits give birth. You have been asked to investigate whether any differences between the 2005 population survey data and the projected 2005 position using the original 1985 data can be explained by inaccurate estimation of the fertility rates.

A further piece of information will be provided later on in the day.

END

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Additional information

To be provided later on in the day

Following the publication of the first scientist's research, two other scientists published differing opinions in reviews of the work.

One scientist who has also researched this rabbit colony claimed that in December 1995 there was a serious epidemic of rabbit 'flu. He has estimated that this 'flu killed one third of the rabbit population and that for the following three years the fertility rates were reduced to 60% of their previous level.

The other scientist, who has observed different rabbit colonies, put forward the opinion that, as for humans, a slightly higher proportion of males than females are born. The impact of this would have a serious impact on the number of females of reproductive age.

For each of these suggestions, you have been asked to investigate whether it could account for the difference between the 2005 population survey data and the projections based on the original 1985 data.

END