This is the start of a project that will culminate in Ma 419. This semester you will focus on developing a life table, computing premiums and policy values. The project will be collected in multiple stages with two large deliverables: the life table and the policy premiums/valuations. You should plan to complete relevant portions of the project prior to the in-class test on the corresponding material for most efficient learning.

Completion of each of the major portions of the assignment (Life Tables and Premium/Valuation) as described can earn at most a B+ (maybe an A- if your professor is very, very impressed with your work and its presentation). There are enhancement opportunities for each of the major portions. Completion of the enhancements will give you the opportunity to raise your grade for each assignment respectively.

There are several goals for this assignment.

- To help you develop your understanding of life tables and the computations involved in premium determination and policy valuation.
- To help you develop your ability to handle larger, less well-defined problems than homework and exam problems provide. Feel free to ask questions if any portion of the assignment is not clear.
- To integrate skills learned in other courses and help you develop your R and communication skills.

Work Log: You are to maintain a work log for this project. It should include the following information: Date and number of hours spent (rounded to the nearest 15 minutes), task accomplished during that time, and total time invested to date.

Life Tables Assignment:

1. Given ages at death data, construct a table with all the components of the SOA LTAM SULT as well as expected lifetimes.

2. Estimate values for the Makeham's law from your table using a least squares technique/optimization technique. Present your model and show that it fits the data well.

3. Estimate the probability of death at each age given they are alive at age 20, and address the error bounds for these estimates. Determine the sample size necessary for the estimates to be accurate to six decimals.

4. Life Table Enhancement: For each age $20, 20.25, 20.5, 20.75, \ldots, 114.75, 115$, compute $l_x, d_x, {}_{0.25}p_x$, and ${}_{0.25}q_x$. Using p_x and q_x for integer values of x from your table and the UDD and constant force of mortality assumptions estimate ${}_{0.25}p_x$ and ${}_{0.25}q_x$. Compare and discuss the accuracy of these estimators for mortality as described by your data set.

First Step: Make a list of every piece of information that you are going to need to generate even if it isn't explicitly listed on the table. Add the section number from the text that covers the material (include later sections in the text which may contain alternate formulas for the computation in question). Using the estimated test dates for the course and the content order of the textbook, add an estimated date that the material will be covered, and based on these dates estimate due dates to complete each task (order your list in chronological order).

R Initialization: Create an R project to contain all your work and save your environment/history and an R Markdown file to contain your code and the outputs. Import the provided data and create a dataframe with columns for everything you think you will need (give your columns readable/interpretable names). Fill the column containing the ages (the x column) for your table.

Using section labels (#, ##, etc.) in R Markdown, create an R code section and a short text description/formulas for each thing you think you will need to compute (preferably in the order that you will need to compute it). Impose structure/hierarchy to make it easier to follow and search through your code (use the Outline feature). Work on learning to format the text portions so that it knits attractively (Latex is helpful here).

Life Table Expectations:

1. Assume an annual interest rate of 5%(1), a starting age of 20 and a final age of 115.
2. You must create your tables in R manually (not using the MortalityTables or other similar packages). You may not use the life table workbook provided with the LTAM tables. These resources defeat a major portion of the exercise.
3. Present your life table neatly and attractively formatted, easy to read, one page wide.
4. Each computation should be clearly developed in your RMarkdown file (include a description/explanation of the computation prior to the computation). You may wish to learn about Latex for adding math equations to your RMarkdown.

Project Initialization/Plan Submission: Submit the project timetable and your knitted HTML file of your outline (printed in class).

Project Initialization/Plan (15 pts)

Due In Class: August 31, 2023, 9:30am

Meetings: Schedule a meeting with your professor during the weeks of September 5th, 18th and October 2nd to discuss your progress and your plan for next steps. Email your work log in advance of the meeting. Come prepared to give an update on your progress and have at least two questions you have about the project, your project planning, or problems you are or anticipate having. This meeting will a graded activity and your grade will be based on your preparation for the meeting, your completion of work, and your participation in the discussion (the more ownership of this meeting you take, the better your grade will be).

Meeting Completed (20 pts) by: September 8, 2023, 3:00pm

Meeting Completed (20 pts) by: September 22, 2023, 3:00pm

Meeting Completed (20 pts) by: October 6, 2023, 3:00pm

Life Tables Submission: Your submission should include your work log, a pdf of your life table, your RMarkdown file, and a knitted HTML file of your RMarkdown file. Your RMarkdown file should contain every command needed to generate your life table.

Life Tables Deliverables (175 pts)

Due Online: October 19, 2023, 11:59pm

Life Table Revision: Recompute any columns in your table that have incorrect values and resubmit the Life Table deliverables in its entirety. You may wish to confirm with your professor that your corrections are right before resubmitting them. You are welcome to get additional help from your professor. You may not continue with the project until you have a correct life table.
If there were no errors in your life table, you do not need to resubmit the life table.

Life Tables Revision (20 pts) and Enhancement (30 pts)

Due Online: November 1, 2023, 11:59pm

Premiums and Policy Valuation Assignment:

First Step: Do some research using credible sources. Define anticipated characteristics about your life at age 25 and past, and determine the life insurance you expect to need (include everything necessary to define the policy). Explain the logic of your answer. Be sure to appropriately cite all sources for your research.

Life Insurance Policy (15 pts)

Due To Professor: November 8, 2023, close of building

Assignment: Use the insurance policy approved by your professor. Assume premiums are payable annually for 30 years, initial expenses are \$150 plus 40% of the premium, annual renewal expenses are \$15 plus 5% of the premium, and expenses at the time benefits are paid are \$300 plus 2% of the issue amount. Using the life table, create an RMarkdown file that computes the premium for your policy as well as the valuation for each year the policy is active (assume that all premiums are paid).

Submission: Submit your work log and a written report summarizing the policy information given and computed. The document should be professionally formatted and contain all information about the policy (a self contained document). Also submit your RMarkdown file and the knitted HTML file of your RMarkdown file. The RMarkdown file should contain all the commands needed to generate your results.

Enhancement: Create a random interest rate for each year the policy is in effect. Using Monte Carlo simulation recompute the valuation for each year using the randomly generated yearly rate. Present a report including the descriptives and a distribution for the interest rates and valuation for the year with largest valuation (justify from the data that you've selected the most likely year to have the largest valuation).

Meeting: Schedule a meeting with your professor during the week of November 27th to discuss your progress and your plan for next steps. Email your work log in advance of the meeting. Come prepared to give an update on your progress and have at least two questions you have about the project, your project planning, or problems you are or anticipate having. This meeting will a graded activity and your grade will be based on your preparation for the meeting, your completion of work, and your participation in the discussion (the more ownership of this meeting you take, the better your grade will be).

Meeting Completed (20 pts) by: December 1, 2023, 3:00pm

Premium Computation/Policy Valuation (100 pts) and Enhancement (15 pts)

Due Online: December 7, 2023, 11:59pm

MA 418 ACTUARIAL MATH RUBRIC NAME:

MEETINGS ~ 20 POINTS

_____/ 50% Work log submitted, appropriate time invested and progress made

_____/ 25% Prepared for the meeting with updates of progress and questions

_____/ 25% Managed the meeting well

_____/ 20 pts

MA 418 ACTUARIAL MATH RUBRIC NAME:

MEETINGS ~ 20 POINTS

_____/ 50% Work log submitted, appropriate time invested and progress made

_____/ 25% Prepared for the meeting with updates of progress and questions

_____/ 25% Managed the meeting well

_____/ 20 pts

LIFE TABLE ~ 175 POINTS

_____/ 10% Clarity and organization of RMarkdown file, R code is easy to follow/good use of chunking, naming convention is readable, readability/presentation of tables, etc.

_____/ 60% Table completeness/accuracy

$x \quad l_x \quad q_x \quad \ddot{a}_x \quad A_x \quad {}^2A_x \quad \ddot{a}_{x:\overline{10}|} \quad A_{x:\overline{10}|} \quad \ddot{a}_{x:\overline{20}|} \quad A_{x:\overline{20}|} \quad {}_5E_x \quad {}_{10}E_x \quad {}_{20}E_x \quad e_x/\mathring{e}_x$

_____/ 15% Model for force of mortality, $\mu_x = a + be^{cx}$, presentation and fit

_____/ 15% Estimates and error bounds for ${}_{x-20}|q_{20}$, sample size

– _____/ 0% Penalty: failure to follow directions, lack of professionalism, etc.

_____/ 175 pts

LIFE TABLE REVISION ~ 20 POINTS

_____/ 20 pts Table completeness/accuracy

$x \quad l_x \quad q_x \quad \ddot{a}_x \quad A_x \quad {}^2A_x \quad \ddot{a}_{x:\overline{10}|} \quad A_{x:\overline{10}|} \quad \ddot{a}_{x:\overline{20}|} \quad A_{x:\overline{20}|} \quad {}_5E_x \quad {}_{10}E_x \quad {}_{20}E_x \quad e_x/\mathring{e}_x$

ENHANCEMENT ~ 30 POINTS

_____/ 70% Comp and approx complete/accuracy $x \quad l_x \quad q_x \quad {}_{0.25}p_x \quad {}_{0.25}q_x \quad UDD \quad Const\ \mu$

_____/ 30% Accuracy comparison is clearly, professionally presented, includes all pertinent information

_____/ 30 pts

Life Insurance ~ 15 points

_____/ 15 pts Appropriately researched, reasonable logic/amount, all information needed

Premiums and Policy Valuation ~ 100 points

_____/ 10% Clarity and organization of RMarkdown file, readability/presentation of tables, etc.

_____/ 70% Correct premium and valuation computation

_____/ 20% Summary is clearly, professionally presented, includes all pertinent information

– _____/ 0% Penalty: failure to follow directions, lack of professionalism, etc.

_____/ 100 pts

Enhancement ~ 15 points

_____/ 65% Monte Carlo simulation for valuations

_____/ 25% Descriptives of simulation and distribution of valuation values, justification of largest

_____/ 10% Professionalism of presentation of results

_____/ 15 pts