Project examples.

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I am very early in my thoughts on the contents of my project, hence the scarse description. In general, i would prefer my number one priority.

1. **Non-markov modelling**
   In general, a study on the repercussions of specified Markov model when in fact the underlying process is Non-Markov. Offer a solution in implementing a Non-markov model in calculating future expected cash flow. Study some of the questions/tasks below broadly and others in depth.

   (a) Define a general jump process in terms of the cumulative transition rates $q_{i,jk}(t,s)$ revolving around the dynamics of q and its role in the jump process.

      i. Classify the Non-Markov and Markov model as examples and show how q is defined in each model. Perhaps give a framework for semi-markov jump processes such as them with state duration. How can this be reflected in the definition in (a)?

   (b) Determine estimators for the cumulative transition rates.

      i. Apply them to the models described in (a).i.

      ii. Do the converge to the desired object? How?

      iii. How do they relate to on another and what data is required?

   (c) If possible, compute the systematic error and estimation error under some appropriate loss function.

   (d) Simulate at least two datasets from a Markov and Non-markov jump process respectively. Maybe, give a short description on how the data is generated.

      i. What are the estimates for a Markov and Non-Markov regression? How do the predictions differ?

      ii. Calculate the systematic error and estimation error in each dataset. How do the two models compare?

      iii. How could one improve on the error? Is the error bounded?

   (e) If possible, study a real-life dataset. Estimate and compute cash flows.

   (f) Discuss, how one may test if the underlying model is Markov or Non-Markov? Can one say anything concretely on for instance the need number of observations?

   (g) Discuss, if one can formulate an alternatively Non-markov estimator that does not need *as much information* in order to converge if indeed the process is Non-Markov.

   Some relevant literature could include: Christiansen 2021 on *On the calculation of prospective and retrospective reserves in non-Markov models.*

2. **Transaction time models**
   Study more advanced real life products in life insurance, that are greatly impacted by the delays in reporting and/or approving. What need to be modelled and what data need to be collected? Implement methods in estimating reserves given simulated or real data. Some questions/task could include.

   (a) Defining a theoretical framework for the transaction time model and the valid time model. Here let Z_t be the transaction time model and X_t be the underlying biometric model.

   (b) Define a generalized insurance product including related transaction model.

   (c) Give a concrete example of an insurance product.

   (d) Discuss, how one may simulate from the joint process (X_t, Z_t). Simulate data.

   (e) Discuss estimation methods and implement an estimation of the jump intensities. What does one have to assume about (X_t, Z_t) and how does on incorporate the data in the estimation?

   (f) Study the expected cash flow in transaction time and the reserve in transaction time and valid time. How do the differ? What may be the consequences of not modelling transaction time?

   Some relevant literature could include: Buchardt, Furrer, and Sandqvist, 2023 on *Transaction time models in multi-state life insurance*.