Problem Set 1

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1 Model of firms performance outcomes based on consultant quality

In the article *Coevolution in Management Fashion: An Agent- Based Model of Consultant-Driven Innovation* by D. Strang, *et. al.*[1], the authors describe a simple theoretical model of a firms performance outcomes (O_{it}) based on the quality of their consultant (Q_c) and a few other factors, this is given in equation 1 and is found on page 234 of the issue.

$$O_{it} = \alpha V_j + \beta Q_c + (1 - \alpha - \beta)\varepsilon_{it} \tag{1}$$

This model has two parameters α and β, who are constrained by the relationship given in equation 2.

$$0 \leq \alpha + \beta \leq 1 \tag{2}$$

The equation has a firms performance outcome (O_{it}) at a particular time interval (t) and for a specific firm (i) as an endogenous variable which is dependant on the two exogenous variables: V_j the firms chosen innovation and Q_c the quality of the consultant. There is also an error term ε_{it} that is described as being "*random noise*", so I assume a uniform distribution. This model is simply a starting point for the much more complex agent-based model so the units of the variables (as well as their exact meanings) are left undefined.

The model is not static as different between time intervals are considered. The model is linear as each variable is linearly related. And the model is stochastic as their is an error term that gives stochastic results.

While this model is simple by design I think a cross term would a much to its validity. In particular a variable relating the previous results of all firms O_{t-1} to the performance outcome this interval. This would take the form of a vector giving the modifier each firm's results last interval have on this firm this interval. This then might multiply with Q_c to amplify or dampen the consultant's effect.

[1] Strang, David, Robert J. David, and Saeed Akhlaghpour. "Coevolution in Management Fashion: An Agent-Based Model of Consultant-Driven Innovation1." *American Journal of Sociology* 120.1 (2014): 226-264.

2 Musician Lifespan Model

We can model the lifespan of popular musicians as a Bernoulli process. Each year is a trial, success they live, failure they don't. The probability of success I propose, p_{live}, is given in equation 3.

$$p_{live} = tanh(\alpha(N_{t-1} - N_t) + \beta) + 1 \quad (3)$$

Where N_t is the average popularity,if they do not die, of the musician during year t (year 1 is the first year they are alive, year 2 is the second ... and $N_0 = 0$) (an exogenous variable), α and $beta$ are scaling factors (parameters) and $tanh$ is the hyperbolic tangent function. Thus musicians are most likely to die when they are becoming less popular and least likely to die when their popularity is increasing rapidly. To use this model to predict a musicians lifespans you would need their popularity measurements at all years after their birth. Then you simulate a large number of runs and compute their mean life expectancy. To simulate a run at each year you compute their p_{live}, then do a single Bernoulli trial with that probability and if it is a success go to the next year, while if it is a failure record that year as the terminal one.

As this model is only dependant on a single factor, popularity, it has the largest impact and is thus is the key factor. Outside of the model age, health and wealth are all very significant to a humans life expectancy and thus would likely improve the model if added. I decided to not include these as they correlate with the measure I am using, which is the delta of popularity. When the musician is young and healthy their chance of death is low, which is what my model predicts. Then as time progresses they will stop becoming more popular which correlates with age and thus an increase in mortality risk. If there is a sudden decrease in popularity that will likely also reduce income and thus increase risk of death. One note though is that this model does allow for musicians to live indefinitely, particularly if they constantly increase in popularity.

To test this model I would gather the lifetime popularity information about a series of artists as well as their posthumous popularity, although this would need to be corrected for the spike do to their death. Using this data I could compute their expected lifespans as well as the variance and check how closely this fits with my model. Also the model allows me to predict which years are most likely to be fatal so checking if those years are more likely would be another test.