MA888 Ecological Statistics

`Maple`: Detecting parameter redundancy

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1 Introduction

The original `Maple` code to detect and diagnose parameter redundancy in mark-recapture models was written by Ted Catchpole. `Maple` is a symbolic algebra package and is capable of calculating derivatives of symbolic expressions and also the rank of the derivative matrix which is the methodology proposed by Catchpole and Morgan for detecting parameter redundancy within the models. Diana Cole has rewritten Ted's code to be compatible with the current version of `Maple` on the student desktops.

2 Start Up Instructions

1. Copy the folder `Maple` from the MA888 Ecological Statistics course folder on moodle.

2. Start Maple by accessing it through the departmental software (START → All Programs → Departmental Software → IMSAS → Maple 13).

3. Within `Maple`, open the file `StartingCode.mw` which is located in the `Maple` folder.

4. Firstly, we need to read in the functions which have been written for you. Place the cursor next to the

   ```
   > restart;
   ```

   command on the screen and press `RETURN`. This instructs the program to perform the command. You need to go through all of the code on the screen and whenever there is a > command you need to press `RETURN` on that line.

5. Once you have reached the end of the code on the screen you are ready to start using the functions you have loaded.

3 Basic Cormack-Jolly-Seber Model

1. Suppose we want to examine a Cormack-Jolly-Seber model which had three cohorts of animals released and 3 recapture occasions. First lets enter the dimensions of the experiment, and also the size of the parameter matrices we are going to be constructing:

   ```
   > m:=3:k:=3:
   > Phi:=Matrix(m,k):
   > P:=Matrix(m,k):
   ```

2. Now we wish to establish the form of the ϕ's and the p's. Note that when we wish to enter a block of code without finishing it on a single line, rather than just pressing `RETURN` to start the new line, you must enter `SHIFT-RETURN`. This will allow you to keep typing the command without the program trying to run it. To enter:

   ```
   > for i from 1 to m do
           for j from i to k do
                   Phi[i,j]:=phi[j]:P[i,j]:=p[j]:
           end do:
     end do:
   ```

   You actually have to type:

   ```
   > for i from 1 to m do SHIFT-RETURN
           for j from i to k do SHIFT-RETURN
                   Phi[i,j]:=phi[j]:P[i,j]:=p[j]: SHIFT-RETURN
           end do: SHIFT-RETURN
     end do: RETURN
   ```

3. You can see what is in the matrix Φ by typing:

   ```
   > Phi;
   ```

4. You can see what is in the matrix P by typing:

   ```
   > P;
   ```

5. Next we use the procedure `CumSurviv`:

   ```
   > Z:=CumSurviv(Phi);
   ```

6. Then we use the procedure `CumRecp`:

   ```
   > W:=CumRecp(P);
   ```

7. Now we perform point-wise multiplication of the matrices Z and W in order to form the basic probability matrix, which we call Ω:

   > Omega:=pmult(Z,W);

8. Next enter the parameters:

   > pars:=<phi[1]|phi[2]|phi[3]|p[1]|p[2]|p[3]>;

9. Next we convert Ω to a column vector using the procedure `Matvec`:

   > kappa:=Matvec(Omega);

10. We then form the derivative matrix

    > DD:=Dmat(kappa,pars);

11. In order to calculate the number of estimable parameters we then calculate the rank of the derivative matrix:

    > Rank(DD);

    How many of the six parameters in the model are estimable?

12. What happens if we examine the log of the Ω matrix instead? The code below finds the log of the entries of κ.

    ```
    > for i from 1 to Dimension(kappa) do
          kappa[i]:=ln(kappa[i]):
      end do:
    ```

13. Recalculate the derivative matrix using the newly defined κ. How does the derivative matrix change?

14. Calculate the rank of the new derivative matrix. Is the rank the same for $ln(\kappa)$ as for κ?

15. As the model is not full rank, what combinations of parameters are estimable? This can be found using the procedure `Estpars`:

    > Estpars(DD,pars);

4 Further CJS Example

Suppose now, instead of having 3 columns and 3 rows of data, that you are limited with only 2 rows of data, but still 3 columns of data. By setting $m = 2$ and $k = 3$, rerun the analysis above and explain which of the parameters are estimable now. Explain the result intuitively.