Principal Components Analysis Utility in the Livestock Field

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Abstract

Principal Component Analysis is a method factor - factor analysis - and is used to reduce data complexity by replacing massive data sets by smaller sets. It is also used to highlight the way in which the variables are correlated with each other and to determine the (less) latent variables which are behind the (more) measured variables. These latent variables are called factors, hence the name of the method i.e. factor analysis. Our paper shows the applicability of Principal Components Analysis (PCA) in livestock area of study by carrying out a research on some physiological characteristics in the case of ten cow breeds. By using PCA only two factors have been preserved, concentrating over 80% of their information from the four variables in question, one factor concentrating weight and height and the other factor concentrating trunk circumference and weight at calving, respectively.

Keywords: correlation matrix, factor analysis, main components

INTRODUCTION

Principal Components Analysis method first appeared in various psychological studies that attempted to assess variables such as intelligence, more exactly how one can evaluate characteristics such as power of assimilation, understanding, responsiveness, and one found that many of them are determined by a hidden variable i.e. intelligence (Helmy *et.al*, 2009). The initiator of Principal Components Analysis was Pearson and in 1933 this method was subsequently developed by Hotelling.

AIMS AND OBJECTIVES

The objective of this paper is to provide information about the Factor Analysis method which is method widely spread and used in various domains, such as livestock sector.

MATERIALS AND METHODS

Four physiological characteristics were considered in our analysis: height (cm), weight

(kg), the trunk circumference (cm) and weight of the calves at calving (kg) for ten breeds of cattle. For these ten breeds of cattle were considered average values for height, weight, trunk circumference and weight of calves at calving. The data are showed in Table 1 below.

The Principal Components Analysis method consists in the presence of a set of variables $X_1, X_2, \dots, X_m$, and one aims to determine a new set of variables $F_1, F_2, \dots, F_n$, also called factors or components, where $F_i = v_{i1}X_1 + v_{i2}X_2 + \dots + v_{im}X_m$, provided that $n < m$. Reversal is also required, that is the possibility to retrieve the variables X using components, i.e. $X_i = b_{i1}F_1 + b_{i2}F_2 + \dots + b_{in}F_n$. Thus one may notice that via components one attempts to reduce the number of variables, without losing the original variables variance.

RESULTS AND DISCUSSION

Our paper uses Principal Components Analysis technique using SPSS. KMO (Kaiser-Meyer-Olkin) is a statistic test that indicates the degree of

Tab. 1. Physiological characteristics in the case of ten cattle breeds

Breed Cows	Physiological Characteristics			
	Height (cm)	Weight (kg)	Trunk circumference (cm)	Weight calves at calving (kg)
Romanian Spotted Cow	133	600	186	39
Jersey	130	400	130	25
Fleckvieh	150	750	145	30
Brown Cow	123	450	127	32
Piemontese	128	570	150	45
Holstein	140	650	160	40
Simmental	138	700	140	42
Red Steppe Cow	133	525	145	35
Estonian Red Cow	130	530	140	30
Ayrshire	134	450	132	32

Tab. 2. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.304	57.603	57.603	2.304	57.603	57.603	1.754	43.842	43.842
2	1.135	28.373	85.976	1.135	28.373	85.976	1.685	42.134	85.976
3	.482	12.038	98.013						
4	.079	1.987	100.000						

Extraction Method: Principal Component Analysis.

Tab. 3. Rotated Component Matrix^a

	Component	
	1	2
Height	.985	-.019
Weight	.852	.448
Trunk_circumference	.238	.805
Weight_calves_at_calving	.031	.915

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

association of the variables. In our case, KMO test is 0.436. This value is an argument favorable to the existence of factors, suggesting that factoring is appropriate.

From Table 2 below one concludes how much of the total variance is explained by retaining the two components as follows: if one accepts only one component 57.60% of the data total variance

is explained; by accepting two components one recovers and additional 28.37% of the data total variance, therefore a total of 85.97% is a very good result for this analysis.

For a better understanding of data their rotation was required using Varimax method that minimizes the number of variables with high loadings on each factor. Loading matrix

was displayed after rotation and in this case the differences in terms of load factors are highlighted better. A latent variable factor should bear a name in order to be understood. Loading structure of a factor can provide suggestions in this regard, namely loadings >0.6 are considered to be important and those <0.4 are low (see Table 3).

In the chart on the left one may notice the distribution of variables by the two components, namely:

- Factor 1 is well correlated with weight and height;
- Factor 2 is strongly correlated with trunk circumference and with the weight of calves at calving.

CONCLUSION

This paper is conceived to provide a theoretical section for the factor analysis method and a practical application thereof in the livestock sector, by reducing data size, by using four variables i.e. weight, height, circumference of the

trunk and weight of the calves at calving for ten cattle breeds. By using PCA only two factors have been preserved, concentrating over 80% of their information from the four variables in question, one factor concentrating weight and height and the other factor concentrating trunk circumference and weight at calving, respectively.

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