

RANKING OF PRINCIPAL COMPONENT SCORES, BY MEANS OF A TOTAL QUALITY INDICATOR

E. Cascini

AICQ – AISS

e-mail: e.cascini @ alice.it



THE CONTEXT

LET US CONSIDER 10 ITEMS, EACH OF ONE IS CHARACTERIZED BY 7 DIFFERENT CHARACTERISTICS. EACH CHARACTERISTIC IS RANKING FROM BETWEEN 0 AND 1.

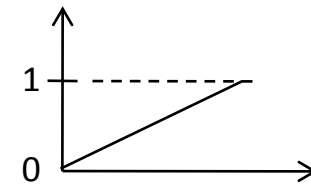
		<i>Caratteristiche</i>						
		1	2	3	4	5	6	7
<i>Item</i>	1	0,40	0,68	0,92	0,32	0,66	0,12	0,22
<i>Item</i>	2	0,30	0,72	0,90	0,28	0,77	0,14	0,25
<i>Item</i>	3	0,45	0,58	0,88	0,40	0,78	0,18	0,99
<i>Item</i>	4	0,48	0,66	0,79	0,30	0,65	0,26	0,30
<i>Item</i>	5	0,46	0,65	0,12	0,38	0,66	0,30	0,42
<i>Item</i>	6	0,90	0,72	0,70	0,30	0,77	0,14	0,25
<i>Item</i>	7	0,55	0,70	0,85	0,26	0,66	0,14	0,90
<i>Item</i>	8	0,30	0,72	0,90	0,28	0,77	0,14	0,88
<i>Item</i>	9	0,48	0,20	0,79	0,30	0,65	0,26	0,30
<i>Item</i>	10	0,48	0,66	0,10	0,42	0,60	0,32	0,40



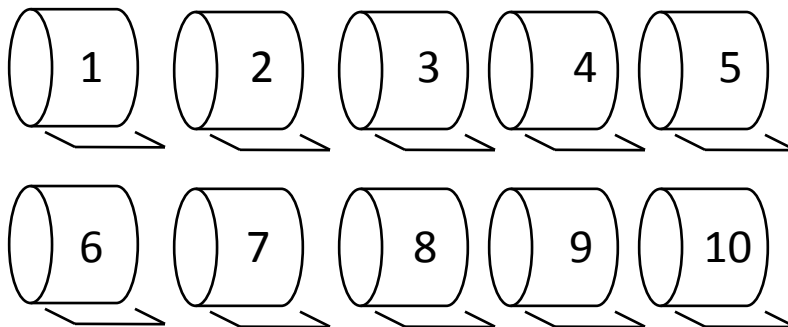
IN THE TABLE AN ITEM IS A POLYESTER ROLL, A CHARACTERISTICS IS A QUALITY REQUIREMENT, SUCH AS:

1. THICKNESS
2. CALIPER VARIATION
3. BREAK STRENGTH
4. BREAK ELONGATION
5. HEAT SHRINKAGE
6. SURFACE DEFECTIVENESS
7. HAZE

FOR EACH OF THE CHARACTERISTICS
A PROPER FUNCTION IS STATED, TO
TRANSFORM A PHYSICAL MEASURE
IN A NUMBER RANKING FROM 0 AND 1



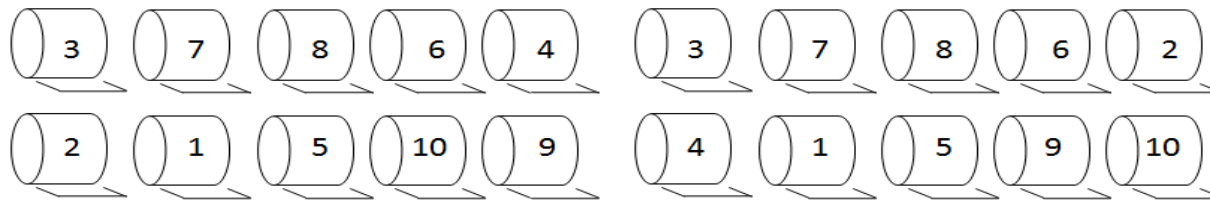
A PHYSICAL MEASURE



TO EACH OF THE CHARACTERISTICS
A WEIGHT OF IMPORTANCE ,RANKING
FROM BETWEEN 0 AND 1, IS GIVEN



IN THIS WORK IT IS SHOWN HOW THE RANKING HEREBELOW REPORTED HAS BEEN ESTABLISHED. AN INDEPENDENT RANKING BY A VERY PROFESSIONAL CUSTOMER HAS REPORTED TOO.



FROM CALCULATIONS

FROM PROFESSIONAL CUSTOMER

THE PROCEDURE STARTS FROM THE SCORES COMING FROM THE PRINCIPAL COMPONENT ANALYSIS; AND SHOWS HOW RANKING THE SCORES BY A TOOL INDICATING THE TOTAL QUALITY OF AN ITEM. IT IS SHOWN, THEN, THAT PASSING THROUGH THE PRINCIPAL COMPONENTS ANALYSIS CAN BE AVOIDED



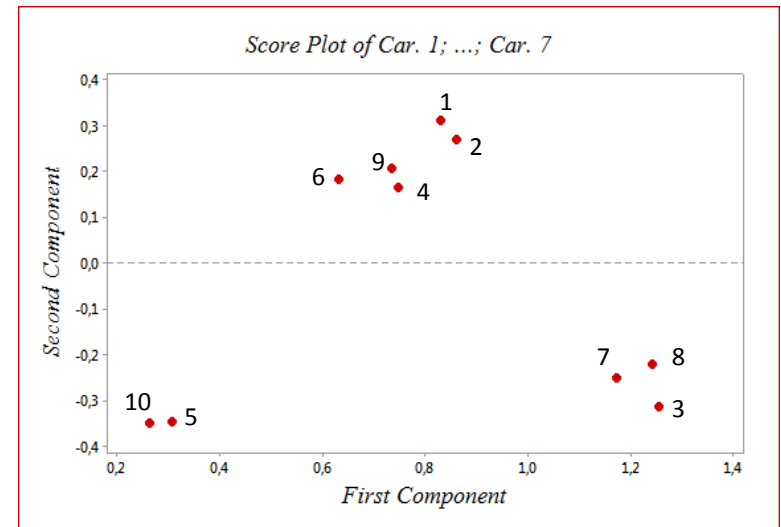
PRINCIPAL COMPONENT ANALYSIS

Eigenanalysis of the Covariance Matrix

Eigenvalue	0,12390	0,07874	0,02825	0,02378	0,00277	0,00129	0,00078
Proportion	0,477	0,303	0,109	0,092	0,011	0,005	0,003
Cumulative	0,477	0,781	0,890	0,981	0,992	0,997	1,000

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7
Car. 1	-0,127	0,059	0,792	0,587	-0,058	-0,062	0,037
Car. 2	0,032	-0,095	0,566	-0,784	-0,137	-0,127	0,143
Car. 3	0,757	0,601	0,018	0,041	-0,092	-0,205	0,117
Car. 4	-0,075	-0,109	-0,049	0,015	0,324	-0,897	-0,265
Car. 5	0,110	0,026	0,127	-0,053	0,916	0,229	0,278
Car. 6	-0,157	-0,101	-0,178	0,115	-0,150	-0,284	0,904
Car. 7	0,607	-0,777	0,039	0,154	-0,055	0,023	0,004

Score 1	Score 2	Score 3	Score 4	Score 5	Score 6	Score 7
0,830534	0,310905	0,773476	-0,24262	0,476428	-0,46453	0,428075
0,859585	0,271038	0,730122	-0,33301	0,56172	-0,40328	0,487146
1,255737	-0,31044	0,786114	-0,01648	0,575368	-0,49043	0,480769
0,748382	0,164984	0,801111	-0,15678	0,445427	-0,46258	0,542363
0,305357	-0,3438	0,762671	-0,16471	0,532345	-0,40102	0,480055
0,630652	0,18392	1,200873	0,011156	0,551774	-0,41741	0,480568
1,173145	-0,24785	0,927969	-0,06722	0,411577	-0,39826	0,465243
1,241833	-0,21825	0,754402	-0,23616	0,527074	-0,38881	0,489939
0,733621	0,208759	0,540678	0,203662	0,508491	-0,4042	0,476519
0,263113	-0,34799	0,769895	-0,15863	0,487768	-0,45517	0,470611



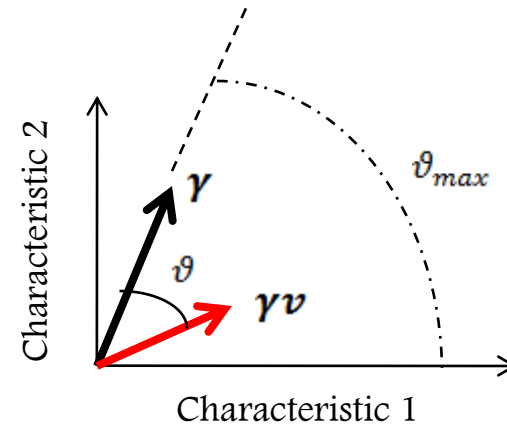
LET US, NOW, INTRODUCE THE TOTAL QUALITY INDICATOR.

$$I_q = c_1 \cos[\vartheta_{max}(1 - c_2)] = \frac{\gamma_1^2 v_1 + \gamma_2^2 v_2 + \dots + \gamma_n^2 v_n}{\gamma_1^2 + \gamma_2^2 + \dots + \gamma_n^2}$$

$$c_1 = \frac{Mod(\gamma v)}{Mod(\gamma)}$$

$$\vartheta_{max} = \arccos \frac{\gamma_{min}}{\sqrt{\gamma_1^2 + \gamma_2^2 + \dots + \gamma_n^2}}$$

$$c_2 = 1 - \frac{\vartheta}{\vartheta_{max}}$$



AND CALCULATE THE NUMERICAL VALUES ASSUMED BY THE INDICATOR FOR EACH ITEM

Item	c1	teta	teta max	c2	lq
1	0,543796	0,511164	1,1832	0,567981	0,474286
2	0,557033	0,532169		0,550229	0,48
3	0,664831	0,414351		0,649805	0,608571
4	0,529177	0,379998		0,678839	0,491429
5	0,462122	0,391581		0,669049	0,427143
6	0,607454	0,475734		0,597926	0,54
7	0,637854	0,429198		0,637256	0,58
8	0,641872	0,47776		0,596214	0,57
9	0,472773	0,449965		0,619705	0,425714
10	0,459005	0,383203		0,67613	0,425714



THEN, A DETERMINISTIC LINEAR RELATION CAN BE DETERMINED BETWEEN I_q AND SCORES (THIS CAN BE PROVED ANALYTICALLY). IN THE PRESENT CASE WE HAVE OBTAINED:

Score 1	Score 2	Score 3	Score 4	Score 5	Score 6	Score 7	I_q
0,830534	0,310905	0,773476	-0,24262	0,476428	-0,46453	0,428075	0,474286
0,859585	0,271038	0,730122	-0,33301	0,56172	-0,40328	0,487146	0,48
1,255737	-0,31044	0,786114	-0,01648	0,575368	-0,49043	0,480769	0,608571
0,748382	0,164984	0,801111	-0,15678	0,445427	-0,46258	0,542363	0,491429
0,305357	-0,3438	0,762671	-0,16471	0,532345	-0,40102	0,480055	0,427143
0,630652	0,18392	1,200873	0,011156	0,551774	-0,41741	0,480568	0,54
1,173145	-0,24785	0,927969	-0,06722	0,411577	-0,39826	0,465243	0,58
1,241833	-0,21825	0,754402	-0,23616	0,527074	-0,38881	0,489939	0,57
0,733621	0,208759	0,540678	0,203662	0,508491	-0,4042	0,476519	0,425714
0,263113	-0,34799	0,769895	-0,15863	0,487768	-0,45517	0,470611	0,425714

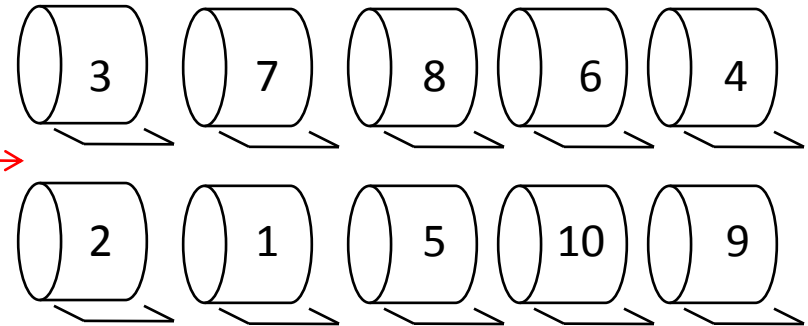
$$I_q = 0,164 \times s_{.1} - 0,056 \times s_{.2} + 0,188 \times s_{.3} + 0,01 \times s_{.4} + 0,107 \times s_{.5} - 0,189 \times s_{.6} + 0,174 \times s_{.7}$$



CONCLUSIONS

0,608571	3
0,580000	7
0,570000	8
0,540000	6
0,491429	4
0,480000	2
0,474286	1
0,427143	5
0,425714	10
0,425714	9

← FROM CALCULATIONS →



Iq EVALUATION	CUSTOMER EVALUATION
3	3
7	7
8	8
6	6
4	2
2	4
1	1
5	5
10	9
9	10

