Holzinger-Swineford 9 ability tests (301 students x 9 ability tests) (Matlab HS\_9Var.m)

consist of correlations among 9 ‘ability’ variables collected by Holzinger & Swineford in one Chicago junior high school in 1939. The 9 variables consist of 3 perceptual tests, 3 verbal tests and 3 counting/math tests, so one might expect a 3-factor solution would be sufficient to account for the correlations, with 3 non-overlapping, orthogonal factors.

Correlation matrix

1.0000 0.2973 0.4407 0.3727 0.2934 0.3568 0.0669

0.2973 1.0000 0.3398 0.1529 0.1394 0.1925 -0.0757

0.4407 0.3398 1.0000 0.1586 0.0772 0.1977 0.0719

0.3727 0.1529 0.1586 1.0000 0.7332 0.7045 0.1738

0.2934 0.1394 0.0772 0.7332 1.0000 0.7200 0.1020

0.3568 0.1925 0.1977 0.7045 0.7200 1.0000 0.1211

0.0669 -0.0757 0.0719 0.1738 0.1020 0.1211 1.0000

0.2239 0.0923 0.1860 0.1069 0.1387 0.1496 0.4868

0.3903 0.2060 0.3287 0.2078 0.2275 0.2142 0.3406

Columns 8 through 9

0.2239 0.3903

0.0923 0.2060

0.1860 0.3287

0.1069 0.2078

0.1387 0.2275

0.1496 0.2142

0.4868 0.3406

1.0000 0.4490

0.4490 1.0000

PCA (factor loadings)

|  |  |
| --- | --- |
| T1 VISUAL PERCEPTION TEST FROM SPEARMAN VPT, PART III | 0.3671 0.0984 0.3174 |
| T2 CUBES, SIMPLIFICATION OF BRIGHAM'S SPATIAL RELATIONS TEST | 0.2173 0.0677 0.5318 |
| T4 LOZENGES FROM THORNDIKE--SHAPES FLIPPED THEN IDENTIFY TARGET | 0.2660 0.2574 0.4644 |
| T6 PARAGRAPH COMPREHENSION TEST | 0.4270 -0.3488 -0.1450 |
| T7 SENTENCE COMPLETION TEST | 0.4113 -0.3778 -0.1856 |
| T9 WORD MEANING TEST | 0.4306 -0.3350 -0.0972 |
| T10 SPEEDED ADDITION TEST | 0.1945 0.3912 -0.5059 |
| T12 SPEEDED COUNTING OF DOTS IN SHAPE | 0.2533 0.4796 -0.2823 |
| T13 SPEEDED DISCRIM STRAIGHT AND CURVED CAPS | 0.3294 0.3998 -0.0169 |

Explained variance of the components

F3 F2 F1

1.3652 1.6387 3.2163

Total variance explained by 3 PCA components = 1.3652+1.6387+3.2163=6.2202

Total variance explained by 9 variables = 9.

Rotation Variamax

|  |  |
| --- | --- |
| T1 VISUAL PERCEPTION TEST FROM SPEARMAN VPT, PART III | 0.1269 0.0695 0.4735 |
| T2 CUBES, SIMPLIFICATION OF BRIGHAM'S SPATIAL RELATIONS TEST | -0.0211 -0.1288 0.5635 |
| T4 LOZENGES FROM THORNDIKE--SHAPES FLIPPED THEN IDENTIFY TARGET | -0.0851 0.0671 0.5839 |
| T6 PARAGRAPH COMPREHENSION TEST | 0.5700 0.0036 0.0081 |
| T7 SENTENCE COMPLETION TEST | 0.5871 -0.0038 -0.0409 |
| T9 WORD MEANING TEST | 0.5515 -0.0092 0.0526 |
| T10 SPEEDED ADDITION TEST | 0.0340 0.6339 -0.2091 |
| T12 SPEEDED COUNTING OF DOTS IN SHAPE | -0.0361 0.6098 0.0270 |
| T13 SPEEDED DISCRIM STRAIGHT AND CURVED CAPS | -0.0002 0.4475 0.2614 |

Rotation matrix

0.7391 0.4365 0.5131

-0.6203 0.7380 0.2657

-0.2627 -0.5147 0.8162

Clustering and disjoint PCA

If the CDPCA Orthogonal is run with 301 clusters for objects and 3 clusters for variables

>> [Vocdpca,Uocdpca,Aocdpca, Cocdpca, Yocdpca,focdpca,inocdpca]=CDPCAO(X, 301, 3, 100);

We obtain the loading matrix A CDPCA Orth

|  |  |  |  |
| --- | --- | --- | --- |
| T1 VISUAL PERCEPTION TEST FROM SPEARMAN VPT, PART III | 0 | 0 | 0.597739 |
| T2 CUBES, SIMPLIFICATION OF BRIGHAM'S SPATIAL RELATIONS TEST | 0 | 0 | 0.551720 |
| T4 LOZENGES FROM THORNDIKE--SHAPES FLIPPED THEN IDENTIFY TARGET | 0 | 0 | 0.581646 |
| T6 PARAGRAPH COMPREHENSION TEST | 0.562557 | 0 | 0 |
| T7 SENTENCE COMPLETION TEST | 0.644599 | 0 | 0 |
| T9 WORD MEANING TEST | 0.517709 | 0 | 0 |
| T10 SPEEDED ADDITION TEST | 0 | 0.625499 | 0 |
| T12 SPEEDED COUNTING OF DOTS IN SHAPE | 0 | 0.587213 | 0 |
| T13 SPEEDED DISCRIM STRAIGHT AND CURVED CAPS | 0 | 0.513742 | 0 |

and the orthogonal rotation matrix C

0.4909 0.2075 0.8461

0.4526 0.7691 -0.4513

0.7444 -0.6045 -0.2836

Total variance explained by 5 CDPA Orthogonal components

F1 F2 F3

1.2531 1.6080 3.1295

Total variance explained by 3 PCA components = 1.2531+1.6080+3.1295= 5.9907

The loss of variance with respect to PCA

LossVar= (6.2202-5.9907)/9 \*100 = 2,5%

Matrix on the components rotated to have orthogonal components A\*C

|  |  |
| --- | --- |
| T1 VISUAL PERCEPTION TEST FROM SPEARMAN VPT, PART III | **0.4450 -0.3613** -0.1695 |
| T2 CUBES, SIMPLIFICATION OF BRIGHAM'S SPATIAL RELATIONS TEST | **0.4107 -0.3335** -0.1565 |
| T4 LOZENGES FROM THORNDIKE--SHAPES FLIPPED THEN IDENTIFY TARGET | **0.4330 -0.3516** -0.1650 |
| T6 PARAGRAPH COMPREHENSION TEST | **0.2762** 0.1168 **0.4760** |
| T7 SENTENCE COMPLETION TEST | **0.3165** 0.1338 **0.5454** |
| T9 WORD MEANING TEST | **0.2542** 0.1074 **0.4380** |
| T10 SPEEDED ADDITION TEST | **0.2831** **0.4811** **-0.2823** |
| T12 SPEEDED COUNTING OF DOTS IN SHAPE | **0.2658** **0.4516** -0.2650 |
| T13 SPEEDED DISCRIM STRAIGHT AND CURVED CAPS | 0.2325 **0.3951** -0.2318 |

If the CDPCA Orthogonal is run with 5 clusters for objects and 3 clusters for variables

[Vocdpca1,Uocdpca1,Aocdpca1, Cocdpca1, Yocdpca1,focdpca1,inocdpca1]=CDPCAO(X, 5, 3, 100);

We obtain the same solution with 301 clusters for objects.

vbls = {'T1','T2','T3','T4','T5','T6','T7','T8','T9'};

biplot(Aocdpca,'scores',Yocdpca, 'varlabels',vbls);