





Donor Insights : using factor analysis

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Background: an organization wants to know if there are some relationships in characteristics of potential donors. They could explore these variables and see if there is any pattern.

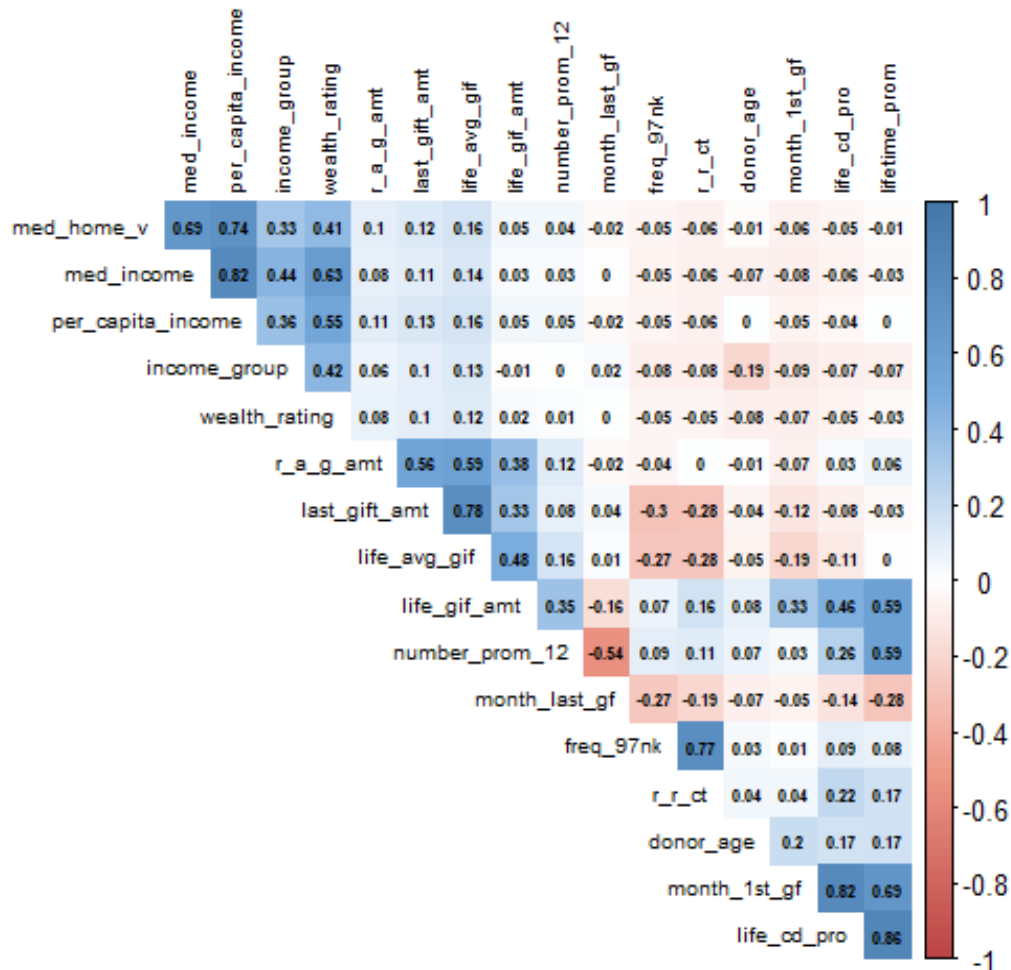
- Variable description: all patrons' data is from their database. Just to list a few:
 - ☐ donor_age
 - ☐ income_group: from 1 to 7.
 - ☐ last_gift_amt: the amount donor gave last time.
 - ☐ lifetime_gift_amount: the total amount a donor gave in life time.
 - ☐ lifetime_prom: the number of solicitations ever sent.
 - ☐ median_home_value
 - ☐ median_household_income
 - ☐ per_capita_income: census data.
 - ☐ months_since_first_gift
 - ☐ number_prom_12: the number of promotions in the last 12 months.
 - ☐ wealth_rating: from 1 to 9.



Methodology: consider doing a factor analysis to all variables and see if there is any latent factors among donors, using R package stats, psych().

- Before doing factor analysis, needs to see if these variables have some linear relationships. (in other word, if the correlation matrix is different from an identity matrix)
 - if variables have no linear relationships then factor analysis is not appropriate.
- We could use correlation coefficient matrix to get a general idea and Bartlett's test to verify.
 - use psych() for Bartlett's test.
 - use corrplot() for correlation matrix plot.

Correlation Coefficient Matrix



- Correlation coefficients show that there are some positive correlation between:
 - home value and household income.
 - recent avg card gift amount and life gift amount.
 - last gift amount and life avg gift amount.
 - count of donations and count of response to promotions.
- Some negative correlation between:
 - count of promotion in last 12 months and months since last gift donation.
 - last gift amount and count of response to promotion.
- Infers the more frequent you contribute, the less your contribution amount is!

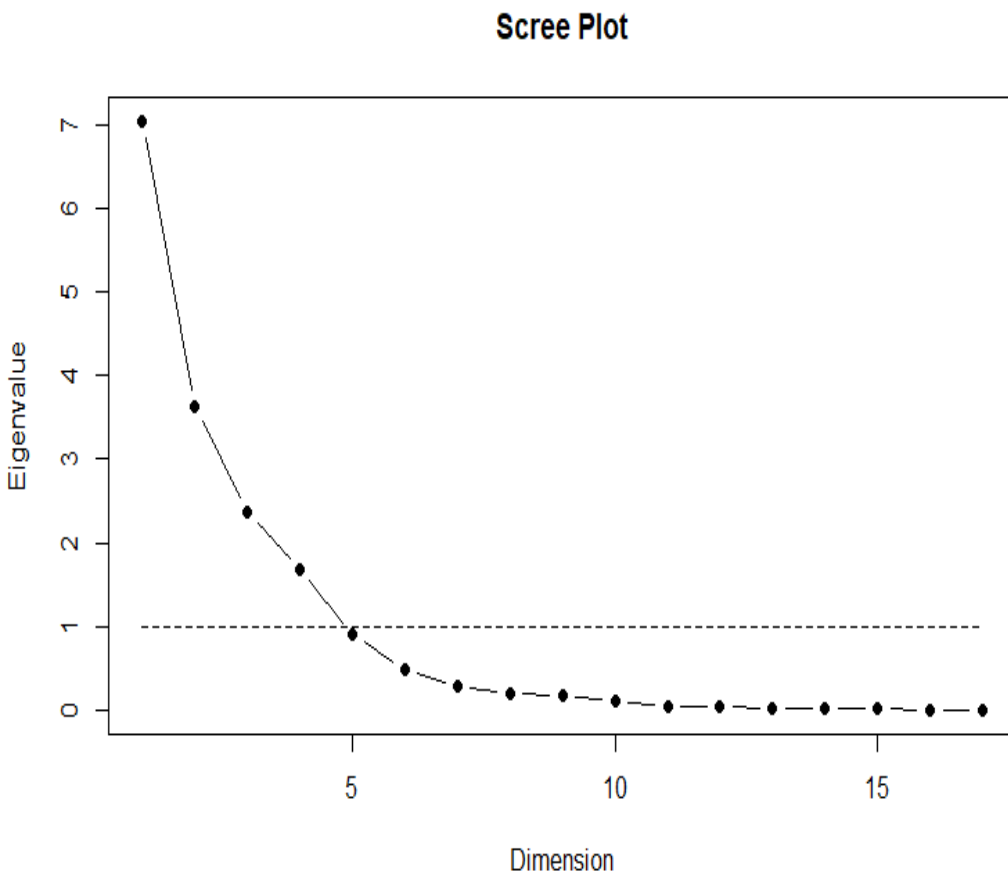
Bartlett's Test

- Test shows that the null hypothesis is rejected at 0.05 level. Therefore, the correlation coefficients matrix is significantly different from an identity matrix. We could go to next step.

```
> cortest.bartlett(cor(dona03),n=1000)
$chisq
[1] 10553.27

$ p.value
[1] 0
```

Determine the number of factors using scree plot.



- Scree plot shows need to keep 4 factors (eigenvalue >1)

Extracting factors: factanal()

- Set the number of factors to be 4 and using factor rotation to make explanation easier.

```
factor_num <- 4  
fit <- factanal(dona03, factor_num, scores=c("regression"),  
               rotation="varimax", lower=0.1)
```

- Use varimax rotation method to make the explanation simpler.
- Factor result is on the next page.

Result discussion: 4 factors explained about 60% of variance!

Loadings:

	Factor1	Factor2	Factor3	Factor4
median_home_value	0.77			
median_household_income	0.92			
per_capita_income	0.89			
wealth_rating	0.64			
lifetime_card_prom		0.94		
lifetime_prom		0.91		
months_since_first_gift		0.83		
last_gift_amt			0.78	
lifetime_avg_gift_amt			0.92	
lifetime_gift_amount		0.51	0.59	
recent_avg_card_gift_amt			0.64	
frequency_status_97nk				0.84
recent_response_count				0.88
donor_age				
income_group	0.45			
months_since_last_gift				
number_prom_12		0.36		

	Factor1	Factor2	Factor3	Factor4
SS loadings	2.89	2.87	2.37	1.76
Proportion Var	0.17	0.17	0.14	0.10
Cumulative Var	0.17	0.34	0.48	0.58

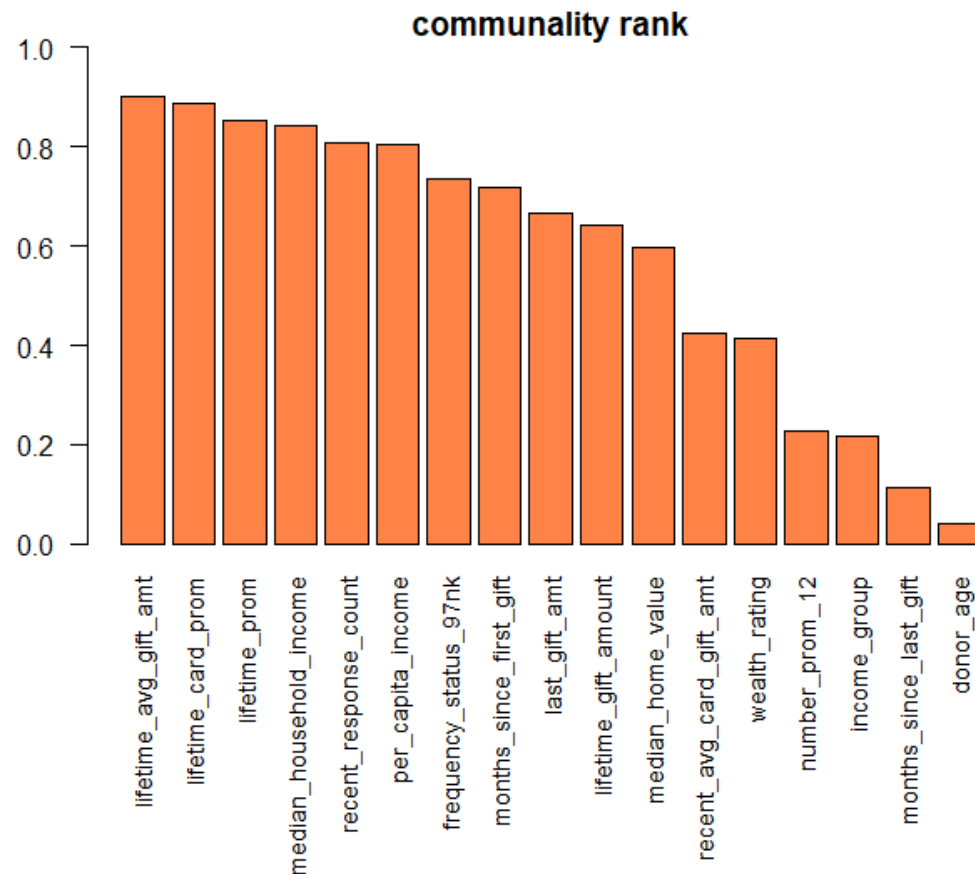
■ Factor explanation:

- 1st factor is related to donor's wealth: income, home value etc.
- 2nd factor relates to historic participation of promotion events.
- 3rd factor measures historic gift amounts contributed by the donor.
- 4th factor measures response to historical promotion and donations.

■ Factor cumulative :

- The total variance explained by 4 factor model is 58%.

Result discussion: ranking of communalities

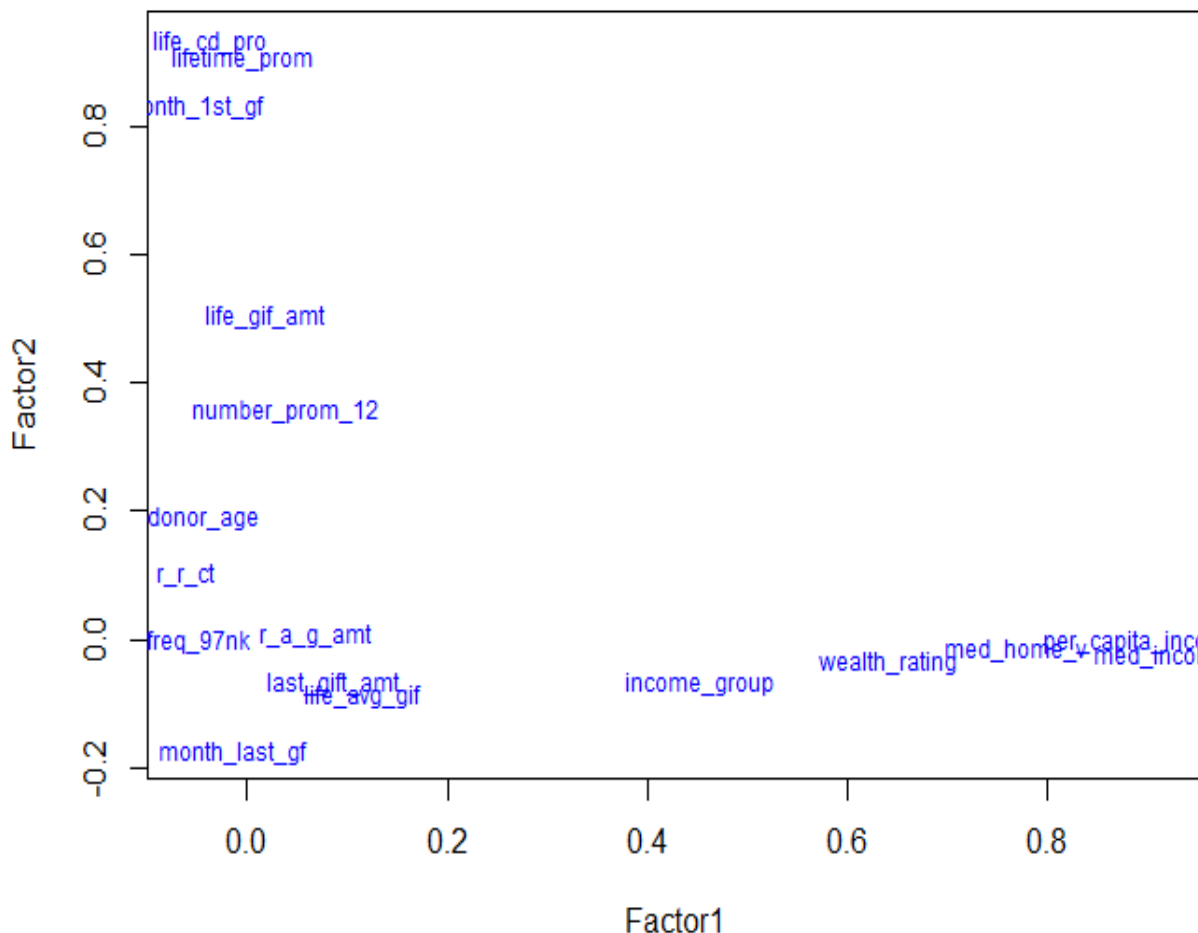


■ Rank of communalities of variables.

- The higher the bar, the better the variable is explained by factors. The lower the bar, the harder variable can be explained by factors.
- Age and month since last gift are not easily explained by our 4 factors.
- Life time gift amount, life time card promotion, life time promotion, and median household income are better represented by factors.

Factor1(wealth of donor) vs Factor2 (past involvement in promotion) plot

factor & variable plot



- Plot F1(wealth) vs F2(past promotion amt)
 - Some variables reflect wealth, others measure past involve in promotions.
 - Note recent gift amount does not have higher loading on either F1 or F2, meaning recent gift amt does not indicate wealth or past participation.
 - Also, life gift amt does not load high on F1(wealth), indicating there is no strong relationship between wealth and total donation.