Paper SD04

Dependent Scores within KAI and MBTI Instruments

Marie Risov, University of Louisville, Louisville, KY

ABSTRACT

Various psychometric instruments assessing human personality preferences strive to measure divergent aspects, such as career aptitude, creativity style, communication and learning style, to name just a few. Two of such instruments, Myers-Briggs Type Indicator® and ™Kirton Adaptation-Innovation Inventory, were developed to measure personal preferences and creativity style respectively. These aspects were first assumed to be independent variables that contribute to a human character.

This work uses a psychometric data set built over a decade by Rolf Smith's School for Innovators and shows that psychometric parameters tend to work in tandem, although more unusual cases exist and may be worth special attention. The assessment has been completed with the General Linear Model (GLM) and Generalized Linear Model (GLIM). The known psychometric scale correlations have been confirmed, and new insights have been discovered in regards to intra- instrument relationships.

INTRODUCTION

Human personality preferences can be measured by various instruments and for different purpuses, such as career development, learning style, personal or group relationships. Two of such instruments, Myers-Briggs Type Indicator (MBTI)® (Myers Briggs, 1989) and ™Kirton Adaptation-Innovation Inventory (KAI) (Kirton, 1989), were developed to quantify personal preferences and creativity style respectively. These instruments are widely used in various types of counseling, including career planning, education facilitation, child rearing, and family advice.

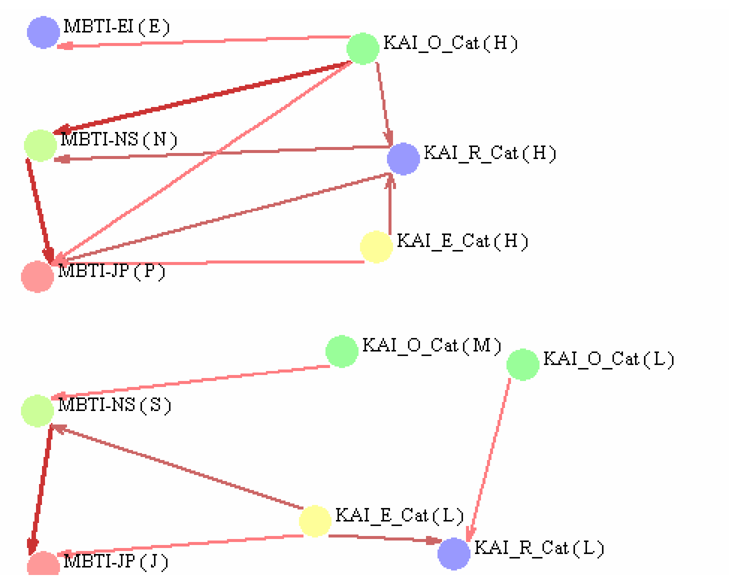
The Myers-Briggs Type Indicator reveals individual preferences in energy/stimulation (Extraversion vs. Introversion), information collection (Sensing vs. Intuitive), decision making (Thinking vs. Feeling) and life style (Judging vs. Perceiving). The Kirton Adaptation-innovation Indicator measures the style of creativity (and not its amount). People with higher cumulative scores are called Innovators. They are much more prone to big change, have futuristic, sometimes visionary views, but could be detached from their surroundings. Individuals with the scores lower than average are called Adaptors. They have a more down-to-earth approach, prefer innovating in smaller increments, and pay better attention to detail. The instrument has three subscales that measure Originality, Rule Conformity, and Efficiency, with high Originality scores corresponding to a greater number of diverse ideas. The high Rule Conformity score corresponds to less attention to existing rules and structure and a high Efficiency score denoting less focus on being thorough and efficient in completing tasks. In short, Adaptors do a task better, while innovators do it differently. The right mixture of both types is essential for any initiative to be successful.

These scales of both MBTI and KAI were first developed as independent instruments that measured distinct aspects of a human character. Later research (Hughes 1998, Lattanzio 2002, Isaksen 2003) questioned these assumptions and found significant correlations of Intuitive, Thinking and Perception scores to the total KAI score, as well as to all three of its subscales.

Isaksen (2003) has provided a summary of research supporting significant correlations between KAI subscales and two of MBTI subscales: Intuition/Sensing and Judging/Perception. The studies were conducted by four different research teams from 1982 to 1995, where the number of subjects ranged from 54 to 615. All studies report very substantial correlations (up to .66) of the total KAI scores, as well as to the Originality scores taken separately, to the Intuition preference on the MBTI scale. Almost identical correlation has been found for the Perception preference on the MBTI scale. For the Intraversion/Extraversion and Thinking/Feeling components the KAI correlation, results varied.

Our current effort confirms the strong MBTI to KAI correlations on the example of a substantial data set collected by the School for Innovators (SFI) founded and directed by Rolf Smith. Furthermore, we show that significant correlations occur among KAI subscales and among some MBTI subscales within each tool. The researchers' preliminary studies of the data (Risov, 2006) involved link analysis in addition to the correlations pointed out by other researchers. The link analysis indicated associations of KAI Originality and Efficiency to the Rules & Structure subscale. On the MBTI side, the preference for Intuition was linked to Perception, and the preference for Sensing linked to Judging. Figure 1 represents the results of our link analysis, where nodes represent categorical dimensions, and links reveal which values have interesting correlations.

Figure 1: Preliminary psychometric scales correlation assessment



MBTI-EI(E) – MBTI Extraversion preference
MBTI-NS(S) – MBTI Sensing preference
MBTI-NS(N) – MBTI Intuitive Preference
MBTI-JP(P) – MBTI Perceiving preference
MBTI-JP(J) – MBTI Judging preference

KAI_O_Cat(H) – High KAI Originality scores
KAI_R_Cat(H) – High KAI Rules scores
KAI_E_Cat(H) – High KAI Efficiency scores
KAI_O_Cat(M) – Medium KAI Originality scores
KAI_O_Cat(L) – Low KAI Originality scores
KAI_E_Cat(L) – Low KAI Efficiency scores
KAI_R_Cat(L) – Low KAI Rules scores

The goal of the current work is to confirm and expand these preliminary findings, as well as to add precision to the models.

DATA SOURCE

The original database was obtained from the School for Innovators in the Excel format. There were 3991 records collected and the following dimensions present:

#	Dimension	Type	Comment
1.	ID	Numeric	Unique ID of an SFI student
2.	Expedition Name	Categorical	Name of a specific class given to specific group of students
3.	Age	Numeric	Student's age
4.	Sex	Categorical	Male/Female
5.	Occupation/Title	Free text	
6.	Department	Free text	
7.	Education	Free text	
8.	Originality	Numeric	KAI Sufficiency of Originality subscale, interval from 13 to 65
9.	Efficiency	Numeric	KAI Efficiency subscale, interval from 7 to 35
10.	Rules & Structure	Numeric	KAI Rule/Group Conformity subscale, interval from 12 to 48
11.	Total Score	Numeric	Total KAI score, interval from 26 to 160
12.	MBTI	Categorical	Myers-Briggs word pair (four letter) profile
13.	MBTI Sub Score	Text	Integer preference sub scores combined in a single field and delimited by slashes, dashes, commas, spaces, and other delimiters that were convenient to the scribe at any particular time. A typical example would look like the following: 11/14 13/12 21/3 21/8
14.	Company	Free Text	SFI student's company name

The data were collected by SFI staff during various events and classes initiated by the school. It was intended for each team's comprehension of personality style and its impact on professional and personal relationships. No structured study was intended at the time of data collection. Being gathered since 1991, the data set contained primarily KAI data, with MBTI being a later addition to the program.

The nature of events was not uniform, and the courses relied on different metrics over the years. For instance, when the school was founded, only the KAI instrument was used as a metric important in the workplace. Beginning in 1995, the MBTI was added to the curriculum, but not all versions of the innovation workshop incorporated MBTI metrics. Therefore, only 45% of the records contained at least partial KAI data, while 25% contained complete MBTI data.

To complicate the arrangement, with the new standard MBTI form (Form M) being introduced in 1998, the early MBTI data was recorded with the Form G, while most of the newer data was recorded with the form M. These two form results were not directly compatible.

In addition to format differences, although we obtained almost 4000 records, the data was extremely sparse. We decided not to use any demographic information in the analysis because about 80% of Age, Gender, Occupation, Education and workplace (Company) information was missing.

Considering all of the above, we were left with 601 records that had complete KAI and MBTI data without any inherent ambiguities due to the source format or invalid scores.

SOFTWARE TOOLS

Considering that correlations within the data were well-defined by prior art and our own preliminary studies, the use of linear statistical models provided by SAS® Enterprise Guide was a natural fit for the project. A General Linear Model was used to confirm the measures of known correlations. Modeling of the KAI subscale correlations involve the Generalized Linear Model as it allowed fine-tuning of the results with advanced link functions.

DATA FORMAT AND PREPROCESSING

The majority of data pre-processing was completed in Microsoft Excel. All KAI and MBTI subscale scores were normalized to the 0 -1 interval in order to be easily comparable on charts. The following formula has been used: (VALUE – min)/(max – min). In addition, the Stack Columns tool from SAS Enterprise Guide was used in order to use PROC KDD for KAI data distribution assessment.

From all available KAI and MBTI dimensions, the following fields were derived:

#	Dimension	Type	Comment
1.	KAI_O-norm	Numeric	Normalized* KAI Originality, interval 0 - 1
2.	KAI_E-norm	Numeric	Normalized* KAI Efficiency, interval 0 - 1
3.	KAI_R-norm	Numeric	Normalized* KAI Rule Conformity, interval 0 – 1
4.	KAI_Cat	Ordinal	KAI simple H(igh), M(edium) and L(ow) categorization based on scores. Bin boundaries defined as max-([max – min]/3) and max-2([max – min]/3)
5.	E-score	Numeric	MBTI Extraversion score parsed out from the MBTI Sub Score string
6.	I-score	Numeric	MBTI Introversion score parsed out from the MBTI Sub Score string
7.	S-score	Numeric	MBTI Sensing score parsed out from the MBTI Sub Score string
8.	N-score	Numeric	MBTI Intuition score parsed out from the MBTI Sub Score string
9.	T-score	Numeric	MBTI Thinking score parsed out from the MBTI Sub Score string
10.	F-score	Numeric	MBTI Feeling score parsed out from the MBTI Sub Score string
11.	J-score	Numeric	MBTI Judging score parsed out from the MBTI Sub Score string
12.	P-score	Numeric	MBTI Perception score parsed out from the MBTI Sub Score string
13.	MBTI Ambiguity	Categorical	Yes/No/Checking, assigned during the data validation process and used during the record selection stage
14.	EI-norm	Numeric	Normalized** MBTI Extraversion/Introversion score, interval 0 - 1
15.	SN-norm	Numeric	Normalized** MBTI Sensing/Intuition score, interval 0 - 1
16.	TF-norm	Numeric	Normalized** MBTI Thinking/Feeling score, interval 0 - 1
17.	JP-norm	Numeric	Normalized** MBTI Judging/Perceiving score, interval 0 - 1
18.	MBTI-EI	Categorical	MBTI Extraversion/Introversion preference parsed from the word-pair scores. Possible values: E, e, I, i
19.	MBTI-SN	Categorical	MBTI Sensing/Intuition preference parsed from the word-pair scores.

#	Dimension	Type	Comment
			Possible values: S, s, N, n
20.	MBTI-TF	Categorical	MBTI Thinking/Feeling preference parsed from the word-pair scores. Possible values: T, t, F, f
21.	MBTI-JP	Categorical	MBTI Judging/Perceiving preference parsed from the word-pair scores. Possible values: J, j, P, p

RESULTS

We have fitted several models assuming all KAI and MBTI scales being independent measurements rather than pre-grouped by the instrument.

1. VALIDATING PRIOR ART RESULTS FOR THE SFI DATA SET WITH A GENERAL LINEAR MODEL

The Originality scale of KAI was best predicted from the MBTI normalized scores using the SAS code

```
PROC GLM DATA=WORK.SORT5671;
  MODEL KAI_O_norm=   EI_norm JP_norm SN_norm TF_norm/ SS3    SOLUTION
SINGULAR=1E-07;
```

The model was significant with R-square = 0.39 and p < 0.0001. All MBTI scores were significant, with the Intuitive trend contributing the most. In general, the model shows that SFI students with Extraverted Intuitive Thinking Perceiving type tended to have the highest Originality scores.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.6109354399	0.02038477	29.97	<.0001
EI_norm	0.1664813246	0.01784857	9.33	<.0001
JP_norm	-.0933786078	0.02134839	-4.37	<.0001
SN_norm	-.2474453524	0.02227426	-11.11	<.0001
TF_norm	0.1308879238	0.02206082	5.93	<.0001

The KAI Rules and Conformity score was also strongly predicted from MBTI scores with the overall model R-square=0.36 and p < 0.0001.

```
PROC GLM DATA=WORK.SORT5671;
  MODEL KAI_R_norm=   EI_norm JP_norm SN_norm TF_norm/ SS3 SOLUTION SINGULAR=1E-
07;
```

Although all MBTI parameters had a significant impact on the result, with the same general pattern preference as for the Originality score, the most important were Intuitive Perceiving trends.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.6353807201	0.02190791	29.00	<.0001
EI_norm	0.0486599571	0.01918221	2.54	0.0114
JP_norm	-.1621343349	0.02294353	-7.07	<.0001
SN_norm	-.2647102980	0.02393858	-11.06	<.0001
TF_norm	0.0875015133	0.02370919	3.69	0.0002

The KAI Efficiency score model was not as solid the two previous cases, but still significant with R-square = 0.25 and p < 0.0001.

```
PROC GLM DATA=WORK.SORT5671;
 MODEL KAI_E_norm=   EI_norm JP_norm SN_norm TF_norm/SS3 SOLUTION SINGULAR=1E-07;
```

High Efficiency score was significantly connected only to the Intuitive Perception trends.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.6266917299	0.02670272	23.47	<.0001
EI_norm	0.0347113030	0.02338046	1.48	0.1382
JP_norm	-.2273223056	0.02796499	-8.13	<.0001
SN_norm	-.1667227140	0.02917782	-5.71	<.0001
TF_norm	-.0286660688	0.02889823	-0.99	0.3216

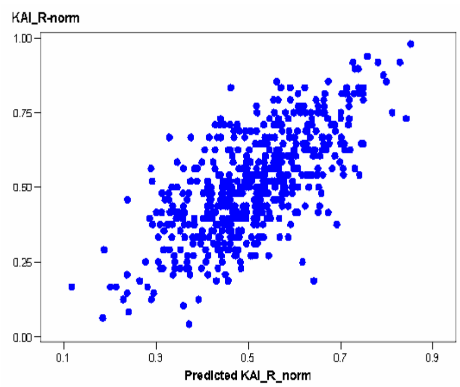
2. KAI SCALES INTER-DEPENDENCE

As we have discussed earlier, we went beyond simply confirming the overlap in KAI and MBTI measurements. Based on the preliminary link analysis, we could argue that for the majority of people, all three KAI scores tend to be following a similar pattern. Our previous analysis showed that the Rules score is linked to both Originality and Efficiency scales. However, it was not clear if all three scales scores could be symmetrically derived from the other two. We have started with the most expected good dependency of KAI-Rules on KAI-Originality and KAI-Efficiency using the General Linear Model.

```
PROC GLM DATA=WORK.SORT9907;
 MODEL KAI_R_norm=   KAI_E_norm KAI_O_norm/ SS3 SOLUTION  SINGULAR=1E-07;
```

The results were very strong with the R-square = 0.48 and p < 0.0005. Originality and Efficiency contributions were almost identical, with Originality only slightly in the lead. The model was well-defined and did not required improvement.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.0633020818	0.02075030	3.05	0.0024
KAI_O_norm	0.4686141808	0.03241595	14.46	<.0001
KAI_E_norm	0.3674303133	0.02736349	13.43	<.0001



Next, we had to answer the symmetry question, which inquired whether the remaining KAI subscales were as easily derived from extra KAI subscores. If they were, we would have to argue that all three measurements essentially predicted one another and could be combined. The attempt to model KAI Originality from Rules and Efficiency resulted in a weaker model with R-square = 0.32 and p < 0.0001.

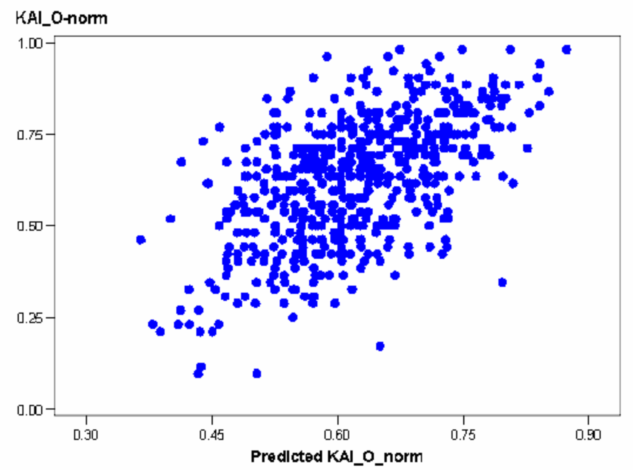
```
PROC GLM DATA=WORK.SORT9907;
 MODEL KAI_O_norm=   KAI_E_norm KAI_R_norm/ SS3 SOLUTION  SINGULAR=1E-07;
```

The most important finding was the lack of symmetry. While the Rules score had a very significant impact on

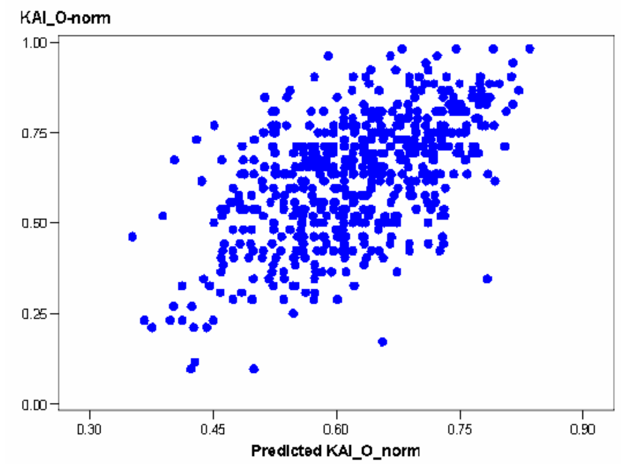
Originality, the impact of Efficiency was not statistically significant.

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	0.3455438337	0.01777652	19.44	<.0001
KAI_E_norm	-.0148574432	0.03389493	-0.44	0.6613
KAI_R_norm	0.5526281092	0.03822753	14.46	<.0001

Besides proving the higher independence of the Originality and Rule Conformity scales, we worked on the model improvement by employing the Generalized Linear Model with the Logit link function instead of the General Linear Model. The improvement was very insignificant; therefore, the General Linear Model could be safely used.



General Linear Model



Generalized Linear Model with Logit link function

And lastly, we modeled the dependency of the Efficiency parameter on both Rules and Originality.

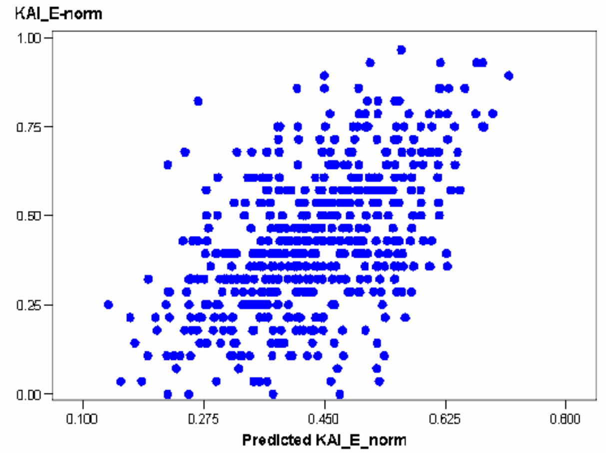
```
PROC GLM DATA=WORK.SORT9907;
 MODEL KAI_E_norm=   KAI_O_norm KAI_R_norm/ SS3 SOLUTION  SINGULAR=1E-07;
```

Considering our recent results, we did not expect a tight match. The model was significant with R-square = 0.30 and $p < 0.0001$. The results relied on the Rules component even more heavily than in the previous example of Originality modeling. This time, the Originality component was insignificant.

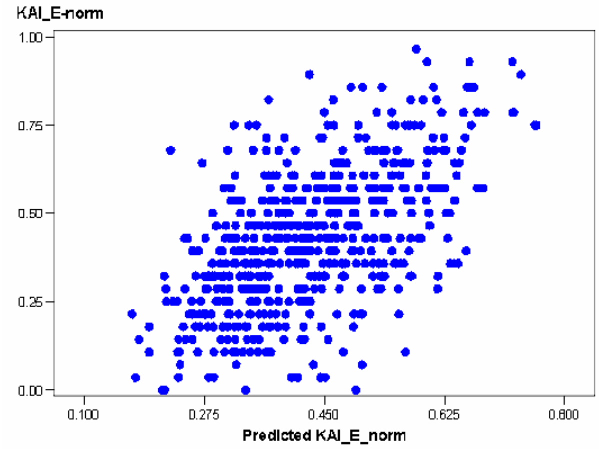
Parameter	Estimate	Standard Error	t Valu e	Pr > |t|
Intercept	0.1207360090	0.02694386	4.48	<.0001
KAI_R_norm	0.6304961780	0.04695468	13.43	<.0001
KAI_O_norm	-.0216189208	0.04932018	-0.44	0.6613

The Observed vs. Predicted values plot looked even less tidy than the one produced by the Originality model and somewhat "heavy" toward the bottom. Therefore, we decided to try the Generalized Linear Model with the Log link function to shift the weight. The adjustment appeared to curve the results in the opposite direction. The third test with the Logit link function appeared to produce the most accurate results.

```
PROC GENMOD DATA=WORK. SORT9907;
  MODEL KAI_E_norm=   KAI_O_norm KAI_R_norm SN_norm JP_norm EI_norm TF_norm/
         LINK=LOGIT
         DIST=NORMAL;
```

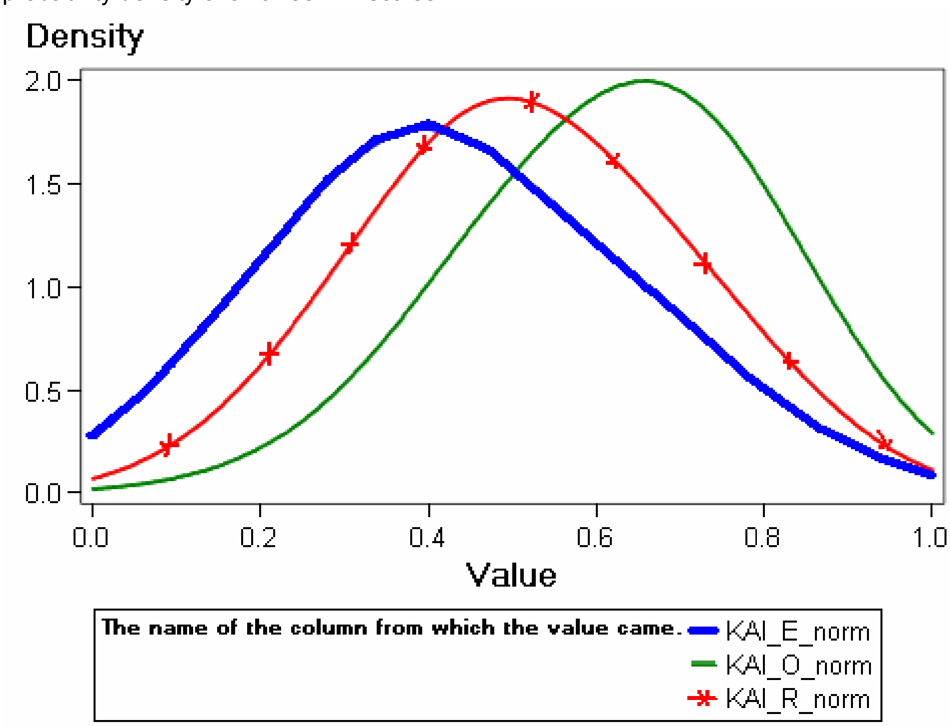


General Linear Model



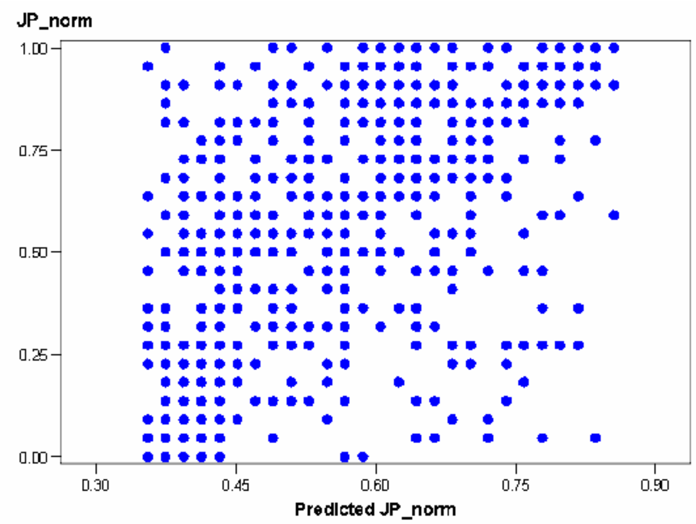
Generalized Linear Model with Logit link function

The modeling results above had shown that Originality and Efficiency scores are more independent from each other than each of them from the Rules score. That must imply that generally, the normalized Rules score must be between the Originality and Efficiency normalized scores. In order to assess this conjecture, we have explored the probability density of all three KAI scales.

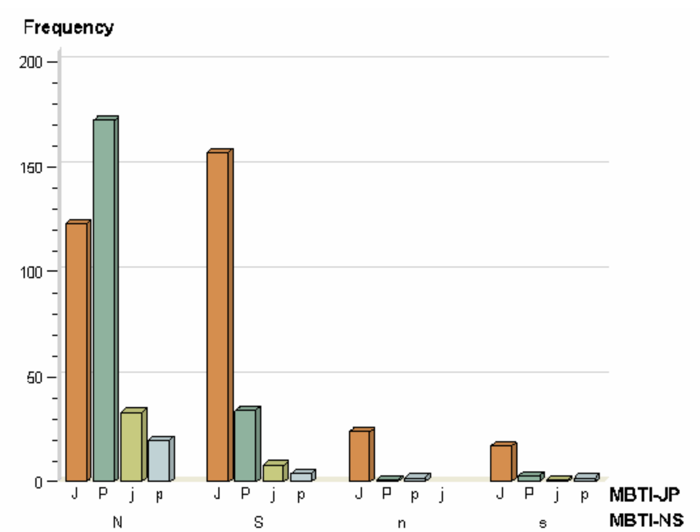


As can be generally confirmed, the Originality component tends to be higher, and the Efficiency component tends to be lower than the Rules component for the SFI students data.

3. MBTI CORRELATIONS BETWEEN INTUITION/SENSING AND PERCEIVING/JUDGING PREFERENCES
Assessing the possible dependence between N/S (Intuition/Sensing) and P/J(Perception/Judging) parameters of MBTI yielded a significant enough model with R-square = 0.22 and $p < 0.0001$. However, the Observed vs. Predicted values plot revealed a high rate of predictive inaccuracy. Applying the Generalized Linear Model with various link functions did not improve the results.



The model also did not correlate with the general population statistics that give an approximately equal number of Intuitive Perceivers and Intuitive Judgers. Therefore, we looked at the distribution of these preferences in the SFI sample.



As can be easily seen, strong Intuitive Perceivers constitute the dominant group in the SFI sample, closely followed by Sensing Judgers. This distribution explains the significant correlations identified along these two axes.

CONCLUSION

This work used psychometric data built for over a decade by Rolf Smith's School for Innovators and shows that psychometric parameters tend to work in tandem, although more unusual cases exist and may be worth special attention. Various data mining techniques have been used for exploration, beginning with Link Analysis and followed by precise modeling with the General and Generalized Linear Models.

In addition to confirming relationships between MBTI and KAI subscores described in the prior art, we have found a strong correlation between the KAI-Rules scale and both KAI-Originality and KAI-Efficiency scales. However, the Originality and Efficiency scales were found not having a strong effect on one another. If this relationship is confirmed in further studies with additional samples, we could question the Rules and Group Conformity scale as an independent entity. Logically, thoroughness and efficiency expressed by low Efficiency scores would naturally require an affinity to structure and rules (and vice versa). As for Originality, one can hardly produce a lot of out of the box ideas while being an ardent existing structure conformer. As a further stage of research, we suggest looking specifically at cases that break the pattern of Efficiency < Rules < Originality. We predict that personalities with other patterns (especially the reverse) could represent interesting social outliers.

A weaker correlation found within the MBTI Intuition/Sensing and Perception/Judging scales has far less merit from the theoretical standpoint and can be attributed to the problem of the SFI sample not being random. The School for Innovators as an enterprise naturally attracts more innovative students, which, as we already proved, tend to be on the Intuitive Perceiving side of MBTI. Apparently, the fact that some organizations send entire teams to SFI with a good mix of adaptors and innovators does not offset the strong population bias toward innovators.

Another factor affecting the sample distribution was the selection strategy for the sample as only the records with complete KAI and MBTI scores were considered. According to the researchers' knowledge, the full use of both instruments was typical for advanced SFI courses, while beginning bootcamps collected and explained only more general scores, such as MBTI four-letter profiles and KAI total scores. Naturally, the advanced SFI classes represent an even less homogeneous population than the entire student base of the school.

REFERENCES

1. Hughes, Melanie A., 1998, "Myers-Briggs Type Indicators and Kirton Adaptation-Innovation Inventory Correlations", Executive Research Project, The Industrial College of the Armed Forces, National Defense University, Fort McNair, Washington, D.C., http://www.au.af.mil/au/awc/awcgate/ndu/94-f-28.pdf

2. Isaaksen, Scott G., Kenneth J. Lauer, 2003,"An examination of the Relationship Between Personality Type and Cognitive Style", Creativity Research Journal, Vol. 15, No. 4, 343-354.
http://www.leaonline.com/doi/abs/10.1207/S15326934CRJ1504_4;jsessionid=oSO2XB9rE3NaTkt-9Q?journalCode=crj

3. Kirton, Michael J., 1998, *Adaptors and Innovators: Styles of Creativity and Problem-Solving*, Routledge, New York
Lattanzio, Grace Ann, 2002, "The Myers-Briggs Type Indicator Meets the Kirton Adaption-Innovation Inventory: An Executive Summary of Sundell's 1999 Master's Project", International Center for Studies and Creativity, http://www.buffalostate.edu/orgs/cbir/readingroom/execsums/Sundevx.pdf

4. Myers Briggs, Isabel, McCaulley, Mary H., 1989, *MBTI Manual: A guide to the development and use of the Myers Briggs type indicator*. Consulting Psychologists Press, Palo Alto, CA

5. Risov, Marie, 2006, "KAI and MBTI Score Patterns in the School for Innovators Students", Unpublished essay, University of Louisville, KY

6. Smith, Rolf, 2002, *The 7 Levels of Change: different thinking for different results – 2nd ed*., Tapestry Press, Irving, TX

ACKNOWLEDGEMENTS

We express a special gratitude to the director and instructor of the School for Innovators Rolf Smith and the school idea catalyst Durwin Sharp for providing their data as well as consultation regarding the nature and format of the data. We would also like to thank Dr. Patricia Cerrito, a University of Louisville professor, for close guidance and advice.

CONTACT INFORMATION

Your questions and comeents are valued and encouraged. Please use the following points of contact:

Marie Risov
University of Louisville, KY
E-mail: moriso01@louisville.edu

Marie Risov, Technical Consultant
Electronic Data Systems
750 Tower Dr.
Troy, MI 48098
E-mail: maria.risov@eds.com
Phone: (248)265-5546