

Using Latent Class Models to Derive Subsets for the Enneagram Personality Typology

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Presentation Goals

Methodology: Demonstrate the utility of latent class (LC) models to analyze ranked response data

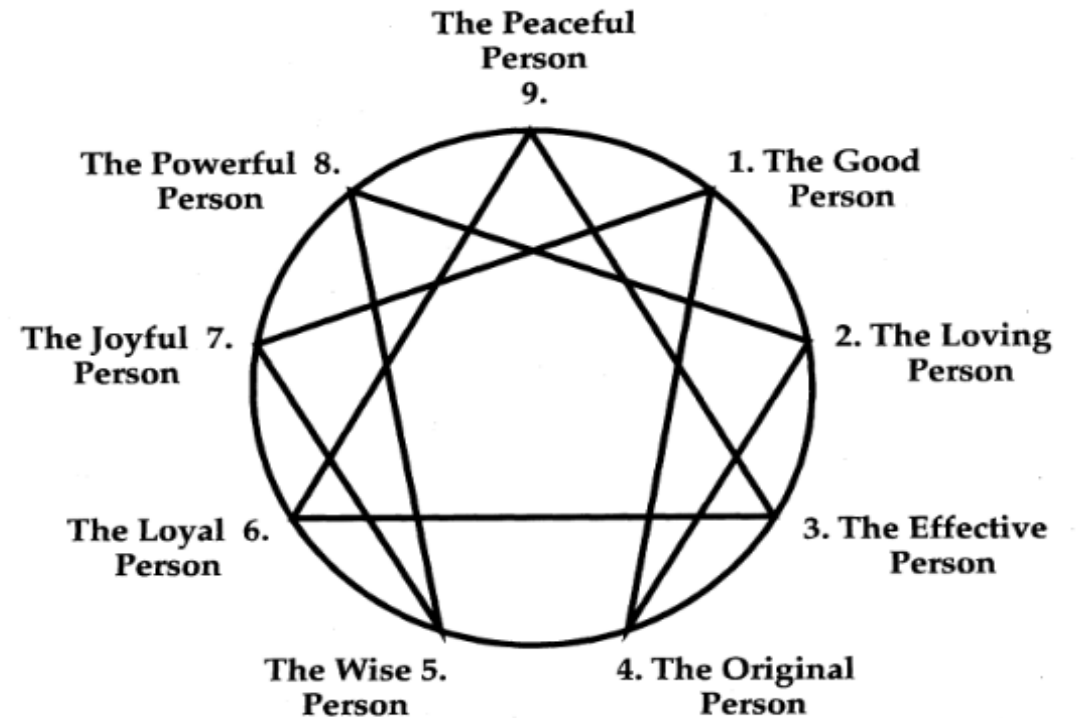
Application: Demonstrate how this LC methodology can be used with ranked personality type identification to provide a richer understanding of one's personality

Acknowledgement: I would like to thank Jerry Wagner for providing the Enneagram data for this research.

What is the Enneagram?

- The Enneagram is a popular personality typology.
- Enneagram theory postulates nine personality types, each belonging to one of 3 centers – Heart (2,3,4), Head (5,6,7) and Gut (8,9,1)
- Main result of an Enneagram assessment is specification of which of the nine types a test taker most identifies – their ‘core’ type.

The Nine Core Enneagram Types*



Current state of Enneagram Community

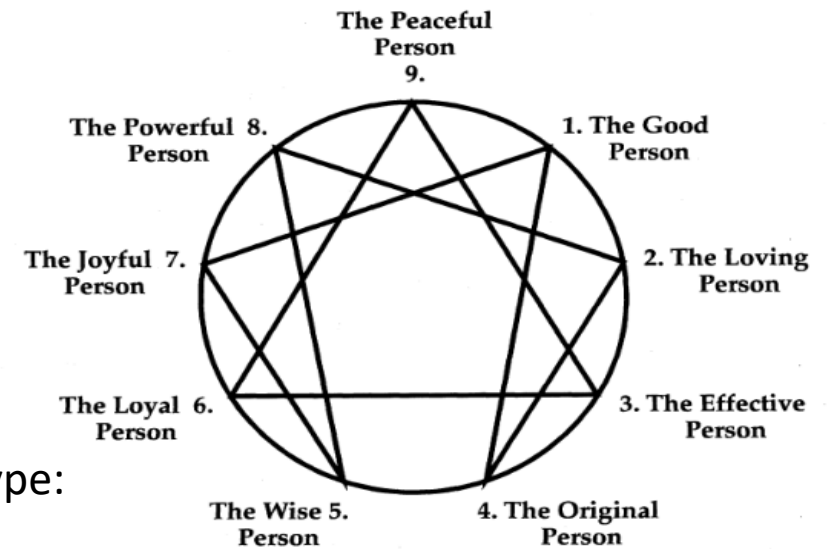
Enneagram teachers largely **Agree**:

- on general descriptions for each of the nine types
- that each person identifies with one of these as their *core* type
- on the benefit of additional information beyond one's core type

Enneagram teachers tend to **differ in their opinion** on:

- **What** supplementary information is most useful to know beyond one's core type:
 - Many teachers subdivide each core type into 3 subgroups:
 - (Self Preservation, Social, or Sexual)
 - referred to as "**Subtypes**" (Chestnut, 2013) or "**Instinctual variants**" (Russ Hudson)
 - which are postulated to interact with one's core Enneagram type
 - **Wings** -- which type on either side of their core type one identifies with more

The Nine Core Enneagram Types



Example of Wings:

Core Type 9 with '8 wing'
or
Core Type 9 with '1 wing'

Here we use latent class modeling to **derive underlying subgroups** (called "subsets") that provide the **best fit to data**, and examine how well these results support the theoretical subgroups.

Source of Enneagram Ranked Response Data

- Our data comes from N= 160,119 individuals who took the Wagner Enneagram Personality Styles Scales (WEPSS) Assessment* during the period September 2011 - May 2021.
- Raw scores for each of the 9 types were computed for each individual and transformed to percentiles** .
- For each test taker, ranks were obtained by ordering their nine percentile scores from high to low, the highest scoring style representing their Core Type.

Core Type	Frequency	Percent
1	15,579	9.7
2	17,943	11.2
3	20,867	13.0
4	17,833	11.1
5	16,748	10.5
6	15,783	9.9
7	17,244	10.8
8	17,795	11.1
9	18,012	11.2
Subtotal (N)	157,804	98.6
Omitted***	2,315	1.4
Total	160,119	100.0

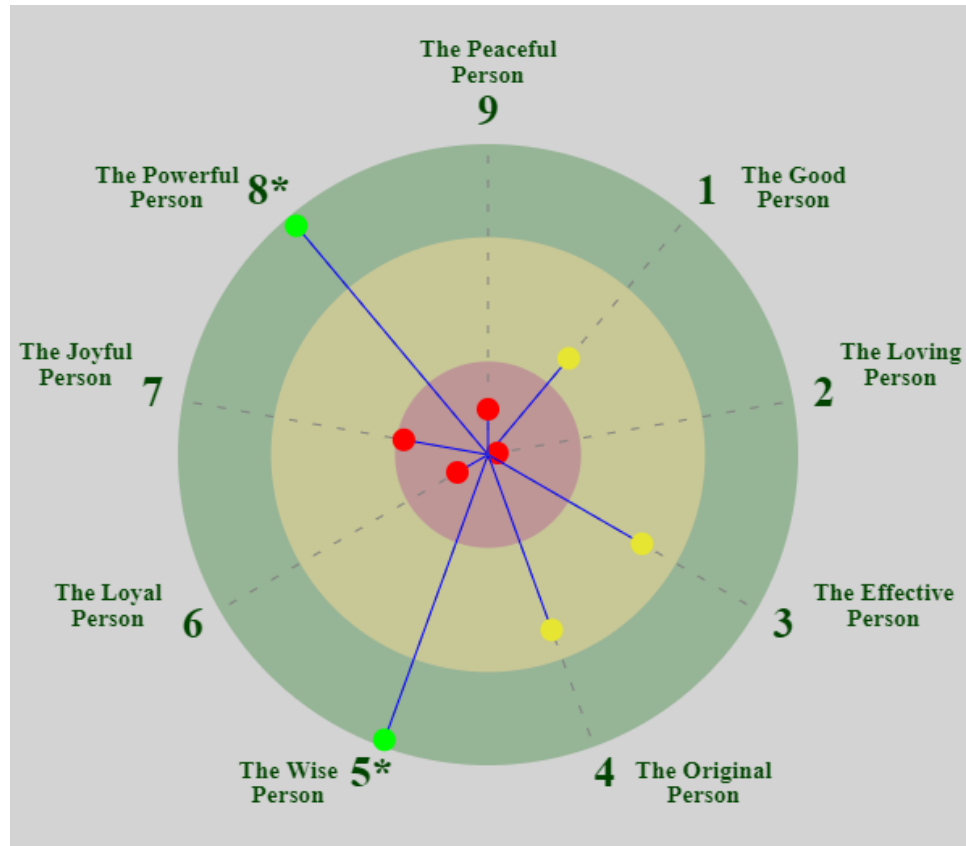
* WEPSS consists of 198 Likert items (22 for each of the 9 types). Test-takers used a 5-point agreement scale to rate how much they identify with the behavior described by each item For further information see www.WEPSS.com .

** Percentile scores were developed by the author based on all 160,119 test takers.

*** 1.4% of the cases were excluded due to insufficient differentiation between their top four percentile scores (these include *random respondents*)

Example: Person A's Test Results Suggests they Most Identify with Type 5.

Person A's highest percentile score occurs for Type 5 which is reported as their *Core* Enneagram Personality Type



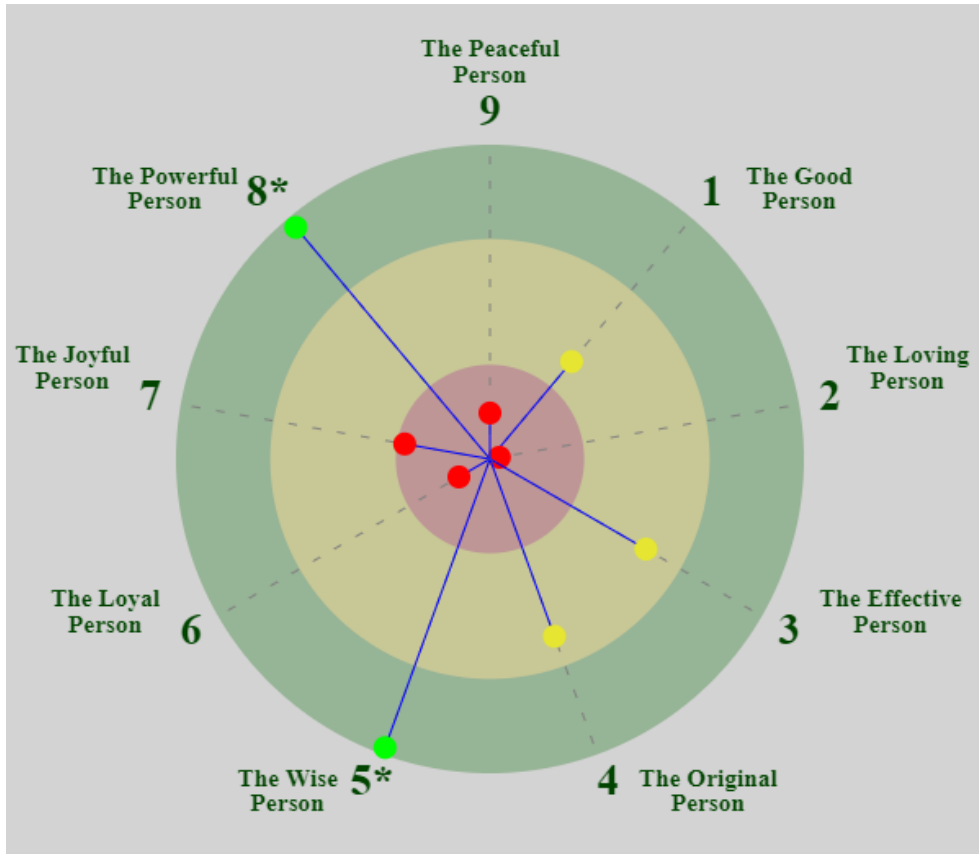
5* The Wise Person (percentile: 98)

Personality Style FIVE: The Wise Person†

FIVES are attracted to and value **wisdom, knowledge, and learning**. They want to understand the world and make it a more reasonable place to live in. Having insights, learning about the nature of things, and seeing how everything fits together is what life is all about.

† Enneagram personality Style description obtained from Jerry Wagner's website www.enneagramspectrum.com.

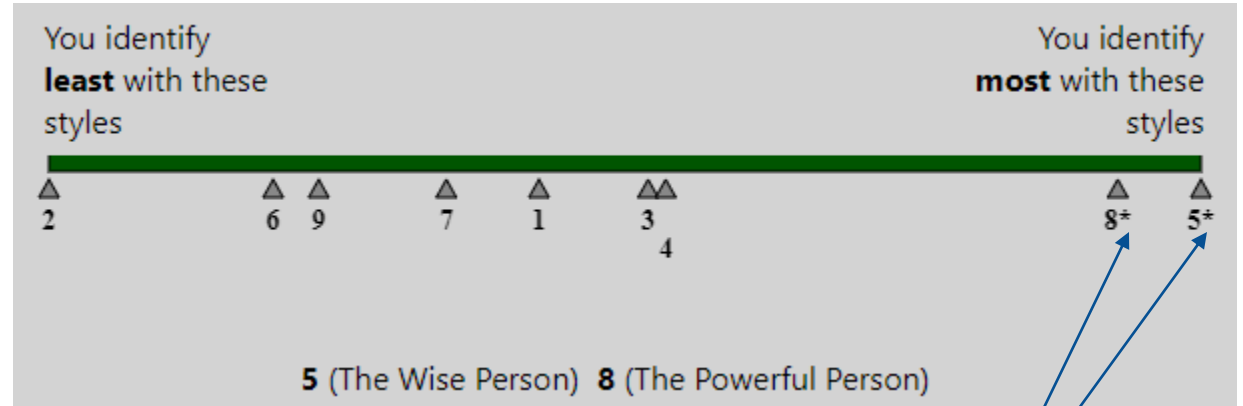
Person A also highly identifies with *Style 8* – their 2nd highest percentile score



5* The Wise Person (percentile: 98)

8* The Powerful Person (percentile: 96)

Relative Distance Plot (Magidson, 1998)

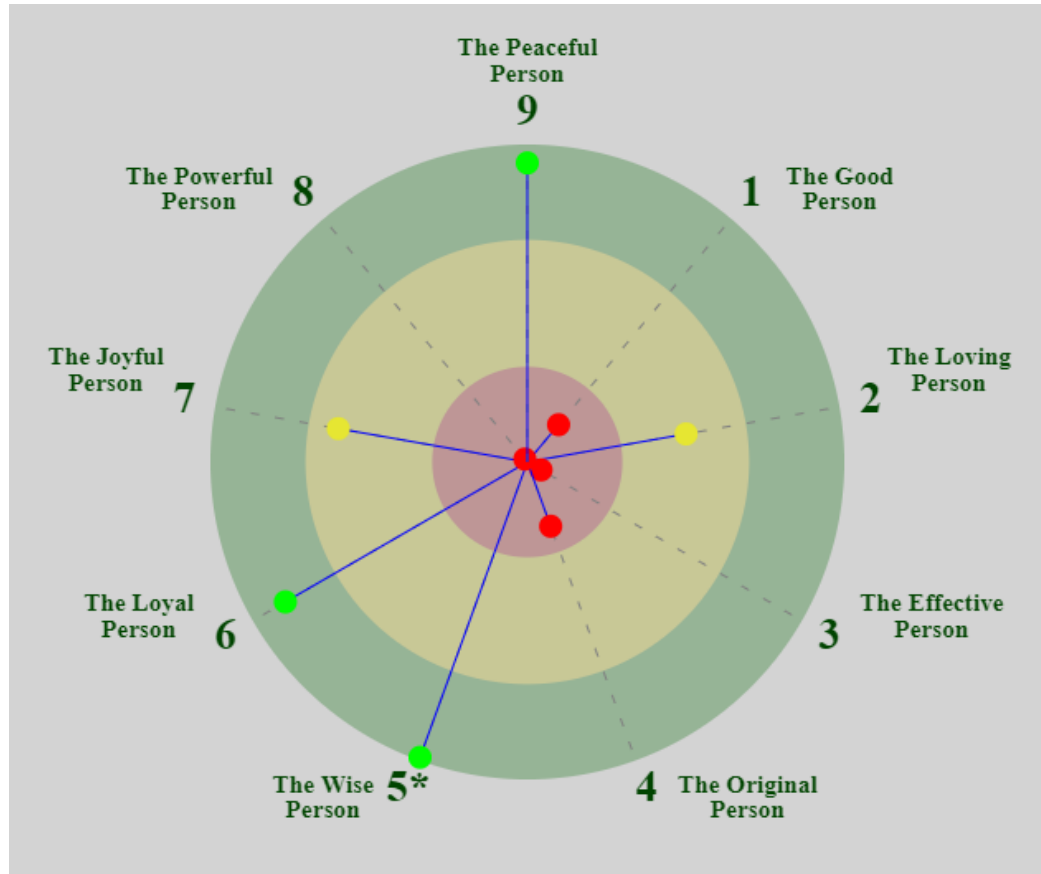


* Like Person A, more than half of all WEPSS test takers identify highly with more than 1 Enneagram style. Both types are flagged by *.

Personality Style EIGHT: The Powerful Person

EIGHTS are attracted to and appreciate **power**. They desire to be strong, independent, straightforward, **assertive** persons, who use their strength and influence to make the world a more just place to live in. They value equity, the equal distribution of power, and show a concern for the underprivileged and disenfranchised. Being your own person, doing your own thing, protecting your own is what life is all about.

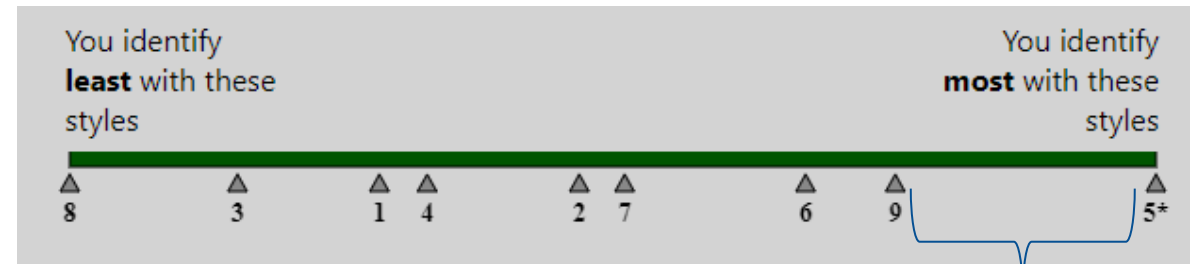
Similar to A, Person B also has Enneagram Personality 5 as their Core Type, but unlike A, B has *Style 9* as their 2nd highest, and identifies *least* with Style 8.



5* The Wise Person (percentile: 99)

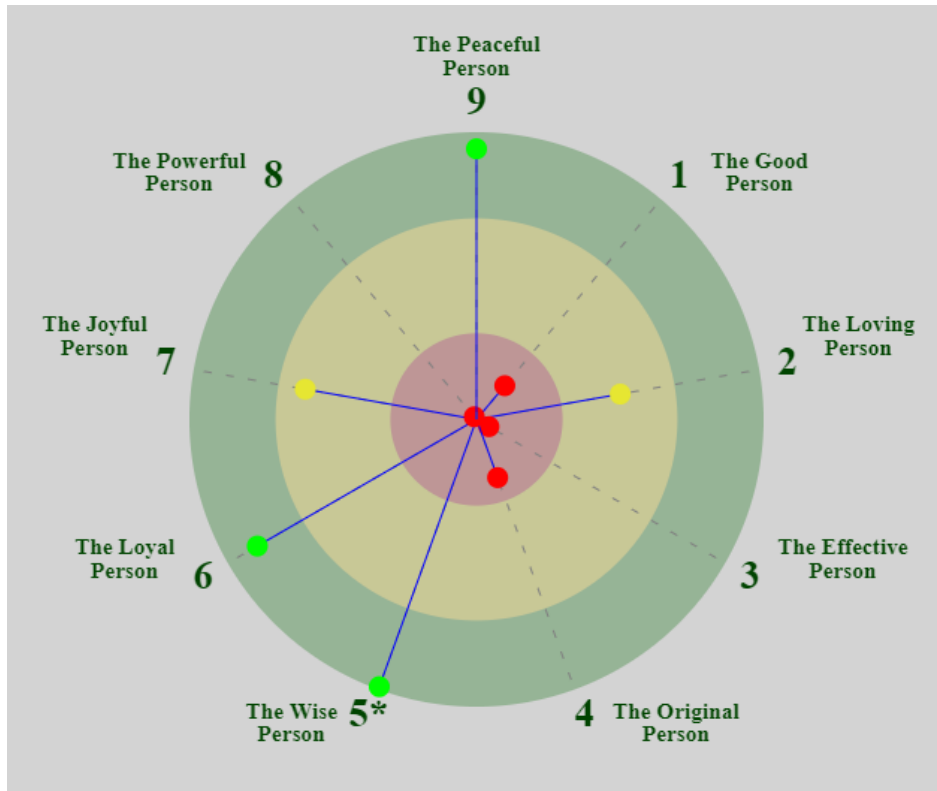
Personality Style NINE: The Peaceful Person †

NINES are attracted to and value **peace, harmony, and unity**. value **peace, harmony, and** . They desire to make the world an ecumenical, harmonious, conflict-free place to live in. They like being peaceful, calm, and ordered and prefer to go with the flow. The universe is unfolding as it should and they see no need to push the river since it's flowing fine by itself. Being at one with yourself and your surroundings is what life is all about.



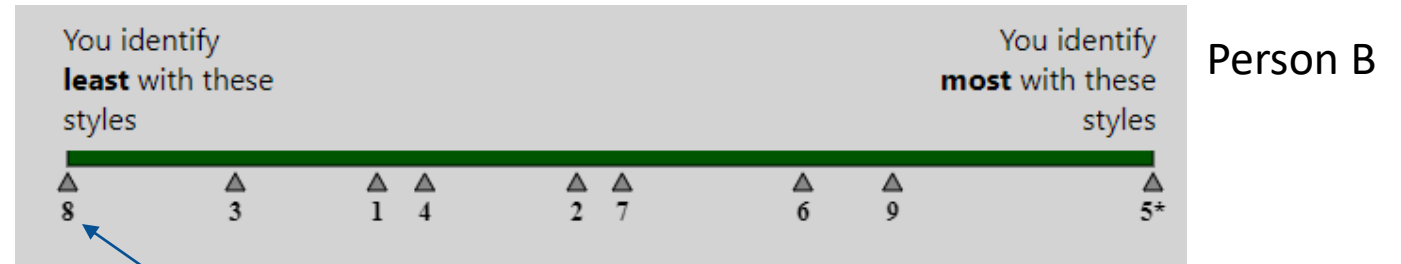
† Person B is one of 40% of WEPSS test takers whose distance between their core type and their 2nd highest is statistically significant.

Although they share the same *core type*, A and B may have ***very different personalities***



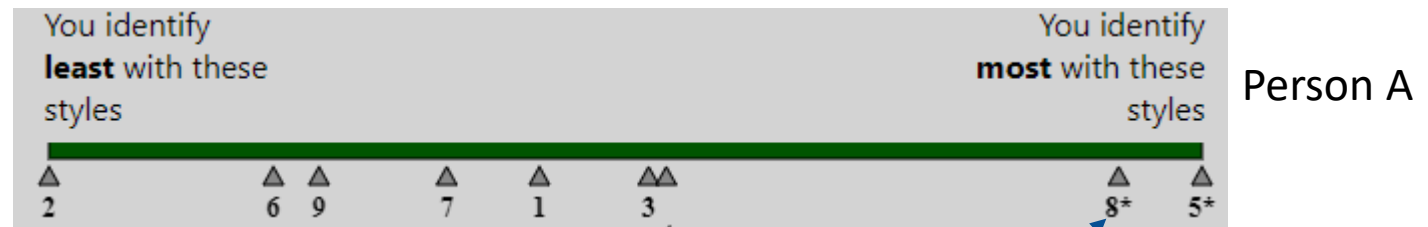
5* The Wise Person (percentile: 99)

9 The Peaceful Person (percentile: 94)



Style 8 is B's ***least*** identified style

8 The Powerful Person (percentile: 1)



Style 8 is A's **2nd** highest identified style

8* The Powerful Person (percentile: 96)

Approaches for Determining Personality “Buckets” for the Enneagram

- **Status quo approach:** Each bucket consists of a core type. **This results in 9 buckets.**
- **Extreme ranking approach:** Each bucket consists of individuals who share the same ranking for all 9 types. While as many as $9! = 362,880$ rankings are theoretically possible, only about 40,000 of these were actually observed in the data. **Result: 40,000 buckets.**
- **LC Modeling approach/** Use a latent class model with J classes to split each core type into J homogeneous “subsets”. **This results in $9 \cdot J$ buckets.**
 - For example, the **3-class LC model** would split each core type into 3 groups (subsets) according to which latent class they belong, resulting in a total of $9 \cdot 3 = 27$ **total personality buckets.**
 - **A 4-class LC model** would result in $9 \cdot 4 = 36$ **total personality buckets.**

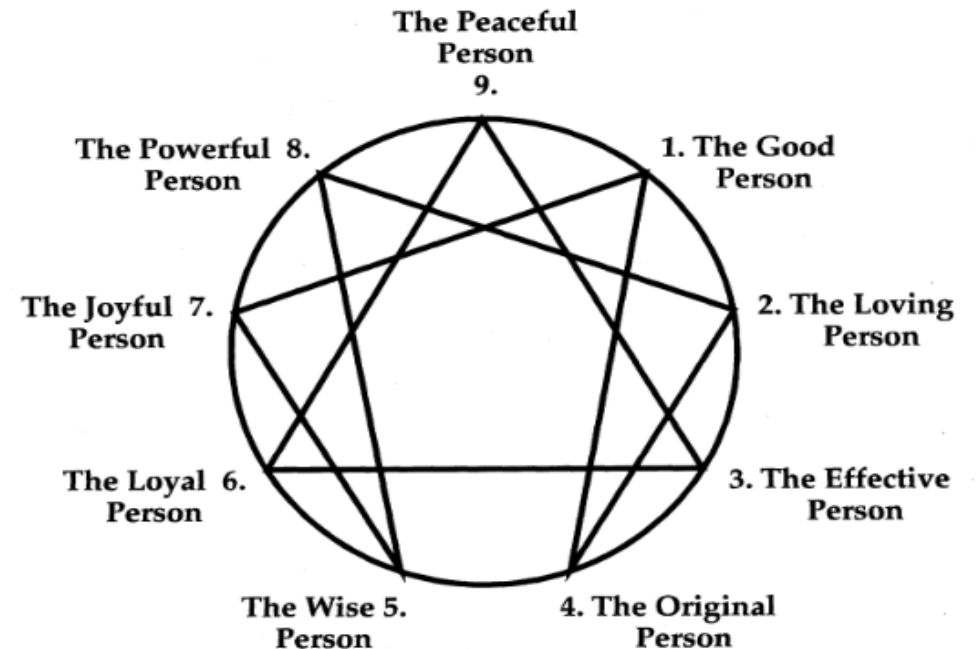
Using LC Sequential Choice Models to Derive Latent Classes (“Subsets”)

LC models were used to analyze the full ranking* of all nine types for all N=160,000 test takers. This resulted in a synthesis of enneagram identification information into a small number K of personality buckets.

Research questions:

- Can the latent classes and resulting graphs provide meaningful supplementary information about one’s personality?
 - Which types are most similar (in behavior)/ most different from each other? For each core type, which subsets are most different and how different? e.g., is a 5-9 type more behaviorally similar to a 9-5 type or a 5-8 type?
 - How much more information is provided by one’s full ranking than knowing one’s core type alone? by knowing one’s core and secondary types (e.g., 5-9)?

The Nine Enneagram Types



*Ranking data for a given test taker obtained by ordering their nine percentile scores from highest to lowest

LC Model used is Sequential Logit Model as Implemented in Latent GOLD®

- Models the ranking task as a *sequential choice process**.
 - Following the 1st choice (core type), each subsequent choice is treated as if it were a first choice out of a set from which alternatives already selected were eliminated.
 - For example, if a person's first choice out of a set of 9 alternatives is alternative 5, the second choice is equivalent to a (first) choice from the 8 remaining alternatives 1, 2, 3, 4, 6, 7, 8, and 9. Suppose the second choice is 8. The third choice will then be equivalent to a (first) choice from alternatives 1, 2, 3, 4, 6, 7 and 9.

$$P_{j,tk} = \exp(V_{j,t,k}) / \sum_{j_t} \exp(V_{j_t,k}) \quad j = 1,2, \dots, 9; k = 1,2, \dots, K$$

where $P_{j,tk}$ = Probability of ranking type j highest in sequential trial t for persons in latent class k
 $V_{j,k}$ = Utility of type j for persons in latent class k (measured on a logit scale)

Each type j has its own utility $V_{j,k}$ which depends on the latent class k

*See Bockenholt, 2002; Croon, 1989; Kamakura et. al., 1994.

Results for LC Estimated based on Rankings from N=157,804 Individuals.

Model	LL	BIC(LL)	Npar	% LL Explained
1-class	-2020042	4040180	8	0%
2-class	-1972640	3945483	17	38%
3-class	-1943682	3887675	26	61%
4-class	-1928181	3856781	35	73%
5-class	-1917747	3836021	44	81%
6-class	-1910695	3822025	53	87%
7-class	-1904084	3808910	62	92%
8-class	-1898900	3798650	71	96%
9-class	-1894397	3789752	80	100%
Discrete Factor Models				
2-DFactors	-1928939	3858190	26	73%
3-Dfactors	-1903854	3808127	35	92%

2-dimensional →

2-dimensional 4-class LC model* →

We focus on 2-dimensional models, which can position the core Enneagram types, partial rankings of types and individuals based on their complete ranking of types on a 2-dimensional map.

← 9-class model used as baseline

*The 2-DFactor model (Magidson and Vermunt, 2007) is a restricted 4-class model that fits almost as well as the unrestricted 4-class model (see above) and is equal to the 3-class model in parsimony, both yielding 2-dimensional maps (see Technical Appendix for Latent GOLD® syntax).

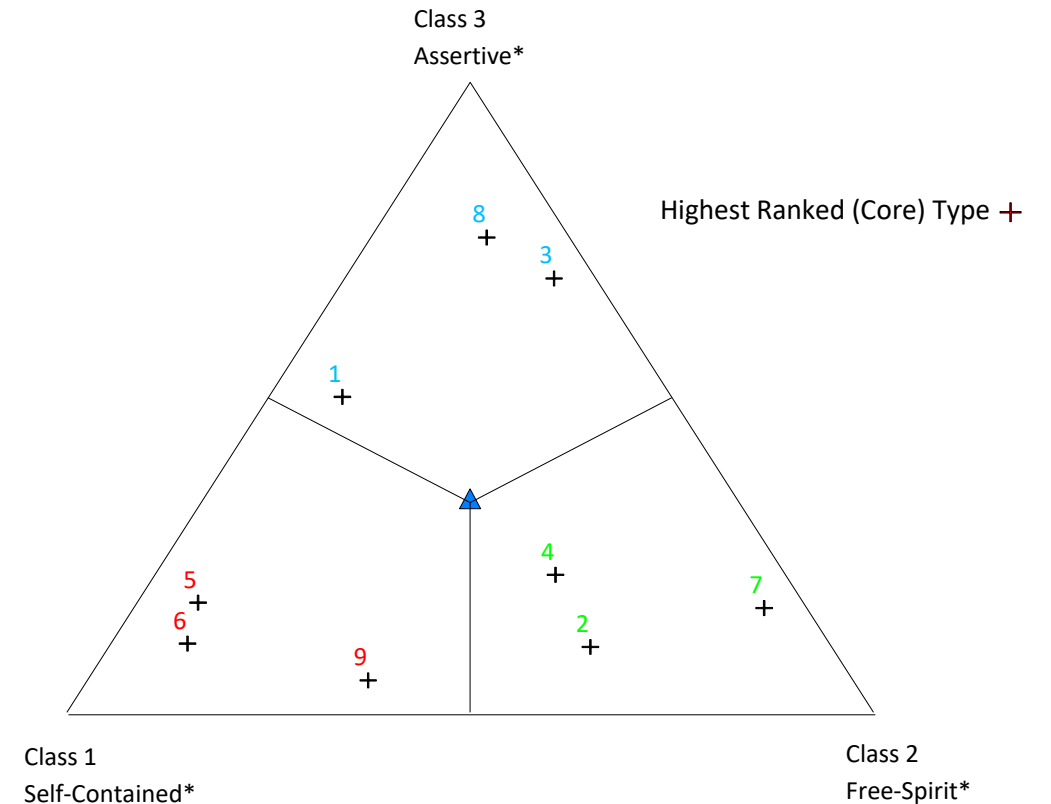
LC Results for 3-class Model

Profile Table Output for Core Type

	Class1	Class2	Class3
Class Size	0.41	0.31	0.28
Ennea-Type			
1	0.11	0.04	0.13
2	0.08	0.18	0.04
3	0.04	0.10	0.28
4	0.07	0.13	0.05
5	0.20	0.04	0.05
6	0.24	0.04	0.05
7	0.05	0.29	0.07
8	0.05	0.07	0.28
9	0.16	0.10	0.03

For each class, the 3 core types with the highest probability are highlighted in the table above.

Tri-Plot mapping of 3-class model results



* Labels for the Tri-plot vertices were chosen based on what is known about the types. The 3 classes appear to be similar to the Subtypes/ Instinctual Variants (e.g., Self-Contained class is similar to Self Preservation Subtype)

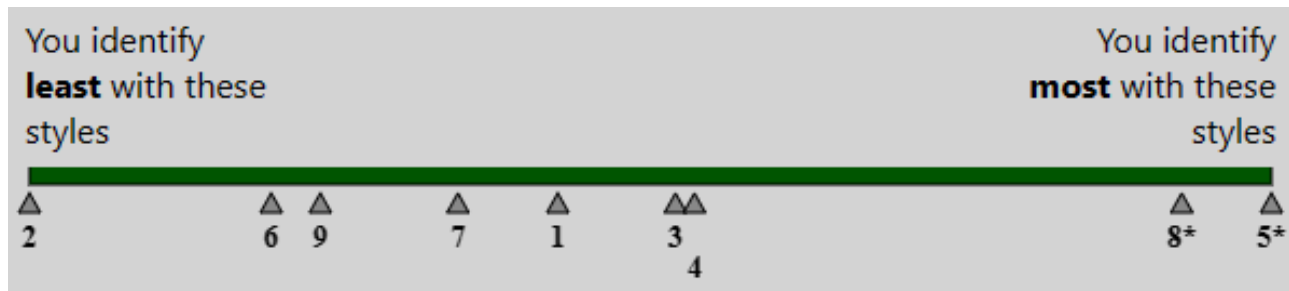
Persons A and B are Clearly Different as they are Assigned to Different Latent Classes

Posterior probabilities (3-class model)

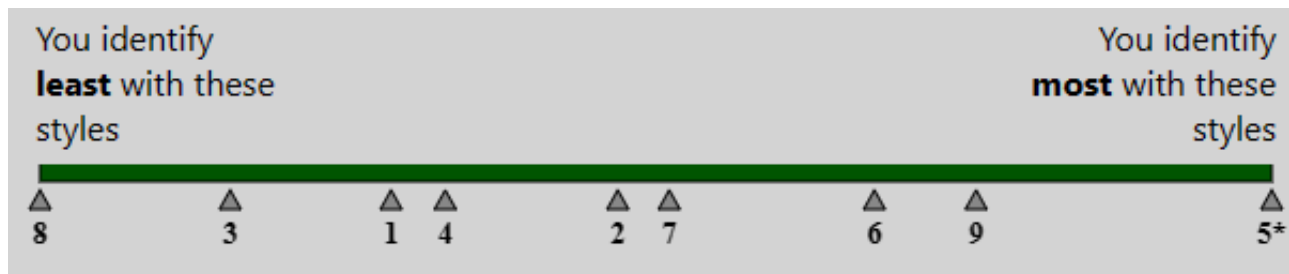
Prob(Class1, Class2, Class3)

Person A (.01, .00, .99) -> assigned to Class #3 (Assertive)

Person B (.99, .01, .00) -> assigned to Class #1 (Self-Contained)



Person A's 2nd highest personality type is E-8, the Powerful, Assertive type



Person B identifies *least* with E-8, and 2nd highest is E-9, the *least* Assertive type.

While A and B share the same core type (E-5), their personalities are *quite* different, A being more assertive

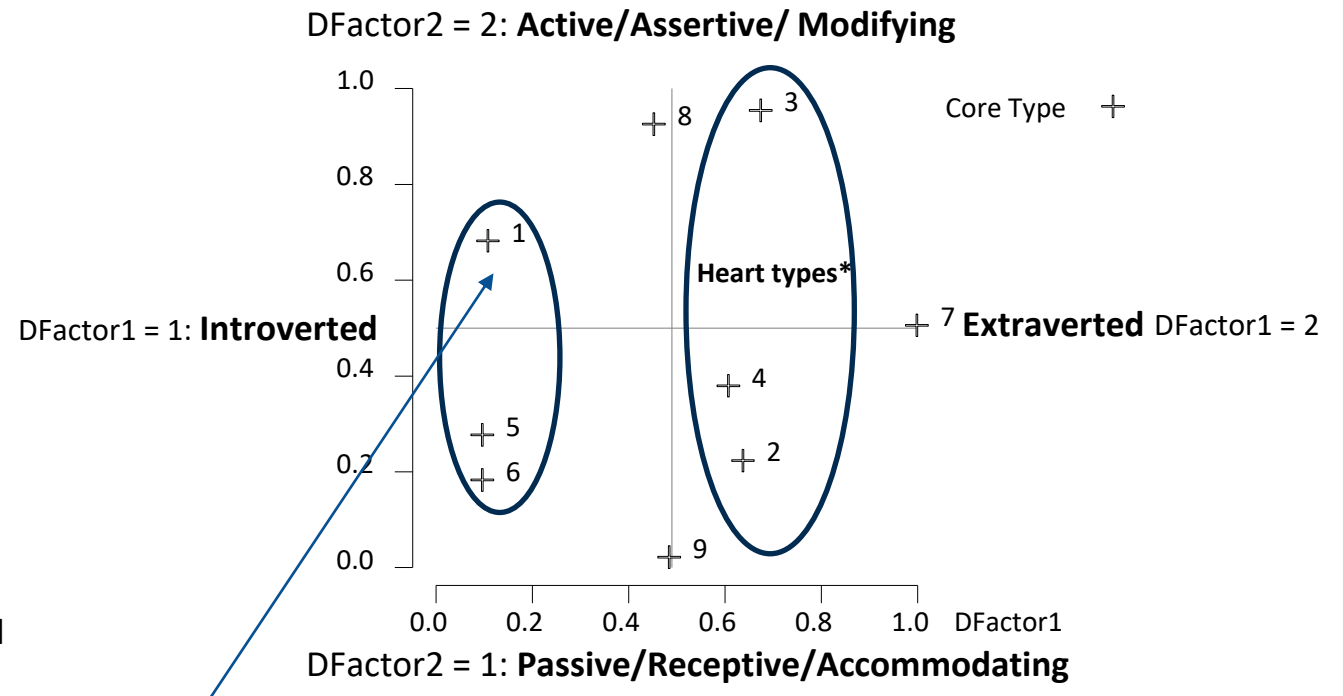
LC Results from 2-DFactor Model

Probability of Core Type for 2x2=4 Joint Latent Classes

DFactor1	1	1	2	2	
DFactor2	1	2	1	2	Overall
Class Size	0.28	0.25	0.25	0.22	
Ennea-Type					
1	0.09	0.26	0.02	0.03	0.10
2	0.11	0.04	0.24	0.06	0.12
3	0.01	0.18	0.02	0.36	0.13
4	0.09	0.08	0.18	0.10	0.11
5	0.24	0.12	0.03	0.01	0.10
6	0.25	0.07	0.03	0.01	0.10
7	0.00	0.00	0.23	0.23	0.11
8	0.01	0.25	0.02	0.20	0.11
9	0.20	0.01	0.23	0.00	0.11

Types with highest probability of being Core Type are highlighted

Map of Results from 2-DFactor Model (Biplot)



Horizontal Axis is Introverted vs. Extraverted: (Types 1*, 5 and 6 tend to be *introverted*, Type 7 is the most *Extraverted*)

Vertical Axis is Active/ Assertive/ Modifying vs. Passive/ Receptive/ Accommodating

*Type 1 is known as an *outgoing introvert*. This is consistent with a higher mapping on the vertical axis towards **Active/Assertive/ Modifying** relative to the other introverted types 5 and 6 who are mapped lower on this axis towards **Passive/Receptive/Accommodating**. Note that *heart types* tend towards being Extraverted.

Types 2, 3, and 4 are *Heart** Types

Personality Style TWO: The Loving Person

TWOS value and are attracted to **love**. They want to be generous persons, seeking to make the world a more loving place to live in. Harmonious intimate mutual relationships are what life is all about.

Personality Style THREE: The Effective Person

THREES are attracted to and value **efficiency, industriousness, and competence**. They want to be productive persons, seeking to make the world a more efficient place to live in. Bringing projects to completion, accomplishing goals, working effectively is what life is about. The *cosmos* is an orderly harmonious system and THREES work to keep it running smoothly.

Personality Style FOUR: The Original Person

FOURS are attracted to and value **originality, authenticity, individuality, and artistic expression**. They desire to be sensitive, refined persons, seeking to make the world more beautiful. They value the inner journey and are on the quest for the Holy Grail, their real self. Honoring your uniqueness and deeply connecting to others and to the world is what life is all about.

Individual Level Probabilities Differ Substantially for Persons A and B

- In LC models, individual i 's posterior membership probabilities for class k , $P_{k,i}$, used as weight to map each individual's position on the biplot*.
- The tables below show that posteriors for Persons A and B differ substantially from each other under both the 3-class and 2-DFactor models.

Posterior probabilities (3-class model)

Prob(Class1, Class2, Class3)

Person A (.03, .01, .96) -> Class #3

Person B (.97, .03, .00) -> Class #1

Posterior probabilities (2-DFactor model)

Prob(DFac11, DFac12, DFac21, DFac22)

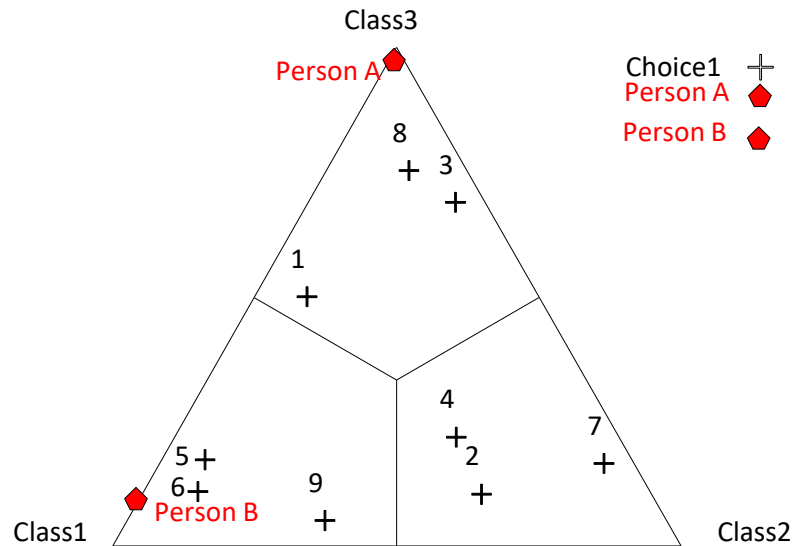
Person A (.01, .94, .00, .05)

Person B (.91, .00, .09, .00)

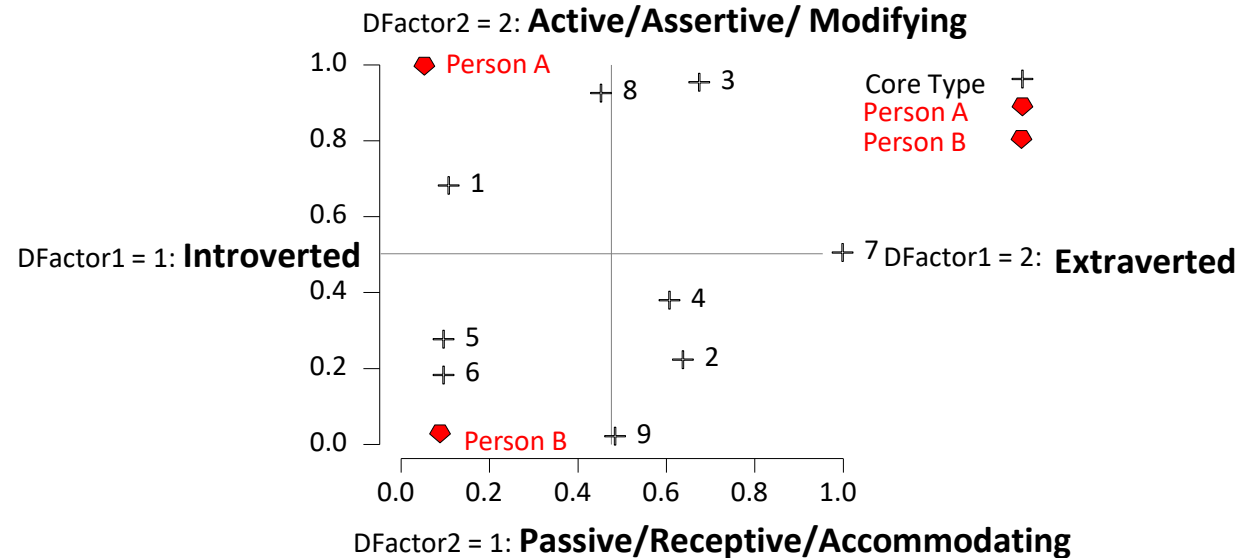
*See Magidson and Vermunt (2001).

Both Triplot and Biplot Maps Show Large Separation* Between Persons A and B

3-class Model Triplot Map



2-DFactor Biplot*



*Large separation between A and B suggests large difference in Enneagram™ personalities despite both being Core Type 5s.

Persons A and B both tend to be introverted -- posterior probability for DFactor1 = 2 (.05 and .09 respectively).

Enneagram theory suggests that Persons A and B share the Core type 5 motivation of *self sufficiency*.

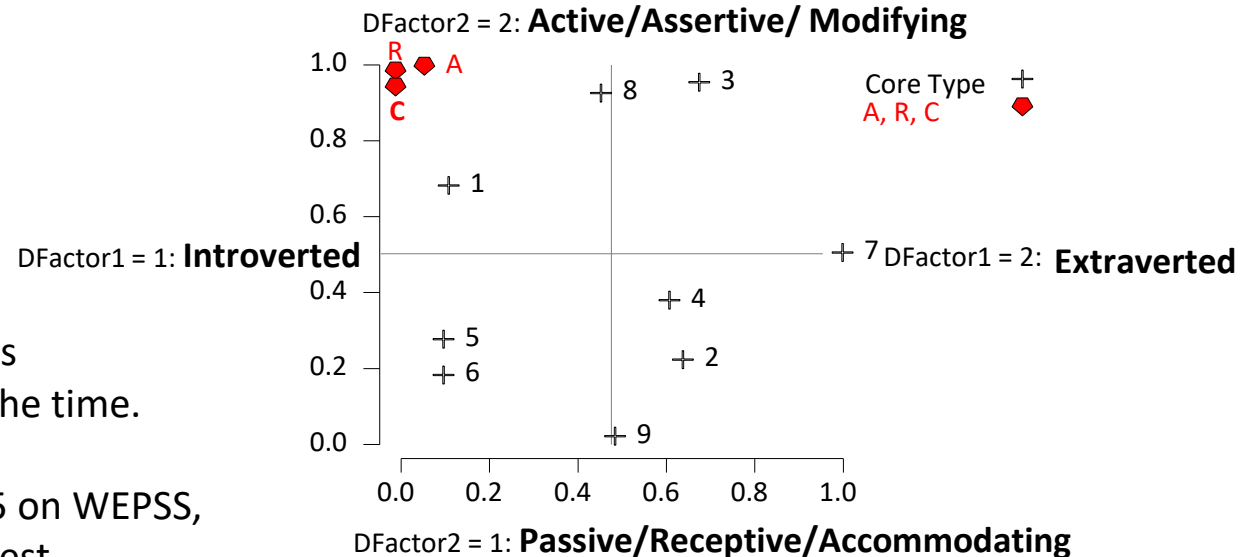
Person A tends to be more Assertive, while B is more Receptive

Three Different Tests with Different Type Results Yield Virtually Same Enneagram™ Mapping

Core Type result for Person A was '5', '1' and '8' in 3 different tests:

<u>TEST</u>	<u>Map Label</u>	<u>Full ranking</u>	<u>Reported Type</u>
WEPSS:	'A'	583417962	5
RHETI:	'R'	158346972	1
COMPASS:	'C'	856173492	8

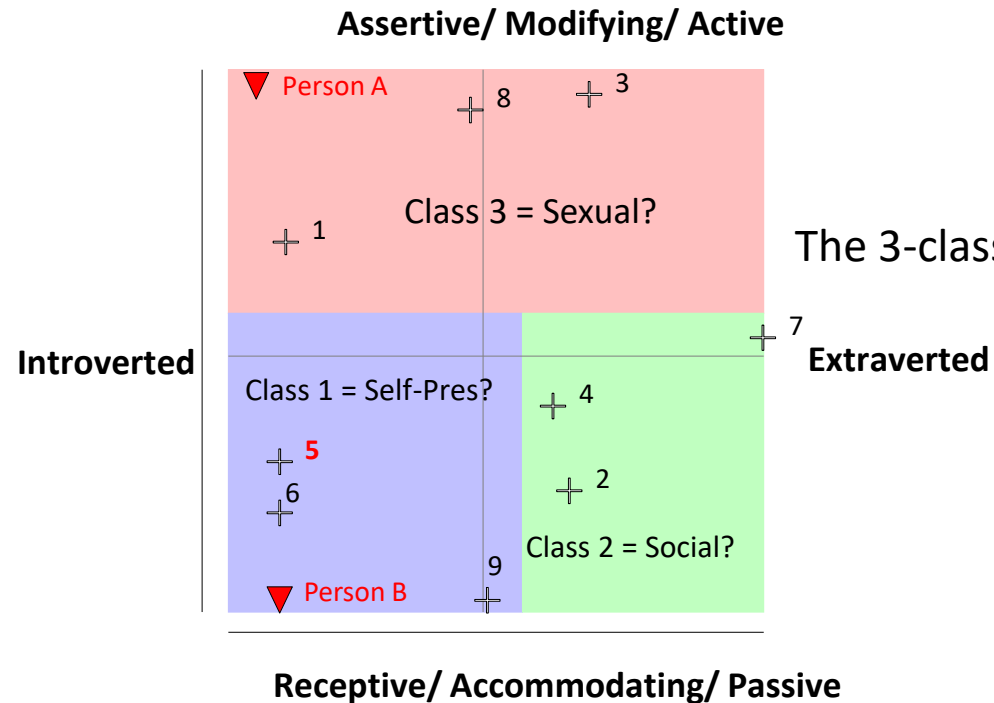
2-D Factor Biplot*



- Rothaizer, J. M. & Hill (2022) report that one's core type is misreported by the best Enneagram tests about 20% of the time.
- Person A who identifies as a Core 5, came out as a Type 5 on WEPSS, as a Type 1 on the RHETI and as Type 8 on the Compass test (see full ranking reported by each test above)
- Despite these differences, all 3 of the rankings are plotted in virtually the same location on the biplot. This result demonstrates the robustness* of one's Enneagram™ personality.

* The robustness in part is due to the optimal properties from maximum likelihood estimates of one's factor scores which are used to position one's Enneagram™ personality on the biplot.

Embedding 3-class Model into 2-DFactor Biplot Yields 3 Colored Sections



The 3-classes appear to be related to the 3 Subtypes/ Instinctual Variants *

Class 1 related to Self Preservation subtype?

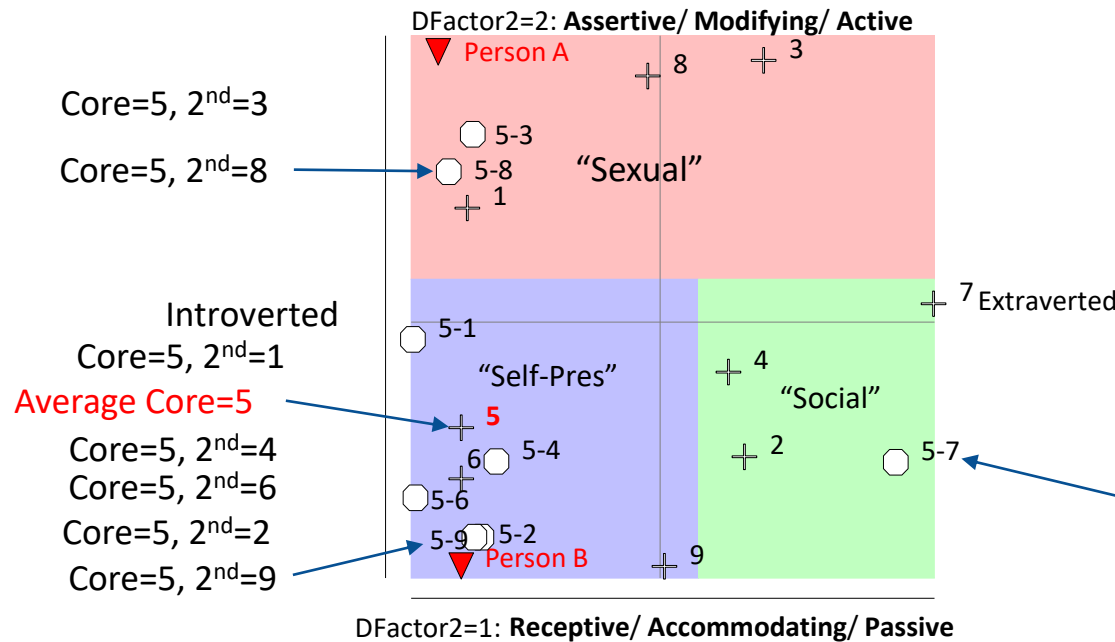
Class 2 related to Social subtype?

Class 3 related to Sexual subtype?

*Technical note: An external measure of the Subtypes or Instinctual Variants could be included as a covariate in the LC models to improve prediction of the posteriors and test the extent to which the covariate is predictive of the 3 classes. The 3 categories of this covariate can also be plotted as an 'active or 'inactive' covariate in tri-plot and 2-Dfactor Biplot. For further details, see Magidson and Vermunt (2001).

Individual Level Probabilities Suggest 81% of Type 5s are "Self Pres", and only 6% are "Social"

Positioning in Biplot based on:
1) individual level probabilities (for Persons A and B) and
2) partial ranks for all Core 5s



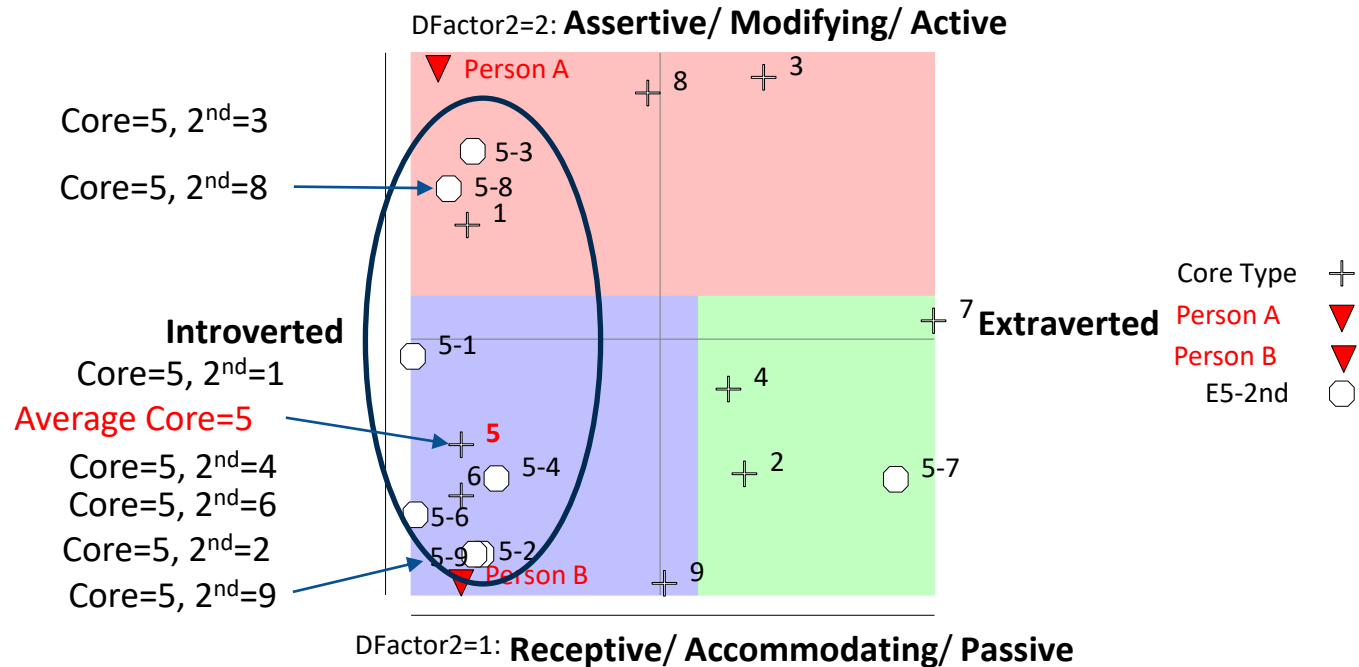
Core Type 5

2nd Highest Type	Frequency	Percent
1	2,242	13%
2	485	3%
3	903	5%
4	1,914	11%
6	3,775	23%
7	336	2%
8	1,919	11%
9	5,174	31%
Total	16,748	100%

- Core type 5 persons who secondarily most identify with style 7 ("5-7") are relatively rare (2%).

- Individual level probabilities are based on a test taker's full ranking
- Partial ranks are based on Type 5 as Core + 2nd Highest: 5-8 (for Person A) and 5-9 (for Person B)

Most Core 5s turn out to be in the Left (*Introverted*) Section of the Biplot



- Core type 5s whose 2nd highest is Type 9, 6, or 4 (65%) tend to be more *Receptive* than the average Type 5 (plotted in bottom left of biplot).
- Core type 5s whose 2nd highest is Type 8, 1, or 3 (29%) tend to be more *Assertive* than the average Type 5 (plotted higher in left of biplot).

Core + 2nd Highest Type is much more Informative than One's *Core Type Alone*

- Entropy R² obtained from Step 3 LC analyses predicting the 2-DFactor model joint classes provides useful metric for comparing importance of alternative supplementary data, with one's 'core type only' used as baseline
 - Complete ranking assesses best, but core + 2nd already predicts much better than core type alone
 - The Core type alone yields R² = .45 (baseline)
 - Core + 2nd Highest yields R² = .63
 - The full ranking yields R² = .86

Note: Core + Wings (e.g., 4 vs. 6 for E-5) predicts about same as alternatives (R² =.49 for Alt #1; R² =.54 for Alt #2)

Predicting Posteriors based on:	Entropy R ²
Core type only	45%
Core + 2nd Highest	63%
Core + 2nd Highest + 3rd Highest	73%
Complete Ranking (individual level)	86%
Core + "Wings" (e.g., 4 vs. 6 for E-5)	52%
Core + "Alt #1" (e.g., 3 vs. 7 for E-5)	49%
Core + "Alt #2" (e.g., 2 vs. 8 for E-5)	54%
Core + 3-class model assignment	65%

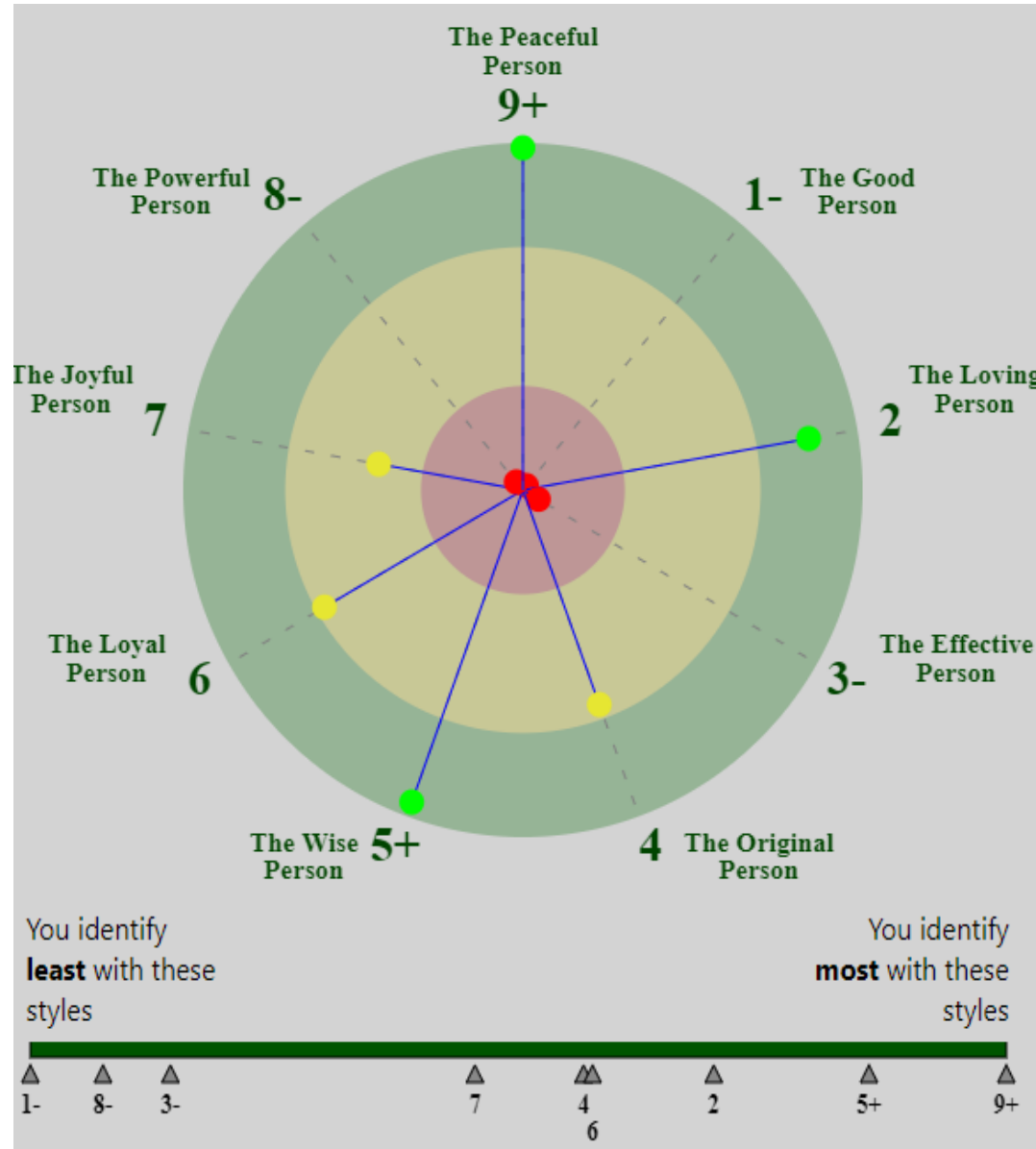
*One's *Enneagraph™* personality as displayed on biplot based on Core type + 2nd Highest is much more informative than that based on one's core type alone. Such comparisons reveal substantial amount of heterogeneity among persons with same core type. *Enneagraph* is a trademark of Statistical Innovations Inc.

Person C: A Type 9 who Secondarily Identifies with Type 5 and Identifies Least with Types 1, 8 and 3

Among all Core 9 types, 83% have second highest identification with
 -> type 5 (32%)
 -> type 2 (19%)
 -> type 7 (17%)
 -> type 6 (15%)

The remaining 17% of core 9s have second highest identification with
 -> type 4 (5.8%)
 -> type 8 (4.3%)
 -> type 3 (3.5%)
 -> type 1 (3.5%)

Note that only 8% of core 9s have second highest identification with one of their wings (types 1 or 8)



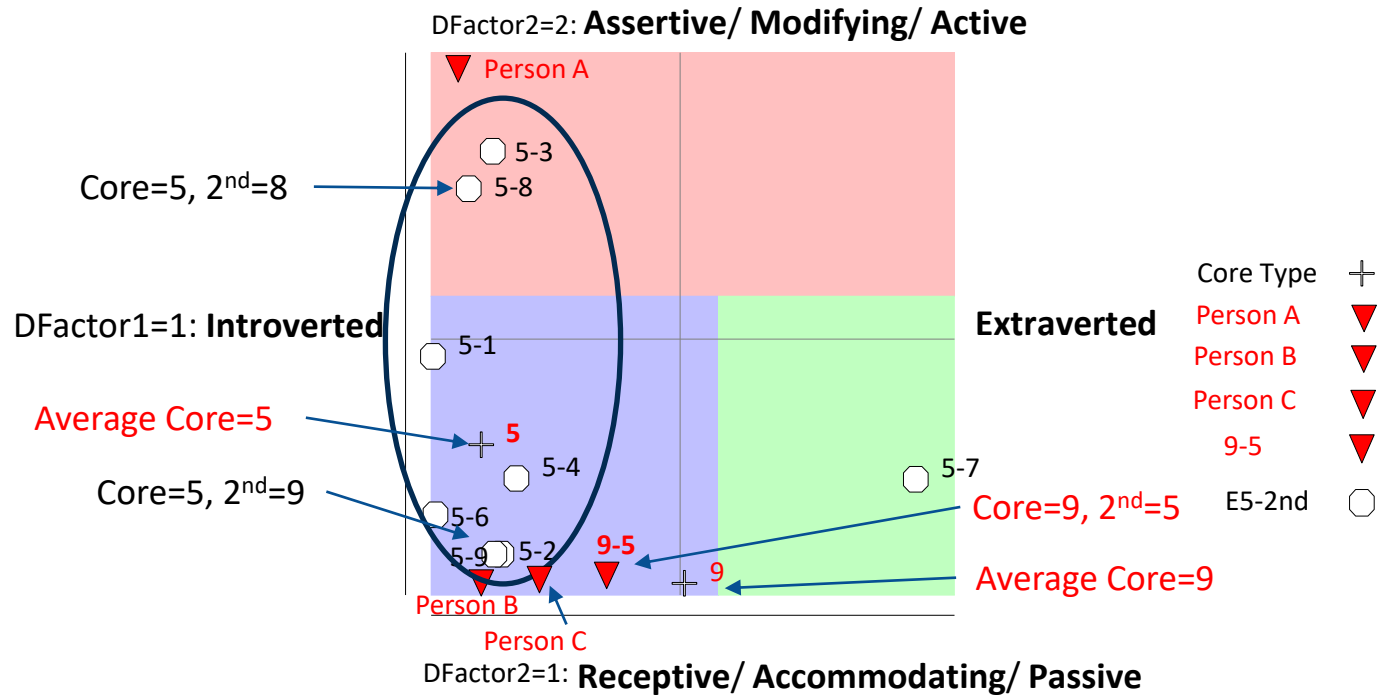
Person C is a Core 9 type

Similar to most type 9s, Person C does not identify with either wing.

It may reveal more about C's Enneagram™ personality to report whether they identify more with type 5 or 7 (Introverted vs. Extraverted).

For example, Person C relates more with type 5 than type 7. Overall, Core Type 9s tend more to have their second highest identification with type 5 than type 7 (32% vs. 17%)

Persons B and C have Similar Enneagram™ Personalities – Quite Different from Person A



Core Type 9

2nd Highest Type	Frequency	Percent
1	614	3%
2	3,388	19%
3	600	3%
4	1,022	6%
5	5,780	32%
6	2,806	16%
7	3,051	17%
8	751	4%
Total	18,012	100%

Core type 9 persons who secondarily most identify with style 5 ("9-5") are relatively common (32%).

Type 5-9 (Person B) is Much More Similar to Type 9-5 (Person C) than to Type 5-8 (Person A)

Summary

- Latent Class Models were applied to a large amount of Enneagram data (N= 160,000) to reveal the underlying personality structure within the nine core types
- Heterogeneity findings were consistent with the theory of Subtypes / Instinctual Variants
- Unlike the theoretical approaches, rank-based LC Models were used to synthesize large amount of Enneagram identification data revealing “Subsets” immediately, without the need for additional test items dictated by theory
 - Result was a novel **personality mapping for individual test takers** based on their reported identification with *all* types
 - *For perspective, the nine core types and partial ranks were also positioned on the map according to the model*
 - *While complete ranking is best, core + 2nd highest already explains much of the heterogeneity in core type*
 - Example: Mistake to label all 7s as *assertive*; while 7-3s, and 7-8s tend to be *assertive*, 7-9s tend to being *receptive*
 - Similarly: Mistake to describe all 5s as *non-assertive*; 5-9s are, but 5-8s tend to be *assertive*

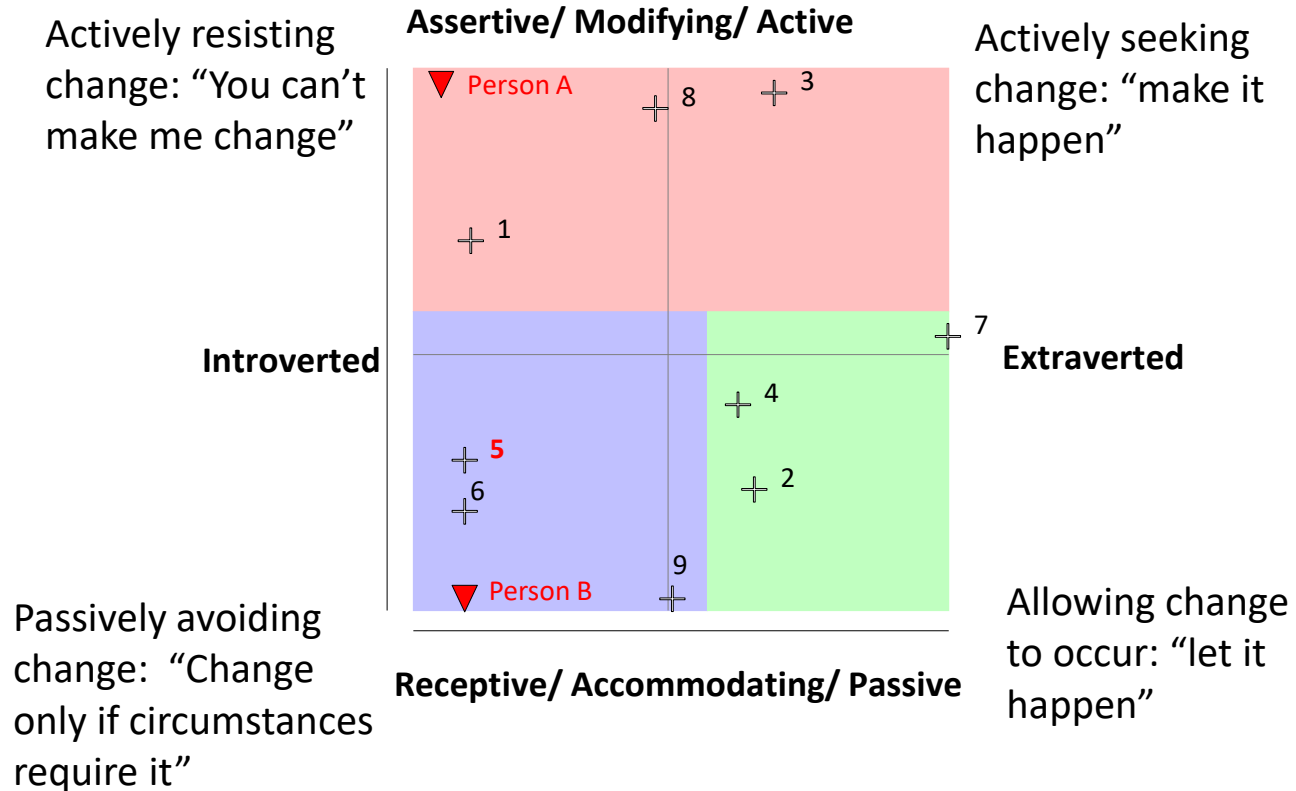
<u>Value of information contained in:</u>	<u>Entropy R²</u>
Core type only	45%
Core + 2nd Highest	63%
Core + 2nd Highest + 3rd Highest	73%
Complete Ranking (individual data)	86%

Conclusion: The Potential Benefits of Latent Class Methodology

- Latent Class modeling has unique advantages over other statistical methodologies in that its EM algorithm maximizes both the fit to the data (log-likelihood) and separation between the classes (Entropy) simultaneously (Hathaway, 1986).
- LC models provide a good fit to these data and yield meaningful personality maps
- The resulting classes appear to support various aspects of current Enneagram theory, which can be tested formally by including covariates in the model.
- Use of statistical modeling can resolve aspects of the Enneagram credibility problem described by Fitzsimons and Killen (2013).

Our Research is Ongoing

We will test Wagner's theory of how each quadrant of the biplot is oriented toward change:



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Appendix: Latent GOLD® syntax for ranking models based on Long file format – each case has 9 records as shown below

/ Latent GOLD Syntax for 3-class ranking model

Variables

caseid ID;
dependent Choice ranking;
attribute E1 nominal;
latent
Class nominal 3;

Equations

Choice <- E1 | Class;

id	choice
9990031	8
9990031	4
9990031	3
9990031	1
9990031	7
9990031	9
9990031	6
9990031	2

/ Latent GOLD Syntax for 2-DFactor ranking model*

Variables

caseid ID;
dependent Choice ranking;
attribute E1 nominal;
latent
DFac1 nominal 2, DFac2 nominal 2;

Equations

DFac1 <- 1; DFac2 <- 1;
Choice <- E1 + E1 DFac1 + E1 DFac2 ;

* DFactor choice models were first introduced in Magidson and Vermunt (2007)