Exploring the Structure of Protective and Risk Factors

Steven Andrew Culpepper
Department of Statistics
University of Illinois at Urbana-Champaign

This research was partially supported by NSF grants #1758631 and #1818458.

STEM Undergraduate Success Conference
Atlanta, Georgia
July 11-12, 2019

Overview

The goal for our setting is to diagnose characteristics associated with the PVEST framework.

Discuss measurement and modeling in the social sciences.

Present applications involving the Project Knowledge PIAB items to demonstrate analytic frameworks for future investigations.

The Building Blocks of Measurement

We ask people questions and they respond by selecting an anchor.

Ex. "I usually keep track of my progress toward my goals"
1 = Strongly disagree
2 = Disagree
3 = Uncertain or unsure
4 = Agree
5 = Strongly agree

There are five probabilities to describe responses,

```
    1     2     3     4     5
0.031 0.047 0.307 0.430 0.184
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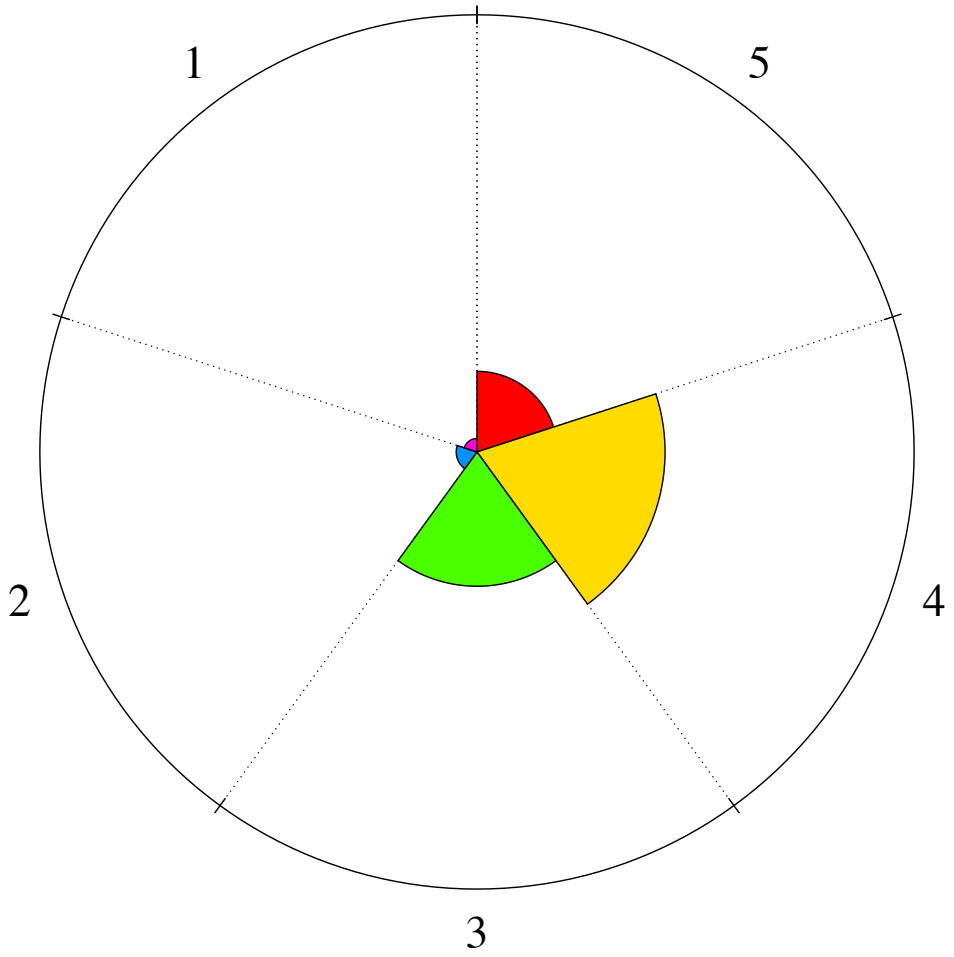

1
5
2
4
3

A Second Item

Consider a second item with five response options,

"I can do even the hardest work in class if I try.".

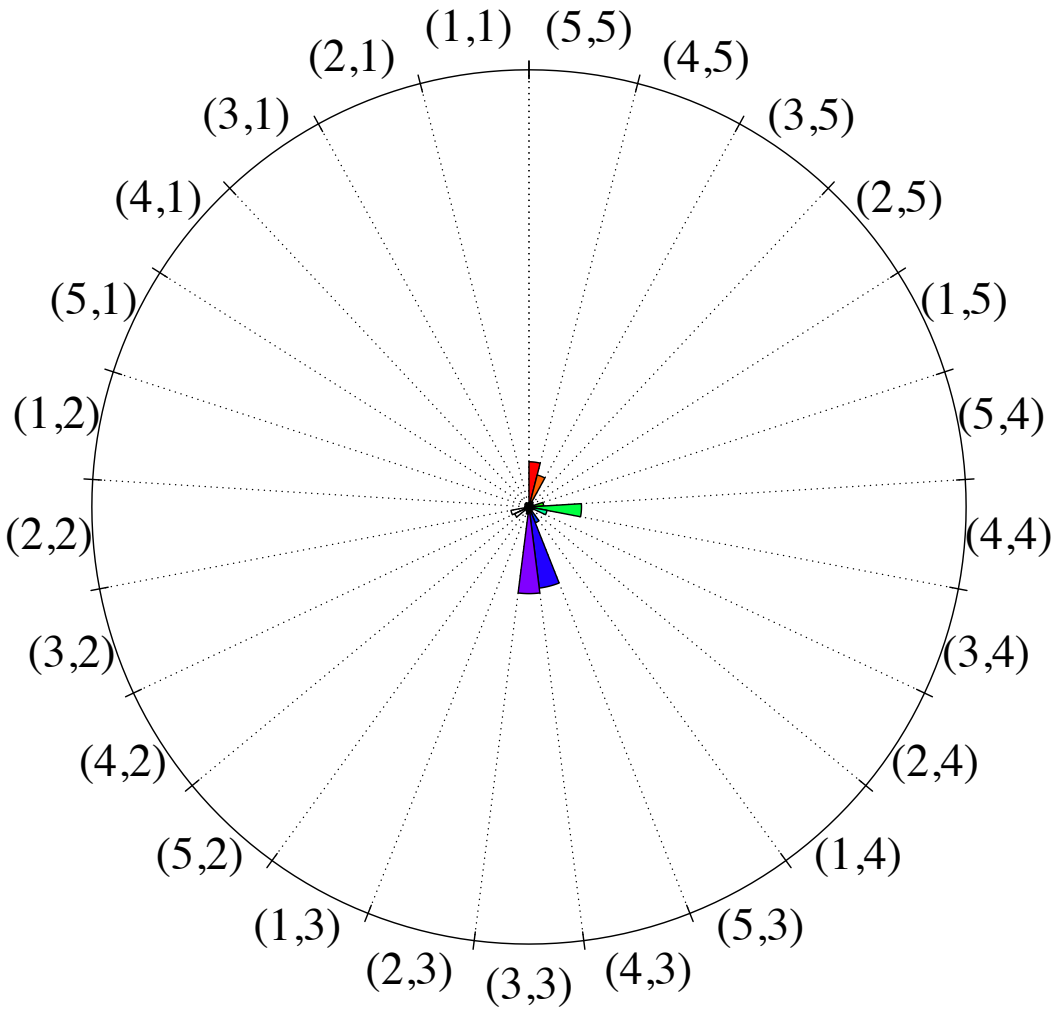
1 - Not at all True
2
3 - Somewhat True
4
5 - Very True

Two Items

There are 25 response patterns for the two items with five anchors.

For instance, the bivariate probabilities for all arrangements of item 1 (rows) and item 2 (columns) are,

	1	2	3	4	5
1	0.008	0.008	0.011	0.000	0.003
2	0.000	0.008	0.017	0.011	0.011
3	0.011	0.042	0.198	0.042	0.014
4	0.011	0.036	0.187	0.120	0.075
5	0.006	0.003	0.039	0.034	0.103


(1,1)
(5,5)
(2,1)
(4,5)
(3,1)
(3,5)
(4,1)
(2,5)
(5,1)
(1,5)
(1,2)
(5,4)
(2,2)
(4,4)
(3,2)
(3,4)
(4,2)
(2,4)
(5,2)
(1,4)
(1,3)
(5,3)
(2,3)
(3,3)
(4,3)

The number of probabilities grows exponentially as the number of items and categories increases.

If there are M anchors and J items there are M^J response patterns.

For instance, there are 9.765625×10^6 response patterns for a 10 item instrument with 5 response options.

Psychometric Models

Rather than study M^J response patterns we approximate them with a model.

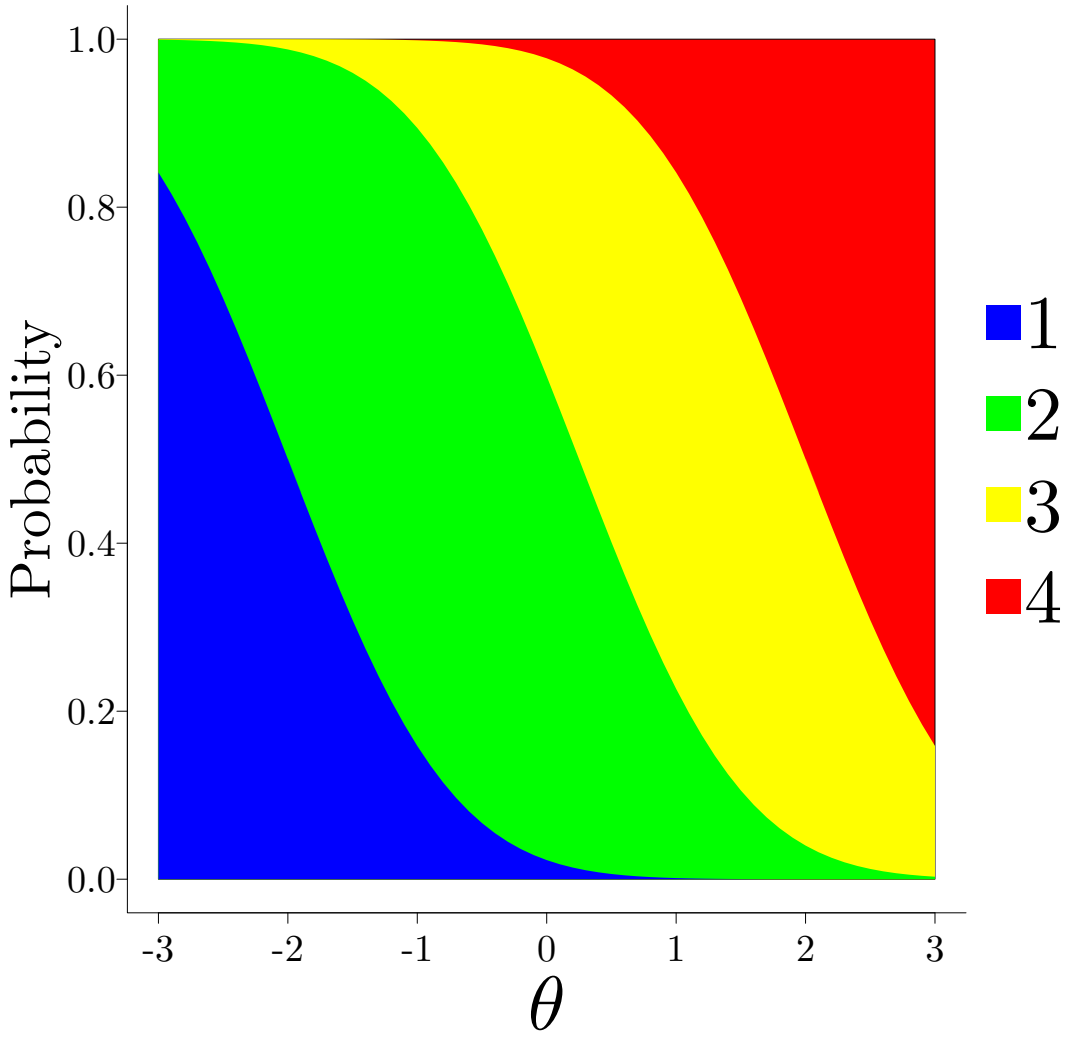
The model mathematically represents our understanding of how responses are generated.

A "good" model is parsimonious and provides an acceptable representation of the data.

The Factor Model

The classic factor model assumes you can map individuals onto a continuum, θ.

Individuals with higher θ's will choose anchors with higher values.


1.0
0.8
0.6
0.4
0.2
0.0
Probability
-3
-2
-1
0
1
2
3
θ
1
2
3
4

PVEST Informed Constructs

- *Risk factors* Responses indicate the presence of factors that put academic achievement at risk (+R) or the presence of factors that reduce this risk (-R)
- *Protective factors* Responses indicate the presence of factors that provide support in the face of academic/other stressors (+P) or the presence of factors that reduce this support (-P)

Purpose:

The types and magnitude of stresses associated with being a student at an HBCU varies due to student life experiences, institutional histories, and personality traits.

Developing scales capturing risk/protective factors helps to identify the needs of specific (classes) of HBCU students based on these attributes.

Survey Instrument and Data

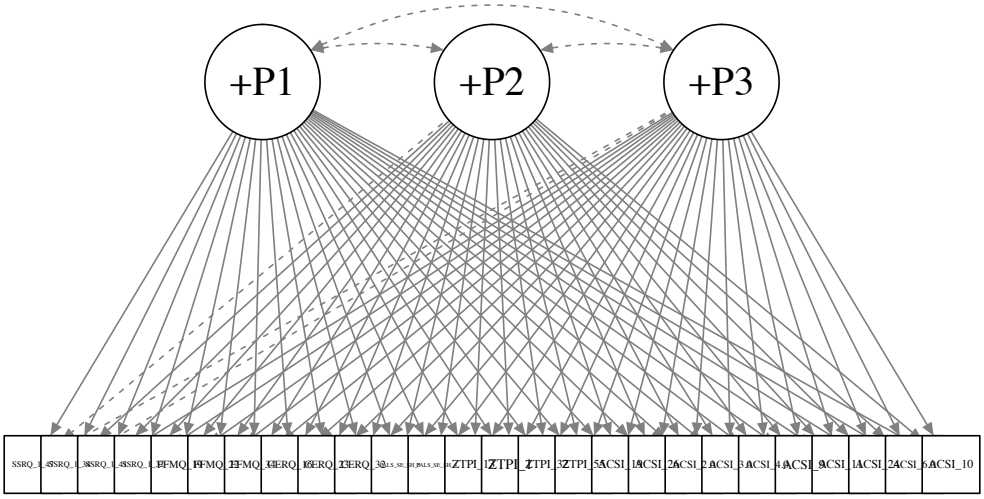
Data were collected from STEM majors at VSU.

Project Knowledge is a five-year NSF funded project (#1818458).

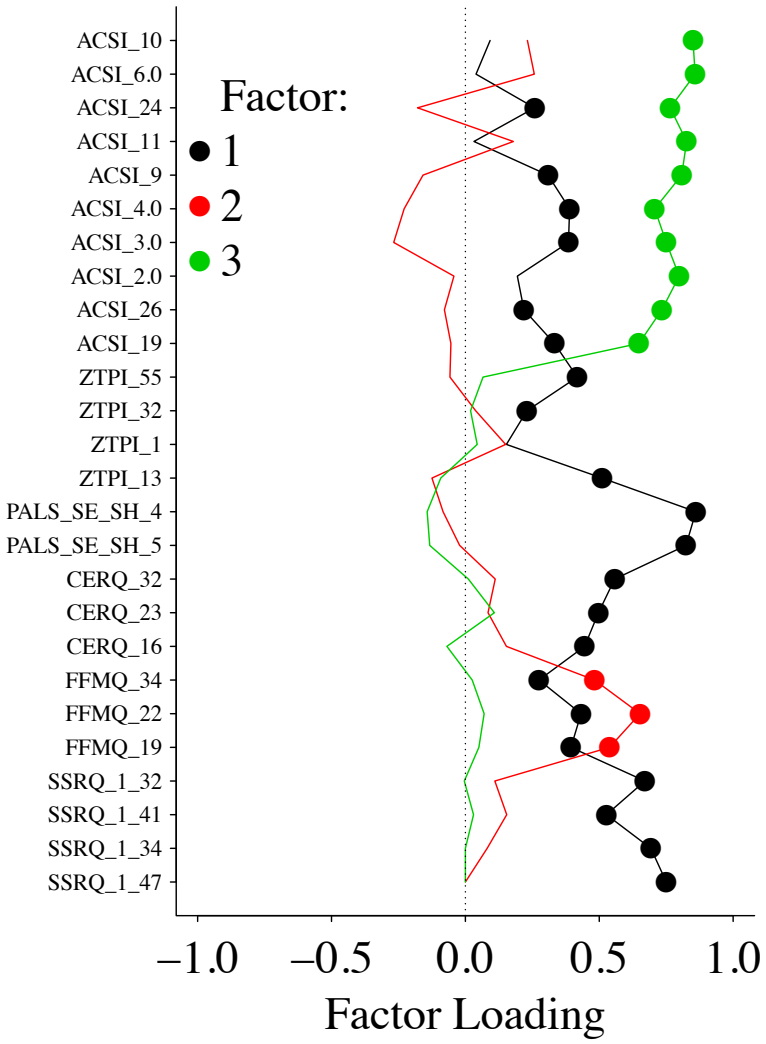
+P Items

	Variable	Stem
1	SSRQ_1_47	Once I have a goal, I can usually plan how to reach it
2	SSRQ_1_34	I have a lot of willpower
3	SSRQ_1_41	I am able to resist temptation
4	SSRQ_1_32	As soon as I see a problem or challenge, I start looking for possible solutions
5	FFMQ_19	When I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting taken over by it.
6	FFMQ_22	In difficult situations, I can pause without immediately reacting.
7	FFMQ_34	When I have distressing thoughts or images, I just notice them and let them go.
8	CERQ_16	I think that other people go through much worse experiences
9	CERQ_23	I think about how to change the situation
10	CERQ_32	I think about a plan of what I can do best
11	PALS_SE_SH_5	Even if the work is hard, I can learn it.
12	PALS_SE_SH_4	I can do almost all the work in class if I don't give up.
13	ZTPI_13	Meeting tomorrow's deadlines and doing other necessary work comes before tonight's play.
14	ZTPI_1	I believe that getting together with one's friends to party is one of life's important pleasures.
15	ZTPI_32	It is more important for me to enjoy life's journey than to focus only on the destination.
16	ZTPI_55	I like my close relationships to be passionate.
17	ACSI_19	Sought out people I thought would make me laugh.
18	ACSI_26	Attended a social event (dance, party, movie) to reduce stress caused by the situation
19	ACSI_2.0	Got a group of family or friends together to help with the problem
20	ACSI_3.0	Shared your feelings with a friend or family member.
21	ACSI_4.0	Remembered what a parent (or other relative) once said about dealing with these kinds of situations.
22	ACSI_9	Sought advice about how to handle the situation from an older person in my family or community.
23	ACSI_11	Asked for suggestions on how to deal with the situation during a meeting of my organization or club.
24	ACSI_24	Sought emotional support from family and friends.
25	ACSI_6.0	Went to church (or other religious meeting) to get help from the group
26	ACSI_10	Read a scripture from the Bible (or similar book) for comfort and/or guidance

+P Factor Model



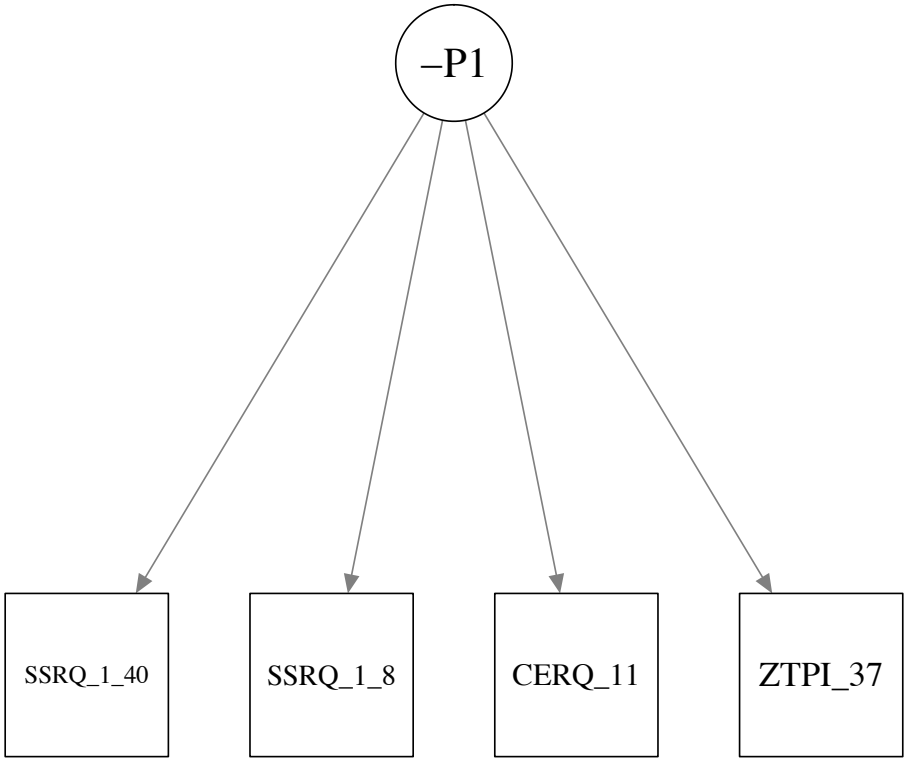
+P Profiles


ACSI_10
ACSI_6.0
ACSI_24
ACSI_11
ACSI_9
ACSI_4.0
ACSI_3.0
ACSI_2.0
ACSI_26
ACSI_19
ZTPI_55
ZTPI_32
ZTPI_1
ZTPI_13
PALS_SE_SH_4
PALS_SE_SH_5
CERQ_32
CERQ_23
CERQ_16
FFMQ_34
FFMQ_22
FFMQ_19
SSRQ_1_32
SSRQ_1_41
SSRQ_1_34
SSRQ_1_47
Factor:
1
2
3
−1.0
−0.5
0.0
0.5
1.0
Factor Loading

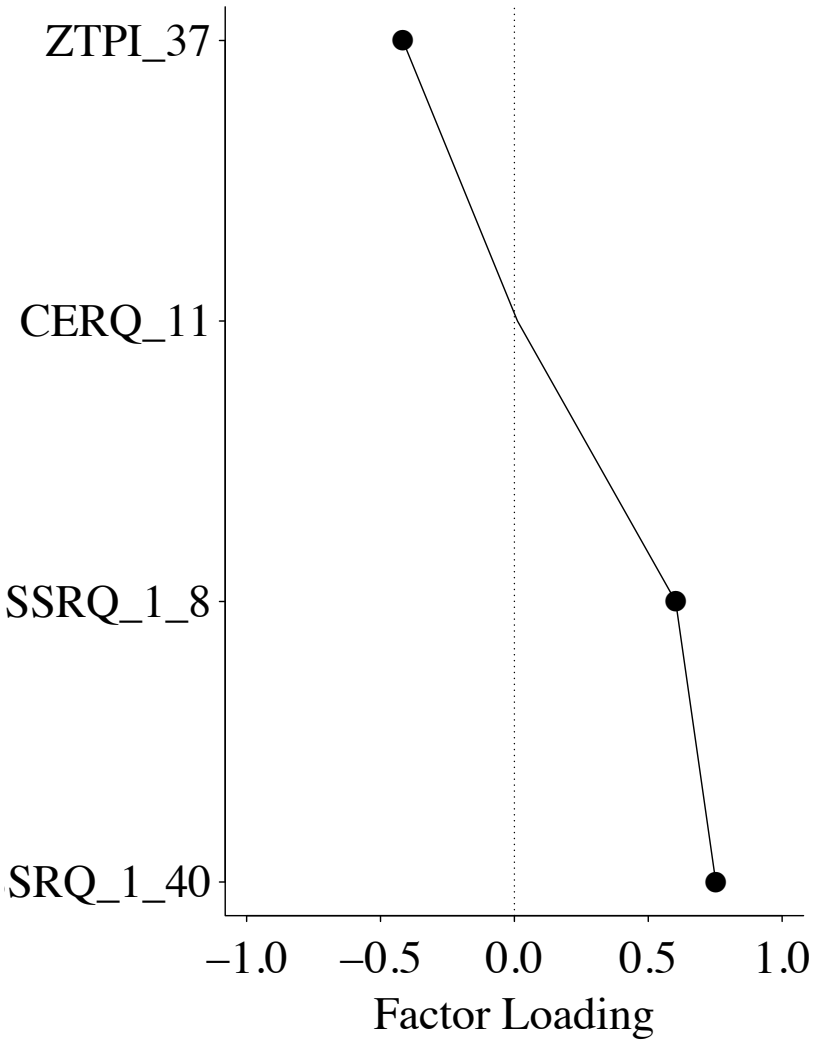
-P Items

	Variable	Stem
1	SSRQ_1_40	I have trouble making plans to help me reach goals
2	SSRQ_1_8	I don't notice the effects of my actions until it's too late
3	CERQ_11	I think that I have to accept the situation
4	ZTPI_37	You can't really plan for the future because things change so much.

-P Factor Model



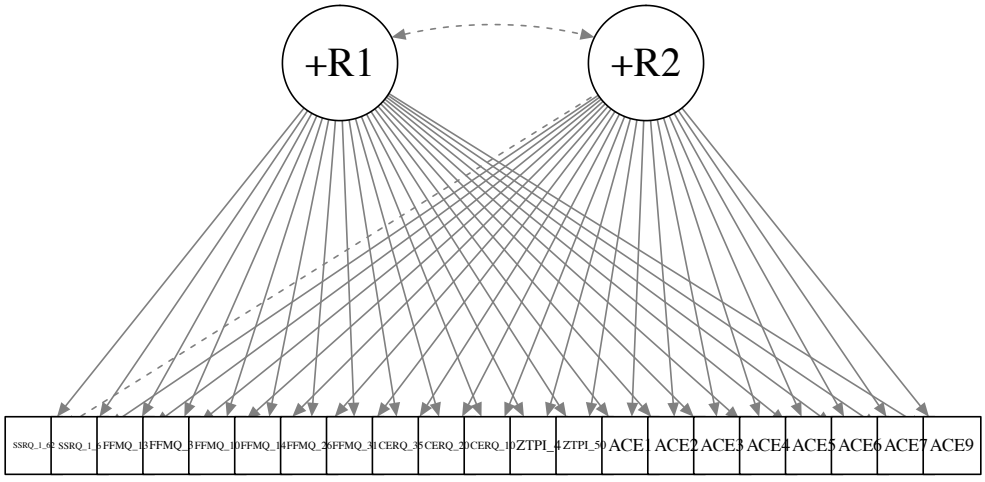
-P Profiles



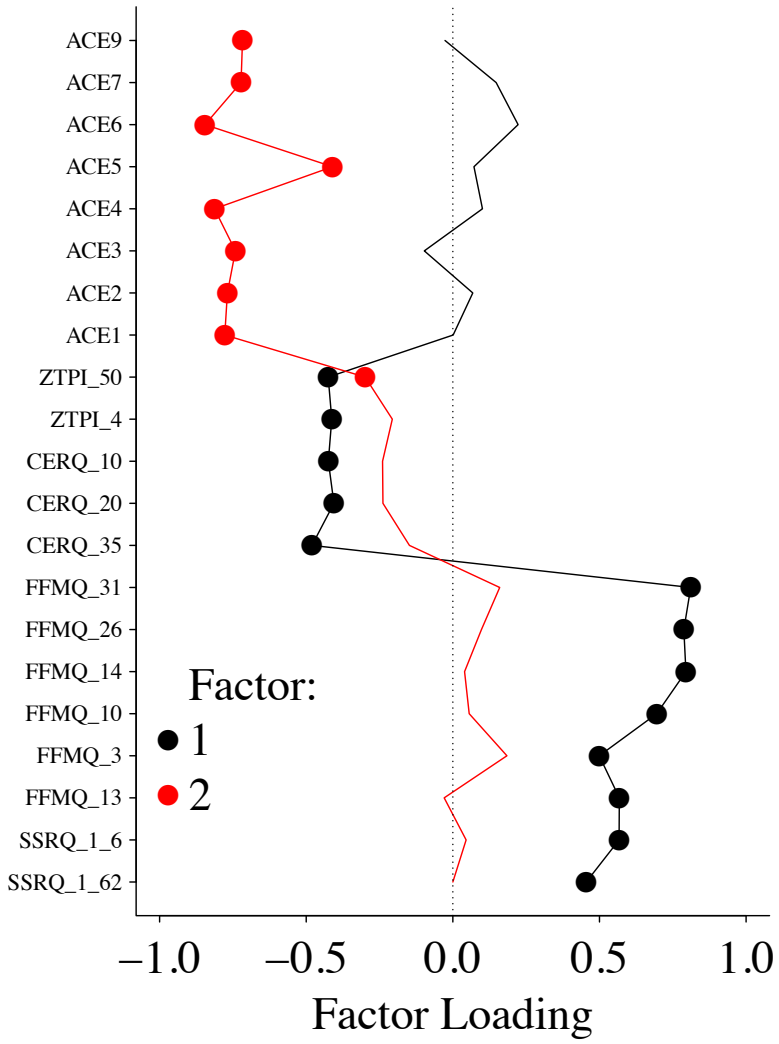
+R Items

	Variable	Stem
1	SSRQ_1_62	I give up quickly
2	SSRQ_1_6	I get easily distracted from my plans
3	FFMQ_13	I am easily distracted.
4	FFMQ_3	I criticize myself for having irrational or inappropriate emotions.
5	FFMQ_10	I tell myself I shouldn't be feeling the way I'm feeling.
6	FFMQ_14	I believe some of my thoughts are abnormal or bad and I shouldn't think that way.
7	FFMQ_26	I tell myself that I shouldn't be thinking the way I'm thinking.
8	FFMQ_31	I think some of my emotions are bad or inappropriate and I shouldn't feel them.
9	CERQ_35	I continually think how horrible the situation has been
10	CERQ_20	I think that I cannot change anything about it
11	CERQ_10	I feel that I am the one who is responsible for what has happened
12	ZTPI_4	I often think of what I should have done differently in my life.
13	ZTPI_50	I think about the bad things that have happened to me in the past.
14	ACE1	[emotional abuse of self]
15	ACE2	[physical abuse of self]
16	ACE3	[emotional neglect]
17	ACE4	[parental neglect]
18	ACE5	Were your parents ever separated or divorced?
19	ACE6	[Physical abuse of mother/stepmother]
20	ACE7	Did you live with anyone who was a problem drinker or alcoholic or used street drugs?
21	ACE9	Did a household member go to prison?

+R Factor Model



+R Profiles


ACE9
ACE7
ACE6
ACE5
ACE4
ACE3
ACE2
ACE1
ZTPI_50
ZTPI_4
CERQ_10
CERQ_20
CERQ_35
FFMQ_31
FFMQ_26
FFMQ_14
FFMQ_10
FFMQ_3
FFMQ_13
SSRQ_1_6
SSRQ_1_62
Factor:
1
2
−1.0
−0.5
0.0
0.5
1.0
Factor Loading

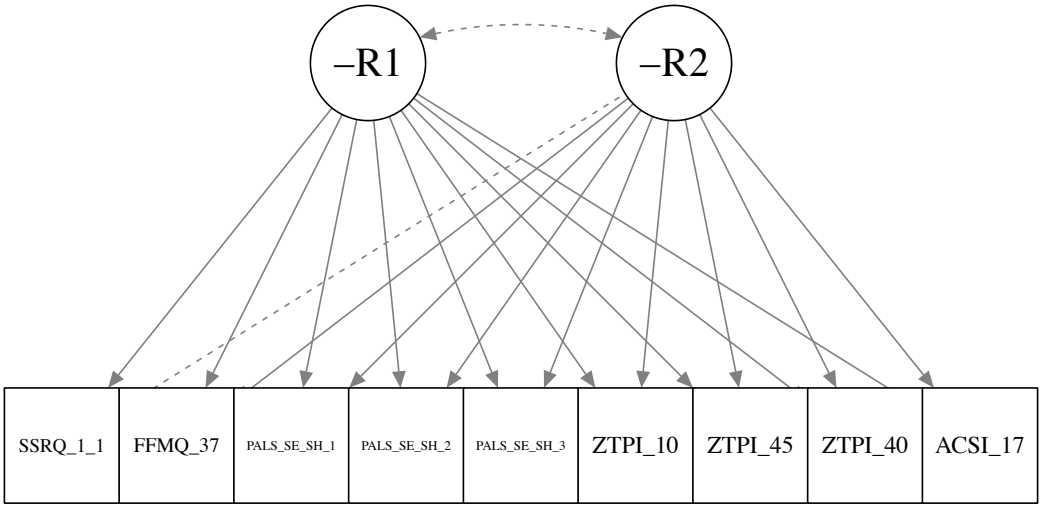
Note Factor 2 appears to be a methods factor.

ACE1 to ACE9 are all dichotomous Yes/No responses.

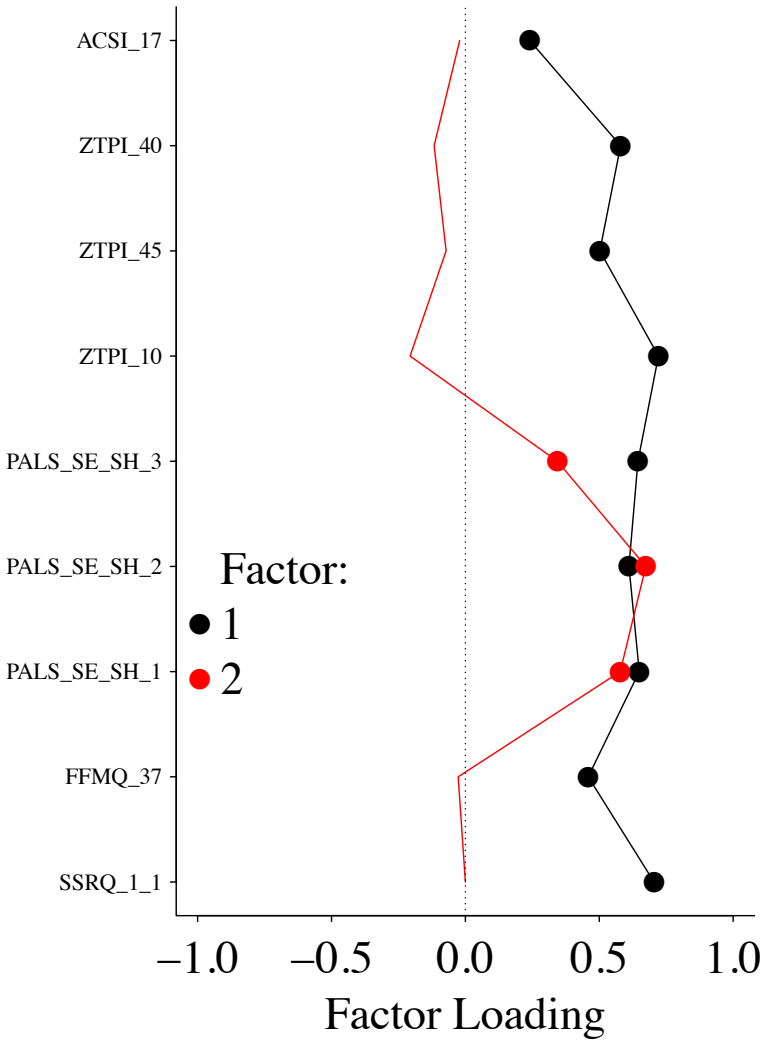
-R Items

	Variable	Stem
1	SSRQ_1_1	I usually keep track of my progress toward my goals
2	FFMQ_37	I pay attention to how my emotions affect my thoughts and behavior.
3	PALS_SE_SH_1	I'm certain I can master the skills taught in class this year.
4	PALS_SE_SH_2	I'm certain I can figure out how to do the most difficult class work
5	PALS_SE_SH_3	I can do even the hardest work in class if I try.
6	ZTPI_10	When I want to achieve something, I set goals and consider specific means for reaching those goals.
7	ZTPI_45	I am able to resist temptations when I know that there is work to be done.
8	ZTPI_40	I complete projects on time by making steady progress.
9	ACSI_17	Spent more time than usual doing things with friends and family

-R Factor Model



-R Profiles


ACSI_17
ZTPI_40
ZTPI_45
ZTPI_10
PALS_SE_SH_3
PALS_SE_SH_2
PALS_SE_SH_1
FFMQ_37
SSRQ_1_1
Factor:
1
2
−1.0
−0.5
0.0
0.5
1.0
Factor Loading

Benefits of the Factor Model

A θ can be introduced to represent each underlying theoretical construct.

The model provides a clear interpretation and connection between the hypothesized theoretical latent structure and the items.

Scale development proceeds by writing items to distinguish high/low standing on each θ.

Structural models can be specified to relate latent variables to each other or other outcomes of interest.

Potential Limitations of the Factor Model

The latent variables are assumed to be continuous.

This framework is less diagnostic and more useful for ranking.

Change in this framework is generally smooth and may not capture discontinuous shifts between states.

Discrete Mixture Models

An alternative is to classify individuals into *latent* groups.

The model assumes individuals' responses within latent groups are more similar than different.

Benefit of Discrete Mixture Models

We may be able to classify individuals into theoretically meaningful groups.

Interventions may be designed to target development for individuals in different groups.

Change is fundamentally discontinuous as it implies transitions between states and latent group membership.

Potential Limitations of Discrete Mixture Models

The connection between theory and group differences is not explicitly articulated.

The challenge with this approach is that we often need to "read the tea leaves" to understand the relationship between latent groups and item responses.

Item writing for scale construction may be more difficult in this framework.

Latent Structure Models (LSMs)

LSMs have features of both the factor and discrete mixture models [Culpepper, 2019].

Similar to factor models, items are mapped to the latent structure. Latent groups are theoretically defined.

There is a role for theory in scale construction.

Similar to discrete mixture models, the procedure classifies individuals into theoretically homogeneous groups.

Measurement is diagnostic with the goal of prescribing interventions to promote changes in states.

Rather than a continuous θ, we introduce vector of binary attributes,

$$\boldsymbol{\alpha} = (\alpha_1, \alpha_2, \ldots, \alpha_K).$$

$\alpha_k = 1$ for students who possess some attribute and 0 otherwise.

Ex. There are eight latent groups if there are three attributes:

$$(0,0,0),\ (0,0,1),\ (0,1,0),\ (0,1,1),$$
$$(1,0,0),\ (1,0,1),\ (1,1,0),\ (1,1,1).$$

LSMs allow for different latent processes (e.g., main-effects and interactions).

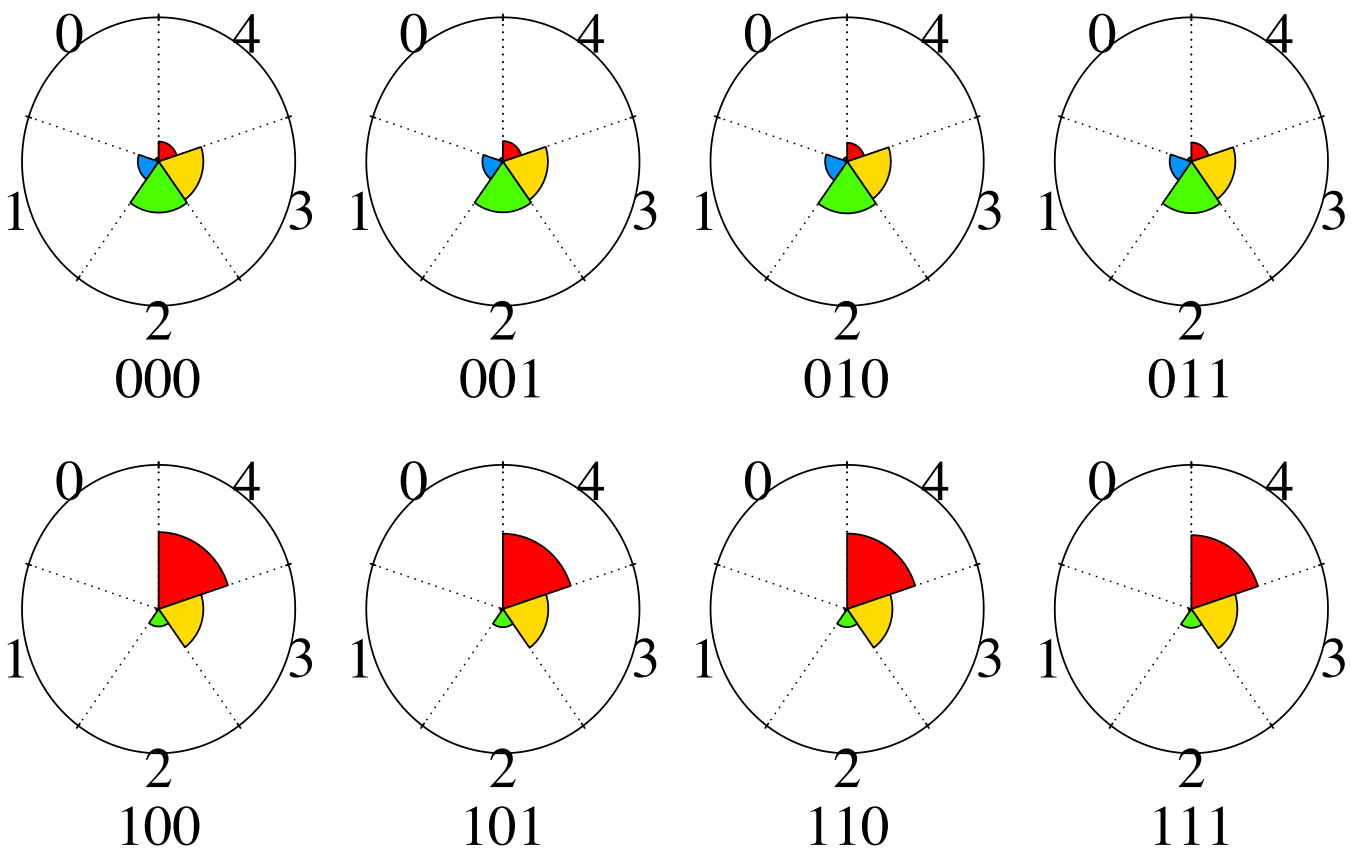
Application to +P Items

	Attribute 1	Attribute 2	Attribute 3
1. SSRQ_1_47	1.00	0.12	0.10
2. SSRQ_1_34	1.00	0.18	0.05
3. SSRQ_1_41	1.00	0.06	0.11
4. SSRQ_1_32	1.00	0.11	0.13
5. FFMQ_19	1.00	0.04	0.21
6. FFMQ_22	1.00	0.09	0.27
7. FFMQ_34	0.79	0.04	0.33
8. CERQ_16	1.00	0.19	0.16
9. CERQ_23	1.00	0.78	0.33
10. CERQ_32	1.00	0.27	0.23
11. PALS_SE_SH_5	1.00	0.35	0.13
12. PALS_SE_SH_4	1.00	0.21	0.19
13. ZTPI_13	1.00	0.16	0.85
14. ZTPI_1	0.00	0.00	1.00
15. ZTPI_32	0.00	1.00	0.00
16. ZTPI_55	0.00	1.00	0.00
17. ACSI_19	0.07	1.00	1.00
18. ACSI_26	0.07	1.00	1.00
19. ACSI_2.0	0.03	1.00	1.00
20. ACSI_3.0	0.13	1.00	1.00
21. ACSI_4.0	0.17	1.00	1.00
22. ACSI_9	0.26	1.00	1.00
23. ACSI_11	0.03	0.21	1.00
24. ACSI_24	0.10	1.00	1.00
25. ACSI_6.0	0.35	1.00	1.00
26. ACSI_10	0.07	1.00	1.00

	Class	$\boldsymbol{\pi}$
1	000	0.125
2	001	0.047
3	010	0.365
4	011	0.088
5	100	0.165
6	101	0.091
7	110	0.068
8	111	0.050

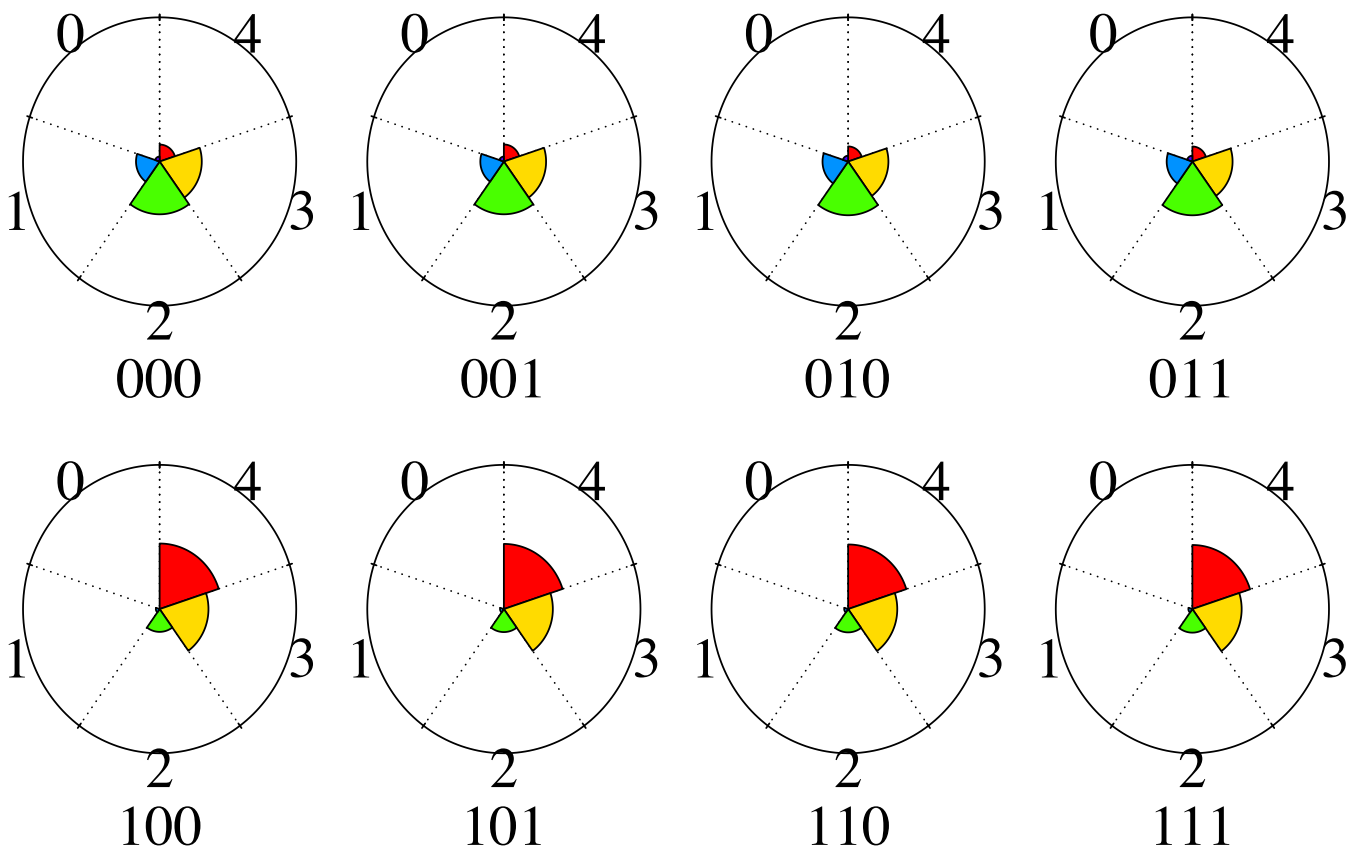
Attribute 1 for Item 1

Once I have a goal, I can usually plan how to reach it



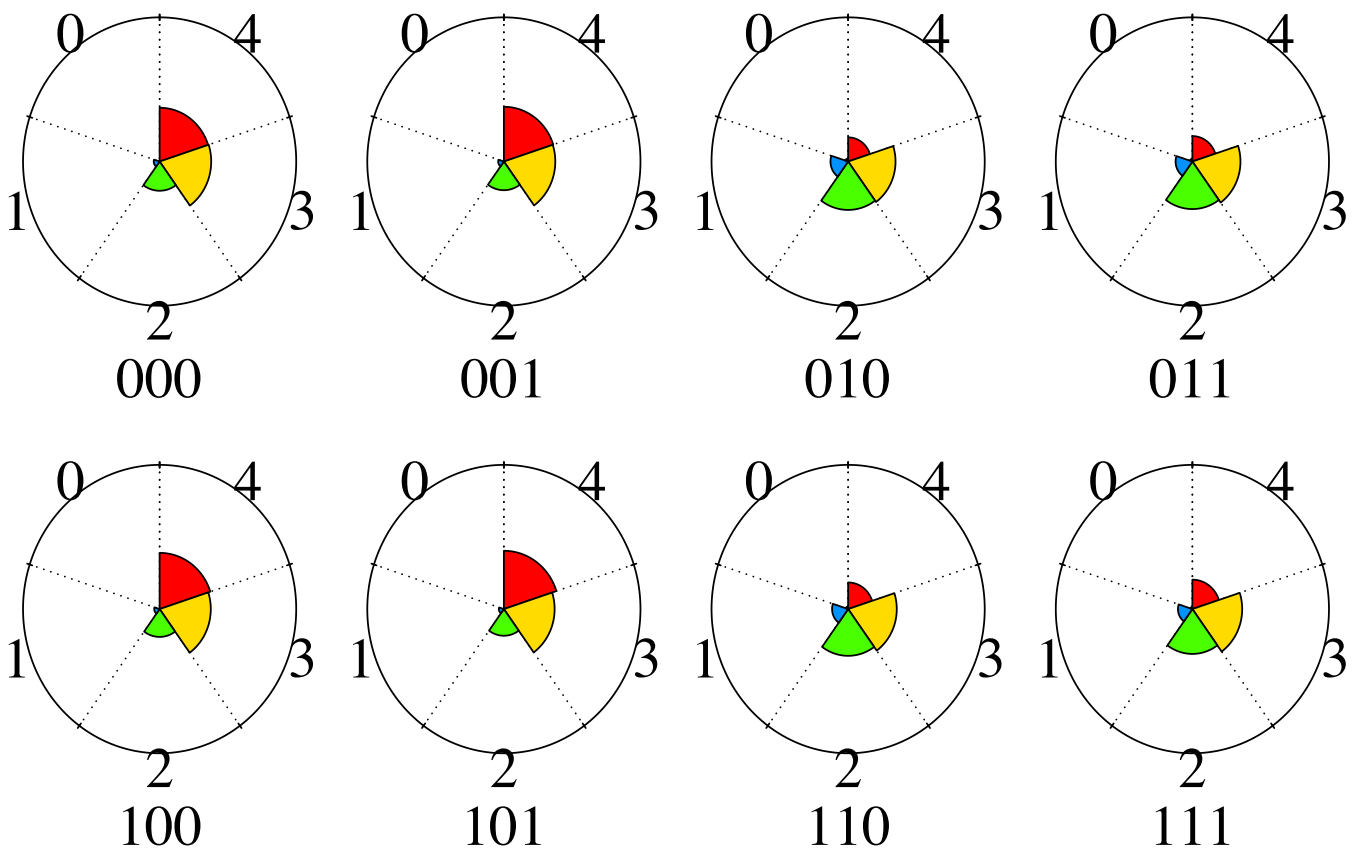
Attribute 1 for Item 2

I have a lot of willpower



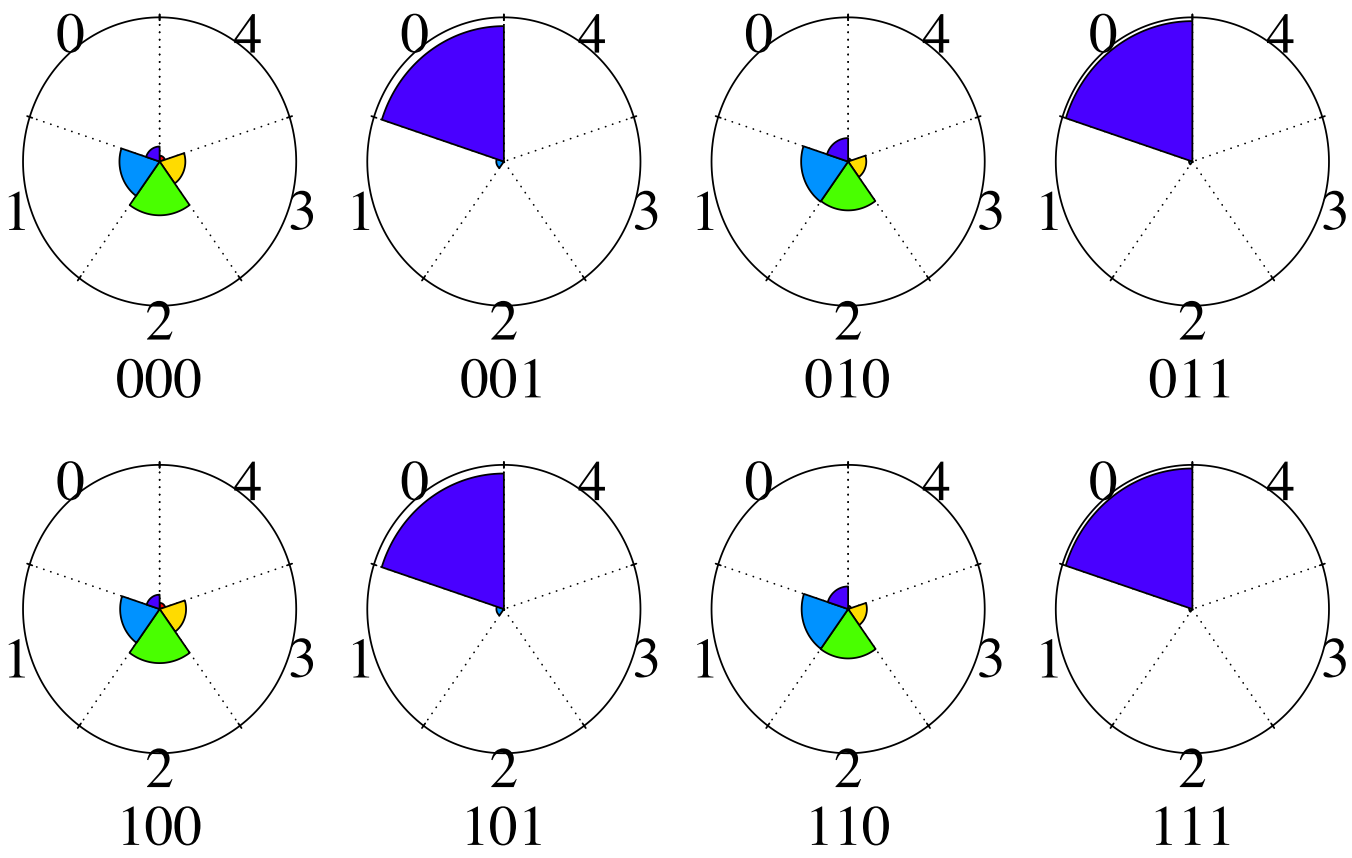
Attribute 2 for Item 16

I like my close relationships to be passionate.



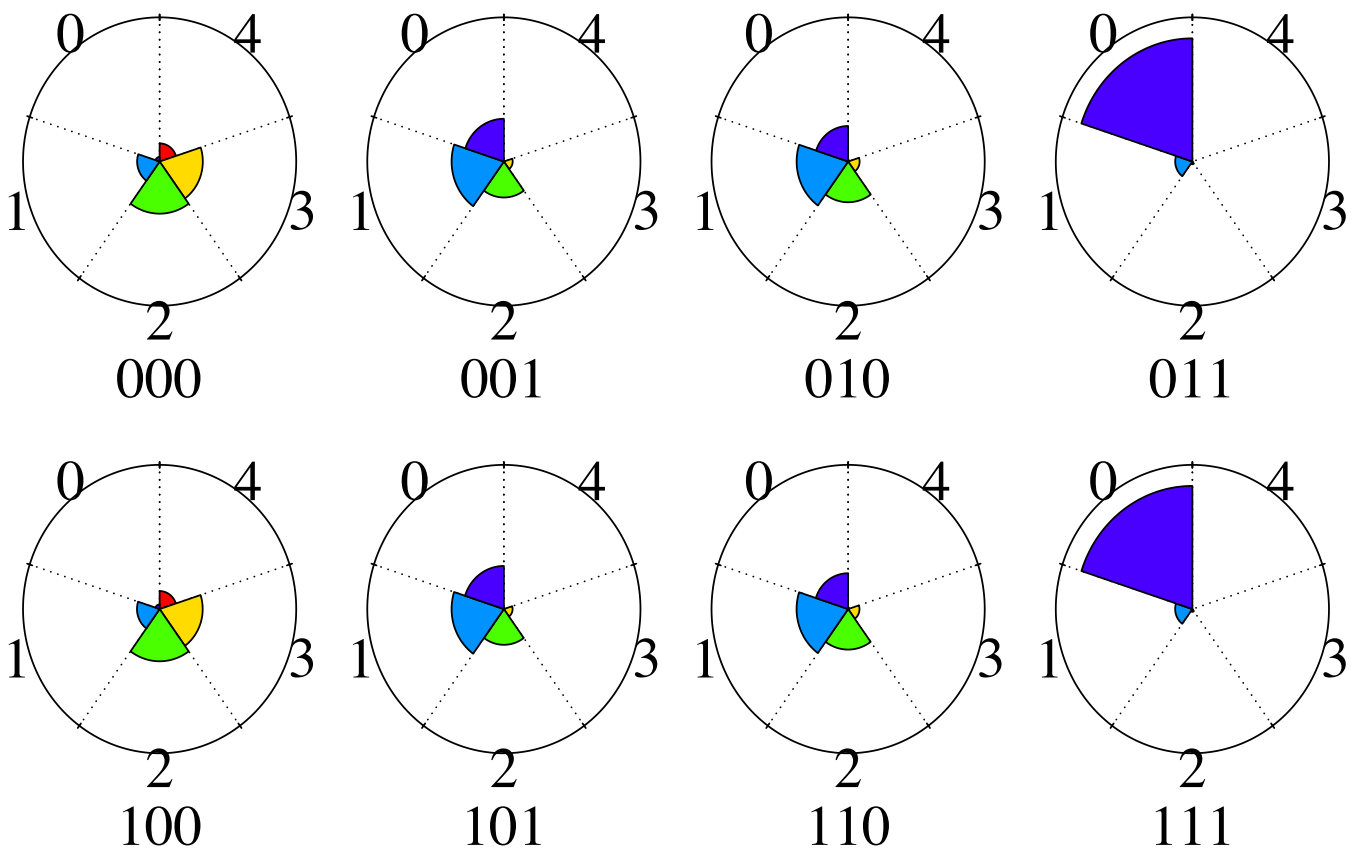
Attribute 3 for Item 23

Asked for suggestions on how to deal with the situation during a meeting of my organization or club.



Attributes 2 and 3 for Item 19

Got a group of family or friends together to help with the problem



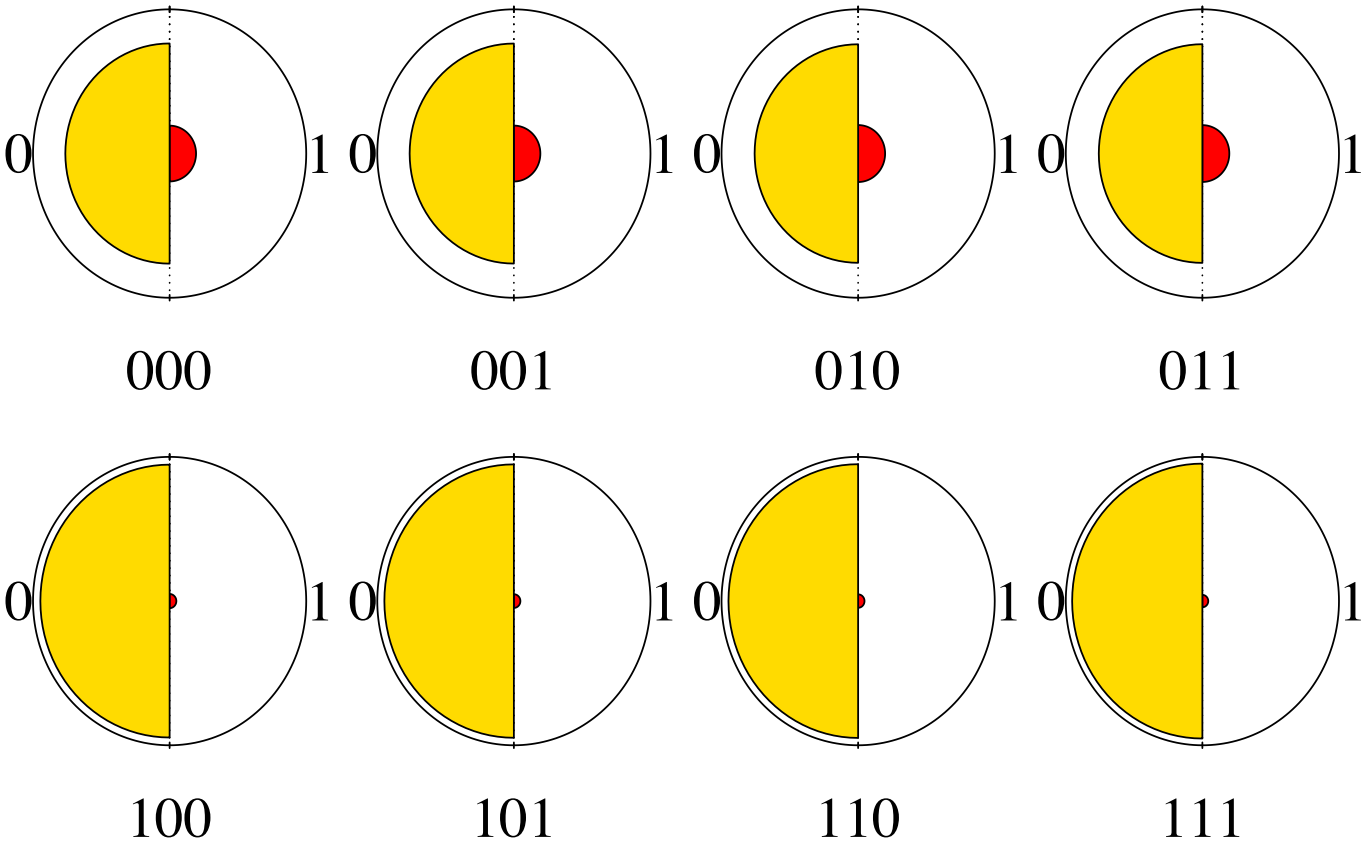
Application to +R Items

	Attribute 1	Attribute 2	Attribute 3
1. SSRQ_1_62	1.00	1.00	0.45
2. SSRQ_1_6	1.00	1.00	0.08
3. FFMQ_13	1.00	1.00	0.07
4. FFMQ_3	0.88	1.00	1.00
5. FFMQ_10	1.00	1.00	1.00
6. FFMQ_14	1.00	1.00	1.00
7. FFMQ_26	1.00	1.00	1.00
8. FFMQ_31	1.00	1.00	1.00
9. CERQ_35	1.00	1.00	1.00
10. CERQ_20	1.00	1.00	1.00
11. CERQ_10	1.00	1.00	1.00
12. ZTPI_4	0.36	1.00	0.46
13. ZTPI_50	0.60	1.00	0.69
14. ACE1	1.00	0.40	0.17
15. ACE2	1.00	0.40	0.32
16. ACE3	0.43	0.93	0.08
17. ACE4	0.00	0.00	1.00
18. ACE5	0.00	0.00	1.00
19. ACE6	1.00	0.28	0.40
20. ACE7	1.00	0.15	0.12
21. ACE9	0.38	0.87	0.08

	Class	$\boldsymbol{\pi}$
1	000	0.050
2	001	0.074
3	010	0.038
4	011	0.194
5	100	0.547
6	101	0.028
7	110	0.027
8	111	0.042

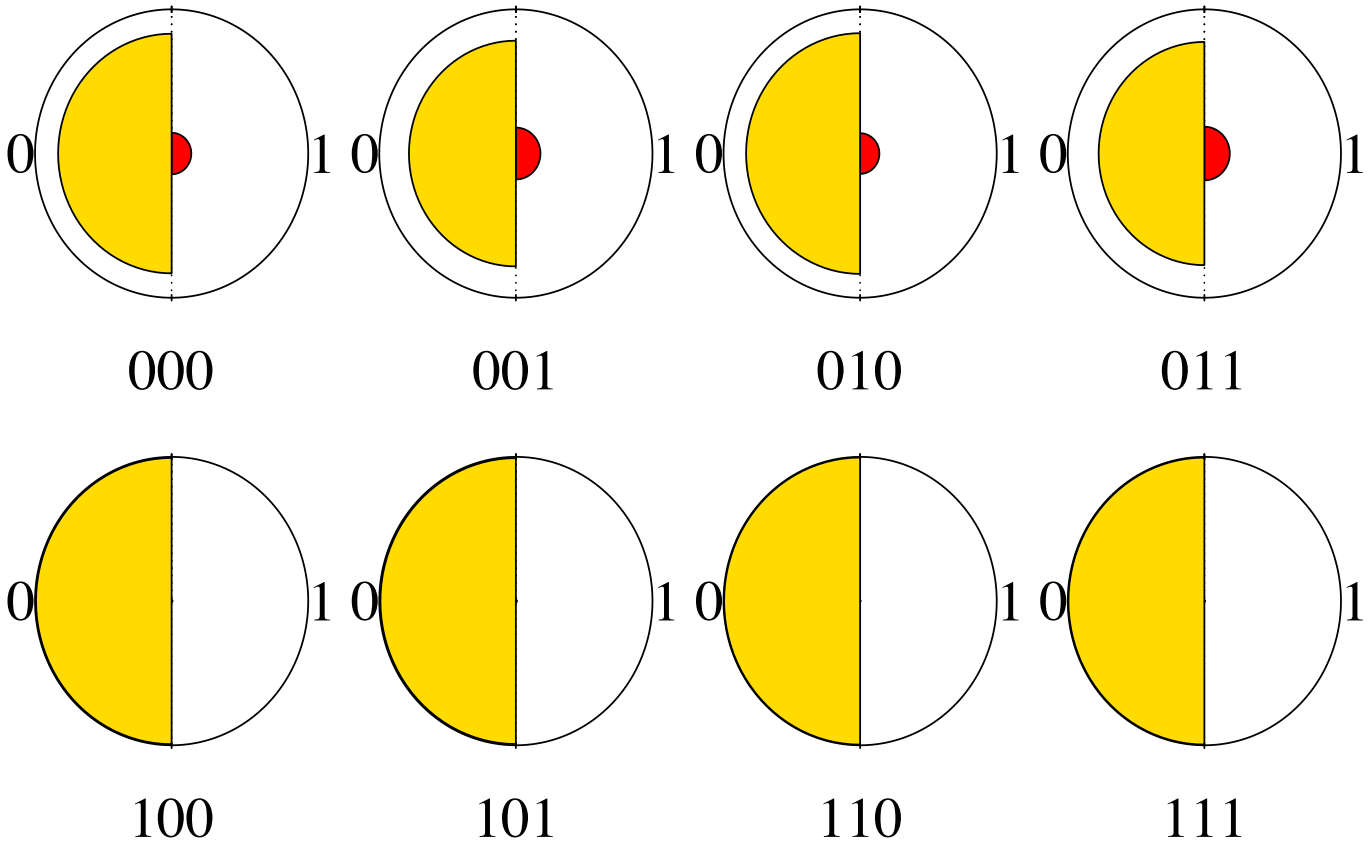
Attribute 1 for Item 20

Did you live with anyone who was a problem drinker or alcoholic or used street drugs?



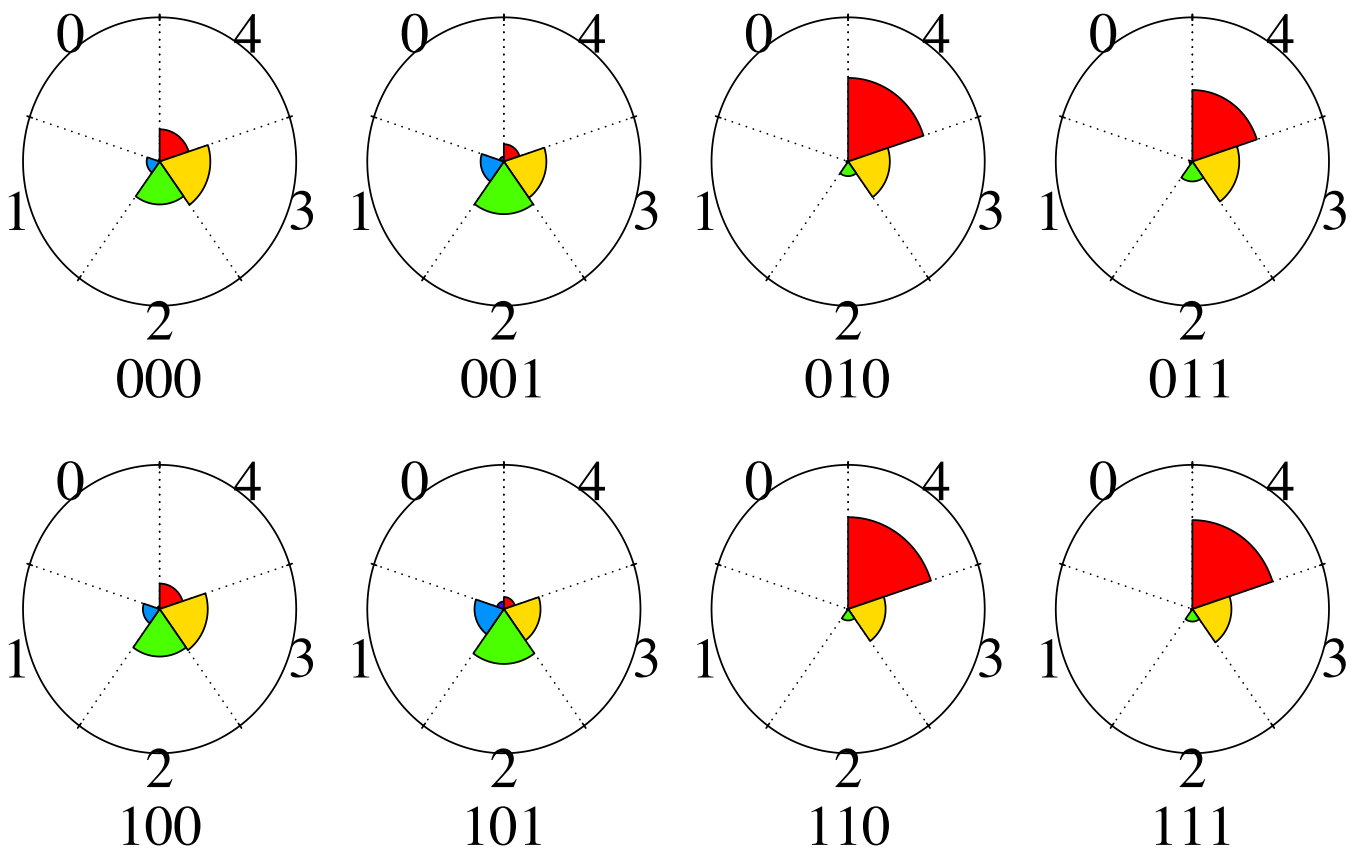
Attribute 1 for Item 19

[Physical abuse of mother/stepmother]



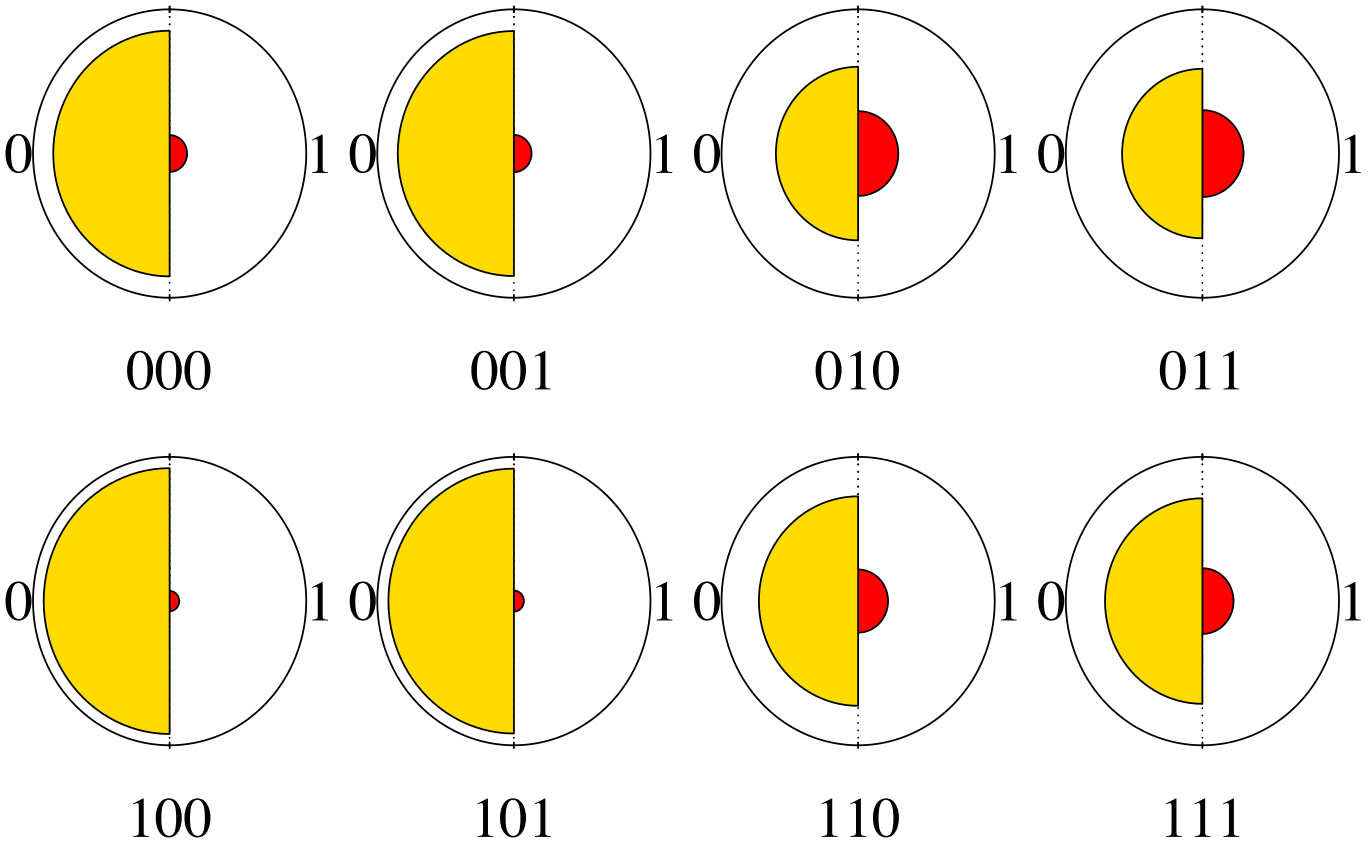
Attribute 2 for Item 12

I often think of what I should have done differently in my life.



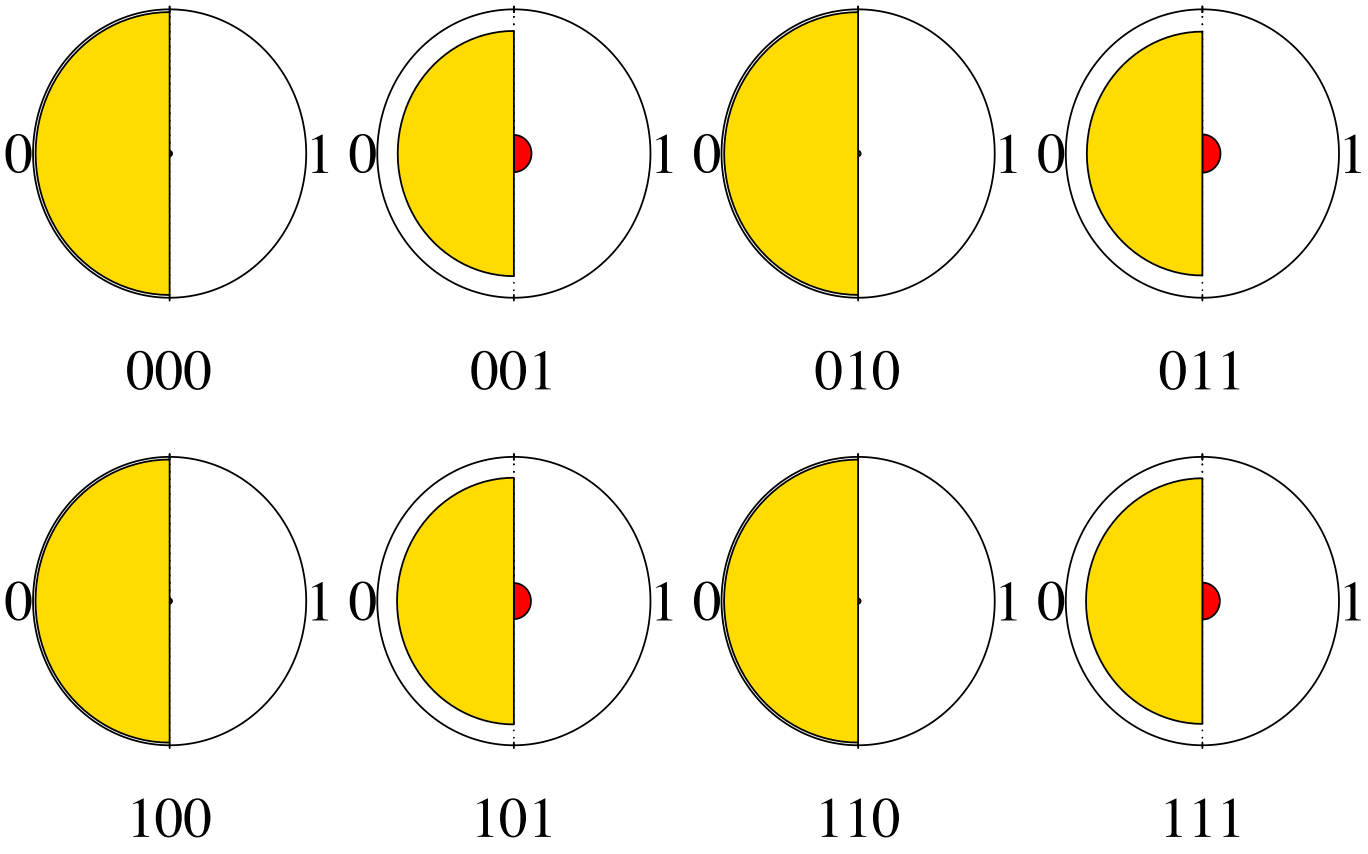
Attribute 2 for Item 16

[emotional neglect]



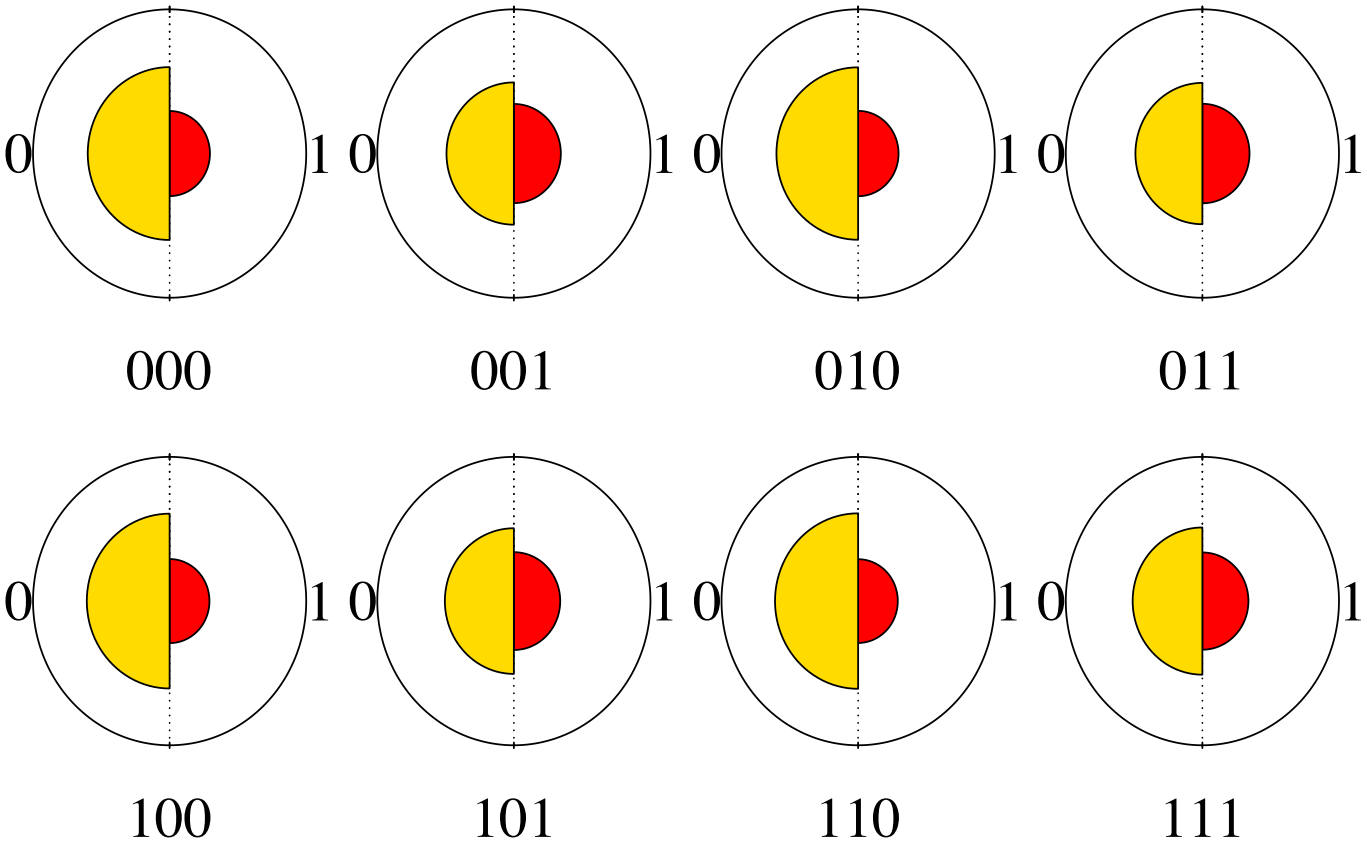
Attribute 3 for Item 17

[parental neglect]



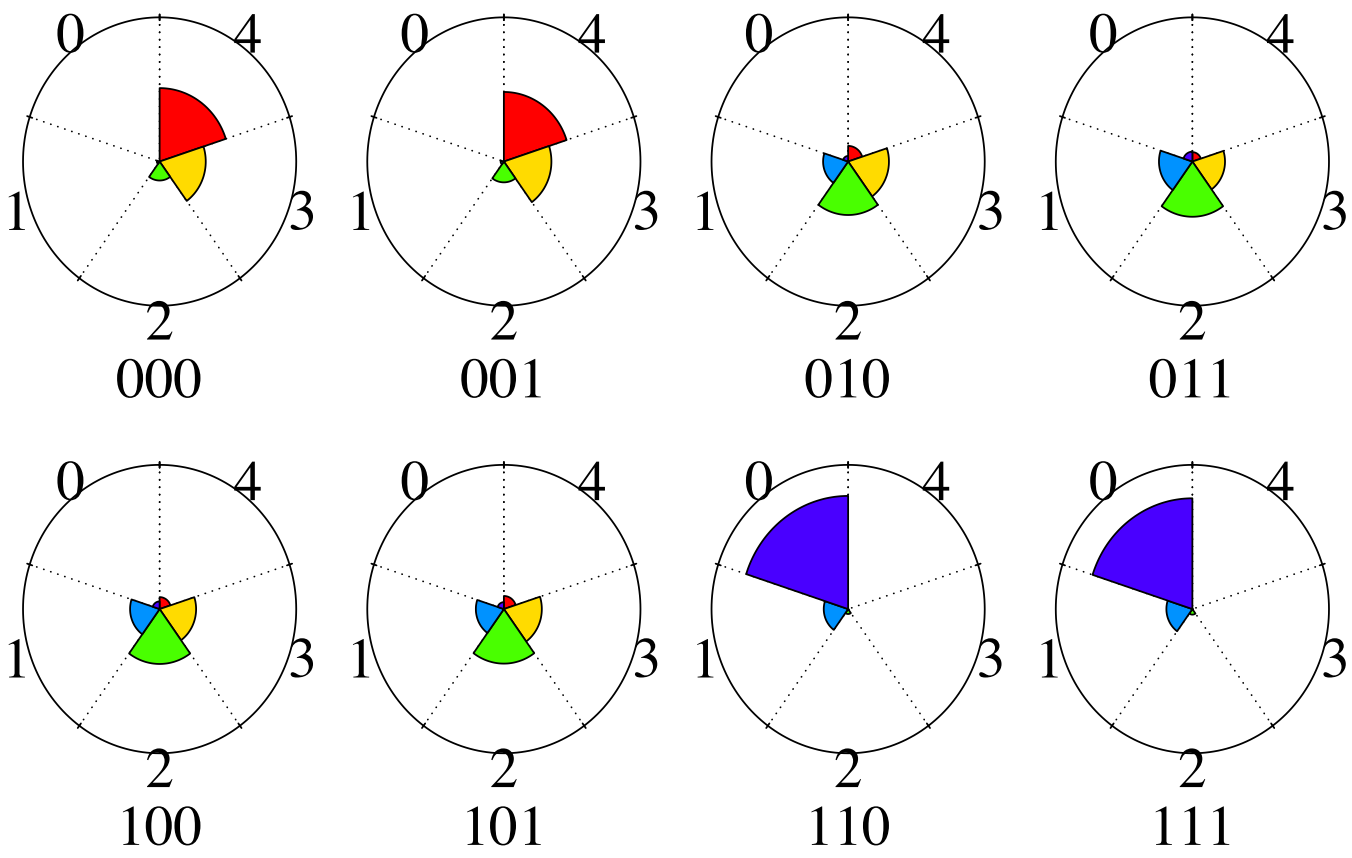
Attribute 3 for Item 18

Were your parents ever separated or divorced?



Attributes 1, 2, 3 for Item 1

I give up quickly



Change in Latent Structure Models

In LSMs, change is the process of transitioning from not a state of not having an attribute to a state of having it [Chen et al., 2018, Wang et al., 2017].

LSMs are ideal for tracking the change process and for evaluating factors that promote change.

For LSMs, change is characterized by

$$\alpha_{t-1} = 0,\ \alpha_t = 1$$

or

$$\alpha_{t-1} = 1,\ \alpha_t = 0.$$

Selected References I

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Concluding Thoughts

Consider the computational demands of a unified analysis of +P, -P, +R, -R items.

Relate the latent attributes to other outcomes of interest, such as grade point average.

Examine student characteristics and other contextual factors that describe differences in attribute classifications.

Thank you!

Special thanks to:

The teams at VSU and AUC for their support!

Dr. Talley for inviting me to contribute to the team.

Dr. Spencer for guidance on the theoretical framework.

Dr. Graziul for conversations about the data and the content of the slides.

NSF for supporting grant #1758631.