

How well can Noncognitive Skills predict Unemployment? A Machine Learning Approach

Jana Mareckova

University of St. Gallen

Winfried Pohlmeier

University of Konstanz

Statistische Woche 2019, Trier
September 11, 2019

Modeling Economic Labour Market Outcomes

- ▶ Traditionally, focus on cognitive skills.
- ▶ Attempt to explain unobserved individual differences beyond cognition/ability.
- ▶ **Goal:** Study importance of noncognitive skills (NCS) in predicting difference in the labor market performance of individuals by means of machine and statistical learning techniques.

Panoply of Measures of Noncognitive Skills

- ▶ Big Five
 - ▷ Openness
 - ▷ Conscientiousness
 - ▷ Extraversion
 - ▷ Agreeableness
 - ▷ Emotional Stability
- ▶ Locus of control
- ▶ Self-control, Self-esteem, ...

▶ Panoply

Personality in Economics

- ▶ Concentration on single psychological theory of personality
 - ▷ Big Five: Barrick & Mount (1991), Uysal & Pohlmeier (2011)
 - ▷ Locus of Control: Heckman, Stixrud & Urzua (2006), Caliendo, Cobb-Clark & Uhlendorff (2015), Piatek & Pinger (2016)
- ▶ Methods: Simple Indices, PCA, (Bayesian) Factor Models, SEM

Contribution of the Paper

Dimensionality Reduction:

- ▶ Incorporating maximum amount of information from surveys.
- ▶ Dimensionality reduction of the survey items into noncognitive skills indices in two data-driven steps.
- ▶ A target-oriented index construction of noncognitive skills measures.

Predictive Modeling:

- ▶ Yielding an interpretable predictive model which can serve as a basis for further training.
- ▶ Predictive model can be statistically or economically tuned.

Dimensionality Reduction of the Personality Measures

- ▶ Large-scale datasets contain large number of survey items measuring noncognitive skills.
- 1. Grouping survey items capturing the same NCS and calculating a single-value index representing the NCS.
 - ▷ apriori knowledge,
 - ▷ PCA analysis or factor model analysis,
 - ▷ clustering.
- 2. Data-driven selection of the NCS indices predictive for unemployment by group lasso (achieves sparsity in groups of variables).

Index Construction I

- ▶ Let $C_{i1}, C_{i2}, \dots, C_{iK}$ be the responses of individual i on K different items/questions related to conscientiousness, then the index follows:
- ▶ use the group lasso selection property to construct NCS indices along with conventional approaches.

$$IC_i^C = \sum_{j=1}^K \omega_j^C C_{ij}, \quad \text{where } \sum_j \omega_j^C = 1.$$

Index Construction II

- ▶ 3 strategies to determine the weights ω_j^C :
 1. *Equal weights*: $\hat{\omega}_j^C = 1/K$.

Index Construction II

- ▶ 3 strategies to determine the weights ω_j^C :
 1. *Equal weights*: $\hat{\omega}_j^C = 1/K$.
 2. *PCA based weights*: $\hat{\omega}_j^C = \pi_j^{PCA,C} / \sum_j \pi_j^{PCA,C}$.

Index Construction II

► 3 strategies to determine the weights ω_j^C :

1. *Equal weights*: $\hat{\omega}_j^C = 1/K$.
2. *PCA based weights*: $\hat{\omega}_j^C = \pi_j^{PCA,C} / \sum_j \pi_j^{PCA,C}$.
3. *Group Lasso based weights*: Estimate the weights using a group lasso penalty on the following model

$$Y_i = \underbrace{\beta_1^C C_{i1} + \beta_2^C C_{i2} \dots \beta_K^C C_{iK}}_{\text{total impact of C on Y}} + \underbrace{\dots}_{\text{other indeces}} + \\ + \text{OtherControls}_i' \delta + \varepsilon_i,$$

to get target-oriented weights: $\hat{\omega}_j^C = \frac{\hat{\beta}_j^C}{\sum_j \hat{\beta}_j^C}$. Additionally, group lasso also selects the most relevant groups for the model.

Group Lasso

- NCS survey items are divided into J indices, k_j survey items in index j .

$$\min_{\beta} \|Y - \sum_{j=1}^J X_j \beta_j - Z\delta\|_2^2 + \lambda \sum_{j=1}^J \sqrt{k_j} \|\beta_j\|_2$$

$Y - N \times 1$, dependent variable

$X_j - N \times k_j$, survey items corresponding to the j -th index

$\beta_j - k_j \times 1$, parameters for items in index j

$Z - N \times p$, other covariates

$\delta - p \times 1$, non-regularized parameters

$\lambda - 1 \times 1$, regularization parameter, $\lambda \geq 0$

- Euclidian norm is zero, when all components are zero $\Rightarrow$ group kicked out $\Rightarrow$ sparsity in groups.

Model

Goal: Predictive model for unemployment status.

$$Y_i = g_i(\theta) = g(\alpha + \text{Indices}_i' \gamma + \text{OtherControls}_i' \delta) + \varepsilon_i. \quad (1)$$

Y_i - labor market outcome,

- unemployment dummy, $g(z) = \Lambda(z)$, logit model.

α - unknown constant,

γ - unknown parameters for noncognitive skills,

δ - unknown parameters for other controls,

ε_i - error term

and $\theta = (\alpha, \gamma', \delta')'$.

► Other Controls

Optimal Intervention I

$$\hat{Y}_i(\tau) = \begin{cases} 1 & \text{if } g_i(\hat{\theta}) > \tau \\ 0 & \text{if } g_i(\hat{\theta}) \leq \tau \end{cases}.$$

Table 1: Confusion Matrix

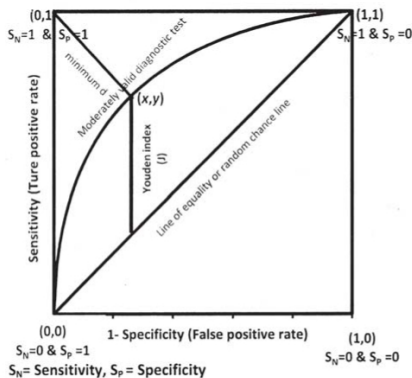
prediction	unemployment status	
	$Y = 1$	$Y = 0$
$\hat{Y}(\tau) = 1$	True Positive (TP)	False Positive (FP)
$\hat{Y}(\tau) = 0$	False Negative (FN)	True Negative (TN)
total	All positives in the data (P)	All negatives in the data (N)

► Question: How to choose the τ ?

Optimal Intervention II

1. Statistically optimal choice of τ

- Receiver Operating Characteristics (ROC) Curve capturing the trade-offs in the confusion matrix.



► Sensitivity $= 1 - \beta(\tau) = P[\hat{Y}_i(\tau) = 1 | Y_i = 1]$

► Specificity $= 1 - \alpha(\tau) = P[\hat{Y}_i(\tau) = 0 | Y_i = 0]$

Source: Kumar, R. & Indrayan A. (2001)

Optimal Intervention III

2. Economically optimal choice of τ

- ▷ economic cost-benefit analysis.

Table 2: Confusion Matrix of Costs per Worker

predicted	unemployment status	
	$Y = 1$	$Y = 0$
$\hat{Y}(\tau) = 1$	$\varphi u + c$ (TP)	c (FP)
$\hat{Y}(\tau) = 0$	u (FN)	0 (TN)

u ... average unemployment benefits, c ... intervention costs, $\varphi < 1$... fraction of u paid after the intervention.

Optimal Intervention IV

Table 3: Confusion Matrix of the Classification Probabilities

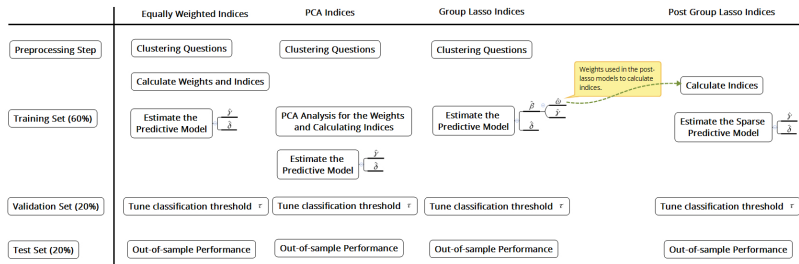
predicted	unemployment status		
	$Y = 1$	$Y = 0$	
$\hat{Y}(\tau) = 1$	$\pi(1 - \beta(\tau))$	$(1 - \pi)\alpha(\tau)$	$\pi(1 - \beta(\tau)) + (1 - \pi)\alpha(\tau)$
$\hat{Y}(\tau) = 0$	$\pi\beta(\tau)$	$(1 - \pi)(1 - \alpha(\tau))$	$\pi\beta(\tau) + (1 - \pi)(1 - \alpha(\tau))$
total	π	$1 - \pi$	1

Expected costs:

$$E[C(\tau)] = (\pi(1 - \beta(\tau)) + (1 - \pi)\alpha(\tau))c + (\pi(1 - \beta(\tau))\varphi + \pi\beta(\tau))u.$$

$$\tau_{opt} = \arg \min_{\tau} E[C(\tau)].$$

Procedure



British Cohort Study

- ▶ BCS follows the lives of children born in Great Britain in a single week in April 1970.
- ▶ Data are collected roughly every four years.
- ▶ Data on health, physical, educational and social development, and economic circumstances among other factors.
- ▶ Data on noncognitive skills were collected for the respondents at the age of 10.

Large-Scale Personality Measures

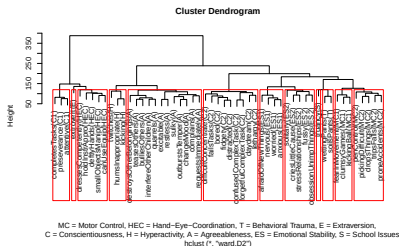
- ▶ BCS dataset contains large number of survey items measuring noncognitive skills.
- ▶ Self-Esteem at the age of 10:
 - ▷ 12 self-rated items [▶ Details](#), 1 ... Yes, 2 ... No
 - ▷ higher score = more self-esteem
- ▶ Locus of Control at the age of 10:
 - ▷ 16 self-rated items [▶ Details](#), 1 ... Yes, 2 ... No,
 - ▷ higher score = internalizer
- ▶ Child's behavior at the age of 10: 38 mother-rated items, 53 teacher-rated items
 - ▷ Scale from 0 (Certainly) to 100 (Does not apply)
- ▶ In total: 119 Questions

Clustering

Goal: collect questions measuring the same concept into groups.

► Details

- 8 clusters (from 38 mother-rated items) ► Details
- 12 clusters (from 53 teacher-rated items) ► Details



Empirical Results I

- ▶ Outcome: Unemployment status at 34 years of age.
- ▶ Prediction over a horizon of 24 years (covariates measured at the age of 10).
- ▶ Male subsample.

	Training Set	Validation Set	Test Set	Total
Sample Size	1649	551	549	2749
Unemployment Rate (%)	9.76	9.98	9.65	9.79

- ▶ Choice of λ for Group Lasso:
 - ▷ 10-fold cross validation.

Empirical Results II

► Comparing:

- ▷ a model without non-cognitive skills, $\gamma = 0$, (M_0),
- ▷ restricted models $\delta = 0$, only non-cognitive skills models,
- ▷ a model with non-cognitive skills using equal weights (eq),
- ▷ a model with non-cognitive skills using PCA,
- ▷ a model with non-cognitive skills using group lasso (GL),
- ▷ a model with non-cognitive skills estimated by post group lasso (postGL).

► Criteria - Prediction:

- ▷ Area Under the Curve (AUC) = based on the ROC curve, probability that a randomly chosen unemployed person is classified as more likely to be unemployed than a randomly chosen employed person by a model.
- ▷ Economic Costs = expected costs of the intervention.

Empirical Results III

Table 4: Statistical and Economic Criteria

	M_0	onlyEW	onlyPCA	onlyGL	post only GL	EW	PCA	GL	post GL
AUC (Test Set)	0.533	0.528	0.533	0.567	0.563	0.535	0.538	0.576	0.568
Costs (ST)	204.98	203.94	201.47	200.69	249.34	208.61	197.39	190.74	243.96
Costs (ET)	138.26	167.06	166.59	132.52	129.68	138.75	132.46	131.06	134.15

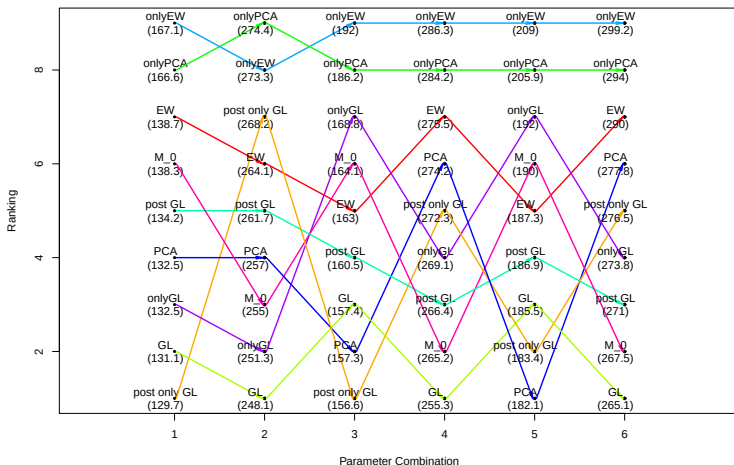
The first row contains the AUC of different classification models. ST ... τ chosen based on Youden's statistic evaluated on the validation set. ET ... τ chosen based on expected economic costs. The last two rows contain the expected economic costs for the classifiers for $\theta = 0.1$, $c = 100$ GBP, $u = 2800$ GBP (average annual JSA payments per JSA claimant) and $\pi = 0.0979$, the corresponding unemployment rate in the 2004 BCS sample. Bold numbers indicate the best values.

Empirical Results IV

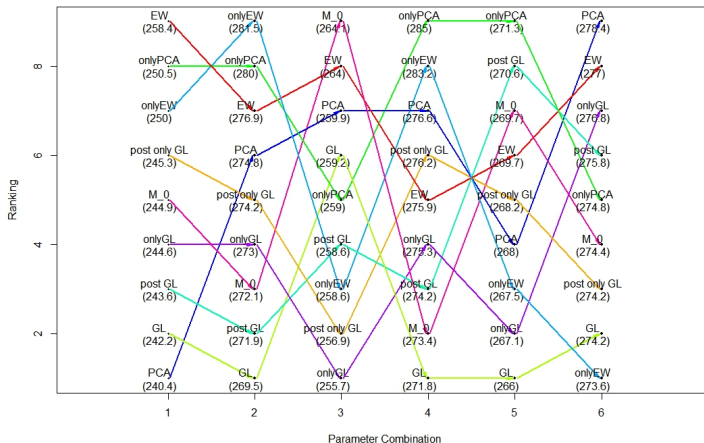
Stability/Robustness checks:

	High Effectiveness	Low Effectiveness
φ	{0.1, 0.2, 0.3}	{0.7, 0.75, 0.8}
c	{100, 250} GBP	{50, 100} GBP
u	2800 GBP	
π	0.0979	

Empirical Results V - High Effectiveness



Empirical Results VI - Low Effectiveness



Empirical Results VII

Table 5: Ranks for the Economic Costs, Economically Trained, Male, 34Y sample

	M_0	onlyEW	onlyPCA	onlyGL	post onlyGL	EW	PCA	GL	post GL
Mean	4.50	7.00	7.75	4.08	3.92	6.67	4.67	2.00	4.08
Median	4.50	8.50	8.00	4.00	5.00	7.00	5.00	1.50	3.50

Rank counts based on the economic costs across all parameter combinations.

Conclusion

- ▶ two step data-driven dimensionality reduction (clustering + group lasso),
- ▶ target-oriented NCS indices,
- ▶ sparse predictive interpretable models,
- ▶ pure predictive analysis for higher external validity,
- ▶ GL indices perform statistically and economically well.

References

-  Barrick, M. R., & Mount, M. K. (1991). The big five personality dimensions and job performance: a meta-analysis. *Personnel psychology*, 44(1), 1-26.
-  Caliendo, M., Cobb-Clark, D. A., & Uhlendorff, A. (2015). Locus of control and job search strategies. *Review of Economics and Statistics*, 97(1), 88-103.
-  Heckman, J. J., Stixrud, J., & Urzua, S. (2006). The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior. *Journal of Labor economics*, 24(3), 411-482.

References

-  Kumar, R., & Indrayan, A. (2011). Receiver operating characteristic (ROC) curve for medical researchers. *Indian pediatrics*, 48(4), 277-287.
-  Piatek, R., & Pinger, P. (2016). Maintaining (locus of) control? Data combination for the identification and inference of factor structure models. *Journal of Applied Econometrics*, 31(4), 734-755.
-  Uysal, S. D., & Pohlmeier, W. (2011). Unemployment duration and personality. *Journal of economic psychology*, 32(6), 980-992.

Quasi-cognitive Traits¹

- ▶ Creativity
- ▶ Emotional intelligence
- ▶ Cognitive style
- ▶ typical intellectual engagement
- ▶ practical intelligence

Facets of Openness to Experience

- ▶ Curiosity ("ideas")
- ▶ Imagination ("fantasy")

are often associated with intellect and measured intelligence.

Interactions between Cognition and Personality

- ▶ performance on tests of fluid intelligence are affected by personality !
- ▶ personality traits are also positively associated with acquired skills and knowledge (i.e. crystallized intelligence)
- ▶ often the correlation between test of fluid intelligence and personality traits is close zero

The Panoply of Measures

The Panoply of Measures and constructs also points to the relatively recent and incomplete convergence of personality psychologists on the Big Five model, as well as the lack of consensus among researchers about identifying and organizing lower order facets of the BigFive factors (e.g. DeYoung, Quilty, and Peterson, 2007, and Hofstee, deRaad, and Goldberg, 1992).

For example, some theorists argue that impulsivity is a facet of Neuroticism (Costa & McCrae, 1992), others claim that it is a facet of Conscientiousness (Roberts, Chernyshenko, Stark & Goldberg, 2005), and still others suggest that it is a blend of Conscientiousness, Extraversion, and perhaps Neuroticism (Revelle, 1997).

► Back

Source: Almlund et al. (2015), Table 1.3, p. 44.

Big Five Personality Factor	American Psychology Association Dictionary Description	Facets (and Correlated Trait Adjective)	Related Traits	Childhood Temperament Traits
Conscientiousness	"the tendency to be organized, responsible, and hardworking"	Competence (efficient) Order (organized) Dutifulness (not careless) Achievement striving (ambitious) Self-discipline (not lazy) Deliberation (not impulsive)	Grit Perseverance Delay of gratification Impulse control Achievement striving Ambition Work ethic	Attention/(lack of) distractibility Effortful control Impulse control/delay of gratification Persistence Activity*
Openness to Experience	"the tendency to be open to new aesthetic, cultural, or intellectual experiences"	Fantasy (imaginative) Aesthetic (artistic) Feelings (excitable) Actions (wide interests) Ideas (curious) Values (unconventional)	—	Sensory sensitivity Pleasure in low-intensity activities Curiosity

Source: Almlund et al. (2015), Table 1.3, p. 44.

Extraversion	“an orientation of one’s interests and energies toward the outer world of people and things rather than the inner world of subjective experience; characterized by positive affect and sociability”	Warmth (friendly) Gregariousness (sociable) Assertiveness (self-confident) Activity (energetic) Excitement seeking (adventurous) Positive emotions (enthusiastic)	—	Surgency Social dominance Social vitality Sensation seeking Shyness* Activity* Positive emotionality Sociability/affiliation
Agreeableness	“the tendency to act in a cooperative, unselfish manner”	Trust (forgiving) Straightforwardness (not demanding) Altruism (warm) Compliance (not stubborn) Modesty (not show-off) Tender-mindedness (sympathetic)	Empathy Perspective taking Cooperation Competitiveness	Irritability* Aggressiveness Willfulness

Source: Almlund et al. (2015), Table 1.3, p. 45.

Big Five Personality Factor	American Psychology Association Dictionary Description	Facets (and Correlated Trait Adjective)	Related Traits	Childhood Temperament Traits
Neuroticism/ Emotional Stability	Emotional stability is “predictability and consistency in emotional reactions, with absence of rapid mood changes.” Neuroticism is “a chronic level of emotional instability and proneness to psychological distress.”	Anxiety (worrying) Hostility (irritable) Depression (not contented) Self-consciousness (shy) Impulsiveness (moody) Vulnerability to stress (not self-confident)	Internal vs. External Locus of control Core self-evaluation Self-esteem Self-efficacy Optimism Axis I psychopathologies (mental disorders) including depression and anxiety disorders	Fearfulness/behavioral inhibition Shyness* Irritability* Frustration (Lack of) soothability Sadness

Personality Measures

1. Motor Control (MC(M))

- ▷ Child Drops Things Which Are Being Carried
- ▷ Child Is Noticeably Clumsy
- ▷ Child Trips Or Falls Easily Into Objects Or Other People

2. Hand-Eye-Coordination (HEC(M))

- ▷ Child Has Twitches Mannerisms Or Tics Of The Face And Body
- ▷ Child Has Difficulty Picking Up Small Objects
- ▷ Child Has Difficulty In Using Scissors

Personality Measures

3. Conscientiousness (C(M))

- ▷ Child Cannot Settle To Anything For More Than A Few Moments
- ▷ Child Is Inattentive, Easily Distracted
- ▷ Child Fails to Finish Things He/She Starts, Short Attention Span
- ▷ Child Has Difficulty Concentrating On Any Particular Task Though May Return To It Frequently

Personality Measures

4. Hyperactivity (H(M))

- ▷ Child Is Squirmy Or Fidgety
- ▷ Child Is Very Restless, i.e. Running Often, Jumping Up And Down
- ▷ Child Shows Restless Or Over-Active Behavior
- ▷ Child Hums Or Makes Other Odd Noises At Inappropriate Times
- ▷ Child Is Given To Rhythmic Tapping Or Kicking

Personality Measures

5. Agreeableness (A(M))

- ▷ Child Frequently Fights With Other Children
- ▷ Child Bullies Other Children
- ▷ Child Interferes With The Activity Of Others
- ▷ Child Is Often Disobedient
- ▷ Child Often Tells Lies
- ▷ Child Often Destroys Own Or Others' Belongings
- ▷ Child Sometimes Takes Things Belonging To Others

Personality Measures

6. Emotional Stability (ES(M))

- ▷ Child Cries For Little Cause
- ▷ Child Often Appears Miserable, Unhappy
- ▷ Child Is Sullen Or Sulky
- ▷ Child Is Irritable
- ▷ Child Changes Mood Quickly And Drastically
- ▷ Child Displays Outbursts Of Temper, Explosive Or Unpredictable Behaviour
- ▷ Requests Must Be Met Immediately, Easily Frustrated
- ▷ Child Is Impulsive, Excitable

Personality Measures

7. Behavioral Trauma (TR(M))

- ▷ Child Frequently Sucks Thumb Or Fingers
- ▷ Child Frequently Bites Nails Or Fingers

8. Extraversion (E(M))

- ▷ Child Is Not Much Liked By Other Children
- ▷ Child Tends To Do Things On His Own
- ▷ Child Is Fussy Or Over Particular
- ▷ Child Is Often Worried
- ▷ Child Tends To Be Fearful Or Afraid Of New Things Or New Situations
- ▷ Child Becomes Obsessional About Unimportant Things

▷ Back

Personality Measures

► Self-Esteem (SE)

- ▷ Do you think that your parents like to hear about your ideas?
- ▷ Do you often feel lonely at school?
- ▷ Do other children often break friends or fall out with you?
- ▷ Do you think that other children often say nasty things about you?
- ▷ When you have to say things in front of teachers, do you usually feel shy?
- ▷ Do you often feel sad because you have nobody to play with at school?

Personality Measures

► Self-Esteem (SE)

- ▷ Are there lots of things about yourself you would like to change?
- ▷ When you have to say things in front of other children, do you usually feel foolish?
- ▷ When you Want to tell a teacher something, do you usually feel foolish?
- ▷ Do you often have to find new friends because your old friends are playing with somebody else?
- ▷ Do you usually feel foolish when you talk to your parents?
- ▷ Do other people often think that you tell lies?

► Back

Personality Measures

► Locus of Control (LC)

- ▷ Do you feel that most of the time it's not worth trying hard because things never turn out right anyway?
- ▷ Do you feel that wishing can make good things happen?
- ▷ Are people good to you no matter how you act towards them?
- ▷ Do you usually feel that it's almost useless to try in school because most children are cleverer than you?
- ▷ Is a high mark just a matter of "luck" for you?
- ▷ Are tests just a lot of guess work for you?
- ▷ Are you often blamed for things which just aren't your fault?
- ▷ Are you the kind of person who believes that planning ahead makes things turn out better?

Personality Measures

► Locus of Control (LC)

- ▷ When bad things happen to you, is it usually someone else's fault?
- ▷ When someone is very angry with you, is it impossible to make him your friend again?
- ▷ When nice things happen to you is it only good luck?
- ▷ Do you feel sad when it's time to leave school each day?
- ▷ When you get into an argument is it usually the other person's fault?
- ▷ Are you surprised when your teacher says you've done well?
- ▷ Do you usually get low marks, even when you study hard?
- ▷ Do you think studying for tests is a waste of time?

► Back

Personality Measures

► **Motor Control 1 (MC1(T))**

- ▷ Child Is Noticeably Clumsy In Formal Or Informal Games.
- ▷ Finds It Difficult To Kick A Ball Forward.
- ▷ Child Is Fearful In Movements, Requires Much Encouragement To Move Faster.

► **Motor Control 2 (MC2(T))**

- ▷ Trips Or Falls Easily Or Bumps Into Objects Or Other Children.
- ▷ Child Shows Difficulty When Picking Up Small Objects.
- ▷ Child Drops Things Which Are Being Carried.
- ▷ Child Shows Adequate Control When Handling A Pencil Or Paint Brush.
- ▷ Child Experiences Classroom Or Playground Accidents

► Back

Personality Measures

► Hand-Eye-Coordination (HEC(T))

- ▷ Works Deftly With His Or Her Hands.
- ▷ Dresses And Undresses Competently (e.g. for P.E).
- ▷ Child Manipulates Small Objects Easily With His/Her Hands.
- ▷ Child Can Use Scissors And Similar Manipulative Equipment Competently.
- ▷ Child Holds Writing And Drawing Instruments Appropriately.

► Conscientiousness 1 (C1(T))

- ▷ Shows Preservance, Persists With Difficult Or Routine Work
- ▷ Child Pays Attention To What Is Being Explained In Class
- ▷ Child Completes Task Which Are Started.

► Back

Personality Measures

► **Conscientiousness 2 (C2(T))**

- ▷ Child Is Given To Daydreaming.
- ▷ Cannot Concentrate On Any Particular Task, Even Though The Child May Return To It Frequently.
- ▷ Becomes Bored During Class.
- ▷ Becomes Confused Or Hesitant When Given A Complex Task.
- ▷ Child Is Squirmy Or Fidgety.
- ▷ Child Is Easily Distracted.
- ▷ Child Is Forgetful When Given a Complex Task.
- ▷ Child Shows Lethargic And Listless Behaviour.
- ▷ Child Fails to Finish Things He/She Starts.

► Back

Personality Measures

► **Hyperactivity (H(T))**

- ▷ Child Hums Or Makes Other Odd Noises At Inappropriate Times.
- ▷ Child Is Given To Rhythmic Tapping Or Kicking During Class.
- ▷ Child Has Twitches Mannerisms Or Tics Of The Face And Body.

► Back

Personality Measures

► Agreeableness (A(T))

- ▷ Complains About Things.
- ▷ Displays Outbursts Of Temper, Explosive Or Unpredictable Behaviour.
- ▷ Teases Other Children To Excess.
- ▷ Child Interferes With The Activity Of Other Children.
- ▷ Child Changes Mood Quickly And Drastically.
- ▷ Child Is Excitable, Impulsive
- ▷ Child Shows Restless Or Over-Active Behaviour.
- ▷ Child Quarrels With Other Children.
- ▷ Child Destroys Own Or Other Children's Belongings.
- ▷ Child Bullies Other Children.
- ▷ Child Is Sullen Or Sulky.
- ▷ Requests Must Be Met Immediately, Easily Frustrated.

Personality Measures

► Emotional Stability 1 (ES1(T))

- ▷ Is Fearful Or Afraid Of New Things Or Situations.
- ▷ Child Is Worried And Anxious About Many Things.
- ▷ Anxious-Unworried Temperament (higher score = less worried)

► Emotional Stability 2 (ES2(T))

- ▷ Child Cries For Little Cause.
- ▷ Child Is Fussy Or Over Particular.
- ▷ In Relations With Others Appears To Be Miserable, Unhappy, Tearful or Distressed.
- ▷ Child Becomes Obsessional About Unimportant Things.
- ▷ Child Tends To Do Things On His Own.

► Back

Personality Measures

► Behavioral Trauma (TR(T))

- ▷ Has Problems With Wetting Pants During Class.
- ▷ Child Has Problems Of Soiling Pants During Class.

► Extraversion (E(T))

- ▷ Assess Extrovert-Introvert Temperament (higher score = more extraverted).

► School Issues (S(T))

- ▷ Child Truants From School.

► Back

Cognitive Skills and Other Controls

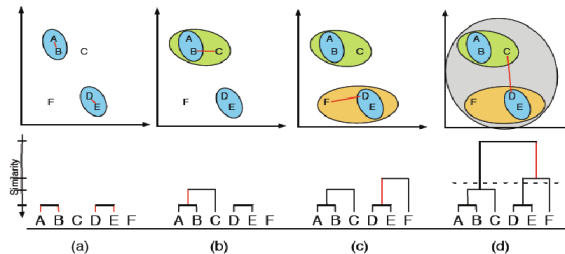
SocialClass10Y	social class of the family at the age of 10, the better occupation of the parents taken. 6 categories: = 6 if professional, = 5 if managerial-technical, = 4 if skilled non-manual, = 3 if skilled manual, = 2 if partly skilled, = 1 if unskilled
AbilityMath10Y	standardized score of a “Friendly Math Test” taken at the age of 10
AbilityRead10Y	standardized score of the “Edinburgh Reading Test” taken at the age of 10

[▶ Back](#)

Clustering I

- ▶ Goal: Merge questions measuring the same concept into groups.
- ▶ Ward's method - merging so that the within-cluster variance increases minimally

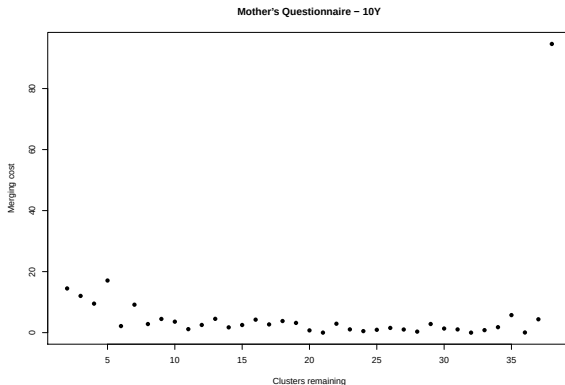
Example: Hierarchical Agglomerative Clustering



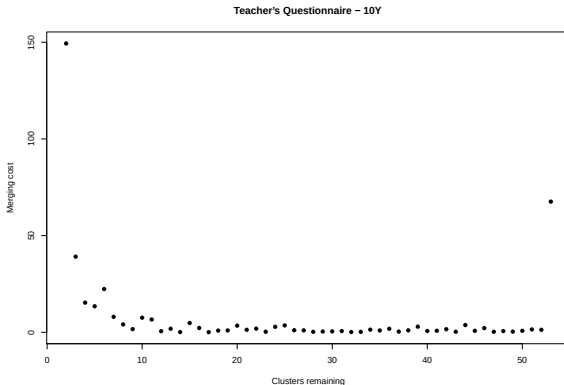
Source: http://www.researchgate.net/profile/Carsten_Walther

Clustering II

Optimal number of clusters = relatively big jump in the merging cost



Clustering III



Clustering IV

Mother-rated items (8 clusters)

MC_M = Motor Control,
HEC_M = Hand-Eye-Coordination,
T_M = Behavioral Trauma,
E_M = Extraversion,
C_M = Conscientiousness,
H_M = Hyperactivity,
A_M = Agreeableness,
ES_M = Emotional Stability.

Teacher-rated items (12 clusters)

MC1_T = Motor Control - fast movement,
MC2_T = Motor Control - coordination,
HEC_T = Hand-Eye-Coordination,
T_T = Behavioral Trauma,
E_T = Extraversion,
C1_T = Conscientiousness - (+) formulation,
C2_T = Conscientiousness - (-) formulation,
H_T = Hyperactivity,
A_T = Agreeableness,
ES1_T = Emotional Stability - inner,
ES2_T = Emotional Stability - outer,
S_T = School Behavior.

Subscripts M and T indicate survey items from the mother's and teacher's questionnaire respectively.