1    A multi-faceted, open source, measure of personality

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## Abstract

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## 1. Introduction

### 1.1. Short history and relevance of the Big Five

19        Over the last decades, the Five Factor Model as well as the Big Five model have
20 become widely accepted models for describing general attributes of personality. Often the
21 terms are even used synonymously, which is why we will refer to the Big Five from here on.
22 The Big Five is a hierarchical model which describes human individual differences in
23 personality at the dispositional level: one of the most basic, universal, biologically-influenced
24 and stable layers of human inter-individual differences in behavior, cognition and feeling
25 (McAdams & Pals, 2006). Its hierarchical nature is relevant to acknowledge behavior from
26 the most specific (nuances), to the most broad differences in temperament and character
27 (dimensions), through a varying number of mid-level personality characteristics called facets.
28 Most of the research concerning criterion validity of the Big Five inventories has focused on
29 the covariation between the Big Five dimensions and relevant external outcomes. However,
30 specific dispositional characteristics captured on the facet level might be of extreme utility to
31 provide more complex descriptions of individuality and to predict life outcomes to a major
32 extent (Lounsbury, Sundstrom, Loveland, & Gibson, 2002; Paunonen & Ashton, 2001;
33 Ziegler et al., 2014). Unfortunately, the number and nature of the facets below the Big Five
34 and being measured by different personality instruments is far from being consensual. In
35 fact, different facet level models have been proposed (XXXX). One potential reason for this
36 could be that many facet level models were developed after a questionnaire version without
37 such a level had been published. Thus, the facets were developed as an elaboration. While
38 this has many theoretical advantages it also has the disadvantage of potentially limiting the
39 search space of possible facets. In this work we aim at maximizing this search space and
40 present a personality questionnaire which is broad at the facet level, open-access, and
41 measurement invariant across two different cultures.

**1.2. A short history of the Big Five**

Francis Galton proposed the fundamental lexical hypothesis as a ground from where to describe interpersonal differences in personality. The hypothesis states that every apprehended characteristic in the realm of personality should have its place in the natural language, a corollary derived from this first statement is that the essential features must represent a unique word in the lexical universe of this language. Galton himself (1884), and later Allport and Odbert (1936) and still later Norman (1967) used English dictionaries for a systematic collection of all adjectives which could be related to human personality characteristics. Using exploratory factor analyses on self- and other ratings five broad factors could repeatedly be extracted from the data. These efforts were also replicated in different languages, such as in German (Klages,...), Baumgartner,...

Cattell was one of the first researchers who systematically applied exploratory factor analysis in order to explore personality structure. He inspected the correlation structure of the items in the word lists of his predecessors, finding 16 personality oblique factors, including one factor specifically for intelligence, these factors form the 16-PF. These 16 factors were the primary factors in a hierarchical structure for Cattell (coetany to L.L. Thurstone and undoubtedly influenced by him). Cattell himself viewed personality as a hierarchical structure, containing three layers (Cattell, 1956). The second order factors resemble the Big Five dimensions (Digman, 1990).

Different researchers followed Cattell in the study of dispositional traits of personality. One of the most influential models was Eysenck's Big Three. Grounded on a strong biological basis, Eysenck's theory supposed a link between temperament and personality. Its structural proposal concerned at first two big factors, named Neuroticism vs. Emotional stability and Extraversion vs. Introversion. These two dimensions were later joined by a third factor that Eysenck called Psychoticism. This label was criticized by others who suggested that a more appropriate term would be psychopathy (Digman, 1990). Eysenck's big two are still „alive" today in the Big Five, and his third factor, psychoticism, can be operationalized

69  as two dimensions of the Big Five: Agreeableness (or . . . ) and Conscientiousness (or . . . .).

70      A large number of studies have focused on the problem of personality structure

71  resulting in a five factor solution (Fiske, 1949; Norman, 1963; Tupes & Christal, 1961;

72  Borgatta, 1964). Possibly the two most widely cited works relating to the foundations of the

73  Big Five are those by Goldberg (. . . ) and McRae Costa (. . . ). Goldberg can be seen as one

74  of the first who extended research concerning the Big Five, while McRae and Costa's

75  importance rests on popularizing the terminology (OCEAN) and the development of one of

76  the most used tools to assess personality based on the Big Five: the NEO-PI. The Big Five

77  dimensions are labeled as follows: I) Extraversion vs. Introversion. II) Agreeableness or

78  Friendliness. III) Conscientiousness or Achievement or Will. IV) Emotional Stability

79  vs. Neuroticism. V) Openness or Intellect or Culture.

80      One of the most important features of the Big Five is the fact that it could be

81  replicated in different languages. Research is available in Japanese, Vietnamese, German,

82  Spanish, Greek, (refs). . . This finding suggests that the way human beings construe

83  personality is at some point universal and that its basic features are retained within the Big

84  Five. Another essential characteristic relies on its hierarchical nature. The five domains are

85  useful to retain the big picture of personality, maximize the situation consistency and

86  reliably assess difficult subjects such as children. Nonetheless, each dimension is

87  conceptualized as a latent construct formed by more specific narrow factors called facets,

88  which in turn are useful to depict the impact of personality characteristics into specific

89  behaviors and concrete life outcomes.

90      The Big Five has proven to be a valid theoretical and empirical model to predict

91  relevant life outcomes. Research such as Ozer and Benet-Martinez (2006) or Roberts;

92  Kuncel; Shiner; Caspi & Goldberg ( 2007) has shown that scores for the Five Dimensions

93  (and their related facets) are able to explain outcomes such as Academic and work

94  performance, health, personality disorders, political attitudes and many more. The empirical

95  findings linking Big Five measures to life outcomes have reinforced the concurrent validity of

the test scores interpretations. At the same time, the broad nature of the domains has spurned research into the more fine-grained lower order structure of facets.

**1.3. Facet Structures**

There are a number of models that include a facet structure below the five broad domains. The most widely known model is the one suggested by Costa and McCrae (XXX). Other popular models have been suggested for the Big Five Inventory 2 (BFI-2, Soto & John, 2017), the IPIP (JRP paper), and the HEXACO model (XXX), which assumes six broad domains. Table 1 gives an overview of these different models listing their facets per domain as well as some information regarding their psychometric properties.

table 1

As shown in table 1, there are many different possibilities of facets forming the domains. However, there is still a degree of overlap on the facets covered by the different instruments. Soto and John (2009) inspected the convergences between the NEO-PI-R and the first version of the BFI, suggesting that two constructs per domain were measured at the facet level by both inventories. The constructs defined by Soto and John (2009) were: Assertiveness and Activity for Extraversion; Altruism and Compliance for Agreeableness; Order and Self-Discipline for Conscientiousness; Anxiety and Depression for Neuroticism; and Aesthetics and Ideas for Openness. The convergence holds for the four instruments listed in table 1, as these ten constructs are covered within the facets for every instrument. Some of the constructs are explicitly covered at the facet level (e.g. Anxiety); meanwhile others are mainly covered though the four instruments, although sometimes implicitly (e.g. Liveliness in HEXACO resembles the "core" construct Activity, present in all other instruments). The reverse is not always true, not every facet within the four instruments is covered by the constructs proposed by Soto & John (2008). As an example we find Self-Consciousness, a Neuroticism facet defined by the NEO-PI-R and the IPIP-NEO-120, which is clearly tapping at a construct different from Anxiety or Depression.

The nomological network commonly assumed in Big Five questionnaires is drawn from nuances through facets to domains, from more specific to more general. Relying in domains to explain and predict behavior can benefit from ease of interpretability. However, optimal predictions for specific contexts can be enhanced if a more specific set of traits is used. On the other hand, using nuances to predict behavior might yield even stronger predictive ability (Seeboth & Mottus, 2018), but as the number of predictors grows the interpretations become more complex. Facets are on a middle ground between nuances and domains, in a compromise between specificity and sensitivity in the bandwidth-fidelity dilemma. This narrow aggregation both satisfies the specificity of predictions to concrete situations and environments and also enhances the ease of interpretability when summarizing individual personality characteristics.

Furthermore, there is a large corpus of research which points towards facets as important criterion predictors showing incremental validity to domains. For academic achievement, Paunonen and Ashton (2001) showed that the facets achievement motivation and intellectual curiosity increased the variance accounted for by college students' grades, above and beyond its respective dimensions: Conscientiousness and Openness to experience. Similarly, Lounsbury et al. (2002) provided evidence regarding the facets work drive and aggression, which added an extra 12% of explained variance over the Big Five domains on 10th grade students' GPA. Ziegler, Danay, Schölmerich, and Bühner (2010) showed that better performance in college grades was associated with low gregariousness, excitement seeking and order as well as high activity, openness to ideas and openness to values. Often different facets within the same domain can have effects in opposite directions, partially canceling out the predictive ability when only paying attention to the domain score. This is the case for Openness to ideas vs. Openness to fantasy, as the former is related positively to academic achievement whereas the latter is related negatively (**???**), resulting in a potential masking effect on the ability of Openness predicting the academic achievement.

As described above, facet measures often yield scores that have stronger test-criterion

149 correlations than their respective domain scores (e.g., Ziegler et al., 2012; . . . ). However,

150 facet scores have also been shown to be related to personality disorders. Thus, the

151 combination of a higher fidelity along with the potential clinical relevance of facet scores

152 might open up unique advantages for clinical research.

## 153 1.4. The Big Five and Personality Disorders

154 Personality disorders are steadily shifting from a categorical definition into a continua

155 conceptualization within the clinical realm. This process is not new for personality science

156 history, as the subject itself moved from a qualitatively distinct set of definitions, called

157 types, into a subset of continuous domains in which both normality and extreme tendencies

158 were moving along, named traits. In fact, the new version of the Diagnostic and Statistical

159 Manual of mental disorders, DSM- V, now proposes two different ways of assessing

160 personality disorders: 1) A descriptive model of personality disorders in section II which

161 mimics the former model of assessing personality disorders and; 2) A novel trait model that

162 follows research on the personality scientific domain (In section III), which conceptualizes

163 personality disorders as extreme tendencies located in the continuum of the Big Five domains

164 and facets (American Psychiatric Association, 2013; Widiger & Mullins-Sweatt, 2009)

165 This paradigm shift in clinical assessment of personality has led to the construction of

166 the Personality Disorder Inventory (PID-5; Krueger, Derringer, Markon, Watson, & Skodol,

167 2013), a 25-facet and five-dimension self-report inventory, with an informant-report version

168 (Markon, Quilty, Bagby, & Krueger, 2013). The big five dimensions mirror the Big Five

169 domains, although with a focus on the maladaptive end of the continuum,: I) Detachment

170 (Big Five's introversion), II) Antagonism (absence of Big Five's Agreeableness), III)

171 Disinhibition (absence of Big Five's Conscientiousness), IV) Negative affect (Big Five's

172 Neuroticism) and V) Psychoticism (Absence of Big Five's Openness). The PID-5 has shown

173 satisfying evidences of criterion validity (. . . summary). However, the limited number of

174 facets on the PID-5 has already raised some concerns due to the low reliability when

studying developmental phenomena of personality disorders (Clercq et al., 2014)', and may also limit the capacity of portraying vivid personality profiles which are suitable for explanatory purposes in the clinical domain.

In line with what has been stated previously for academic achievement, the examination of facets may result in an enhancement of the specificity of assessment when looking at the nature of PDs (Clark, 2005; Samuel & Widiger, 2008). This improvement of specificity resulted in a predictive gain ranging from 3% to 16% when comparing facets to domains predicting PD in the Reynolds and Clark (2001) study. Furthermore, the use of facets may be of extreme utility for those PD whose personality profile is less clear at the domain level. As Saulsman and Page (2004) point out, Schizotypal and Obsessive-Compulsive disorders are examples of PD which are not well covered by Big Five domains. A reason for it may be found in a pattern inconsistency of facets within the same dimension or in a lack of coverage for essential characteristics of the PD. For example, aberrant cognitions are essential characteristics of schizotypal disorder and are not covered by some instrument's facets like the NEO-PI-R (Samuel & Widiger, 2008; Saulsman & Page, 2004). Likewise, the expected high scores on warmth and low scores on assertiveness could mask the effects of extraversion when predicting Dependent Personality Disorder, following the theoretical correspondence between PD and Big Five facets proposed by Costa Jr. and Widiger (1994). Moreover, the PID-5 has prompted the elaboration of a number of Five Factor Model Personality Disorders (FFMPD) scales to maximize the facet coverage in relation to specific PDs (Bagby & Widiger, 2018).

Facet analysis and dedicated Big Five questionnaires have been used to solve issues like those mentioned in the last paragraph. We propose to base such research on a broader facet basis. To this end we suggest a general instrument to cover a broad number of facets which could aim for fine grained assessments.

### 1.5. This study

We present in this paper an instrument for personality assessment which aims to cover the need for an internationally usable, open source, and differentiated measure at the facet level. Two studies are presented, for each one inspects the factor structure of the instrument in a different sample drawn from a different culture (American vs. German). Measurement invariance across samples will be examined. Internal consistency and test-criterion correlations will be estimated for all scores. To sum up, the aim for this research project was to provide an instrument that can be used in non-clinical but also in clinical research which emphasizes the facet level of the Big Five.

## 2. Study 1 - US-American Sample

### 2.1. Methods

**2.1.1. Participants.** The sample consisted of 726 American undergraduate students (59.3% male) who participated voluntarily. The mean age was 21.6 years (SD=5.9). Students were emailed a link to a computerized assessment battery that included the IPIP items as well as several other tests not reported in this paper.

At a first data preparation the data set was randomly split in two equally sized samples. Both samples were matched in relation to missing values, outliers and extreme values. In Sample 1 the mean age was 21.8 years (SD=6.3), in Sample 2 the mean age was 21.5 years (SD=5.6).

### 2.1.2. Measures.

**International Personality Item Pool (IPIP).** Altogether, 525 items from the *International Personality Item Pool (IPIP)* were used to measure Neuroticism, Extraversion, Openness (to experience), Agreeableness and Conscientiousness. The IPIP is an open source database of personality items, which was launched in 1996, and contains over 2000 items (L. R. Goldberg et al., 2006). Participants were asked to rate themselves on typical behaviors or

225 reactions on a 5-point Likert scale, ranging from 1 ("Not all like me") to 5 ("Very much like
226 me").

227     **GPA.**   This measures academic achievement.

228     **Satisfaction With Life (SWL).**   Scale of satisfaction with life

### 2.1.3. Procedure

230     **EFA with subsample 1.**   To determine the number of possible facets per domain
231 Velicer's (1976) Minimum Average Partial (MAP) method and Horn's (1965) parallel
232 analysis (PA) method were employed for every domain. Based on these results an
233 exploratory factor analysis was calculated for each domain via Mplus using a geomin
234 rotation (Quelle) and a maximum likelihood estimator (ML). The decision for the preferred
235 number of facets per domain was based partly on comparing model fits (CFI, RMSEA,
236 SRMR). More importantly though was the interpretability of the facet solution. After all
237 facet solutions of other personality measures were looked at to compare it to the found facet
238 structure. If there were important parts missing to present the domain with regards to
239 content, new facets would be added afterwards.

240     **CFA and ESEM with subsample 2.**   To confirm the structure of facets the EFAs
241 delivered, multiple confirmatory factor analyses were calculated via Mplus. In a first step
242 measurement models were estimated for each of the facets. To obtain balance between the
243 facets, the items were reduced to five per facet based on item content and loading pattern in
244 a second step, afterwards the estimations for the measurement models on facet levels were
245 repeated. For both steps estimators were WLSMV (weighted least squares adjusted for
246 means and variances). Aim was to ensure an optimal breadth and sufficient reliability. In a
247 final model, all five domain structural models were integrated using exploratory structural
248 equation modeling (ESEM) (Asparouhov & Muthén, 2009). Marsh et al. (2010) could show
249 that ESEM fits personality data better and results in substantially more differentiated
250 factors than it would using CFA, while using an EFA measurement model with rotations in a

structural equation model. All facets were able to load on all domains. If there would show

up facets that do not significantly load on the intended domain, this facets would get

eliminated subsequently. The estimators used were ML (maximum likelihood), factor scores

were used as indicators and the rotation was oblique (using Geomin). Model fit was

determined based on the guide lines by Hu and Bentler (1999) as well as Beauducel and

Wittmann (2005). Consequently, to consider a good fit of a proposed model, the

Comparative Fit Index (CFI) should be at or over .95, the standardized root mean squared

residual (SRMR) smaller than .08 and the root mean square error of approximation

(RMSEA) smaller than .06.

**Criterion validity evidence.** To examine the nomological structure of the facets

and domains to external constructs like life satisfaction and education, correlations and

multiple regression were computed.

## 2.2. Results

**Results of EFA.** In *Table 2* you can see model fits for the chosen facet model for

each domain as well as Eigenvalues and results from MAP and PA test.

To ensure that each facet is homogeneous and therefore, to reduce the risk of cross

domain loadings, items with factor loadings less than .30 were eliminated. This was only

done when item content was also judged as being non-central to the domain in question

(Ziegler, 2014).

According to that Agreeableness consists of eight facets after two facets were

eliminated due to weakly loading and inconsistent items. The remaining facets are named

Appreciation, Integrity, Low Competitiveness, Readiness to Give Feedback, Search for

Support, Good Faith, Genuineness and Altruism.

Conscientiousness consists of nine facets after one facet with item factor loadings less

than .30 was excluded, which are named: Dominance, Persistence, Self-discipline, Task

planning, Goal orientation, Carefulness, Orderliness, Wish to work to capacity and

277    Productivity.

278        Extraversion comprises of nine facets, after a new facet (Energy) was added. The

279    original model with eight facets did not explain the physical part of Extraversion very well.

280    The facets are Sociability, Readiness to take risks, Wish for affiliation, Positive attitude,

281    Forcefulness, Communicativeness, Humor, Conviviality and Energy.

282        Neuroticism (here interpreted in the way of emotional stability) consists of seven facets.

283    One facet was dropped due to poor interpretability, and was therefore not included in the

284    subsequent analyses. The final set of facets are named Equanimity, Confidence, Carefreeness,

285    Mental balance, Drive, Emotional robustness and Self-attention.

286        Openness to experience comprises of nine facets. One facet was identified as a method

287    factor and eliminated, because it solely contained negatively formulated items and no

288    coherent underlying trait could be identified. Furthermore another facet (Intellect) was

289    added, because the remaining facets lacked an intellectual content. The facets of Openness

290    are named Creativity, Wish for variety, Open-mindedness, Interest in reading, Artistic

291    interests, Wish to analyze, Willingness to learn, Sensitivity and Intellect.

292        The items to each facet are listed in the appendix (A).

293        **Results of CFA and ESEM..**    All measurement models for the facets were fitting

294    well, results can be found in *Table 3*.

295        Table 3

296        The exploratory structural equation model (ESEM) of the final model with all five

297    domains fits well with CFI = .87, RMSEA = .072, SRMR = .036. As you can see in *Table 4*

298    nearly all facets load significantly on their intended domain, but sometimes have loadings on

299    other domains also, which are conform with the theory and the facet content.


300                              **Study 2 – German Translation**


301    **Methods**

$_{302}$     **Participants.**   The representative sample consisted of 387 German speakers (49.1%

$_{303}$ male) with a mean age of 45.6 years (SD=17.5).

$_{304}$     **Measures.**   The five items per facet derived from Study 1 were translated and

$_{305}$ back-translated by bilingual experts, creating a German version of the measure used there.

## Procedure

$_{307}$     **Step 1 – Examining the structure.**   To check the facet structure Study 1

$_{308}$ delivered, multiple confirmatory factor analyses were calculated via Mplus following an

$_{309}$ analogue procedure to Study 1. First, measurement models were estimated for all facets,

$_{310}$ estimator was WLSMV. Model fit was determined based on the guide lines as before. In a

$_{311}$ final model, all five domain structural models were integrated using again exploratory

$_{312}$ structural equation modeling (ESEM).

$_{313}$     **Step 2 – Testing for measurement invariance.**   In a next step, measurement

$_{314}$ invariance between German and US samples was examined. We followed the procedure

$_{315}$ suggested by Sass (2011) and tested configural, factorial and strong factorial invariance. The

$_{316}$ cutoffs suggested by Chen (2007) were applied to compare model fits. According to this

$_{317}$ configural measurement invariance can be assumed when the same item is associated with

$_{318}$ the same factor in each domain, while the factor loadings can differ. If the factor loadings of

$_{319}$ each item would not differ between the samples, factorial measurement invariance can be

$_{320}$ assumed. Strong factorial measurement invariance can be assumed when on top of that the

$_{321}$ intercepts of each item are equal. The limit to factorial measurement invariance was set to $\Delta$

$_{322}$ CFI $< .01$, $\Delta$ RMSEA $< .015$ and $\Delta$ SRMR $< .03$, at which the limit to strong factorial

$_{323}$ measurement invariance was set to $\Delta$ CFI $< .01$, $\Delta$ RMSEA $< .015$, $\Delta$ SRMR $< .01$ (Chen,

$_{324}$ 2007).

## Results

$_{326}$     **Results of CFA.**   The measurement models of the American sample were replicated

$_{327}$ for the reduced number of item per facet. Model fits can be seen in Table 4. The ESEM with

328 all five domains fits well with CFI = .82, RMSEA = .078, SRMR = .044. Table 5 shows the

329 ESEM factor loadings for the German sample. All facets load significantly on their intended

330 domain but can have loadings on other domains as well.

**Results of MI**

332     For analyzing the measurement invariance the latest facet model structure (with

333 additional facets) was taken. The results are shown in Table 6. Configural measurement

334 invariance is assumed for the facets Appreciation of others, Superiority/Grandiosity, Need to

335 be liked, Crybabiness, Manipulation, Altruism (facets of Agreeableness), Perseverance, Task

336 Planning, Goal-orientation/Achievement striving, Preferred Load, Procrastination (facets of

337 Conscientiousness), Assertiveness, Sociability/Gregariousness, Activity (facets of

338 Extraversion), Irritability, Self-serving Attention (facets of Neuroticism), Self-attributed

339 Inginuity, Openness to actions and activities, Openmindedness/Judgement, Love of Learning,

340 Openness to feelings and Intellect (facets of Openness).

341     Factorial measurement invariance is assumed for the facets Meanness, Trust (facets of

342 Agreeableness), Control of others, Lack of (Self-) Control, Deliberation/Caution, Lack of

343 Tidiness/Order (facets of Conscientiousness), Sensation Seeking, Reclusiveness, Emotionality,

344 Humor (facets of Extraversion), Depression, Anxiety, Self-assuredness, Lethargia,

345 Sentimentality (facets of Neuroticism), Openness to reading, Openness to arts and Need for

346 cognition (facets of Openness).

347     The only facet with strong factorial measurement invariance is Shyness, a facet of

348 Extraversion

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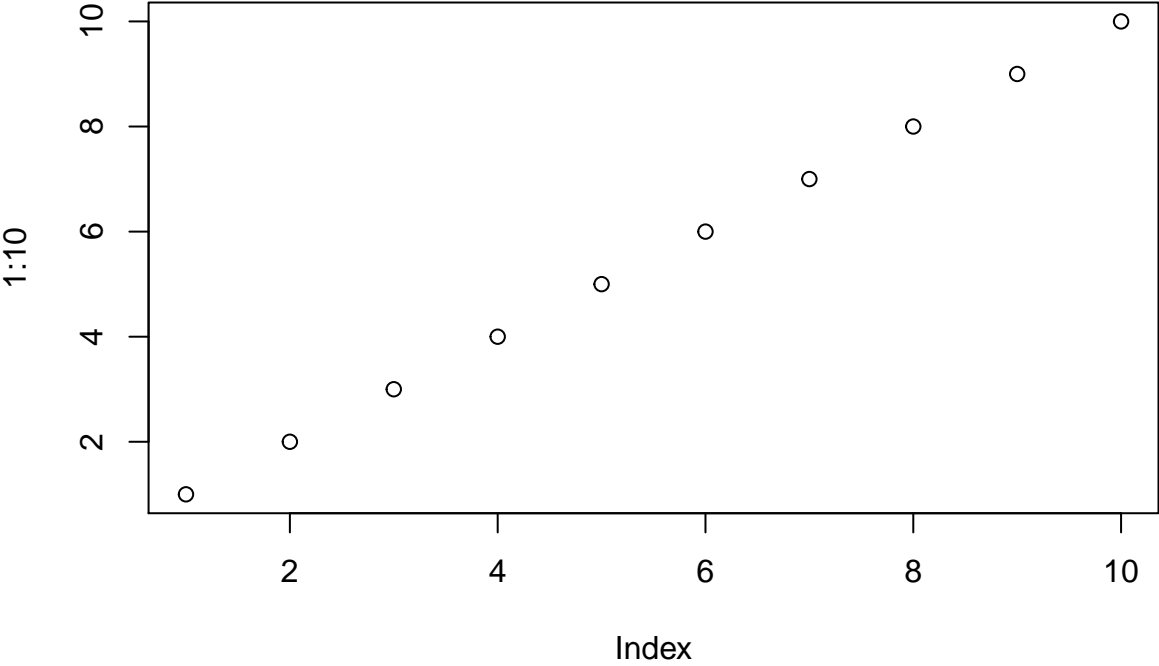
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Appendix

384  Appendix



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