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| Grant application preproposal form 2023NWO Talent Programme – Vidi scheme |   |
| Applied and Engineering Sciences Science Social Sciences and Humanities  |

*Version: August 2023*

The information on rules and guidelines (the explanatory notes) are embedded in the preproposal form. Please expand the ‘Explanatory Notes’ for information on terms, conditions and requirements.

Note: on Apple computers the rules and guidelines can be made visible by selecting “Outline” under the “View” tab in Word. The rules and guidelines are automatically visible in Google docs.

🡨 Expand for general Explanatory Notes

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| General Notes |
| * The preferred font is **Calibri**, **black, 9.5 point** font size, except for references to the literature, which may be given in 8.5 point. Use line spacing 1. If using LaTeX, please make use of a font (size) that most closely approximates the preferred font; use margins of 2.5 centimetres.
* Word counts include **all text** (including text in tables, footnotes and figures)**.** Exceptions are explicitly mentioned.
* Provide only the requested information. When asked for personal details, please only mention initials and last name, and refrain from mentioning first name(s) in order to reduce gender effects.
* Please **make sure the Explanatory notes are not visible in the PDF version of your application**. In order to achieve this you should remove the Explanatory note text boxes.
* Important note: when writing your proposal, take into account that it will be read by a broadly composed assessment committee within your chosen domain and/or panel (SSH).

**Guidelines for the use of hyperlinks**The use of hyperlinks is prohibited in all sections of the application except for the Key Output (section 2b). Note that some hyperlinks will become active again when converting the document to PDF. To prevent this from happening, remove the 'https' affix. In section 2b, you may use only one hyperlink per output item, on the condition that it directly links to the output item and does not show additional output item(s). This hyperlink should preferably be in the form of a persistent identifier (e.g. a DOI). **Guidelines for the use of quality indicators**You may only use quality indicators that are measured at the level of the individual output item, for instance article level indicators. All indicators that do not satisfy this rule are excluded, whether quantitative or qualitative. This means that **journal impact factors (JIF)** or any other indicator that refers to a journal, publisher or publication platform may not be stated, nor may descriptions of reputation such as **“top journal”** and **“high-quality university press”**. **H-index** and **sums and averages of citations** may also not be stated, as these indicators are measured at author level.You are requested to provide context and explain in a motivation the choice of indicators to support the assessment.You may not mention lists or total numbers of publications, grants or prizes, nor the total acquired sum. You are allowed to mention amounts for individual grants or prizes. In case you mention specific prizes or grants, you must provide context, e.g. by describing how the opportunities offered by the grant or prize were used.You are allowed to mention total amounts of PhD students supervised, if relevant. Note that NWO recommends that you provide substantial information on your approach to mentorship and supervision.Do not refer to reputation in any section, e.g. do not mention terms as **‘leading institution’** or **‘world renowned scholar’**, but provide substantiation of relevant qualities and how you have benefitted and/or contributed, or will benefit and/or contribute. Before completing the preproposal form, please study the information as provided in the Call for proposals of the NWO Talent Programme – Vidi 2023, the guidelines provided in the Explanatory notes throughout the form, and the [FAQ](https://www.nwo.nl/en/researchprogrammes/nwo-talent-programme/faq) (‘Frequently Asked Questions’). You can download these texts from the NWO website or in the ISAAC system. The original Dutch-language text of the Call for proposals is the authoritative version. Where the English-language text is open to a different interpretation, no additional rights may be derived from it.**Please note that** **PDF format is required for all documents to be submitted via ISAAC**. To fill out the application form, you are free to use programs other than Word, as long as you preserve the form’s overall structure and lay-out.Please submit your preproposal using **the ISAAC system** ([www.isaac.nwo.nl](https://www.isaac.nwo.nl)) for applications to Applied and Engineering Sciences (AES), Science (ENW) or Social Sciences and Humanities (SSH). If applying to the Netherlands Organisation for Health Research and Development (ZonMw), please use **Mijn ZonMw** ([mijn.zonmw.nl](https://mijn.zonmw.nl)). ZonMw uses a separate application form that is available on the ZonMw website. Note that ISAAC and MijnZonMw may use a session timeout. **Save your application data regularly and avoid long sessions with periods of inactivity.**When you submit a proposal in ISAAC you are required to fill out the “Abstract” section. Please fill out this section using the same text as the ‘research idea” (2c) (max 150 words).In ISAAC, upload only the preproposal, the embedding guarantee and the optional literature list. You may not upload any other document.Completed preproposals must be converted to PDF before submission. In order for ISAAC and MijnZonMw to process the application data properly, all submitted PDF files must be free of security locks and bookmarks. If you do not know how to convert your application to PDF format, allow extra time to get help from your institution’s computer support department or from the application system help desk (see below). The deadline for submitting your preproposal is **2 November 2023, 14:00:00 hrs** (CET). This means that you must have filled out all fields, uploaded the preproposal form and the annexes, and have clicked the ‘submit’ button **before** 14:00:00 hrs (CET). **Applications received after the deadline are automatically disqualified.** Complete the application entirely in **English**. Do not exceed the stated maximum number of words for each section of the form. If you exceed the stated maximum number of words or fail to supply the necessary documents, your application may be disqualified from the competition.If you have any questions about the preproposal form or application process, please do not hesitate to contact the programme coordinator of your domain. Contact details can be found in the Call for proposals and on the NWO website: <https://www.nwo.nl/en/researchprogrammes/nwo-talent-programme>.You will receive a confirmation of the eligibility of your submission — i.e., whether it complies with all formal requirements — within approximately two to three weeks after the submission deadline.For any technical questions regarding submission, please contact the ISAAC helpdesk: isaac.helpdesk@nwo.nl or +31 70 344 0600 |

1. Institution and field of research‏‏‎‏

🡨 Expand for Explanatory Notes on section 1

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| Explanatory Notes 1b. Main field of research |
| Fill out one or more research fields that correspond to the subject of your research proposal.Refer only to the research fields listed on the NWO research field list, using the exact names and codes: [www.nwo.nl/researchfields](http://www.nwo.nl/researchfields). You can also find the codes and research fields using the drop down menu. Please fill out the exact same information in the ISAAC system as in this form, on the tab “General Information” (*Algemeen*) section ”Research fields” (Disciplines) before submitting the preproposal. Also note that in the ISAAC system, you only add the research field(s) and do not need to add the associated code manually. For example, if your main field of research is business administration, fill out the following:- In the application: 39.90.00, Business Administration;- In ISAAC: Business Administration.NB: ISAAC will list the research fields in the language of correspondence you have previously indicated (English or Dutch). You must search for your research field(s) in the language you selected (e.g., Business Administration or Bedrijfskunde). |

1a. NWO domain (Choose one)

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| Social Sciences and Humanities (SSH/SGW) |

1b. Main field(s) of research

Indicate the main field of research and (if applicable) other fields of research, in order of relevance, using the codes and names from the dropdown menu. For more information see the Explanatory Notes.

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|  | Code/Field of research: |
| Main field of research: | 40.60.00    Psychometrics |
| Other field(s) of research (if applicable): | Choose an item. |
| Choose an item. |
| Choose an item. |

2. Evidence Based Curriculum Vitae

🡨 Expand for Explanatory Notes on section 2

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| General Notes 2. Evidence Based Curriculum Vitae |
| Sections 2a and 2b are used as basis for the assessment of the criterion “Quality of the researcher”. For this criterion, the committee assesses:* Whether the researcher fits in the target group: is the researcher in transition to leadership, i.e. are they ready to establish a research group or expand a recent research group, and to what extent will the Vidi contribute to the researcher's leadership development?
* The extent to which the researcher's qualities clearly exceed what is customary within the international peer group, as evidenced in the CV by the quality and impact of the key output and by other academic achievements\*;
* The extent to which the researcher's work is clearly positioned with respect to scientific and (where possible) societal themes or questions;
* The quality of the (inter)national network, collaborative abilities and visibility of the researcher;
* Whether the researcher's key output and academic profile clearly align with the research idea, or whether the researcher presents a convincing vision of how this alignment will be achieved;
* The extent to which the researcher demonstrates the capability of generating innovative ideas and independently developing these successfully;
* The extent to which researcher's approach to leadership and mentorship and plans for contributing to the development of individuals, as described in the academic profile, are appropriate.

\*Examples of 'other academic achievements' are contributions to the development of scientific theories and methods, indications of independence, contributions to Open Science and 'academic citizenship'.Note that the CV will be assessed by a broad scientific committee within the NWO submission window of your choice. Make sure that your academic profile and key output sections are clear and comprehensible for the broadly composed assessment committee. |

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| Explanatory Notes 2a. Academic profile  |
| * The word count includes all text used in section 2a, including – but not limited to – references, footnotes, text in figures, figure captions and tables.
* The use of hyperlinks is prohibited in this section.

2a Academic profile is divided into two sections: * 2a1: General academic profile;
* 2a2: Leadership and mentorship.

In section 2a1, write a narrative highlighting your academic achievements that are most relevant to your field, other scientific fields, society and/or the research idea. Provide context and evidence of how the elements you choose to include, show qualities that clearly exceed what is customary within your international peer group.You are free to shape your narrative in any way to suit your profile. You may for example choose to simply describe your academic profile in running text, add highlights by using bold or italic fonts, choose to add structure via subheadings, list achievements point by point followed by an explanation, etc. What elements are relevant to mention, depends on the particular field and on your personal situation. You may also include context on situations that have hindered your ability to show your qualities. In section 2a2, highlight your approach and vision to leadership and mentorship. Describe how you have taken steps towards contributing to the development of individuals, including students, non-academic staff and academic staff (such as PhD candidates and postdoctoral researchers). You can add information on expertise that you have provided which contributed to the success of previous or current projects, including project management, collaborative contributions, and/or team support. Section 2a2 can also be used to highlight the establishment of collaborations, such as institutional, and/or international collaborations or collaborations beyond the boundaries of the applicant’s main field of research. Examples of topics you may address are:**Section 2a1 – General academic profile:*** Lines of (independent) research, signs of independence;
* Relevant skills;
* Alignment of the academic profile with the research idea, or vision of how this alignment will be achieved;
* Theoretical and/or methodological contributions;
* (Inter)national orientation and activities, including conference participation, organisation and invited lectures;
* Impact, knowledge utilisation, outreach and popularisation. Relevance of research results and their position relative to societal topics;
* Contributions to open science;
* (Specific) prizes, awards and grants, and how the opportunities offered by the particular prize, award or grant were used\*;
* Interdisciplinary activities;
* Academic citizenship, contributions to improvement of academic culture, membership of scientific boards, editorial boards, and committees;
* Administrative, organisational, and managerial tasks;
* Educational activities, e.g. the connection of research and education;

**Section 2a2 – Leadership and mentorship:*** Approach to leadership and mentorship (required);
* Contributions to the development of individuals (students, academic staff and/or non-academic staff);
* Contributions to the development of projects, organisations, companies and/or institutions;
* Collaborations, roles in teams, and networking capabilities;

*Please note that the focus of section 2a Academic Profile is not on output nor on output indicators, as output can be addressed in section 2b. You are only allowed to refer to the academic output items you also mention in section 2b. In case you do mention one or more key output items in section 2a, you must refer to the number of the output item as it is listed under 2b. Do not refer to any additional output, output metrics, or expected/future output and do not mention total numbers of output.**\* Do not mention lists or total numbers of grants or prizes, nor the total acquired sum. You are allowed to mention amounts for individual grants or prizes. In case you mention specific prizes or grants, you must provide context, e.g. by describing how the opportunities offered by the grant or prize were used.* |

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| Explanatory Notes 2b. Key output |
| In the key output section (2b) you may list a maximum of 10 output items that best show your qualities, relevant for your field, other scientific fields, the research idea and/or society. For each key output item:* Provide the reference to the output item in the text field labelled “Reference”
* Provide a URL that links directly to the output item in the text field labelled “URL”, preferably in the form of a persistent identifier (e.g. a DOI). You may use only one hyperlink per output item. Do not use hyperlinks outside the URL text field. The provided URL must link to a publicly accessible website.
* Select the output type from the drop-down menu in the “Type” field. If you select “Other, please describe” you can add the output type directly behind the drop down menu.
* Select at least one quality indicator from the drop-down menus in the “Quality indicators” field. If you select “Other, please describe” you can add the indicator name directly behind the drop down menu. Note that you may only use indicators that are measured at the level of the individual output item (e.g. article level indicators). Author level and Journal/Publisher level indicators such as h-index and Journal Impact Factor are not allowed.
* In the text field “Motivation” add a motivation for the selection of the output item and explain what the chosen quality indicator(s) mean in this particular case. Explain your contribution, especially for multi-author output. You may choose to combine the motivation for multiple key output items;
* The word count includes all text used in the motivation text fields, including – but not limited to – references, footnotes, text in figures, figure captions and tables.
* Do not mention any of your own academic output beyond the 10 key output items.

Further explanation and examplesWhile the maximum amount of key output items that can be listed is ten, this does not mean that you are required to list ten items. The CV format is designed to accommodate all scientific disciplines. NWO recognises that what is customary in numbers and that types of output vary between disciplines. If you choose to list less than ten items, please remove all remaining, empty key output fields.The committee will be asked to assess each candidate’s selection of output in light of the culture and customs of the scientific field and in light of the candidate’s effective research time. You are encouraged to include relevant information on the culture and customs of the scientific field in the motivation text fields, as long as you refrain from mentioning quality indicators that are banned by NWO.As you motivate your selection of key output and clarify your contribution, we suggest using the [Contributor Roles Taxonomy ‘CRediT’](https://credit.niso.org/).Various types of output may be mentioned. The drop-down menu under “Type” lists a variety of potential output types. If the type of output you want to mention is not listed, simply select “Other” and add the output type directly behind the drop down menu. For journal publications, book publications, and where possible all other output, provide the following information: the author(s) in the order as published, date, title of the publication, journal or series in which the publication appeared, volume, page numbers, and (if applicable) publisher and place. Do not use “et al.”, so committee members can see your position in the author list. Mark open output, e.g. open access publications, open access databases and open source software, by ticking the checkbox “Open access”. Output marked as Open Access must be freely accessible worldwide at least from the time of the deadline forward.In case of publications only mention publications that have actually been published, are in print (which implies that you are able to mention page numbers or a Digital Object Identifier (DOI)), are unconditionally accepted, or are available as pre-print or working paper in an open archive, with identifier (DOI, arXiv id, handle, or other standard persistent identifiers). Pre-prints and working papers are academic manuscripts that have not been peer reviewed or published in a traditional venue (yet). Papers that you are working on, that are not finished and/or not openly available, are not considered to be working papers. For more information on where you can publish preprints, visit the [Directory of Open Access Preprint Repositories](https://doapr.coar-repositories.org/).Do not list publications that are still under review, and do not use the term “forthcoming” (or any derivative thereof) as its meaning is ambiguous. When including preprints, refrain from mentioning whether the document has been submitted to a journal. Note that book contracts are not considered unconditionally accepted publications and thus may not be mentioned as key output, unless the definitive version of the book manuscript has been unconditionally approved by the publisher. The publication status of your output must be clearly indicated.NWO may request proof of the status of your output. The Vidi committee will be asked to ignore any mention of output that does not meet the guidelines. |

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| Explanatory Notes 2c. Research idea |
| * The word count includes all text used in section 2c, excluding the title and key words.
* The use of hyperlinks is prohibited

Please add a title above the description of the idea in Calibri, underlined, 10-point font size.Add up to 5 key words that best fit your research idea. Provide a concise description of your research idea (topic and potential importance of the results) in no more than one hundred and fifty (150) words. In the Vidi preproposal the research idea is an indication of the topic and importance of the envisioned project, rather than a summary of a fully thought-out plan.**Note:** The 'research idea' is not assessed as an independent criterion in the preproposal phase. The committee uses the research idea to evaluate whether the candidate’s CV fits the idea, and if not, if the candidate has provided a convincing plan of how this fit will be achieved (see description of the criteria in these notes). In addition, the research idea and key words may be used by NWO to start the process of finding external reviewers for the full proposal phase.  |

2a. Academic profile

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| *In section 2a1 – General Academic Profile: Write a narrative highlighting your academic achievements that are most relevant to your field, other scientific fields, society and/or the research idea. Provide context and evidence of how the elements you choose to include show your academic qualities.* *In section 2a2 – Leadership and mentorship: Highlight your approach to leadership and mentorship. Describe how you have taken steps towards contributing to the development of individuals, including students, non-academic staff and academic staff (such as PhDs and postdocs). You can add information on expertise that you provided which contributed to the success of your projects, including project management, collaborative contributions, and/or team support. Section 2a2 can also be used to describe the establishment of collaborations (disciplinary and interdisciplinary, institutional, national and international).* *For more information, expand the Explanatory Notes*(Total word limit section 2a1 + section 2a2: 1200 words)

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| Section 2a1 - General academic profile |

*Research focus:* My academic career in psychometrics has focused on developing and disseminating stepwise estimators for latent variable models (LVMs), particularly the area of latent class models (LCMs) and their extensions [1-6]. Research in the social sciences depends on relaiable LVMs to model complex unobservable constructs like intelligence or political participation that can only be measured using proxy items. I have developed **advanced stepwise methods** that explore the relationships between latent constructs and their nomological networks. My application examples include using socioeconomic covariates to predict changing citizenship norms over the course of 16 years in 14 countries [9]. In this Vidi application, I propose expanding my research by producing a novel approach to stepwise estimation of **complex generalized LVMs that combine categorical and continuous latent and observed variables**. This would fill a critical gap in the methodological literature and contribute to producing open-source software for such complex models.My doctoral studies already led to significant advancements in this field, including bias-adjusted three-step estimators for LCMs [1]. In 2015, the North American Classification Society awarded me the prestigious **PhD Thesis award** acknowledging the value of my models to the research community. I disseminated these methods through peer-reviewed articles [1] and I was invited to present at an M3 conference co-organized with the developers of Mplus, the most widely-used LVM software, the latter one example of my commitment to academic collaboration between research groups. Since completing my PhD, I have focused on **simplifying and generalizing stepwise estimation approaches** of LCMs by introducing two-step estimators [2-6]. This approach’s novelty involves excluding a complex computational step that makes it possible to generalize it to a broad family of LVMs. I formed strategic cooperations with experts, including Drs. Jouni Kuha (London School of Economics) and Roberto Di Mari (Catania University), both known for developing LVM estimators that are used broadly across disciplines. Together, we expanded these estimators’applicability to include latent Markov models and multilevel LCMs [5], representing the foundational work I plan to build upon in the proposed Vidi project. The stepwise estimators I co-developed were implemented in the two most popular software packages for LVM: Latent GOLD and Mplus. The integration of my models with these widely-used software packages indicates the value placed on my work by the research community. I played an instrumental role in developing and proliferating the two-step estimator for LCMs across **open-source platforms,** and cooperated in developing the R package MultilevLCA [7] with Dr. Di Mari. Based on this work, Dr. Eric Lacourse (Montreal University) invited me to collaborate in developing StepMix, an LCM Python package. I conduct most of this development work [7] within cooperative networks that I assemble by creating synergies and **advancing integrative open science**. *Recognition as a leading researcher and translational research:*The usefulness of the two-step LCM estimator we designed [2] was quickly recognized and it is now **widely used** in different scientific fields (e.g., psychology, economics). At least 10 peer-reviewed articles have used this method. This rapid uptake indicates the need for the kind of flexible and robust estimators our method provides. My early software implementation in both mainstream commercial and open-source packages helped contribute to meeting this need. Recognizing the value of interdisciplinary collaboration, I frequently work with scientists from diverse fields, applying advanced stepwise LVMs to complex data. For example, as **a senior researcher in** Dr. Jennifer Oser’s (Ben-Gurion University) **ERC-funded project**, I apply stepwise LCMs to political science research [8]. I was also invited to collaborate with Dr. Hans Verhoef (Wageningen University) as **the methodological expert in a Trial Steering Committee** focusing on LVMs in nutrition research, funded by the Swiss National Science Foundation. I have long advocated for using LVMs in translational research in industry and policy. While working at the Organization for Economic Cooperation and Development (OECD), I improved the methodology of large international educational surveys (PISA and TALIS), and at **Shell Corporation,** I redesigned the internal employee surveys using complex LVMs. These experiences outside of academia have enabled me to establish valuable networks where I can promote industrial applications of LVMs [9].*Teaching and academic citizenship:* My great passion, teaching, constitutes approximately 60% of my post-PhD academic endeavors. **Integrating** **my most recent research** into my lectures, I develop and teach large bachelor’s and smaller master’s courses at Leiden University, **encouraging open science practices** by instructing students in using platforms like OSF or GitHUB. Given my commitment to academic citizenship, I serve as an **associate editor for Behavioral Research Methods** and as a **peer reviewer** for several methodological and applied journals (*Psychometrika*, *SEM*, *The Journal of Higher Education*, and more). I am also an active member of professional organizations, like VVSOR and the International Classification Society. Furthermore, I provide policy insights to the faculty board representing the **Young Academy Leiden (YAL)** and the **Institute Council of the Institute of Psychology,** promoting policies that advance Diversity and Inclusion.

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| Section 2a2: Leadership and mentorship |

*Approach to leadership*: I focus on two aspects of leadership: (1) supporting students and (2) forming collaborative cross-disciplinary networks advancing sound research practices. (1) I endeavor to develop an environment where students can thrive and cultivate their unique skills. My efforts focus on creating opportunities that allow individuals to develop bright careers that accord with their aspirations and specific talents within the boundaries of proximal development.I believe that successful PhD projects flourish within an ecosystem of cooperation that nurtures a culture of trial and error and constructive feedback. Several of my PhD and master’s students have proceeded to produce first-author publications and have been invited to present at conferences. *Leadership experience:* I have supervised several **master’s students,** helping to launch their careers by co-authoring publications with them. For example, the first two authors of [6] are my former students who pursued PhD projects following my recommendations and mentoring. Currently, I closely supervise two externally funded **PhD students**. One, Y. Liu, supported by the Chinese Scholarship Council, is developing extensions for latent growth models. The second is scheduled to begin working on prediction models with LVMs in November in a position financed by a Dutch government starter grant. I also mentor and co-supervise two visiting PhD students — R. Fabbricatore (University of Naples FedericoII), for whom I was chief supervisor of two chapters in his successfully defended dissertation, and J. Lyrvall (Catania University), for whom I supervised one dissertation chapter. Both students presented our collaborative work at a CLADAG conference session I organized recently. In addition, I have served on three doctoral committees.(2) The **podcast** I hosted with YAL about open science practices for data diversity [10] epitomizes my approach to leadership for a cause: bringing together leading scholars to discuss complex topics, making this scholarship available to the general public, and embarking on initiatives to make information accessible to my collaborators, including connecting with the PI of the ERC project. I cooperate with Leiden University’s data stewards to promote the adoption of best practices in data stewardship cross-nationally. *In summary, I envision forming a dedicated team developing novel LVM methodologies implemented in open-source and commercial software. Leveraging my strong academic and industry network, my work promises significant academic and societal impact by enhancing our understanding of latent constructs and their influence on human behavior and society.*Total word count 2a Academic Profile: 1200 from 1200  |

2b. Key output

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| *Per key output item (max. 10) provide the reference to the output, add a direct link (preferably a DOI), select the output type and choose at least one indicator that best demonstrates the quality of the output. Under ‘motivation’ explain the selection of each of the output items and indicators. You may choose to combine the explanation for multiple key output items. Describe your contribution to the output, especially in case of multi-author output. Mark output that is available in open access by selecting ‘Yes’ in the checkbox behind “Open Access”.**When selecting quality indicators you may only use ones that meet the Guidelines for the use of quality indicators in the General Notes. The indicator drop-down menus contain a list of approved indicators.**For more information, expand the Explanatory Notes.* (Total word limit section 2b: 400-700 words, for all the motivations, excl. references, URLs and indicators)[Max. 10 items]*In my field, first, second, and last authored articles that introduce a novel methodology are the most sought-after publications. Articles showcasing the application of new methods in disciplinary research are fundamental to developing user communities.***Key output on stepwise LVMs**Key outputs [1-6] are peer-reviewed articles published in international journals showcasing my expertise in the stepwise estimation of LCMs and their extensions. These articles introduce the three [1] and two-step [2] estimators, provide an overview of the field of stepwise estimation [3], and, most importantly, show how the approach can be extended to more complex situations [4-6]. These articles represent the core theoretical base that I will extend to the novel context of generalized LVMs. The estimators proposed in [1-2] are implemented in major commercial software packages (Latent Gold, Mplus) and open source packages (multilevLCA, StepMix), while [5] is implemented exclusively in multilevLCA. In all my first-author papers, I was responsible for conceptualization, writing, formal analysis, investigation, and methodology based on my co-authors’ feedback.All my articles contain supplementary materials with replication codes, reflecting my commitment to open science.  |
| Key output 1 Open Access: No

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| Reference: **Bakk**, **Z.,** Tekle, F.B., Vermunt, J.K., “[Estimating the association between latent class membership and external variables using bias-adjusted three-step approaches](https://scholar.google.nl/scholar?oi=bibs&cluster=13970646824923289946&btnI=1&hl=en)”, Sociological methodology, Vol.43 (1), p.272-311. (2013) |
| URL: [https://doi.org/10.1177/008117501247064](https://doi.org/10.1177/0081175012470644)4 |
| Type: Article, refereed |
| Quality indicators:1) Citations: Total number 2) Software adaptations3) Academic awards, prizes and/or grants directly related to this output |

Motivation: This article from my PhD project introducing the three-step approach to LCA, the basis of my award-winning PhD research, has been cited 536 times. Key output 2 Open Access: Yes

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| Reference: **Bakk,** Z., Kuha, J. “Two-Step Estimation of Models Between Latent Classes and External Variables.” Psychometrika 83, 871–892 (2018).  |
| URL: <https://doi.org/10.1007/s11336-017-9592-7> |
| Type: Article, refereed |
| Quality indicators:1) Citations: Total number2) Software adaptations 3) Scholarly activity: Downloads, views, shares, readership and/or bookmarks on common research tools |

Motivation: This article introduces the two-step approach to LCM that I propose to extend in this Vidi project to the novel context of generalized LVMs, combining categorical and continuous LVMs. The paper was published in a prominent journal and has been cited 107 times and downloaded 2362 times.Key output 3 Open Access: Yes

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| Reference: **Bakk, Z.**, Kuha, J., “[Relating latent class membership to external variables: An overview](https://scholar.google.com/citations?view_op=view_citation&hl=en&user=Nv2sg-oAAAAJ&sortby=pubdate&citation_for_view=Nv2sg-oAAAAJ:5nxA0vEk-isC).” British Journal of Mathematical and Statistical Psychology 74 (2) (2020) |
| URL:  <https://doi.org/10.1111/bmsp.12227>  |
| Type: Article, refereed |
| Quality indicators:1) Academic invitations directly related to this output 2) Scholarly activity: Downloads, views, shares, readership and/or bookmarks on common research tools3) Other, please describe: |

Motivation: This overview article, invited by the editorial board, demonstrates the importance of the topic of stepwise LVMs in the broader field of Statistical Psychology and represents recognition of my in stepwise LCMs by the editorial board. Key output 4 Open Access: Yes

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| Reference: **Bakk, Z.** “Latent class analysis with measurement-invariance testing: simulation study to compare overall Likelihood ratio vs residual fit statistics based model selection.” Structural Equation Modeling: A Multidisciplinary Journal, 2023 (online first) |
| * URL: https://[doi.org/10.1080/10705511.2023.2233115](https://doi.org/10.1080/10705511.2023.2233115)
 |
| Type: Article, refereed |
| Quality indicators:1) Reproducibility- all materials for replication available on open science platform 2) Scholarly activity: Downloads, views, shares, readership and/or bookmarks on common research tools3) Software adaptations |

Motivation: This single-author article investigates the optimal approaches for identifying and modelling LCMs’ measurement invariance. This topic will be developed further in the novel generalized LVM context in the Vidi project. The article was viewed 210 times within its first two months of publication. Key output 5 Open Access: Yes

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| Reference: **Bakk, Z.,** Di Mari,R., Oser, J., J Kuha,J., “[Two-stage multilevel latent class analysis with covariates in the presence of direct effects](https://scholar.google.nl/citations?view_op=view_citation&hl=en&user=Nv2sg-oAAAAJ&sortby=pubdate&citation_for_view=Nv2sg-oAAAAJ:kNdYIx-mwKoC).”, Structural Equation Modeling: A Multidisciplinary Journal 29 (2), 267-277 (2022) |
| * URL: <https://doi.org/10.1080/10705511.2021.1980882>
 |
| Type: Article, refereed |
| Quality indicators:1) Software adaptations 2) Academic invitations directly related to this output 3) Scholarly activity: Downloads, views, shares, readership and/or bookmarks on common research tools |

Motivation: This paper shows the extensibility of [2] to complex models and provides a strong basis for the Vidi project’s viability. I was invited to present this paper at the 51st Scientific Meeting of the Italian Statistical Society. **Output in cooperation with students**Key output [6-7] features my students as first author. In this work I took on the roles: project management, supervision, writing-editing. Key output 6 Open Access: Yes

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| Reference: Janssen, J.H,M., van Laar, S., de Rooij, M., Kuha, J. & **Bakk, Z**.  “The Detection and Modeling of Direct Effects in Latent Class Analysis.”, Structural Equation Modeling: A Multidisciplinary Journal, 26:2, p.280-290, (2019)  |
| * URL: <https://doi.org/10.1080/10705511.2018.1541745>
 |
| Type: Article, refereed |
| Quality indicators:1) Personal development2) Software adaptations 3) Scholarly activity: Downloads, views, shares, readership and/or bookmarks on common research tools |

Motivation: Assuming a senior authorship role, I successfully mentored master students writing their first main-authored paper. The article demonstrates the flexibility of stepwise LCM in detecting and modeling direct effects. This is a strength of the approach that is extendable to the Vidi proposal. **Open-source software adaptation** Key output [7] showcases the open-source software adaptation implemented in R for stepwise LCMs. This work, completed in cooperation with international experts and a visiting PhD student (J. Lyrvall), creates a strong software base for implementing the proposed Vidi project’s approaches. The package has open code that ensures reproducibility and transparency. My roles included project management, writing, editing, and supervision. Key output 7 Open Access: Yes

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| Reference: [Lyrvall](https://scholar.google.com/citations?user=em28B0cAAAAJ&hl=en&oi=sra), [J., DiMari](https://scholar.google.com/citations?user=zXGImzUAAAAJ&hl=en&oi=sra), R., [**Bakk**](https://scholar.google.com/citations?user=Nv2sg-oAAAAJ&hl=en&oi=sra)**, Z.**,  [Oser](https://scholar.google.com/citations?user=gOSYRhkAAAAJ&hl=en&oi=sra), J., [Kuha](https://scholar.google.com/citations?user=wUoi838AAAAJ&hl=en&oi=sra), J. “[multilevLCA: An R Package for Single-Level and Multilevel Latent Class Analysis with Covariates](https://arxiv.org/abs/2305.07276)”, arXiv preprint, 2023  |
| URL: <https://doi.org/10.48550/arXiv.2305.07276>  |
| Type: Software |
| Quality indicators:1) Software adaptations 2) Reproducibility3) Targeted impact, has reached a specific audience |

Motivation: After presenting this study at CLADAG, J. Lyrvall received four invitations to present our work at different universities, indicating the relevance of the package and my skills as a mentor helping to prepare the presentation and introducing the student to a broad network. **Translational research and outreach**Key outputs [8-9] are examples of collaborative research with applied researchers [8] and industry experts [9], highlighting my skills in translating methodological research to applied contexts and forming interdisciplinary networks. Output [10] shows my commitment to outreach and creating synergies for advancing scientific developments in the context of open science. Key output 8 Open Access: Yes

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| Reference: Oser, J., Hooghe, M., **Bakk, Z**. , DiMari, R., “Changing citizenship norms among adolescents, 1999-2009-2016: A two-step latent class approach with measurement equivalence testing.” Quality and Quantity, 57, 4915–4933, (2022).  |
| URL: https://doi.org/10.1007/s11135-022-01585-5 |
| Type: Article, refereed |
| Quality indicators:1) Academic collaboration and/or interdisciplinary engagement 2) Targeted impact, has reached a specific audience3) Transparancy, accessibility |

Motivation: This contribution involves interdisciplinarity cooperation targeting political scientists regarding LVMs’ applicability in their field. The extension of this research line led by Dr. Jennifer Oser and funded by the ERC is a basis for popularizing stepwise LVMs. My roles included writing, review, editing, validation, and methodology development. Key output 9 Open Access: Yes

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| Reference: van der Laken, P. A., **Bakk**, Z., Giagkoulas, V., van Leeuwen, L., & Bongenaar, E. “Expanding the methodological toolbox of HRM researchers: The added value of latent bathtub models and optimal matching analysis.” *Human Resource Management*, *57*(3), 751-760, (2018).  |
| URL: https://doi.org/10.1002/hrm.21847 |
| Type: Article, refereed |
| Quality indicators:1) Targeted impact, has reached a specific audience 2) Commentary/Popular: 3) Public use/interest |

Motivation: This article, written in cooperation with former colleagues at Shell, generated widespread media interest for popularizing the use of LVMs in industry. I wrote the section about applying LVMs to human resource management research. Key output 10 Open Access: Yes

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| Reference **Bakk**, Z., Boy, J., Mons, B., & Van 't Veer, A. Young Academy Leiden - Summer of Data Diversity podcast. Zenodo. (2022, October 11) |
| URL: https://doi.org/10.5281/zenodo.7220703 |
| Type: Audio |
| Quality indicators:1) Stakeholder involvement 2) Transparancy, accessibility3) Originality/novelty |

Motivation: This podcast showcases my commitment to facilitating dynamic discussions aimed at improving the methodologies advancing open science.  |

Word count 2b Key output: **677 from 700**

2c. Research idea

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| *Provide a concise description of your research idea (topic and potential importance of the results) and max. 5 key words that best fit your research idea. Please note that the research idea itself is not assessed, but is used to assess the fit of the academic profile and key output with the research idea.*(max. 150 words, excluding the title)

|  |
| --- |
| Title: A generalized stepwise estimator for latent variable models for increased reproducibility and transparency in the social sciences  |
| Keywords (max 5): latent variable models, stepwise estimator, structural and measurement models, open source software, reproducibility  |

Research idea:The social sciences have been roundly criticized for producing results that often cannot be replicated or validated. This is partially attributable to a lack of unbiased and robust estimators in complex statistical models. I plan to create a stable, robust, efficient, and novel two-step estimator for generalized latent variable models (GLVMs), conditioning the estimation on an *a priori* estimated measurement model while correcting for estimation bias. Because this estimator will be designed to handle complex, longitudinal, and multilevel latent variable models combining continuous and discrete data, it will be applicable to a broad range of social science research fields. The approach will be versatile, allowing conditioning on measurement models obtained from different samples and by different researchers, thereby promoting open science, data exchange, and reproducibility. The estimator will be implemented in open source and mainstream commercial software and applied in diverse scientific fields and industry applications through interdisciplinary collaborations. Word count 2c Research idea: 149 from 150 |

3. Administrative details

🡨 Expand for Explanatory Notes on section 3

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| General Notes 3. Administrative details |
| Provide only the requested information. Note that information in section 3 may be used by the committee as context information in the assessment of the criterion “Quality of the researcher”. |

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| Explanatory Notes 3a. Personal details |
| When asked for personal details mention title(s), initials and last name, and refrain from mentioning first name(s). Note: please make sure that all fields within your ISAAC profile are filled in completely, including your gender. This information will be used for administrative purposes and will influence policy decisions such as the NWO ex aequo policy.We ask you to **make sure that your contact details in your ISAAC profile are up-to-date** (i.e. postal address for full duration of the round, phone number). |

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| Explanatory Notes 3c. Doctorate |
| The date of PhD award is the day stated on your doctoral degree. If this date is not the same as the date of your defence, please use the date you were allowed to use the doctoral title. If there was a gap of more than six months between the defence and the date you are allowed to use the doctoral title, the date of defence applies.In case you have two doctorates, please include information on both doctorates. The date of the second doctorate is leading for the submission period. Please include information since completing your first PhD under question 3e and 3f. |

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| Explanatory Notes 3d. Prospective host institution |
| List the institution that has provided the embedding guarantee. Add the specific group or department where you plan to execute your project. |

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| Explanatory Notes 3e. Work experience since completing your PhD |
| List the dates of each appointment and indicate whether it was full-time or part-time (in FTE), whether it was tenured (‘vast’) or fixed-term (‘tijdelijk’), and provide the name of the institution. Insert as many additional rows as needed.List your appointments chronologically. The bottom row should contain your current position. Please indicate the contract type of your current contract and the position you hold. If you are not a Postdoc, Assistant Professor, Associate Professor or Full Professor, describe whether the position you hold is outside or within the academic sector. |

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| Explanatory Notes 3f. Net academic research time |
| List the net academic research time since you received your PhD title, i.e. how long have you actually been able to work in research, after deducting management tasks, education, leave, interruptions and non-scientific work. This time span between receiving your PhD title and the submission of the grant application is your net academic research time, calculated in full-time equivalents (FTE). You should state this in (full) months. The committee will evaluate your evidence-based CV in relation to your net academic age, allowing the committee to make a fair comparison with other applicants. Do not include your calculation in the form, only list the number of net academic research time in months.**Example**

|  |  |
| --- | --- |
| PhD dissertation defended | May 2017 |
| Deadline for submission of grant application | November 2023 |
| **Gross academic age** | **79 months** |
| Deductions* Sick leave
* Part-time work
* Teaching
* Management tasks
 | 5 months: 100% interruption 5 months deducted2 yr: 80% of full-time 5 months deducted2 yr: 50% of full-time 12 months deducted2 yr: 25% of full-time 6 months deducted |
| Total deductions | 28 months |
| **Net academic research time** | **51 months** |

Any special circumstances (e.g. due to COVID-19) that account for a reduction in productivity may be mentioned in the box underneath the calculation of months. The maximum word limit for this explanation is 100 words. Just like the number of months spent on research, this information will help the committee interpret your academic achievements and scientific output. |

3a. Personal details

|  |  |
| --- | --- |
| Title(s), initial(s), surname(s): | Dr. Z. Bakk |
| Preferred language of correspondence (choose one): | **English** |

3b. Master's degree (‘doctoraal’)

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| --- | --- |
| University/College of Higher Education: | Tilburg University |
| Main subject: | Research master Social and Behavioral Sciences  |

3c. Doctorate

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| --- | --- |
| University/College of Higher Education: | Tilburg University  |
| Starting date (dd/mm/yy): | 01/09/2011 |
| Date of PhD award (dd/mm/yy): | 16/10/2015 |
| Supervisor(s) (‘Promotor(en)’): | Prof Dr. J.K. Vermunt , Dr. D.L. Oberski |
| Thesis title: | Contributions to bias adjusted stepwise latent class modeling |

3d. Prospective host institution

|  |  |
| --- | --- |
| Host institution: | Leiden University  |
| Research group: | Methodology and Statistics Unit, Institute of Psychology  |

3e. Work experience since completing your (first) PhD

 List your appointments chronologically. The bottom row should contain your current position.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Position | Period(date-date) |  Months FTE | Position type (fixed term/permanent/tenure‑track/other) | Institution |
| HR analytics Analyst | 16-03-2015 to 30-10-2015 | 1 | Permanent  | Royal Dutch Shell |
| Assistant professor | 01-11-2015 to 01-03-2018 | 1 | Fixed term | Leiden University |
| Policy Analyst | 02-03-2018 to 31-12-2019 | 1 | Fixed term | Organization for Economic Cooperation and development (OECD) |
| Assistant professor | 01-01-2020 -current | 1 | Permanent | Leiden University |

3f. Net. academic research time

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| Number of months: | 30 months |

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| If applicable: You may mention special circumstances that account for a reduction in productivity (max. 100 words): |
|  |

Statements by the applicant

Use of extension clause

If you make use of the extension clause, (only) add the date of the e-mail you have received from talent@nwo.nl with a confirmation that your extension was granted. An extension is only necessary if you exceed the year limit on the reference date.

Do you make use of the extension clause: No

If yes, the extension was confirmed on: Choose the date

By submitting this form I declare that:

*By submitting this form, I endorse the code of conduct for laboratory animals and the code of conduct for biosecurity/possibility for dual use of the expected results and will act accordingly, if applicable.*

**🞎** I have completed this form truthfully

**🞎** I have submitted the completed and signed embedding guarantee

**🞎** I declare that I satisfy the nationally and internationally accepted standards for scientific conduct as stated in the [Netherlands Code of Conduct for Research Integrity 2018](https://www.nwo.nl/en/netherlands-code-conduct-research-integrity).

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| --- |
| Initial(s) and surname(s)[[1]](#footnote-1):  |
| Place:  |
| Date**:**  |

1. Please refrain from using your first name to reduce gender effects. [↑](#footnote-ref-1)