# Nima Rasekh

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## Academic Positions

Sep 2022–Now **Postdoctoral Fellow**, *Max-Planck-Institut für Mathematik*, Bonn

June 2022 **Academic Visitor**, *Centre de Recerca Matemàtica*, Barcelona

Feb 2020 **Academic Visitor**, *Institut des Hautes Études Scientifiques*, Bures-sur-Yvette

Sep 2019–Aug 2022 **Postdoctoral Fellow**, *École Polytechnique Fédérale de Lausanne*, Lausanne

Mar 2019 **Academic Visitor**, *Czech Academy of Sciences*, Prague

Sep 2018–Aug 2019 **Postdoctoral Fellow**, *Max-Planck-Institut für Mathematik*, Bonn

## Education

2013–2018 **Ph.D. in Mathematics**, *University of Illinois at Urbana-Champaign*
Adviser: Dr. Charles Rezk

2012–2013 **M.S. in Mathematics**, *University of Western Ontario*

2008–2012 **B.S. in Mathematics**, *Shiraz University*

## Publications

### Published

Published **A homotopy coherent nerve for $(\infty, n)$-categories**, *joint with Lyne Moser & Martina Rovelli*, arXiv:2208.02745, DOI:10.1016/j.jpaa.2024.107620
Journal of Pure and Applied Algebra

Published **A Model for the Higher Categories of Higher Categories**, arXiv:1805.03816
Theory and Applications of Categories

Published **Univalent Double Categories**, *joint with Niels van der Weide, Benedikt Ahrens & Paige North*, arXiv:2310.09220, DOI:10.1145/3636501.3636955
Certified Programs and Proofs 2024

Published **Yoneda Lemma for Simplicial Spaces**, arXiv: 1711.03160, DOI:10.1007/s10485-023-09734-z
Applied Categorical Structures

Published **Cartesian Fibrations of Complete Segal Spaces**, arXiv:2102.05190, DOI:10.21136/HS.2023.03
Higher Structures

Published **Constructing Coproducts in Locally Cartesian Closed $\infty$-Categories**, *joint with Jonas Frey*, arXiv:2108.11304, DOI:10.4310/HHA.2023.v25.n1.a4
Homology, Homotopy and Applications

Published **Thom spectra, higher THH and tensors in $\infty$-categories**, *joint with Bruno Stonek & Gabriel Valenzuela*, arXiv:1911.04345, DOI:10.2140/agt.2022.22.1841
Algebraic & Geometric Topology

Published **Cartesian Fibrations and Representability**, arXiv:1711.03670, DOI:10.4310/HHA.2022.v24.n2.a7
Homology, Homotopy and Applications

Published **Quasi-Categories vs. Segal Spaces: Cartesian Edition**, arXiv:2102.05192, DOI:10.1007/s40062-021-00288-2
Journal of Homotopy and Related Structures

Published **Filter Quotients and Non-Presentable $(\infty, 1)$-Toposes**, arXiv:2001.10088, DOI:10.1016/j.jpaa.2021.106770
Journal of Pure and Applied Algebra

Published **Every Elementary Higher Topos has a Natural Number Object**, arXiv:1809.01734
Theory and Applications of Categories

Published **The cotangent complex and Thom spectra**, *joint with Bruno Stonek*, arXiv:2005.01382, DOI:10.1007/s12188-020-00226-8
Abhandlungen aus dem Mathematischen Seminar der Universität Hamburg

### Submitted

Submitted **Insights From Univalent Foundations: A Case Study Using Double Categories**, *joint with Niels van der Weide, Benedikt Ahrens & Paige North*, arXiv:2402.05265

Submitted **$(\infty, n)$-Limits I: Definition and first consistency results**, *joint with Lyne Moser & Martina Rovelli*, arXiv:2312.2312.11101

Submitted **An $(\infty, n)$-categorical straightening-unstraightening construction**, *joint with Lyne Moser & Martina Rovelli*, arXiv:2307.07259

Submitted **Cosmological Unstraightening**

Submitted **Twisted Arrow Construction for Segal Spaces**, *joint with Chirantan Mukherjee*, arXiv:2203.01788

Submitted **Shadows are Bicategorical Traces**, *joint with Kathryn Hess*, arXiv:2109.02144

Submitted **Yoneda Lemma for $\mathcal{D}$-Simplicial Spaces**, arXiv:2108.06168

Submitted **Univalence in Higher Category Theory**, arXiv:2103.12762

Submitted **An Elementary Approach to Truncations**, arXiv:1812.10527

Submitted **A Theory of Elementary Higher Toposes**, arXiv:1805.03805

### Preprint

Preprint **Complete Segal Objects**, arXiv:1805.03561

Preprint **Yoneda Lemma for Elementary Higher Toposes**, arXiv:1809.01736

Preprint **An Introduction to Complete Segal Spaces**, arXiv:1805.03131

Preprint **RGB image-based data analysis via discrete Morse theory and persistent homology**, *with C. Du, C. Szul, A. Manawa, R. Guzman, R. Davidson*, arXiv:1801.09530

## Awards and Certificates

Spring 2018 **Campus Award for Excellence in Undergraduate Teaching**, *University of Illinois*, $2000\$$

Spring 2018 **LAS Award for Excellence in Undergraduate Teaching by a Graduate Teaching Assistant**, *College of Liberal Arts and Sciences*, $2000\$$

Fall 2016 **Departmental TA Instructional Award**, *Department of Mathematics*, $500\$$

Spring 2016 **Teaching Scholar Certificate**, *Center for Innovation in Teaching and Learning*, University of Illinois

Spring 2016 **Graduate Teaching Certificate**, *Center for Innovation in Teaching and Learning*, University of Illinois

Spring 2016 **Foundations of Teaching Certificate**, *Center for Innovation in Teaching and Learning*, University of Illinois

2013–2017 On List of Teachers Ranked as Excellent (x6) and listed as Outstanding (x1)

## Fellowships and Research Funds

Summer 2019 **Research Funds to organize the Summer School on Higher Topos Theory and Univalent Foundations**, $5000£$, joint with Nicola Gambino and Karol Szumilo, University of Leeds

Summer 2018 **Departmental Research Assistantship**, $2270.5\$$, University of Illinois

Spring 2018 **Hogan Fellowship**, $9966.56\$$, University of Illinois

Summer 2017 **Departmental Research Assistantship**, $9136.01\$$, University of Illinois

Spring 2017 **R.H. Schark & B.G. Trjitzinsky Fellowship**, $4885.19\$$, University of Illinois

Summer 2015 **Departmental Research Assistantship**, $4342.72\$$, University of Illinois

Summer 2013 **Research Experience for Graduate Students Summer**, *Advisor: Charles Rezk*, Computational Aspects of Topological Modular Forms, $2000\$$

## Talks and Presentations

### Invited Talks

April 2024 **Conference on $(\infty, n)$-Categories and Their Applications**, *$(\infty, n)$-Limits II: Fibrational Approach and Properties*, Universiteit Utrecht

Feb 2024 **Topology Seminar**, *A Univalence Maxim for Category Theory*, University of Minnesota

Feb 2024 **Research Seminar on Quantum Topology and Categorification**, *Double Categorical Methods in Higher Mathematics*, Universität Hamburg

Jan 2024 **Certified Programs and Proofs 2024**, *Univalent Double Categories*, London

Nov 2023 **Oberseminar Logik**, *Formalizing (Double) Categories*, Bonn Universität

Nov 2023 **Dutch Categories And Types Seminar**, *Univalent Double Categories*, Radboud University Nijmegen

Sept 2023 **Interactions of Proof Assistants and Mathematics**, *Formalizing Categories*, Universität Regensburg

July 2023 **Topologie Seminar**, *Limits in $(\infty, 2)$-Categories*, Universität Regensburg

July 2023 **Category Theory 2023**, *Limits in $(\infty, n)$-Categories*, Université catholique de Louvain

June 2023 **Seminar on Geometric Methods in Mathematics**, *Formalizing (Double-)Categories*, Technische Universität Dresden

Mai 2023 **Beyond finite sets - Homotopy Theory and Combinatorics**, $\infty$-*Categories and Finite Sets*, University of Copenhagen

Apr 2023 **Working Group 6 Type Theory Meeting**, *Category Theory of Universes*, Technische Universität Wien

Apr 2023 **Workshop on Homotopy Type Theory/Univalent Foundations 2023**, *Higher Topoi as Internal Higher Categories*, Technische Universität Wien

Feb 2023 **Sémantique Seminar**, *Category Theory of Universes*, IRIF

Feb 2023 **EPFL Topology Seminar**, *What is a topological structure?*, EPFL

Dec 2022 **Oberseminar Topologie**, *Hochschild Homology via homotopy-coherent Shadows*, WWU Münster

Oct 2022 **Topology** & **Geometry Seminar**, *Higher Algebra in non-classical Mathematics*, Norges teknisk-naturvitenskapelige universitet

Oct 2022 **eCHT Networking Event**, *Homotopy Invariant Mathematical Foundations*

Oct 2022 **Algebraic Topology, in memory of Hans-Joachim Baues**, *Contributed talk: Algebraic topology in non-classical mathematics*, Max Planck Institute for Mathematics

May 2022 **PSSL 106**, *Stone Spaces and Integer Objects*, Masaryk University

Jan 2022 **HoTTEST Event for Junior Researchers 2022**, *Constructing Coproducts in locally Cartesian closed $\infty$-Categories*

Dec 2021 **Topology Seminar**, *THH and Shadows of Bicategories*, University of Warsaw

Nov 2021 **Topology Seminar**, *THH and Shadows of Bicategories*, Bilkent University

Nov 2021 **Topology Seminar**, *Filter Quotient $\infty$-Categories*, Universität Regensburg

Oct 2021 **Geometry and Topology Seminar**, *THH and Shadows of Bicategories*, Binghamton University

Oct 2021 **Topology Seminar**, *Shadows are bicategorical Traces*, University of Kentucky

Oct 2021 **Warwick Algebraic Topology Seminar**, *Shadows are bicategorical Traces*, University of Warwick

Aug 2021 **Category Theory 2021**, *Fibrations of $(\infty, n)$-Categories*, Università di Genova

Jun 2021 **Toposes online**, *Every Elementary Higher Topos has a Natural Number Object*

Jun 2021 **8th European Congress of Mathematics**, *Towards Non-Presentable Models of Homotopy Type Theory*

Apr 2021 **Homotopy Type Theory Seminar**, *Every Elementary Higher Topos has a Natural Number Object*, Carnegie Mellon University

Feb 2021 **OCHoTop Zoom Seminar**, *Non-Standard Truncations*

Nov 2020 **Florida State University Homotopy Theory Seminar**, *Thom spectra, higher THH and Tensors in $\infty$-Categories*

Nov 2020 **Homotopy Type Theory Electronic Seminar**, *Filter Products and Elementary Models of Homotopy Type Theory*

July 2020 **Workshop on Homotopy Type Theory/Univalent Foundations 2020**, *A Step towards Non-Presentable Models of Homotopy Type Theory*

Mar 2020 **Topics in Category Theory**, *An Elementary Approach to Localizations*, University of Edinburgh

Feb 2020 **Topology Seminar**, *An Elementary Approach to Truncation*, Université Paris XIII

Feb 2020 **Groupe de Travail: Catégories Supérieures, Polygraphes et Homotopie**, *Fibrations for Segal spaces*, Institut de Recherche en Informatique Fondamentale

Feb 2020 **Topology Seminar**, *Truncations Revisited*, Université de Paris

Jan 2020 **SU Topology Seminar**, *Thom spectra, higher THH and Tensors in $\infty$-Categories*, Stockholms Universitet

Jan 2020 **SU Logic Seminar**, *An Example of an Elementary Higher Topos that is not a Grothendieck Higher Topos*, Stockholms Universitet

Dec 2019 **Bochum Topology Seminar**, *Thom spectra, higher THH and Tensors in $\infty$-Categories*, Bochum Universität

Jul 2019 **Category Theory 2019**, *A Theory of Elementary ($\infty$,1)-Toposes*, University of Edinburgh

Jun 2019 **Summer School on Higher Topos Theory and Univalent Foundations**, *Elementary Higher Toposes*, University of Leeds

Jun 2019 **Early Career Topology Researchers Conference**, *An Axiomatic Approach to Algebraic Topology*, Sheffield University

Mar 2019 **CAS Topology Seminar**, *An Axiomatic Approach to Algebraic Topology*, Czech Academy of Sciences

Feb 2019 **EPFL Topology Seminar**, *An Axiomatic Approach to Algebraic Topology*, EPFL

Feb 2019 **Homotopy Type Theory Electronic Seminar**, *Algebraic Topology in an Elementary Higher Topos*

Jan 2019 **Higher Geometric Structures along the Lower Rhine XII**, *An Axiomatic Approach to Algebraic Topology*, Radboud University Nijmegen

Oct 2018 **Oberseminar Topologie**, *Fundamental Group and Natural Number Objects*, Bonn University

Mar 2018 **AMS Sectional Meeting (Special Session in Homotopy Theory)**, *A Theory of Elementary Higher Toposes*, Ohio State University

Feb 2018 **Ohio Topology Seminar**, *A Theory of Elementary Higher Toposes*, Ohio State University

Jan 2018 **Rochester Topology Seminar**, *A Theory of Elementary Higher Toposes*, University of Rochester

Jan 2018 **Joint Mathematical Meetings 2018**, *Analyzing RGB Images using Topology*, San Diego

Nov 2017 **ND Topology Seminar**, *A Theory of Elementary Higher Toposes*, Notre Dame University

Nov 2017 **Algebraic Topology Seminar**, *A Theory of Elementary Higher Toposes*, University of Chicago

Nov 2017 **UIC Algebraic K-Theory Seminar**, *A Theory of Elementary Higher Toposes*, University of Illinois Chicago

Nov 2017 **Graduate Student Colloquium**, *Higher categories: What's up with that?*, University of Illinois at Urbana Champaign

Oct 2017 **JHU Topology Seminar**, *A Theory of Elementary Higher Toposes*, Johns Hopkins University

Oct 2017 **Northwestern Topology Seminar**, *A Theory of Elementary Higher Toposes*, Northwestern University

Oct 2017 **Graduate Student Homotopy Seminar**, *Why Higher Categories come into Topological Field Theories*, University of Illinois at Urbana Champaign

Sept 2017 **UVA Topology Seminar**, *A Theory of Elementary Higher Toposes*, University of Virginia

Sept 2017 **Purdue Topology Seminar**, *A Theory of Elementary Higher Toposes*, Purdue University

### Selected List of Talks

June 2018 **Talbot Workshop 2018**, *Other approaches to model-independent $\infty$-category theory*, Government Camp, OR

July 2017 **Homotopy Theory: Tools and Applications**, *Representable Cartesian Fibrations*, University of Illinois at Urbana Champaign

April 2017 **Topology Seminar**, *Representable Cartesian Fibrations*, University of Illinois at Urbana Champaign

April 2017 **AMS Sectional Meeting (Special Session in Homotopy Theory)**, *Composition Fibrations*, Indiana University

May 2016 **Workshop on Homotopy Type Theory and Univalent Foundations**, *Complete Segal Objects and Univalent Maps*, Fields Institute, Toronto

April 2016 **Graduate Student Geometry Topology Conference 2016**, *A new Approach to the Straightening Construction*, Indiana University

Feb 2016 **Graduate Student Geometry Topology Seminar**, *Yoneda Lemma and the Fundamental Group*, University of Illinois at Urbana Champaign

Nov, 2014 **Graduate Student Homotopy Seminar**, *Complete Segal Objects*, University of Illinois at Urbana Champaign

Oct, 2014 **Graduate Student Geometry Topology Seminar**, *Topos Theory: Sketches of an Elephant*, University of Illinois at Urbana Champaign

Apr, 2013 **Talbot Workshop 2013**, *The Chromatic Spectral Sequence*, South Lake Tahoe, CA

## Teaching Experience

### Projects Supervised at Max-Planck-Institut für Mathematik

Fall 2023 - Spring 2024 **M.Sc. Thesis**, *Theofanis Chatzidiamantis Christoforidis*, Bonn University
**Thesis Topic:** Formalizing Higher Categories

Spring 2023 **B.Sc. Thesis**, *Deborah Stein*, Bonn University
**Project Topic:** Classical Topology in Higher Topos Theory

Fall 2022 - Spring 2023 **M.Sc. Thesis**, *Qi Zhu*, Bonn University
**Thesis Title:** Fractured Structure on Condensed Anima

### Courses taught at École Polytechnique Fédérale de Lausanne

Spring 2022 **Homotopical Algebra**, *Teaching Assistant*

Fall 2020 **Homotopical Algebra**, *Teaching Assistant & Lecturer*
*Designed and graded weekly exercises, ran online exercise sessions (via Zoom) and online question forum (via Slack). Also designed and taught last chapter with combination of pre-recorded and Zoom lectures.*

Spring 2020 **Higher Categories: Theory and Practice**, *Primary Instructor*
*Designed a new course with the goal of giving students an insight into the inner workings and applications of higher category theory. Lecture notes available online.*

Fall 2019 **Advanced Linear Algebra**, *Teaching Assistant*

### Projects Supervised at École Polytechnique Fédérale de Lausanne

Spring 2022 **M.Sc. Project**, *Sami Mir*, EPFL
**Project Title:** Functor Quasi-Category

Spring 2022 **M.Sc. Thesis**, *Virgile Constantin*, EPFL
**Thesis Title:** Categorical Models of Homotopy Type Theory

Fall 2021 **M.Sc. Project**, *Donghan Wang*, EPFL
**Project Title:** Sheaves, Spectra, and Quasi-categories: A Definition of the $\infty$-Category of Differential Cohomology Theories

Spring 2021 **B.Sc. Project**, *Gabin Kolly*, EPFL
**Project Title:** Filter Quotient Model Categories

Spring & Fall 2021 **M.Sc. Thesis**, *Chirantan Mukherjee*, University of Trento
**Thesis Title:** Complete Segal Spaces as a Model of Higher Categories

Fall 2020 **M.Sc. Thesis**, *Djian Post*, EPFL
**Thesis Title:** A Simplicial Model for Homotopy Type Theory

Spring 2020 **M.Sc. Thesis**, *Emma Chollet*, Université de Neuchâtel
**Thesis Title:** An Introduction to Simplicial Sets and Model Categories

### Courses taught at University of Illinois at Urbana-Champaign

Summer 2018 **Illinois Scholars Program Summer Bridge Experience**, *Teaching Assistant & Instructor*
*A three week summer program for incoming under-represented and first generation students with the goal of preparing students for the first semester. Designed and implemented individual lesson plans for students with the goal of preparing them for the appropriate course in the calculus sequence.*

Fall 2017 **Calculus 2**, *Merit section discussion leader*
*These classes are highly-interactive discussion sections in which students are engaged in groupwork via challenging problem sets. Participating students are selected from underrepresented groups, as well as from small high schools.*

Fall 2016 **Calculus 3**, *Merit section discussion leader*

Summer 2016 **Calculus**, *Primary Instructor*
*Designed the syllabus and all of the course material, held classes in an active learning format to enhance teaching and used quizzes for immediate feedback. Also designed, held and graded exams.*

Spring 2016 **Calculus 2**, *Merit section discussion leader*

Fall 2015 **Calculus 1**, *Merit section discussion leader*

Spring 2015 **Calculus 2**, *Merit section discussion leader*

Fall 2014 **Calculus 1**, *Mathematica based discussion leader*
*These classes are interactive discussion sections in which students apply scientific softwares (Mathematica) to visualize and master intricate mathematical subjects.*

Spring 2014 **Calculus for Business 1**, *Active learning discussion Session Leader*

Fall 2013 **Calculus**, *Discussion Session Leader*

### Courses taught at University of Western Ontario

Summer 2013 **Advanced Calculus**, *Teaching Assistant*

Spring 2013 **Methods of Calculus**, *Teaching Assistant*

Fall 2012 **Introductory Calculus**, *Teaching Assistant*

## Academic Service and Professional Development

Fall 2022 **Organizer**, *Online workshop on* $(\infty, 2)$*-Categories*, MPIM

Fall 2022 **External Expert**, *Master Thesis Committee*, EPFL

Fall 2019 - Spring 2022 **Organizer**, EPFL Topology Seminar, EPFL

Since 2017 **Reviewer**, zbMath, Mathematical Reviews

**Referee**, *Applied Categorical Structure, Algebraic & Geometric Topology, Journal of Pure and Applied Algebra, Theory and Applications of Categories, Honam Mathematical Journal*

June 2019 **Organizer**, Summer School on Higher Topos Theory and Univalent Foundations, University of Leeds

Fall 2017, Spring 2018 **President**, AMS Graduate Student Chapter

Fall 2017 **Organizer**, Graduate Student Homotopy Seminar

*I organized a student seminar where each student had the opportunity to present their current research.*

Fall 2017 **Committee Chair, TA Teaching Awards Committee**, Dept. of Mathematics

*This committee selects exemplary graduate students as recipients of various departmental teaching awards. I assembled the remainder of the committee, solicited applications, read and evaluated teaching statements and portfolios, observed/interviewed applicants, scheduled and oversaw meetings, mediated between the committee members, and reported our decisions to the department chair.*

Summer 2017 2018 **Merit Program Advising**, Dept. of Mathematics

*Held brief advising appointments with incoming freshmen interested in Merit program, and authorized students for registration to Merit sections.*

Spring 2017 - Spring 2018 **Member of the Senate Committee on Academic Freedom and Tenure**, University of Illinois at Urbana Champaign

*D*iscussing matters of freedom of speech and academic freedom and giving the university recommendations on which actions to take.

Spring 2017 **Organizer**, Higher Category Theory Reading Seminar

Fall 2016 - Spring 2018 **Merit Program TA Mentor**, Dept. of Mathematics

*I* guided several students through their first experience with the merit program and helped them adjust to the new environment.

Fall 2016 **TA Mentor**, Dept. of Mathematics

*I guided several first time TAs throughout their first semester by providing first day of class instructions, observing their teaching in class, discussing feedback forms and giving mental support.*

Aug 2016 **Workshop Organizer**, Graduate Academy for College Teaching

*I ran a one hour session for first time TAs introducing basics of active learning and group work methods.*

Aug 2016 **Co-organizer and Developer of the TA Training Program**, Mathematics Ph.D. Orientation Program

*I assisted in developing and organizing two sessions for both incoming and current teaching assistants. I organized one session focusing on international TAs and one concerned with international diversity in the classroom.*

Fall & Spring 2016 **Project Manager**, *Discrete Morse Theory, Vector Fields, and Materials Science*, Illinois Geometry Lab

*I managed a team of 4 undergraduate students applying discrete Morse theory to the analysis of qualitative features of gray scale images, where we did this by modifying a given code. My main duty was to manage the team, assign responsibilities, and organize meetings and future plans.*

Spring 2016 **Organizer**, Spectral Sequence Seminar

*I organized a student seminar focused on spectral sequences with and effort to include students' research into the syllabus.*

Fall 2015 **Organizer**, Graduate Student Homotopy Seminar

May 2015 **Orals Competition Judge**, Illinois Council of Teachers of Mathematics State Math Finals

*As a judge, I evaluated high school students as they presented solutions to various questions, and I assisted in final selection of the awardees.*

March 2015 **Co-organizer**, Graduate Student Geometry Topology Seminar 2015

*I was part of the conference organization team and as part of that team I chose conference speakers, determined conference schedule, designed conference schedule sheet and helped with the technical aspects.*

## Memberships

2023 - Now **Association for Computing Machinery**, *(ACM)*

2013 - 2018 **American Mathematical Society**, *(AMS)*