Arvind Satyanarayan

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EDUCATION

2017 **Ph.D. Computer Science**, *Stanford University*
Thesis: Declarative Interaction Design for Data Visualization
Advisor: Jeffrey Heer (University of Washington)

2014 **M.S. Computer Science**, *Stanford University*

2011 **B.S. Computer Science with Honors**, *University of California, San Diego*
Thesis: Using Overlays to Support Collaborative Interaction with Display Walls
Advisor: James D. Hollan

EMPLOYMENT

2018 – **NBX Career Development Assistant Professor**, *MIT EECS/CSAIL*

2017 – 2018 **Postdoctoral Research Scientist**, *Google Brain Team*

2011 – 2017 **Graduate Research Assistant**, *Interactive Data Lab, Stanford University/University of Washington*
With Prof. Jeffrey Heer

2014 – 2016 **Co-Founder and Advisor**, *Apropose, Inc.*

2013 – 2014 **Co-Founder and Chief Architect**, *Apropose, Inc.*
Led initial development of core infrastructure and prototype applications, culminating in a $1.9M seed investment from NEA and a16z.

AWARDS & HONORS

2022 Significant New Researcher Award, *IEEE Visualization & Graphics Technical Committee (VGTC)*
MIT Professor Amar G. Bose Research Fellowship
EuroVis Best Paper Honorable Mention (Rich Screen Reader Experiences)
ACM CHI Best Paper Honorable Mention (Shared Interest)
ACM IUI Best Paper Honorable Mention (Embedding Comparator)

2021 MIT Committed to Caring (C2C) Award for Graduate Advising (nominated by students)
MIT EECS Seth J. Teller Award for Excellence, Inclusion and Diversity
Google Research Scholar Award
ACM CHI Best Paper Honorable Mention (Viral Visualizations)

2020 NSF CAREER Award
Kavli Fellow, *Kavli Frontiers of Science at the National Academy of Science*
Kolokotrones Education Award, *MIT EECS*

2019 MIT Teaching with Digital Technology Award Nomination (nominated by students)

2016 IEEE InfoVis Best Paper Award (Vega-Lite)

2016 – 2018 Google PhD Fellowship

2015 Kantar Information is Beautiful Awards Shortlist (Lyra)

2013 ACM CHI Best Paper Award (Webzeitgeist)

2011 – 2014 SAP Stanford Graduate Fellowship, *Stanford University*

2011 Outstanding Senior, *UC San Diego Alumni Association*
Phi Beta Kappa, *UC San Diego*

2010 Undergraduate Summer Research Scholar, *Calit2, UC San Diego*

2009, 2010 Ernest Mort Award for Excellence in Leadership, *Revelle College, UC San Diego*

2009 Tau Beta Pi, *UC San Diego*

2008 – 2010 Provost's Honors, *Revelle College, UC San Diego*

PEER-REVIEWED PUBLICATIONS

2023 **Animated Vega-Lite: Unifying Animation with a Grammar of Interactive Graphics.** Jonathan Zong*, Josh Pollock*, Dylan Wootton, Arvind Satyanarayan. *To appear in IEEE Trans. Visualization & Computer Graphics (Proc. IEEE VIS '22)*, January 2023.

Striking a Balance: Reader Takeaways and Preferences when Integrating Text and Charts. Chase Stokes, Vidya Setlur, Bridget Cogley, Arvind Satyanarayan, Marti Hearst. *To appear in IEEE Trans. Visualization & Computer Graphics (Proc. IEEE VIS '22)*, January 2023.

2022 **Rich Screen Reader Experiences for Data Visualization.** Jonathan Zong*, Crystal Lee*, Alan Lundgard*, JiWoong Jang, Daniel Hajas, Arvind Satyanarayan. *Computer Graphics Forum (Proc. EuroVis '22)*, June 2022. Best Paper Honorable Mention (2 awarded).

Varv: Reprogrammable Interactive Software as a Declarative Data Structure. Marcel Borowski, Luke Murray, Rolf Bagge, Janus B. Kristensen, Arvind Satyanarayan, Clemens N. Klokmose. *Proc. ACM Human Factors in Computing Systems (CHI)*, May 2022.

Shared Interest: Measuring Human-AI Alignment to Identify Recurring Patterns in Model Behavior. Angie Boggust, Benjamin Hoover, Arvind Satyanarayan, Hendrik Strobelt. *Proc. ACM Human Factors in Computing Systems (CHI)*, May 2022. Best Paper Honorable Mention (Top 5%).

Teaching Humans When To Defer to a Classifier via Exemplars. Hussein Mozannar, Arvind Satyanarayan, David Sontag. *Proc. AAAI Conference on Artificial Intelligence (AAAI)*, March 2022.

Embedding Comparator: Visualizing Differences in Global Structure and Local Neighborhoods via Small Multiples. Angie Boggust*, Brandon Carter*, Arvind Satyanarayan. *Proc. ACM Intelligent User Interfaces (IUI)*, March 2022. Best Paper Honorable Mention (3 awarded).

Intuitively Assessing ML Model Reliability through Example-Based Explanations and Editing Model Inputs. Harini Suresh, Kathleen M Lewis, John V Guttag, Arvind Satyanarayan. *Proc. ACM Intelligent User Interfaces (IUI)*, March 2022.

Accessible Visualization via Natural Language Descriptions: A Four-Level Model of Semantic Content. Alan Lundgard and Arvind Satyanarayan. *IEEE Trans. Visualization & Computer Graphics (Proc. IEEE VIS '21)*, January 2022.

DIEL: Interactive Visualization Beyond the Here and Now. Yifan Wu, Remco Chang, Joseph M. Hellerstein, Arvind Satyanarayan, Eugene Wu. *IEEE Trans. Visualization & Computer Graphics (Proc. IEEE VIS '21)*, January 2022.

2021 **Viral Visualizations: How Coronavirus Skeptics Use Orthodox Data Practices to Promote Unorthodox Science Online.** Crystal Lee, Tanya Yang, Gabrielle Inchoco, Graham M Jones, Arvind Satyanarayan. *Proc. ACM Human Factors in Computing Systems (CHI)*, May 2021. Best Paper Honorable Mention (Top 5%).

Beyond Expertise and Roles: A Framework to Characterize the Stakeholders of Interpretable Machine Learning and Their Needs. Harini Suresh, Steven R. Gomez, Kevin K. Nam, Arvind Satyanarayan. *Proc. ACM Human Factors in Computing Systems (CHI)*, May 2021.

Assessing the Impact of Automated Suggestions on Decision Making: Domain Experts Mediate Model Errors but Take Less Initiative. Ariel Levy, Monica Agrawal, Arvind Satyanarayan, David Sontag. *Proc. ACM Human Factors in Computing Systems (CHI)*, May 2021.

Lyra 2: Designing Interactive Visualizations by Demonstration. Jonathan Zong, Dhiraj Barnwal, Rupayan Neogy, Arvind Satyanarayan. *IEEE Trans. Visualization & Computer Graphics (Proc. InfoVis '20)*, February 2021.

2020 **B2: Bridging code and Interactive Visualization in Computational Notebooks.** Yifan Wu, Joseph M. Hellerstein, Arvind Satyanarayan. *Proc. ACM User Interface Software and Technology (UIST)* , October 2020.

Representing Real-Time Multi-User Collaboration in Visualizations. Rupayan Neogy, Jonathan Zong, Arvind Satyanarayan. *Proc. IEEE Visualization (VIS)*, October 2020.

VisuaLint: Sketchy In Situ Annotation of Chart Construction Errors. Aspen Hopkins, Michael Correll, Arvind Satyanarayan. *Computer Graphics Forum (Proc. EuroVis)*, May 2020.

Critical Reflections on Visualization Authoring Systems. Arvind Satyanarayan, Bongshin Lee, Donghao Ren, Jeffrey Heer, John Stasko, John R. Thompson, Matthew Brehmer, Zhicheng Liu. *IEEE Trans. Visualization & Computer Graphics (Proc. InfoVis '19)*, January 2020.

2019 **Sociotechnical Considerations for Accessible Visualization Design.** Alan Lundgard, Crystal Lee, Arvind Satyanarayan. *Proc. IEEE Visualization (VIS)*, October 2019.

Sherlock: A Deep Learning Approach to Semantic Data Type Detection. Madelon Hulsebos, Kevin Hu, Michiel Bakker, Emanuel Zgraggen, Arvind Satyanarayan, Tim Kraska, Çağatay Demiralp, César Hidalgo. *Proc. ACM Knowledge Discovery and Data Mining (KDD)*, August 2019.

VizNet: Towards a Large-Scale Visualization Learning and Benchmarking Repository. Kevin Hu, Neil Gaikwad, Madelon Hulsebos, Michiel Bakker, Emanuel Zgraggen, César Hidalgo, Tim Kraska, Guoliang Li, Arvind Satyanarayan, Çağatay Demiralp. *Proc. ACM Human Factors in Computing Systems (CHI)*, May 2019.

2018 **Altair: Interactive Statistical Visualizations for Python.** Jacob VanderPlas, Brian E. Granger, Jeffrey Heer, Dominik Moritz, Kanit Wongsuphasawat, Arvind Satyanarayan, Eitan Lees, Ilia Timofeev, Ben Welsh, Scott Sievert. *Journal of Open Source Software 3(32)*, October 2018.

Augmenting Code with In Situ Visualizations to Aid Program Understanding. Jane Hoffswell, Arvind Satyanarayan, Jeffrey Heer. *Proc. ACM Human Factors in Computing Systems (CHI)*, April 2018.

The Building Blocks of Interpretability. Chris Olah, Arvind Satyanarayan, Ian Johnson, Shan Carter, Ludwig Schubert, Katherine Ye, Alexander Mordvintsev. *Distill 3(3)*, March 2018.

2017 **Vega-Lite: A Grammar of Interactive Graphics.** Arvind Satyanarayan, Dominik Moritz, Kanit Wongsuphasawat, Jeffrey Heer. *IEEE Trans. Visualization & Computer Graphics (Proc. InfoVis '16)*, January 2017. Best Paper Award (1 Annually).

2016 **Visual Debugging Techniques for Reactive Data Visualization.** Jane Hoffswell, Arvind Satyanarayan, Jeffrey Heer. *Computer Graphics Forum (Proc. EuroVis)*, June 2016.

Reactive Vega: A Streaming Dataflow Architecture for Declarative Interactive Visualization. Arvind Satyanarayan, Ryan Russell, Jane Hoffwell, Jeffrey Heer. *IEEE Trans. Visualization & Computer Graphics (Proc. InfoVis '15)*, January 2016.

2015 **Declarative Interaction Design for Data Visualization.** Arvind Satyanarayan, Kanit Wongsuphasawat, Jeffrey Heer. *Proc. ACM User Interface Software and Technology (UIST)*, October 2014.

Lyra: An Interactive Visualization Design Environment. Arvind Satyanarayan, Jeffrey Heer. *Computer Graphics Forum (Proc. EuroVis)*, June 2014.

Authoring Narrative Visualizations with Ellipsis. Arvind Satyanarayan, Jeffrey Heer. *Computer Graphics Forum (Proc. EuroVis)*, June 2014.

2013 **Webzeitgeist: Design Mining the Web.** Ranjitha Kumar, Arvind Satyanarayan, Cesar Torres, Maxine Lim, Salman Ahmad, Scott R. Klemmer, Jerry O. Talton. *Proc. ACM Human Factors in Computing Systems (CHI)*, May 2013. Best Paper Award (Top 1%).

2012 **Using Overlays to Support Collaborative Interaction with Display Walls.** Arvind Satyanarayan, Nadir Weibel, James D. Hollan. *Proc. ACM Intelligent User Interfaces (IUI),* February 2012 .

PRE-PRINTS

2020 **The Effectiveness of Haptic Properties Under Cognitive Load: An Exploratory Study.** Nava Haghighi, Nathalie Vladis, Yuanbo Liu, Arvind Satyanarayan. *arXiv:2006.00372,* May 2020.

WORKSHOP & POSITION PAPERS, POSTERS & REPORTS

2020 **Shared Interest: Human Annotations vs. AI Saliency.** Angie Boggust, Benjamin Hoover, Arvind Satyanarayan, Hendrik Strobelt. *VISxAI,* October 2020.

Towards a Dynamic Multiscale Personalized Information Space. James Hollan, Amy Fox, Philip Guo, Clemens Klokmose, Arvind Satyanarayan, Haijun Xia. *Convivial Computing Salon, <Programming>,* May 2020.

Self-Interfaces: Utilizing Real-Time Biofeedback in the Wild to Elicit Subconscious Behavior Change. Nava Haghighi, Arvind Satyanarayan. *Work-in-Progress of ACM Tangible and Embodied Interaction (TEI)* February 2020.

2019 **Visualive: Representing Synchronized Visualization Interactions.** Rupayan Neogy, Emily Hu, Arvind Satyanarayan. *Posters of IEEE Visualization (VIS)*, October 2019.

2018 **Designing Cognitively Convivial Physics for Dynamic Visual Information Substrates.** James D. Hollan, Arvind Satyanarayan. *Rethinking Interaction Workshop, ACM Human Factors in Computing Systems (CHI)*, May 2018.

2013 **The CHI 2013 Interactive Schedule.** Arvind Satyanarayan, Daniel Strazzulla, Clemens Klokmose, Michel Beaudouin-Lafon, Wendy Mackay. *Extended Abstracts, ACM Human Factors in Computing Systems (CHI)*, May 2013.

2012 **Learning Structural Semantics for the Web.** Maxine Lim, Ranjitha Kumar, Arvind Satyanarayan, Cesar Torres, Jerry O. Talton, Scott R. Klemmer. *Stanford CSTR 2012-03,* December 2012.

A Platform for Large-Scale Machine Learning on Web Design. Arvind Satyanarayan, Maxine Lim, Scott R. Klemmer. *Extended Abstracts, ACM Human Factors in Computing Systems (CHI),* May 2012

INVITED TALKS & DEMOS

Towards *Effective* Interaction with Data Visualization

March 2022 Invited Talk, All India Council on Technical Education (AICTE)
Nov 2021 Invited Talk, Sigma Computing
Jun 2020 Invited Talk, Symposium on Data Science & Statistics, *American Statistics Association*
Keynote Talk, Workshop on Human-In-the-Loop Data Analytics, *ACM SIGMOD*

From Tools to Toolkits: Towards more Reusable, Composable, and Reliable Machine Learning Interpretability

Aug 2021 Keynote Talk, Visualization in Data Science (VDS) Workshop, *ACM KDD*

Visualization for Machine Learning

Jun 2021 AI Seminar, Information Science Institute, University of Southern California
Apr 2021 Daimler/Mercedes-Benz AI

Visualization: A Petri Dish for Intelligence Augmentation

Apr 2019 Radcliffe Institute for Advanced Study, Harvard University, *Cambridge, MA*
Oct 2018 MIT CSAIL, *Cambridge, MA*
Sep 2018 Northeastern University, *Boston, MA*

The Building Blocks of Interpretability
May 2018 emlyon business school, *Lyon, France*

Vega-Lite: A Grammar of Interactive Graphics
Apr 2017 OpenVis Conf, *Boston, MA*

Declarative Interaction Design for Data Visualization
Apr 2017 Massachusetts Institute of Technology, *Cambridge, MA*
New York University, *Tandon Computer Science & Center of Data Science, New York City, NY*
University of California, San Diego, *San Diego, CA*
Northwestern University, *Evanston, IL*
Mar 2017 University of British Columbia, *Vancouver, Canada*
University of Toronto, *Toronto, Canada*
University of Michigan, *Ann Arbor, MI*
Feb 2017 University of California, Berkeley, *Berkeley, CA*
University of Illinois Urbana-Champaign, *Urbana, IL*
Cornell University, *Computer Science & Information Science, Ithaca, NY*
University of Wisconsin-Madison, *Madison, WI*

The Vega Ecosystem
Oct 2016 Keynote Talk, Visualization In Practice Workshop, *IEEE VIS, Baltimore, MD*

Reactive Building Blocks: Interactive Visualizations with Vega
Jul 2016 Keynote Talk, DataViz Camp, *United Nations*
Apr 2016 OpenVis Conf, *Boston, MA*

Higher-Level Tools for Interactive Data Visualization
May 2016 INRIA Saclay, *Saclay, France*
Sep 2015 BiD Seminar, *UC Berkeley, Berkeley, CA*

Lowering the Threshold of Visualization Design
Apr 2015 Linfield College, *Science Colloquium, McMinnville, OR*
Dec 2014 Tata Innovation Labs, *Tata Consultancy Services, Delhi, India*

Designing Visualizations with Lyra Tutorial
Apr 2015 I247: Information Visualization & Presentation, *UC Berkeley Information School, Berkeley, CA*
Dec 2014 Tata Innovation Labs, *Tata Consultancy Services, Delhi, India*
J221: Introduction to Data Visualization, *UC Berkeley Journalism School, Berkeley, CA*
Nov 2014 HCDE 511: Information Visualization, *University of Washington, Seattle, WA*

Lyra: An Interactive Visualization Design Environment
Apr 2014 OpenVis Conf, *Boston, MA*
Mar 2014 CAR, *Baltimore, MD*
Feb 2014 Tapestry, *Annapolis, MD*

NewsCamp :: Introduction to D3
Mar 2014 CAR, *Baltimore, MD*

TEACHING

2019 – **6.859: Interactive Data Visualization**, *MIT EECS*
(Numbered 6.894 in 2019 and 2020)

2018 – **6.170: Software Studio**, *MIT EECS*
Co-Instructor with Prof. Daniel Jackson

Winter 2016 **HCID 520: User Interface Software & Technology**, *University of Washington*
Co-Instructor with Prof. Jeffrey Heer

Winter 2013 **CS 247: Human-Computer Interaction Design Studio**, *Stanford University*
Graduate Teaching Assistant for Profs. Jeffrey Heer and Michael Bernstein

Fall 2012 **CS 147: Introduction to Human-Computer Interaction**, *Stanford University*
Graduate Teaching Assistant for Prof. Scott Klemmer

Winter 2012 **HCI Online #001**, *Stanford University* and *Coursera*
Graduate Teaching Assistant for Prof. Scott Klemmer

STUDENT ADVISEES

PhD Angie Boggust *(EECS)*, Aspen Hopkins *(EECS)*, Crystal Lee *(STS*, co-advised w/Graham Jones*)*, Alan Lundgard *(EECS)*, Harini Suresh *(EECS*, co-advised w/John Guttag*)*, Dylan Wootton *(EECS)*, Jonathan Zong *(EECS)*

Master's Ben Tang (*ID&M '21*), Katherine Bacher (*EECS '21*), Nava Haghighi *(ID&M '20)*, Houssam Kherraz *(EECS '20)*, Rupayan Neogy *(EECS '20)*, Ebenezer Sefah (*EECS '21*), Wonyoung So *(DUSP '20)*

Undergraduate Anna Arpaci-Dusseau (*EECS '23*), Soomin Chun (*EECS & Math '22*), Dhiraj Kumar (*IIT Kharagpur '20*), Katherine Huang (*CMS & EECS '23*), Allen Lee (*EECS '20*), Anna Meurer (*MechE '23*), Mateo Monterde (*Math & Management '23*), Ethan Nevidomsky (*CMS & EECS '22*), Tanya Yang (*EECS '22*)

Mentoring as a PhD Student
Tianyi "Tina" Lin *(UW CSE '17)*, Matthew Chun *(UW CSE '18)*, Yiyang "Amy" Xu *(UW CSE '18)*, Anjir Hossain *(UW CSE '18)*, Nikhil Khanna *(UW CSE '18)*, Emily Gu *(UW CSE '16)*, Ruijia "Iris" Wang *(UW CSE '17)*, Ryan Russell *(UW CSE '16)*

SERVICE

Reviewing IEEE VIS 2014–2020, EuroVis 2014–2021, IEEE TVCG 2015–2021, ACM UIST 2014–2020, ACM CHI 2013–2021, ACM IUI 2012–2021, IEEE PacificVis 2016.

Recognition for **exceptional reviews**: UIST 2020, CHI 2019, CHI 2017, VIS 2017 (x2).

Committees **Diversity & Inclusivity.** MIT EECS 2019–Present. IEEE VIS 2018–2020, Information+ 2018.
Program Committees. ACM IUI 2019–2021, IEEE VIS 2018–2020, OpenVis Conf 2016–2018, ACM CHI 2016 Late-Breaking Work, Information+ 2018, 2021.

2021, 2022 Publications Co-Chair, *IEEE VIS 2021, 2022*

2018–2020 Distill (http://distill.pub) Co-Editor.

2019, 2020 Diversity & Inclusion Co-Chair, *IEEE VIS 2019, 2020*

2018 Program Co-Chair, *OpenVis Conf*

2013 Interactive Schedule Chair, *CHI 2013 Organizing Committee*

2008 – 2011 **Undergraduate Student Leadership**, *UC San Diego*.

2009 – 2011	Resident Advisor, *Revelle College*
2010 – 2011	Student Conduct Code Re-write Workgroup Student Representative
2010 – 2011	Housing, Dining, Hospitality Advisory Committee Student Representative
Summer 2010	Parent Orientation Leader, *Revelle College*
2009 – 2010	Revelle College Senator, *Associated Students*
2008 – 2009	Director of Communications, *Revelle College Council*

PRESS

2021 **Fifteen MIT faculty honored as "Committed to Caring" for 2021-23.**
Daniel Korsun, MIT News, October 2021
https://news.mit.edu/2021/fifteen-mit-faculty-honored-committed-caring-1022

When more Covid-19 data doesn't equal more understanding.
Daniel Ackerman, MIT News, March 2021
https://news.mit.edu/2021/when-more-covid-data-doesnt-equal-more-understanding-0304

2020 **3Q: Collaborating with users to develop accessible designs.**
Rob Matheson, MIT News, March 2020

http://news.mit.edu/2020/accessible-designs-data%20visualization-0313

2018 **Google Researchers Are Learning How Machines Learn.**
Cade Metz, The New York Times, March 2018
https://www.nytimes.com/2018/03/06/technology/google-artificial-intelligence.html

2014 **Apropose Closes $1.875M Funding Round Led by NEA and Andreessen Horowitz.**
PR Newswire, September 2014
http://www.prnewswire.com/news-releases/apropose-closes-1875m-funding-round-led-by-nea-and-andreessen-horowitz-274728751.html

10 Significant Visualization Developments: January to June 2014.
Andy Kirk, Visualizing Data, August 2014
http://www.visualisingdata.com/index.php/2014/08/10-significant-visualisation-developments-january-to-june-2014/

2008 **Movable Type Experts Team Up on Melody, an Open Source Publishing Platform.**
Techcrunch, June 2009
http://techcrunch.com/2009/06/25/movable-type-experts-team-up-on-melody-an-open-source-publishing-platform/

2007 **Why We Call it a "Community".**
Anil Dash, Six Apart/Movable Type, August 2007
http://www.movabletype.com/blog/2007/02/why-we-call-it-a-community.html