Learning Programming at Scale

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Summary of Major Research Directions
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Where have I been, and where am I now?

- Bachelors+masters in Electrical Engineering & Computer Science, MIT (2001-2006)

- Ph.D. in Computer Science, Stanford (2006-2012)

- Software engineer at Google (2012-2013)

- Postdoc at edX and MIT CSAIL (2013-2014)

- Assistant Professor of Computer Science, University of Rochester (2014-2016)

- **Assistant Professor of Cognitive Science, UC San Diego** (2016-present)

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Publications
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My high-level research interests

Studying how people currently do computer programming, and ***building*** better ways for people to do programming

My early faculty research trajectory (2014-present):
Learning Programming at Scale

1. *Studying* why and how people from diverse backgrounds are now learning programming

2. *Building* new kinds of scalable programming environments to support learners

3. *Building* new kinds of programming-related instructional materials

1. *Studying* why and how people from diverse backgrounds are now learning programming

- Why are older adults (age 60 and over) learning programming?
  [Guo. CHI 2017, **Honorable Mention Paper**]

- What challenges do non-native English speakers face when learning programming? [Guo. CHI 2018]

- What challenges do women programmers face when using the popular Stack Overflow coding Q&A website?
  [Ford, Smith, Guo, Parnin. FSE 2016]

- Why do students attend hackathons, and what do they learn?
  [Warner and Guo. ICER 2017]

- Who's learning to code but doesn't actually need to write code?
  [Chilana, Alcock, Dembla, Ho, Hurst, Armstrong, Guo. VL/HCC 2015], [Chilana, Singh, Guo. CHI 2016], [Wang, Mitts, Guo, Chilana. CHI 2018, **Honorable Mention Paper**]

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2. *Building* new kinds of scalable programming environments to support learners

- How can we visualize the inner-workings of the computer to help learners build mental models?
  [Guo. SIGCSE 2013] http://pythontutor.com/ **(over 5 million users from 180+ countries)**

- Can multiple learners simultaneously interact with and chat about program visualizations?
  [Guo, White, Zanelatto. VL/HCC 2015]

- How can a single tutor simultaneously monitor and help dozens of learners as they code? [Guo. UIST 2015]

- Can we visualize everything about what a piece of code does on-screen at once? [Kang and Guo. UIST 2017]

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2. *Building* new kinds of scalable programming environments to support learners (continued)

- How can we automatically detect learner frustration in a scalable way? [Drosos, Guo, Parnin. VL/HCC 2017]

- How can we help novices get started with learning pair programming, testing, and version control?
[Warner and Guo. CHI 2017]

- How can we use open data on the web to help novices get started with learning data science?
[Zhang and Guo. UIST 2017, **Honorable Mention Paper**]

- How can we let web designers quickly prototype interface ideas by borrowing features from existing websites?
[Zhang and Guo. UIST 2018]

3. *Building* new kinds of programming-related instructional materials

- How do learners interact with CS textbooks? [Warner & Guo. EDM 2015]

- What do instructors use to teach data science? [Kross & Guo. CHI 2019]

- What are limitations of forums for discussing coding questions? [Zhu, Warner, Gordon, White, Zanelatto, Guo. VL/HCC 2015]

- Can learners work together to make step-by-step code walkthroughs? [Gordon & Guo. VL/HCC 2015]

- How can we create and give feedback on multi-app software tutorials? [Mysore & Guo. UIST 2017] [Mysore & Guo. UIST 2018, **Best Paper Award**]

- How can we make coding screencast videos easier to watch? [Khandwala & Guo. Learning at Scale 2018]

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Broader research in online learning at scale

- How do different kinds of videos affect learner engagement?
[Guo, Kim, Rubin. Learning at Scale 2014]

- How do learners from different demographic & geographical backgrounds use MOOCs? [Guo and Reinecke. Learning at Scale 2014]

- How do researchers from different fields approach the challenges of online learning at scale?
[Kross and Guo. Learning at Scale 2018]

- How do online learners from different cultures follow programming tutorials and debug their code?
[Thayer, Guo, Reinecke. VL/HCC 2018]

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Where am I now, and what's next?
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- Currently in my 5th year as an assistant professor, advising 3 Ph.D. and 2 masters students

- Ongoing projects: scaling real-time peer tutoring for programming, making it easier to create and improve software tutorials, lowering barriers to prototyping web applications and data science lessons

- What's farther ahead? Studying more diverse groups of programming learners, generalizing code visualizations across human/computer languages, data science and machine learning education