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?

- Undergrad+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 & MIT (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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My high-level research interests

Studying how people 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 learning programming

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

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

http://pgbovine.net/learning-programming-at-scale-CACM.htm

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

- Why are older adults (age 60 and over) learning programming?
  [Guo. CHI 2017] Honorable mention paper award

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

- What challenges do female 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 there?
  [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 award

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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/ **3.5+ 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 award

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

- How do learners interact with digital textbooks on programming?
  [Warner and Guo. EDM 2015]

- What are the shortcomings of MOOC forums for discussing programming questions? [Zhu, Warner, Gordon, White, Zanelatto, Guo. VL/HCC 2015]

- Can learners work together to create step-by-step annotated code examples for education? [Gordon and Guo. VL/HCC 2015]

- Can we efficiently generate step-by-step tutorials for complex command-line and GUI-based computing tasks?
  [Mysore and Guo. UIST 2017]

- How can we improve the viewing experience of programming tutorial screencast videos? [Khandwala and Guo. Learning at Scale 2018]

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Broader work in online learning at scale

- How do video production styles affect learner engagement in MOOCs?
  [Guo, Kim, Rubin. Learning at Scale 2014]

- How do learners from different demographic and 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]

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Where am I now, and what's next?
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- Finishing my 4th year as an assistant professor

- Advising 4 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 explorations

- What's farther ahead? Studying broader groups of people who are learning to code, generalizing code visualizations across languages and domains, expanding to data science education