

# Robert Xiao

## CURRICULUM VITAE

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Carnegie Mellon University  
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Last Updated: November 14, 2017

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## EDUCATION

### PhD in Human-Computer Interaction

2011 – Present

Carnegie Mellon University, Pittsburgh, PA

Thesis Proposed: March 29, 2017

*On-World Computing: Unleashing Computation on the World Around Us*

Estimated Graduation April 2018

### Bachelor of Mathematics

2007 – 2011

University of Waterloo, Waterloo, ON

Double Honours in Computer Science and Combinatorics & Optimization

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## HONOURS AND AWARDS

### SCHOLARSHIPS & FELLOWSHIPS

#### NSERC Postgraduate Scholarship

2013 – 2015

\$63,000 award for three years, awarded to top Canadian graduates in their third year of a graduate program of study

#### Qualcomm Innovation Fellowship

2012

\$100,000 award for one year for a team of two students

#### NSERC Julie Payette Postgraduate Scholarship

2011

\$25,000 award for one year awarded to top Canadian students in their first year of a graduate program of study

#### NSERC Undergraduate Student Research Award

2008 – 2010

Canadian federal fellowships to support academic research as an undergraduate student

#### Rene Descartes Scholarship

2007 – 2011

Awarded to students with strong performance on Canadian national mathematics competitions

## SELECTED HONOURS AND AWARDS

<b>Fast Company Innovation By Design Student Award</b>	<b>2016</b>
Awarded for EM-Sense, recognizing an outstanding work of innovation. A total of 15 awards were given out from a pool of 1700 nominations	
<b>Allen Newell Award for Research Excellence</b>	<b>2015</b>
Awarded w/ Scott Hudson to recognize outstanding body of work within the School of Computer Science at Carnegie Mellon University	
<b>Governor General's Silver Medal</b>	<b>2011</b>
Awarded to the individual with the highest academic average over all graduating students	
<b>Rising Stars of Research Honourable Mention</b>	<b>2010</b>
Awarded to outstanding posters in the national Rising Stars of Research Poster Competition	
<b>NSERC USRA Poster Competition First Prize</b>	<b>2009, 2010</b>
Awarded to the top poster presented at the University of Saskatchewan USRA Poster Fair	
<b>Putnam Mathematics Competition</b>	<b>2008</b>
110th place in North America (4th in U of Waterloo)	
<b>President's Scholarship of Distinction</b>	<b>2007</b>
Awarded to students with a 95% entrance average or higher	

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## PUBLICATIONS

26. **Xiao, R.**, Schwarz, J., Throm, N., Wilson, A. and Benko, H. (2018). HoloTouch: Adding Touch Input to Head-Mounted Mixed Reality. Conditionally accepted to *IEEE Transactions on Visualization and Computer Graphics* (TVCG). 8 pages.
25. **Xiao, R.**, Hudson, S.E. and Harrison, C. (2017). Supporting Responsive Cohabitation Between Virtual Interfaces and Physical Objects on Everyday Surfaces. In *Proceedings of the 9th ACM SIGCHI Symposium on Engineering Interactive Computing Systems, 2017* (EICS '17). ACM, New York, NY, USA. Article 11. 12 pages.
24. **Xiao, R.**, Laput, G., Zhang, Y. and Harrison, C. (2017). Deus EM Machina: On-Touch Contextual Functionality for Smart IoT Appliances. In *Proceedings of the ACM Special Interest Group on Computer-Human Interaction, 2017* (CHI '17). ACM, New York, NY, USA, 4000-4008.
23. **Xiao, R.**, Hudson, S.E. and Harrison, C. (2016). CapCam: Enabling Quick, Ad-Hoc,

- Position-Tracked Interactions Between Devices. In *Proceedings of the 2016 International Conference on Interactive Surfaces & Spaces (ISS '16)*. ACM, New York, NY, USA, 169-178.
22. **Xiao, R.**, Hudson, S.E. and Harrison, C. (2016). DIRECT: Making Touch Tracking on Ordinary Surfaces Practical with Hybrid Depth-Infrared Sensing. In *Proceedings of the 2016 International Conference on Interactive Surfaces & Spaces (ISS '16)*. ACM, New York, NY, USA, 85-94.
  21. Laput, G., **Xiao, R.** and Harrison, C. (2016). ViBand: High-Fidelity Bio-Acoustic Sensing Using Commodity Smartwatch Accelerometers. In *Proceedings of the 29th Annual ACM Symposium on User Interface Software & Technology (UIST '16)*. ACM, New York, NY, USA, 321-333. **Best Paper Award!**
  20. Zhang, Y., **Xiao, R.** and Harrison, C. (2016). Advancing Hand Gesture Recognition with High Resolution Electrical Impedance Tomography. In *Proceedings of the 29th Annual ACM Symposium on User Interface Software & Technology (UIST '16)*. ACM, New York, NY, USA, 843-850.
  19. **Xiao, R.**, Benko, H. Augmenting the Field-of-View of Head-Mounted Displays with Sparse Peripheral Displays. In *Proceedings of the ACM Special Interest Group on Computer-Human Interaction, 2016 (CHI '16)*. ACM, New York, NY, USA, 1221-1232. **Honorable Mention Award!**
  18. **Xiao, R.**, Schwarz, J. and Harrison, C. (2015). Estimating 3D Finger Angle on Commodity Touchscreens. In *Proceedings of the 2015 International Conference on Interactive Tabletops & Surfaces (ITS '15)*. ACM, New York, NY, USA, 47-50.
  17. Guo, A., **Xiao, R.** and Harrison, C. (2015). CapAuth: Identifying and Differentiating User Handprints on Commodity Capacitive Touchscreens. In *Proceedings of the 2015 International Conference on Interactive Tabletops & Surfaces (ITS '15)*. ACM, New York, NY, USA, 59-62.
  16. Chatterjee, I., **Xiao, R.** and Harrison, C. (2015). Gaze+Gesture: Expressive, Precise and Targeted Free-Space Interactions. In *Proceedings of the 2015 ACM on International Conference on Multimodal Interaction (ICMI '15)*. ACM, New York, NY, USA, 131-138. **Best Paper Award!**
  15. Laput, G., Yang, C., **Xiao, R.**, Sample, A. and Harrison, C. (2015). EM-Sense: Touch Recognition of Uninstrumented, Electrical and Electromechanical Objects. In *Proceedings of the 28th Annual ACM Symposium on User Interface Software & Technology (UIST '15)*. ACM, New York, NY, USA, 157-166. **Best Talk Award!**
  14. Laput, G., Lasecki, W.S., Wiese, J., **Xiao, R.**, Bigham, J.P. and Harrison, C. (2015). Sensors: Adaptive, Rapidly Deployable, Human-Intelligent Sensor Feeds. In

*Proceedings of the ACM Special Interest Group on Computer-Human Interaction, 2015 (CHI '15)*. ACM, New York, NY, USA. 1935-1944.

13. Laput, G., **Xiao, R.**, Chen, X., Hudson, S.E., Harrison, C. (2014). Skin Buttons: Cheap, Small, Low-Powered and Clickable Fixed-Icon Laser Projectors. In *Proceedings of the ACM Symposium on User Interface Software and Technology, 2014 (UIST '14)*. ACM, New York, NY, USA. 389-394.
12. **Xiao, R.**, Lew, G., Marsanico, J., Hariharan, D., Hudson, S.E., Harrison, C. (2014). Toffee: Enabling Ad Hoc, Around-Device Interaction with Acoustic Time-of-Arrival Correlation. In *Proceedings of the 16th International Conference on Human-Computer Interaction with Mobile Devices and Services (MobileHCI '14)*. ACM, New York, NY, USA. 67-76.
11. **Xiao, R.**, Laput, G., Harrison, C. (2014). Expanding the Input Expressivity of Smartwatches with Physical Pan, Twist, Tilt and Click. In *Proceedings of the ACM Special Interest Group on Computer-Human Interaction, 2014 (CHI '14)*. ACM, New York, NY, USA. 193-196.
10. Schwarz, J., **Xiao, R.**, Mankoff, J., Hudson, S.E., Harrison, C. (2014). Probabilistic Palm Rejection Using Spatiotemporal Touch Features and Iterative Classification. In *Proceedings of the ACM Special Interest Group on Computer-Human Interaction, 2014 (CHI '14)*. ACM, New York, NY, USA. 2009-2012.
9. Harrison, C., **Xiao, R.**, Schwarz, J., Hudson, S.E. (2014). TouchTools: Leveraging Familiarity and Skill with Physical Tools to Augment Touch Interaction. In *Proceedings of the ACM Special Interest Group on Computer-Human Interaction, 2014 (CHI '14)*. ACM, New York, NY, USA. 2913-2916.
8. **Xiao, R.**, Harrison, C., Hudson, S.E. (2013). Lumitrack: High Speed, High Precision, Low-Cost Tracking with Projected m-Sequences. In *Proceedings of the ACM Symposium on User Interface Software and Technology, 2013 (UIST '13)*. ACM, New York, NY, USA. 3-12.
7. **Xiao, R.**, Harrison, C., Hudson, S.E. (2013). WorldKit: Rapid and Easy Creation of Ad-hoc Interactive Applications on Everyday Surfaces. In *Proceedings of the ACM Special Interest Group on Computer-Human Interaction, 2013 (CHI '13)*. ACM, New York, NY, USA. 879-888.
6. Tang, J., **Xiao, R.**, Hoff, A., Venolia, G., Therien, P., Roseway, A. (2013). HomeProxy: Exploring a Physical Proxy for Video Communication in the Home. In *Proceedings of the ACM Special Interest Group on Computer-Human Interaction, 2013 (CHI '13)*. ACM, New York, NY, USA. 1339-1342.
5. Bateman, S., Mandryk, R.L., Gutwin, C., **Xiao, R.** (2013). Analysis and Comparison of

Target Assistance Techniques for Relative Ray-Cast Pointing. In *International Journal of Human-Computer Studies* (IJHCS), 71(5), 511-532.

4. Harrison, C., **Xiao, R.**, Hudson, S.E. (2012). Acoustic Barcodes: Passive, Durable and Inexpensive Notched Identification Tags. In *Proceedings of the 25th Annual ACM Symposium on User Interface Software and Technology* (UIST '12). ACM, New York, NY, USA, 563-568.
3. **Xiao, R.**, Nacenta, M., Mandryk, R.L., Cockburn, A., Gutwin, C. (2011). Ubiquitous Cursor: A Comparison of Direct and Indirect Pointing Feedback in Multi-Display Environments. In *Proceedings of Graphics Interface 2011* (GI '11). Canadian Human-Computer Communications Society, Waterloo, Ontario, Canada, 135-142. **Best Student Paper!**
2. Bateman, S., Doucette, A., **Xiao, R.**, Gutwin, C., Mandryk, R.L., Cockburn, A. (2011). Effects of view, input device, and track width on video game driving. In *Proceedings of Graphics Interface 2011* (GI '11). Canadian Human-Computer Communications Society, Waterloo, Ontario, Canada, 207-214.
1. Gutwin, C., Schneider, O., and **Xiao, R.** (2011). Chalk Sounds: Using Synthesized Audio to Improve Workspace Awareness in Distributed Groupware. In *Proceedings of the ACM 2011 conference on Computer supported cooperative work* (CSCW '11). ACM, New York, NW, USA, 85-94.

## POSTERS

3. **Xiao, R.**, Bateman, S., Mandryk, R., Gutwin, C. (2009). Enhancing the Effectiveness of Remote Pointing. Presented at the University of Saskatchewan USRA Poster Fair, August 2009.
2. **Xiao, R.**, Nacenta, M., Cockburn, A., Mandryk, R., Gutwin, C. (2010). Ubiquitous Cursor: Filling in the Space Between Displays. Presented at the University of Saskatchewan USRA Poster Fair, August 2010.
1. **Xiao, R.**, Harrison, C. (2012). Synthetic Sensors and Displays. Presented at the Qualcomm Innovation Winner's Day, September 2012.

## INVITED PRESENTATIONS

2. Invited to demonstrate research projects at the Engadget Live event held in New York City, USA, Oct 29, 2015.
1. Invited speaker to the "WE: Way to Evolve" 2013 summit held in Shenzhen, China, Nov 10, 2013 and hosted by Tencent, Inc. Presented my engineering work on mobile interaction enhancements with Qeexo, and my research on on-world interfaces (WorldKit). [http://we.tencent.com/index\\_en.php](http://we.tencent.com/index_en.php)

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## SELECTED PRESS COVERAGE

### Desktopography, 2017

<http://www.dailymail.co.uk/sciencetech/article-4650346/Fancy-turning-DESK-touchscreen.html>  
<http://www.popularmechanics.com/technology/gadgets/a27124/desk-touchscreen-projector/>

### Deus EM Machina, 2017

<https://www.engadget.com/2017/05/09/deus-em-machina-electromagnetic-emissions-sensing/>  
<https://techcrunch.com/2017/05/09/how-a-tap-could-tame-the-smart-home/>

### ViBand, 2016

<https://techcrunch.com/2016/11/21/overclocked-smartwatch-sensor-uses-vibrations-to-sense-gestures-objects-and-locations/>  
<https://www.theverge.com/circuitbreaker/2016/11/2/13463312/carnegie-mellon-lg-smartwatch-hack-gesture-accelerometer-viband-project>

### SparseLight, 2016

<https://www.theverge.com/2016/4/26/11512820/sparselight-ar-vr-led-hack-microsoft-hololens>  
<https://arstechnica.com/gaming/2016/05/how-side-mounted-leds-can-help-fix-vrs-tunnel-vision-and-nausea-problems/>

### EM-Sense, 2015

<http://www.wired.com/2015/11/em-sense-enabled-smartwatch-can-detect-when-you-touch-a-door-knob/>  
<http://www.nbcnews.com/tech/innovation/disney-smartwatch-knows-what-youre-touching-tells-you-what-do-n461741>  
<https://www.fastcodesign.com/product/em-sense>

### Sensors, 2015

<http://www.pcworld.com/article/2914552/sensors-app-lets-you-crowdsource-live.html>  
<http://gizmodo.com/one-old-android-phone-could-make-all-your-dumb-things-s-1699362305>

### 3D Finger Angle, 2015

<http://gizmodo.com/a-touchscreen-that-knows-the-angle-of-your-finger-is-wa-1742667522>  
<http://www.digitaltrends.com/mobile/qeexo-fingerangle-news/>

### Skin Buttons, 2014

<http://phys.org/news/2014-10-skin-icons-smartwatch.html>  
<http://www.fastcodesign.com/3036985/this-smartwatch-projects-laser-buttons-onto-your-skin>

### TouchTools, 2014

<http://gizmodo.com/what-life-would-be-like-if-skeuomorphism-ruled-our-ipad-1570806039>  
<http://www.engadget.com/2014/05/01/touchtools-user-interface-manipulating-objects/>

### 6DOF Physical Smartwatch, 2014

<http://www.newscientist.com/article/dn25482-tilting-smartwatch>  
<http://www.engadget.com/2014/04/30/concept-smartwatch-joystick/>

## **WorldKit, 2013**

Work featured as segment on “Stephen Hawking’s Science of the Future”, Episode 4.

<http://www.reuters.com/video/2013/06/12/researcher-gives-new-meaning?videoid=243310701>

<http://www.foxnews.com/tech/2013/07/08/projector-turns-everything-into-touchscreen/>

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## **TEACHING EXPERIENCE**

### **Lab Instructor**

**2014**

Lab Instructor for the Programming Usable Interfaces Prototype Lab, in the Human-Computer Interaction Institute at Carnegie Mellon University, during the September-December 2014 academic term.

### **Teaching Assistant**

**2014**

Teaching Assistant for an introductory course on Applied Gadgets, Sensors and Activity Recognition, taught by Scott E. Hudson, in the Human-Computer Interaction Institute at Carnegie Mellon University, during the January-April 2014 academic term.

### **Tutoring and TAing**

**2008-2010**

Various tutoring and TA positions with the Tutorial Center and Tutoring in Residence programs (four semester-long appointments total), Faculty of Mathematics, University of Waterloo

### **MATH 227 TA (Calculus 3 for Honours Physics)**

**2009**

Received outstanding evaluation from MATH 227 professor for TA work

### **MATH 146 TA (Advanced Linear Algebra)**

**2009**

Received outstanding evaluation from MATH 146 professor for TA work

### **CS 116 Tutor (Intro to Computer Science 2)**

**2009**

Developed and maintained entirely new version of the automatic grading system (used by nearly 1000 students per semester). Department of Computer Science, University of Waterloo, Waterloo, ON, Canada.

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## **POSITIONS AND APPOINTMENTS HELD**

### **Research Consultant, Microsoft Research**

**2017**

Mentored by Julia Schwarz and Hrvoje Benko. Work focused on advancing interactions in augmented reality.

Redmond, WA, USA

<p><b>Research Intern, Microsoft Research</b>  Mentored by Andy Wilson and Hrvoje Benko. Work focused on advancing interactions in augmented reality.  Redmond, WA, USA</p>	<b>2016</b>
<p><b>Research Intern, Microsoft Research</b>  Mentored by Andy Wilson. Work focused on expanding the FoV of VR systems using sparse peripheral displays. Work resulted in the Sparse Peripheral Displays paper, which earned an honorable mention at CHI 2016.  Redmond, WA, USA</p>	<b>2015</b>
<p><b>Software Architect, Qeexo, Co.</b>  Summer internship with CMU spinoff. Work focused on engineering rich multitouch solutions for mobile devices.  Pittsburgh, PA, USA</p>	<b>2013</b>
<p><b>Research Intern, Microsoft Research</b>  Mentored by John Tang. Work focused on in-home physical proxies for video communication. HomeProxy publication resulted from this internship.  Redmond, WA, USA</p>	<b>2012</b>
<p><b>Embedded Software Developer, Research in Motion</b>  Development and validation of embedded radio firmware for 3G modems.  Waterloo, ON, Canada</p>	<b>2011</b>
<p><b>Summer Research Student, University of Saskatchewan</b>  Summer research with the Interaction Lab, Department of Computer Science, mentored by Carl Gutwin. Research funded by NSERC under the Undergraduate Student Research Award program.  Saskatoon, SK, Canada</p>	<b>2010</b>
<p><b>Summer Research Student, University of Saskatchewan</b>  Summer research with the Interaction Lab, Department of Computer Science, mentored by Regan Mandryk and Carl Gutwin. Research funded by NSERC under the Undergraduate Student Research Award program.  Saskatoon, SK, Canada</p>	<b>2009</b>
<p><b>Summer Research Student, University of Saskatchewan</b>  Summer research with the Imaging, Multimedia and Graphics Lab, Department of Computer Science, mentored by Mark Eramian. Research funded by NSERC under the Undergraduate Student Research Award program.  Saskatoon, SK, Canada</p>	<b>2008</b>



**Database Analyst, University of Saskatchewan** 2007  
Database analyst with the Centre for Continuing and Distance Education at the University of Saskatchewan. Minimum qualifications required 3rd year Computer Science undergraduates; I took the job while in high school. Saskatoon, SK, Canada

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## COMMUNITY SERVICE

**Program Committee Member, CHI 2018** 2017  
Invited program committee member for the 36th Annual ACM Conference on Human Factors in Computing Systems (CHI 2018) conference held in Montreal, Canada.

**Contributing Writer, Crash Course Computer Science** 2017  
Invited contributing writer for 18 episodes of the PBS Digital “Crash Course Computer Science” educational video series.

**Program Committee Member, IUI 2018** 2017  
Invited program committee member for the 22nd ACM International Conference on Intelligent User Interfaces (IUI 2018) conference held in Tokyo, Japan.

**Student Volunteer, UIST 2017** 2017  
Student volunteer at the program committee meeting and main conference for the 30th Annual ACM Symposium on User Interface Software & Technology (UIST 2017).

**Session Chair, UIST 2015** 2015  
Chair of the “Hands and Fingers” papers session at the 28th Annual ACM Symposium on User Interface Software & Technology (UIST 2015).

**Regular Conference Paper Reviewer**  
Reviewer for over 50 submitted papers across several conferences, including CHI, UIST, UbiComp, DIS, CSCW, ITS/ISS and MobileHCI. Annual reviewer for CHI and UIST since 2013.  
3 “*Excellent Reviewer*” distinctions received at CHI (2016, 2017, 2017).

**Journal Paper Reviewer**  
Reviewer for over 10 journal articles, including articles submitted to IJHCS, IEEE Computer and IEEE Photonics.

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## ADDITIONAL HONORS AND AWARDS

<b>First place, DEFCON CTF</b> Competed with the CMU PPP team at the 22nd annual DEFCON CTF in Las Vegas.	<b>July 2017</b>
<b>First place individual, Cambridge 2 Cambridge Challenge</b> In-person computer security competition held in Cambridge, UK, among over 100 prequalified contestants. £3000 prize for first place individual.	<b>July 2017</b>
<b>First place team, Cambridge 2 Cambridge Challenge</b> In-person computer security competition held in Cambridge, UK, among 22 teams of 5 prequalified people each. £9000 prize for first place team.	<b>July 2017</b>
<b>First place, DEFCON Quals CTF</b> Online team computer security competition; qualified to final competition in Las Vegas, NV	<b>May 2017</b>
<b>First place, NSA Codebreaker Challenge 2016</b> Individual cryptography/reverse engineering competition held online	<b>December 2016</b>
<b>First place, DEFCON CTF</b> Competed with the CMU PPP team at the 21st annual DEFCON CTF in Las Vegas	<b>August 2016</b>
<b>First place, Codegate CTF</b> Four-person team, computer security competition held in Seoul, S. Korea. 50,000,000 KRW (\$45000 USD) prize.	<b>May 2016</b>
<b>Second place, OCTF Finals</b> Four-person team, attack-defense style computer security competition held in Shanghai, China. 20000 RMB (\$3000 USD) prize	<b>April 2016</b>
<b>Fifth place, Microsoft College Puzzle Challenge</b> Four-person team, ranked fifth nationally and first at CMU	<b>April 2016</b>
<b>First place, Microsoft Build the Shield Competition</b> Four-person team computer security competition held in Seattle, Washington with over 40 participating teams.	<b>March 2016</b>
<b>First place, Codegate Quals CTF</b> Online team computer security competition; qualified to final round in Seoul, S. Korea	<b>March 2016</b>
<b>First place, Tsinghua University BCTF</b> Online team computer security and cryptography competition, over 500 participating teams	<b>March 2016</b>

<b>Fourth place, 0CTF Qualification Round</b> Online team computer security competition with over 800 participating teams; qualified to final round in Shanghai, China	<b>March 2016</b>
<b>Third place, Boston Key Party CTF</b> Online team computer security and cryptography competition, over 750 participating teams	<b>March 2016</b>
<b>Top 25, NSA Codebreaker Challenge 2015</b> Individual cryptography/reverse engineering competition held online	<b>December 2015</b>
<b>Fifth place, HITCON 2015 Final CTF</b> Four-person team computer security competition held in Taipei, Taiwan	<b>December 2015</b>
<b>First place, HITCON 2015 Quals CTF</b> Online team computer security competition, qualification for final round	<b>October 2015</b>
<b>Second place, DEFCON 2015 CTF</b> Participated in this team computer security competition in Las Vegas	<b>August 2015</b>
<b>First place, Microsoft Code Hunt</b> Individual programming competition held on the Microsoft campus and open to all employees	<b>August 2015</b>
<b>Third place, SECCON 2014 Final CTF</b> Four-person team computer security competition held in Tokyo, Japan	<b>February 2015</b>
<b>First place, CMU-Citadel Programming Challenge</b>	<b>January 2015</b>
<b>Third place, Microsoft College Puzzle Challenge</b> Four-person team, ranked third in national standings	<b>April 2014</b>
<b>Invited participant of the USA Mathematics Olympiad</b>	<b>2007</b>
<b>Pythagoras Contest Canadian Champion</b>	<b>2001</b>

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## REFERENCES

DR. CHRIS HARRISON  
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