Peter O'Hearn, Brief CV

Professional History and Academic Qualifications

- Facebook UK Ltd, since 9/2013. I have variously held Engineer, Manager, Director and (currently) Research Scientist positions

- University College London. Professor of Computer Science, since 3/2012 (part-time since moving to Facebook with acquisition of Monoidics)

- Co-founder and Director of Monoidics Ltd, 2009-2013

- Queen Mary, University of London. Reader from 1996-1999, Professor from 1999-2012

- Syracuse University. Assistant Professor, 8/90 to 12/95

- PhD (1991), MSc (1987) in Computer Science, Queen's University, Kingston, Ontario, Canada

- BSc (1985) in Computer Science, Dalhousie University, Halifax, Nova Scotia, Canada

Fellowships, Awards, etc

Most Influential POPL Paper (test-of-time) Award, 2019. For POPL'09 paper "Compositional Shape Analysis by means of Bi-Abduction"

Doctor of Laws Honoris Causa (Honorary Doctorate), Dalhousie University, 2018

Fellow of the Royal Society, elected 2018

Fellow of the Royal Academy of Engineering, elected 2016

Gödel Prize, 2016. For the invention of Concurrent Separation Logic.

CAV Award, 2016. For the development of Separation Logic and for demonstrating its applicability in the automatic verification of programs that mutate data structures.

Most Influential POPL Paper (test-of-time) Award, 2011. For POPL'01 paper "BI as an Assertion Language for Mutable Data Structures"

Royal Society Wolfson Research Merit Award, 2007

Main Contributions

- Separation Logic (with JC Reynolds and others, papers [2,10,13,14] in the selected publications below), attacking 30-year problem of tractable reasoning about data structures in computer memory.

  As part of the work on Separation Logic I discovered a theory of *local reasoning*, where specifications and proofs mention only the resources (memory, files, etc) accessed by program components, leading to scalability of automated reasoning applied to large codebases.

- Concurrent Separation Logic [10], which advanced a new approach to modular reasoning about shared-memory concurrent programs.

- Bunched Logic (with DJ Pym, [16]), a novel logic of resources. Separation Logic builds on Bunched Logic.

- Relational Semantics of Local State (with RD Tennent [16]), combining functor categories and relations to describe mathematical principles underlying hidden state in programs

- Separation Logic-based automated verification and analysis (with Berdine, Calcagno, Distefano, Yang and others), achieving the leading research results on automatic analysis of mutable data structures in real-world systems code, represented in the academic tool projects SMALLFOOT [12] SPACE INVADER [8,11], ABDUCTOR[4]

- Co-founded Monoidics Ltd in 2009, which marketed a software verification tool, INFER, that automated my Local Reasoning method. Monoidics was acquired by Facebook in 2013 [C], and as part of the deal I took a position at Facebook.

- Manager for the Infer static analysis team inside Facebook, 2013-2017. As of 2018, over 100,000 issues reported by Infer had been fixed by Facebook developers before reaching production, affecting the the main Facebook app, Instagram, Messenger, and WhatsApp, apps used by over 2 billion people [1]. As part of work on Infer (co-)developed and promoted the Continuous Reasoning model [6], where deep reasoning about code is done incrementally on code modifications.

- Made Infer available open source in 2015 [D,E]. This was crucial for spreading ideas from our work at Facebook into the community. Infer is now used in a number of university courses, and is used by Academics in their research, some of which is funded by Facebook [F]. Also, as a result of open-sourcing, Infer has been used by other companies including Amazon, Spotify, Uber, JD.com, Sky and Marks and Spencer, as well as Facebook [E].

- RacerD concurrency analysis [3,4,5,A,B]. Stepped down from management at Facebook in 2017 to concentrate on technical work, starting with static concurrency analysis (a long-standing open problem). As far as I am aware, RacerD has the most reported impact from a static analysis for concurrency to date: It saw 2,500 fixes of data race issues in the year to March 2018, and was instrumental in the conversion of Facebook's Android app from a single-threaded to a multi-threaded architecture: "Without Infer, Multi-threading in News-Feed would not have been tenable [G]."

Selected Publications

1. Scaling Static Analysis at Facebook. D. Distefano, M Fahndrich, F Logozzo and PW O'Hearn: *Communications of the ACM, August 2019, vol. 62, no. 8*

2. Separation Logic. P O'Hearn: *Communications of the ACM, February 2019, vol. 62, no. 2*

3. A True Positives Theorem for a Static Race Detector. N Gorrogiannis, P O'Hearn, I Sergey: *POPL 2019*

4. RacerD: Compositional Static Race Detection. S Blackshear, N Gorrogiannis, P O'Hearn, I Sergey: *OOPSLA 2018*

5. Experience Developing and Deploying Concurrency Analysis at Facebook. P O'Hearn. *SAS 2018*

6. Continuous Reasoning: Scaling the Impact of Formal Methods. P O'Hearn : *LICS 2018*

   NASA Formal Methods Symposium, 2015.

7. Compositional Shape Analysis by means of Bi-Abduction. C Calcagno, D Distefano, PW O'Hearn, and H Yang. *Journal of the ACM 58(6): 26 (2011)*, 73 pages. (Preliminary version appeared in POPL'09.)

8. Scalable Shape Analysis for Systems Code. H Yang, O Lee, J Berdine, C Calcagno, B Cook, D Distefano and P O'Hearn. *CAV 2008*

9. Resources, Concurrency and Local Reasoning. PW O'Hearn. *Theoretical Computer Science 375(1-3), pp271-307*, 2007. (Prelim version appeared in CONCUR'04)

10. Local Action and Abstract Separation Logic. C Calcagno, PW O'Hearn and H Yang. *LICS 2007*

11. A local shape analysis based on separation logic. D Distefano, P O'Hearn and H Yang. *TACAS 2006*

12. Smallfoot: Modular Automatic Assertion Checking with Separation Logic. J Berdine, C Calcagno and PW O'Hearn. In *FMCO 2006*.

13. Local Reasoning about Programs that Alter Data Structures. P O'Hearn, J Reynolds, and H Yang. *CSL 2001*

14. BI as an assertion language for mutable data structures. S Ishtiaq and PW O'Hearn. *POPL 2001*

15. The logic of bunched implications. PW O'Hearn and DJ Pym. *Bulletin of Symbolic Logic*, 5(2), June 1999, pp215-244.

16. Parametricity and Local Variables. PW O'Hearn and RD Tennent. *Journal of the Association for Computing Machinery, 42(3), 658-709*, May 1995. (Prelim version in POPL'93.)

Selected Non-academic References on Impact and Significance of Facebook Infer

A. "Facebook Engineering Takes a Bite out of Concurrency with RacerD." Michelle Gienow, **TheNewStack, 19 October 2017**

B. "Multithreaded rendering on Android with Litho and Infer." Benjamin Jaeger, Jingbo Yang, Sam Blackshear and Peter O'Hearn. **code.facebook.com blog, 27 Sept 2017**

C. "Facebook Acquires Assets Of UK Mobile Bug-Checking Software Developer Monoidics." Josh Constine, **Techcrunch, 18 July 2013**

D. "Open Sourcing Facebook Infer." Cristiano Calcagno, Dino Distefano and Peter O'Hearn. **code.facebook.com blog, 11 June 2015**

E. "Facebook's AI Tool for Squashing Bugs is now Open to All." Klint Finley, **Wired, 11 June 2015**

E. "Four Facebook Employees Win the Prestigious CAV Award." Bryan O'Sullivan. **research.fb.com blog, 5 Sept 2016** (STATING OVER 1000 BUGS/MONTH FIXED)

F. *fbinfer.com.* WEB PAGE SHOWING INFER'S OPEN-SOURCE USERS INCLUDING AMAZON, SPOTIFY, UBER, MOZILLA AND JD.COM.

Research Funding

- **Most Recent:**
  - EPSRC Programme Grant. Inferface Reasoning for Interacting Systems. £6.1M. 1 January 2018 to 31 December 2023. (Prof DJ Pym is PI, I am coI with 6 others) According to EPSRC, 'Programme grants are a flexible mechanism for providing funding to address significant major research challenges.'
  - EPSRC Programme Grant. Resource Reasoning. £3.2M. 1 January 2010 to 31 December 2015. (PI, with coI's Cook at UCL, Gardner and Calcagno at IC, Yang at Oxford.) (Prof DJ Pym, took over from me when I moved to Facebook.)
  - EPSRC Platform Grant. Extreme Reasoning. £720K. 1/08–07/2012. According to EPSRC, 'Platform Grants provide underpinning funding to world leading groups.'

- **Past:** 16 grants totalling approx £2.1M, from EPSRC, EU, GCHQ, Nuffield Foundation, Microsoft, and NSERC (Canada).

Selected Keynotes and Invited Tutorials

- "Continuous Reasoning: Scaling the Impact of Formal Methods." Plenary invited lecture, *Federated Logic Conference*, Oxford, July 2018. (This was a joint meeting of 6 main conferences and 74 workshops)

- "Experience Developing and Deploying Concurrency Analysis at Facebook." Invited tutorial, *Static Analysis Symposium*, Freiburg, August 2018.

- "From Categorical Logic to Facebook Engineering." Joint Keynote Speaker for *Symposium on Logic in Computer Science* and *International Colloquium on Automata, Languages and Programming* , Kyoto, July 2015.

- "Moving Fast with Software Verification." Invited talk at *Computer Aided Verification*, July 2015, San Francisco.

- "Separation Logic." Invited tutorial, *POPL: Principles of Programming Languages*, Philadelphia, January 2012.

- "Algebra, Logic, Locality, Concurrency." Joint invited lecture for *1st International Conference on Certified Programs and Proofs (CPP)* and *7th Asian Symposium on Programming Languages and Systems (APLAS)*, Taiwan, December 2011.

- "Concurrent Separation Logic" and "How to Cook a Static Analyzer, or, The Surprising Effectiveness of Substructural Proof Theory." Invited Tutorial lectures. *NSA High Confidence Software and Systems Conference*, Baltimore, May 2009.

- "Space Invading Systems Code." Keynote lecture, at *18th International Symposium on Logic-Based Program Synthesis and Transformation*, Valencia, July 2008. (Plenary invited lecture for a meeting of 4 conferences.)

- "Tutorial on Separation Logic." Invited tutorial, at *30th International Conference on Computer Aided Verification*, Princeton, July 2008. Repeated at *25th International Conf. on Logic Programming*, Udine, 2008.

- "Proof Procedures for Separated Heap Abstractions." Keynote at *Fifth International Workshop on Satisfiability Modulo Theories*, Berlin, July 2007;

- "Separation Logic and Program Analysis." Keynote lecture, at *13th International Static Analysis Symposium*, Seoul, August 2006.

- "Concurrent Separation Logic." Invited tutorial, at *International Symposium on Concurrency Theory*, London, August 2004.

- "Local Reasoning about Programs that Alter Data Structures." *15th Annual Conference on Computer Science Logic*, Paris, Sept 2001.

Personal Information

Born in Halifax, Nova Scotia, Canada 13/07/1963. British and Canadian citizen.

Contact Information

Peter William O'Hearn
Department of Computer Science
University College London
Gower Street, London, WC1B 6BT United Kingdom
phone: +44 7796174966
fax: +44 2073871397
email: p.ohearn@ucl.ac.uk
Web: http://www0.cs.ucl.ac.uk/staff/p.ohearn/