Peter Clark, PhD

peterc@allenai.org, https://pclark425.github.io/

AREAS OF EXPERTISE

- Natural Language Processing
- Automated Scientific Discovery
- Machine Reasoning
- Commonsense Reasoning
- Knowledge Acquisition
- Large Language Models
- Machine Learning

CAREER PROGRESSION

Interim CEO 2022-2023
Allen Institute for AI (AI2)

Senior Research Director 2013-now
Allen Institute for AI (AI2)

Senior Research Scientist 2010-2013
Vulcan Inc.

Associate Technical Fellow 2004-2010
Boeing Research & Technology

Research Scientist 1996-2004
Boeing Research & Technology

Research Fellow 1994-1996
Computer Science, Univ Texas at Austin

Research Associate 1992-1994
National Research Council, Canada

Postdoctoral Fellow 1991-1992
University of Ottawa, Canada

Research Scientist 1985-1991
Turing Institute, Glasgow, UK

EDUCATION

PhD Computer Science 1991
Strathclyde Univ., Glasgow, UK

Masters in Information Technology: Knowledge-Based Systems 1985
University of Edinburgh, UK

BA in Physics 1984
First Class Honors (top 8% of graduates)
Oxford University, UK

PROFILE

Internationally recognized expert in artificial intelligence, in particular in the areas of automated scientific discovery, knowledge representation and reasoning, commonsense reasoning, and natural language understanding, with 35 years of experience and over 250 refereed publications in the field (28k citations, h-index 67).

SELECTED ACHIEVEMENTS

- **Significant, impactful research** in the field of artificial intelligence as reflected in: over 250 refereed publications in the area, including a AAAI Best Paper Award (1997); 3 EMNLP Best Paper Awards (2014, 2023, 2024), AKBC Best Paper Award (2014), co-chair for the International Conference on Knowledge Capture (2005); tutorial co-chair for the NAACL Computational Linguistics Conference (2010); keynote speaker for the CLEF Conference (2012), European Conference on Knowledge Engineering and Management (2008); multiple invited talks; AAAI Senior Member (2014); Three Boeing Breakthrough Recognition awards (2006,7,9); appointment as Boeing Associate Technical Fellow (2004).
- Co-founder of the **Allen Institute of AI** (2012-2013). With others at Vulcan, planned, hired for, and launched the Allen Institute for AI.
- Led **Project Aristo**, the flagship project of the Allen Institute of AI, resulting in the first system to score of 90% on the New York. Regents Science Exam (8th Grade multiple choice) in 2019.
- Directly involved with, and major contributions to, **Vulcan's Project Halo** since its inception in 2002. From 2002-2010, major contributions to the AURA knowledge acquisition and reasoning system, in particular:
  - Co-created the original vision of a system able to acquire knowledge via graphical manipulation of general knowledge fragments.
  - Created, with Prof Bruce Porter, and implemented the knowledge representation and reasoning engine (KM) used in these systems.
  - Developed a state-of-the-art natural language interface (called CPL/BLUE) enabling users to ask questions in simplified English.

  From 2011-present, created and led an innovative new thread of research for Vulcan **on answering questions and acquiring knowledge directly from text**, addressing some of the scalability issues of the earlier work.
- Created high-performance technology for **recognizing textual entailment** (RTE), the task of inferring whether a fact follows from a passage of text. The resulting RTE system performed competitively (top 50%) in the 2009 international RTE challenge. A later derivative won 2nd place for Vulcan (out of 11 international teams) in the 2012 Question-Answering for Machine Reading (QA4MRE) competition.
- With Prof Bruce Porter, **created KM (the Knowledge Machine)**, a sophisticated system for knowledge representation and reasoning, used in several large-scale AI projects.
- Created vision for and developed Boeing's **Technical Expert Locator,** an AI application for finding expertise within the company. This tool was deployed and in full commercial use from 2001-5.
- Developed a **theory of concept composition** with Prof. Bruce Porter. This work won a AAAI'97 Best Paper award, and was later a cornerstone of the Shaken knowledge acquisition system.
- Co-developed a **new machine learning algorithm**, CN2 (1987). CN2 is still extensively used and cited in the ML community.

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WORK HISTORY

Senior Research Director, Allen Institute for AI 2013-present

- **Research Lead and Project Co-Director, Project Asta (2024-present)**
  Co-leading a 40 person team developing Asta, an **agentic ecosystem for advancing scientific discovery** through all stages of research (literature analysis, hypothesis generation, planning experimentation, data analysis, and reporting).

- **Research Lead and Project Director, Project Aristo (2013-present)**
  Created and led an innovative new thread of research for Project Aristo to acquire knowledge and answer science questions directly from natural language text, based on:
  - reasoning at the textual level (**"textual entailment"**), using representations derived automatically from text via natural language processing (NLP)
  - large-scale, automatic extraction of rules from text to support that reasoning
  - use of machine learning to combine multiple sources of evidence to improve robustness

  This work was recently featured in the New York Times, where Aristo scored over 90% on the New York Regents Science Exam (8th Grade, non-diagram multiple choice questions).

Senior Research Scientist, Vulcan Inc 2010-2013

- Co-creator of the **Allen Institute of AI** (2012-2013). With others at Vulcan, planned, hired for, and launched the Allen Institute for AI.

- **AURA project (2010-2013)**
  Designed and developed the **Suggested Question mechanism** for AURA, based on an early prototype from SRI, allowing AURA to propose semantically similar, answerable questions when it was unable to handle a user's question directly. This mechanism was critical for AURA's robustness and usability in trials with students in 2011.

- **General (2010-present)**
  With other team members, continuous involvement in defining, critiquing, and planning the evolution of the Halo Program. Substantial technical involvement in other aspects of Halo, including the "hybrid" prototype.

Associate Technical Fellow (2004-2010), Research Scientist (1996-2004), Boeing Research

- **Principal Investigator for Boeing's work in the Vulcan Halo Project (2002-2010)**
  Involvement in all aspects of the SRI/Boeing/UT team's work on the Halo AURA system for acquiring and reasoning with scientific knowledge bases since the project's inception. In particular:
  - Developed AURA's **natural language interface for asking questions**, allowing users to ask questions in a simplified form of English (CPL/BLUE) rather than a formal query language. Technical achievements include:
    - Development of a full semantic interpreter for converting simplified English into formal logic
    - Use of knowledge to guide interpretation, improving AURA's ability to disambiguate sentences by preferring interpretations that "make sense" with respect to the knowledge base
    - Use of a database of paraphrases to expand the range of language AURA understands
  - Developed AURA's **knowledge representation and reasoning engine**, KM (The Knowledge Machine), allowing AURA to represent knowledge and perform reasoning to answer users' questions. Technical achievements include methods for combining (unifying) knowledge from different parts of the KB together, handing a wide variety of knowledge forms, and methods for explaining KM's reasoning to the user.

- **Principal Investigator for IARPA AQUAINT (Advanced QA for Intelligence) Project (2006-8)**
  Created, won, and managed Boeing's (Prime) project in this program, including managing work by two subcontractors (Princeton Univ and USC/ISI). Developed **novel software capable of extracting implicit knowledge from text** by exploiting large amounts of commonsense knowledge drawn from two online resources (WordNet and DIRT). This combined full language processing, semantic interpretation, machine inference, and world knowledge. In 2007, Boeing formally recognized this work as a Breakthrough Technology.

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- **Principal Investigator for Boeing's work in DARPA's Reading to Learn Project (2005-6)**
  Directed and conducted research into the feasibility of a machine **acquiring text-book knowledge,** via language processing, if that text was first rewritten in simplified English. (The chemistry text from the Vulcan Halo Pilot was used for this research). Developed a prototype application, and published an extensive analysis of the challenges involved, contributing to plans for DARPA's subsequent MOBIUS and Machine Reading projects.

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- **Principal Investigator for Boeing's work in DARPA's MOBIUS project (2005-8)**
  Conducted collaborative research into the feasibility of **large-scale machine reading from text.** Contributed novel technical ideas (on using knowledge to guide reading) and software to the demonstration prototype. This project directly led to DARPA launching a full program in Machine Reading in 2009.

- **The Technical Expert Locator (Boeing Internal) (1999-2001)**
- Created vision for and developed Boeing's **Technical Expert Locator** (TEL), an AI tool for finding experts that exploited Boeing's Aerospace Thesaurus as a massive source of semantic knowledge. The TEL was deployed and in full commercial use from 2001-5, and was a primary vehicle for locating expertise within the company.

Neutral Representation Project (Boeing Internal) (1996-2000, Principal Investigator 1999-2000)

- Development of techniques, and identification of the limits, for representing aircraft design knowledge in a portable ("neutral") format, to improve reuse and reduce vendor dependence.

Research Fellow - University of Texas at Austin 1994-1996

- **Developed a theory of concept composition** with Prof. Bruce Porter, by which representations of complex, concepts can be assembled from modular components. This work won a AAAI'97 Best Paper award.
- Developed and implemented the **DCE Help-Desk Assistant**, a prototype knowledge-based system that inferred answers to certain types of customer queries using machine reasoning.

Research Associate – Knowledge Systems, Canadian National Research Council 1992-4

- Created and developed **Electronic Trader (ET)**, a prototype for automatically detecting arbitrage opportunities using AI techniques. ET was licensed and used in field trials by Canada's Export Development Corporation.

Postdoctoral Fellow – Dept Computer Science, The University of Ottawa 1991-2

- Developed a technique for **guiding inductive learning using domain knowledge**, with Prof Stan Matwin, biasing the machine away from "clearly nonsensical" hypotheses. This work has been cited over 70 times.

Research Scientist – The Turing Institute, Glasgow, UK 1985-1991

- Developed a **computational model of argumentation**, based on Toulmin's work, by which an expert system and user could interact ("cooperatively argue") to jointly solve a problem. This work was the basis of my PhD.
- Principal Investigator and developer of Optimist, **a full-scale, commercial AI system** that implements the above theory. Optimist assisted geologists in oil exploration, and was in commercial use from 1989-1994.
- Co-developed a new **rule induction algorithm**, CN2, now well-known and frequently cited in the community.

AWARDS AND RECOGNITION

- AAAI Senior Member (2014)
- Boeing Associate Technical Fellow (2004)
- NSF Grant Review Committee (2003)
- SRI Letter of Commendation for work on DARPA's RKF project (2000)
- AAAI Best Paper Award (1997)
- EMNLP Best Paper Awards (2014,2023,2024)
- AKBC Best Paper Award (2014)
- Keynote speaker for the Conference and Labs of the Evaluation Forum (CLEF 2012)
- Invited speaker at the DARPA Machine Reading Program (2011)
- Tutorial co-chair for NAACL Computational Linguistics Conference (2010)
- Organizing Committee for International Recognizing Textual Entailment Competition (2010)
- Three Boeing Breakthrough Technology Awards (2006,7,9)
- Keynote speaker for European Conference on Knowledge Engineering and Management (2008)
- Co-chair of International Conference on Knowledge Capture (2005)
- Treasurer of International Conference on Knowledge Capture (2003)
- Multiple invited talks (e.g., USC/ISI Colloquium series, Univ Rochester Colloquium series, AAAI Spring Symposium on Question Answering)

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SELECTED PUBLICATIONS

- D. Agarwal, B. Majumder, …, Peter Clark. **Open-ended Scientific Discovery via Bayesian Surprise.** in NeurIPS'25 (to appear).
- P. Jansen, O. Tafjord, M. Radensky, …, P. Clark. **CodeScientist: End-to-End Semi-Automated Scientific Discovery with Code-based Experimentation.** in Findings ACL'25.
- N. Kassner, O. Tafjord, A. Sabharwal, K. Richardson, H. Schütze, P Clark. **Language Models with Rationality**. in EMNLP'24.
- B. Bogin, K. Yang, S. Gupta, K. Richardson, E. Bransom, P. Clark, A. Sabharwal, T. Khot **SUPER: Evaluating Agents on Setting Up and Executing Tasks from Research Repositories.** In EMNLP'24. (Best paper award)
- A. Madaan, N. Tandon, …, P. Clark. **Self-Refine: Iterative Refinement with Self-Feedback.** In NeurIPS'23 (2200+ citations)
- O. Tafjord, B. Dalvi, P. Clark. **ProofWriter: Generating Implications, Proofs, and Abductive Statements over Natural Language**, Findings of ACL'21.
- N. Kassner, O. Tafjord, H. Schutze, P. Clark. BeliefBank: **Adding Memory to a Pre-Trained Language Model for a Systematic Notion of Belief**. In EMNLP'21.
- P. Clark, O. Tafjord, K. Richardson. **Transformers as Soft Reasoners over Language,** IJCAI'20.
- P. Clark, O. Etzioni, et al., **From 'F' to 'A' on the N.Y. Regents Science Exams: An Overview of the Aristo Project**. AI Magazine 41 (4) pp 39-53, 2020.
- P. Clark, I. Cowhey, O. Etzioni, et al. **Think you have solved question answering? try ARC, the AI2 reasoning challenge.** arXiv:1803:05457. 2018. (3000+ citations)
- J. Berant, V. Srikumar, P.-C. Chen, A. Vander Linden, B. Harding, B. Huang, P. Clark, C. D. Manning. **Modeling Biological Processes for Reading Comprehension.** In EMNLP'14. (Best paper award)
- P. Clark,, P. Harrison, N. Balasubramanian, O. Etzioni. **Constructing a Textual KB from a Biology TextBook**. In Proc. Workshop on Automatic Knowledge Base Construction and Web-scale Knowledge Extraction (AKBC-WEKEX 2012), 2012. (Best paper award)
- P. Clark,, Harrison, P., Yao, X. **An Entailment-Based Approach to the QA4MRE Challenge**. In Proc. CLEF 2012 (Conference and Labs of the Evaluation Forum) - QA4MRE Lab, 2012.
- D. Gunning, V. Chaudhri, P. Clark, K. Barker, et al., **Project Halo Update - Progress Toward Digital Aristotle** In AI Magazine (vol 31 no 3), 2010.
- P. Clark, P. Harrison. **An Inference-Based Approach to Recognizing Entailment**. In Proceedings of 2009 Text Analysis Conference (TAC'09), Gaithsburg, Maryland, 2009.
- P. Clark, P. Harrison. **Large-Scale Extraction and Use of Knowledge From Text**. In Proc Fifth Int Conf on Knowledge Capture (KCap'09), 2009.
- P. Clark, P. Harrison. **Boeing's NLP System and the Challenges of Semantic Representation**. In Proc SIGSEM Symposium on Text Processing (STEP'08), Venice, Italy, 2008.
- P. Clark, P. Harrison, T. Jenkins, J. Thompson, R. Wojcik. **Acquiring and Using World Knowledge using a Restricted Subset of English**. In: The 18th International FLAIRS Conference (FLAIRS'05), 2005.
- K. Barker, V. Chaudhri, S. Chaw, P. Clark, et al., **A Question-Answering System for AP Chemistry: Assessing KR&R Technologies.** Proc 9th Int Conf on Knowledge Representation and Reasoning (KR'04), 2004.
- N. Friedland, G. Matthews, M. Witbrock, P. Clark, et al., **Project Halo: Towards a Digital Aristotle**. In: AI Magazine 25 (4), 2004, pp. 29-47. AAAI Press.
- P. Clark, V. Chaudhri, S. Mishra, J. Thomere, K. Barker, B. Porter. **Enabling Domain Experts to Convey Questions to a Machine: A Modified, Template-Based Approach**. In 2nd International Conference on Knowledge Capture (KCap'03), 2003.
- P. Clark and B. Porter. **Building Concept Representations from Reusable Components**. In AAAI'97, pages 369-376, CA:AAAI Press, 1997. (Best Paper Award).
- P. Clark and T. Niblett. **The CN2 Induction Algorithm.** Machine Learning, 3(4):261-283, 1989. (3700+ citations)