

# Curriculum Vitae

## Pat Langley

### Personal Information

#### *ISLE Address:*

Institute for the Study of Learning and Expertise  
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#### *Stanford Address:*

Center for Design Research, 424 Panama Mall  
Stanford University, Stanford, CA 94305 USA  
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Citizenship: USA

### Education

Carnegie Mellon University, M.S., 1976, Ph.D., 1979, Cognitive Psychology  
Texas Christian University, B.A., 1975, Mathematics and Psychology

### Employment/Administrative History

Director and President, Institute for the Study of Learning and Expertise, Palo Alto, CA (9/88–present)  
Research Scientist, Center for Design Research, Mechanical Engineering, Stanford University (8/00–present)  
Professor of Computer Science, University of Auckland, Auckland, NZ (6/12–12/15, Honorary from 1/16)  
Distinguished Scientist, Carnegie Mellon University, Moffett Field, CA (8/12–5/15)  
Professor of Computing and Informatics / Psychology, Arizona State University, Tempe, AZ (8/06–8/12)  
Consulting Professor of Symbolic Systems, Stanford University, and Head, Computational Learning Laboratory, Center for the Study of Language and Information (1/1/97–9/09)  
Head, Adaptive Systems Group, DaimlerChrysler Research & Technology Center (9/1/96–10/31/00)  
Senior Research Associate, Robotics Laboratory, Stanford University (1/94–9/96)  
Senior Scientist, Learning Systems Department, Siemens Corporate Research (12/92–12/93)  
Senior Scientist, AI Research Branch, NASA Ames Research Center (9/89–9/92)  
Associate Professor, Department of Computer Science, University of California, Irvine, CA (7/84–6/91)  
Research Scientist, The Robotics Institute, Carnegie Mellon University, Pittsburgh, PA (9/81–6/84)  
Research Associate, Department of Psychology, Carnegie Mellon University, Pittsburgh, PA (9/79–8/81)

### Grants, Contracts, and Gifts

AN ARCHITECTURE FOR NORMATIVE, EXPLAINABLE, AND JUSTIFIED AGENCY, AFOSR [\$446,745] 8/1/2020 – 7/31/2023 (co-PIs L. Leifer)  
RAPID ACQUISITION OF HIERARCHICAL PROCEDURES FROM INSTRUCTIONAL DOCUMENTS, ONR [\$1,340,358] 5/18/2020 – 5/17/2023 (co-PIs H. Shrobe and B. Katz, MIT)  
SCALABLE INFERENCE OF AFFORDANCE, ACTIVITY, AND INTENT FROM SPATIO-TEMPORAL INPUT, ONR [\$245,645] 06/01/2017 – 12/31/2020 (subaward from University of Auckland, PI M. Sridharan)  
AN ARCHITECTURE FOR RADICALLY AUTONOMOUS SYSTEMS, ONR [\$542,252] 07/01/2015 – 12/31/2018  
INTERACTIVE CONSTRUCTION OF CASCADED CAUSAL MODELS, GE [\$50,000] 05/01/2016 – 12/31/2016  
ACTIVE TRANSFER OF KNOWLEDGE FOR PROCESS MODELING, ONR [\$861,253] 10/1/2010 – 9/30/2016  
AUTONOMOUS DISCOVERY OF OBJECT PROPERTIES: ROBOTS THAT CREATE SIMPLE MACHINES, ONR [\$211,797] 1/1/2012 – 7/31/2015 (subaward from Georgia Tech, PI M. Stilman)  
MENTAL SIMULATION AND LEARNING IN THE ICARUS ARCHITECTURE, ONR [\$538,952] 2/1/2012 – 6/30/2015  
UNDERSTANDING AND AIDING PROBLEM FORMULATION IN CREATIVE CONCEPTUAL DESIGN, NSF [\$741,000] 8/1/10 – 7/31/15 (Co-PIs J. Shah and E. Campana)

A UNIFIED COMPUTATIONAL THEORY OF LANGUAGE AND COGNITION, Office of Naval Research (MURI program) [~\$4,400,000] 6/1/09 – 5/31/12 (co-PI's N. Cassimatis, J. Hobbs, S. Nirenburg)

SOFTWARE INTEGRATION FOR COMPUTATIONAL COGNITIVE MODELS IN VIRTUAL ENVIRONMENTS, AFOSR [\$228,702] 7/1/09 – 9/14/11 (Subcontract from SET Corporation, PI A. Pope)

SYMPOSIUM ON COMPUTATIONAL APPROACHES TO CREATIVITY IN SCIENCE, NSF [\$18,000] 2/1/08 – 1/31/09 (Co-PI W. Bridewell)

EFFECTIVE HUMAN-ROBOT INTERACTION. . . THROUGH ROBUST. . . DIALOGUE AND DYNAMIC AUTONOMY, ONR [~\$2,500,000] 10/1/2007 – 9/30/2012 (Subaward from Indiana University, PI M. Scheutz)

COMPUTATIONAL APPROACHES TO CREATIVITY THROUGH GOAL-DIRECTED CROSS-DOMAIN ANALOGY, National Science Foundation [\$199,828] 8/16/07 – 2/28/10 (Co-PI S. Kambhampati)

LEARNING HIERARCHICAL TASK MODELS FROM BEHAVIORAL TRACES, Defense Advanced Research Projects Agency [\$1,045,367] 4/1/06 – 3/31/09 (Subcontract from BBN, PI M. Burstein)

TRANSFER LEARNING IN INTEGRATED COGNITIVE SYSTEMS, Defense Advanced Research Projects Agency [\$12,242,291] 10/1/05 – 4/30/10 (Co-PIs P. Domingos, L. Holder, and others)

LEARNING HIERARCHICAL RELATIONAL SKILLS FROM KNOWLEDGE AND EXPERIENCE, Defense Advanced Research Projects Agency [\$1,571,070] 11/1/03 – 10/31/06

COMPUTATIONAL INDUCTION OF SCIENTIFIC PROCESS MODELS, NSF [\$2,650,000] 9/15/03 – 9/14/09 (Co-PIs K. Arrigo and B. Widrow)

NEW RESEARCH DIRECTIONS IN COGNITIVE ARCHITECTURES, NSF [\$99,271] 9/1/03 – 6/30/05

COMBINING SHALLOW SEMANTICS AND DOMAIN KNOWLEDGE, Scottish Enterprise through Edinburgh University and Stanford University [\$351,000] 4/1/2004 – 3/31/2007 (Co-PI C. Manning)

SYMPOSIUM ON REASONING AND LEARNING IN COGNITIVE SYSTEMS, ONR [\$5,100], NSF [\$4,500] 3/1/04 – 2/28/05 (Co-PI S. Rogers)

SYMPOSIUM ON MACHINE LEARNING FOR ANOMALY DETECTION, NSF [\$5,600] 5/1/04 – 11/1/04 (Co-PI S. Bay)

SYMPOSIUM ON ADVANCES IN COGNITIVE ARCHITECTURES, DARPA [\$10,000], NSF [\$7,510] 3/1/03 – 2/28/04 (Co-PI D. Shapiro)

INTERACTIVE COMPUTATIONAL ASSISTANT FOR VIDEO SEGMENTATION AND CLASSIFICATION, Media X, Stanford University [\$22,129] 4/1/2003 – 8/31/2003 (Co-PIs C. Manning and M. Gervasio)

COMPUTATIONAL DISCOVERY OF COMMUNICABLE KNOWLEDGE, Nippon Telegraph and Telephone Company [\$623,657] 10/16/00 – 10/15/05

COMPUTATIONAL TECHNIQUES FOR RECONSTRUCTION AND DISCOVERY OF METABOLIC, SIGNAL TRANSDUCTION, . . . , NASA Ames [\$348,500] 7/1/01 – 6/30/04 (Co-PIs A. Pohorille and J. Shrager)

FILTERING INFORMATION IN COMPLEX TEMPORAL DOMAINS, NASA Ames [\$776,000] 3/1/01 – 7/31/04

COMPUTATIONAL DISCOVERY OF KNOWLEDGE IN EARTH SCIENCE, NASA Ames [\$175,000] 7/1/99 – 3/31/01

ADAPTIVE USER INTERFACES FOR CRISIS RESPONSE TASKS, Office of Naval Research [\$580,000] 8/1/99 – 7/31/01

ADAPTIVE CRISIS RESPONSE: INTELLIGENT ASSISTANTS FOR JOINT-FORCE CRISIS RESPONSE, Office of Naval Research [\$3,000,000] 9/1/96 – 8/31/99 (co-PI M. Fehling)

LEARNING OBJECT MODELS FROM VISUAL OBSERVATION AND BACKGROUND KNOWLEDGE, Office of Naval Research and ARPA [\$615,832] 6/1/94 – 3/31/00 (co-PI T. Binford)

MACHINE LEARNING FOR ROBOTIC LOCALIZATION AND NAVIGATION, ONR [\$281,658] 3/1/94 – 2/28/97

COMPUTATIONAL MODELS OF HUMAN LEARNING WITH INSTRUCTIONAL RELEVANCE, Air Force Office of Scientific Research [\$308,167] 1/1/94 – 12/31/97 (co-PI N. Nilsson)

WORKSHOP ON FIELDED APPLICATIONS OF MACHINE LEARNING, ONR [\$4,800] 6/1/93 – 12/31/93 (Co-PI Y. Kodratoff)

SYMPOSIUM ON LEARNING METHODS FOR PLANNING AND SCHEDULING, DARPA [\$5,200], ONR [\$5,100], AAAI [\$5,000] 1/1/91 – 12/31/91 (Co-PI S. Minton)

SYMPOSIUM ON COMPUTATIONAL APPROACHES TO CONCEPT FORMATION, NSF [\$5,000], ONR [\$5,000], AAAI [\$5,000] 1/1/90 – 12/31/90 (Co-PI D. Fisher)

SYMPOSIUM ON COMPUTATIONAL MODELS OF SCIENTIFIC DISCOVERY, NSF [\$7,300], ONR [\$5,000], AAAI [\$5,000] 1/1/89 – 12/31/89 (Co-PI J. Shrager)

FOURTH INTERNATIONAL WORKSHOP ON MACHINE LEARNING, National Science Foundation [\$7,001], Office of Naval Research [\$5,000], Defense Advanced Research Projects Agency [\$5,000], American Association for Artificial Intelligence [\$10,000], 1/1/87 – 12/31/87

FOURTH INTERNATIONAL WORKSHOP ON MACHINE LEARNING, NSF [\$7,001], ONR [\$5,000], DARPA [\$5,000], AAAI [\$10,000] 1/1/87 – 12/31/87

A LABORATORY FOR SOFTWARE RESEARCH, NSF Coordinated Experimental Research Grant, 7/1/86 – 6/30/91 [\$3,131,000] (Co-PI's R. Taylor, R. Selby, et al.)

LEARNING IN A REACTIVE ENVIRONMENT, DARPA, 7/1/85 – 8/30/86 [\$250,127], Army Research Institute [\$1,381,907] 9/1/85 – 8/31/90 (Co-PI's D. Kibler and R. Granger)

MACHINE LEARNING RESEARCH, Hughes Aircraft, [\$60,000] 7/1/85 – 6/30/87 (Co-PI D. Kibler)

FOCUSED RESEARCH PROGRAM IN COMPUTATION AND LEARNING, University of California, Irvine [\$100,000] 7/1/85 – 6/30/88 (Co-PI K. Wexler)

THE EFFECT OF MULTIPLE KNOWLEDGE SOURCES ON LEARNING AND TEACHING, Office of Naval Research [\$324,926] 7/1/85 – 6/30/88 (Co-PI D. Kibler)

RESEARCH IN MACHINE LEARNING, ONR [\$375,000] 1/1/84 – 12/31/86 (Co-PI J. G. Carbonell)

MODELING THE STRATEGIES OF MATHEMATICS STUDENTS, ONR [\$203,425] 12/1/82 – 11/30/84

DATA-DRIVEN DISCOVERY OF EMPIRICAL LAWS, Office of Naval Research [\$205,674] 2/15/82 – 12/31/83 (Co-PI H. A. Simon)

AN INFORMATION PROCESSING THEORY OF PROCEDURAL LEARNING, NSF 9/1/79 – 8/31/81 [\$53,715]

### Research Interests

Cognitive architectures for physical agents	Computational scientific discovery
Computational models of human cognition	Science informatics and e-science
Problem solving and reasoning	Computational biology and ecology
Synthetic characters for virtual environments	Human-robot interaction
Machine learning and induction	Adaptive interfaces and personalization

### Professional Memberships

American Association for Artificial Intelligence (Fellow), Cognitive Science Society (Fellow)  
 Association for Computing Machinery (SIG for Knowledge Discovery and Data Mining)

### Courses Taught (at UCI, Stanford University, Arizona State University, and University of Auckland)

Introduction to Artificial Intelligence – Winter, 1985; Fall, 1986, 1987, 2013, 2014  
 AI Projects/Programming Techniques – Winter, 1986; Spring, 1986, 1988  
 Introduction to Machine Learning – Spring, 1985, 1986, 1987, 1991; Winter, 1995; Spring, 1996  
 Production System Models of Learning and Development – Winter, 1987  
 Projects in Artificial Intelligence – Spring, 1986  
 Readings/Projects in Artificial Intelligence – Fall, 1985, 1986; Spring, 1986

Experimental Methodologies for Machine Learning – Winter, 1988  
 Computational Models of Learning and Development – Spring, 1995  
 Adaptive Interfaces and User Modeling – Spring, 1999, 2000  
 Causal Models in Biomedical Informatics – Winter, 2003  
 Reasoning and Learning in Cognitive Systems – Winter, 2004, 2005, 2006  
 Computational Approaches to Scientific Reasoning and Discovery – Spring, 2004, 2005  
 Cognitive Systems and Intelligent Agents – Spring, 2007, 2008, 2009, Fall, 2009, 2011, Spring, 2014  
 Introduction to Science Informatics – Spring, 2009; Decision Making and Modeling – Spring, 2012  
 Machine Learning and Data Mining – Fall, 2012; Introduction to Cyberspace – Fall, 2013, 2014  
 Interactive Cognitive Systems – Spring, 2014, 2015

### Postdoctoral Mentorships

Brian Yamauchi (1995–1996)	Marcus Maloof (1996–1998)
David Moriarty (1996–1997)	Simon Handley (1997–1998)
Cindi Thompson (1998–2000)	Melinda Gervasio (1997–2000)
Stephen Bay (2001–2004)	Will Bridewell (2004–2009)
Ljupčo Todorovski (2004–2005)	Stuart Borrett (2005–2007)
Tolga Könik (2005–2010)	Stephen Racunas (2005–2007)
David Stracuzzi (2005–2007)	Alfredo Gabaldon (2012–2014)

### Doctoral Committees (*completed dissertations in italics*)

<i>Douglas Fisher</i> , Member (1984–1987)	<i>Jeff Schlimmer</i> , Member (1985–1987)
<i>Randy Jones</i> , Chair (1985–1989)	<i>Bernd Nordhausen</i> , Chair (1985–1989)
<i>Wayne Iba</i> , Chair (1986–1991)	<i>John Gennari</i> , Chair (1986–1990)
<i>James Wogulis</i> , Member (1986–1990)	Patrick Young, Chair (1986–1988)
Kevin Thompson, Chair (1986–1992)	<i>Donald Rose</i> , Chair (1984–1989)
<i>Klaus Gross</i> , Member (1989–1991)	John Allen, Chair (1988–1992)
<i>Ron Kohavi</i> , Member (1996)	<i>George John</i> , Member (1994–1997)
<i>Ofer Maitan</i> , Member (1997)	<i>Daniel Shapiro</i> , Co-Chair (1997–2000)
Oren Shiran, Co-Chair (2003–2005)	<i>Nan Li</i> , Chair (2006–2009), Member (2012–2013)
<i>Dongkyu Choi</i> , Chair (2003–2010)	<i>Negin Nejati</i> Co-Chair (2003–2011)
Nima Asgharbeygi, Co-Chair (2004–2011)	<i>Chunki Park</i> , Co-Chair (2005–2013)
<i>Archana Ramesh</i> , Member (2009–2010)	<i>Mahmoud Dinar</i> , Member (2014–2015)
Adam Arvay, Chair (2013–2018)	<i>Christopher MacLellan</i> , Member (2012–2017)

### University Service

Industrial Affiliates Committee (Chair), ICS Department, UCI, 1984–1985  
 Faculty Chair, ICS Department, UCI, 1984–1985  
 Computing Resources Committee, ICS Department, UCI, 1985–1986  
 Executive Committee, ICS Department, UCI, 1985–1986  
 Organizer, Seminar on Computational Learning and Adaptation, Stanford University, 1994–2006  
 Consulting Professor, Symbolic Systems Program, Stanford University – 1996–2005  
 Symbolic Systems Program Masters Committee, Stanford University, 1997–1998  
 CSLI Distinguished Lecture Series Committee, Stanford University, 1999–2001  
 CSLI Advisory Committee, Stanford University, 2003–2007  
 Executive Committee, Department of Computer Science, Arizona State University, 2008–2009

## Professional Service

Founding Executive Editor, *Machine Learning*, 1985–1988  
Editor, *Machine Learning*, 1989–1990, 1996–1998  
Editor, Morgan Kaufmann Series in Machine Learning, 1990–1999  
Founding Editor, *Advances in Cognitive Systems*, 2012–2020  
Program Co-chair, Nineteenth Annual Conference of the Cognitive Science Society, 1997  
Program Chair, AAAI Fall Symposium on Advances in Cognitive Systems, 2011  
Program Chair, First Annual Conference on Advances in Cognitive Systems, 2012  
Program Co-chair, Sixth Annual Conference on Advances in Cognitive Systems, 2018  
Co-editor, special issue of *Machine Learning* on learning with probabilistic representations, 1997  
Associate, *Behavioral and Brain Sciences*, 1987–1991  
Editorial board, *Machine Learning*, 1985–2018  
Editorial board, *Knowledge Discovery and Data Mining*, 1996–2018  
Editorial board, *Cognitive Science*, 2003–2005  
Editorial board, *Journal of Artificial Intelligence Research*, 1993–1996  
Reviewer, National Science Foundation, 1986–1988, 1991, 1994, 1998, 2002, 2004, 2005  
Reviewer, *Artificial Intelligence*, 1986, 1988, 1993, 1994  
Reviewer, International Joint Conference on Artificial Intelligence, 1983, 1985, 1987, 1989, 1995, 2001  
Program committee, International Joint Conference on Artificial Intelligence, 1989, 2017, 2018  
Program committee, International Conference on AI Planning Systems, 1992, 1994, 1996, 2004  
Program committee, AAAI Conference on Artificial Intelligence, 1987–1988, 1991, 1996–1997, 2005  
Program co-chair, AAAI Integrated Intelligence track, 2007, 2008, 2010  
Program chair, International Workshop/Conference on Machine Learning, 1987, 2000  
Program committee, International Conference on Machine Learning, 1988/89, 1991/3/7, 2000/2/3/4/5  
Reviewer, Annual Meeting of the Cognitive Science Society, 1985, 1993, 1994, 2004, 2010  
Program committee, International Conference on the Foundations of Digital Games, 2009  
Reviewer, *Cognitive Science*, 1986, 1987, 1994, 2001–2008  
Reviewer, *Journal of Artificial Intelligence Research*, 1993–1996, 2003, 2005  
Co-organizer, Symposium on Computational Models of Scientific Discovery, 1989  
Co-organizer, Symposium on Computational Approaches to Concept Formation, 1990  
Co-organizer, Symposium on Learning Methods for Planning and Scheduling, 1991  
Co-organizer, Workshop on Fielded Applications of Machine Learning, 1993  
Organizing committee, AAAI Spring Symposium on Integrated Intelligent Architectures, 1991  
Co-presenter – AAAI/IJCAI Tutorial on Machine Learning – 1985, 1986, 1988, 1992  
Organizer and co-presenter – CSLI Tutorial on Applications of Machine Learning – 1994–1996, 1998  
Organizing committee, AAAI Workshop on Computational Models of Human Learning, 1996  
Co-organizer, Symposium on Applications of Reinforcement Learning, 1998  
Organizer, Symposium on Computational Discovery of Communicable Knowledge, 2001  
Co-organizer, Symposium on Advances in Cognitive Architectures, 2003  
Co-organizer, Symposium on Reasoning and Learning in Cognitive Systems, 2004  
Co-organizer, Symposium on Machine Learning for Anomaly Detection, 2004  
Co-organizer, Symposium on Computational Approaches to Creativity in Science, 2008  
Co-organizer, Symposium on Systems Biology of Aging, 2008

## Books

- [1] Langley, P. (Ed.) (2000). *Proceedings of the Seventeenth International Conference on Machine Learning*. Stanford, CA: Morgan Kaufmann.
- [2] Shafto, M. G., & Langley, P. (Eds.) (1997). *Proceedings of the Nineteenth Annual Conference of the Cognitive Science Society*. Mahwah, NJ: Lawrence Erlbaum.
- [3] Langley, P. (1996). *Elements of Machine Learning*. San Francisco: Morgan Kaufmann.
- [4] Fisher, D. H., Pazzani, M. J., & Langley, P. (Eds.) (1991). *Concept Formation: Knowledge and Experience in Unsupervised Learning*. San Francisco: Morgan Kaufmann.
- [5] Shrager, J., & Langley, P. (Eds.) (1990). *Computational Models of Scientific Discovery and Theory Formation*. San Francisco: Morgan Kaufmann.
- [6] Langley, P. (Ed.) (1987). *Proceedings of the Fourth International Workshop on Machine Learning*. San Francisco: Morgan Kaufmann.
- [7] Langley, P., Simon, H. A., Bradshaw, G. L., & Żytkow, J. M. (1987). *Scientific Discovery: Computational Explorations of the Creative Processes*. Cambridge, MA: MIT Press.
- [8] Klahr, D., Langley, P., & Neches, R. (Eds.) (1987). *Production System Models of Learning and Development*. Cambridge, MA: MIT Press.

## Refereed Journal Articles

- [1] Langley, P., Shrobe, H. E., & Katz, B. (in press). A cognitive task analysis of rapid procedure acquisition from instructional documents. *Advances in Cognitive Systems*.
- [2] Langley, P., & Meadows, B. (2019). Heuristic construction of explanations through associative abduction. *Advances in Cognitive Systems*, 8, 93–112.
- [3] Langley, P. (2019). Scientific discovery, causal explanation, and process model induction. *Mind & Society*, 18, 43–56.
- [4] Langley, P., Barley, M., & Meadows, B. (2018). Adaptive search in a hierarchical problem-solving architecture. *Advances in Cognitive Systems*, 6, 251–270.
- [5] Choi, D., & Langley, P. (2018). Evolution of the ICARUS cognitive architecture. *Cognitive Systems Research*, 48, 25–38.
- [6] Arvay, A., & Langley, P. (2016). Heuristic adaptation of quantitative process models. *Advances in Cognitive Systems*, 4, 207–226.
- [7] Dinar, M., Danieleescu, A., MacLellan, C., Shah, J. J., & Langley, P. (2015). Problem Map: An ontological framework for a computational study of problem formulation in engineering design. *Journal of Computing and Information Science in Engineering*, 15, 031007/1–10.
- [8] Langley, P., Meadows, B., Gabaldon, A., & Heald, R. (2014). Abductive understanding of dialogues about joint activities. *Interaction Studies*, 15, 426–454.
- [9] Meadows, B., Langley, P., & Emery, M. (2014). An abductive approach to understanding social interactions. *Advances in Cognitive Systems*, 3, 87–106.
- [10] Gabaldon, A., Langley, P., & Meadows, B. (2014). Integrating meta-level and domain-level knowledge for task-oriented dialogue. *Advances in Cognitive Systems*, 3, 201–219.
- [11] Langley, P., Pearce, C., Barley, M., & Emery, M. (2014). Bounded rationality in problem solving: Guiding search with domain-independent heuristics. *Mind and Society*, 13, 83–95.
- [12] MacLellan, C. J., Langley, P., Shah, J., Dinar, M. (2013). A computational aid for problem formulation in early conceptual design. *Journal of Computing and Information Science in Engineering*, 13, 031005/1–10.

- [13] Li, N., Stracuzzi, D. J., & Langley, P. (2012). Improving acquisition of teleoreactive logic programs through representation extension. *Advances in Cognitive Systems*, 1, 109–126.
- [14] Bridewell, W. & Langley, P. (2010). Two kinds of knowledge in scientific discovery. *Topics in Cognitive Science*, 2, 36–52.
- [15] Könik, T., O’Rorke, P., Shapiro, D., Choi, D., Nejati, N., & Langley, P. (2009). Skill transfer through goal-driven representation mapping. *Cognitive Systems Research*, 10, 270–285.
- [16] Langley, P., Choi, D., & Rogers, S. (2009). Acquisition of hierarchical reactive skills in a unified cognitive architecture. *Cognitive Systems Research*, 10, 316–332.
- [17] Langley, P., Laird, J. E., & Rogers, S. (2009). Cognitive architectures: Research issues and challenges. *Cognitive Systems Research*, 10, 141–160.
- [18] Cassimatis, N. L., Bello, P., & Langley, P. (2008). Ability, breadth and parsimony in computational models of higher-order cognition. *Cognitive Science*, 32, 1304–1322.
- [19] Bridewell, W., Langley, P., Todorovski, L., & Džeroski, S. (2008). Inductive process modeling. *Machine Learning*, 71, 1–32.
- [20] Bridewell, W., Billman, D., Sánchez, J. N., & Langley, P. (2006). An interactive environment for the modeling and discovery of scientific knowledge. *International Journal of Human-Computer Studies*, 64, 1099–1114.
- [21] Langley, P., Shiran, O., Shrager, J., Todorovski, L., & Pohorille, A. (2006). Constructing explanatory process models from biological data and knowledge. *Artificial Intelligence in Medicine*, 37, 191–201.
- [22] Langley, P., & Choi, D. (2006). Learning recursive control programs from problem solving. *Journal of Machine Learning Research*, 7, 493–518.
- [23] Asgharbeygi, N., Bay, S., Langley, P., & Arrigo, K. (2006). Inductive revision of quantitative process models. *Ecological Modelling*, 194, 70–79.
- [24] Jones, R. M., & Langley, P. (2005). A constrained architecture for learning and problem solving. *Computational Intelligence*, 21, 480–502.
- [25] Ichise, R., Shapiro, D., & Langley, P. (2005). Structured program induction from behavioral traces. *Systems and Computers in Japan*, 36, 49–59.
- [26] Schroedl, S., Wagstaff, K., Rogers, S., Langley, P., & Wilson, C. (2004). Mining GPS traces for map refinement. *Knowledge Discovery and Data Mining*, 9, 59–87.
- [27] Thompson, C. A., Göker, M. H., & Langley, P. (2004). A personalized system for conversational recommendations. *Journal of Artificial Intelligence Research*, 21, 393–428.
- [28] Todorovski, L., Džeroski, S., Langley, P., & Potter, C. (2003). Using equation discovery to revise an Earth ecosystem model of carbon net production. *Ecological Modelling*, 170, 141–154.
- [29] Lavrac, N., Motoda, H., Fawcett, T., Holte, R., Langley, P., & Adriaans, P. (2004). Lessons learned from data mining applications and collaborative problem solving. *Machine Learning*, 57, 13–34.
- [30] Bay, S. D., Shrager, J., Pohorille, A., & Langley, P. (2003). Revising regulatory networks: From expression data to linear causal models. *Journal of Biomedical Informatics*, 35, 289–297.
- [31] Maloof, M. A., Langley, P., Binford, T. O., Nevatia, R., & Sage, S. (2003). Improved rooftop detection in aerial images with machine learning. *Machine Learning*, 53, 157–191.
- [32] Langley, P. (2000). The computational support of scientific discovery. *International Journal of Human-Computer Studies*, 53, 393–410.
- [33] Kocabas, S., & Langley, P. (2000). Computer generation of process explanations in nuclear astrophysics. *International Journal of Human-Computer Studies*, 53, 377–392.

- [34] Blum, A. L., & Langley, P. (1997). Selection of relevant features and examples in machine learning. *Artificial Intelligence*, 97, 245–271.
- [35] Yamauchi, B., & Langley, P. (1997). Place recognition in dynamic environments. *Journal of Robotic Systems*, 14, 107–120.
- [36] Langley, P., Pfeleger, K., & Sahami, M. (1997). Lazy acquisition of place knowledge. *Artificial Intelligence Review*, 11, 315–342.
- [37] Langley, P., & Simon, H. A. (1995). Applications of machine learning and rule induction. *Communications of the ACM*, 38, November, 55–64.
- [38] Nordhausen, B., & Langley, P. (1993). An integrated framework for empirical discovery. *Machine Learning*, 12, 17–47.
- [39] Langley, P., & Żytkow, J. M. (1989). Data-driven approaches to empirical discovery. *Artificial Intelligence*, 40, 283–312.
- [40] Gennari, J. H., Langley, P., & Fisher, D. H. (1989). Models of incremental concept formation. *Artificial Intelligence*, 40, 11–61.
- [41] Iba, W., & Langley, P. (1987). A computational theory of motor learning. *Computational Intelligence*, 3, 338–350.
- [42] Żytkow, J. M., Langley, P., & Simon, H. A. (1987). Computer system of discovery STAHL. *Studia Filozoficzne or Zagadnienia Naukoznawstwa*, 23, 518–536.
- [43] Rose, D., & Langley, P. (1986). Chemical discovery as belief revision. *Machine Learning*, 1, 423–451.
- [44] Langley, P. (1985). Learning to search: From weak methods to domain-specific heuristics. *Cognitive Science*, 9, 217–260.
- [45] Langley, P., Larson, P., Silas, S., & Wertz, S. (1983). A proof of CNQNP from CPQ by the rule of detachment in Jeffrey’s system 5.6. *International Logic Review*, 14, 37–40.
- [46] Bradshaw, G. L., Langley, P., & Simon, H. A. (1983). Studying scientific discovery by computer simulation. *Science*, 222, 971–975.
- [47] Langley, P. (1983). Representational issues in learning systems. *IEEE Computer*, 16, 47–51.
- [48] Langley, P. (1983). Learning search strategies through discrimination. *International Journal of Man–Machine Studies*, 18, 513–541.
- [49] Langley, P. (1982). Language acquisition through error recovery. *Cognition and Brain Theory*, 5, 211–255.
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## Refereed Conference Papers

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- [2] Langley, P. (2019). Explainable, normative, and justified agency. *Proceedings of the Thirty-Third AAAI Conference on Artificial Intelligence* (pp. 9775–9779). Honolulu, HI: AAAI Press.



- [3] Langley, P. (2019). An integrative framework for artificial intelligence education. *Proceedings of the Ninth Symposium on Educational Advances in Artificial Intelligence* (pp. 9670–9677). Honolulu, HI: AAAI Press.
- [4] Langley, P., Choi, D., Barley, M., Meadows, B., & Katz, E. P. (2017). Generating, executing, and monitoring plans with goal-based utilities in continuous domains. *Proceedings of the Fifth Annual Conference on Cognitive Systems*. Troy, NY.
- [5] Langley, P., & Cooper, R. P. (2017). Symposium on problem solving and goal-directed sequential activity. *Proceedings of the Thirty-Ninth Annual Meeting of the Cognitive Science Society*. London.
- [6] Langley, P. (2017). A cognitive systems analysis of personality and conversational style. *Proceedings of the Fifth Annual Conference on Cognitive Systems*. Troy, NY.
- [7] Langley, P., & Arvay, A. (2017). Flexible model induction through heuristic process discovery. *Proceedings of the Thirty-First AAAI Conference on Artificial Intelligence* (pp. 4415–4421). San Francisco: AAAI Press.
- [8] Langley, P. (2017). Progress and challenges in research on cognitive architectures. *Proceedings of the Thirty-First AAAI Conference on Artificial Intelligence* (pp. 4870–4876). San Francisco: AAAI Press.
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- [15] Meadows, B., Heald, R., & Langley, P. (2015). An integrated account of explanation and question answering. *Proceedings of the Thirty-Seventh Annual Meeting of the Cognitive Science Society*. Pasadena, CA.
- [16] To, S. T., Langley, P., & Choi, D. (2015). A unified framework for knowledge-lean and knowledge-rich planning. *Proceedings of the Third Annual Conference on Cognitive Systems*. Atlanta, GA.
- [17] Dinar, M., Park, Y.-S., Shah, J. J., & Langley, P. (2015). Patterns of creative design: Predicting ideation from problem formulation. *Proceedings of the ASME International Design Engineering Technical Conferences & Computers and Information in Engineering Conference*. Boston: ASME.
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- [24] Danielescu, A., Dinar, M., MacLellan, C. J., Shah, J., & Langley, P. (2012). The structure of creative design: What problem maps can tell us about problem formulation and creative designers. *Proceedings of the ASME International Design Engineering Technical Conferences & Computers and Information in Engineering Conference*. Chicago: ASME.
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## Invited Chapters and Papers

- [1] Langley, P., & Arvai, A. (in press). Scientific discovery, process models, and the social sciences. In M. Addis & F. Gobet (Eds.), *Scientific discovery in the social sciences*. Berlin: Springer.
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## Symposium and Workshop Papers

- [1] Langley, P., Sridharan, M., & Meadows, B. (2018). Representation, use, and acquisition of affordances in cognitive systems. *Proceedings of the AAAI Spring Symposium on Integrating Representation, Reasoning, Learning, and Execution for Goal Directed Autonomy*. Stanford, CA: AAAI Press.
- [2] Choi, D., Langley, P., & To, S. T. (2018). Creating and using tools in a hybrid cognitive architecture. *Proceedings of the AAAI Spring Symposium on Integrating Representation, Reasoning, Learning, and Execution for Goal Directed Autonomy*. Stanford, CA: AAAI Press.
- [3] Bai, Y., Pearce, C., Langley, P., Barley, M., & Worsfold, C. (2015). An architecture for flexibly interleaving planning and execution. *Poster Collection: The Third Annual Conference on Advances in Cognitive Systems*. Atlanta, GA.
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## Technical Reports

- [1] Shapiro, D., Billman, D., Marker, M., & Langley, P. (2004). *A human-centered approach to monitoring complex dynamic systems* (Technical Report). Institute for the Study of Learning and Expertise, Palo Alto, CA.
- [2] Langley, P., & Fehling, M. (1998). *The experimental study of adaptive user interfaces* (Technical Report 98-3). Institute for the Study of Learning and Expertise, Palo Alto, CA.
- [3] Langley, P. (1998). *Computational learning in humans and machines* (Technical Report 98-3). Institute for the Study of Learning and Expertise, Palo Alto, CA.

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- [5] Maloof, M. A., Langley, P., Binford, T. O., & Sage, S. (1998). *Improving rooftop detection in aerial images through machine learning* (Technical Report 98-1). Institute for the Study of Learning and Expertise, Palo Alto, CA.
- [6] Moriarty, D., & Langley, P. (1998). *Distributed learning of lane-selection strategies for traffic management* (Technical Report 98-2). Daimler-Benz Research & Technology Center, Palo Alto, CA.
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## Editorials, Essays, and Commentaries

- [1] Langley, P. (2019). Authoring papers on cognitive systems research. *Advances in Cognitive Systems*, 8, 3-12.
- [2] Langley, P. (2018). Planning systems and human problem solving. *Advances in Cognitive Systems*, 7, 13-22.
- [3] Langley, P. (2018). Ongoing advances in cognitive systems. *Advances in Cognitive Systems*, 7, 1.
- [4] Langley, P. (2018). Theories and models in cognitive systems research. *Advances in Cognitive Systems*, 6, 3-16.
- [5] Langley, P. (2018). Encouraging advances in cognitive systems. *Advances in Cognitive Systems*, 6, 1.
- [6] Langley, P. (2017). Heuristics and cognitive systems. *Advances in Cognitive Systems*, 5, 3-12.
- [7] Langley, P. (2017). Further developments in cognitive systems. *Advances in Cognitive Systems*, 5, 1.

- [8] Langley, P. (2017). The Herbert A. Simon Prize for Advances in Cognitive Systems. *Advances in Cognitive Systems*, 5, 2.
- [9] Langley, P. (2016). The central role of cognition in learning. *Advances in Cognitive Systems*, 4, 3–12.
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- [13] Langley, P. (2012). Intelligent behavior in humans and machines. *Advances in Cognitive Systems*, 2, 3–12.
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- [24] Langley, P. (2000). The maturing science of machine learning. *Proceedings of the Seventeenth International Conference on Machine Learning* (pp. xi–xii). Stanford, CA: Morgan Kaufmann.
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