

Rensselaer AI & Reasoning Laboratory
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Education

Ph.D. Program in Computer Science, August 2004-Present
Rensselaer Polytechnic Institute, Troy NY

B.S., Computer Science and Philosophy of Science, *Summa Cum Laude* (3.9/4.0), May 2004
Rensselaer Polytechnic Institute, Troy NY

Dissertation

Thesis Advisor: Selmer Bringsjord

Title: Elisa: A System to Assist Humans in Making Discoveries

Synopsis: It has been a longstanding goal of artificial intelligence (AI) to mechanize the process of discovery, especially scientific discovery; that is, to produce automated systems capable of constructing novel conjectures, hypotheses, proofs, and theories. Unfortunately, this goal has never been reached; the systems in question have neither made discoveries on their own, nor significantly assisted the human discovery process. This dissertation aims to at long last reach this goal, through the design and implementation of the system — Elisa — which will assist a human reasoner through the full process of discovery, from start to finish. Elisa will rely on the human pilot when pure computation is (admittedly) insufficient, but take the wheel, so to speak, when the AI technologies (many of which I will, through this project, invent) are up to the task. There are well-known engineering advantages that come from at least initially focusing on a particular domain, and so we will design Elisa for discovery, confirmation, and reporting in the domain of mathematical systems central to computer science — while at the same time laying a foundation that allows Elisa to *bridge* from the formal to the rest of the sciences, and from there to general discovery in arbitrary domains. Unlike data mining in connection with vast but still finite spaces, and associated forms of discovery, Elisa is designed to discover things from the sort of infinite spaces that are customarily explored by humans in rigorous branches of computer science, cognitive science and other fields. Elisa is also marked by a willingness to explore and exploit algorithms from different (and sometimes cognitive) paradigms.

Research Experience

Graduate Research Assistant
Department of Computer Science

Rensselaer Polytechnic Institute Troy, NY
2004-Present

Have worked on numerous funded projects requiring expertise in knowledge representation and reasoning, and NLP. Am a primary developer for Slate, a multifaceted computational assistant for intelligence analysis facilitating structured evidence collection (through interoperability with other IC systems), evidence marshaling, hypothesis tracking, hypothesis generation, predication, and semi-automated report generation. (Supervised by S. Bringsjord) See <http://www.cogsci.rpi.edu/slate>.

*Undergraduate Research Assistant
Department of Computer Science*

**Rensselaer Polytechnic Institute
Troy, NY
2002-2004**

Initial development of the Slate system (described above). R&D in Existential Graphs, an interactive visual reasoning system. Work included proving soundness and completeness results, implementing methods automated theorem proving, and invention of the Pegasus system. (Supervised by B. van Heuveln)

Teaching Experience

**Department of Cognitive Science, Department of Computer Science,
Rensselaer Polytechnic Institute, Troy, NY**

Computability and Complexity	<i>Graduate Teaching Assistant</i>	Fall 2006
Introduction to Logic	<i>Co-lecturer</i>	Fall 2005
Computability and Logic	<i>Undergraduate Teaching Assistant</i>	Spring 2004
Introduction to Logic	<i>Undergraduate Teaching Assistant</i>	Fall 2003
Intermediate Logic	<i>Undergraduate Teaching Assistant</i>	Spring 2003
Computer Science 1	<i>Undergraduate Teaching Assistant</i>	Spring 2002
Introduction to Logic	<i>Undergraduate Teaching Assistant</i>	Fall 2002

Technical Skills

Programming Languages: Common Lisp, Scheme, Java, C, C++, ML, HTML, DHTML, PHP, ASP, SQL, Basic, Lex, Yacc, OpenGL.

Operating Systems: MacOS X, Microsoft Windows 95/98/ME/NT/2000/XP, Linux, Solaris, FreeBSD

Expertise includes knowledge representation and reasoning, natural language processing, foundations of artificial intelligence, and cognitive science.

Familiarity with ontology languages such as IKL, Common Logic, OWL, KIF.

Excellent technical writing, grammar, and presentation skills. Strong proficiency with the typesetting package \LaTeX

Strong and broad proficiency in key formalisms: probability theory and Bayesian networks, mathematical logic, artificial neural networks.

Scientific Software

Bringsjord, Shilliday, Taylor. *Slate*. System for Logic and Theorem Extraction; a logic-based application for assisting reasoners in the fields of Intelligence Analysis, Logic, Math, etc. 2003–present.
<http://www.cogsci.rpi.edu/slate>

Bringsjord, Clark, Shilliday, Taylor, Werner. *Solomon*. A Next-Generation Q&A System. 2006–2007.
<http://www.cogsci.rpi.edu/solomon>

A. Shilliday. *Pegasus*. A system for visualizing proofs in Peirce's Existential Graph proof calculus. 2002–2003.
<http://www.cs.rpi.edu/~shilla/pegasus>

Publications

SHILLIDAY, A., TAYLOR, J., AND BRINGSJORD, S. (Forthcoming), “Toward ethically correct autonomous unmanned aerial vehicles via provability-based semantic interoperability between heterogeneous ontologies.” In title TBD: Focus “Semantic Technology, Ontologies, Information Sharing within the Intelligence Community & Its Customers”, L. Obrst, T. Janssen, and W. Ceusters, Eds. IOS Press.

BRINGSJORD, S., TAYLOR, J., SHILLIDAY, A., CLARK, M., AND ARKOUDAS, K. (2008), “Slate: an Argument-Centered Intelligent Assistant to Human Reasoners.” In *Proceedings of the 8th International Workshop on Computational Models of Natural Argument* (Patras, Greece, July 21 2008), F. Grasso, N. Green, R. Kibble, and C. Reed, Eds., pp. 1–10.

BRINGSJORD, S., SHILLIDAY, A., WERNER, D., CLARK, M., CHARPENTIER, E., AND BRINGSJORD, A. (2008), “Toward logic-based cognitively robust synthetic characters in digital environments.” In *Artificial General Intelligence 2008 - Proceedings of the First AGI Conference*, P. Wang, B. Goertzel, and S. Franklin, Eds., vol. 171 of *Frontiers in Artificial Intelligence and Applications*, IOS Press, pp. 87–98.

SHILLIDAY, A., TAYLOR, J., AND BRINGSJORD, S. (2007), “Toward automated provability-based semantic interoperability between ontologies for the intelligence.” In *Proceedings of the Second International Ontology for the Intelligence Community Conference*, K. S. Hornsby, Ed., vol. 299 of *CEUR Workshop Proceedings*, CEUR-WS.org.

TAYLOR, J., SHILLIDAY, A., AND BRINGSJORD, S. (2007), “Provability-based Semantic Interoperability via Translation Graphs.” In *Advances in Conceptual Modeling — Foundations and Applications*, J. L. Hainaut, E. Rundensteiner, M. Kirchberg, M. Bertolotto, M. Brochhausen, P. Chen, S. Cherfi, M. Doerr, H. Han, S. Hartmann, J. Parsons, G. Poels, C. Rolland, J. Trujillo, and E. Yu, Eds., vol. 4802 of *Lecture Notes in Computer Science*, Springer-Verlag, pp. 180–189.

BRINGSJORD, S., ARKOUDAS, K., MUKHERJEE, D., SHILLADAY, A. E., TAYLOR, J., CLARK, M. H., AND BRINGSJORD, E. (2007), “The multi-mind effect.” In *Proceedings of the 2007 International Conference on Artificial Intelligence*, H. R. Arabnia, M. Q. Yang, and J. Y. Yang, Eds., vol. I, CSREA Press, pp. 43–49.

Bringsjord, S., Arkoudas, K., Clark, M., Shilliday, A., Taylor, J., Schimanski, B. & Yang, Y. (2007) “Reporting on Some Logic-Based Machine Reading Research,” in Etzioni, O., ed., *Machine Reading: Papers from the AAAI Spring Symposium Technical Report SS-07-06*, pp. 23–28.

BRINGSJORD, S., SHILLIDAY, A., TAYLOR, J., BELLO, P., YANG, Y., AND ARKOUDAS, K. (2006), “Harnessing intelligent agent technology to ‘superteach’ reasoning.” In *International Journal of Technology in Teaching and Learning*, vol. 2, pp. 88–116.

BRINGSJORD, S., KELLETT, O., SHILLIDAY, A., TAYLOR, J., VAN HEUVELN, B., YANG, Y., BAUMES, J., AND ROSS, K. (2006) “A New Gödelian Argument for Hypercomputing Minds Based on the Busy Beaver Problem.” In *Applied Mathematics and Computation* 176, 2, 516–530.

Presentations

Bringsjord, S., Shilliday, A., Taylor, J., and Clark, M. “Updates on Advanced Knowledge Representation and Reasoning for Interactive Visualization.” Presented at ASpace-X Site Visit, Rensselaer Polytechnic Institute, Troy, NY, February 7, 2008. (Bringsjord Presented.)

Shilliday, A., Bringsjord, S., and Taylor, J. "Solving the Database Schema Mismatch Problem through PBSI and Translation Graphs". Presented at the Federal Semantic Interoperability Community of Practice Special Conference: Building Semantic Interoperability Solutions for Information Sharing and Integration. February 5, 2008. Falls Church, VA. (Shilliday presented.)

Shilliday, A., Taylor, J., and Bringsjord, S. "Toward Automated Provability-Based Semantic Interoperability between Ontologies for the Intelligence Community." Presented at the Second International Ontology for the Intelligence Community Conference (OIC-2007). November 28-29, 2007. Columbia, MD. (Shilliday presented.)

Taylor, J., Shilliday, A., and Bringsjord, S. "Provability-based Semantic Interoperability via Translation Graphs." Presented at the International Workshop on Ontologies and Information Systems for the Semantic Web, part of the 26th International Conference on Conceptual Modeling (ER 2007). November 5-9, 2007. Auckland, New Zealand. (Shilliday presented.)

Bringsjord, S., Arkoudas, K., Mukherjee, D., Shilliday, A., Taylor, J., Clark, M., and Bringsjord, E. "The Multi-Mind Effect." Presented at the 2007 International Conference on Artificial Intelligence, in the Extending Computational Cognitive Modeling to Issues of Multi-agent Interaction workshop. June 28, 2007. (Mukherjee presented.)

- <http://kryten.mm.rpi.edu/PRES/ICAI07/ICAI-Pres.v06.pdf>

Bringsjord, S., Werner, D., Shilliday, A., Taylor, J., Clark, M. "The Solomon QA System: Updates (Blue Sky P-o-C Project)." Presented at the AQUAINT Principal Investigator Meeting, University of Maryland, College Park, May 16, 2007. (Bringsjord presented.)

Bringsjord, S., Arkoudas, K., Clark, M., Shilliday, A., Taylor, J., Schimanski, B., and Yang, Y. "Some Remarks on Logic-Based Machine Reading Research". Presented at the 2007 Association for the Advancement of Artificial Intelligence Spring Symposium on Machine Reading, March 27, 2007, Stanford University, Palo Alto, CA. (Bringsjord and Taylor presented.)

- http://kryten.mm.rpi.edu/PRES/AAAISS07MR/RAIR_Lab_AAAISS2007MR.pdf

Bringsjord, S., Shilliday, A., Taylor, J., and Clark, M. "On Slate." Presented at DTO ARIVA Principal Investigator Meeting, Falls Church, VA. June 14, 2006.

Bringsjord, S., Shilliday, A., Taylor, J., Arkoudas, K., Khemlani, S., Pratt, E., Schimanski, B., and Mulley, G. "Artificial Intelligence and the Future of Intelligence Analysis and Wargaming." Presented at Pacific Northwest National Laboratory, August 8, 2005. (Bringsjord presented.)

- http://kryten.mm.rpi.edu/PRES/PNNL0805/sb_pnnlprez.080805.key.tar.gz
- http://kryten.mm.rpi.edu/PRES/PNNL0805/sb_pnnlprez.080805.pdf
- http://kryten.mm.rpi.edu/PRES/PNNL0805/sb_pnnlprez.080805.ppt

Shilliday, A., Taylor, J., Pratt, E., and Bringsjord, S. "Slate 'Core' Development Directions." Presented at IBM, T.J. Watson Research Center, Hawthorne, NY. June 6, 2005.

Bringsjord, S., Shilliday, A., Taylor, J., Werner, D., and Clark, M. "Updates on Advanced Knowledge Representation and Reasoning for Interactive Visualization." Presented at ASpace-X Site Visit, Rensselaer Polytechnic Institute, Troy, NY, June 5, 2007. (Bringsjord Presented.)

Taylor, J., Bringsjord, S., Shilliday, A., Arkoudas, K., and Khemlani, S. "An Overview of Slate" Undergraduate Research Presentations, Minds and Machines Seminar, Rensselaer Polytechnic Institute, Troy, NY. March 30, 2005. (Taylor and Khemlani presented.)

Shilliday, A., Taylor, J., and Bringsjord, S. "Slate: An Intelligent Assistant to Professionals and Students in the Fields of Intelligence Analysis, Mathematics, and Logic." Presented for The Institute for Informatics, Logics and Security Studies, Albany, NY. March 18, 2005.

Bringsjord, S., Arkoudas, K., Yang, Y., Shilliday, A., Taylor, J., and Destefano, M. "New Architectures, Algorithms, and Designs that Lead to Implemented Machine Reasoning over Knowledge in Epistemic and Deontic Formats, in the Service of Wargaming." Presented at AFRL Rome, February 23 2005. (Bringsjord and Arkoudas presented.)

- <http://kryten.mm.rpi.edu/PRES/AFRLUPDATE0205/afrl-rome.visit022305.mov>
- <http://kryten.mm.rpi.edu/PRES/AFRLUPDATE0205/afrl-rome.visit022305.tar>

Bringsjord, S., Shilliday, A., and Taylor, J. "Two Types of Tacit Knowledge in the Analytic Process." Presented at NIMD Principle Investigators Meeting, Orlando, Florida. November 30 2004. (Bringsjord presented.)

Bringsjord, S., Shilliday, A., and Taylor, J., "On Model Building-Based Hypothesis Generation." Presented at NIMD Principle Investigators Meeting, Orlando, Florida, November 30, 2004. (Bringsjord presented.)

Bringsjord, S., Arkoudas, K., Yang, Y., Shilliday, A., and Taylor, J. "Toward Engineering a System for the 'Commander's Predictive Environment' that Not Only Issues Predictions, But Justifies Those Predictions." Syracuse NY, organized and sponsored by Gene Santos, AFRL/AFOSR. November 4, 2004. (Bringsjord presented.)

Bringsjord, S., Shilliday, A., Taylor, J., and Arkoudas, K. "Intelligence Analysis is Plagued by Bias, and Logic (Embodied in Slate) is the Antidote." Presented at Booz Allen Hamilton, to BAH's intelligence analysts and wargamers, McLean VA, October 21, 2004.

Bringsjord, S. and Shilliday, A. "Slate: An Intelligent Assistant for Argument/Hypothesis Checking and Generation," at the Annual U.S. Computing and Philosophy Conference, Carnegie Mellon University, Pittsburgh, PA, August 5, 2004. (Shilliday presented.)

Bringsjord, S., Shilliday, A., Taylor, J., Khemlani, S., Destefano, M., and Arkoudas, K. "The Status of Slate." Presented at ARDA Review, University of Maryland, College Park. April 5, 2004.

- http://kryten.mm.rpi.edu/PRES/NIMDREV040505/rairl_nimdqreview_040505.pdf
- http://kryten.mm.rpi.edu/PRES/NIMDREV040505/rairl_nimdqreview_040505.key.tar.gz

Bringsjord, S., Shilliday, A., Taylor, J., and Wodicka, J., Destefano, M. "Status Update of RAIR Lab's NIMD/Sage R&D" Presented at ARDA review, San Diego, CA. November 12, 2003. (Taylor presented.)

Grants

(all listed here are projects I contributed directly to, and are ones that resulted from proposals I helped prepare)

"Toward Cognitively Robust Synthetic Characters" 7.1.2007–7.1.2008. \$50,000 Seed Grant, Office of Research at Rensselaer.

"AKRRIV" originally in the ARIVA program, now in A-SpaceX. 2005–present. Started 2005. Total award \$, . . . , . . . from DTO (now under IARPA). The funder requests that award amounts be kept nondisclosed.

“Poised-For Learning and the Mechanization Thereof (through MARMML).” 2004–2006. Total award \$600,000 from DARPA IPTO.

“The SAGE Environment in Support of Novel Intelligence from Massive Data (NIMD Program).” 2002–2005. Total award approximately \$·,· · ·,· · · from ARDA. The NSA requests that award amounts be kept nondisclosed.

Honors, Awards, Appointments

AAAI 2008 Fall Symposium on Automated Scientific Discovery, *Co-Chair*.

Award for notable presentation given at SICoP, 2008.

Deans List, 2000-2004, Rensselaer Polytechnic Institute.

Upsilon Phi Epsilon, 2003, Rensselaer Polytechnic Institute.

Personal

Born 9/16/1981, Pittsburgh, PA. Married to Nicole Shilliday; Father of Liam Myles Shilliday (born, 9/11/2008).